ETF Working together Learning for life
European Training Foundation

THE EU AGENCY SUPPORTING COUNTRIES TO DEVELOP THROUGH LEARNING

THE FUTURE OF SKILLS

CASE STUDY OF THE ENERGY SECTOR IN TUNISIA

Disclaimer

This report was prepared for the ETF.

The contents of the report are the sole responsibility of the ETF and do not necessarily reflect the views of the EU institutions.

PREFACE

In November 2018, the European Training Foundation (ETF) launched an international investigation to examine how global trends impact upon developing and transition economies and to explore the actions needed to prepare labour forces in a changing world. The ETF conference 'Skills for the Future: Managing Transition' concluded that monitoring and understanding how skills demand develops in the face of ongoing technological change and the greening of the economy was an essential prerequisite for any informed policy response.

The ETF and its partners found that countries could best anticipate emerging skills needs by combining traditional methods of data collection and analysis with emerging approaches driven by the application of data science techniques.

This study on the future of skills in the energy sector in Tunisia was launched following the above discussion. The study investigates how various drivers of change – mainly technological – impact upon occupations and related skills in the sector and how education and training are adapting to these changing needs. The rationale behind this choice, besides the importance of energy production for the Tunisian economy, is to understand how the climate crisis and the push for more sustainable development affect the demand for skills.

The study concentrates on the changing skills needs and occupations driven by technological innovation. It does not assess potential changes in the volume of employment and skills demand; instead, it provides qualitative information on occupations, identifying the skills that people working in the energy sector will increasingly need to acquire. The study also provides information on how companies adapt to technological change and acquire the associated skills. As such, it gives an indication of how the supply of skills is keeping pace with technological advances in the energy sector. Ultimately, the aim of the study is to raise awareness of the changing skills demand, identify pointers of change and stimulate a discussion among policymakers and practitioners in the field, so that the findings can be further exploited and used to adapt education and training provision.

The study is part of a series of ETF studies focusing on economic sectors that present niches of innovation and potential for further development in its partner countries. It is based on a new methodological approach that combines traditional research methods (desk research, data analysis and interviews) with the use of big data text mining techniques. The use of big data analysis is gaining traction in skills research. Despite some limitations, it provides new insights and real-time information on recent trends. When combined with other methods – such as interviews with key stakeholders, statistical analysis of skill trends, etc. – it provides a powerful means of identifying emerging skills needs and their implication for education and training provision and the reskilling of workers within companies.

Fondazione Giacomo Brodolini and Erre Quadro worked with the ETF to conduct the sector studies in various countries. A group of international and national researchers from each country was brought together to carry out the studies in addition to the ETF's team of experts. The study in Tunisia was conducted between August and November 2021. This report was drafted by Riccardo Apreda, Liga Baltina, Riccardo Campolmi, Chiara Fratalia and Terence Hogarth with input from national expert Ayoub Baba and extensively commented on by ETF experts Ummuhan Bardak, Abdelaziz Jaouani and Sabina Nari.

The report documents all steps of the research and presents the findings in a detailed manner. This is because the ETF wants to raise awareness among all stakeholders in the partner countries – be they researchers, practitioners or policymakers – about the changing skills needs in the energy sector. The findings also provide food for thought, especially in relation to the ability of the education and training system to respond to the changing skills demand and prepare workers for the new jobs and occupations that are likely to emerge. Shorter and more targeted publications (e.g. policy briefs, infographics, a methodological note) and further discussion papers will follow at a later stage after all the case studies have been completed.

Finally, the ETF would like to thank all the relevant public and private institutions and individuals (see the list in Annex 2) in Tunisia for sharing information and views and actively participating in the ETF's online consultation workshops organised in September and November 2021. This report would not have been possible without their contributions.

CONTENTS

EXECUTIVE SUMMARY

Overview of the Tunisian energy sector

The energy sector comprises all activities related to the production and supply of energy, including both non-renewable (petroleum products, gas, nuclear, etc.) and renewable (e.g. hydropower, biofuels, solar and wind power) sources. It encompasses all steps from exploration and extraction to transportation, refining and distribution of oil or gas reserves, oil and gas drilling, pipeline and refining, mining (coal, nuclear), and renewable energy. As such, it includes the electrical power industry: generation, distribution networks and sales. Jobs and skills are the occupational focus of the sector, with particular attention paid to technological change in this report.

Tunisia is heavily reliant on fossil fuels for its energy needs, with natural gas and oil accounting for 53% and 47% of total energy demand respectively (in 2018). Most of its energy is imported, mainly from neighbouring Algeria, which provides half of all natural gas supply to Tunisia and 72% of total electricity production. This is a recent development in a country that was once a net exporter of oil and gas. As of 2018, energy imports accounted for 51% of Tunisia's energy consumption (World Bank, 2019), posing a real challenge to the country's energy security. In 2020, just 3% of energy production came from renewable sources, mostly wind (International Trade Administration, 2021), while the remaining 97% came from fossil fuels.

The energy sector in Tunisia is highly subsidised, accounting for up to one third of the fiscal deficit (World Bank, 2019). The system of subsidies for oil products, natural gas and electricity aims to protect low-income consumers by lowering market prices. The cost of the subsidy system has increased over time due to a fall in local currency value, the decrease in national energy production and the reduction in rent income from the Algerian gas transit to Italy (Dhakouani et al., 2020).

The economic environment in which the energy sector operates has faced several serious crises in recent decades, with the Arab Spring providing a dividing line between two distinct chapters of economic development. The early 2000s saw strong growth in the services sector, FDI and the private sector. The 2008 economic crash, its concurrent food crisis and the 2011 Arab Spring reset the direction of the country with a new political landscape and a severe economic setback. Whilst key economic indicators such as unemployment have improved over the past decade, the onset of the COVID-19 pandemic has once again caused a significant downturn for the Tunisian economy.

Since the introduction of the Energy Law in 2015 and its later implementations in 2017, Tunisia has begun to review its energy strategy for the next 20 years. The fundamental challenges for the Tunisian Government are to ensure energy security and implement its COP 21 commitments. These include reducing CO_2 emissions by 41% by 2030 (Jeune Afrique, 2015) and meeting the renewable energy (RE) target by increasing the percentage of energy from renewables in the energy mix to 30% by 2030. The country has a high renewables potential, particularly in wind and solar, which the Tunisian Government hopes to exploit.

Tunisia pioneered a sustainability focus on energy production and consumption in the 1980s. This involved attempts to reduce energy intensity, strengthen energy independence and reduce carbon emissions. This focus was implemented through three pillars: institutional, regulatory and financial. The key institution for the energy sector in Tunisia is the National Agency for Energy Management (ANME) founded in 1985 and operating under the supervision of the Ministry of Energy. Other key players include the Société Tunisienne de l'Electricité et du Gaz (STEG) and the Observatoire National de l'Energie et des Mines (ONEM), established in 1990. The regulatory pillar is marked by the adoption of laws stating an ambitious political will to support energy efficiency and renewable energy investments. Key components of this include the Tunisian Solar Plan (TSP) and the Solar Promotion Programme (PROSOL). The main regulatory development in renewable energy in Tunisia came with the 2015 Law establishing a legal framework governing the development of renewable energy projects. The financial pillar is split into three distinct forms: direct subsidies, credit lines and tax benefits.

Tens of thousands of Tunisians enter the labour market every year; in this context, changes in the energy sector can only be expected to play a modest role in job creation. The total level of expected employment will ultimately depend on the amount of renewable energy inputs produced in the country. A multiplier effect from investments in the energy sector can be anticipated both upstream – through the manufacturing of machinery and components – and downstream, within the communities where maintenance is delivered.

It can therefore be observed that Tunisia has laid the institutional, regulatory and financial foundations for a greener energy transition. The cornerstone is the 2015 law, but significant progress will be required to reach the 30% renewable energy mix commitment under the COP 21 agreement. A low-carbon energy network will require new competences and skills in the domestic labour market. The shift towards a greener energy sector will be dependent on building the skills to allow new technologies to be developed, implemented, operated and maintained. The extent to which this creates employment for Tunisia's burgeoning labour market participants will depend upon the development of domestic industry and investment in 'quick wins' such as energy efficiency projects.

Drivers of change

Several factors are driving the evolution of the sector, from the need to reduce dependency on imported gas to an increased awareness of sustainability. The transition phase calls for quick adaptation of the regulatory framework and a clear definition of energy-related long-term strategies.

Various factors, such as growing consumption, the need to increase energy efficiency from production to distribution, and the large potential offered by renewable energy sources ,make Tunisia a particularly favourable environment for creating new job opportunities in the sector.

A combination of big data analysis, insights from desk research, and feedback from interviews has made it possible to identify the following drivers of change in the Tunisian energy sector.

- Environmental sustainability. Given that the main energy source is imported gas, environmental sustainability is a key issue. Tunisia's annual CO2 emissions have steadily increased in recent years, with the energy sector accounting for the largest share of the total, 29% (Worldometers, 2016). The sustainability factor is pushing the country to seek alternative solutions to the fossil fuels on which it has been historically most dependent.
- Investments in energy facilities. Attracting both national and international investments is essential for a sector in which technology adoption requires huge investments. Investors see great potential for investments in Tunisia, provided that the Government's energy vision and strategy are clear and well-defined.
- Policies and regulations in the energy sector. The Government's promptness in responding to endogenous and exogenous factors affects the ability to adapt in this sector. Adopting a clear political vision of the national energy strategy and defining a regulatory framework are fundamental for increasing resilience, confidence and investment.
- Availability of energy sources. Most of Tunisia's domestic energy demand is covered by gas imported from Algeria. With more than 300 days of sun per year, solar energy could be a valid alternative. Tunisia started to deploy solar power solutions in 2010, but the total installed capacity has only reached 55 MW so far. Energy from wind and biofuels might also be considered, to reduce the country's dependency on external sources. Despite its great potential, the country is currently not exploiting its natural sources to their full potential.
- Increased energy consumption. The country's economic growth and the extension of energy coverage to include rural areas mean that the demand for energy in Tunisia is constantly increasing (Enerdata, 2019). To cope with this growth in demand, it is necessary to consider not

only introducing new types of sources in parallel with the traditional fossil fuels, but also strengthening transmission and distribution facilities and increasing energy efficiency.

- Sectoral technological innovation. The sector is continuously evolving with the introduction of innovative solutions. The adoption of new technologies must be accompanied by an improvement in the skills and abilities of the national workforce. The development of up-to-date technical skills must also be supported by managerial skills and a cultural approach that favours the introduction of new technologies.
- Aridity. While the country's climate facilitates the deployment of solar and wind solutions, on the other hand it causes the scarcity of other kinds of resources such as water. Desalinisation units allow natural mineral water to be produced from seawater but require high energy consumption. In this field, the introduction of renewable energies plays an important role: supporting the production and distribution of water in the country in the most sustainable way possible.
- Climate change. Tunisia is a party to the Paris Agreement on climate change. The Government's commitment to produce 30% of the country's energy needs from renewable energy sources by 2030 is a step in this direction. Although the target looks ambitious for a country that currently generates only 3% of its total energy from renewables (International Trade Administration, 2021), it shows the Government's willingness to adapt its energy mix to meet international regulations. Climate change also has an impact on other factors, such as an increase in the already severe problem of aridity.

Emerging technologies

The above-mentioned drivers have implications for the types of technology used in the energy sector.

In particular, patent analysis has shown that wind energy, solar energy, transmission and distribution are likely to be the most active areas of innovation in the future. If Tunisia decides to pursue a strategy of internal energy generation, the possible implication for the relevant occupational profiles and skills should be considered.

A wide range of technologies, in particular digital control systems, offer solutions for enhancing production performance, improving efficiency and reducing energy losses.

Transversal technologies (i.e. those required by various sub-sectors) underpin the development of the sector, but their adoption requires a more diversified set of skills.

Overall, text-mining analysis has revealed the following to be the most commonly mentioned technologies.

- Wind energy technologies:

Wind turbine generators, wind turbines' blades, wind turbine towers, rotary shafts, wind turbine nacelles.

- Solar energy devices:

Solar collectors, photovoltaic power generation systems, solar cell arrays, reflective layers, solar thermal power generation.

- Transmission and distribution solutions:

Solutions for smart grid network and technologies, power transmission, shift devices, energy conversion devices, energy lift devices.

- Thermal energy solutions:

Turbines activated by steam or gas, heat pumps, heat exchangers, roaster modules and chambers.

- Hydropower technologies:

Pumps and systems for hydropower generation, water turbines, water wheels, hydraulic power units.

- Oil and gas extraction technologies:

Various types of wells for production, submersible pumps for crude oil, extraction pipelines, oil pumping drills.

- oil and gas transportation technologies:

Gas and transmission pipelines, branch pipelines, pipeline seal systems, gas pipeline networks, subsea pipelines.

- oil and gas refinery technologies:

Solutions for gas refinement, natural gas and fuel oil distillers, petroleum distillation and for treatment equipment.

- Biofuel energy devices:

Gasification unit and biogas reactors, biofuel cells, biomass containers and fermenters, biogas flow control and monitoring systems.

- Energy-efficiency solutions:

Control systems, control displays, power consumption regulators, energy consumption controllers, meters, power efficiency controllers, supervisory control and data acquisition systems.

The data analysis also mentions nuclear energy, which until recently was considered an unfeasible option for the country's energy production. Should this option be taken into consideration again, the main technologies returned by the analysis are:

- Nuclear energy solutions:

Radiation detectors, radiation protection equipment, nuclear reactors, protective layers, control devices.

