IRENA
International Renewable Energy Agency

THE REPUBLIC OF TUNISIA

Renewables Readiness Assessment

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About IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future and serves as the principal platform for international co-operation, a centre of excellence and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy – including bioenergy, geothermal, hydropower, ocean, solar and wind energy – in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.

Acknowledgements

This report was prepared by IRENA in close collaboration with the Government of Tunisia, as represented by the Ministry of Industry, Energy and Mines and the National Agency for Energy Conservation (ANME).

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Renewables Readiness Assessment

Foreword

from the Minister of Industry, Energy and Mines

For over three decades, Tunisia has been committed to a clean energy transition through a proactive and uninterrupted energy management policy, positioning itself as a pioneer in the region. Tunisia embarked on an accelerated energy transition to achieve multiple objectives; to realise its energy security through a diversified energy mix and to improve the country's economic competitiveness within the framework of its strategic vision towards a low-carbon economy.

Tunisia's energy transition strategy is based on four main pillars: energy security; increasing energy independence; reducing costs; and diversifying energy resources. With abundant renewables sources, renewable energy technologies constitute the main pillar of Tunisia's energy transition strategy given the socio-economic benefits that this strategy will provide to the Tunisian economy in terms of increased investments, a clean economic growth, job creation and preserving the environment. Similarly, improving energy efficiency would contribute to this energy transition by reducing the demand for energy.

In this regard, a Tunisian solar plan was adopted in 2015, which aims to reduce primary energy demand by 30% and increase the share of renewables in the electricity production mix to 30% by 2030.

I would like to thank the International Renewable Energy Agency (IRENA) for its support throughout the process to deliver the Renewables Readiness Assessment report that provides a detailed analysis on the status of renewable energy in the country and identifies short- to medium-term actions needed to develop enabling frameworks conducive to increased renewable energy investments.

This analysis was conducted through close collaboration between the National Agency for Energy Conservation (ANME), the Ministry of Industry, Energy and Mines and IRENA. It provides relevant and focused information to all the stakeholders in the field of renewable energy, including governmental institutions, public and private-sector companies, and regional and international development organisations.

On behalf of the Ministry of Industry, Energy and Mines let me reiterate my thanks to, all the IRENA team members and national stakeholders who contributed to the completion of this report. I hope that this co-operation will be accelerated in the future, allowing the achievement of the Energy Transition goals in Tunisia.

H.E. Mr Mohamed Boussaîd,
Minister of Industry, Energy and Mines,
Republic of Tunisia

Foreword

from the IRENA Director-General

Tunisia's need to ensure a continuous energy supply, enhance energy security and long-term industrial and socio-economic development provides a compelling case for renewables. As governments advance on recovery plans amid significant public financing constraints, an energy transition with renewables is a central pillar of decarbonising the energy mix. With increasing cost-competitiveness and abundantly available resources, renewable energy solutions will be instrumental in achieving the objectives of improving energy security, reducing cost of energy supply for consumers and advancing environmental preservation.

Tunisia's energy transition is notably based on the implementation of an energy management strategy that is built on the increase of energy efficiency and the development of renewable energy, with a 30/30 target to reduce primary energy demand by 30% in 2030 compared to the trend scenario; and renewable energy to 30% of the electricity production by 2030, in comparison to the installed 373 MW renewable energy in 2019.

Renewables Readiness Assessment: Tunisia, prepared in collaboration with the National Agency for Energy Conservation (ANME) and the Ministry of Industry, Energy and Mines, identifies key challenges as the country pursues environmentally and economically sustainable power and heat. It offers recommendations under five thematic areas that address renewables applications in the power sector and long-term energy planning, and attract renewable energy financing. The recommended actions present the collective outcome of which is for renewables to reach a much higher share in Tunisia's energy mix while improving energy security and cost of supply.

Tunisia has made important strides over the past decade to encourage the involvement of the private sector and accelerate the realisation of national objectives, the assessment finds the need to improve the mapping of renewable energy resources, establish an energy planning framework with higher shares of renewables that building capacity of local financing institutions and developers will unlock further investment in the sector, and reinforce Tunisia's renewable energy targets.

IRENA wishes to thank the team at ANME for their key input and engagement. We also appreciate the valuable contributions of numerous other stakeholder and international partners. I sincerely hope the resulting study helps to accelerate Tunisia's shift to a sustainable energy future.

Francesco La Camera
Director-General,
International Renwable Energy Agency

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Abbreviations

ANME	National Agency for Energy Management *(Agence Nationale pour la Maîtrise de l'Energie)*
ANGED	National Waste Management Agency *(Agence Nationale de Gestion des Déchets)*
CSP	Concentrated Solar Power
CTER	Technical Commission for Independent Power Production from Renewable Energy *(Commission Technique de production privée de l'électricité à partir des Energies Renouvelables)*
DNI	direct normal irradiance
FTE	Energy Transition Fund *(Fonds de Transition Energétique)*
GDP	gross domestic product
HV	high voltage
IPP	independent power producer
IRENA	International Renewable Energy Agency
LV	low voltage
MIEM	Ministry of Industry, Energy and Mines *(Ministère de l'Industrie, de l'Energie et des Mines)*
MISME	Ministry of Industry and Small and Medium-sized Enterprises *(Ministère de l'Industrie et des Petites et Moyennes Entreprises)*
MEMTE	Ministry of Energy, Mines and the Energy Transition *(Ministère de l'Energie des Mines et de la Transition Enérgitque)*
MV	medium voltage
NDC	Nationally Determined Contribution *(national climate pledge under the Paris Agreement)*
O&M	operation and maintenance
PPA	power purchase agreement
PV	photovoltaic
RRA	Renewables Readiness Assessment
SDP	Strategic Development Plan
SME	small or medium-sized enterprise
STEG	Tunisian Company of Electricity and Gas *(Société Tunisienne de l'Electricité et du Gaz)*
SWH	solar water heating
TFEC	total final energy consumption
TND	Tunisian dinar
TPES	total primary energy supply
TSP	Tunisian Solar Plan
VRE	variable renewable energy

Units of measurement

GW	gigawatt
GWh	gigawatt-hour
kWh	kilowatt-hour
kWp	kilowatt peak
km	kilometre
km²	square kilometre
ktoe	thousand tonnes of oil equivalent
kV	kilovolt
m²	square metre
MW	megawatt
MWh	megawatt-hour
m/s	metres per second

Executive summary

Tunisia has witnessed growing deficits in its energy balance over the past two decades. This trend is largely the result of increasing energy consumption in all economic sectors, coupled with the decline of hydrocarbon production. This led to an energy deficit amounting to 50% in 2019 compared to 7% in 2010, thus leading the country to become more dependent on imported fossil energy.

The electricity generation mix is dominated by natural gas, while renewable energy resources represented only 3.0% in 2019. This strong dependence on natural gas has serious implications for Tunisia's energy security, since domestic production of gas has stagnated to the point of even declining in recent years.

In response to the energy security challenges of the early 2000s, and Tunisia's vulnerability to volatile international energy prices, the country has decided to embark on an energy transition process as part of its wider sustainable economic and social development strategy. Amid the coronavirus outbreak in early 2020, renewables and energy efficiency have become a key part of the country's recovery plans.

Tunisia's energy transition is notably based on:

- Diversification of the energy mix and integration of renewable energies
- Strengthening energy efficiency
- Rationalisation of the energy subsidy
- Strengthening of the grid and the interconnections

The implementation of an energy management strategy that is built on the increase of two components: (i) energy efficiency and the development of renewable energy, with a 30/30 target to reduce primary energy demand by 30% in 2030 compared to the trend scenario; and (ii) renewable energy to 30% of the electricity production by 2030.

The Tunisian Solar Plan (TSP) is the intended operational tool to implement the strategy to increase the share of renewable electricity. The latest TSP version was updated by Tunisia's National Agency for Energy Management (ANME – Agence Nationale pour la Maîtrise de l'Energie) in 2015 and adopted by the government in July 2016.

To achieve the country's update objectives, the TSP has established a target for total installed renewable energy capacity at 1 860 megawatts (MW) by 2023 and 3 815 MW by 2030, a five-fold and ten-fold increase, respectively, from the 2017 installed renewable energy capacity.

The targets were updated to reflect Tunisia's climate commitment to reduce the country's carbon intensity by 41% compared to 2010 by 2030 compared to an unconditional target to reduce carbon intensity by 13%, specifically as pledged in its Nationally Determined Contributions under the Paris Agreement. The bulk of the country's identified mitigation potential arises from the energy sector, including 68% from energy efficiency and 32% from renewable energy.

The considerable amount of installed renewable energy capacity needed to meet the targets set out in the TSP will require extensive private investment support. In response, the Tunisian state adopted regulatory reforms in 2015 through a new law (Law No. 2015-12) relating to the production of electricity from renewable energy. The objective is to establish a legal framework that is conducive to private-sector investment in the production of electricity that will arise from renewable energy sources through three new regulatory regimes: (i) self-generation/consumption; (ii) independent power production for local consumption (concession and authorisation); and (iii) independent power production for export.

Notwithstanding the new legal framework and the various measures adopted by the Tunisian government over the past two years, several of these measures include enabling policy initiatives, update of the current documentation surrounding current electricity purchase agreements, and establishment of guarantees to encourage the development of renewable energy. There remain several challenges that hinder the transition, however; these have been identified under Tunisia's national energy strategy.

Various barriers to renewable energy development were identified through the Renewables Readiness Assessment (RRA) process. These could be addressed through eight key recommended actions.

The RRA's main recommendations can be summarised as follows:

Establish a renewable energy planning and scheduling framework

- With the TSP calling for additions of about 4 gigawatts (GW) of variable renewable energy (VRE) sources (i.e. solar and wind power) to the grid, the country will require a holistic long-term planning methodology that will include realistic scheduling for capacity additions to the national electricity system beyond 2023. Advance plans on new capacity, locations and technologies can help to address system constraints. VRE deployment must be supported by robust long-term energy and power sector planning.

- The plan could also address electricity grid infrastructure development to enable the smooth integration of VRE into the system. The plan should provide long-term visibility on renewable energy development prospects in Tunisia. In this context, the opportunities for regional dialogue and collaboration are significant and may lead to broader flexibility solutions (IRENA, 2020a).

Enhance renewables resource assessment through zoning

- Long-term energy planning relies on data from resource databases. Tunisia's current resource database, therefore, should be improved to reflect the recent assessment campaigns on renewable energy resources. More detailed resource data will be essential to define promising development zones across Tunisia's territory for different renewable energy technologies. The Global Atlas for Renewable Energy, an online resource assessment platform hosted by the International Renewable Energy Agency (IRENA), provides guidance on identifying cost-effective zones with high renewable energy potential.

Simplify procurement procedures for power grid development

- The acquisition and implementation of grid transmission infrastructure by the Tunisian Company of Electricity and Gas (STEG) is subject to long-running public procurement procedures, resulting in a time lag between renewable energy plant completion dates and connection to the grid to send out the electricity produced.

- IRENA has established that integrated studies with key renewable energy stakeholders could help identify grid infrastructure scenarios. Such studies would reflect planned additions of both solar and wind capacity totalling 1000 MW under the Concessions scheme. This would ensure alignment between renewable generation development and grid infrastructure reinforcement.

Clarify institutional roles and strengthen human resources

- Private-sector developers have faced difficulties understanding the procedures to obtain authorisation for projects, given the considerable number of ministries and public institutions involved in renewable energy projects. In response, the Government of Tunisia has taken preliminary measures, supported by international partners in the field, such as the United Nations Development Programme. Measures include a Help Desk provided by the ANME that would provide guidance to the private sector.

- IRENA has found that combining efforts and creating a single online platform may ensure transparency and clarity of the roles of the various involved institutions in terms of project agreements. The platform would include guidelines under a standard template and would list the public institutions involved, including the roles and responsibilities of each during the various stages of project implementation (Section 4.3).

COVID-19 pandemic recovery

Amid the coronavirus outbreak in early 2020, renewables and energy efficiency have become a key part of the country's recovery plans.

- Renewable energy transition will bring with it ample benefits, including the opportunity to build human resources and skills. In this context, public institutions may opt to strengthen their current human capacity through enhanced training sessions on the technical, economic, administrative and legal aspects relating to the development of renewable energy projects.

Establish an independent electric power regulator

- The procedures to create and establish an independent regulatory authority for the electricity sector are being finalised as part of Tunisia's NDCs to ensure the achievement of its renewable energy targets. The authority will ensure compliance with regulations and will promote a transparent and fair competitive environment for private producers.[1]

- The regulatory authority will, among other responsibilities, oversee a range of project development procedures for renewable energy, including the monitoring of legislation to ensure effectiveness and the validation of technical conditions for electricity evacuation. It also will ensure the streamlining of not only the governing administration but also of the various market actors.

Operationalise the Energy Transition Fund

- The Energy Transition Fund (FTE – Fonds de transition énergétique) is the principal financing tool for energy efficiency and renewable energy activities in Tunisia. For the fund to effectively support renewables in the country, work must begin to mobilise the necessary funding from the public and private sectors to foster their development. To do this effectively will require a combination of incentives, loans and credit lines from international finance institutions.

Create a dedicated financing mechanism for solar water pumping

- Design a programme encouraging farmers to substitute solar photovoltaic (PV) energy for diesel, given the important socio-economic impacts of solar water pumping. This programme may be developed under the broader Prosol and Prosol électrique programme mechanisms, such that the state subsidy, including the credit system, is compatible with the repayment capacity of farmers.

Involve local banks in the financing of renewable energy

- The development of renewable energy applications in Tunisia, particularly for farmers and small- and medium-size enterprises, requires involvement by local banks. To improve the capacity for project risk assessment at local financial institutions and boost their confidence to develop lending schemes, the government should reinforce their human and technical capacity.

- The search for favourable foreign financial lines should be strengthened, particularly through bilateral co-operation and climate financing programmes guaranteed by the Tunisian Guarantee Company (Société tunisienne de garantie)[2] or reinforced by the Central Bank of Tunisia. This should reduce concerns that surround private sector investment risk over the need to commit 30% equity for PV installations and thus improve financial viability.

- The Energy Transition Fund, Tunisia Investment Authority and Tunisian Guarantee Company can be complemented with guarantee funds or secure credit lines (e.g. liquidity guarantees or credit lines) to local commercial banks by international finance institutions like the French Development Agency (AFD) and International Finance Corporation.

1 Several international partners are working with ANME to establish an electricity regulatory authority to oversee licenses, power grid connections and third-party access for auto producers.

2 A public interest company that guarantees various loans granted to small- and medium-size enterprises by credit institutions.

Introduction

1.1 Country background

Tunisia is located in the northernmost part of Africa. Tunisia's capital, Tunis, is in the northeast of the country. The total surface area coverage of Tunisia is 163 610 square kilometres (km^2), with arable land constituting 19% of total land area (Trading Economics, 2020) and the Sahara representing more than 30% (RES4MED, 2016).

The population of Tunisia in 2017 reached 11.54 million, with an annual growth rate of 1.1%. Total urban population is 69% (INS, 2018a).

Tunisia benefits from unique climatic features, placing the country as an emerging economic hub and attractive tourist destination. The climate varies considerably from one region to another - Mediterranean in the north and along the coast, semi-arid within the country and arid in the south. The landscape similarly contrasts, with mountainous regions in the northwest, steppes in the centre, vast plains in the north, the Sahel to the east and desert in the south.

Tunisia had an average annual gross domestic product (GDP) growth rate of 4.3% over the period 2000–2010, and was considered the most competitive economy in Africa. Despite political instability, Tunisia has witnessed a rapid recovery of its GDP growth following a recession in 2011, reaching 4.0% in 2012. Since then, however, it has struggled to maintain this level, with a 2.6% growth rate in 2018. The evolution of GDP growth since 2000 is shown in Figure 1.

Figure 1. **Gross domestic product growth: Annual change, Tunisia, 2000–2018**

Source: Trading Economics (2020).

Table 1. **Main economic indicators, Tunisia, 2015–2018**

	2015	2016	2017	2018
Investment rate (% of GDP)	19.9	18.4	19.3	20.4
Unemployment rate (%)	15.4	15.5	15.5	15.5
Rate of coverage (exports/imports in %)	69.7	69.8	68.8	69.2
Budget deficit (% of GDP)	4.8	6.2	5.9	4.6
Government debt (% GDP)	55.4	61.9	69.9	71.4

Source: Central Bank of Tunisia (2018).
Note: GDP = gross domestic product; GNDI = gross national disposable income.

Several factors challenge the national economic situation today, including the devaluation of the Tunisian dinar, thus amplifying the public debt and foreign trade deficit to record highs. As of September 2018, Tunisia has a public debt of 71.4% relative to GDP, with a foreign trade deficit that widened by 16.8% over 2017 (Trading Economics, 2020). Table 1 presents further details on the economic indicators recorded in Tunisia during the last few years.

Tunisia has undertaken a series of reforms, including a Strategic Development Plan (SDP) that was adopted for the period 2016–2020 to boost economic activity and investment, as well as to reassure stakeholder confidence. The SDP represents a new development model that is based on the promise of a new social contract under which the state is expected to provide a level playing field to ensure inclusion and equal opportunity.

The main objective of the SDP is the transformation and modernisation of Tunisia's existing economic model, aiming to reduce unemployment to 11.5% and reach an average GDP growth rate of 5% in 2020.

Box 1. Five pillars of Tunisia's Strategic Development Plan, 2016-2020

- **Good governance** includes fighting corruption and easing the administrative barriers to economic participation, in order to increase opportunities for success for all citizens.
- **Shifting to a hub economy** focuses on increasing productivity for competitiveness and positioning Tunisian businesses in global value chains.
- **Promoting human development and social inclusion** emphasises quality education, women's participation in economic and political activity, improved health outcomes, and a social protection system.
- **Tackling regional disparity** seeks to achieve the ambitions of economic development in rural regions through advancing investment in infrastructure and supporting entrepreneurship.
- **Promoting green growth for sustainable development** to ensure the sound utilisation of natural resources, with emphasis on rationalising water and energy use.

1.2 Renewables Readiness Assessment for Tunisia

The International Renewable Energy Agency (IRENA) developed the Renewables Readiness Assessment (RRA) as a tool for carrying out a comprehensive evaluation of the conditions for renewable energy deployment in a country. The RRA is a country-led and consultative process. It provides a framework for multi-stakeholder dialogue to identify challenges to renewable energy deployment and to arrive at recommendations to overcome existing barriers. Short-and medium-term recommended actions are presented to governments to guide the formation of new policies or the reform of existing ones, thus opening a more enabling environment for renewable energy. The RRA also consolidates existing efforts and mobilises resources for priority actions.

The RRA elaboration process was launched at the request of the previously known Ministry of Energy, Mines and Renewable Energy (Ministère de l'Energie des Mines et des Energies Renouvelables), now known as Ministry of Industry, Energy and Mines. However, from March 2020 to October 2020, renewable energies were taken up by the Ministry of Energy, Mines and the Energy Transition (Ministère de l'Energie des Mines et de la Transition Enérgitique). From September 2018 to March 2020, renewable energies were taken up by Ministry of Industry and Small and Medium Enterprises (MISME – Ministère de l'Industrie et des Petites et Moyennes Entreprises,).[3]

IRENA developed this RRA assessment for Tunisia in conjunction with the National Agency for Energy Management (ANME – Agence Nationale pour la Maîtrise de l'Energie), the public agency responsible for executing the government's policies in energy management studying and promoting renewable energy.

Applying the RRA framework to Tunisia provides a comprehensive analysis of the presence or absence of enabling conditions for the development of renewables.

Crucially, the analysis considers how the country's renewable energy policies can contribute to its national policy objectives. This coincides with the government's efforts to assess the context for renewables in Tunisia, particularly since the introduction of the country's renewable energy action plan, the Tunisian Solar Plan (TSP), was put in place in 2015. The RRA highlights the key issues to be tackled in implementing the TSP, with the aim of recognising Tunisia's positionas a regional hub economy as part of the broader framework of the SDP.

A general overview of the Tunisian energy sector was outlined during the first stage of process, with a special focus on renewable energy. Potential barriers and bottlenecks were identified to the ensure successful deployment of renewables. IRENA and ANME organised an expert validation workshop on 21 June 2018 to validate these findings and facilitate open dialogue among a wide range of stakeholders. The main objectives were to discuss the identified challenges for renewable energy deployment and the corresponding recommendations to ensure favourable conditions for the sector.

The event provided the opportunity to review global renewable energy best practices and highlight the country's commitments to renewable energy. It enabled local stakeholders to validate the set of recommended actions identified through the RRA process to further advance the renewable energy sector, for endorsement by MEMTE. This report lays out the necessary actions and conclusions drawn from the RRA process in Tunisia.

3 Given the role of the different institutions in renewable energy governance, citations within the report are referenced to the Ministry of Industry and Small and Medium Enterprises and the Ministry of Energy, Mines and Renewable Energy.

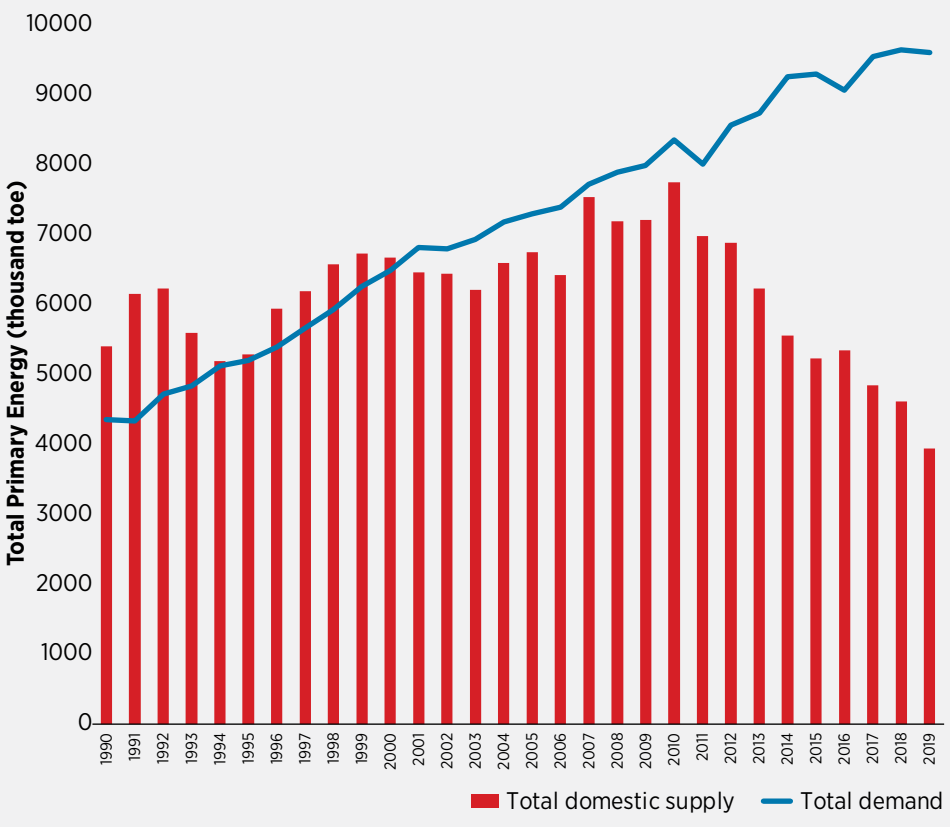
Meteline – Kchabta wind park in Bizerte
Photograph: National Agency for Energy Conservation (ANME)

Energy Context

The energy sector is a key contributor to Tunisia's various economic sectors. In the past two decades, however, the country has witnessed a growing energy balance deficit, largely as a result of relying on fossil fuel sources – oil and natural gas – to meet its heightened energy demand. The decline of its own hydrocarbon resources has led to increased dependence on fossil fuel imports, which rose to record levels in 2019 when the deficit in the balance of primary energy reached 5 672 thousand tonnes of oil equivalent (ktoe), as shown in Figure 2, highlighting that 49% of total energy consumed is imported.

In response, Tunisia has begun to leverage its wide array of renewable energy sources to diversify its energy mix. This is coupled with energy efficiency programmes to alleviate its energy balance deficit.

Figure 2. **Evolution of domestic primary energy supply and demand, Tunisia, 1990–2019**



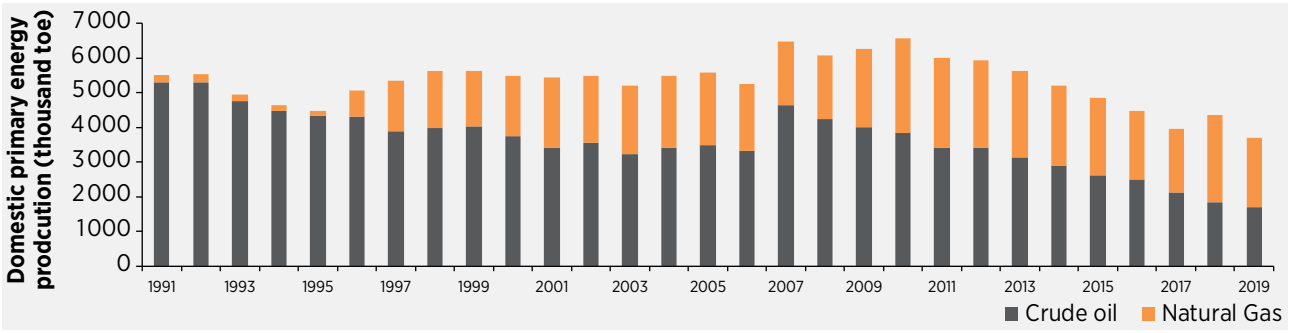
Source: (MISME, 2019a)

2.1 Energy supply and demand in Tunisia

The country is close to being fully electrified at 99.8%. The electricity generation mix is dominated by natural gas at 97.5%. The strong dependence on natural gas has serious implications for Tunisia's energy security, as domestic production of natural gas has stagnated and even declined during recent years. Between 1990 and 2019, primary energy production fell from 5 400 ktoe to 3 703 ktoe. Domestic production of oil and natural gas has dropped significantly since 2010 (54% and 47%, respectively), as shown in Figure 3.

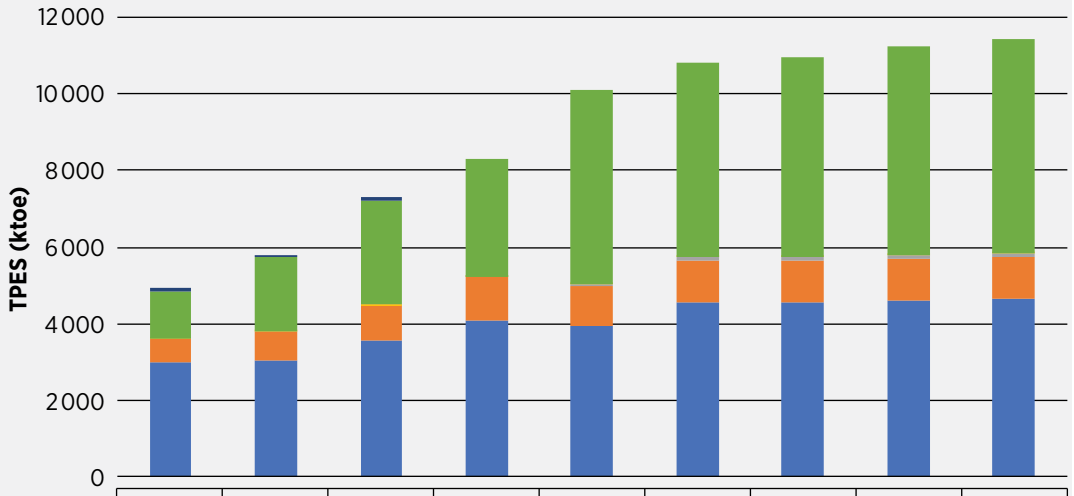
In 2018, natural gas accounted for 48.7% of total primary energy supply (TPES), equivalent to 5 569 ktoe, and oil (including primary and secondary oil) accounted for 40.8 % of TPES, totalling 4 665 ktoe (Figure 4) (MISME, 2018b). The remainder largely came from biomass and waste sources.

Figure 3. **Domestic primary energy production of crude oil and natural gas, Tunisia, 1991–2019**



Sources: INS (2018a), MISME (2019a).

Figure 4. **Total primary energy supply (TPES) by source, Tunisia, 1990–2018**



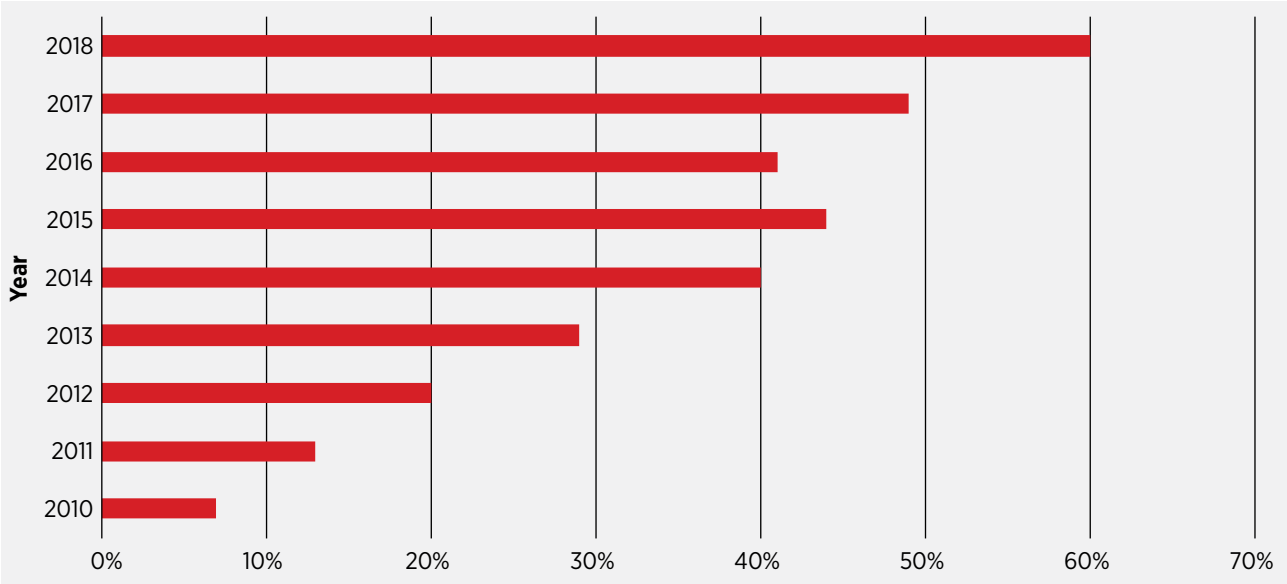
	1990	1995	2000	2005	2010	2015	2016	2017	2018
Coal	82	71	79	0	0	0	0	0	0
Natural Gas	1 234	1 924	2 732	3 091	5 083	5 055	5 209	5 436	5 569
Nuclear	0	0	0	0	0	0	0	0	0
Hydro	4	3	6	12	4	6	4	2	1
Geothermal, solar, wind	0	0	2	4	39	89	100	103	103
Biofuels and waste	638	750	934	1 121	1 058	1 076	1 081	1 082	1 090
Primary and secondary oil	2 989	3 053	3 554	4 087	3 933	4 573	4 552	4 612	4 665

Sources: INS (2018a), MISME (2019a).

Primary energy demand reached 9 606 ktoe in 2019 against 8 358 ktoe in 2010, with an average annual growth rate of 1.7%. After a dip in 2016, the energy demand/supply balance deficit accelerated again in 2017, strengthening a major structural deficit that compels the country to further rely on energy imports, increasing from an import dependency rate of 7% in 2010 to 60% in 2018, as shown in Figure 5.

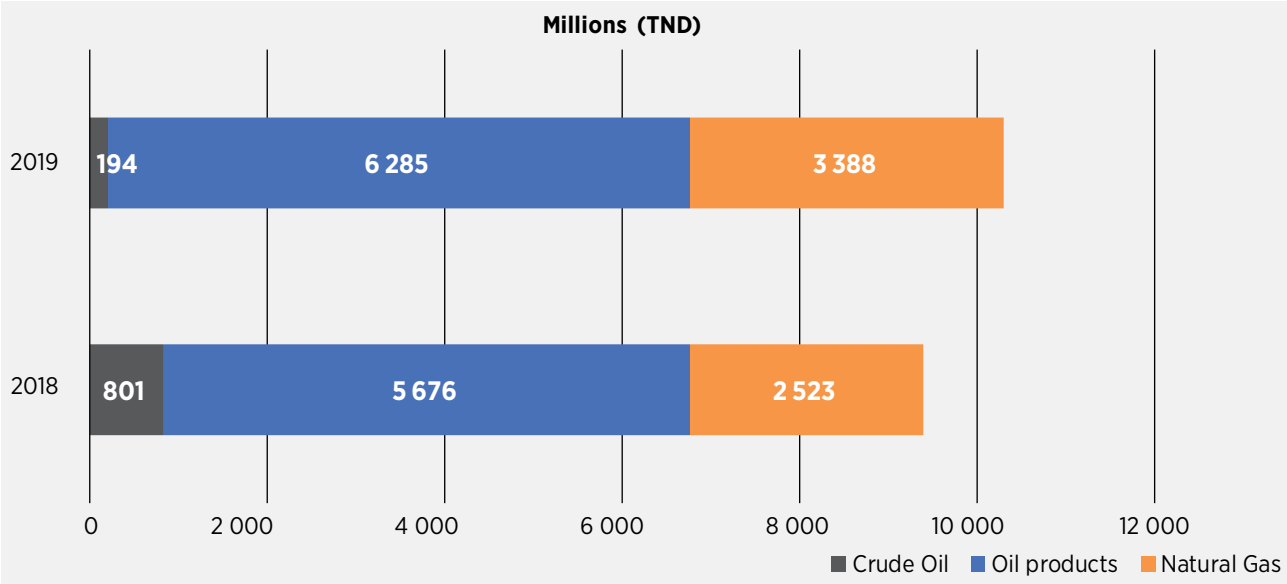
The country's energy deficit problem is likely to deteriorate further given rising energy demand, coupled with depleting oil and gas production. The current increase in energy imports highlights Tunisia's economic and social vulnerability amid volatile international energy prices, further amplified with the devaluation of the Tunisian dinar (TND). Figure 6 shows the evolution of the energy import bill, which peaked in 2014 at more than TND 7 billion (over USD 3.5 billion at the time or USD 2.5 billion at mid-2019 exchange rates).

Figure 5. **Energy import dependency, Tunisia, 2010–2018**



Sources: ONE (2018a), MISME(2019b).

Figure 6. **Energy import bill, Tunisia, 1993–2017**

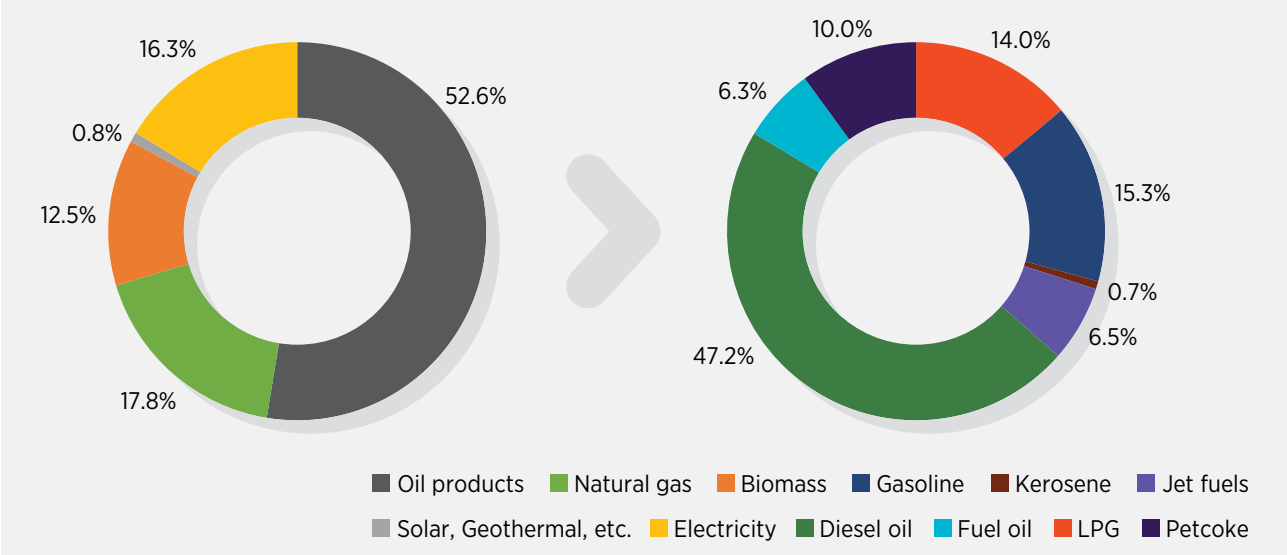


Source: INS (2018b).

According to the National Energy Observatory (Observatoire National de l'Energie),[4] total final energy consumption (TFEC) reached approximately 8 710 ktoe in 2019; excluding biomass,[5] it amounted to 7 620 ktoe. Oil products accounted for 53% of TFEC, followed by natural gas and electricity in equal shares, as shown in Figure 7.

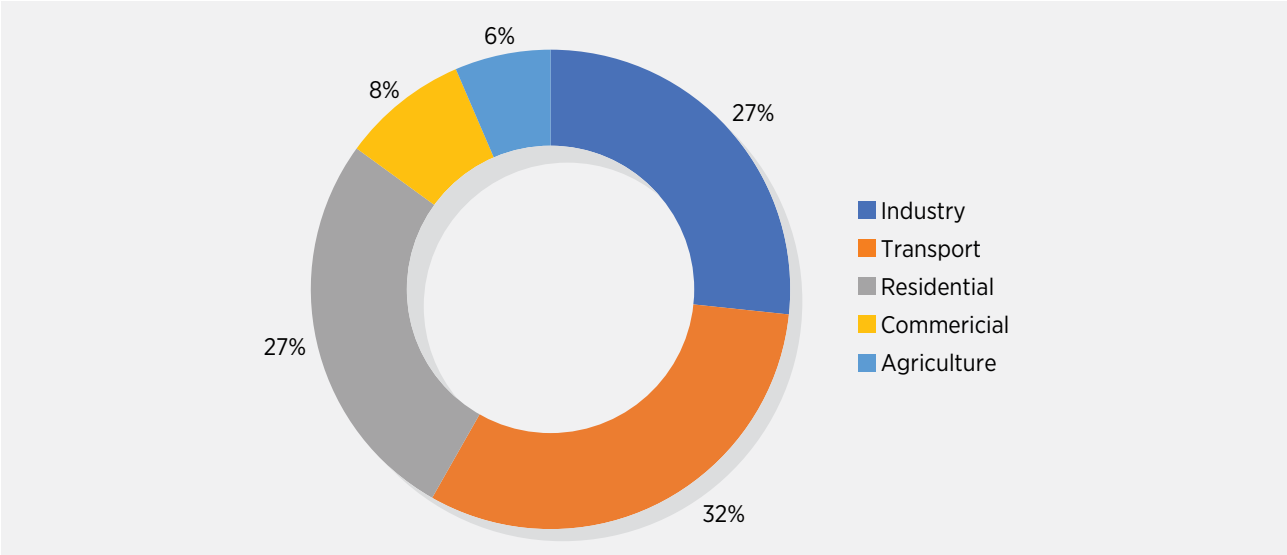
Energy is used in various end-use sectors in the economy, including transport (32%), industry (27%) and the residential sector (27%). This is followed by the commercial and agricultural sectors (8% and 6%, respectively), as shown in Figure 8.

Figure 7. **Total final energy consumption, Tunisia, 2018**



Source: MISME (2018b).
Note: LPG = liquefied petroleum gas.

Figure 8. **Total final energy consumption by sector, Tunisia, 2018**

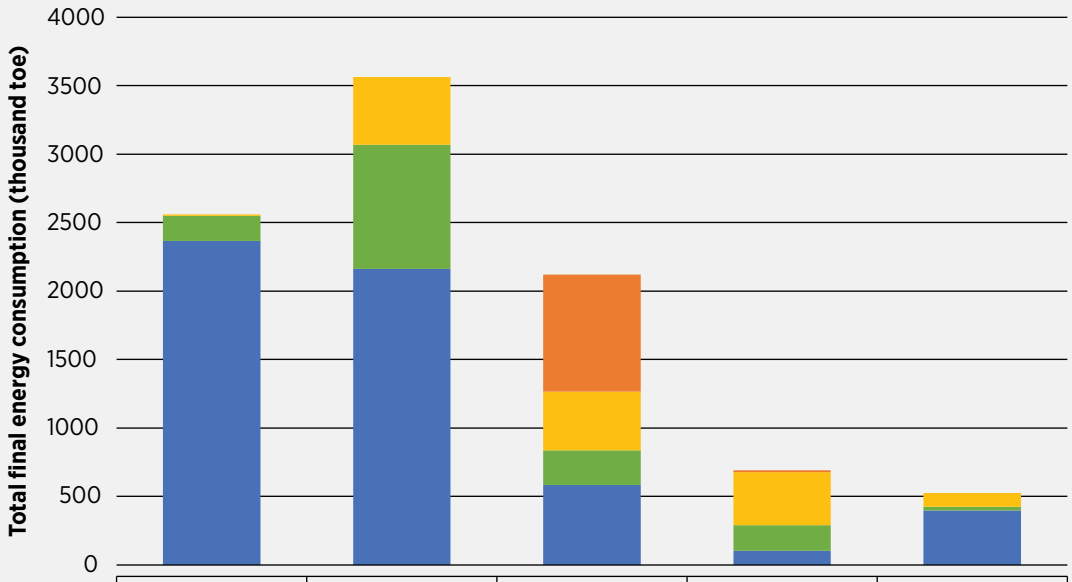


Source: IEA (2019), MISME (2019b).

4 The National Energy Observatory is the public institution mandated by MEMTE to ensure the effective collection of data relevant to energy. Since April 2017, it has been renamed the National Observatory of Energy and Mines (Observatoire National de l'energie et des Mines).

5 Biomass in the Tunisian context mainly relates to modern means of biomass, as defined by the International Energy Agency's statistics database, used in relation to Tunisia's residential sector (Figure 9).

Figure 9. **Total final energy consumption by source and sector, Tunisia, 2018**



	Transport	Industry	Residential	Commercial and public services	Agriculture
Biofuels and waste	0	0	855	12	0
Electricity	9	493	430	387	100
Natural Gas	185	907	252	190	26
Oil Products	2364	2162	583	101	398

Source: IEA (2019), MISME (2019a).

The source of TFEC differs from one economic activity to another. Figure 9 shows that natural gas is consumed mainly by the industrial sector, while the energy consumption of the agricultural, residential and transport sectors is dominated by petroleum products, particularly liquefied petroleum gas in households that are not connected to the natural gas distribution network.

2.2 Electricity governance

As of March 2020, the Tunisian electricity sector is managed by the Ministry of Energy, Mines and the Energy Transition. For the past two years, renewable energy portfolio was managed by the Ministry of Industry, Small and Medium Size Enterprises. MEMTE is responsible for electricity infrastructure, planning and the implementation of national policy in the field of electricity, energy efficiency and renewable energy, with regulatory oversight also carried out by the ministry. Yet, Tunisia has no independent regulator. Instead, MEMTE monitors and analyses the evolution of supply and demand, with two directorates responsible for carrying out specific activities in the energy sector:

- **Directorate General for Electricity and Renewable Energy:** Responsible for implementing state policy in the renewable energy sector and examining requests for private production and self-consumption of electricity from renewable energy.
- **Directorate General for Energy from Hydrocarbon sources:** Re-sponsible for implementing state policy in the hydrocarbon sector.
- **Directorate General for overseeing Strategy and Co-ordination:** Responsible for developing programmes and strategies, as well as national and sectoral policies, pertaining to the energy sector, coupled with action plans to ensure better management of resources.
- **Directorate General for Manufacturing Industries:** Responsible for implementing government policy relevant to industry, including development of an enabling environment for the promotion of the renewables industry.

The monopoly on electricity generation, transmission and distribution from 1962 to 1996 was held by the Tunisian Company of Electricity and Gas (STEG – Société Tunisienne d'Electricité et du Gaz). STEG is a state-owned company responsible for managing the production, transmission and distribution of electricity and gas in Tunisia in high-, medium- and low-voltage lines and pipelines, including the implementation and operation of renewable energy projects.

ANME, a public institution under the Ministry of Energy, Mines and the Energy Transition, became responsible as of 1985 for executing the government's policies for promoting energy efficiency measures and the deployment of renewable energy. Moreover, ANME is responsible for proposing regulations and manages the Energy Transition Fund (FTE – Fonds de transition énergétique). ANME's additional responsibilities include managing the specific renewable energy programmes (i.e. Prosol and Prosol électrique) and developing awareness and training campaigns for the deployment of renewable energy.

The **High Commission for Independent Power Production** (Commission Supérieure de la Production Indépendante d'Electricité), a commission established under Law No. 96-27, was organised as an inter-ministerial body responsible for deciding on the procedures and selection criteria for the public tender process to (i) select independent power producers (IPP); (ii) award contracts to IPPs; (iii) pass rulings on granting tax incentives to IPP investors, the benefits from which are to be granted to the developers of concessions; as well as any other matter relating to independent power production.

The **Interdepartmental Commission for Independent Power Production** (Commission Interdépartementale de la Production Indépendante d'Electricité), an inter-ministerial body serving as a de facto regulator, is responsible for suggesting the terms and conditions to be granted to IPP concession developers, reviewing the reports and examination of tenders submitted for decision to the High Commission for Independent Power Production, monitoring the negotiations for concession awards and securing public subsidies on a case-by-case basis. Moreover, the Interdepartmental Commission for Independent Power Production is responsible for proposing the extension of concession benefits and overseeing matters relevant to the implementation of projects submitted by the Ministry of Energy, Mines and Renewable Energies.

The **Technical Commission for Renewable Energy** (CTER – Commission Technique des Energies Renouvelables) approves power generation projects from renewable sources, subject to the system of authorisation under the Ministry of Energy, Mines and Renewable Energies while approving extensions to the validity of authorisations. In addition, CTER is the entity responsible for verifying the feasibility of developing private renewable projects on lands belonging to the state domain. It also examines all queries and concerns relevant to the production of electricity from renewable energy resources.

Law No. 96-27 (April 1996) authorises the private generation of electricity through concessions provided by state authorities. It does not allow, however, unsolicited private power production (either from conventional or renewable sources). Only one concession agreement has been granted, authorising the creation and operation of Tunisia's first IPP (Carthage Power Company in Radès, 471 megawatts (MW)). This power station began operation in 2002 under a 20-year power purchase agreement (PPA). A private initiative to generate electricity from flared gas led to a change in legislation, thus paving the way for the second concession agreement and Tunisia's second IPP (Société d'Electricité d'El Bibane, SEEB, 27 MW) commissioned in 2003 in El Bibane, southern Tunisia, and shut down in 2010 due to unforeseen gas supply contamination and the struggle to meet scheduled loan repayments. As of February 2018, the concessions are operationalised by Power Turbine Tunisia.