Interviews with companies highlighted hydrogen technologies as an additional area of interest for the country, based on hydrogen generation from renewable energy and its export via existing infrastructure. Solutions for this energy source found via text mining show the following to be the most recurrent:

- Hydrogen technologies:

Fuel cells, water electrolysis, high-pressure electrolysis, methane pyrolysis, fermentative hydrogen, underground hydrogen storage, chemical storage, hydrogen pipeline transport.

Changing jobs

The energy sector's capacity to obtain the maximum benefit from new technologies and improve energy efficiency depends on the availability of skills to facilitate their introduction, use, and maintenance. To identify the skills required for the technologies listed above, semantic software was used to match these technologies with the standardised multilingual classification of the European Skills/Competences Qualifications and Occupations (ESCO) database. Since ESCO may not contain emerging (future) jobs or new skills needs, another source – Wikipedia – was also used to identify emerging skills not included in existing classifications.

The results of the text-mining analysis, as well as knowledge from interviews, revealed a variety of occupations likely to be most affected by new technical developments (including new types of energy production and distribution) and new greening policies. These occupations can be grouped according to three broad categories.

- Technical or technology-related occupations comprising those who are competent to manage and use a given technology. The key assumption is that the growing interest in a certain technology will lead, sooner or later, to a growing need for professionals able to use that technology. The scale of demand may vary for a number of reasons, but if that technology is adopted in the country, the related competences and occupations will be needed at least to a certain extent.
- Business services and related occupations, non-technological jobs more related to business aspects such as management, marketing and sales, or export and trade, which are relevant to the business models that companies adopt and the way they organise production. These professions affect the adoption and use of energy technologies.
- Expert positions, i.e. managerial profiles and specialist consultants in specific areas. These roles will be key in guiding and taking full advantage of the energy transition, particularly through the expertise to manage energy projects and improve energy efficiency in every sector of the economy, from energy generation and distribution to industrial production.

Stakeholders believe that increased automation and digitisation will not reduce the overall level of employment in the future, also thanks to the current and expected growth in the renewable energies market and the need for managerial competences.

It is possible to use data mining results not just to list occupations, but also to estimate their relative relevance in the future labour market based on technological trends, and to combine this information with the indications from interviews.

Technical or technology-related occupations

The analysis shows that the professional and associate professional occupations that will be more in demand are engineers and technicians in various fields, from more general profiles such as energy engineer to more specific occupations such as solar energy engineer. In more detail, the top-ranked positions are:

- energy engineer
- mechanical engineer
- civil engineer
- renewable energy engineer
- energy analyst
- solar energy engineer
- electrical engineer
- wind energy engineer
- energy system engineer
- power distribution engineer

Demand will also increase for medium-skilled technical occupations related to day-to-day operations, such as the following:

- control panel assembler
- solar energy technician
- control panel tester
- electrical equipment assembler
- battery assembler
- industrial electrician
- solar power plant operator
- power plant control room operator
- electricity distribution worker
- electrical equipment inspector

The above are aggregated results. Studying the potential demand by sub-sector shows that while some professionals have vertical competences related to a specific sub-sector (e.g. wind energy engineers, substation engineer, drilling engineer, oil refinery control room operator), others have more transversal competences covering more or all sub-sectors (e.g. mechanical engineer, energy engineer, manufacturing manager).

While vertical profiles are relevant especially for sub-sectors that are expanding or expected to do so, such as renewable energy, profiles with competences related to different fields will be in high demand due to their transversal relevance; moreover, they will be critical for supporting the energy transition, especially those with competences in energy efficiency, smart grids, and more efficient and sustainable energy management along the entire chain from production to consumption.

A second general finding is that, notwithstanding the technical innovations that are being introduced, the sector is still relying, and will continue to rely in the future, on medium- and low-skilled key figures, such as assemblers, maintainers, technicians and installers, as confirmed by the companies interviewed.

Business services and related occupations

Among business-oriented profiles, demand is high for managerial roles, related to the management of the operational aspect of the plants, and for salespeople and other market-oriented professionals specialising in the energy field, in particular:

- renewable energy consultant
- solar energy sales consultant
- renewable energy sales representative
- manufacturing manager
- operations manager
- energy manager

Expert positions

Specific opportunities are open for experts able to support the country's energy transition, particularly those with the expertise to manage energy projects and improve energy efficiency in every sector of the economy, from energy generation and distribution to industrial production.

Four profiles stand out as rising in demand: environmental manager and waste manager, both needed to ensure the sustainability of energy production (from waste in the case of the waste manager); energy manager, a particularly important role for medium-sized and large companies to monitor energy consumption, detect energy wastes and losses, and identify the measurements and strategies to be taken to improve energy efficiency; and energy assessor, to perform energy audits in buildings and plants.

Skills demand

Looking at how the content of those jobs will develop over the short to medium term, it is necessary to identify which particular skills within the occupations will be increasingly in demand.

One main trend is that workers will need a wider set of skills than before. In relation to energy engineers, for instance, there is a potentially wide range of areas where skills will need to be acquired to master the use of various technologies, such as more specific know-how in solar energy and management of energy projects.

A crucial element of the general trend is the introduction of digital technologies: many different profiles, both technical and business-related, will be required to possess increasingly transversal IT skills. In the coming years, people will be expected to be more digitally linked, while still maintaining basic knowledge. Having skills for example in IT, security testing, data science, AI or VR, in addition to electrical or mechanical competences, will be important for future engineers and technicians.

Due to the pandemic, some new professions and jobs have appeared on the market. These include IT and electronics-related jobs linked to the introduction of SCADA systems and VPNs, as remote working has become more common.

Digitisation and process automation may lead to a reduction in the number of operators working on site and to an upskilling of those working remotely. Installers and maintainers will need to learn digital and remote working techniques.

Another category of emerging new skills relates to the energy transition, from expertise in renewable energy to expertise in energy efficiency and related managerial tasks for greener production. In the coming years, as more solar and wind power plants are expected to be built to meet decarbonisation targets, more installers, maintainers and technicians will be required. High-skilled professional profiles with skills for managing energy projects (how to reduce costs, how to promote projects, etc.) are currently lacking in medium-sized and large companies. Since the development of a new regulatory framework requires the introduction of managerial and administrative roles, more people are more likely to be needed, not only in the private sector but in the public sector as well.

Stakeholders value soft skills highly. Thus, the debate on the future of skills is not just about technical skills, but also the mix of technical and soft skills. In addition to managerial competences such as time and cost management, job approach and attitude are also important for companies. Risk management skills are also particularly appreciated for managerial-level profiles.

Skills provision

According to the interviews conducted for this report, Tunisia's education system provides a solid foundation for the development of high-level profiles such as engineers. Many engineering schools are present in the country (chemical, electrical, mechanical, energy etc.) and provide good educational and theoretical preparation. Seven universities propose degrees directly specialising in the energy field, while various other institutions offer training related to energy. Three engineering schools offer a higher degree dedicated to the energy sector and four universities have master's degrees in this domain.

On the other hand, the number of graduates in the sector decreased in the last 8 years, with an average decrease rate of 4% per year. Master's graduates in energy are increasing but at a slow pace. The market is not successfully absorbing graduates: the number of employees in engineering sectors is stagnating, with a loss of 1% of the workforce in recent years.

The energy training offer is not very diversified at bachelor's and master's level. Energy is mainly studied as a module in other courses in most engineering schools. The contribution of the private sector at master's level is marginal.

Medium-level technical competences are instead in high demand, but the offer is less able to keep pace with companies' needs and requests, especially because of the need for specific skills (e.g. laser welding) still lacking in the workforce.

Vocational training in Tunisia involves several public and private providers. The agencies of the Ministry of Vocational Training and Employment manage 136 vocational training institutions covering 13 sectors, and the energy courses cover 12 specialisms. Initial vocational training is run both in the public sector and by 930 private establishments, but there is no training specifically dedicated to the field of energy; the courses cover general scientific bases. Continuous training has 2 700 training structures overall, and is one of the pillars of the country's human resources development system. Continuous education programmes in the energy sector are also organised by companies, and other institutions and organisations such as ANME.

The main issue is to update curricula in line with the needs of the labour market. With the exception of courses directly organised by companies, common feedback is that there is a distinctive lack of courses on new and specific technologies and practical skills.

Improving skills anticipation

The use of a mixed methodological approach – combining desk research, data analysis, data-mining techniques and interviews with stakeholders – has provided more nuanced information on emerging skills needs. It has identified the key technologies that will drive skills demand over the short-to-medium-term and the skills that will be increasingly in demand. The results can guide future training provision so that skills shortages that might constrain growth can be avoided. The data collected can also be further refined for additional skills forecasting and foresight exercises. As the landscape is continuously evolving, the analysis carried out in this study must be repeated periodically.

Responding to change: the views of stakeholders

The interviews with key stakeholders yielded the following findings.

- There are several factors strongly affecting the development of the energy sector in Tunisia, from the need to reduce the dependence on imported gas, to increased energy consumption by end users. The complexities associated with managing different energy sources and meeting increased demand require long-term strategies to develop the skills that are increasingly likely to be in demand.
- At the same time, various factors may constrain the growth of the energy sector, some of the most notable being the poorly defined regulatory framework, the interruption of several energy projects for political and economic reasons, the shortage of technical profiles and the lack of investments.
- A common perception is that there is a lack of integration between the public and private sectors and that any type of initiative (creation of training centres or surveys on the skills required by the market) is left to the individual company or organisation. The current absence of large-scale energy projects leads in turn to a lack of internal expertise.
- At national level, there are only a few specific courses on energy and renewable energies, some of which are very expensive and inaccessible to part of the population. At the same time, educational and training curricula are sometimes regarded as being too theoretical and not sufficiently up to date with the latest technological developments.
- Companies report a high level of unemployment, particularly among high-skilled profiles. In contrast, there is gap between demand and supply (i.e. vacancies are proving hard to fill) for medium and low-skilled profiles (such as plumbers and welders), which often forces companies to seek the relevant workers abroad. This situation reveals a mismatch between labour supply and demand.
- The reasons given for the skills mismatch and gaps are varied: inadequate curricula (see above); lack of regular skills needs analysis mechanisms to anticipate and plan training programmes; emigration of qualified professionals; lack of experience due both renewables being relatively new in the country and to large projects being on hold.
- Most companies meet their skills needs mainly through internally training new recruits, less often via external training; still others outsource the relevant activities. Interviews revealed a significant degree of outsourcing of the expertise needed by the energy companies, sometimes from abroad.
- To reach the Tunisian Solar Plan target of 30% of production from renewable energy by 2030, projects must be unlocked to encourage investments and skills must be updated.
- Some progress and good practices are in place, for example the introduction by the Government of a certification for photovoltaic installers. A possible suggestion could be to expand the internship and apprenticeship programme between the public and private sectors, which is currently implemented sporadically and on a voluntary basis. Holding events and workshops will help to gather information on emerging skills needs and how to meet them. It is also possible to learn from good practices in other countries in the areas of skills development, the transfer know-how, and partnerships between the energy sector and the education and training sector.

1. INTRODUCTION

This report is part of a study commissioned by the European Training Foundation designed to identify and analyse how new technologies, innovation and other drivers of change are disrupting the labour market and skills needs in ETF partner countries. The focus here is on the Tunisian energy sector. One important rationale behind this analysis stems from the climate crisis, which threatens countries globally and for which the energy sector is critical.

Tunisia is a lower middle-income country (according to the World Bank classification) in a process of market liberalisation after historic state involvement in the era following independence. It has experienced rapid economic progress and significant political democratisation since 2010. The country had a GDP of TND 114.9 billion in 2019 (Institut National de la Statistique, 2019a).

Due to the COVID-19 pandemic and political turmoil, Tunisia is currently facing a socio-economic crisis on a scale not seen since the Arab Spring a decade ago. In 2020, unemployment returned to the 2011 revolution peak. The number of citizens in poverty is expected to rise, with the bulk in Tunisia's poorer Centre-West and South-East regions (World Bank, 2020a). This outlook is slightly worse than for many regional peers due to weak growth in 2018 and 2019. In the first quarter of 2020, GDP at market prices decreased by 2.1% compared to the same quarter of 2019; similarly, the second, third and fourth quarters of 2020 saw a decrease in GDP of 21.3%, 5.7% and 6.3% compared to the same quarters in 2019 (Institut National de la Statistique, 2019b)

The country's economy in nominal GDP terms has risen significantly since 1980. Per capita GDP rose persistently from 1995 to 2010, but has stagnated since then. The poorest Tunisians have increased consumption levels at a higher percentage rate than wealthier sections of the population, although starting at a much lower absolute level (World Bank, 2016). Its social policy mix has delivered improvements in citizens' well-being in the areas of health, housing and infrastructure to a higher level than in other low middle-income economies (OECD, 2018).

The Tunisian energy sector has been historically reliant on gas imports from neighbouring Algeria, in addition to domestic production. In light of the climate crisis, Tunisia is reviewing its decades-old reliance on gas in favour of a mixed-renewable strategy. This is in line with the Paris Agreement, which aims to reduce the country's CO2 emissions by 41% by 2030. In particular, the country plans to increase the share of renewable sources in the energy mix to 30% by the same year, by focusing mostly on solar power generation. Alongside this, shale gas, energy efficiency and cross-border energy supplies are being developed. This has the potential to aid the labour market in Tunisia, which is marked by high youth unemployment and skills mismatches.