Law No. 2015-12 sets the framework for renewable energy proliferation, which includes electricity production from renewable energy to generate electricity, transport the generated electricity to other consumption points through the national grid, and sell the excess produced energy to STEG at fixed prices within the limits of the maximum rate. With that said the law introduced three new regulatory regimes: (i) self-generation/ consumption; (ii) independent power production for local consumption (concession and authorisation); and (iii) independent power production for export. The fixed prices are set by the Minister in charge of energy - in this case MEMTE - on opinion of the technical commission, with a contract subject to approval by MEMTE.

Law No. 2015-12, however, was amended by **Law 2019-47**, dated 29 May 2019, with adjustments to allow for corporate PPAs. This provides the right for companies adopting renewables for self-production to sell electricity to other consumers or companies with subscribed power greater than the threshold set by MEMTE electricity 30% and use the national grid network to transport electricity.

2.3 Electricity supply and demand

By the end of 2018, total installed power generation capacity had reached 6 147 MW, of which STEG owns and operates 74.6% (4 587 MW). The remainder includes the natural gas combined-cycle IPP, commissioned in 2002 and managed by Carthage Power Company, with an installed capacity of 471 MW. Natural gas accounts for 94.5% of domestic installed power capacity. See modifications in Table 2. The evolution of the power generation capacity during the period 2016-2018 and its composition are detailed in the table.

Electricity production by STEG and Carthage Power Company during the period 2013–2018 increased from 16 995 gigawatt-hours (GWh)/year to 19 060 GWh/year (STEG, 2019a), recording an average annual growth rate of 3%.

In this context, domestic production of natural gas stood at approximately 2 139 ktoe, equivalent to 58% of the country's overall electricity production needs. With domestic natural gas production declining, Tunisia's energy security could face serious challenges in the coming years.

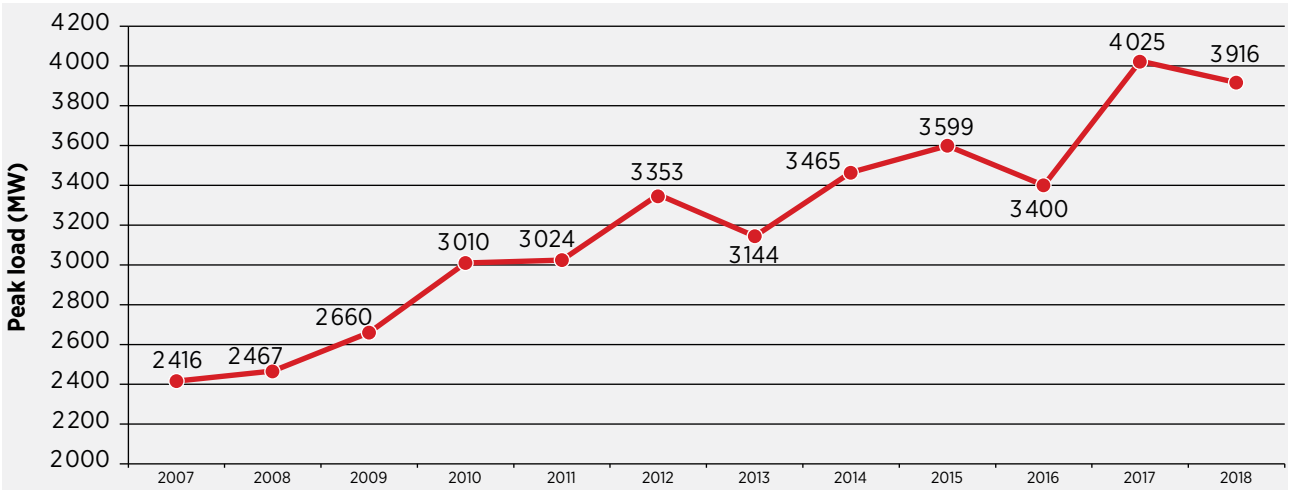
Tunisia's peak load has experienced robust growth during the past decade, as shown in Figure 10. The annual peak in electricity demand increased from 2 172 MW in 2005 to 4 025 MW in 2017 (STEG, 2018a), climbing at an average pace of 161 MW/year and with an average annual growth rate of 5.5%. In 2018, however, the peak load dropped due to heightened energy efficiency measures. Since 2000, peak load demand has transitioned from the winter period at night to the summer season in the day due to an increase in residential and commercial space cooling.

Table 2. **Composition of net power generation capacity, Tunisia, 2016 - 2018,**

Types of equipment		2016	2017	2018
Tunisian Company of Electricity and Gas	Steam turbines	1 020	920	660
	Combined-cycle gas turbines	1 639	1 612	1 612
	Open-cycle gas turbines	1 772	2 004	2 004
	Hydro	62	62	66
	Wind	240	240	245
Total STEG		4 753	4 838	4 587
Solar rooftop*		36	45	62
Independent power producer		471	471	498
Total installed capacity (MW)		**5 260**	**5 315**	**6 147**

* Based on interviews conducted with National Agency for Energy Management (Agence Nationale pour la Maîtrise de l'Energie) and Tunisian Company of Electricity and Gas (STEG – Société Tunisienne de l'Electricité et du Gaz).

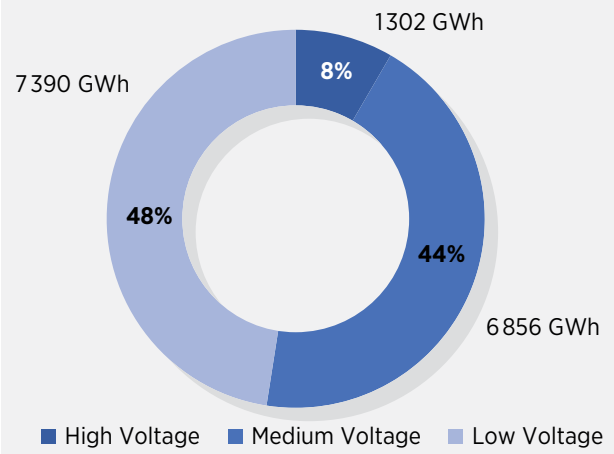
Figure 10. **Annual peak load (MW), Tunisia, 20017- 2018**



Source: STEG (2019a), STEG (2018a); STEG (2016).

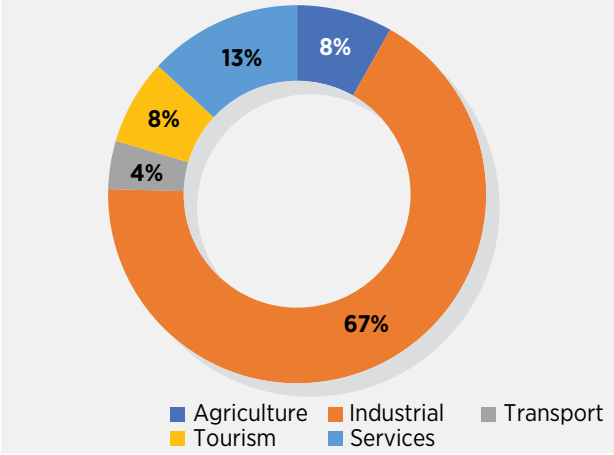
Electricity consumption increased from 10 355 GWh in 2005 to 15 671 GWh in 2018, recording an average growth rate of 4% per annum. Despite Tunisia's slowdown in economic growth, the industrial sector remains the largest consumer of electricity. Its share of total electricity consumption, has increased from 45% in 2005 to 67% in 2018. Since 2013, the largest growth in consumption has been recorded by STEG customers connected to the low-voltage (LV) grid, accounting for 47% of the electricity consumed in 2017. Figure 11 illustrates the evolution of electricity consumption for the different economic sectors during the period 2005-2018.

Figure 11. **Evolution of electricity consumption by voltage level, Tunisia, 2018**



Source: STEG (2019a).

Figure 12. **Evolution of electricity consumption in high-voltage and medium-voltage levels by economic sector, Tunisia, 2018**



Source: STEG (2019a).

2.4 Transmission and distribution

STEG operated about 6 906 kilometres (km) of transmission lines in 2018, with 208 km at the 400 kilovolt (kV) level, 2 910 km at the 225-kV level, 2 382 km at the 150-kV level and 1 406 km at the 90-kV level. The rate of loss on the transmission grid reached 2.3% in 2018, as in 2017 (STEG, 2019a).

The transmission grid is currently interconnected via one 400 kV line, two 225 kV lines, one 150 kV line and two 90 kV lines. Tunisia also has two 225 kV interconnections. Electricity trade with countries in the region represents less than 1% of national consumption and the interconnections are used mainly for reliability and emergency purposes (STEG, 2019a).

To expand interconnections and the capacity of the national grid for renewable energy absorption, an infrastructure project known as ELMED has been signed to build an underwater interconnection line with a capacity of 600 MW between Tunisia and Italy (400 kV, direct current, about 200 km).

Tunisia's electricity distribution network totalled 175 389 km by the end of 2018, including 59 691 km medium-voltage (MV) lines and 115 698 km LV lines. The number of MV/LV transformer substations reached 75 065 in 2018. Tunisia has an electrification rate estimated at 99.8%. The number of STEG customers connected to the electricity grid is 4.05 million (high voltage (HV): 21 customers; MV: 19 291 customers; LV: 4 030 130 customers) (STEG, 2019a).

2.5 Electricity tariffs

The selling price of electricity supplied to consumers is set by the Tunisian government based on a proposal submitted by STEG and after approval of MEMTE and the Ministry of Finance. The underlying principle of the electricity tariffs is the level of the supply voltage.

LV tariffs depend on the sector of the consumer (residential or non-residential), monthly consumption (in kilowatt-hours (kWh)) and the level of power contracted (in kilovolt amperes). The two LV consumer categories are defined in Table 3. Tariff prices for the LV network are presented in Table 4 for the respective categories.

Table 3. Low-voltage tariff categories, Tunisia

Low-voltage tariff categories	
Economic Category	Normal Category
Level of power supply: ≤ 2 kVA	Level of power supply: > 2 kVA
Monthly electricity consumption is up to 200 kWh	Monthly electricity consumption goes beyond 200 kWh
Electricity billing is based on progressive tranches with monthly consumption (1–50 kWh; 51–100 kWh; 101–200 kWh)	Electricity billing is based on progressive tranches with monthly consumption (1–200 kWh; 201–300 kWh; 301–500 kWh; greater than 500 kWh)

Source: STEG (2019a).
Note: kVA = kilovolt ampere; kWh = kilowatt hour.

Table 4. Current tariffs for low-voltage network, Tunisia, June 2019

Tariff*	Sector	Power charge (USD/kVA/month)	Energy price (USD/kWh) Range of monthly consumption (kWh/month)					
			1–50	51–100	101–200	201–300	301–500	501 +
Economic Category (1 and 2 kVA and consumption ≤ 200 kWh/month)	Residential	0.24	0.022					
	Non-residential		0.0322					
			0.035					
Economic Category (1 and 2 kVA consumption > 200 kWh/month) Normal Category (> 2 kVA)	Residential	0.24	0.059			0.073	0.114	0.139
	Non-residential		0.065			0.081	0.117	0.131

Source: STEG (2019b).
Note: USD = U.S. dollar; kVA = kilovolt ampere; kWh = kilowatt-hour.
* TND 1 = USD 0.355 (July 2020).

Table 5. Time schedule for Four-shift tariff, Tunisia

Time schedule	September to May	June to August
Day	07:00–18:00	06:30–08:30; 13:30–19:00
Morning peak summer	–	08:30–13:30
Evening peak	18:00–21:00	19:00–22:00
Night	21:00–07:00	22:00–06:30

Source: STEG (2019b).

For MV subscribers, there are two main tariffs: Uniform tariff and the Four-shift tariff.

Under the Four-shift tariff, the price per kWh varies according to the time of electricity consumption. The distribution of the four shifts (day, morning peak summer, evening peak and night) differs between seasons, as shown in Table 5.

In addition to the two main tariffs, three special tariffs exist for irrigation services in water pumping and agriculture alike, as well as emergency services. These are shown in Table 6. Electricity sold to farmers for water pumping is the least expensive.

Table 6. **Medium-voltage tariffs, Tunisia, June 2019**

Tariff	Power charge (USD*/kW/ month)	Energy price (USD/kWh)			
		Day	Morning peak summer	Evening peak	Night
Uniform	1.68		0.084		
Four-shift	3.69	0.081	0.123	0.110	0.063
Pumping for irrigation**	NA	0.094	NA	Cut-off	0.076
Agricultural irrigation	NA	0.064	Cut-off	0.0663***	0.046
Emergency services	2.01	0.086	0.137	0.122	0.067

Source: STEG (2019a).
Note: NA = not applicable; USD = U.S. dollar; kW = kilowatt; kWh = kilowatt-hour.
* TND 1 = USD 0.355 (July 2020).
** Pumping for irrigation tariff refers to the irrigation service charges (water tariffs) that are no longer applicable.
*** During the winter months, from September to May, the tariff is not considered. The tariff applies only during peak summer hours.

Solar PV sites in Tunis
Photograph: National Agency for Energy Conservation (ANME)

In addition to the above tariffs, there were natural gas tariffs for grey cement industries. These related to high pressure and medium pressure lines (Table 7).

For HV users, only the four-shift tariff is available. This holds the distinction of being considered a special tariff for emergency scenarios, as shown in Table 8.

Due to increased natural gas imports, electricity selling prices in Tunisia have been subject to several rises. These price adjustments are not periodic and depend on the evolution of oil prices and the exchange rate of the local currency.

Prices also depend on government policies, including those wherebysubsidies are provided by the state to the energy sector.

The increases during the past decade have been significant and have affected all electricity consumers, apart from low-consumption households. As an indication, Figure 13 presents the evolution of the price of electricity sold to those companies connected to the MV grid with the Uniform tariff. For this category, the total increase stands at about three times those of 2010 prices.

Table 7. Medium-voltage tariffs for grey cement industry, Tunis

Tariff	Subscribed flow (MJ/h)	Subscription fee		Price of Energy	
		(USD/month)	(USD/MJ-h-month)	Indexation formula	Energy price*
High pressure	≥ 41 868	105.99	0.06	1 xP_g	0.020
Medium pressure	4 187 – 125 604	7.1	0.21	1.032 xP_g	0.020

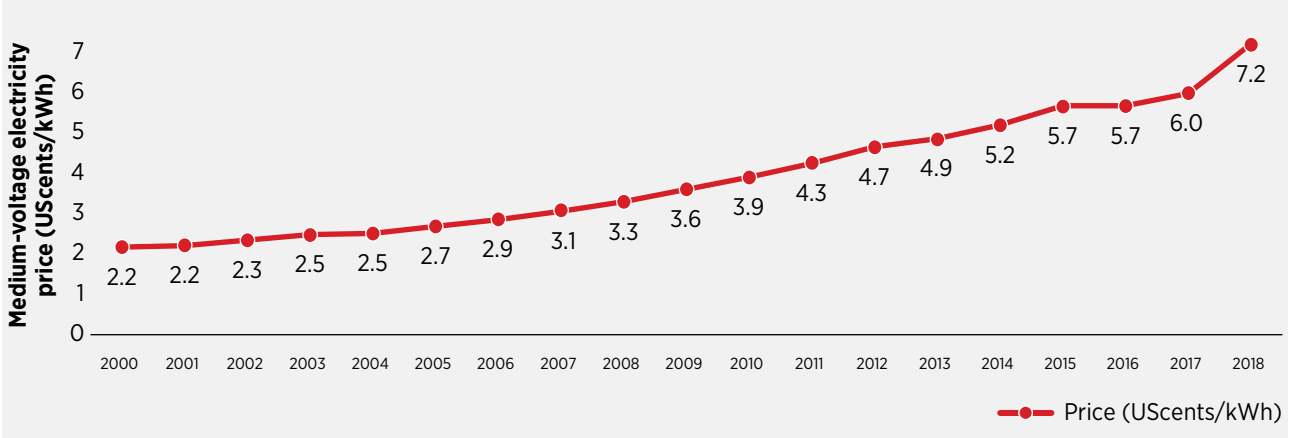
P_g=purchase of natural gas in units of $\frac{millimes}{thermies}$
Note: MJ = megajoule; h = hour; USD = U.S. dollar;
* Price of energy based on the purchase price of natural gas of 0.005 (USD/MJ).

Table 8. High-voltage electricity tariffs, Tunisia

Tariff	Power charge (USD/kW/month)	Energy price (USD/kWh)			
		Day	Morning peak summer	Evening peak	Night
Four-shifts	3.35	0.069	0.103	0.094	0.054
Emergency services	1.74	0.075	0.117	0.106	0.056

Source: STEG (2019a).
Note: USD = U.S. dollar; kW = kilowatt; kWh = kilowatt hour.

Figure 13. Evolution of medium-voltage electricity selling prices for Uniform tariff subscribers, Tunisia



Source: STEG (2019a), STEG (2018a); STEG (2016).

Enabling environment for Renewable Energy

3.1 Energy transition strategy

In response to energy security challenges and the vulnerability to volatile international energy prices, Tunisia has decided to embark on an energy transition process as part of its wider sustainable economic and social development strategy. A national energy debate was launched in 2013 to define the strategic objectives of the new policy through extensive consultations with key energy stakeholders from various institutions, public and private organisations, civil society, experts, financial organisations and academia, among others.

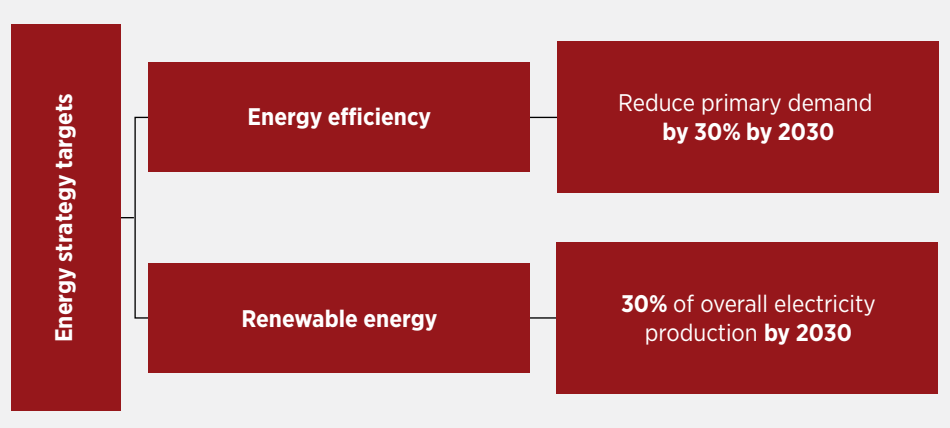
The results of this debate concluded that Tunisia must fully engage in an energy transition. This should be based on a revision of the modes of production, processing and energy consumption to strengthen its energy security, and should safeguard the competitiveness of its economy and protect the environment.

Tunisia's energy transition is based on the implementation of an energy management strategy with two components: the increase of energy efficiency and the development of renewable energy, such that the main targets are achieved, as defined in Figure 14.

The main objectives of this strategy, developed in 2014 and updated in 2019, are as follows:

- **Energy efficiency:** Strengthen policies and measures for the rational use of energy to reduce overall primary energy consumption by 30% in 2030, compared to the baseline scenario.
- **Renewable energy:** Increase the share of renewable energy in the electricity production mix to reach 30% in 2030.

Figure 14. **Energy strategy targets, Tunisia**



ANME initiated work in 2017 on a low carbon strategy to 2050 that would include carbon pricing instruments. The Partnership for Market Readiness, United Nations Development Programme and World Bank are supporting Tunisia in the implementation of its Nationally Determined Contributions (NDC) and low carbon strategy. In this context, Tunisia's NDCs pledge to include measures to reduce carbon intensity by 41%, including an unconditional target of 13% and a conditional target of 28%. Moreover, 75% of these reductions stem from mitigation measures in renewable energy. This commitment is well reflected in the TSP and includes measures to build institutional capacity and further address the planning gaps from the first round to the second round of NDC reviews in 2020 (UNDP, 2018a).

The low carbon strategy, to be finalised in 2020, will be based on carbon pricing instruments, in line with Tunisia's Energy Conservation Policy (30-30 target), FTE and development of its Nationally Appropriate Mitigation Actions. It also will depend on international support through financial and technical assistance (UNDP, 2018b).

Drivers for the Energy transition strategy:

1. **Energy Security:** With a growing energy balance deficit, there is a compelling case for renewables, based on a decline in conventional resources against a sustained increase in demand. The ability of renewable energy to address energy imports is significant. Renewable energy solutions bring about important benefits to energy security, including availability, accessibility, affordability and a long-term outlook.

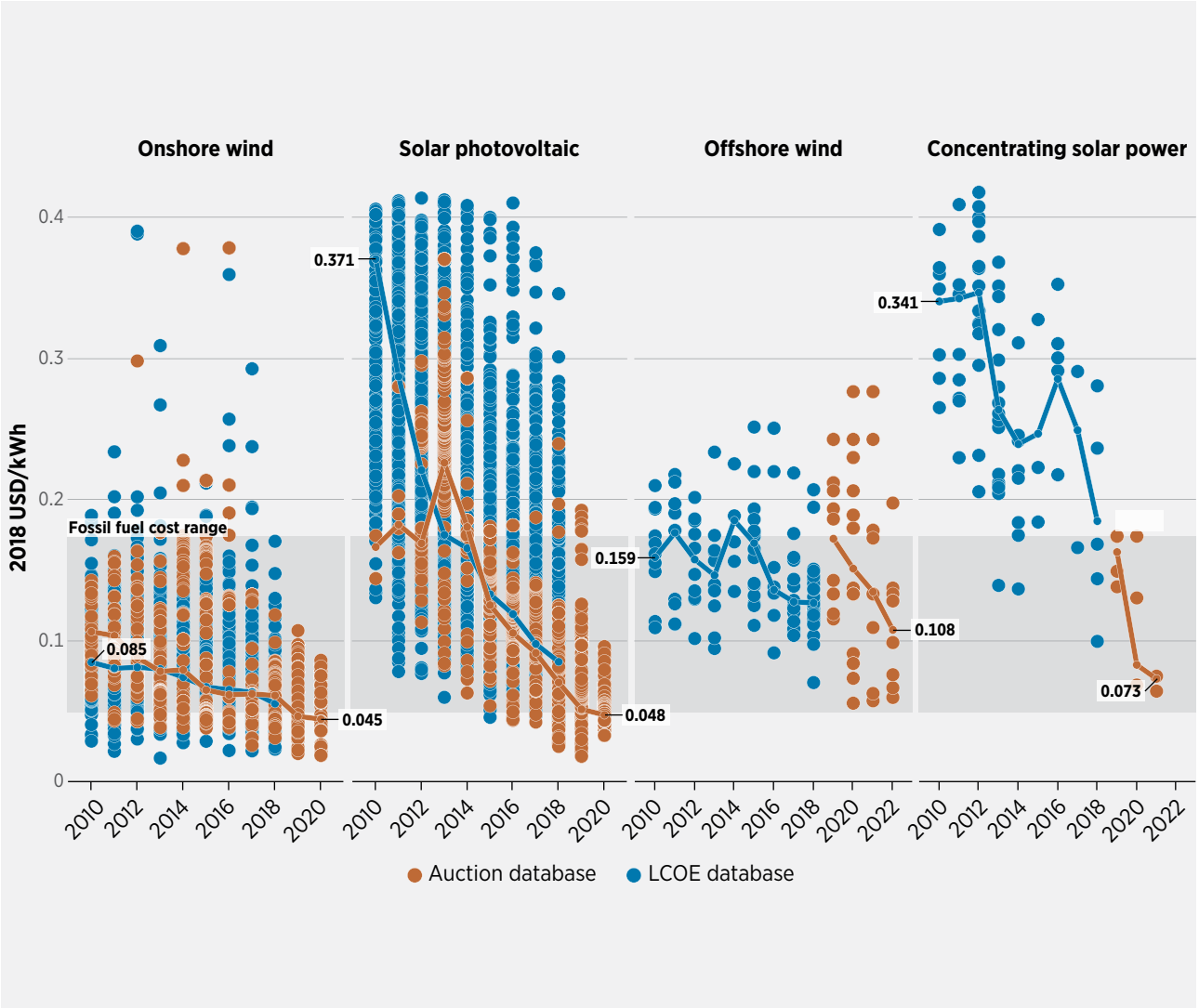
2. **Economics:** With the reduction in the cost of renewable energy technologies over the past decade, governments have continued to search for renewables projects to benefit from economies of scale. Global average prices have dropped from approximately USD 241/megawatt hour (MWh) to USD 66/MWh for solar photovoltaic (PV), while onshore wind prices have dropped from approximately USD 79/MWh to USD 46/MWh. Solar PV prices continued to fall between 2017 and 2018, albeit at a slower pace, reaching USD 62/MWh in 2018. Onshore wind prices have edged slightly upward, reaching USD 55/MWh. The Middle East/North Africa region has seen remarkably low prices for new renewable energy projects, especially solar PV. Tunisia, itself, recorded the lowest bid in Africa for a 500 MW solar PV tender at USD 0.0244/kWh (pvmagazine, 2019a).

3. **Environmental:** Tunisia, in its NDCs, has included measures to reduce its carbon intensity with a focus on reducing greenhouse gas emissions by 41%, with 75% of these reductions stemming from mitigation measures in renewable energy and energy efficiency. The development of renewable energy is a central pillar of decarbonising the energy mix while securing a reliable energy supply. In 2018 alone, renewable energy generation from solar PV and wind avoided nearly 1.5 million tonnes of carbon emissions.

Moreover, around 20 energy efficiency actions have been included in the calculation of avoidable emissions, covering the industrial, building, transport and agriculture sectors. This commitment is well reflected in the TSP, and the country has taken measures to build institutional capacity and further address the planning gaps from the first round to the second round of NDC reviews in 2020 (UNDP, 2018a).

In 2017, ANME initiated work on a low carbon strategy to 2050 that would include carbon pricing instruments. The Partnership for Market Readiness, United Nations Development Programme and World Bank are supporting Tunisia in the implementation of its NDC and low carbon strategy.

Figure 15. **Global weighted average of total installed costs and project percentile ranges for concentrated solar power, solar photovoltaic and onshore and offshore wind, 2010 - 2018**

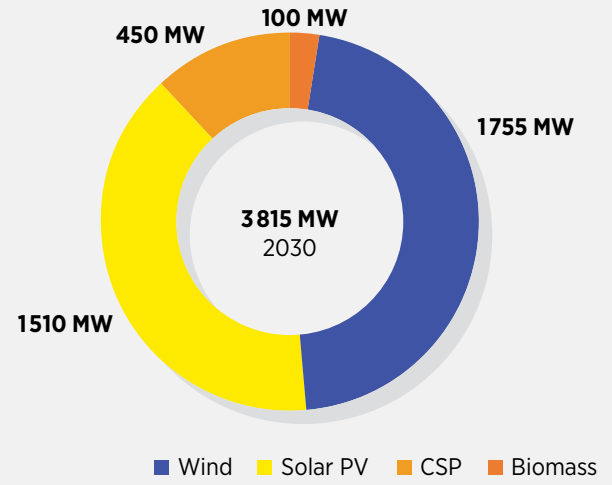


Source: IRENA (2019a).

Tunisian Solar Plan

The TSP is the operational tool to implement the Tunisian strategy for the deployment of renewables in the power sector. As such, it focuses only on on-grid electricity generation, based on wind, solar PV, CSP and biomass. The first version of the TSP was launched in 2009. The present version is the result of several improvements made over the years to reflect Tunisia's national strategy and targets. It was finalised by ANME in 2015 and adopted by the Tunisian government in July 2016. Tunisia took note of the notable progress in renewable energy deployment In December 2017, and has further updated and extended the targets to 2022.

Figure 16. **Renewable energy target, Tunisia, 2030**



Source: ANME (2015b).
Note: CSP = concentrated solar power; PV = photovoltaic; MW = megawatt.

To achieve the objectives of the national strategy, the TSP has set a total capacity for renewable electricity generation of 1 860 MW by 2022 and 3 815 MW by 2030, in comparison to the installed 373 MW renewable energy in 2018 (IRENA, 2020b). The distribution of projected capacity between the different renewable technologies is shown in Figure 16.

Box 2. Tunisian Solar Plan

- **Objective:** 30% renewable energy in electricity production in 2030
- **NDC pledges:** Reduce carbon intensity by 41%, with 75% of the reduction resulting from the energy sector
- **Target for installed renewable capacity:** 3 815 megawatts (2030)
- **Market access mechanism:** Net metering – Self-production – Independent power production for domestic consumption – Private concession by tender – Direct public investment by Tunisian Company of Electricity and Gas (STEG)
- **Investment cost (2015):** USD 9 436 million
- **Renewable projects (2015):** USD 7 465 million
- **Project for strengthening the electrical system:** USD 1 971 million
- **Funding:** Public sector: USD 3 106 million; Private sector: USD 6 331 million
- **Impacts:**

1. Cumulative energy savings over the period 2015–2030: 16 million tonnes of oil equivalent
2. Cumulative carbon dioxide emissions reduction over the period 2015–2030: 38 million tonnes of carbon dioxide equivalent
3. Gain on the energy bill: USD 16 billion
4. Jobs created: Approximately 10 000.

3.2 Renewable energy resources and exploitation

Tunisia is endowed with abundant renewable energy resources, particularly solar and wind energy; however, renewable energy currently plays a minor role in the country's energy supply. Tunisia's total installed renewable power generating capacity had reached approximately 352 MW by the end of 2019, with wind energy at 245 MW, hydropower at 66 MW) and PV at 62 MW (IRENA, 2020b). The use of solar thermal energy for heating water can be regarded as a success story, with a total installed area of 980 000 square metres (m^2) at the end of 2017 (ANME, 2018).

Wind energy

Wind resources were evaluated by ANME in 2009 in collaboration with Spain's National Renewable Energy Centre (Centro Nacional de Energias Renovables). This was possible through the development of a wind atlas for the entire country (Figure 18).

Tunisia's wind map illustrates the existence of several suitable sites for wind farms. The most interesting sites (speed exceeding 7 metres per second (m/s) at 80 metres height) are found in the regions of Bizerte and Nabeul, in the central region (Kasserine) and in the southern regions (Tataouine, Western Cape, Gabes and Kebili).

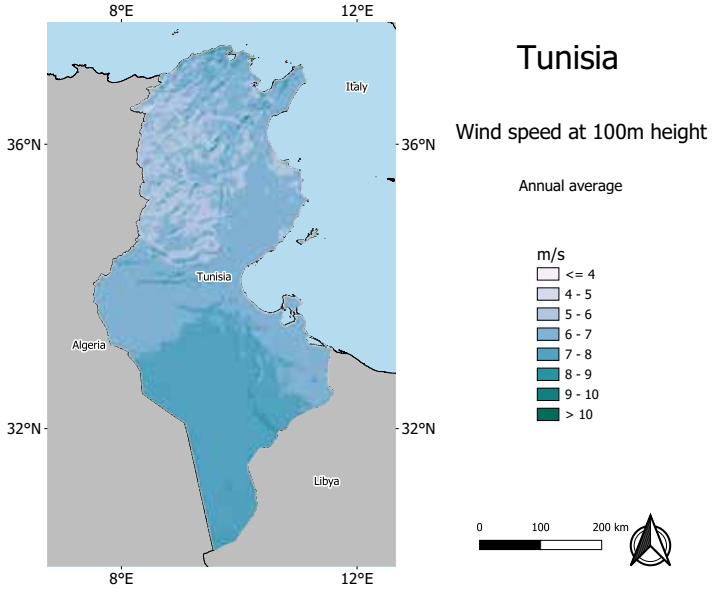
By comparison, sites with less attractive wind conditions (speed between 6.5 m/s and 7 m/s) can be found in the eastern areas of Tozeur, the east coast of Medenine and the Monastir region (IRENA, n.d).

The total area available for wind power development is estimated to be about 32 200 km^2. The gross wind energy potential in Tunisia is estimated at more than 8 000 MW (GIZ, 2013). This potential does not consider potential development opportunities in offshore wind.

Tunisia's wind generation development began in 2001, when STEG brought online a wind farm at the Sidi Daoud site in the northeast, with an initial capacity of 10 MW and later expanding to 55 MW in 2008. The wind farm of Sidi Daoud is comprised of three diverse wind turbine profiles: two small turbine models of 300 kilowatts and 800 kilowatts, and larger turbines of 1.32 MW (RES4MED, 2016).

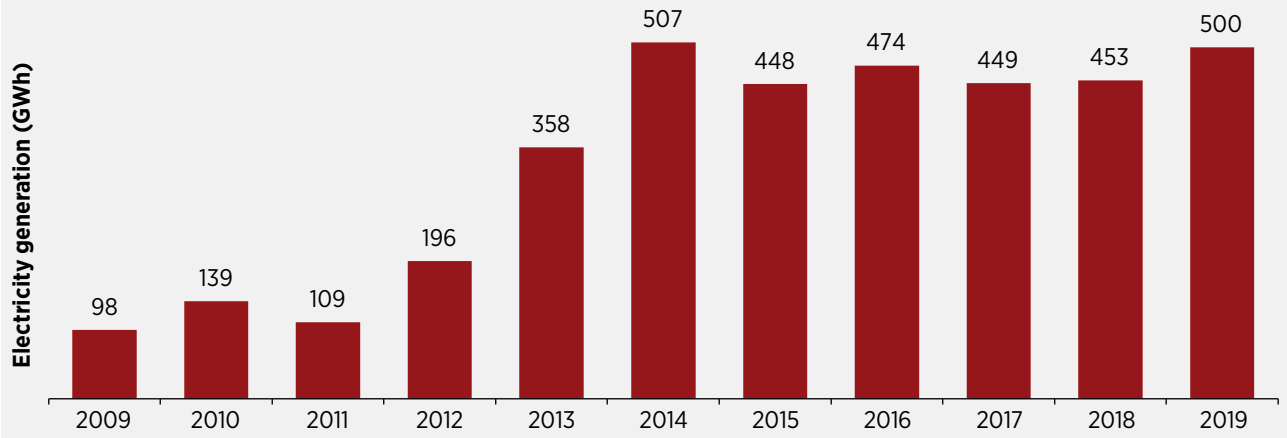
STEG launched two other wind farms in 2012 at the sites of Metline and Kchabta (Bizerte region). Together they account for a total of 143 wind turbines with a total capacity of 190 MW. The total electricity production of the three wind farms installed by STEG in 2017 reached 449 GWh, and peak production was recorded in 2014 at 507 GWh, as shown in Figure 17.

Figure 17. **Wind map of Tunisia**



Sources: IRENA: Global Atlas; Map data: Technical University of Denmark (DTU), 2021, 2021 OpenStreetMap contributors, 2021 United Nation administrative boundaries.
Notes: m = metre; m/s = metres per second.
Disclaimer: This map is provided for illustration purposes only. Boundaries and names shown on this map do not imply the expression of any opinion on the part of IRENA concerning the status of any region, country, territory, city or area or of its authorities, or concerning the delimitation of frontiers or boundaries.

Figure 18. **Electricity generation of wind farms (gigawatt hours), Tunisia, 2009–2019**



Sources: MISME (2019a).

Solar energy

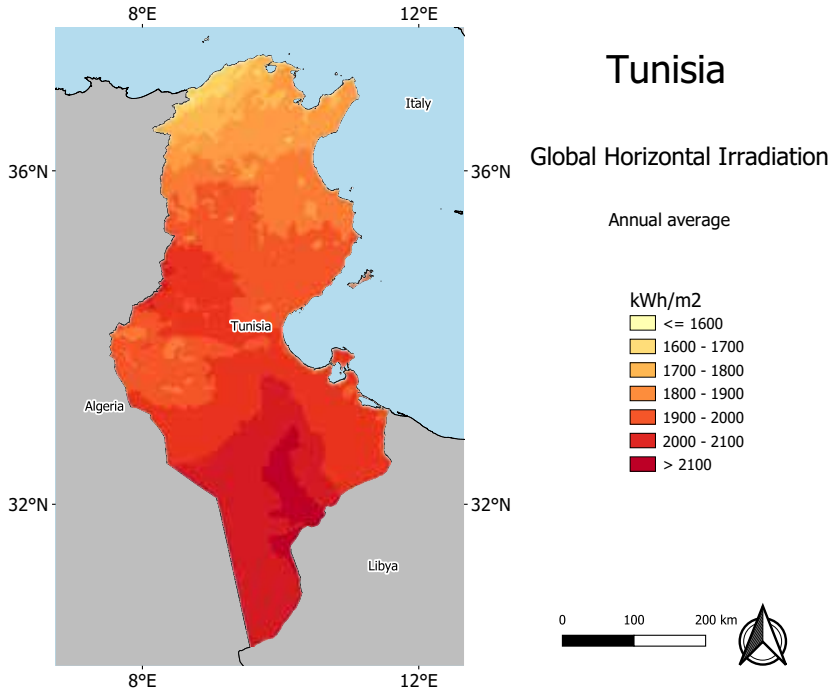
Tunisia has solar resources exceeding 3 000 hours/year, although hours of sunshine vary throughout the different regions. Most of the southern provinces have a solar exposure time of more than 3 200 hours/year, with peaks of 3 400 hours/year on the south coast (Gulf of Gabes), while the minimum period of insolation in the northern provinces is between 2 500 and 3 000 full-sun hours equivalent (Renewable and Sustainable Energy Reviews, April 2016). Solar irradiation ranges from 1 800 kWh/m^2/year in the north to 2 600 kWh/m^2/year in the south.

Global horizontal irradiance is a reliable resource measure for solar PV installations. As shown in Figure 20, the daily average global solar irradiance is between 4.2 kWh/m^2/day in the northwest of Tunisia and 5.8 kWh/m^2/day in its far south.

With these favourable conditions, the productivity of PV solar systems in Tunisia is very high. According to IRENA's Global Atlas, annual electricity production by PV solar systems varies between 1 450 kWh per kilowatt-peak (kWp) in the northwest region and 1 830 kWh/kWp for systems installed in the extreme southeast region.

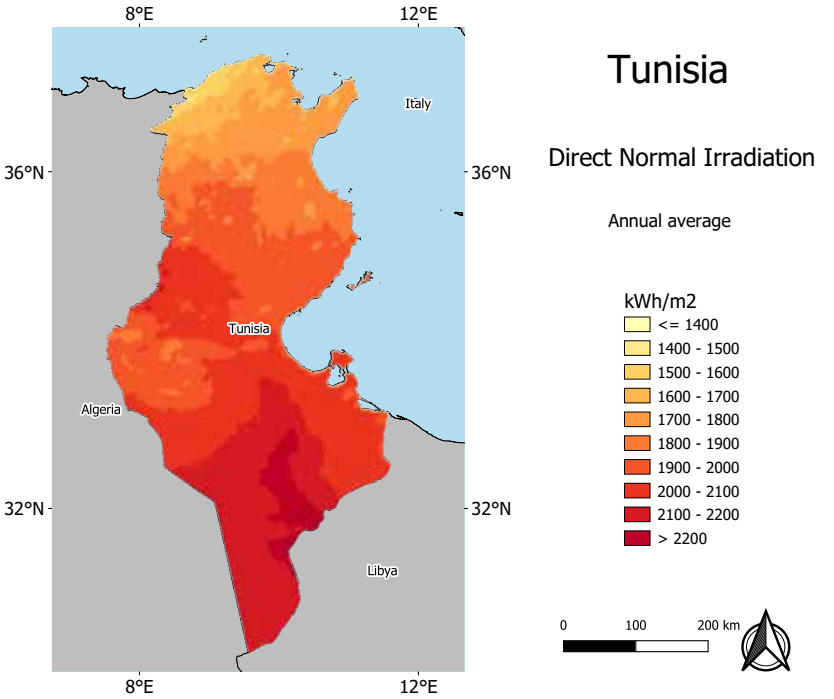
Direct normal irradiance (DNI) is the main parameter for evaluating the potential for concentrated solar power (CSP) technology. Generally, the DNI should be at least 2 000 kWh/m^2/year to provide a viable energy yield. In Tunisia, as shown in Figure 21, direct solar irradiation in the south and in most of the central region exceeds this typical DNI value. The DNI in some regions of the extreme southeast of Tunisia can reach a value of 2 300 kWh/m^2 /year.

Figure 19. **Global horizontal irradiance, Tunisia**



Sources: IRENA: Global Atlas, Map data: World Bank, ESMAP, 2021, 2021 OpenStreetMap contributors, 2021 United Nation administrative boundaries.
Disclaimer: This map is provided for illustration purposes only. Boundaries and names shown on this map do not imply the expression of any opinion on the part of IRENA concerning the status of any region, country, territory, city or area or of its authorities, or concerning the delimitation of frontiers or boundaries.

Figure 20. **Direct normal irradiance, Tunisia**



Sources: IRENA: Global Atlas, Map data: World Bank, ESMAP, 2021, 2021 OpenStreetMap contributors, 2021 United Nation administrative boundaries.
Disclaimer: This map is provided for illustration purposes only. Boundaries and names shown on this map do not imply the expression of any opinion on the part of IRENA concerning the status of any region, country, territory, city or area or of its authorities, or concerning the delimitation of frontiers or boundaries.

Solar PV

The use of solar PV systems in Tunisia began with decentralised rural electrification and pumping for drinking water supply, supporting low-income populations with very high subsidies. Only about 100 pumping stations, concentrated in the south of the country, have been installed. Tunisia had about 13 200 rural households electrified by PV systems by the end of 2014, totalling an installed capacity of approximately 1 450 kWp. Despite this advancement, no information is currently available on the real operating number of systems, as there is no monitoring procedure. Solar PV systems for decentralised rural electrification have minimal potential, given that STEG's electricity network covers most remote areas, while limited potential exists for pumping for small-scale irrigation.

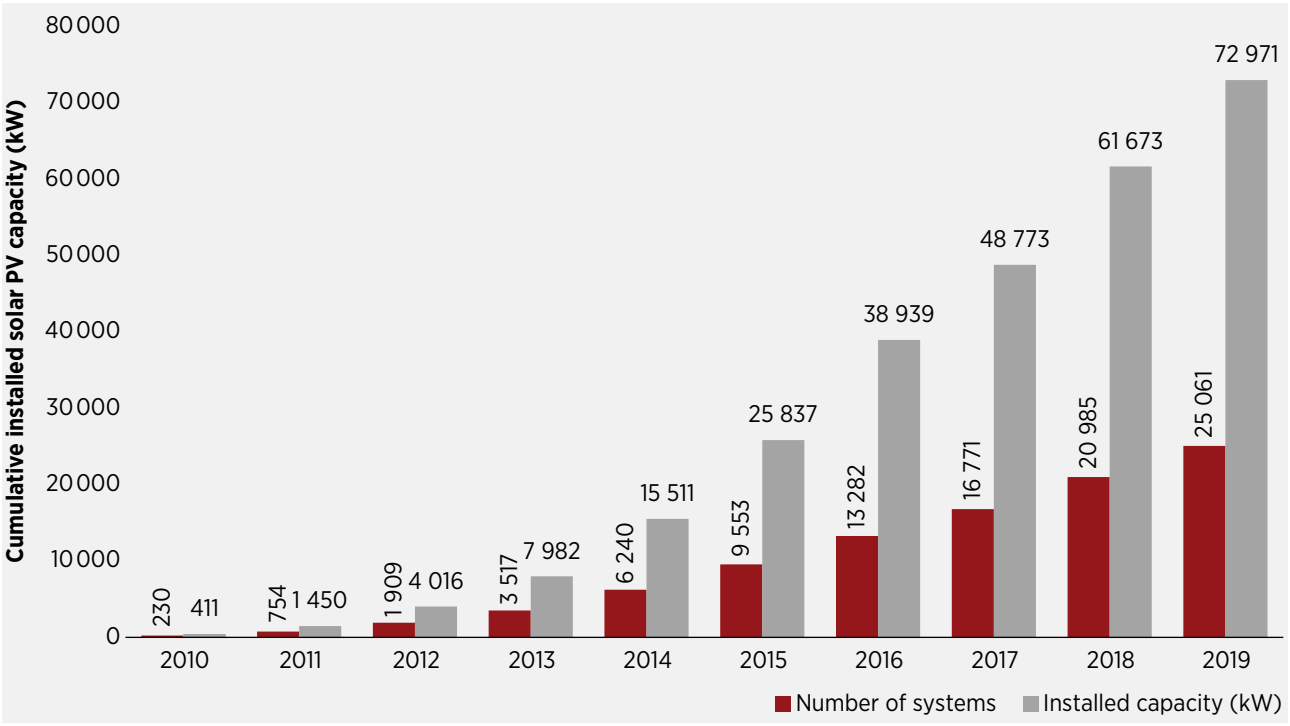
Grid-connected solar PV systems are recent in Tunisia. Their installation started upon the issuance of Law No. 2009-7, which authorises self-production of electricity from renewable energy sources. Grid-connected solar PV has mainly been implemented through the Prosol électrique programme, initiated in May 2010 by ANME and STEG.

The financial mechanism for this programme, exclusively intended for residential consumers connected to the LV grid, combines subsidies granted by the FTE and loans repaid over a period of seven years via the consumer's STEG electricity bill.

By the end of 2019, 3 644 solar PV systems were connected to the LV grid. The total PV capacity installed is evaluated at around 11 298 kWp, 90% of which were installed in the residential sector. Figure 22 illustrates the evolution of the cumulative solar PV capacity connected to the LV grid.

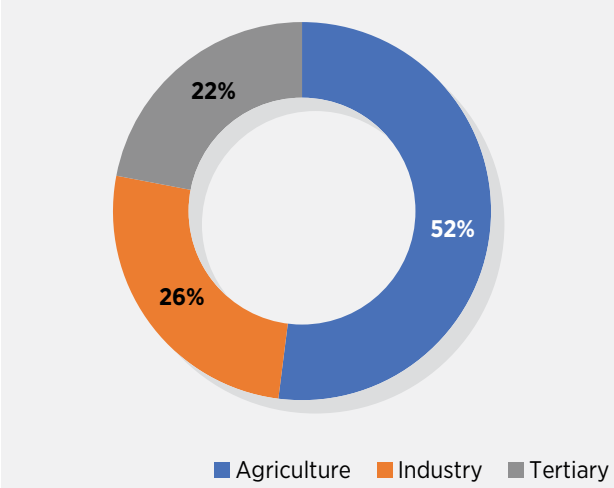
With continuing increases in electricity rates and the significant price decline of PV systems, the profitability of solar energy continues to improve for all electricity consumers, including those connected to the MV grid. In this context and until February 2020, MIEM has granted the necessary authorisation for 150 solar PV installations, totalling a capacity of approximately 26 megawatts-peak (MWp), with intended for production to the MV grid (ANME, 2020). The distribution of the PV energy projects is largely in the agriculture sector, followed by the industry and tertiary sectors, with 64% of the installations below 100-kilowatt capacity.