This shift in energy supply described above is likely to result in substantial technological change with a parallel change in the demand for skills. This is where this study has a role to play, as it provides an assessment of current and emerging skills demand by using a mixed methodological approach.

A detailed description of the methodology can be found in a separate report (ETF, 2021), but a summary is provided in Section 2 of this report for country-specific aspects. Sections 3 and 4 present an overview of the Tunisian economy and energy sector, based on a literature review and analysis of official employment statistics. Section 5 analyses the main drivers of change in the sector, while Section 6 provides information on emerging skills needs and their impact on occupational job profiles (the analysis by sub-sector is further detailed in Annex 1). Section 7 discusses the skills bottlenecks hindering change and outlines the training strategies put in place for responding to the observed or expected changes.

2. METHODOLOGICAL APPROACH

The purpose of the study is to understand the drivers of change affecting the energy sector in Tunisia, identify current and impending technological changes and determine the resulting skill needs. Understanding the links between technological change and skills demand can help policymakers better respond to emerging skills needs. The initial research questions, which provided the framework for the study, are shown in the box below.

Questions about the state of development in the sector analysed

1. What is the relationship of the selected sub-sector to the whole sector and the broader economy (e.g. production, employment, export)?
2. What are the main drivers of change currently shaping the sector (e.g. trade, global value chains, new technologies, digital tools, climate change)?
3. What has driven/generated innovation in this part of the sector, and does it have the potential to influence the rest of the sector?

Questions about the empirical evidence of the changes occurring in the sector

4. What are the ongoing changes observed in the sector in terms of production, storage, marketing, business practices, labour, and skills utilisation?
5. What are the main occupational profiles used in the sector? Has the content of some occupations evolved as a result of the above changes in the sector, and if so, how?
6. Which new tasks and functions have emerged in the jobs and/or occupations in this sector? Which old ones have disappeared?
7. What are the differences in the job profiles of this innovative sector? What changes are observed in the profiles of new recruitments and job vacancies published?
8. What is the impact of these changes on labour and skills demands in the sector? Do changes require higher levels of the same skills or completely new sets of skills from workers?
9. How do these changes affect skills utilisation and working conditions in the sector (e.g. salary, contracts, working hours, formality)?
10. How do businesses meet their new skills needs (new hiring, retraining, etc.)? Are there initiatives/cooperation between companies and education and training providers?

Questions about policy implications

11. Do technology, innovation and other changes push countries towards higher added value and integration in the global value chain? Are skills contributing to this shift? If so, how?
12. Are there any spill-over effects from the changes in the sector as a whole? What context-specific and general lessons can be derived from these studies?

2.1 Defining the energy sector and main steps of the research

The energy sector or industry is the totality of all activities related to the production and supply of energy (both non-renewable and renewable). It encompasses all steps from exploration and extraction to transportation, refining and distribution in the case of fuels, as well as the electrical power industry, including electricity generation, electric power distribution and sales. It comprises integrated large power utility companies as well as alternative energy and sustainable energy companies, and includes traditional sources such as the collection and distribution of firewood for cooking and heating.

When defining the perimeter of the investigation, it is useful to make reference to standard industrial classifications such as NACE (the Statistical Classification of Economic Activities in the European Community – see the glossary for more details). It is then possible to collate statistical data on workforce composition and the like from national statistical offices. Some caution is necessary: general classifications may not reflect all specific circumstances in a country and the rapid introduction of new technologies may have redefined some of the principal activities taking place in the sector[1].

Given the characteristics of the country (e.g. the import of gas from neighbouring countries and the presence of an important gas pipeline, the TransMed Pipeline), the energy sector in Tunisia can be defined with reference to the following NACE codes:

- B 06 Extraction of crude petroleum and natural gas
- C 19.2 Manufacture of refined petroleum products
- D 35 Electricity, gas, steam and air conditioning supply
- D 35.1 Electric power generation, transmission and distribution
- D 35.11 Production of electricity 3510*
- D 35.12 Transmission of electricity 3510*
- D 35.13 Distribution of electricity 3510*
- D 35.14 Trade of electricity 3510*
- D 35.2 Manufacture of gas; distribution of gaseous fuels through mains
- D 35.21 Manufacture of gas 3520*
- D 35.22 Distribution of gaseous fuels through mains 3520*
- D 35.23 Trade of gas through mains
- E 38 Waste collection, treatment and disposal activities; materials recovery
- E 39 Remediation activities and other waste management services
- F 42.9 Construction of water projects and other civil engineering projects
- H 49.5 Transport via pipeline

As the study needs to be forward-looking, a mixed-method approach has been used, combining desk research and data analysis with data mining techniques and interviews with stakeholders and companies, as shown in the box below. More detailed explanations on the methodology can be found in the ETF Methodological Note (ETF, 2021).

[1] Please note that not all sub-sectors in NACE B, D and E can be considered part of the energy sector. Furthermore, some other NACE sub-sectors could be considered part of the energy sector in the context of Tunisia, such as H49.5 (Transport via pipeline) and F42.9 (Construction of water projects and other civil engineering projects). The employment statistics of these sub-sectors were not broad enough to give a reliable level of analysis; therefore, we opted for analysing employment statistics in three NACE sectors (B,D,E), despite their limitations. As a consequence, the numbers should be taken as indicative.

Box 1: Steps followed in the study's mixed-method approach

1. Review of existing reports and analyses on the energy sector in Tunisia, its production and consumption patterns and related national policy framework;
2. Analysis of employment statistics in the Tunisian energy sector that reveal its current position in terms of labour and skills demand;
3. Big data analyses using text mining techniques to capture data on technological change and associated skills needs from a variety of sources (e.g. patents, scientific papers, policy papers, etc.);
4. Comparing and matching the list of relevant technologies extracted from text mining to the related occupations and skills listed by the ESCO classification of occupations (see glossary), by using semantic matching algorithms;
5. Focus group discussions with key stakeholders and bilateral interviews with selected Tunisian companies in the sector to verify and refine the results of the previous steps.

2.2 Country specifics

Patent data was taken from the official database of the European Patent Office, containing over 120 million documents from around the world and updated daily. For scientific papers, both Scopus (by Elsevier) and Web of Science (by Clarivate) were consulted, the two largest databases of peer-reviewed papers, where an equivalent study was performed on around 70 million scientific papers.

The number of scientific papers about energy in Tunisia is sufficient to study the drivers of change affecting this economic sector in the country. However, as for technologies, it was found that despite a non-negligible number of Tunisian patents filed in all sectors between 1986 and 2017, the number of patents specifically related to the energy sector is very limited. This may be related to the fact that investments in R&D were hampered by the general economic situation, or more likely to the fact that traditionally the country has relied on well-established technologies such as those linked to fossil fuels, while the recent interest in solar and wind energy mainly involves importing technologies from abroad, with local firms only handling installation and maintenance.

To overcome this limitation, comparison and benchmarking with current trends in Europe, where a large amount of data is available, has been used. In particular, European patents (patents filed with the European Patent Office and valid in the 38 countries that have joined the European Patent Convention) have been analysed to provide a clear picture of the relevant technologies in the sector, also given the fact that the EU accounts for 64% of Tunisian trade.

Of course, not all of these technologies may have an impact on Tunisia. But those that are related to the drivers of change shaping the future of the sector will sooner or later be introduced in the country. For example, any development in solar panels in the EU will be adopted by Tunisian companies, which are now entering the market and keen to install the latest solutions. Moreover, the analysis of EU trends provides an input for shaping the discussion with the country's stakeholders (i.e. identifying the technologies adopted at national level, and the extent to which the skills associated with these technologies are in demand by employers and are being provided by the education and training system).

Thus, the technologies shown in Section 5 are derived from the analysis of EU patents, but only those that are expected to be relevant for each sub-sector present in the country are discussed. In the same way, in the ranking of the relevance of professional profiles based on the correlation with technologies in Section 6, only technologies that are likely to be adopted in the near future in Tunisia have been included, with a weight that depends on relevance of both the technology itself (as calculated from patent data) and sub-sector in the country's future planning (estimate obtained combining data mining results, desk research and interviews).

As for the fieldwork, due to the COVID-19 pandemic, focus group discussions were held online in September 2021, involving relevant stakeholders from both the energy sector and the education and training system. Many representatives from government institutions, academia and research, and associations and organisations attended the discussions. After the focus group, face-to-face in-depth interviews, guided by a semi-structured interview questionnaire, were conducted between August and October 2021. A final validation event with the main stakeholders was held in November 2021.

The first set of interviews was undertaken with key stakeholders in the energy sector. More than 20 stakeholders were identified during the planning of the fieldwork. The stakeholders represent a broad base, including sector representatives (e.g. social partners and professional associations), policymakers, government organisations, education and training providers, universities, members of the research community, intermediaries, entrepreneurs and international organisations active in the sector. Six face-to-face stakeholder interviews were conducted to gain insight into how they perceive and manage the process of technological change and how they acquire the skills they need, but also to explore the incentives for skills development. A full list of these key stakeholders (identified as institutions, not individuals) is provided in Annex 2. The names of individuals from these institutions are not included for data privacy reasons.

The second group of interviews was conducted with innovative companies in the sector, to understand their perceptions and actions in managing technological change and the means they employed to address their skills needs. Over 40 candidate companies were selected based on desk research, patent analysis, and the guidance of the national expert and various stakeholders. In total, 12 companies from the sector were interviewed. The questions focused on how companies deal with the process of technological change (including barriers to its implementation such as shortages of capital and skills), and the impact of those changes on job descriptions and the related skills needs. The names of the companies and individuals interviewed are kept confidential for data privacy reasons.

Collecting the views of key stakeholders and interviewing the most innovative companies was an important step, since new skills demands can be revealed only by understanding the responses of companies to the signals about emerging technologies. Arguably, by interviewing the most innovative companies, it is impossible to provide a fully balanced picture. However, the study intended to collect evidence on how technological change, if implemented, affected employment and skills demand. Thus, the research needed to interview companies in the vanguard of technological change to identify its impact on skills demand.

2.3 Main advantages and limitations

The use of a combination of methodologies provides a number of advantages:

- While each methodology, taken alone, might fail to capture certain skills needs in a sector, different techniques complement one another, each compensating for the potential shortcomings of the other, thus achieving the best coverage possible.
- A forward-looking perspective is important to have more opportunity to influence future changes. Patents are a particularly good source of data on impending technological change, since companies file patents to protect the innovations that they are planning to put into production. Text mining of patents thus allows a variety of disruptive factors to be identified, which can be then explored with key stakeholders to discuss how they will affect the demand for skills.

- Data mining, by extracting what is often relatively scarce data scattered across many different sources, can deliver information on future skills needs, which would otherwise be unobserved until economically damaging skills shortages emerged.
- While text mining provides a wealth of information, obtaining the views of key stakeholders and company representatives is still fundamental in order to understand how they plan to respond to the signals about emerging technologies, which in turn will reveal much about future demands on education and training systems.

However, the following issues need to be borne in mind.

- The information provided by companies and other key stakeholders should be regarded as indicative rather than comprehensive, given the small number of people interviewed in the study.
- The text mining was limited to searches in English. Nevertheless, it is likely that most of the scientific papers were published in English in this period.
- Patenting activity from the Tunisian energy sector has been limited in the last 50 years. On the other hand, some innovations that are relevant for the country might not be patented. Non-technological innovations are also important; the review of scientific papers and interviews with companies and stakeholders captured other drivers of change.
- Despite the mixed-method approach used in the study, this report is unable to indicate the scale or volume of any change in jobs and employment (e.g. it cannot estimate how many extra welders or installers will be required), the relative importance of particular skills, or the extent of any skills mismatches. Other methodologies are required to address these issues.
- The skills analysis was limited to those associated with technologies and other trends identified by the text mining. If a certain technology is linked to occupations and skills in the ESCO database, this was captured. But certain occupations may have incomplete descriptions of the skills related to recent technologies – e.g. digital competences – in databases such as ESCO.

Despite these limitations, the data science approach brings added value. It makes it possible to identify the skill content of jobs in the energy sector and the specific skills needs that arise due to technological change. Accordingly, the focus is on actual jobs and how they will change over the short to medium term, rather than on broad aggregations of jobs into occupations. This approach captures data on specific skills in specific jobs rather than on the total demand for certain occupations. The approach is flexible, and the algorithms can be run and rerun relatively quickly. This means that if a sudden economic shock or a crisis emerges – such as COVID-19 – the analysis can be quickly rerun to capture its effects (as long as there is searchable data).