Figure 21. **Cumulative installed solar photovoltaic capacity for self-production on the low-voltage grid, Tunisia, 2011–2019**



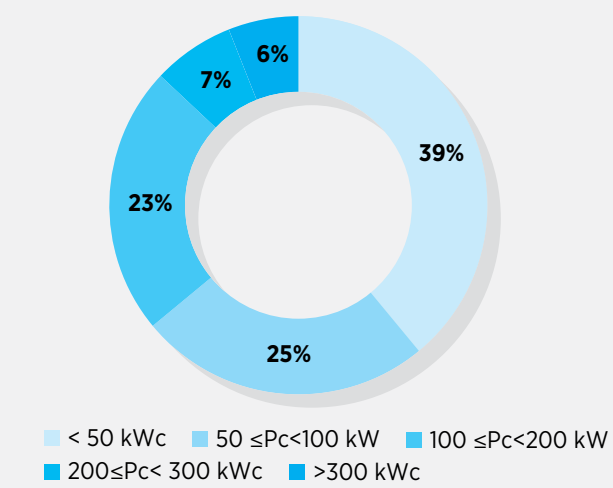
Sources: IRENA (n.d.); World Bank (2020).
Disclaimer: The designations employed and the material presented in this map do not imply any opinion on the part of IRENA concerning the legal status of any region, country territory or area, or concerning the delimitation of frontiers or boundaries.

Figure 22. **Sector distribution of photovoltaic projects relating to the medium-voltage grid, Tunisia**



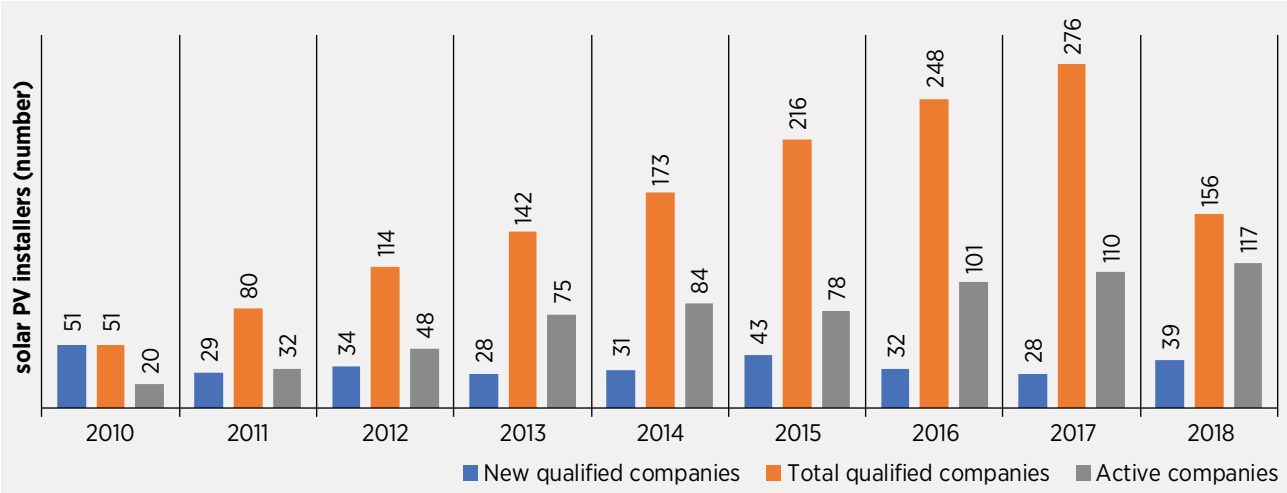
Source: ANME (2019).

Figure 23. **Distribution of power installations, Tunisia**



Source: ANME (2019).

Figure 24. **Registered Solar PV installers**



Sources: Nur Energie (n.d.).

Solar PV demand in Tunisia has led to the creation of a network of companies specialising in the installation of PV systems. By the end of 2019, ANME listed 350 registered companies, among which 150 were active. In addition, five manufacturing units for PV modules were created in Tunisia during the period 2011–2019, with an annual production capacity estimated at 100 MW.

Concentrated solar power

Studies by DESERTEC found the gross potential of CSP plants in Tunisia to vary with irradiation from 50 gigawatts (GW) to 1250 GW. But with limited water available for cooling, this falls to between 4 GW and 65 GW (mitigationmomentum, 2016).

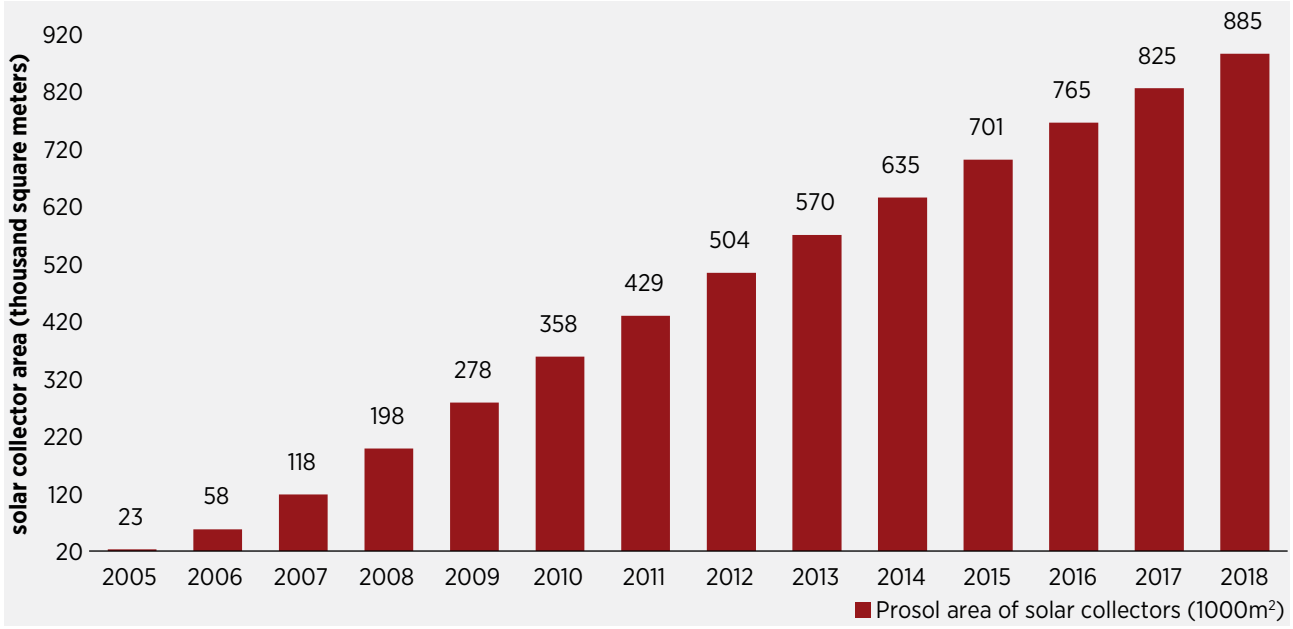
Currently, Tunisia does not have any CSP generation plants. A pre-feasibility study was conducted in 2009, however, for a 50–100 MW capacity CSP project in the region of Gabes (Oued Akarit).

Separately, an ambitious project was presented, by a private company, to the Tunisian government in 2008 to build a CSP plant in southern Tunisia and export its electricity production to Europe: the TuNur CSP Project. The proposed project consists of a 2250 MW solar CSP plant in the Sahara Desert and a 2 GW HV direct-current submarine cable from Tunisia to Italy (Figure 26).

Figure 25. **Proposed TuNur consolidated solar power project in southern Tunisia**

Sources: Nur Energie (n.d.).

Figure 26. **Solar collector area installed under Prosol programme, Tunisia, 2005–2018**



Sources: ANME (2019).

Solar water heating

The solar water heating (SWH) sector in Tunisia was initiated in the 1980s through the creation, in 1982, of the first manufacturing unit for solar water heaters and the establishment of a specific consumer credit system. Hindered by technical skill levels, however, the country experienced a sharp decline in annual installations from approximately 5 000 m^2/year installed collector area to only several hundred square metres in the mid-1990s.

The market was revived through a Global Environmental Facility project that provided a grant of up to 35% of the purchase price and the establishment of technical requirements and guarantees for solar water heaters sold on the market to restore consumer confidence in SWH technology.

The project helped revitalise the market, restore the technology's reputation and create a more competitive local business. The project stopped in late 2001, however, with the depletion of the funds reserved for the grant (USD 6.6 million). The market then declined significantly to less than 8 000 m^2 in 2004.

As of 2005 the Tunisian government decided to boost the SWH market by implementing the Prosol programme, based on an innovative financing and incentive mechanism. The programme offers capital grants combined with value-added tax exemption, reduction of custom duties and reduced interest loans paid back through electricity bills (Solarthermalworld, 2017).

This programme transformed the Tunisian SWH market whereby, by 2008, the annual installed area of solar water heaters in the residential sector had reached more than ten times the average recorded prior to the start of the Prosol programme.

After reaching an annual peak of 80 000 m^2 during the period 2008–2010, the market registered a decrease in 2011. The total collector's area installed under the Prosol since its start in 2005, however, is about 885 000 m^2. Figure 27 illustrates the evolution of annual and cumulative solar collector area installed under Prosol.

A programme specific to the commercial and industrial sector also was established in 2009, named Tertiary Prosol, which had installed around 28 000 m^2 of solar collectors by the end of 2016. This specific programme has not experienced the same dynamic as in the residential sector; the payback period often is not attractive for end users in the tertiary sector due to competition from heavily subsidised natural gas.

From the commercialisation of SWH systems in 1982 until the end of 2018, the cumulative total area of solar collectors installed in Tunisia is estimated at 1 040 000 m^2, as shown in Figure 28. The evolution of SWH has been accompanied by a significant growth in the number of suppliers, installation companies and equipment models sold on the Tunisian market.

The SWH market offer at the end of 2016 was characterised by the presence of:

- 53 suppliers, including ten local manufacturers;
- 1200 installers, of which 500 were qualified, according to the Qualisol label[6] established by ANME;
- 250 approved models of SWH systems;
- 16 engineering consulting firms;
- 12 qualified installation companies of collective solar heating systems; and
- three technical control offices.

Hydropower

Hydropower was the first renewable resource exploited in Tunisia through the installation of two hydropower stations in Arroussia and Nebeur (northwest region) in 1956, with a total capacity of 18 MW.

Its installed hydro capacity by 2018 stood at 66 MW, spread over seven stations, as shown in Table 9.

Tunisia does not have large dams and its hydraulic energy potential is limited. The production of hydropower is variable, and its share of total electricity production is very limited, as shown in Figure 29. Electricity produced from hydropower in 2018 totalled approximately 18 GWh, which represented 0.12% of STEG electricity production.

Figure 27. **Area of solar collectors, Tunisia, 2018**

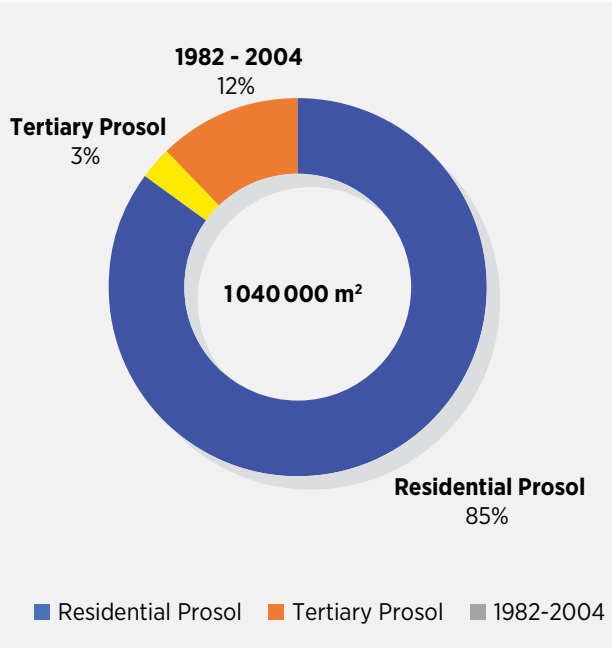


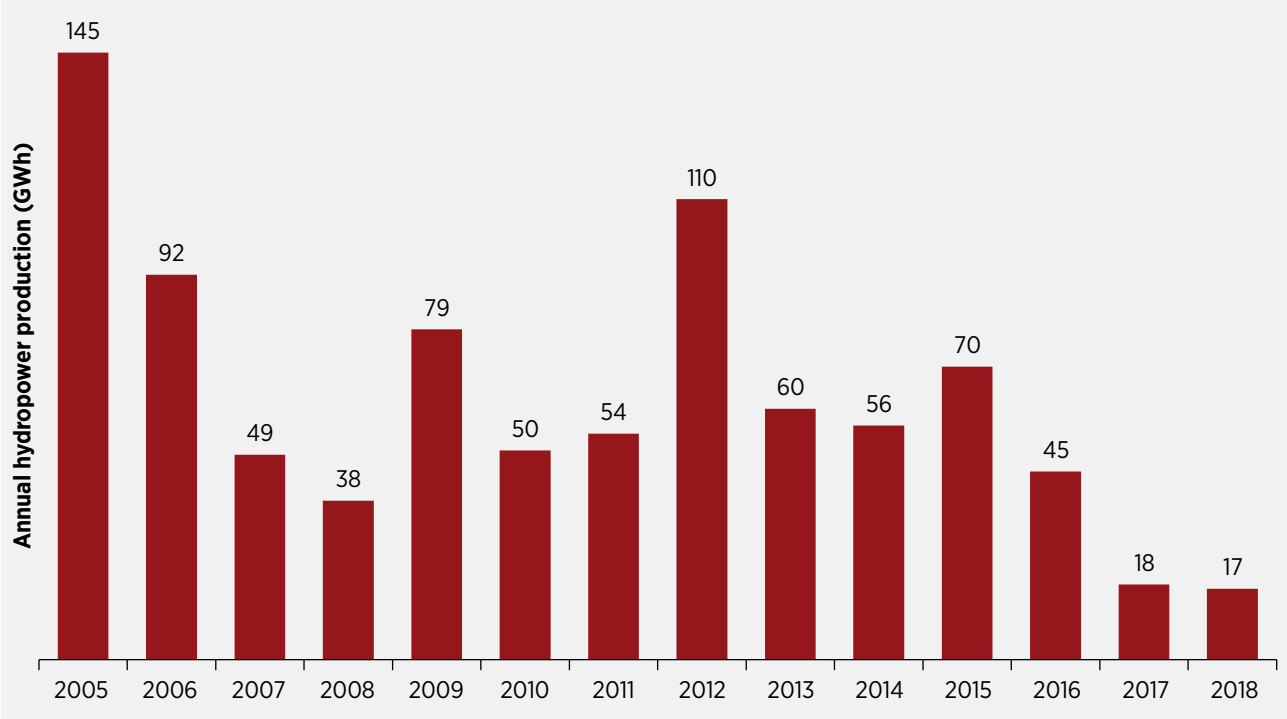
Table 9. **Hydropower stations, Tunisia, 2015**

Hydropower stations	Capacity (MW)
Sidi Salem	36.0
Fernana	9.7
Nebeur	13.0
Aroussia	4.8
Kasseb	0.7
Bouherthma	1.3
Sejnene	0.6
TOTAL	**66**

Source: STEG (2019a).

6 This is a training and qualification programme for installers who are required to respect a specific code and comply with definitive criteria and standards during the installation of solar water heaters.

Figure 28. **Annual hydropower production, Tunisia, 2005–2018**



Sources: MISME (2019a).

Biofuels and waste-to-energy

There is minimal use of traditional biomass fuels in Tunisia as almost the entire country has access to electricity and to non-solid fuels for cooking. The production of charcoal has remained almost stable over the last decade, averaging 150 ktoe/year, and wood is frequently used in traditional ovens.

The National Waste Management Agency (ANGED – Agence Nationale de Gestion des Déchets) estimates that the country produces approximately 6 million tonnes of organic waste annually (2.2 million tonnes of household waste, 2.2 million tonnes from farms and agri-industry, 1 million tonnes from olive oil processing, 400 000 tonnes from poultry droppings and 200 000 tonnes from waste water treatment). According to ANGED, the potential for generating electricity through waste is estimated at 1000 GWh/year. Various challenges currently exist to exploit this potential, including initial investment cost constraints, a lack of technical knowledge, limited knowledge on biomass resources, lack of clarity on the long-term supply of power plants from low-cost waste, and overlapping roles between ANGED and municipalities, both responsible for waste collection.

One pilot biogas plant capable of generating 2.4 GWh/year of electricity was developed in 2010. The plant is set up to use waste from the wholesale market of Bir El Kassaa; however, it remains offline due to technical problems (ANME, 2017).

Geothermal energy

The southern part of the country, specifically the Kebili, Gabes and Tozeur regions, is rich in hot springs - a good indicator of geothermal activity. These geothermal resources originate from the extensive Continental Intercalary aquifer, covering an area of 1 million km^2 and spreading into the neighbouring countries of Libya and Algeria. The aquifer is about 2.8 km deep and has temperatures ranging from 30°C to 80°C (UN, 2008).

Use of geothermal energy in the power sector, however, is underdeveloped due to the low enthalpy of geothermal resources. Therefore, many geothermal applications are based on direct use of geothermal heat in agriculture (e.g. for heating greenhouses, powering irrigation pumps) and recreational thermal baths.

3.3 Renewable energy regulatory framework

The first regulatory framework allowing for the use of renewable energy to produce electricity was set up in 2009 through the promulgation of Law No. 2009-7 (adopted 9 February 2009). This law authorises households, companies and groups of companies active in different economic sectors to exploit renewable resources to produce electricity to cover their needs. The law provides the possibility for companies connected to the MV and HV grids to sell their production surpluses to STEG. The requirements and procedures for these projects were set by Decree No. 2009-2773 (28 September 2009) (MEMTE, 2016).

Aware of the need to establish regulatory reforms to mobilise private investment for the development of renewable energy, the Tunisian government began discussions in 2012 to put in place a new legislative framework more attractive to various kinds of private developers.

In 2015 Tunisia adopted a new legislation relating to electricity sources from clean energy developments. Law No. 12 of 11 May 2015, relating to electricity produced from renewable energy sources, was implemented to promote the development of renewable energy, encourage private-sector investment and liberalise rules regarding the production (and export) of clean energy. This new law provides for three regulatory regimes, as follows.

- Production projects for self-consumption
- IPPs to meet the needs of local consumption
- IPPs intended for export.

This law provides several legal texts that are essential for its implementation (i.e. decree, order, decision). Currently, the regulatory framework for electricity generation from renewable energy is defined through the key texts outlined in Table 10.

Table 10. **Overview of renewable energy support policies and regulation, Tunisia**

Legislation	Type
Law No. 96-27 of 1 April 1996	• Establishes concessions on electricity production
Decree No. 96-1125 of 20 June 1996	• Sets the conditions and procedures for granting the concession of electricity generation to private consumers
Law No. 2015-12 of 11 May 2015	• Promotes the development of renewable energy and encourages private sector investment • Liberalises rules regarding the production (and export) of clean energy
Law No. 2016-71 of 30 September 2016	• Establishes the law on investment
Governmental decree No. 2016-1123 of 24 August 2016	• Sets the conditions and procedures for the completion of projects relating to electricity production from renewable energy
Ministerial Decision of 6 December 2016	• Designates members of the technical committee for independent power producers from renewable energy
Ministerial Decisions issued on 9 February 2017 and 30 August 2018	• Ratifies connection grid codes • Ratifies typical contracts for the purchase and transmission of electricity in various production regimes
Governmental decree No. 2017-389 of 9 March 2017	• Supports investment through financial incentives under the Investment Law
Governmental decree No. 2017-983 of 26 July 2017	• Regulates the Energy Transition Fund (Funds de transition énergétique)
Governmental decree of 30 August 2018	• Approves the revision of the standard power purchase agreement contracts for the sale of electricity produced by renewable energy sources under authorisation scheme to the Tunisian Company of Electricity and Gas (STEG)
Law No. 2015-12 was amended to Law 2019-47 of 29 May 2019	• Amended to allow for corporate power purchase agreements
Governmental Decree No. 2020-105	• Amended and completed decree No. 2016-1123 of August 24, 2016

Source: STEG (2019a).

According to Law No. 2015-12, renewable energy projects are to be developed under four different legal regimes. These are set out in Table 11.

Table 11. **Criteria under the legal regimes for renewable energy projects, Tunisia**

Legislation	Type
Energy production for self-production	• Installations connected to the low-voltage grid need approval from the Tunisian Company of Electricity and Gas (STEG).
Authorisation scheme: energy-selling projects ≤ maximum power	• Installations connected to the medium- and high-voltage grids require an authorisation from the Ministry of Industry, Energy and Mines. • A prior agreement is granted by MIEM following a call for projects. • The agreement is valid for a period of two years for photovoltaic projects and three years for wind projects, during which the developer will have to form the project company and complete the plant with a possibility for extension by one year subject to challenges within the project. • The developer receives authorisation from MIEM to operate and produce electricity after the commissioning test by the Tunisian Company of Electricity and Gas.
Concession scheme for energy-selling projects > maximum power	• MIEM grants a concession after a public call for tenders. • Projects are carried out in accordance with the concession procedures defined by Decree No. 96-1125 of 20 June 1996. • Project Agreement (PPA and concession agreement) are submitted to Parliament for validation.
Concession scheme for energy export projects	• MIEM grants a concession after a call for tenders. • Contracts are submitted to Parliament for validation.

Source: GIZ (2014); ANME (2015a).
Note: Maximum power = the maximum installed capacity of electricity generation projects from renewable energy intended to meet the needs of local consumption. It is subject to authorisation by MIEM and is set by Decree No. 2016-1123: 10 MW for solar PV and solar thermal; 30 MW for wind energy; 15 MW for biomass; and 5 MW for projects using other renewable resources.

Meteline – Kchabta wind park in Bizerte
Photograph: National Agency for Energy Conservation (ANME)

Box 3. Addressing power system flexibility in Tunisia

Tunisia has set ambitious renewable energy targets in its Tunisia Solar Plan (TSP) for the year 2030. A national plan to maintain grid stability is essential, taking curtailment into account, as the current grid may need to be reinforced to handle additional capacity from renewable energy sources due to current grid infrastructure limitations. This will become a major concern when large-scale projects under the concession scheme come online.

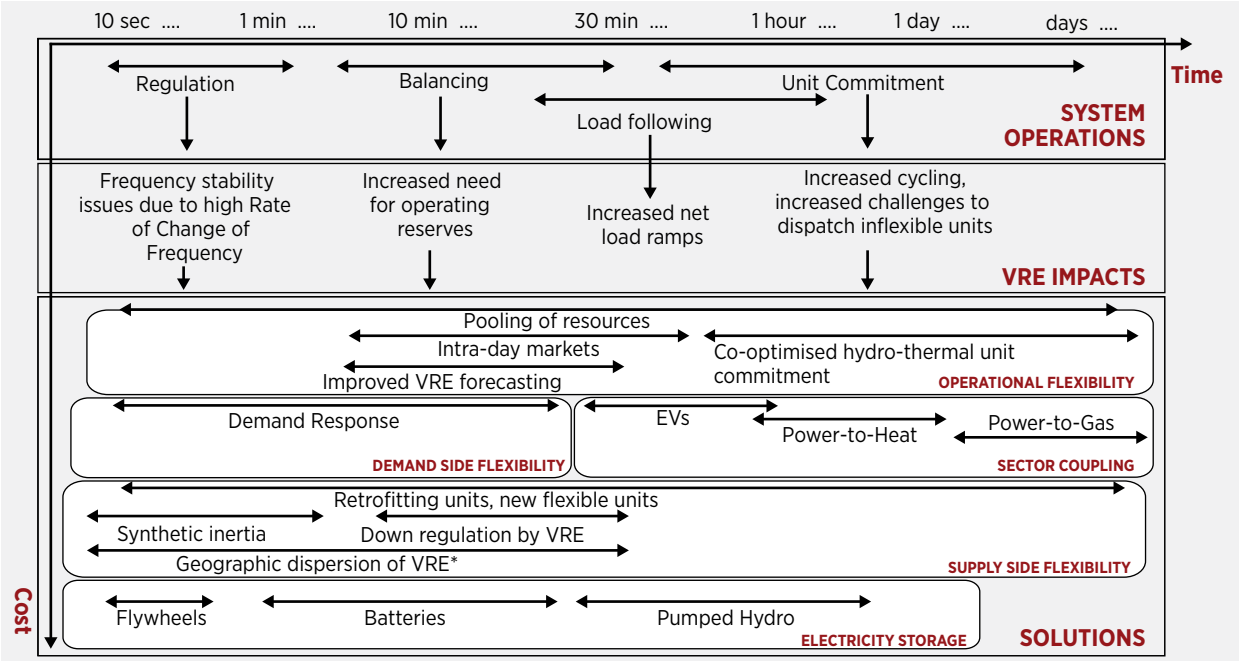
In this context, IRENA's analysis in Power System Flexibility for the Energy Transition finds that, for the effective management of large-scale VRE, several flexibility sources need to be exploited and planned for ahead of time.

Flexibility in the energy system can be provided by different sectors, including transmission and distribution systems, storage and more flexible demand (demand-side management and sector coupling). Therefore, proper planning methodologies need to be undertaken to integrate all energy system players, including both technical and institutional aspects. Figure 25 shows the different flexibility measures that may be taken at different timescales to address VRE curtailment. In this context, China has integrated different measures to address curtailment, including the improvement of operational practices, implementation of wholesale energy markets, grid infrastructure development, integration of demand-side programmes with a focus on interruptible loads and pumped hydro solutions (IRENA, 2018a).

IRENA finds that planning for flexibility is a complex multi-step process that requires significant mathematical computation using the appropriate tools. As such, IRENA has developed the Flex tool to assess the current flexibility of the power system in different countries. The Flex tool is a user-friendly tool that analyses the power system holistically, considering traditional and innovative technologies that enrich the concept of flexibility, including flexible demand, energy storage and sector coupling. Moreover, the Flex Tool can be used to carry out long-term analysis, proposing various solutions to Tunisia's goal of including 30% renewables in its future power system by 2030.

Addressing variable renewable energy in long-term planning comes as a timely assessment, as MIEM is currently drafting the updated national plan for the years 2021 – 2025, as stipulated by articles 40 and 43 of law No. 2015-12. The plan is expected to include disaggregated renewable energy targets defined for each production regime. IRENA's FlexTool analysis aims to help the MIEM assess different flexibility solutions to enable Tunisia to reach key goals and fulfil the TSP.

Figure 29. **Flexibility solutions**



For the integration of renewables onto the electricity grid, key items under Law No. 2015-12 must be accounted for. These include power system flexibility for the integration of variable renewable energy (VRE) onto the grid. Current grid infrastructure and operations accommodate the current share of renewables in the grid, which is at 2.5%. The TSP expects a share of 30% by 2030, however, and therefore further measures must be taken. In this context, Article 3, Article 4 and Article 40 of Law No. 2015-12 account for power flexibility measures.

Law No. 2015-12 requires the creation of a national plan to produce renewable electricity. MIEM, in consultation with the national council of energy, is responsible for developing a national plan for electricity generation from renewable energy. Article 3 of Chapter II of the law lists the requirements of the national plan (i.e. grid stability, consistency in supply and demand, reserves, rate of industrial integration, and inventory zones), while Article 4 of Chapter II sets out the process for agreement of the national plan.

The approval of the plan by government decree on a proposal by MIEM is followed by agreement from the ministers in charge of finance, national defence, state property, agriculture, environment, equipment and local communities.

Meanwhile, Article 40 of Chapter VI deals with the timing of the national plan: it must be finalised and approved within five years from the date of the law's entry into force. The plan will include disaggregated renewable energy capacity targets by technology and production regime.

Self-consumption scheme

The main regulatory and administrative provisions for renewable energy production for self-consumption vary according to the nature of the project, with the primary distinction being between projects connected to the LV grid or the MV grid (Table 12).

Solar PV site in Tunis
Photograph: National Agency for Energy Conservation (ANME)

Table 12. **Provisions for self-consumption projects connected to low- and medium-voltage grids, Tunisia**

Self-consumption scheme		
Characteristics	**Projects connected to low-voltage (LV) grid**	**Projects connected to medium-voltage (MV) grid**
Eligible self-producers	• All customers of the Tunisian Company of Electricity and Gas (STEG) connected to LV network	• Any local authority, public or private establishment operating in the industrial, agriculture or tertiary sector subscribed to STEG • Any facility connected to the MV or high-voltage grid
Renewable power capacity	• Installed power capacity must not exceed that of the STEG subscriber	• No limitations on power contracted but the producer cannot sell surplus electricity greater than 30% of annual production to STEG
Technical requirements	• Installation must be technically compliant with the specifications for electricity dispatch from renewable energy connected to the LV network	• Wheeling services to areas of consumption are available for a fee • Installation must be technically compliant with the specifications for the connection and evacuation of energy produced from renewable energy installations to the MV and high-voltage network.
Administrative requirements	• Project request subject to approval from STEG	• Obtain an authorisation by the minister in charge of energy (on the advice of the Technical Commission for Independent Power Production from Renewable Energy (Commission Technique de production privée à partir des Energies Renouvelables).
Validity of contract	• One year, with tacit renewal for period of one year	• 20 years
Specific provisions for photovoltaic solar installations	• Qualified installers are extracted from the lists of the National Agency for Energy Management (Agence Nationale pour la Maîtrise de l'Energie) • Photovoltaic modules must be certified by the National Agency for Energy Management. • Inverters must be certified by STEG.	• Sale of surplus production: up to 30% of the annual production of the renewable energy plant • Sales tariff of surplus production differs according to the hourly period

Sources: MDICI (2017); ANME (2014).

Authorisation scheme

Under the Authorisation scheme, energy-selling projects can be initiated subject to meeting all the regulatory and technical requirements, with final approval from MIEM. The agreements are granted within the limit of the overall installed capacity defined in the annual notice relating to the renewable capacity to be achieved through the authorisation system.

Following lengthy discussions regarding the guaranteed purchase tariffs and the modalities of their application and revision, however, the decision was taken to grant authorisations only based on calls for projects announced by MIEM and within the limits of the objectives set by the annual notice. According to this approach, electricity sales prices are not fixed and, instead, are offered by private developers interested in participating in calls for projects. Figure 30 sets out the procedure applied under the Authorisation scheme.

Power purchase agreements

The PPA is an essential formal consensus that governs the power transaction between the renewable energy producer and the off-taker, serving as a key element of project bankability. PPAs should be designed to be relevant to country context for private project developers and government alike. Accordingly, Tunisia has developed bankable documentation (projects agreements), including a standard PPA form under the Authorisation and Concession schemes, approved under the decision of 30 August 2018 (repealing that of 9 February 2017) by MIEM.

As such, the PPA between developer and utility must include the following key items (MEMTE, 2017b):

- **Contract term:** Initial term of 20 years, with a take or pay mechanism.
- **Tariffs:** Individually determined, based on offer made by developer.
- **Connection costs:** Developer's responsibility, including initial connection and reinforcement costs.
- **Technical requirements:** Electricity produced is supplied in line with connection codes, approved by the ministry.
- **Force Majeure:** No compensation is available under the PPA for either party affected in the context. STEG is entitled to suspend performance under political force majeure.
- **Transfer conditions:** Capital transfers are allowed, subject to approval by MIEM.

In addition to the PPA, several other key documents are required: agreements on implementation, operation and maintenance, supply and installation, as well as finance facility term sheets. In this context IRENA, together with the Terrawatt Initiative, launched the Open Solar Contracts project to standardise contracts and thereby simplify and streamline project development and finance practices. In this regard, the Open Solar Contracts project will reduce risk, save time and unlock greater investment by providing confidence to the project developers (IRENA, 2018a).

Figure 30. **Procedure for energy-selling projects under Authorisation scheme, Tunisia**

Source: MEMTE (2017a).

Concession scheme

Projects under the Concession scheme are defined by Decree No. 2015-12, which states that private production projects with capacity exceeding minimum power (Figure 31), defined by MIEM, are to be carried out through concessions in accordance with the legislation in force following call for tenders. The scheme procedure is outlined in Figure 31.

3.4 Renewable energy institutional framework

Several institutions involved in electricity governance are responsible for renewable energy deployment. There are various support mechanisms for the deployment of renewable energy, from setting an enabling strategy and regulatory framework, to providing support for schemes in the form of grants and subsidies (further details on the energy-relevant institutions and their respective roles are presented in Annex I).

Furthermore, several associations and institutions are active in the field of vocational training, including the following:

The **National Centre for Continuous Vocational Training and Professional Promotion** (Centre National de Formation Continue et de Promotion Professionnelle) is responsible for managing the 1.5% of tax revenues set aside for the vocational training of professionals in the field of renewable energy.

The **National Centre for Instructor Training and Training Development** (Centre National de Formation de Formateurs et d'Ingénierie de Formation) and the **Mechanical and Electrical Industries Technical Centre** (Centre Technique des Industries Mécaniques et Electriques) are responsible for developing training programmes and products to disseminate the necessary knowledge to build competency and skills.

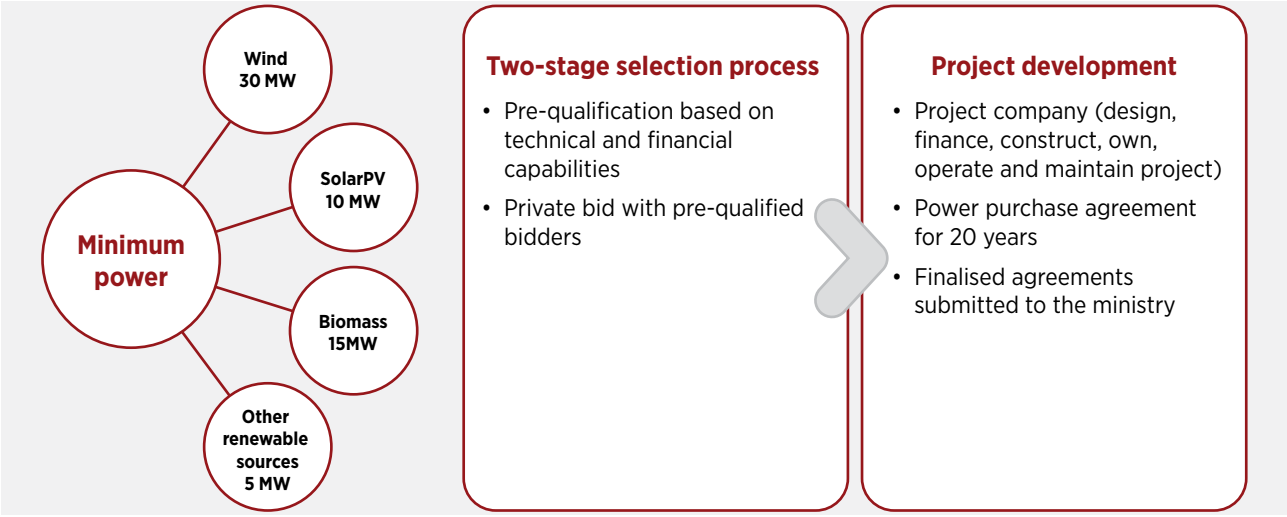
In the field of certification and standardisation, the **National Institute of Standardisation and Industrial Property** (Institut National de la Normalisation et de la Propriété Industrielle) is responsible for standards development, certifying compliance and ensuring the Tunisian national certification system accords to ISO standards.

Renewable energy programmes and project pipeline

Following the completion of the renewable energy regulatory framework, MIEM made an announcement in January 2017 that it would adjust the renewable electricity capacity to be installed during the period 2017–2020. According to this announcement, the production programme for the period 2017–2020 is limited to solar PV and wind energy, and aims to achieve an additional capacity of **1000 MW**. The same document sets the additional capacity to be installed during the period 2020–2025 at **1 250 MW**. It also specifies that a portion of this capacity may be advanced and implemented during the period 2017–2020.[7]

7 Tunisia updated the targets in the TSP in May 2019 to accurately reflect the current targets and progress undertaken in the country.

Figure 31. **Project proposal procedure for energy-selling projects under Concession scheme, Tunisia**



Source: Bennani and Associés (2018).

The renewable electricity generation programme for the period 2017–2020 was updated in April 2018 by MIEM. According to this adjustment, the power level to be achieved during this period was set at **1 860 MW** instead of the **1 000 MW** initially planned. The largest capacity increase was recorded for projects under concessions, as shown in Table 13.

Notably, the upward revision of renewable energy capacity for the period 2017–2020 was decided after a national conference in Tunis on 7-8 December 2017. Discussion took place on the possibility of accelerating the implementation of the TSP. By increasing the capacity for concessions, the Tunisian government seeks mainly to cut costs via economies of scale.

In 2019, the renewable energy targets set in the TSP were updated and extended to 2022.

MIEM launched pre-qualification tenders on 23 May 2018 for the realisation by concession (build, own, operate) of five solar PV plants, totalling a capacity of 500 MW, and four wind farms with a total capacity of 500 MW. The sites planned for these projects already have been selected and they mostly belong to the state, except for 200 MW of wind, for which the land should be proposed by the developers with a maximum capacity of 100 MW per project. The geographical distribution of solar PV and wind concessions is provided in Table 14.

Table 13. **Revised renewable energy programme targets, Tunisia, 2017–2022**

Type of project	Mode of realisation	Wind (MW)	Solar photovoltaic (MW)
Concession	Tender (independent power producer)	500	500
Authorisation	Call for projects	130	140
Self-consumption	Spontaneous requests	80	130
Tunisian Company of Electricity and Gas (STEG)	Tender (engineering, procurement and construction)	80	300
Total		**790**	**1 070**

Source: MEMTE (2018a).

Table 14. **Geographical distribution of renewable energy projects under Concession scheme, Tunisia**

Renewable energy technology	Regions with projects under Concession scheme	Capacity (MW)
Solar photovoltaic	Kairrouan	100
	Sidi Bouzid	50
	Gafsa	100
	Tozeur	50
	Tataouine	200
Wind	Kebili	100
	Nabeul	200
	Pending developer proposals	200

Sources: MEMTE (2018b), MEMTE (2018c).

MIEM announced on 23 November 2018 the list of developers who pre-qualified to participate in two private tenders for the concession of PV and wind power plants (Refere, 2018). The pre-qualified lists include:

- 16 companies and consortia for the concession of PV power plants on state land;
- 12 companies for the concession of wind farms on state lands; and
- private sites - still pending.

Candidates were invited to present bids for a 20-year concession contract at the start of 2019 with energy sales to STEG (ANSAmed, n.d.). Despite the delay in the bidding process, five bids were received for the 500 MW solar tender. The proposed bids were all within the range of USD 0.0244/kWh to USD 0.0286/kWh (MEMTE, 2019a). While all the bids received were below USD 0.03/kWh, the USD 0.0244/kWh bid tendered by Scatec Solar for the 200 MW Tataouine project (Table 14) was the lowest bid recorded in Africa (MEMTE, 2019a).

For renewable projects under the Authorisation scheme, MISME proceeded in May 2017 to launch the first call for projects for the development of 210 MW from solar PV and wind. For projects under authorisation in May 2018, the capacity of wind power plants should not exceed 30 MW, and the maximum capacity of PV power plants was set at 10 MW. The breakdown of renewable energy plants covered by this first call for projects under the Authorisation scheme is provided in Table 15.

Solar photovoltaic proposals under Authorisation scheme

The evaluation results of the proposals that came out of this call for projects allowed the selection of six solar PV projects, with a unit capacity of 10 MW, and four projects of 1 MW capacity. The proposed tariffs vary from USD cents 4.6/kWh to USD cent 6.9/kWh for the 10 MW solar plants and from USD cents 6.7/kWh to USD cents 9.7/kWh for the solar plants of 1 MW capacity (MEMTE, 2018d).

All project sites were proposed by the selected developers. Preliminary studies carried out by STEG have confirmed the possibility of connecting these plants to the electricity grid and have estimated the costs required for this connection. The solar projects selected following the first call for projects will be located on different sites in the regions of Sidi Bouzid, Kairouan, Sfax, Kasserine, Tataouine, Gafsa and Beja.

MIEM launched a second call on 30 May 2018 for projects for solar PV power plants with a total capacity of 70 MW; 60 MW for projects with a maximum capacity of 10 MW; and 10 MW for solar PV plants with a capacity not exceeding 1 MW. The deadline for submitting applications was set for 15 August 2018, which was extended to April 2018, and the results were announced in April 2019 with an average tariff of 4.5 cents (USD 0.045)/kWh for projects with 10 MW capacity and 7.2 cents (USD 0.072)/kWh for projects with a capacity of 1 MW (MEMTE, 2019b).

Under the Authorisation scheme, Tunisia has initiated a third tender for the development and construction of several solar power plants not exceeding 10 MW in size (MEMTE, 2019c).

Table 15. **Renewable capacities announced under the first call for projects, Authorisation scheme, Tunisia**

Source	Total capacity (MW)	Maximum Individual capacity (MW)	Deadline
Wind	60-120	up to 30	January 2019
Solar photovoltaic	60	1 to 10	April 2018; extended to March 2019
	10	Up to 1	4 MW in April 2018; extended to April 2019

Source: MISME (2019c).

Table 16. **Proposed capacity for installation by Tunisian Company of electricity and gas, Tunisia**

Source	Installed capacity (MW)
Solar photovoltaic	300
Wind	80

Source: Bennani & Associés (2018).

Wind projects under Authorisation scheme

For wind projects, proposals received for the first round were conditional on changes being made to the terms of the PPA. As a result, bidding companies were invited to submit new proposals by 18 December 2018 (an extension from the initial deadline of 15 August 2018), based on the new PPA that was approved by order on 30 August 2018 and published in Tunisia's Official Gazette on 28 September 2018.

Results were announced on 10 January 2019 and four authorisations were granted with an average of tariff received of 4.26 cents (USD 0.0426) /kWh (MEMTE, 2019d).

STEG renewable energy projects

STEG designed a programme for its future renewable energy development in the period 2017–2022. STEG began building a solar PV power plant in 2017 with a capacity of 10 MW (extended to 20 MW) in Tozeur, southeast Tunisia. The first 10 MW was commissioned in the beginning of 2020 while the latter 10 MW is under construction.

According to the notice published by MIEM, the total capacity of the renewable energy plants to be built by STEG during the period 2017–2022 amount to 380 MW, of which 300 MW comprise solar PV and 80 MW comprise wind energy. STEG has completed the preliminary studies for these plants and the selection of their sites.

3.5 Financial initiatives for renewable energy

The FTE is the specific instrument for the financial support of energy policy in Tunisia. It was established by the Finance Law No. 54-2013 of 30 December 2013 (article 67 -68) to replace the National Fund for Energy Management, created in 2005, and whose field of action was limited to the granting of direct subsidies for certain energy management actions. Through the creation of this new fund, the Tunisian state seeks to boost the country's energy transition through diversification by providing funding to:

- encourage investment in the field of energy conservation;
- support the creation and promotion of energy companies;
- facilitate the implementation of national programmes contributing to energy conservation; and
- support the implementation of the NDC through the provision of smart subsidies, loans and equity.

The FTE is funded by several resources, including:

- taxes on the first registration of cars;
- taxes on air-conditioning appliances;
- taxes on energy products consumed;
- taxes on used engine and spare part imports;
- donations and grants from individuals and legal entities to the fund; and
- resources from the fund's interventions.

The FTE also may be financed through other resources that can be allocated for its benefit, including funding provided by international development funds. The rules governing the organisation, functioning and modalities of FTE intervention were fixed by Governmental Decree No. 2017-983 of 26 July 2017. In accordance with this decree, the support provided by the FTE may be provided in the form of:

- direct subsidies for tangible and intangible investments;
- additional credits to loans granted by banking institutions;investment funding in the form of equity investment; and

- funding of national projects and programmes initiated by the state and local communities.

The amounts of the various subsidies provided by the FTE are defined usually as a percentage of the cost of the investment, with a ceiling amount defined according to the purpose of the investment. The FTE may also provide subsidised loans for renewable energy projects. The conditions for receiving these loans are as follows:

- The need for a bank to participate in the financing of the project.
- The maximum amount of the FTE loan must not exceed 50% of the cost of the investment.
- The amount of the FTE loan must not exceed the amount of credit granted by the bank.
- The repayment period of the loan must not exceed seven years.
- The maximum grace period is two years.

Despite the publication of the decree setting out the FTE's available interventions being July 2017, the technicalities of supporting the fund through additional loans and repayable endowments or participation in the capital market have yet to be defined, and its current intervention is limited to the granting of subsidies.

While the FTE's support is limited to the provision of subsidies, a new fund has been established under Law No. 2016-71 - the Tunisian Investment Fund (FTE) which enables the provision of grants and loans for new investment projects. In the renewable energy context, projects under the Authorisation scheme are eligible to receive incentives from this fund, subject to site-specific criteria.

The grants provided vary between 15% and 30% of the cost of the investment, ranging between USD 390 000 and USD 1170 000, respectively. The different rates and amounts of subsidies and additional loans accorded by the FTE in 2018 for renewable energy are summarised in Table 17.

Table 17. **Financial incentives provided by the Energy Transition Fund for renewable energy, Tunisia, 2018**

	Investment	Subsidy		Energy Transition Fund loan ceiling
		Rate (%)	Max. amount (USD)	
Intangible investments	Feasibility studies	70	11 700	-
	Assistance and support activities	70	27 400	-
	Other intangible investments	70	27 400	-
Tangible investments	Individual solar water heater (storage < 300 litres)	USD 78/system		-
	Individual solar water heater (storage > 300 litres)	USD 158/system		-
	Collective solar water heating in industrial and tertiary sectors	30	USD 100 per square metre of solar collector	-
	Biogas production	30	19 500	39 000
	Solar photovoltaic self-production connected to low-voltage grid (residential)	USD 470–590 per kilowatt	1 200	-
	Solar photovoltaic self-production connected to low-voltage grid (non-residential)		2 000	-
	Renewable energy self-production connected to medium- and high-voltage grids	20%	78 000	235 000
	Electricity production not connected to the grid by renewable resources	USD 390–2 350 per kilowatt	19 500	39 000

Sources: MDICI (2017); ANME (2014).

Key challenges and recommendations

Conscious of the vulnerability and dependency of its energy situation, Tunisia has set ambitious targets for the development of renewable energy, particularly in the power sector.

To achieve these objectives, Tunisia has undertaken several measures, including:

- adoption of the TSP;
- creation of an independent regulatory authority for the electricity sector to enhance the framework for the mobilisation of renewable energy investment;
- development of innovative financing tools for promoting renewables in the residential sector; and
- strengthening of the FTE.

Despite the recent reforms to encourage the involvement of the private sector and accelerate the realisation of national objectives, there are several barriers that continue to hold back more accelerated renewables deployment. The next section presents the main challenges and the corresponding recommended actions to overcome them, a result of the RRA process.

4.1 Long-term energy planning

Achieving higher shares of renewable energy in the electricity mix - as well as successful integration of VREs such as wind and solar energy - into the national electricity grid requires an integrated long-term energy planning process. Several key factors should be considered, including:

- evolution of electricity demand and the corresponding electricity production and transmission infrastructure;
- capacity of the current electricity grid to accommodate higher shares of renewables and the need for its reinforcement;
- renewable energy potential in different application segments (utility scale, remote decentralised systems and cities);
- land availability and access; and
- topographical constraints and limitations.