3. THE COUNTRY: ECONOMY, EMPLOYMENT AND SKILLS

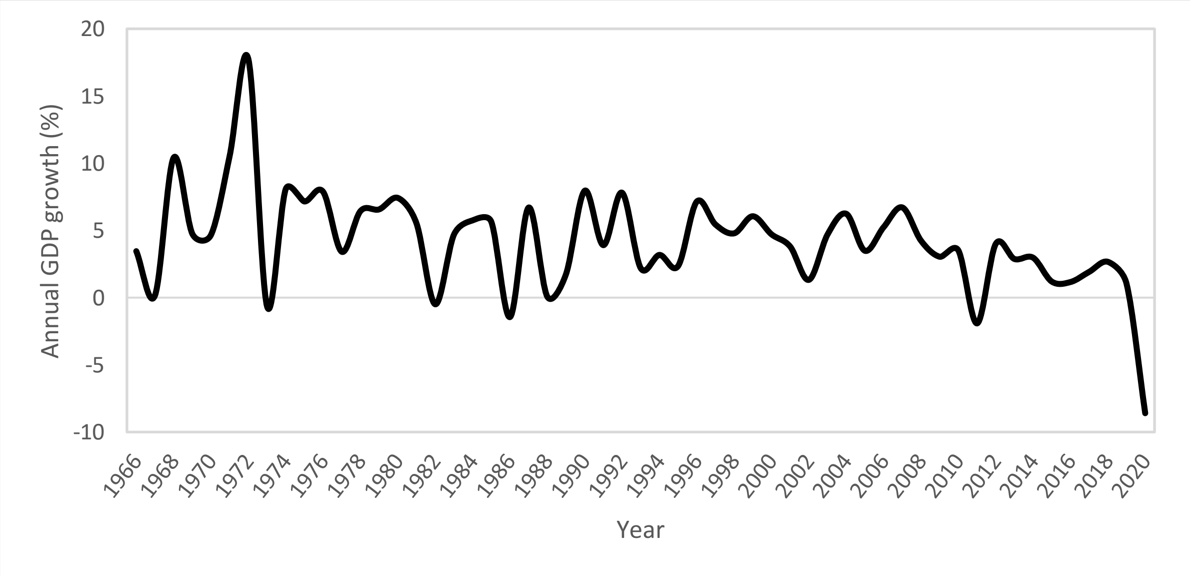
KEY ISSUES COVERED

- Recent trends in the Tunisian economy
- Changes in the overall demand for, and supply of, labour and skills
- Employment in the Tunisian energy sector
- Drivers of skills demand in the energy sector

3.1 The economy

Tunisia's modern economic history can be divided into four distinct periods: (1) a brief period of liberalisation post-independence (1956-60); (2) an experiment in collectivism and import substitution (1961-69); (3) the development of a protectionist market economy (1970-85); and (4) a liberalisation process centred on private investment, competitiveness and market openness (1986-present) (Ayadi and Mattoussi, 2014). These distinct periods are all characterised by fluctuating economic growth rates with a stabilising low growth rate over the last decade (summarised in Figure 3.1 below).

Figure 3.1: Annual growth in GDP volumes, 1966-2020



Source: World Bank

The Tunisian economy is primarily reliant on services, which account for 61.7% of GDP, followed by industry (22.7%) and agriculture (10.4%) (World Bank, 2021; OECD, 2021). Tunisia's main export markets are France (30.3%), Italy (19%) and Germany (13.7%) (OEC, 2020). Overall, the EU is Tunisia's largest trading partner, accounting for 64% of its trade: 78.5% of its exports and 54.3% of its imports (European Commission, 2021). Tunisia's exports to the EU are mainly composed of machinery and transport equipment (41%), textiles and clothing (23.7%), and agricultural products

(6.1%). Neighbouring Algeria is Tunisia's fifth-largest import market, accounting for 6.58% of total import values, of which 91.9% is, importantly, petroleum gas (OEC, 2020). Libya is another petroleum gas import market, although much smaller in recent years due to ongoing instability there. Tunisia is an export-oriented economy with ICT, agriculture, tourism, and textile, chemical and electrical manufacturing accounting for 80% of goods and services traded (Whiteshield Partners for the EBRD, 2013).

The last two decades of economic growth in Tunisia have been complex, with the Arab Spring marking a dividing line between the two periods. The 2000s saw a significant development of the service sector, which yielded an average growth rate of 7.2% per annum (Ayadi and Mattoussi, 2014). Technologically advanced sectors also grew, with mechanical and electronic industries growing by 8.9% and technological-intensive sectors in general growing to 20.4% of GDP by 2006 (up from 16.8% in 2001). Investment grew at a rate of 5.1% during this period, while FDI boomed, encouraging the entry of many foreign firms into the country. The private sector also rose to dominance during this decade, accounting for 91% of new jobs, 57.1% of investment and 85% of exports (Ayadi and Mattoussi, 2014).

The second and most recent chapter of this period stems from the Arab Spring of 2011. Several factors led to this seismic event, including high levels of youth unemployment, corruption, poverty, and human rights violations, which were summarised in the revolution's slogan 'Employment, Liberty, Dignity'. The uprising had a significant initial economic impact, with investment falling across all sectors apart from electronics. In 2011, FDI fell by 29% compared to 2010, and 182 foreign firms ceased operations in the country. A timid economic recovery began in 2012 with FDI recovery. The fiscal deficit has slowly improved over the past decade, down to 3.9% in 2019 from 4.4% in 2018. Overall, growth rates have failed to return to the pre-Arab Spring era (African Development Bank, 2017). This is due in part to a wider cyclical slowdown in the euro area, Tunisia's main trading partner.

Table 3.1: Economic fundamentals in Tunisia, 2017-2021 (projections)

	2017	2018	2019	2020	Proj. 2021
GDP growth	1.9	2.7	1.0	-8.0	2.5
Inflation (average)	5.3	7.3	6.8	5.8	5.3
Government balance/GDP	-5.9	-4.6	-3.9	-8.1	-8.3
Current account balance/GDP	-10.2	-11.2	-8.5	-8.3	-7.3
Net FDI/GDP [neg. sign = inflows]	-2.0	-2.5	-2.1	-0.6	-1.4
External debt/GDP	82.0	86.1	99.4	100.3	n.a.
Gross reserves/GDP	14.1	13.1	19.1	23.2	n.a.
Credit to private sector/GDP	80.3	80.4	77.4	82.1	n.a.

Source: EBRD, 2021

The environmental performance of the Tunisian economy consists of an environmental footprint of 1 gha per capita (global hectares from the Global Footprint Network, National Footprint Accounts dataset), much smaller than its northern neighbours. On top of this, its renewable energy consumption share of total energy consumption in 2019 was 12.6% (World Economic Forum, 2019).

The ongoing Libyan crisis has caused a major exogenous shock to the Tunisian economy since 2011. Libya is Tunisia's most important trading partner after the EU, especially for construction and agri-food. The impact of this crisis has been multifaceted, with an influx of Libyan refugees entering the country and the return of Tunisian emigrants. Many of the Libyan refugees had relatively high to medium incomes, which boosted the level of consumption in the country; in contrast, 60 000 returning Tunisians from Libya were mainly low-income workers, thereby exacerbating unemployment and poverty levels in the poorer regions from which they had originally emigrated. Estimates by the World Bank suggest that Libya's led to a 1-percentage-point fall in Tunisian economic growth between 2011 and 2015 (World Bank, 2017).

Estimates suggest that COVID-19 contracted the GDP of Tunisia by between -7% (World Bank, 2020a) and -9% in 2020 (World Bank, 2020b). The pandemic is having a significantly negative effect on Tunisia's tourism industry, which accounts for around 7% of GDP (International Monetary Fund, 2020a) and fell by 60% in the first 9 months of 2020 (International Monetary Fund, 2020b). The health emergency has hit a sector that had only just recovered from a steep fall in demand following terrorist attacks in 2015. Although exports declined in 2020, imports fell even more, meaning the country's current account deficit shrank to 7% of GDP in 2020 compared to 8.8% in 2019. Foreign direct investments fell by 25% in the first 9 months of 2020. The fiscal deficit increased to 10.5% in 2020 due to the cost of the pandemic, a higher level than many regional peers. The Government enacted a range of measures in response to the crisis, including cash transfer top-ups for 260 000 households, pension increases and unemployment benefits (–TND 200) for those on reduced hours. The support packages aimed to stem the economic impact of the crisis on incomes through direct social transfers. Various emergency measures to businesses in the form of loans and grants have also been implemented.

The business environment in Tunisia shows signs of improvement. The amount of time that businesses must spend verifying government regulations fell from 47% of a manager's time to 0.1% in the period 2013 to 2019 (World Bank, 2020b). The annual employment growth rate also increased over the same period. Tunisian firms are also less likely than regional peers to be involved in bribery or corruption. Investment opportunities have opened up in information and communication technology, healthcare, electronics and electric industries. Tunisia is also a regional leader in ICT and boasts a growing electronics sector (Whiteshield partners for the EBRD, 2013). The European Bank of Reconstruction and Development has observed that Tunisia could take advantage of the prospective relocation of Asian industry to the southern Mediterranean post-COVID-19 to reflect a more regionalised world in need of more secure trade supply routes (EBRD, 2020a).

3.2 The labour market

This section will present key data on the Tunisian labour market. In terms of activity rate, labour force participation in Tunisia has been stable over the past decade at around 46.9 % (ETF, 2020). Sex-disaggregated data shows a slight reduction in the activity rate for men and a slight increase for women. The activity rate for men declined from 69.5% in 2010 to 68% in 2019, while women's grew from 24.8% in 2010 to 26.6% in 2019 (ETF, 2020).

A similar trend can be observed for the employment rate, which has been stable at around 40% in the past decade. There has been a slight reduction in men's employment, from 61.9% in 2010 to 59.6% in 2019, and a slight increase in women's employment, from 20.1% in 2010 to 20.6% in 2019. The slow growth of these indicators may be partly due to the Arab Spring and the subsequent political and social crises.

Table 3.2 below presents an overview of the main labour market indicators for Tunisia and the EU.

Table 3.2. statistics on employment in TUNISIA and the EU

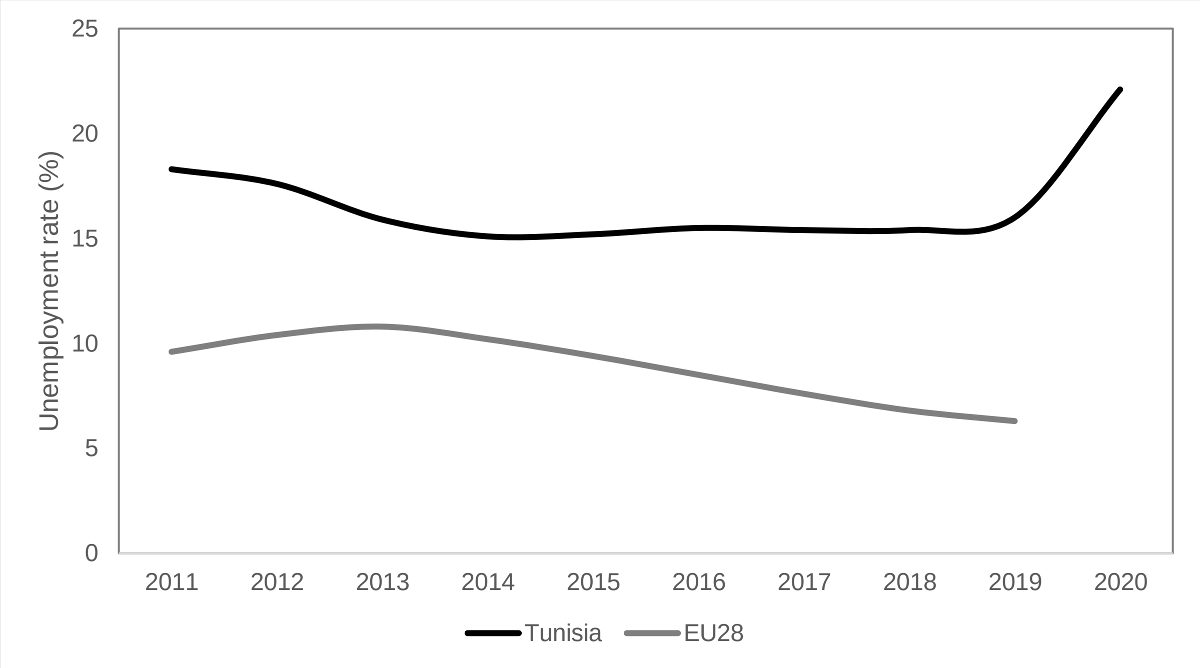
	Tunisia	EU-28

	2010	2019	Change	2010	2019	Change
Population size (millions and percentage change)	10.6	11.6	+1.0	503.2	513.1	+2.0
Population aged 34 years and under (%)	63.8	54.6 (2018)	-9.2	41.2	38.8	-2.4
Activity rate (15+) – Total	46.9	46.9	0	71.0	74.1	+3.1
Men	69.5	68.0	-1.5	77.6	79.4	+1.8
Women	24.8	26.6	+1.8	64.4	68.7	+4.3
Employment rate (15-64) – Total	40.8	39.7	+1.1	64.1	69.3	+5.2
Men	61.9	59.6	-2.3	70.0	74.5	+4.5
Women	20.1	20.6	+0.5	58.2	64.1	+5.9
Unemployment rate (15+) – Total	13.0	15.2	+2.3	9.6	6.3	-3.3
Men	10.9	12.3	+1.4	9.6	6.1	-3.5
Women	18.9	22.4	+3.5	9.6	6.5	-3.1
Youth unemployment rate (15-24)	29.4	34.4	+5.0	21.2	14.3	-6.9
	2015	**2019**	**Change**	**2015**	**2019**	**Change**
Employment rate of recent graduates (% aged 15-34)	30.4	32.2	+1.8	78.4	81.8	+3.4
Youth not in employment, education, training (NEET % aged 15-24) – Total	29.1	32.0	+2.9	12.0	10.1	-1.9
Men	19.4	18.3	-0.9	11.8	9.9	-1.9
Women	31.2	33.0	+1.8	12.3	10.4	-1.9

Source: Eurostat, EU LFS data and ETF 2020 KIESE Database

Tunisia’s unemployment rate had been improving from its peak of 18.3% during the Arab Spring to 16% in 2019, before the onset of COVID-19. In 2020, the rate peaked again at 22% (Figure 3.2). In any case, the unemployment rate has remained consistently above 15% throughout the entire period, while in the EU it has steadily decreased, never exceeding 11% in the last decade. The labour income share as a percentage of GDP has remained constant in the range of 45-48% for the last 10 years (International Labour Organization, 2021).

Figure 3.2: Unemployment rate for population aged 15+, 2011-2020



Source: ILOSTAT, Eurostat

The youth unemployment rate (people aged 15-24) remained high at 35.8% in 2019, although it has improved from its peak of 42.3% in 2011 (ILOSTAT). Data on the percentage of young people not in education, employment or training (NEET) is sparse, with the 2010 Labour Force Survey revealing 25.6% in 2010 (International Labour Organization, 2021), increasing to 29.1% in 2015 before decreasing slightly to 27.4% in 2019 (ETF, 2019). This is a substantial rate for a country where the majority of the population is under 25 years of age (Whiteshield partners for the EBRD, 2013).

Tunisia allocates a high amount of resources to higher education at 1.6% of GDP (compared to Morocco at 1%) (Whiteshield partners for the EBRD, 2013). However, this investment is not necessarily reflected in more skilled jobs, with 29.12% of graduates unemployed in 2017 (International Labour Organization, 2021). The supply-side explanation suggests that there is a mismatch between degree programmes and the types of skills that employers need. However, this situation could also be explained by the poor rate of job creation in the country, with most new jobs in low-value-added activities, often in the informal sector. The expansion of tertiary education has not been matched by a levelling up through the value chain in the wider economy, resulting in an oversupply of skilled graduates with few opportunities outside the public sector (World Bank, 2014a).

The lack of job opportunities and low remuneration are the key drivers of Tunisia's brain drain (Boghzala, 2018). In 2010, Tunisians accounted for 20% of the share of highly skilled migrants in OECD countries, up from 6% in 1990 (Musette, 2016). More than 0.5 million residence permits were issued to Tunisians by EU Member States between 2008 and 2017 (out of a population of 11 million) (Alcidi et al., 2019). Furthermore, these emigrants are unlikely to return to Tunisia (El Jafari, 2012). Other problems in the labour market include system-wide nepotism, corruption, and regional inequalities in opportunities (World Bank, 2014b).

The sectoral composition of the Tunisian labour market broadly follows the GDP share of the relevant sectors (agriculture, industry and services) noted in the prior section. According to the ILO database, in 2019, out of a total 3 444 000 workers, 438 000 were employed in agriculture, 1 119 000 in industry and 1 886 000 in services (International Labour Organisation, 2021). Tunisia is ranked 133rd out of 144 countries for its labour market flexibility by the World Economic Forum.

Labour market rules and institutions have created an environment favourable to low-value-added jobs, which are often insecure. Open-ended contracts have strict rules against firing employees, whilst fixed-term contracts allow the creation of very flexible short-term contracts that grant employees few rights. This dichotomy in employment contracts is known in Tunisia as *sous-traitance* (World Bank, 2014a). It has incentivised the creation of poorly paid low-skilled work based on flexible labour. It is disputed whether making high-skilled labour more flexible would resolve this problem (World Bank, 2014a) or whether all labour should be made more secure since flexibility has no correlation with high-value job creation (Rodgers, 2007).

Informality and low-value production both hamper skills development. In 2016, one-third of the labour force, a total of 1.1 million people, worked in the informal sector (OECD, 2017). These jobs are generally of low quality and pay, with reliance on migrant employment from sub-Saharan Africa. Informality is particularly prevalent in SMEs, which are given little help to formalise. This area of the economy is also growing, posing an ongoing obstacle to a skills-based growth model.

Whilst women's representation in political office has improved significantly since the 2011 revolution, (and indeed is higher than in many rich economies), the gender divide in the labour market persists. The female labour force participation rate in 2019 stood at just 23.8% (international Labour Organization, 2021). The female unemployment rate is also much higher than men's, with 50.4% of young women in rural Tunisia being NEETs. The rate in urban areas is not much better, at 32.4% (World Bank, 2014b). In the centre and south of the country, the problem is at its worst, on account of the patriarchal traditions and social norms deeply rooted in these areas.

The Tunisian Ministry of Professional Training and Employment (MVTE) provides a range of ALMPs to foster skills development for unemployed people. Tunisia spends more than any other country in the region on ALMPs, averaging 0.5% of GDP (World Bank, 2014b). Urban areas along the coast are the primary beneficiaries of these programmes, few of which are available in poorer, less urbanised regions. Most ALMPs currently serve graduates, a bias that originates from their large share of the unemployed population. However, this bias is a disservice to the many non-graduates who would otherwise benefit from these programmes. The National Agency for Employment and Independent Work (ANETI – the Public Employment Service) reports to the MVTE and is responsible for ALMP design and delivery. The main ALMPs are: AMAL, a programme designed for unemployed university graduates (since closed); the Professional Internship Programme (SIVP), which targets unemployed graduates for subsidised places in firms; and the Labour Market Access and Employability Programme (CAIP), for graduates and non-graduates alike to receive support funds and training opportunities. Many more programmes are also running at a smaller scale. International organisations such as the International Labour Organization (ILO) and the United Nations Industrial Development Organization (UNIDO) have also funded ALMP programmes in the country. More recent schemes include the Employability Improvement Cheque, the Employment Support Cheque, and Support to Small Business Entrepreneurs. All these schemes attempt to enable unemployed persons to access the domestic or a foreign labour market through training, support, vocational adjustment, subsidies and funding (ETF, 2014).

Tunisia is committed to upgrading its skills and training infrastructure. The National Employment Strategy 2013-2017 contained six clear objectives with a focus on smoothing school-to-work pathways. The 2015-2020 National Plan for universities and scientific research then attempted to improve employment outcomes for graduates. A monitoring agency, the National Body for Assessment, Quality Assurance and Accreditation (IEAQA), will be tasked with overseeing progress in this area, a sign of governance commitment (OECD, 2017). In 2019, the process for defining the new Employment Strategy 2020-2030 was launched (Leaders, 2019). The new strategy aims to offer an integrated, multidimensional and transversal approach by covering all the levers likely to create jobs in sufficient quantity and quality, and bringing together a large group of players in the field of employment (Ministère de la Formation Professionnelle et de l'Emploi, 2021).

3.3 Skills

According to the World Bank Human Capital Index, Tunisia's human capital scores just below the global median[2]. The Government has committed an average of 6% of GDP and 20% of government expenditure to education over the past decade (OECD, 2017). Rates of literacy and access to primary and secondary education have increased as a result. The country also boasts one of the highest tertiary education enrolment rates in the region. However, there is a skills mismatch, as witnessed by the level of graduate unemployment. According to a World Bank Enterprise survey, in 2013, 32.5% of firms perceived a lack of skilled labour as a constraint on their organisation's growth despite the rates of tertiary education in the country (OECD, 2017). A lack of investment in higher-value-added sectors has halted increases in skills development and graduate employment. Many Tunisians instead aim at public sector employment, where job security and benefits are guaranteed (60% of all graduates are employed in the public sector) (Morsy et al., 2018).

Take-up of VET programmes in Tunisia is low, since these programmes are viewed as unattractive by potential participants. This is despite significant effort by the Government of Tunisia to develop a VET reform strategy in 2012. These programmes have also failed to develop serious links with employers and other stakeholders to deliver useful course content. The arrangements for implementing these programmes are also too complicated, with six ministries and seven agencies involved in their delivery and coordination (OECD, 2017). This results in these programmes being under-subscribed, leading to a shortage of workers in web management, logistics, e-commerce, engineers and technicians. Unfilled vacancies in Tunisia include 11.9% in textiles and clothing manufacturing, 24.3% in commerce and 16% in professional services (Morsy et al., 2018). Based on vacancies publicised online in 2020, the highest share of vacancies was for professionals at 34.2%, followed by technicians and associate professionals at 26.63% (ETF, 2020). Software developer was the most sought-after profession, with 2 500 online advertisements during the period.

The share of the adult population with advanced education has remained stable at 67%, according to the data available (Table 3.3). This is a modest increase from 63.5% in the first recorded data in 2005. However, the largest occupational grouping in the labour market remains at the elementary level (Figure 3.4 below). In the wider picture, 97% of young people attend school in Tunisia, a significant achievement (Whiteshield Partners for the EBRD, 2013).

Table 3.3: Summary statistics on education and training: Tunisia and the EU compared

	Tunisia			EU-28		
	2010	2019	Change	2010	2019	Change
Early leavers from education and training (aged 18-24) (%)	51.3	37.1	+14.2	13.9	10.3	-3.6
Share of adult population (25-64) with high level of education (ISCED-5-8) (%)[3]	12.6	16.4	+3.8	27.9 (2017)	29.5	1.6

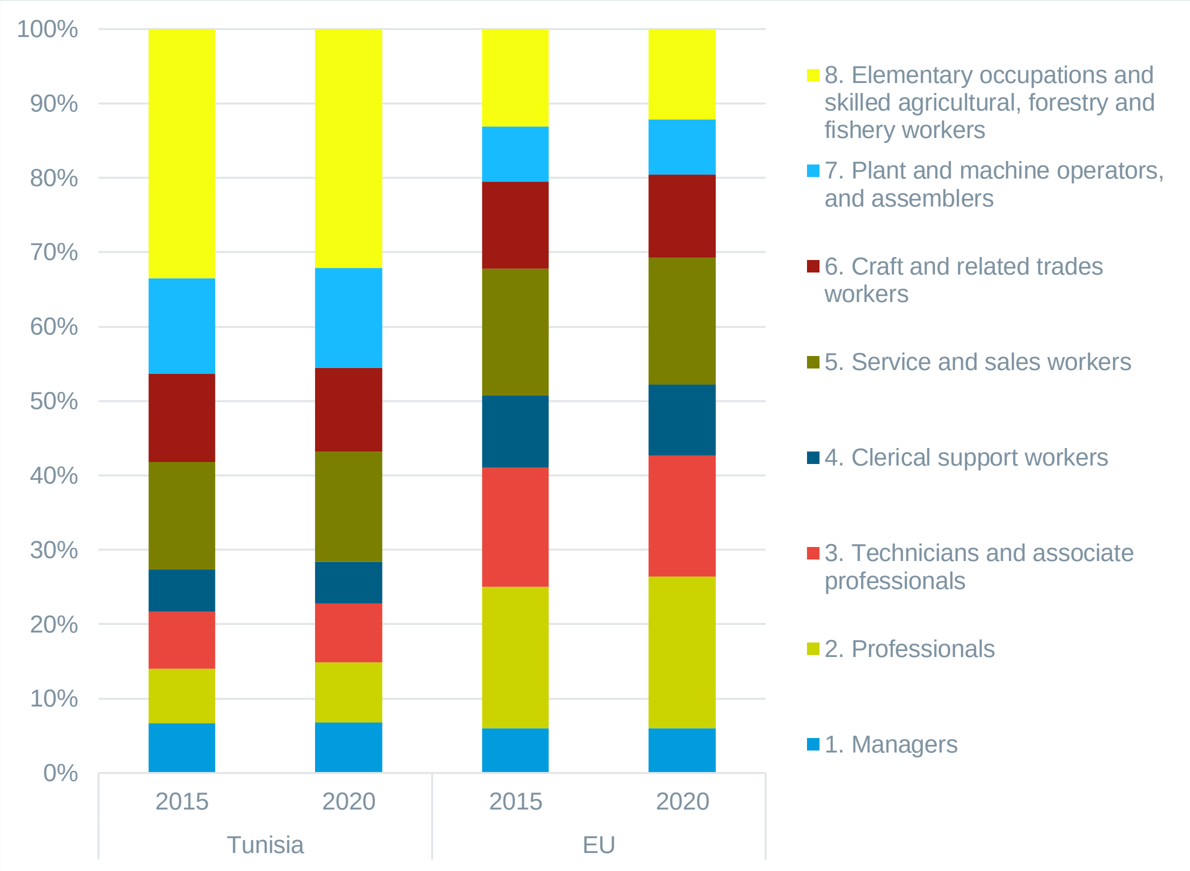
2 The components of the Human Capital Index (HCI) are combined into a single index by first converting them into contributions to productivity relative to a benchmark of complete education and full health. Multiplying these contributions to productivity together gives the overall HCI. https://www.worldbank.org/en/publication/human-capital

3 For Tunisia, data refers to educational attainment of the total population.

Enrolment rates in VET (% of upper secondary enrolment)	10.6 (2011)	9.6 (2015)	-1	49.3	48.4	-0.9
Participation in lifelong learning (last 4 weeks) (% aged 25-64)	1.8	2.9	+1.1	7.8	10.8	3

Source: Eurostat / INSTAT / ETF KIESE database

Figure 3.3: Distribution of employment by occupation, Tunisia and EU-28, 2015-2020



Source: ILOSTAT
Note: in this dataset, the ILO joined ISCO-6 occupations (Skilled agricultural, forestry and fishery workers) and ISCO-9 occupations (Elementary occupations) into a single category (No 8). As a result, the numbering of categories 6, 7 and 8 does not reflect the ISCO major group classification.