Yet, Tunisia does not have a solid long-term timeframe to account for capacity additions. The integrated planning for the period 2017–2022 was set mainly by MIEM with reference to the objectives of the TSP. The preparatory phase of this programme did not include all the relevant stakeholders and did not consider the various aspects relating to the implementation of energy planning, such as access to land.

Furthermore, Law No. 2015–12 calls for a national plan to produce renewable electricity within five years from the date the law entered into force. The national plan will have to be data driven; include a holistic evaluation of different renewable energy technologies; and ideally consider a mix of renewable power generation assets that include utility-scale power plants, remote decentralised grids, and residential distributed systems. With respect to utility-scale generation targets, the zones currently allocated for concessions could be a starting point. A comprehensive least-cost assessment for the development of generation assets, however, is yet to be developed, in addition to a corresponding assessment of the cost of reinforcing the electricity grid. Such a plan is yet to be developed although, in 2018, ANME initiated the preparatory phase to define the necessary studies for the development of this plan.

Moreover, to meet the ambitious targets of the TSP (i.e. 30% renewable share in the electricity mix) - coupled with the reduction in the cost of VRE, solar and wind power deployment - is likely to increase, particularly when the concession schemes come online. Achieving these ambitious targets will require corresponding investments in the grid to maintain reliability and avoid curtailment. Fortunately, numerous new technologies and approaches are available that can ease the integration of variable renewables (wind and solar PV) into electricity systems (IRENA, 2019b).

Establish an energy planning framework with higher shares of renewables

The long-term energy planning process must be solidified through a participatory approach involving a range of stakeholders, thereby ensuring stronger institutional buy-in and rapid resolution of possible constraints. The plan may also address electricity grid infrastructure development that will help smooth the integration of VRE into the system. The plan should provide long-term visibility on renewable energy development prospects in Tunisia.

Within the planning framework, the monitoring system also must be evaluated and revised as needed to permit regular updates, taking into account implementation constraints, technological advances, economies of scale and national climate pledges. With rapidly decreasing costs, storage brings substantial value for grid management as a stand-alone asset, as well as when integrated with renewable power supply. When deployed as part of a holistic strategy storage, coupled with sector coupling, also has the potential to reduce the investment needs in transmission and distribution infrastructure to integrate higher shares of variable renewable power (Annex II).

Consider adopting renewable energy targets for end-use sectors

While renewable energy penetration in the power sector has been the government's priority, strong and clear targets for renewables deployment in end-use sectors would signal the political commitment of the government to the public, investors, international institutions and other relevant stakeholders. This also applies to end users in the industrial and residential heating and cooling, along with the transport sectors.

As a first step, the potential and feasibility for the deployment of various technology options in end-use sectors could be assessed, including, electrification of end-use sectors (see Annex I). As the second step, IRENA finds that policies are the main driver for the uptake of renewables in end-use sectors, where government programmes would pave the way for robust engagement by the private sector in the long-term by promoting competition and innovation in deployment. In general, push, pull and integrated policies, such as mandates and taxes, coupled with financial instruments for research, development and demonstration as well as specific sector targets, would stimulate behavioural and market growth (IRENA, IEA and REN21, 2018).

Improve the mapping of renewable energy resources

The long-term planning process requires the establishment of a solid resource database provided by the detailed zoning of the renewable energy resources across the country, particularly for solar and wind energy. A genuine resource mapping process should include, but not be limited to:

- quantitative assessment of resource potential for various renewable energy resources;
- distance to the grid and the nearest sub-station;
- distance to load centres;
- environmentally sensitive areas; and
- land topography.

In this context, IRENA - with its regional partners the Regional Centre for Renewable Energy and Energy Efficiency (RCREEE) and the League of Arab States (LAS) are currently supporting every country in the region, at an operational level, to build solid foundations for the uptake of renewables.

The partnership is conducting a zoning and suitability study for utility-scale and decentralised solar and wind applications to harness the datasets and methods developed through the Global Atlas initiative. The study would combine the resource quality with local constraining criteria, such as the transmission distance and load centres, to provide insight into the theoretical installable capacity and prospective zones in each case for long-term planning to accommodate high shares of VRE, policy and regulatory regime planning.

Additional analyses would assess the financial viability of identified resource-rich areas, such as estimated investment needs and the levelised cost of electricity. In the urban context, 3D building rooftop and resource irradiation models may assist in identifying the optimal business and policy models required to activate this market.

Simplify procurement procedures for power grid development

STEG is currently developing studies for the development and reinforcement of the national electricity grid infrastructure to align renewable generation development with grid infrastructure reinforcement to enable smooth integration of renewable electricity. These studies would identify the necessary grid infrastructure development scenarios needed, based on planned solar and wind electricity capacity additions to the grid, reaching to 1 000 MW as per current plans.

The implementation of grid infrastructure projects by STEG, however, is subject to lengthy public procurement procedures, delaying the evacuation of electricity from the completed renewable energy projects. Simplification and streamlining of such procedures will help reduce delays and thus prevent possible curtailment of electricity.

4.2 Regulatory framework for renewable electricity generation

The implementation of the current regulatory framework for renewables presents several obstacles and challenges for private sector participation. Strengthening the confidence of private investors to invest in renewables would require the enhancement of relevant primary and secondary legislation (particularly, Law No. 2015-12, Decree No. 2016-1123 and ministerial orders of 9 February 2017).

Furthermore, based on past experiences - and given the inadequacy of information and lack of clarity on the regulatory environment and tendering process - stronger involvement of key stakeholders in the revision process of the regulatory framework would enable addressing some of the key concerns of private investors.

Under the **Self-consumption scheme**, developers are subject to complex administrative procedures, including the requirement for a preliminary validation of the installation request by STEG, the examination of the project by the technical commission CTER and the publication of the agreement signed by MIEM in Tunisia's Official Journal. According to the renewable energy guides released in May 2019, validating requests for projects connected to the MV/HV grid takes six months. The lengthy administrative procedures particularly discourage small-scale renewable energy project developers from advancing their projects.

In addition, the current regulatory framework stipulates a complex metering and billing system for establishments connected to the MV grid, which are registered under the uniform tariff regime. This mode of energy metering excludes those consumers that do not match the required renewable energy production profile, including solar PV projects by local administrations for public lighting purposes.

The tariffs for the sale of surplus electricity produced are currently set at low levels and have not been revised since 2014, despite multiple increases in electricity prices. This has constrained growth electricity production, pushing self-consumers to reduce their installed renewable capacity to levels in line with their own consumption needs, rather than selling excess production to STEG.

With respect to the **Authorisation scheme**, one of the main concerns for private developers is the absence of standardised contractual documents for bid submissions, thus resulting in discrepancies and lack of transparency, eventually reducing the bankability of PPAs. In general, the absence of any guarantee scheme regarding the off-taker risks limits the attractiveness of PPAs.

The results of the first call for projects of May 2017 highlighted the constraints in project bankability, where most private sector offers were conditional upon the change in the structure of the PPA.

Owing to this problem, no wind project has been selected at this round of call for projects.

Building on feedback received from the first round, MIEM reviewed the contract and made amendments to the PPA template. These changes, however, were not fully reflected on the ground – various stakeholders were unaware of the consultative process undertaken due to insufficient communication and information from the ministry to private stakeholders.

The second round of calls for projects launched on 30 May 2018 for 70 MW of solar PV and 130 MW of wind energy also has reflected the absence of developer and lender confidence in the process and the overall renewable energy market. Additionally, private developers have often raised concerns pertaining to land acquisition. With the interest shown by these developers in regions with high potential for renewable energy and within proximity of the grid, the price of such land has increased considerably. These landholdings are generally agricultural, and several administrative procedures must be followed to obtain the authorisation to use them for renewable energy facilities.

This situation has prompted developers to search for state land; however, renewable energy Law No. 2015-12 does not set clear criteria for the allocation of state land to private investors. To overcome this problem, MIEM is considering an alternative law that allows temporary occupation of state land by the private sector for a period not exceeding three years.

Corporate PPAs under Law 2019-47 will hedge against rising electricity costs, thus presenting a trade-off for the national utility, STEG. Under the Concession scheme, the requirement to have the parliamentary approval of the concession agreements leads to delays in the implementation of the projects under this scheme.

A virtual platform should be created under the current Authorisation scheme and made accessible to all project developers. The platform would serve as the database for the contractual documents necessary for bid submissions. The public disclosure of these documents will strengthen procurement process transparency and provide clarity.

A complete zoning analysis, therefore, would be advisable before the next round of large-scale projects, to identify the most viable locations for solar PV and wind energy investments.

Projects under the Authorisation scheme also may encounter obstacles in the form of complex land-acquisition agreements, thus dampening the appetite of project developers. A complete zoning analysis, therefore, would be advisable ahead of the next round of large-scale projects, with a view to identifying the most attractive, technically viable and economical locations for solar PV and wind energy investments (Recommendation S.4.1).

The project approval processes under the Concession scheme can also be simplified. An approval mechanism could be placed under the authority of MIEM to accelerate project implementation.

Standardise PPAs for renewable power procurement

The key design elements of current renewable energy PPAs are advised to be reviewed, along with the development of standardised PPAs. Other contractual project document templates for renewable energy projects also should be reviewed as per international best practice.

With the inclusion of corporate PPAs, the key elements may be compared to that of utility-scale PPAs to better understand export criteria. IRENA finds that an auction process run by the system operator lowers possible bids for capacity and power, where the winning bidders would then be able to sign PPAs with corporate buyer of electricity (IRENA, 2018b). This may aid against expensive electricity tariffs. For the duration of the PPA, STEG may need to be engaged directly, as corporate PPAs diminish STEG revenues.

In this context, the Open Solar Contracts initiative can provide the necessary contractual templates that would be included in the bidding process for solar projects. This would include the PPA template (IRENA, 2018a) (Box 3).

Streamline administrative procedures

With respect to the self-consumption scheme for small self-production projects connected to the MV grid with capacities not exceeding a certain threshold, the obligation for ministerial agreement is mandatory, while technical requests by STEG may be revisited. The procedure for net-metering should be simplified. In this regard, the government may consider adjustment and periodic review of the sales tariffs associated with surplus generation of self-producers.

Box 4. Open Solar Contracts, Tunisia

The energy sector today has a legacy where power generation projects were predominantly large in scale and technically complex. Due to their highly intricate transaction structures, these projects require customised and complex legal and financial solutions, which have been inherited by renewables. This has resulted in high transaction costs and prolonged project development timelines, hindering further capacity growth, particularly in small- to medium-scale renewable energy projects. Redesigning prevailing market practices, therefore, need to become a priority in project development and finance, along with reforming the overly complicated contractual framework.

In response, the International Renewable Energy Agency (IRENA) and the Terrawatt Initiative have jointly launched a drive to simplify and streamline the contractual framework for solar power, so as to unlock greater investments globally. The Open Solar Contracts initiative, supported by multiple reputable law firms, will provide a standardised contractual documentation solution that will be freely and publicly available and is designed to be universally applicable.

The initiative aims to decrease transaction costs, shorten project development timelines and establish a balanced risk allocation between public and private parties.

The initiative presents templates for six core contracts:

1. **Implementation agreement**
2. **Power purchase agreement**
3. **Supply agreement**
4. **Installation agreement**
5. **Operation and maintenance agreement**
6. **Finance term sheet**

Work on the contracts was supported by the review of specific model clauses to address cross-cutting matters in a consistent manner and to reduce complexity. These include:

1. **Governing law**
2. **Dispute resolution**
3. **Grid connection principles**
4. **Corruption and sanction**
5. **Force majeure**

The resulting contract templates are intended to be used in conjunction with one another. This will ensure that the scope of work and the risks are appropriately allocated.

The initiative aims to decrease transaction costs, shorten project development timelines and establish a balanced risk allocation between public and private parties. The initiative also aims to simplify due diligence processes by financiers and to build the ground for project aggregation and securitisation. These would eventually support the rapid and widespread scale-up of solar power to the required level.

Contract templates have been finalised and are available to the global solar power community on *www.opensolarcontracts.org*.

4.3 Institutional framework

Current procedures for the execution of renewable energy projects involve several ministries and public institutions. In addition to MIEM and STEG, institutions dealing with land, agriculture, finance planning and environment are involved, along with several commissions (e.g. CTER), ministries responsible for the control of protected areas and restricted zones, authorities issuing building permits, and those responsible for financial and fiscal incentives. The substantial number of actors involved in the process poses a challenge in the absence of a clear and transparent definition of the responsibilities of each institution, sometimes resulting in conflicting roles.

Public institutions involved in renewable energy projects, including STEG and MIEM, face the challenge of insufficient human resources, thus hindering the fulfilment of their commitments vis-à-vis various processes during project development and implementation. The limitations in number and skills of staff are often a source of delay in the execution of procedures, especially under the Self-production and Authorisation schemes.

Furthermore, in the absence of an independent regulatory authority for the electricity sector, such regulatory function is currently performed by MIEM.

Law No. 2015-12 provides for the creation of a specialised authority responsible for the examination of possible disputes and appeals against decisions of the public administration. At present, however, the specialised authority functions as an advisory body to provide recommendations to MIEM, raising concerns over guaranteeing investors' rights and ensuring transparency during the development, execution and operation of renewable energy projects.

Clarify institutional responsibilities and strengthen institutional capacity

With many ministries and public institutions involved Tunisia's renewable power projects, the procedures for obtaining the required authorisations are complicated and time-consuming. To provide clarification on the roles of various public institutions, consideration should be given to creating an online platform and developing a guidebook.

The platform would include details on the following:

- Roles and responsibilities of the various public institutions across the various stages of renewable energy project implementation.Administrative authorisations that should be obtained from each institution.
- Procedures necessary for obtaining such authorisations.

To ensure the effectiveness of the key public institutions involved in the development of renewable energy, local capabilities could be reinforced by:

- making adequate and qualified human resources available to relevant public institutions to perform assigned duties; and
- organising tailored capacity-building programmes for skill development across the renewable energy value chain, including the technical, economic, administrative and legal aspects of renewable energy to meet NDC targets.

Improve the renewable energy investment environment through establishment of an electricity regulatory authority

On the broader issue of electricity sector operation, creating an independent regulatory authority to oversee the electricity sector would enable a transparent and competitive environment for renewable energy developers.

The regulatory authority would, among other actions:

- monitor effective implementation of the renewable energy-related legislation;
- validate technical conditions for evacuation and grid connection concerns;
- ensure non-discriminatory access for private renewable energy producers to the grid;
- enforce compliance with the governing administrative framework for renewable energy project development and implementation; and
- settle conflicts among market actors relating to the interpretation or implementation of established legislation and procedures.

4.4 Financing

The FTE is the main financing tool for renewable energy and energy efficiency activities in Tunisia. The actions financed by this fund and the forms of its support have been broadened through Decree No. 2017-983 of 26 July 2017. It allows the participation of this fund in renewable energy investments through financing and equity participation, in addition to the original function of grant support.

The practicality of these new schemes is not yet tested, and the participation of the FTE is still limited to grant contribution to renewable projects. The payment of such grant support by the ANME - in charge of managing the FTE - is currently processed with significant delay, causing serious financial problems for companies that are active in the fields of solar water heating and solar PV.

The expansion of FTE support will require the mobilisation of substantial additional resources. Current annual resources are in the order of TND 40 million (about USD 14 million at July 2020 exchange rates), while the new scope of support will require an annual budget of more than TND 100 million (USD 36 million) (ANME, 2015a). The law establishing the FTE envisages the possible imposition of taxes on consumed energy products to resource the FTE, but no provision has been made so far to this effect.

In addition, the incentives granted by the FTE cover a small proportion of the investment. Renewable energy promoters generally seek to close the financing of their projects through bank credits.

Access to bank loans represents a major constraint for renewable energy developers, especially for small projects, since local banks are not accustomed to assuming renewable energy project-specific risks and generally require additional guarantees as a precondition for loan approval.

Operationalise the FTE

Most small-scale applications of solar water heaters and PV rooftop systems in the residential sector, developed under the Prosol and Prosol électrique programmes, have benefited from FTE support thanks to its dedicated financing structures. Development of clear and transparent procedures is needed to implement FTE provisions and define operational conditions and modalities, as well as to equip the fund with adequate resources to support renewable energy development at a larger scale. The structure of the fund may be revisited, for instance, to give it financial autonomy and help it act as an effective financial intermediary that makes credit lines and equity investment available to different projects.

Create a dedicated financing mechanism for solar water pumping

Water pumping is vital to the agriculture sector. A dedicated programme for solar water pumping set up by the government - or MIEM under FTE support - and supported by an appropriate financing mechanism could encourage farmers to use solar PV systems as a substitute for diesel generator sets. Such financing mechanism could rely on concessional lending schemes compatible with the repayment capacity of farmers.

Encourage the involvement of local banks in renewable energy financing

The development of renewable energy solutions, especially for farmers and small- and medium-size enterprises (SME), requires a stronger involvement of local banks in the financing of renewable energy projects. The technical dimension of local banks may need to be reinforced to develop capacity for renewable energy projects. Appropriate partnership/co-financing mechanisms should be explored with international financing institutions and bilateral funding partners, including climate funding instruments and programmes, to meet the country's NDC commitments.

In turn, allowing local banks to serve as a financial intermediary to receive resources from international banks may address risk concerns surrounding lending procedures. In this case, setting up credit lines through intermediary financial institutions tends to attract investments to the sector. This increase will lead to Tunisia's Central Bank's endorsement of national loan guarantee schemes. In this context, the scope of the Tunisian Guarantee Company (Société Tunisienne de Garantie) mechanism could be expanded to include renewable energy projects.

Dedicated capacity building programmes can be developed to target the local financial sector and to incentivise project developers to improve the knowledge of, and enable easier access to, the available financial tools. This will help reduce and better address the risks, as well as enhance investment conditions relating to renewable energy projects.

4.5 Maximising the benefits of renewable energy deployment

Deployment of renewable energy presents considerable socioeconomic benefits and opportunities for local value creation along the various segments of the value chain. This includes the sourcing of raw materials, manufacture and assembly of components, construction and installation, and operation and maintenance.

IRENA's assessment of Tunisia's renewable energy manufacturing potential found that there is unfulfilled potential to leverage local value creation along the entire value chain of large-scale solar and wind projects. For example, certain electrical and mechanical components of wind turbines can be produced locally that could account for more than 70% of wind turbine costs (EIB and IRENA, 2015).

Tunisia has well-qualified staff for research and development activities, such that intellectual property rights are well protected, and the quality of its research institutes is acknowledged. Despite these assets, upgrading programmes are necessary for local companies to move from low-value to relatively high-value activities (EIB and IRENA, 2015).

Implement upgrading programmes targeting specific industrial actors

Industrial upgrade programmes can serve as strong assets in the effort to strengthen the capabilities of local firms. These programmes would aim to enhance the technological capabilities of SMEs by enabling them to capture value from renewable energy investments and to facilitate closer linkages with business partners. Therefore, with the support of public authorities and other local stakeholders, developing industrial and service-sector policies can help promote the solar and wind value chains.

Box 5. Leveraging local capacity and the materials required for renewable energy technologies

Renewable energy development can drive economic growth, create new jobs and enhance human health and welfare. To design effective policies in support of value creation, however, policy makers need a thorough understanding of the materials and labour requirements.

The Leveraging Local Capacity report series (IRENA, 2017a; 2017b; 2018c) examines these requirements in the solar photovoltaic (PV) and onshore and offshore wind industries.

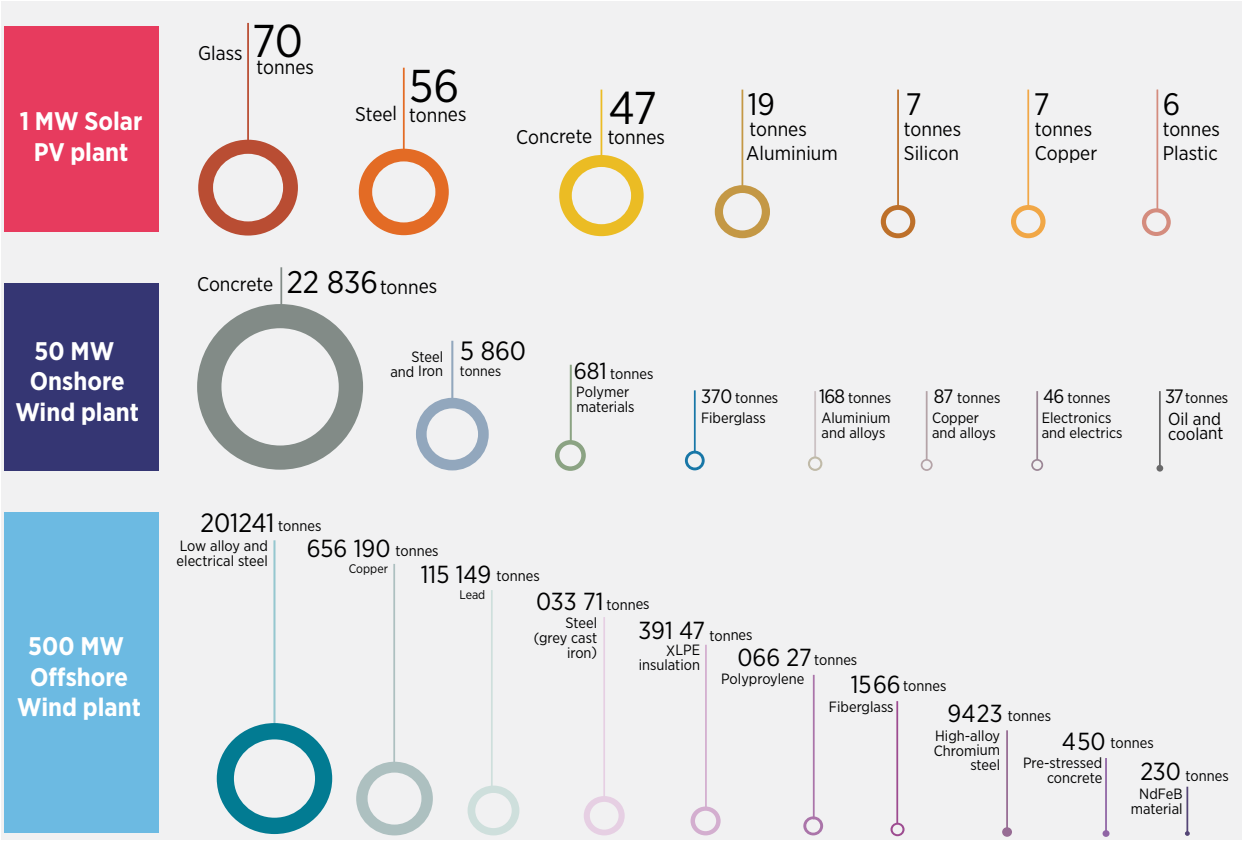
The figure below shows the main materials needed for plants in these industries, and thus indicates the sort of industries most relevant to renewable energy deployment.

Leveraging this capacity can provide expertise, raw materials and intermediary products for the manufacture of PV components, such as cells and modules, inverters, trackers, mounting structures and electrical equipment.

For a typical 50 megawatt (MW) onshore wind facility, almost 23 000 tonnes of concrete are necessary for the foundations, and nearly 6 000 tonnes of steel and iron for the turbines and foundations. For offshore wind, the requirements are similar. Manufacturing the main components of a wind turbine requires specialist equipment, as well as welding, lifting, and painting machines that are used in other industries, such as construction and aeronautics.

Examining these requirements provides insights into industrial capabilities that can be leveraged. The figure below indicates the materials required for a 1 MW solar PV plant, a 50 MW onshore wind plant, and a 500 MW offshore wind plan.