According to the World Economic Forum, the 'skill level' of the Tunisian workforce consistently ranks poorly out of the 141 countries measured. The country's highest position is in 'school life expectancy' (15.1 years), followed by 'pupil to teacher ratio in primary education (55th), 'digital skills among active population (67th) and 'ease of finding skilled employees' (88th), while its lowest position is in 'skillset of graduates' (108th) (World Economic Forum, 2019). The World Bank Human Development Index similarly ranks Tunisia at the middle to lower end, this time in terms of an estimate of human development. The World Bank framework encompasses expected years of schooling, probability of survival to age 5, harmonised test scores, learning-adjusted years of schooling and adult survival rate. This produces a single value of 1 or less, e.g. an economy in which a child born today can expect to achieve complete education and full health scores a value of 1 on the index. Tunisia scored 0.52 in 2020 on this index, placing it just below the median global economy. Regional neighbour Morocco is slightly lower at 0.50, with Algeria slightly higher at 0.53 (World Bank, 2020c).

Gender inequalities exacerbate the skills mismatch experienced in Tunisia. Women are highly educated – 43% of women take up tertiary education compared to 26% of men (Morsy et al., 2018) – but many remain locked out of the labour market. Only 25% of women made it into the labour market compared to 71% of men in 2016 (Morsy et al., 2018). Women are expected to be responsible for the vast majority of care work and are banned from certain tasks or jobs in some sectors. This large pool of skilled labour that is prevented from entering the labour market represents a significant waste of human capital.

To improve the skills situation in Tunisia, it is imperative for policy interventions to focus on improving public-private sector collaboration to deliver skills improvements in the workforce. The country has a demographic advantage due to the high proportion of young and highly educated people. Understanding the value-chain networks in the economy and how skills development can supplement them is key to moving the Tunisian economy up the value chain and increasing high-quality and paid work.

Main findings from this Section

- Tunisia has shifted to a services-based economy in the past two decades with the EU as its main trading partner.
- Tunisia's unemployment rate has fallen over the last decade, with a modest increase in the participation rate of women; this progress has suffered a setback with COVID-19.
- Tunisia has a young population compared to the EU but suffers from high youth unemployment and a high percentage of NEETs.
- The expansion of tertiary education has not been matched by a levelling up through the value chain in the wider economy, resulting in an oversupply of skilled graduates with few opportunities outside the public sector.
- The lack of economic opportunities has resulted in a 'brain drain', with many skilled Tunisians leaving the country and unlikely to return.
- Tunisia's human capital score is just below the global median, with the Government committing a significant proportion of its spending to education.
- Take up of VET programmes in Tunisia is very low, often being viewed as dead-end and unattractive programmes by potential participants.

4. THE TUNISIAN ENERGY SECTOR

KEY ISSUES COVERED

- Trends in the Tunisian energy mix
- Institutional, regulatory and financial developments in the sector
- Employment in the Tunisian energy sector
- Drivers of skills demand in the energy sector

The energy sector comprises the production and supply of energy, including both non-renewable (petroleum products, gas, nuclear, etc.) and renewable sources (e.g. hydropower, biofuels, solar and wind power).. When defining employment in the sector, it is useful to refer to standard industrial classifications such as NACE, although there is no direct correlation between NACE sectors and energy industry. Given the characteristics of the energy sector in Tunisia (e.g. the import of gas from neighbouring countries and the presence of an important gas pipeline, the TransMed Pipeline), employment statistics in the energy sector need to be extracted from the following NACE sectors:

- B 06 Extraction of crude petroleum and natural gas
- C 19.2 Manufacture of refined petroleum products (relevant for Tunisia)
- D 35 Electricity, gas, steam and air conditioning supply
- E 38 Waste collection, treatment and disposal activities; materials recovery
- E 39 Remediation activities and other waste management services
- F 42.9 Construction of water projects and other civil engineering projects
- H 49.5 Transport via pipeline

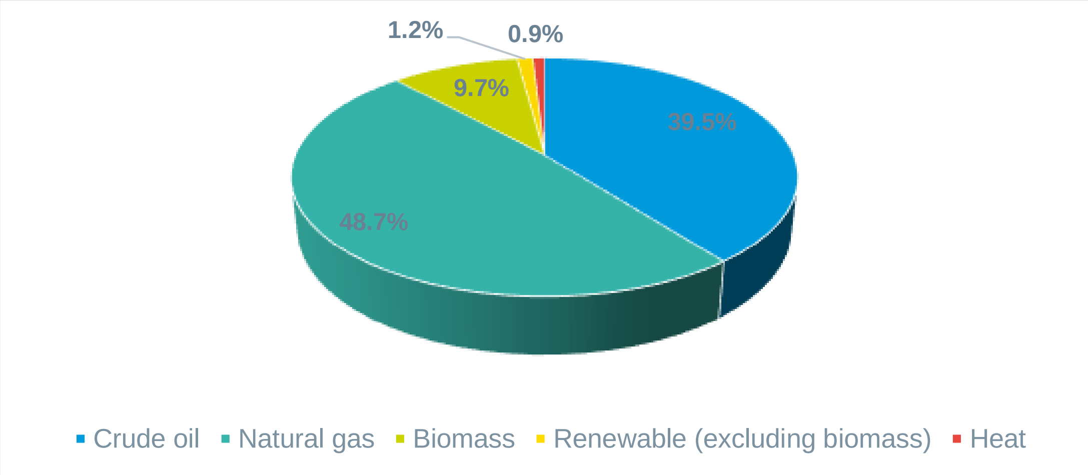
4.1 Overview

In recent years, Tunisia has set in motion an energy transition strategy to deal with a changing economic and energy context. Population growth and depleting gas resources, especially for the electricity sector, which depends on natural gas for up to 97% of production, have had a significant impact on the country's energy balance, and the gap between production and demand is growing every year.

Total primary energy supply

Like most MENA countries, Tunisia is reliant on fossil fuels for most of its energy needs. The total primary energy supply in 2019 was 11 265 ktoe, with natural gas and oil accounting for 48.7% and 39.5% of the total respectively (Figure 4.1). The share of natural gas in the country's primary energy consumption has become increasingly significant. Tunisia receives natural gas from a pipeline linking Algeria and Italy, which runs across its territory.

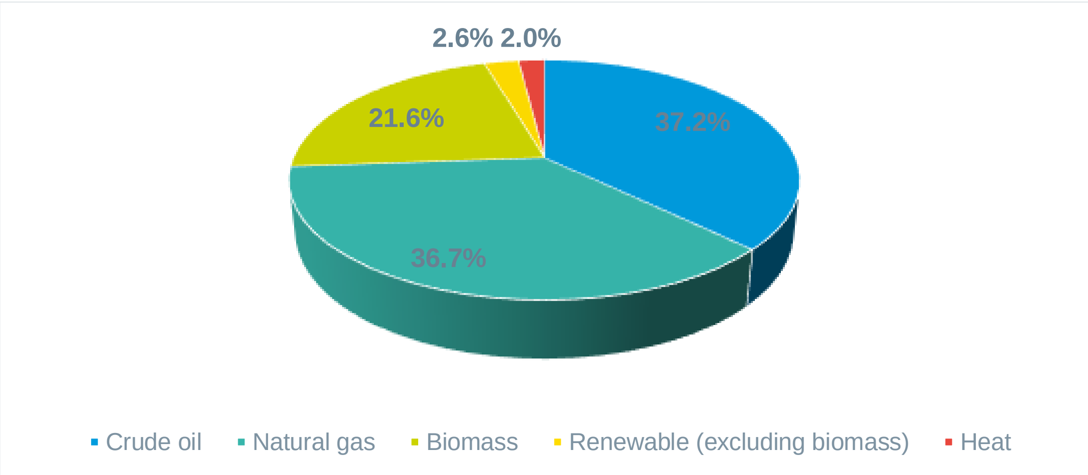
Figure 4.1: Tunisia's primary energy supply by source, 2019



Primary energy production and imports

Since 2001, the country has been **a net energy importer**. Total primary energy production in 2019 reached 5 069 ktoe against a national primary energy demand of around 11.3 Mtoe. Primary production covers only 45% of Tunisia's national primary energy demand. The structure of primary energy production is dominated by fossil fuels with an overall share of around 74%, divided equally into 37% each from crude oil and natural gas (Figure 4.2). Biomass still contributes a significant part of primary energy demand, with a share of 22%. On the other hand, the share of energy production from the waste heat recovery process is around 2%, as is that of renewable energy.

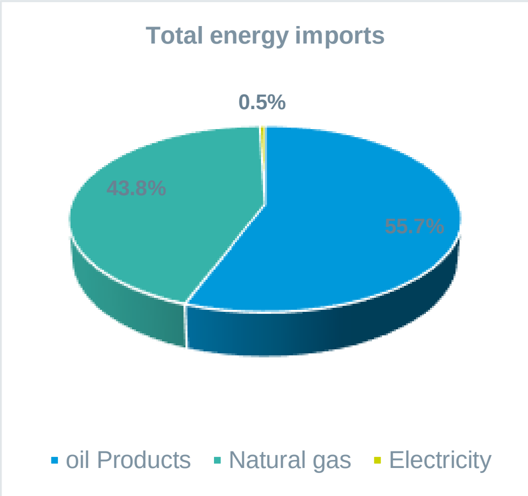
Figure 4.2: Tunisia's total primary energy production by source, 2019

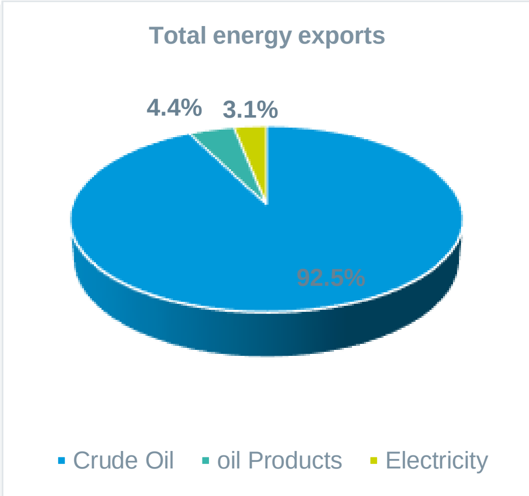


Energy imports and exports

A decrease in production and a sharp increase in demand has created a deficit in the primary energy balance. To meet Tunisia's electricity production needs, energy sources are primarily imported, particularly from Algeria, which supplies half of the natural gas used in Tunisia and 72% of the electricity. This is significant for a country like Tunisia, which was once a net exporter of both oil and gas. Dependency on energy imports accounted for 55% of Tunisia's energy needs in 2019, posing a real challenge to the country's energy security.

Figure 4.3: Tunisia's energy imports (left) and exports (right), 2019

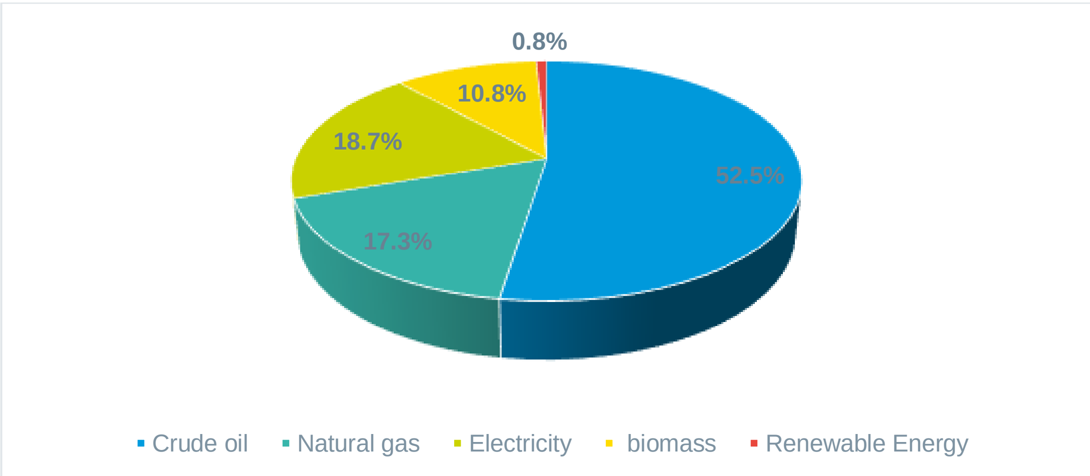




Total final energy consumption

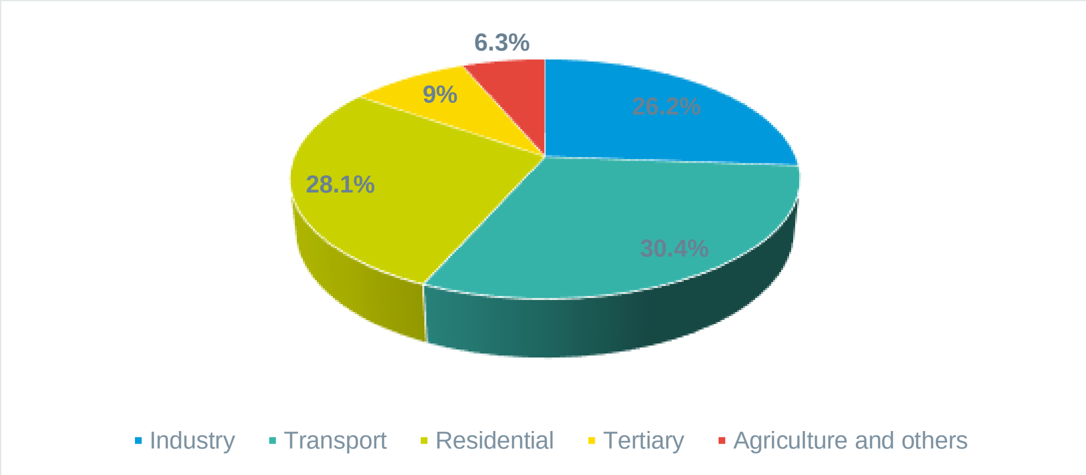
Tunisia's final energy consumption increased by around 1.2% per year on average over the last 10 years and reached 8 Mtoe in 2019. Final energy consumption is characterised by a strong preponderance of petroleum products (52.5%),, followed by electricity (18.7%), natural gas (17.3%), biomass (10.8%), and finally renewable energy, which represents only 0.8% of final energy consumption in 2019 (Figure 4.4).

Figure 4.4: Tunisia's total final energy consumption by source, 2019



The breakdown of final energy consumption in Tunisia by sector shows that the transport sector remains the main energy-intensive sector, absorbing 30.4% of total final energy consumption. This is closely followed by 28.1% consumed by the residential sector and 26.2% by the industrial sector. Only 9% of total energy consumption is absorbed by the tertiary sector, combining the commercial sector and services such as public administration, health, education, banks, etc. By grouping the residential sector (private households) and the tertiary sector (public buildings and private buildings for commerce and services) into a larger 'building' sector, this would represent the most energy-consuming sector, absorbing 37% of the final energy balance in 2019. energy use from the agricultural sector accounts for only 6.3% of total energy consumption, despite agriculture accounting for a significant share of the economy, with 5 000 m^2 of farmable land per inhabitant (Figure 4.5).

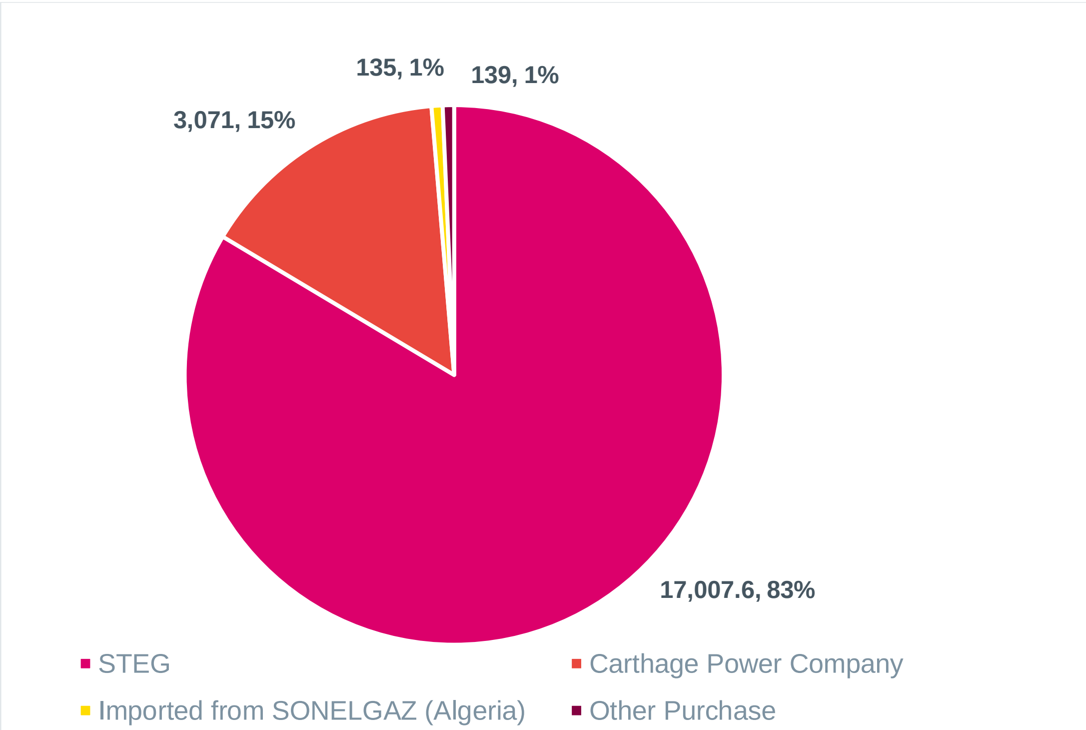
Figure 4.5: Tunisia's total final energy consumption by sector, 2019



Energy sources for electricity generation and distribution

In 2019, Tunisia delivered a total of **20 352 GWh** to the grid, of which 90.5% came from public thermal power plants; only 5.8% came from private self-producing power plants and only 3.7% from renewable sources (hydropower, wind and photovoltaic), as shown in Figure 4.6. However, 18% of the electricity injected into the grid was lost to transmission, distribution, and commercial losses.

Figure 4.6: Tunisia's total production by producer, 2019 (in GWh and %)



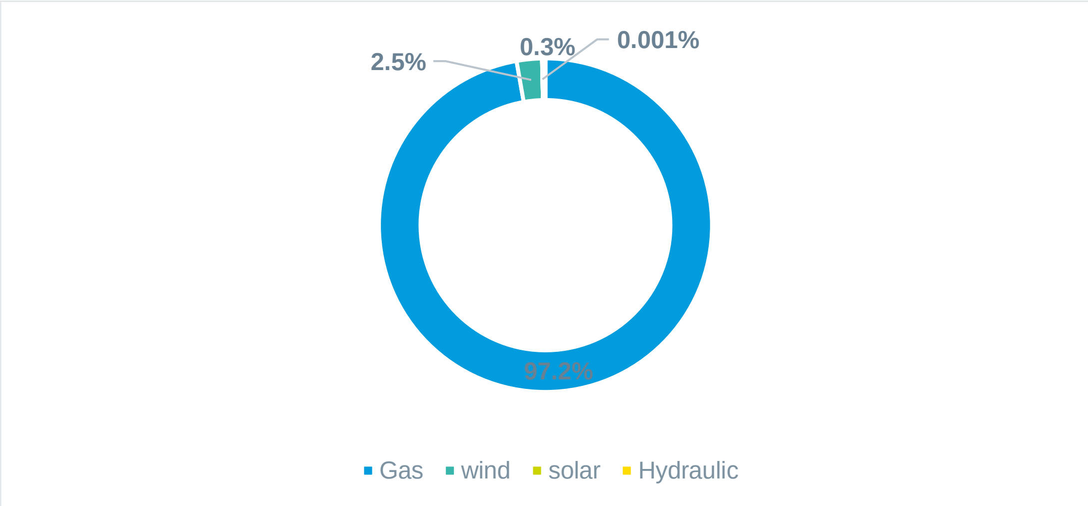
Source: STEG Report 2019

Renewable energy

The electricity production of the Tunisian Company of Electricity and Gas (STEG) from renewable energy (hydropower, wind power and photovoltaic) increased in 2019 to approximately 566 150 GWh (Figure 4.7), while it was only 87 GWh in 2000. Thus, it represented 2.8% of national electricity production of electricity in 2019, i.e. 10 times less than the target set by the Government of 30% by

2030. Over the period 2000-2019, total electricity production from renewable sources was estimated at 5 824 GWh, the largest share of which from wind energy with 68%, followed by hydropower (26%) and photovoltaic (6% – added to the statistics from 2010).

Figure 4.7: STEG electricity production by source, 2019



Source: STEG Report 2019

On the other hand, the development of electricity production from renewable sources has allowed Tunisia to achieve fossil energy savings of around 1 712 ktoe over the period 2000-2018, of which 75% was achieved in the period 2010-2018. Wind alone contributed savings of 820 toe, followed by hydropower (332 ktoe) and photovoltaic PV (72 ktoe).

Finally, total investments made over the period 2005-2018 amounted to around TND 1 423 million, the largest part of which is in wind power at around TND 686 million, followed by photovoltaic at TND 496 million. A breakdown by type shows that 52% of the investments, accounting for TND 737 million, were invested by individuals in solar water heaters, solar panels for roofs, and photovoltaic pumps. It is estimated that investments by private individuals in photovoltaic installations led to savings of around TND 187 million on the total energy bill in 2018, constituting around 1% of the total trade deficit in 2018. In cumulative terms over the period 2000-2018, the saving on the bill is estimated to be around TND 1 245 million, of which 43%comes from wind power and 42% from solar water heaters.

Given this context, Tunisia has begun to review its energy strategy for the next 20 years. Due to the country's high renewable energy potential, particularly in wind, biomass and solar, the Tunisian Government has decided to strengthen its strategy in this area.[4] The challenge for the Tunisian Government today is to reconsider its energy strategy to ensure energy security; achieve the COP 21 commitments, which consist of reducing its CO_2 emissions by 41% by 2030 (Jeune Afrique, 2015); and meeting the renewable energy (RE) target by increasing the percentage of energy from renewables in the energy mix to 30% by 2030.

The energy sector is highly subsidised, posing a macro-fiscal risk, since energy subsidies account for up to one-third of the fiscal deficit (World Bank, 2019). Fuel and electricity subsidies cost 1.6% of GDP in 2017 and 2.5% in 2018 (World Bank, 2019). The subsidies on oil products, natural gas and electricity impose a large burden on public finances and can be regressive. In terms of total money saved, these subsidies benefit wealthier customers more than the poorest because the former consume more energy (absolute regressivity). However, in terms of relative access to energy consumption, subsidies provide coverage for many poorer households that would otherwise have little

4 http://www.tunisia2020.com/projet/biomass-power-generation/

or no access (relative regressivity). Hence, the total financial saving of poorer households is less, but for many, that small amount is the material difference between having electricity and heating or not (Beylis and Cunha, 2018). This is most obviously the case for liquefied petroleum gas (LPG), which is mainly used for cooking and heating. There are also indirect effects on the prices of other goods from lifting subsidies: food and other essentials need to be transported and processed, which uses energy. Thus, shifting subsidies, particularly away from industrial and commercial customers, and redirecting resources to those on low incomes would be a better approach and encourage more efficient energy usage.

4.2 Main policies and responsible authorities in the energy sector in Tunisia

Since the 1980s, Tunisia has adopted a sustainability policy on energy production and consumption. It has implemented a proactive policy to reduce energy intensity, strengthen energy independence and contribute to reducing greenhouse gases, thus largely anticipating the occurrence of the anticipated energy deficit in the mid-1990s. At that time, among developing countries, particularly those in the Mediterranean region, Tunisia was a pioneer in energy management. The country has built its policy in this area around three pillars: institutional, regulatory, and financial.

4.2.1 Institutional framework

In Tunisia, the organisation responsible for energy management is the National Agency for Energy Management (ANME), which was created in 1985 and falls under the supervision of the ministry in charge of energy. The Agency, which became operational in 1986, is responsible for implementing the Government's policy on the rational use of energy, promoting renewable energy, and reducing greenhouse gas emissions.

The Tunisian Company of Electricity and Gas (STEG) is considered a key player in both renewable energies and energy efficiency. With its subsidiaries STEG International Services (SIS) and STEG Energies Renouvelables (SER), STEG has become an important stakeholder in energy management both in Tunisia and across Africa. STEG is responsible for the transmission and distribution of the entire electricity service in Tunisia, with almost 4 million customers (World Bank, 2019). In the late 1990s, the generation segment of the electricity value chain was opened up to independent producers, which can sell to STEG. However, two decades on, only 18% of power generation is provided by independent producers, leaving STEG with a large monopoly (World Bank, 2019). This monopoly has provided near universal access to electricity and gas in the country, but has seen an increase in overall losses on the network to 18% from a European level of 10% since 2011 (World Bank, 2019). This is due to increasing commercial losses and theft.

Another important actor is the National Observatory of Energy and Mines (ONE), established in 1990. The aim of the Observatory, part of the Ministry for Energy and Mines, is to collect and disseminate information regarding energy and mines in the country, including progress against targets and market shocks (Ministère de l'Énergie et des Mines, 2021).

In order to accelerate the implementation of renewable energy production projects, the Tunisian government has recently strengthened the institutional framework by creating:

- the **Technical Commission for Private Electricity Production from Renewable Energies (CTER)**, through Law No 2015-12 of 11 May 2015. Operating under the supervision of the ministry in charge of energy, the Commission draws up the electricity production plan according to national consumption needs while taking into account the grid integration capacity;
- the **Higher Commission for Independent Electricity Production (CSPIE)**, which decides on the methods of choosing concessionaires for independent electricity production projects and the advantages to be granted to them.

In March 2018, the Tunisian Government adopted a decree **establishing a dedicated climate action unit within the Ministry of Environment**. However, to date, no progress has been made regarding **the independent regulatory body** for the electricity sector in Tunisia.

4.2.2 Legislative and regulatory framework

The evolution of a specific regulatory framework for energy is marked by the adoption and enactment of new laws stating an ambitious political will to support energy efficiency and renewable energy investments. The main pieces of legislation are:

- the legal framework governing self-production of energy, established by **Law No 2002-3232 of 3 December 2002**. This law set the terms and conditions for carrying out cogeneration projects for producing electricity and heat, for self-consumption or for meeting local consumption needs. The law authorises manufacturers to sell excess electricity production to STEG if their cogeneration plants meet specific energy efficiency criteria;
- **Law No 12-2015 of 11 May 2015** on the production of electricity from renewable sources. This law allows any public or private investor, alone or in a partnership, to produce electricity and sell its surplus or the entirety of its production to STEG;
- also in the field of renewable energy and the related investments, previous legislation was amended by **Cross-Sectional Law No 47-2019, of 30 May 2019** on the improvement of investments in the fight against climate change, including renewable energy investments. The law aims at facilitating the exchange of energy between different companies and the efficient integration of their electricity production and transmission through the STEG grid.