Materials for a solar photovoltaic plant (1 MW) onshore wind plant (50 MW) and offshore wind plan (500 MW)



Box 6. Leveraging local capacity, distribution of human resources and occupational requirements

The *Leveraging Local Capacity* report series of the International Renewable Energy Agency (IRENA, 2017a; 2017b; 2018c) generates valuable information for policy makers on the occupational and skill structure along the value chain. The figure below illustrates the labour force requirement for solar photovoltaic plants and onshore and offshore wind farms.

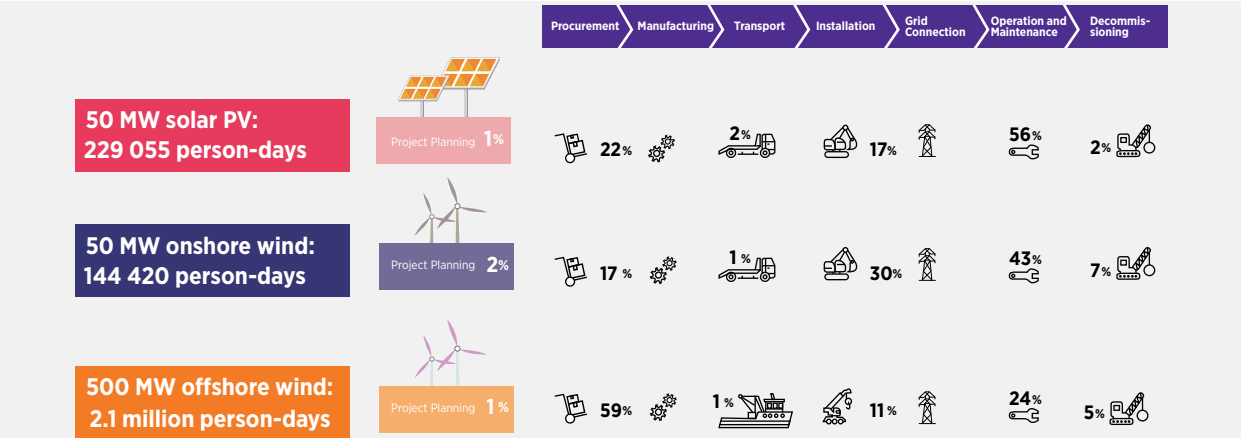
To develop a typical 50 MW solar photovoltaic project, a total of approximately 230 000 person-days is required from project planning to manufacturing, installing and operation and maintenance (O&M), as well as decommissioning. The highest labour force requirements are in O&M (56%), followed by procurement and manufacturing (22%) and construction and installation (17%).

In the procurement and manufacturing segment, factory workers and technicians represent 64% of the labour need, followed by engineers (12%). In the O&M segment, construction workers account for 48% of the labour force requirements, followed by safety experts (19%) and engineers (15%).

Similarly, for the development of a 50 MW onshore wind project, a total of 144 000 person-days is needed. Human resource requirements are highest in O&M (43% of total), followed by construction and installation (30%) and manufacturing (17%).

For offshore wind, the majority of human resources (totalling 2.1 million person-days for a 500 MW farm) lies in the manufacturing and procurement segment. Existing manufacturing facilities for onshore wind can serve the needs of the offshore sector, as many components are comparable. Significant synergies also exist between the offshore oil and gas industry and the offshore wind sector.

Human resource needs for renewable energy infrastructure



Educate and train skilled workforce

Investment in the education and training of engineers and other high-skilled workers is considered a key building block for expanding local institutional capacity in renewable technologies. Agencies and associations already active in such initiatives include (i) the Cairo-based Regional Center for Renewable Energy and Energy Efficiency (RCREEE); (ii) the regional RE-ACTIVATE project of the Germany International Cooperation Agency (GIZ – Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH); (iii) ANME; (iv) the National Centre for Continuing Vocational Training and Professional Promotion (Centre National de Formation Continue et de Promotion Professionnelle); and (v) the Research and Technology Centre for Energy Technologies (Centre de Recherches et des Technologies de l'energie). Such stakeholders have been development and dissemination of energy policies, research activities and training on low- and medium-power renewable applications (e.g. rooftop PV, solar water heaters, water pumping).

Similar efforts could address the training needs of large-scale projects. The role played by international institutions on educational policies through the inclusion of renewables in educational programmes and strategic planning to meet the required skills needs, therefore, will be essential to instil a skilled workforce.

References

ANME (Agence Nationale pour la Maitrise de L'energie) (2019), Agence Nationale pour la Maîtrise de l'Energie (National Agency for Energy Management), *www.anme.tn*, (accessed 20 March 2021).

ANSAmed (n.d.), "Enel vying for Solar and Wind Project in Tunisia", 5 December, *www.ansamed.info/ansamed/en/news/sections/economics/2018/12/05/enel-vying-for-solar-and-wind-project-in-tunisia_cf029e32-4eed-40e5-8707-01ac67d83208.html*.

Bennani & Associés (2018), *Renewable Energy in Tunisia*, Bennani & Associés , Tunisia Office, Tunis, *http://rnepartner.com/wp-content/uploads/2018/08/RnE-Tunisia-market-update-2018.pdf*.

Central Bank of Tunisia (2018), *Annual Report on Banking Supervision 2017*, Central Bank of Tunisia, Tunis, *www.bct.gov.tn/bct/siteprod/documents/sup_bc_ang.pdf*.

EIB (European Investment Bank) and IRENA (International Renewable Energy Agency) (2015), *Evaluating Renewable Energy Manufacturing Potential in the Mediterranean Partner Countries*, EIB, Luxembourg City; IRENA, Abu Dhabi, *https://irena.org/-/media/Files/IRENA/Agency/Publication/2015/femip_study_evaluating_renewable_energy_manufacturing_potential_en.pdf*.

GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit) (2014), *Analysis of the Regulatory Framework Governing Network Access for Producers of Electricity from Renewable Energy Sources in Tunisia*, GIZ, Bonn, *www.giz.de/en/downloads/giz2014-en-renewable-energy-resources-tunisia.pdf*.

GIZ (2013), *Study on the Renewable Energy Potential for Electricity Generation for National Consumption in Tunisia and Export to the EU*, Final Report, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Bonn, *https://energypedia.info/images/2/2b/Renewable_energy_potential_for_electricity_generation_for_national_consumption_in_Tunisia_and_export_to_the_EU.pdf*.

IEA (International Energy Agency) (2019), Data and Statistics, IEA, Paris, *www.iea.org/statistics/balances* (accessed 16 January 2019).

INS (National Institute of Statistics) (2018a), Energie, Statistiques Tunisie, *www.ins.tn/en/themes/energie* (accessed 16 January 2019).

INS (2018b), Energy Import Bill, *http://dataportal.ins.tn/en* (accessed 16 January 2019).

IRENA (2020a), *Power Sector Planning in Arab Countries: Incorporating variable renewables*, IRENA, Abu Dhabi, *www.irena.org/publications/2020/Jan/Arab-VRE-planning*.

IRENA (2020b), *Renewable Capacity Statistics 2020*, IRENA, Abu Dhabi, *www.mitigationmomentum.org/downloads/NAMA-proposal-for-renewable-energy-and-energy-efficiency-in-the-building-sector-in-Tunisia_December%202015.pdf*.

IRENA (2019a), *Renewable Power Generation Cost in 2018*, IRENA, Abu Dhabi, *www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/May/IRENA_Renewable-Power-Generations-Costs-in-2018.pdf*.

IRENA (2019b), *Innovation Landscape for a Renewable -Powered Future*, IRENA, Abu Dhabi, *www.irena.org/publications/2019/Feb/Innovation-landscape-for-a-renewable-powered-future*.

IRENA (2018a), *Open Solar Contracts*, International Renewable Energy Agency, Abu Dhabi, *https://opensolarcontracts.org*.

IRENA (2018b), *Renewable Energy Auctions: A Guide to Design*, International Renewable Energy Agency, Abu Dhabi, *www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/Jun/IRENA_Renewable_Energy_Auctions_A_Guide_to_Design_2015.pdf*.

IRENA (2017a), *Renewable Energy Benefits: Leveraging Local Capacity for Solar PV*, International Renewable Energy Agency, Abu Dhabi, www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Jun/IRENA_Leveraging_for_Solar_PV_2017.pdf.

IRENA (2017b), *Renewable Energy Benefits: Leveraging Local Capacity for Onshore Wind*, IRENA, Abu Dhabi , www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Jun/IRENA_Leveraging_for_Onshore_Wind_2017.pdf.

IRENA, IEA (International Energy Agency) and REN21 (2018), *Renewable Energy Policies in a Time of Transition*, International Renewable Energy Agency, Abu Dhabi; Organisation for Economic Co-operation and Development/ IEA, Paris; and REN21, Paris, www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Apr/IRENA_IEA_REN21_Policies_2018.pdf.

MDICI (Ministry of Development, Investment and International Cooperation) (2017), *Investment Law*, MDICI, Tunis, www.mdici.gov.tn/en/ministry/investment/presentation.

MISME (2019a), *Tunisia Energy Status 2019*, Tunis, Ministry of Industry and Small and Medium Enterprises, www.tunisieindustrie.gov.tn/

MISME (2019b), *National Energy Balance*, Tunis, Ministry of Industry and Small and Medium Enterprises, www.tunisieindustrie.gov.tn/

MISME (Ministry of Industry, Small and Medium Enterprises) (2019c), *Renewable Energy guide summary*, Tunis, Ministry of Industry and Small and Medium Enterprises, www.tunisieindustrie.gov.tn/upload/ENR/Guide_detaille_ENR_tunisie_mai2019.pdf

MEMTE (2019a), "Result of the restricted call for tenders for electricity production from solar PV projects in the concession regime", Ministry of Industry and Small and Medium Enterprises, Tunis, www.energymines.gov.tn/web/resultat-AOR-500MW.pdf

MEMTE (2019b), "Results of the second round of the call for projects for electricity production from renewable energy under the authorisation scheme", Tunis, www.energymines.gov.tn/web/documents/resultat-second-round-solaire-10mw.pdf

MEMTE (2019c), Call for projects for the production of electricity from renewable energies within the framework of the authorization system third round, Ministry of Energy, Mines and Renewable Energy, Tunis, www.energymines.gov.tn/web/addendum-troisieme-round.pdf

MEMTE (2019d), Results of the second round of the call for projects for electricity production from renewable energy under the authorisation scheme, Tunis, www.energymines.gov.tn/web/documents/resultat-second-round-solaire-1mw.pdf

MEMTE (2018a), *Tunisia Renewable Energy Programme*, Ministry of Energy, Mines and the Energy Transition, Tunis, www.energymines.gov.tn/web/Actualites/livret_pst.pdf

MEMTE (2018b), "Call for prequalification applications for the concession of wind power plants with a total capacity of around 500 MW", Ministry of Energy, Mines and the Energy Transition, Tunis, www.energymines.gov.tn/web/autorisation-eo.htm

MEMTE (2018c), "Call for prequalification applications for the concession of photovoltaic solar plants with a total capacity of around 500 MW", Ministry of Energy, Mines and Renewable Energy, Tunis, www.energymines.gov.tn/web/autorisation-pv.htm

MEMTE (2018d), "List of prequalified companies for the 200 MW concession", Ministry of Industry, Mines and Renewable Energy, Tunis, www.energymines.gov.tn/web/documents/liste-MEMprequalifies-PV.pdf

MEMTE (2017a), *Procedural Manual – Electricity Production Projects from Renewable Energy Subject to the Authorisation System*, Ministry of Industry and Small and Medium Enterprises, Tunis, www.energymines.gov.tn/web/documents/Contrat-ventePPA.pdf.

MEMTE (2017b), "Call for projects for the Production of Electricity from Renewable Energy within the Framework of Authorisations – Round One", Ministry of Industry and Small and Medium Enterprises, Tunis, www.energymines.gov.tn/web/autorisation-eo2.htm.

MEMTE (2016), "Official Journal of the Republic of Tunisia", Article 2, Ministry of Energy, Mines and Renewable Energy, Tunis, www.energymines.gov.tn/web/documents/cc-raccordementBT.pdf

Mitigationmomentum (2016), NAMA for renewable energy and energy efficiency in the building sector in Tunisia, March 2016, www.mitigationmomentum.org/downloads/NAMA-proposal-for-renewable-energy-and-energy-efficiency-in-the-building-sector-in-Tunisia_December%202015.pdf

ONE (Observatoire National de l'Energie et des Mines) (2018a), National Energy Balance 2016, ONE.

pv magazine (2019a), "Lowest bid in Tunisia's 500 MW solar tender comes in at $0.0244", 23 July, www.pv-magazine.com/2019/07/23/lowest-bid-in-tunisias-500-mw-solar-tender-comes-in-at-0-0244.

pv magazine (2019b), "Tunisia reveals winners of second 70 MW PV tender", 1 April, www.pv-magazine.com/2019/04/01/tunisia-reveals-winners-of-second-70-mw-pv-tender.

pv magazine (2018), "Tunisia shortlists developers for 500 MW tender", 29 November, www.pv-magazine.com/2018/11/29/tunisia-shortlists-developers-for-500-mw-tender.

RES4MED (Renewable Energy Solutions for the Mediterranean) (2016), *Renewable Energy Solutions for the Mediterranean – Country Profiles: Tunisia*, www.res4med.org/wp-content/uploads/2017/11/Country-Profile-Tunisia-Report_05.12.2016.pdf.

Solarthermalworld (2017a), *Tunisia: National Subsidy Scheme Prosol Extended to 2020*, Solarthermal world, www.solarthermalworld.org/news/tunisia-national-subsidy-scheme-prosol-extended-2020

STEG (Tunisian Company of Electricity and Gas) (2019a), *Annual Report 2018*, Tunisian Company of Electricity and Gas, Tunis, www.steg.com.tn/fr/institutionnel/publication/rapport_act2018/Rapport_Annuel_steg_2018_fr.pdf.

STEG (2019b), "Electricity Tariffs HT-MT for September 2018", Tunisian Company of Electricity and Gas, Tunis, www.steg.com.tn/fr/clients_res/tarif_electricite.html.

STEG (2018a), *Annual Report 2017*, Tunisian Company of Electricity and Gas, Tunis.

STEG (2016), Retrospective Electricity Statistics (2005-2015), Tunisian Company of Electricity and Gas, Tunis, www.steg.com.tn/fr/institutionnel/perspective_qualite.html

Trading Economics (2020), *Tunisia GDP Annual Growth Rate*, https://tradingeconomics.com/tunisia/gdp-growth-annual (accessed April 17)

UN (United Nations) (2008), "Geothermal Energy Development in Tunisia: Present Status and Future Outlook", United Nations University, Geothermal Training Programme, Reykjavik, https://orkustofnun.is/gogn/unu-gtp-30-ann/UNU-GTP-30-20.pdf.

UNDP (United Nations Development Programme) (2018a), "Tunisia: Country Profile", Factsheets, UNDP, New York, www.ndcs.undp.org/content/dam/LECB/docs/factsheets/Tunisia.pdf.

UNDP (2018b), *Tunisia: Market Readiness Proposal*, United Nations Development Programme, New York, https://info.undp.org/docs/pdc/Documents/TUN/Tunisia%20MRP%20English.pdf.

World Bank (2020), *Global Solar Atlas*, World Bank, Washington, DC, https://globalsolaratlas.info/map?c=11.523088,8.173828,3 (accessed 30 July 2020)

Annex 1.
Renewable energy institutional roles

Several institutions play a role in the development of renewable energy in Tunisia. Table A1.1 summarises the key actors and their tasks relating to the promotion and development of renewable energy.

Table A1.1. **Institutions involved in the development of renewable energy, Tunisia**

Institutions	Principal missions
Research and Technology Centre of Energy (Centre de Recherches et des Technologies de l'energie) Under the Ministry of Higher Education and Scientific Research (Ministère de l'Enseignement supérieur et de la Recherche scientifique)	• Conduct research on renewable energy; mainly PV, wind and solar water heaters
Tunisian Agency of Vocational Training (Agence Tunisienne de Formation Professionnelle) Under the Ministry of Employment (Ministre de la Formation Professionnelle et de l'Emploi, MFPE)	• Oversee vocational training
National Centre of Continuing Vocational Training and Professional Promotion (Centre National de Formation Continue et de Promotion Professionnelle) Under MFPE	• Manage the 1.5% of tax revenues designated for vocational training of professionals, include those in renewable energy • Finance the training of professionals in the public and private sectors • Provide technical assistance for the development of training plans and strategies for private companies
National Centre for Instructor Training and Training Development (Centre National de Formation de Formateurs et d'Ingénierie de Formation) Under MFPE	• Develop training programmes and materials • Include the provision of training to trainers to disseminate necessary knowledge
Mechanical and Electrical Industries Technical Centre (Centre Technique des Industries Mécaniques et Electriques) Under MISME	• Address the company's relevant know-how and address competency • Test products, electrical and mechanical components and equipment • Establish a laboratory to test solar PV modules (not yet functional)
Building Materials, Ceramics and Glass Technical Centre (Centre Technique des Matériaux de Construction, de la Céramique et du Verre) Under MISME	• Operate laboratory to test the thermal performance of solar water heaters • Aid solar water heater manufacturers to improve their products
National Institute of Standardisation and Industrial Property (Institut National de la Normalisation et de la Propriété Industrielle) Under MISME	• Develop standards • Certify compliance with product and service standards • Currently developing the Tunisian national certification system for solar heating according to ISO 17065

Ministry of Energy, Mines and Energy Transition (Ministère de l'Energie, des Mines et de la Transition Energitique,MEMTE) Directorate-General for Electricity and Renewable Energy (Direction Générale de l'Electricité et des Energies Renouvelables)	• Define strategic guidelines for the energy sector • Determine energy tariffs • Set purchase price and transmission tariff of surplus electricity produced by self-producers • Decision for granting funding from the Energy Transition Fund (FTE) • Participate in the development of renewable energy laws and regulations • Examine the requests for private production and self-consumption of electricity from renewable energy following their execution
Ministère de l'Industrie et des Petites et Moyennes Entreprises Directorate-General for Manufacturing Industries (Direction Générale des Industries Manufacturières)	• Develop and implement government policy in areas relating to industry
National Agency for Energy Conservation (Agence Nationale pour la Maîtrise de l'Energie)	• Implement policies developed by MEMTE in the fields of energy efficiency and renewable energy • Propose regulations governing renewable energy • Manage the FTE • Manage specific renewable energy programmes (e.g Prosol, Prosol électrique) • Conduct studies on the development of renewable energy • Promote awareness and training
Tunisian Company of Electricity and Gas (Société Tunisienne de l'Electricité et du Gaz)	• Adjust current technical conditions on the electricity grid • Implement and operate renewable energy projects • Contribute to the implementation of renewable energy programmes (e.g Prosol, Prosol électrique)
Technical Commission for Renewable Energy (Commission Technique de production privée à partir des Energies Renouvelables)	• Issue opinions on power generation projects from renewable sources subject to the authorisation regime • Verify the appropriateness of renewable energy projects located on state land
Technical Advisory Committee (chaired by National Agency for Energy Conservation)	• Approve FTE grant applications
Ministry of Finance (Ministère des Finances)	• Take decisions to grant tax benefits • Collect funds for FTE
Renewable energy associations (Chamber of National Union of Renewable Energies (Chambre Syndicale Nationale des Energies Renouvelables /Tunisian Solar Installers' Association (Chambre Syndicale du Photovoltaïque)	• Oversee administrative practices of renewable energy professionals • Conduct training of professionals (e.g. solar water heater and photovoltaic (PV) installers) • Continue dialogue with public institutions

Annex 2.
Sector coupling and the electrification of end-use sectors

The current energy diversification strategy in Tunisia has set a target to meet 30% of its electricity generation from renewables. To achieve such ambitious targets, several enabling initiatives have been established. As solar and wind power gain momentum, they will occupy a larger share of power generation. To accommodate such a large share of electricity, therefore, a stable and flexible grid is essential to maintain reliability and avoid production being curtailed. In the Tunisian context, the current grid is unable to accommodate the ambitious 2030 targets, and additional grid reinforcement measures should be taken.

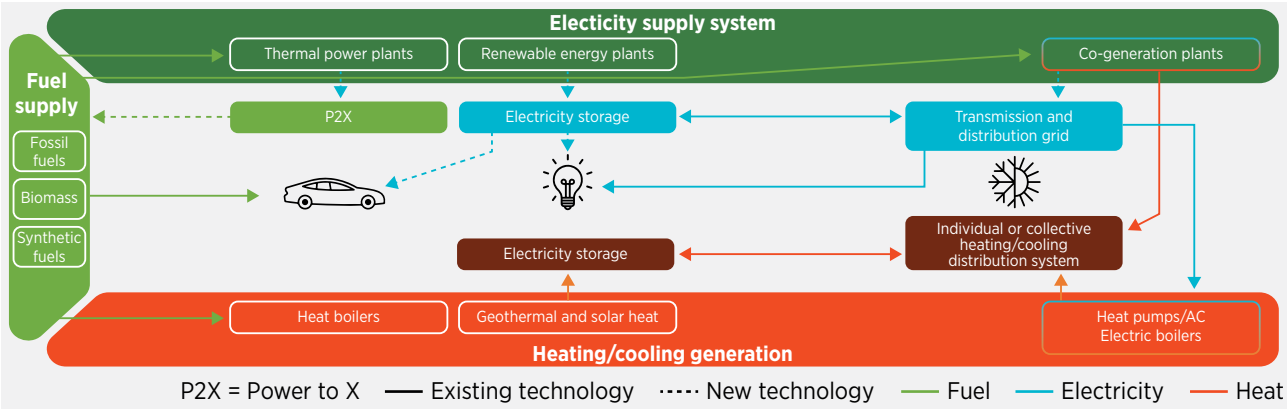
Grid reinforcement measures require significant investment. The report, **Renewable Energy Policies in a Time of Transition**, by the International Renewable Energy Agency, International Energy Agency and REN21 (2018) concluded that policy makers in charge of energy sector planning must explore different cost-efficient methods to address curtailment. In turn, cost-efficient sector coupling may better align electricity demand with variable renewable energy (VRE) production profiles. This is achievable if proper strategies for shaping the demand profile are adopted. Several options are available, including the **electrification of heating and cooling, stationary long- and short-term energy storage, and key sector-coupling applications, such as electric vehicles (EVs)** (Figure A2.1).

Global sales of electric vehicles (EV) hit a record high in 2016. Despite being in the early phases of deployment, the International Renewable Energy Agency has found that EVs have significant potential, its analysis indicating that there likely will be 157 million vehicles in 2030. EVs can assist in providing valuable system services, thus increasing the value of VRE by ensuring that energy is consumed at times of high VRE production.

In addition, electricity can replace fossil fuels in industry and help reduce its energy-related – and, in some cases, process-related – greenhouse gas emissions, while providing enhanced flexibility to the system. Additional sector coupling can be achieved by using renewables to produce hydrogen or hydrogen-rich chemicals to serve as feedstock, process agents or fuels. Power-to-gas or power-to-liquids (commonly named Power-to-X (P2X)) technologies combine hydrogen with carbon or nitrogen to produce fuels for end-use sectors. Producing storable energy carriers, such as hydrogen or synthetic fuels, can increase the long-term value of VRE.

For Tunisia to meet its renewable energy targets, it needs to establish direct policies for the various end-use sectors within the overall energy planning process. As presented in Figure A2.1, several opportunities are available, including the electrification of the heating and cooling sectors, the transport sector and industrial processes, coupled with the use of synthetic fuels. These provide ample opportunities to address flexibility concerns and increase renewable energy deployment (IRENA, IEA and REN21, 2018).

Figure A2.1. **Project proposal procedure for energy-selling projects under Concession scheme, Tunisia**



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