Furthermore, Tunisia submitted an ambitious nationally determined contribution (NDC) to the United Nations Climate Change Secretariat (UNFCCC) prior to the Paris Climate Change Conference in 2015. This plan aims to reduce the country's carbon intensity by 41% (13% unconditionally and another 28% conditionally) by 2030 relative to 2010 levels. Mitigation efforts focus especially on the energy sector, which accounts for 75% of the proposed emission reductions. By ratifying the Paris Agreement in 2016, Tunisia committed itself internationally to implementing its NDC. Lastly, in March 2021, Tunisia ratified the Kigali amendment, which aims to gradually reduce hydrofluorocarbons (HFCs) in the refrigeration sector.

The Tunisian Solar Plan (TSP) and the Solar Promotion Programme (PROSOL)

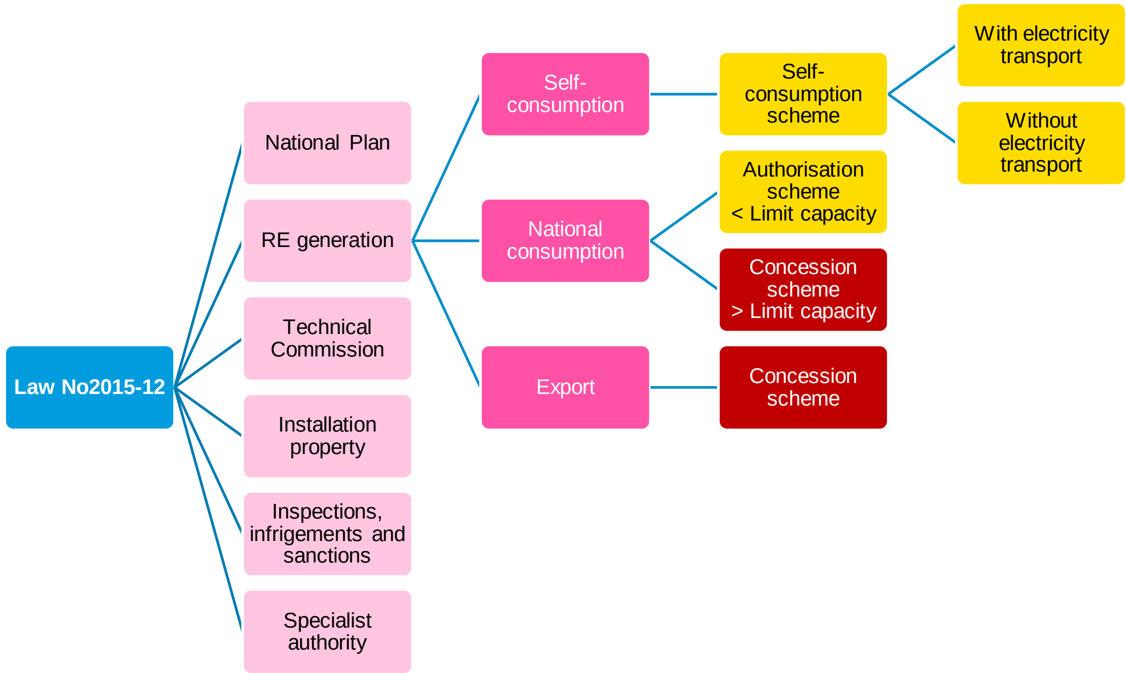
In May 2005, the Tunisian Government passed a law promoting electricity generation from renewable sources (Law No -82-2005 of 15 August 2005). A government decision in 2016 (Decree No 1123/2016 of 24 August 2016) and further implementing provisions brought the law into effect (GIZ, 2015). Tunisia has decided to invest heavily in the solar sector to meet its targets of electricity generation from renewable sources. Therefore, in 2005, the Tunisian Government initiated its solar programme, PROSOL. The programme aims to promote the development of the solar thermal market through financial and fiscal support. PROSOL is a joint initiative of the ANME, the STEG, the United Nations Environment Programme and the Italian Ministry for the Environment, Land and Sea. It has established a loan facility to subsidise the cost of purchasing solar water heaters. The programme has been renewed several times and is still ongoing as at the date of this report (United Nations, 2011).

The country has established a target of 30% electricity production from renewables by 2030 in the Tunisian Solar Plan (TSP), first published in 2009 and revised in 2012. From 360 MW installed by 2019, the plan identifies an additional 1 860 MW of renewables needed by 2022 and 3 815 MW by 2030 (IRENA, 2020).

2015 Law on the implementation of renewable energy projects

The 2015 Law is the main act regarding renewable energy in Tunisia. Enacted on 11 May 2015, it established a legal framework governing the development of renewable energy projects. The law describes the national plan for the generation of electricity from RE sources, with a project development framework. It also describes the role of the technical commission for private electricity production from renewable energy, the installation and decommissioning obligations, the inspection and infringement procedures, and the role of the authority in charge of examining issues and claims related to renewable energy projects.

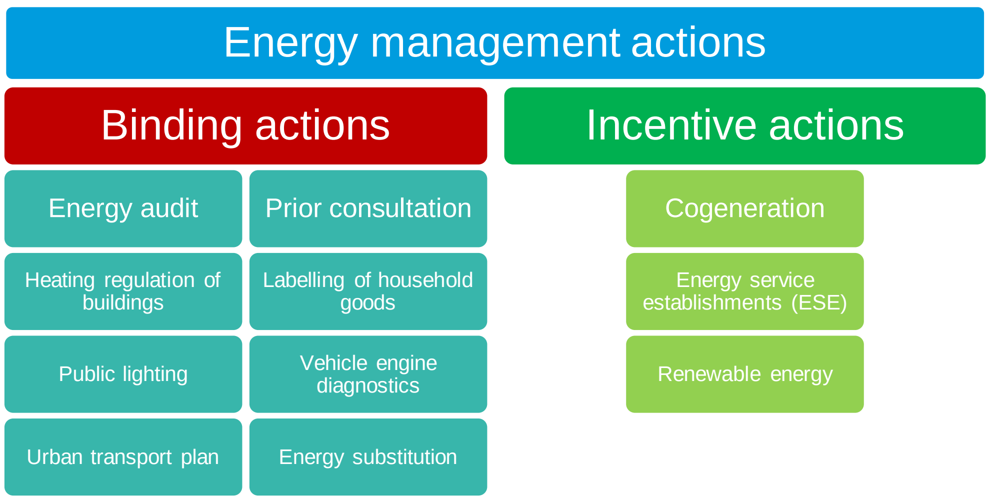
Figure 4.8: The 2015 Law



Source: German Federal Ministry for Economic Cooperation and Development (BMZ), 2019

All these laws have defined priority energy conservation measures and actions, which cover all the programmes and projects aimed at improving energy efficiency and diversifying energy sources. They have been grouped into two types: binding actions and incentive actions. The following figure illustrates these two types of measures, which are all currently implemented and in force.

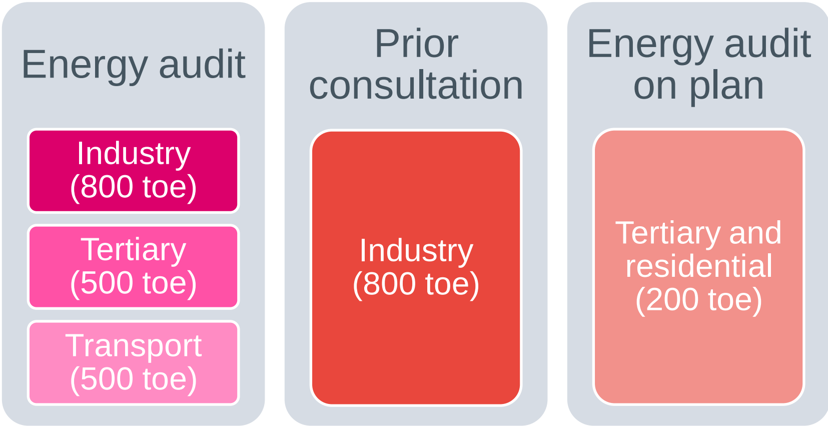
Figure 4.9: National energy conservation actions



Source: CES-MED Report 2015: Actions Nationales Recommandées pour l'Energie Durable et la Viabilité Urbaine en Tunisie.

The following graph (Figure 4.10) illustrates some examples of key energy management actions as mandated by the current regulatory framework in Tunisia.

Figure 4.10: Periodic energy audit (toe= ton of oil equivalent)



Source: Rétrospective_Energie_Tunisie _ATPG_2019

4.2.3 Financial and incentive framework

In order to encourage investment in the energy sector, Tunisia has initiated a financial incentive framework in three forms: **direct subsidies, credit lines** and **tax advantages.**

The main financial incentives for renewable energy and energy efficiency projects in Tunisia are as follows:

- Direct subsidies: FTE and FTI
  - Energy Transition Funds: FTE/FNME

Direct subsidies are funded through the National Fund for Energy Management (FNME). Law No 82-2005mobilised extra-budgetary resources to finance public support for energy investments. This law created the FNME, which aims to provide financial support for actions aimed at reducing energy consumption and promoting renewable energy. This fund is managed by ANME and is financed by taxes on the first registration of cars, on air conditioners and on incandescent lamps.

The FNME was recently transformed into the Energy Transition Fund (FTE) by Law No 54- 2013 of 30 December 2013, the budget law for 2014, with new incentive measures and more suitable financing mechanisms (credit lines) that significantly increased the Fund's resources to support energy conservation programmes and expand its intervention methods: subsidies, credit lines, investment funds and interest rate subsidies.

- Tunisian Investment Fund (FTI):

The Tunisian Investment Fund was created by Law No 2016-71 of 30 September 2016, (the Investment Law). The fund operates under the control of a supervisory commission, chaired by the minister responsible for investments. The rates, ceilings, and conditions for accessing these incentives are set out in Government Decree No 389-2017 of 9 March 2017.

The fund's resources consist of government resources, loans, and grants from local and international donors. It operates mainly via:

- subsidies for direct investment operations in priority sectors, including the production of renewable energy;
- equity participation.

Table 4.1: Tunisian investment fund objectives and funding

Fund	Remuneration	Maximum amount

Premium for increased added value and competitiveness	15 % of the approved investment cost	TND 1 million
Regional development bonus	Dependent on regional development zones: 1st group, 15% of the approved investment cost 2nd group, 30% of the approved investment cost	TND 1.5 million for zones in the 1st group, TND 3 million for zones in the 2nd group
Employability development bonus	State support for the employer's social security contributions for employees of Tunisian nationality recruited for the first time on a permanent basis: For 5 years from the date of the effective start of activity (if the project is located in an area in the 1st group) For 10 years from the date of the effective start of activity (if the project is located in an area in the 2nd group) For 3 years from the date of the effective start of activity (if the project is not located in a development zone) State support for part of the salaries paid to Tunisian employees (holding a higher education diploma or a higher technician certificate), depending on the level of supervision: management level from 10 to 15%: payment of 50% of the salary for 1 year; management level greater than 15%: payment of 50% of the salary for 3 years. This premium cannot be combined with the premium provided for by the regulations in force from which private-sector companies benefit in the same way.	no ceiling TND 250 per month Cannot be combined with the premium provided for by the regulations in force from which companies in the private sector benefit in the same way.
Sustainable development premium	50% of the valuation of the investment components approved for projects adopting clean and non-polluting technologies enabling the reduction of pollution at source or the control of the exploitation of resources.	TND 300 000

Source: Décret gouvernemental 2017-389 du 9 mars 2017

According to the Ministry of Finance (October 2018), FTI and FTE subsidies do not overlap because these funds support different projects: projects dependent on the authorisation regime are supported by the FTI, while projects dependent on self-consumption are supported by the FTE.

- Tax advantages:
  - Incentives for importing renewable energy equipment and components

Renewable energy components and equipment used in the field of renewable energies benefit from tax advantages when they are acquired on the local market or imported. These advantages began in 1995 through provisions in the budget law, introduced by Decree No 95-744.

- **VAT:** Under Table B appended to the VAT Code of 2017, 'ENR components' benefit from VAT reduced to 6% (as opposed to the standard rate of 18%). This rate may be amended by the budget law each year.
- **Customs duties:** Under paragraph 7.21 of Chapter 2 of the preliminary provisions on import customs duties (Law No 89-113), the imported 'ENR components' mentioned above having no similar locally manufactured alternative benefit from reduced customs duties of 10 %. This rate may be amended by the budget law each year.

4.3 Skills demand and employment in the energy sector

Several studies have been carried out on skills demand in the Tunisian energy sector, particularly focusing on the renewable energy sub-sector. Most of these studies were conducted by international organisations and/or donors: e.g. GIZ 2012, ILO 2018, WB 2019, Schafer 2016, Lehr 2016, etc. A summary of the key findings of the existing studies is presented below.

Skills demand in the energy sector going forward is expected to reflect the following range of jobs needed in RE production based on World Bank research (World Bank, 2019):

- Energy specialists
- Power engineers
- Energy economists
- Procurement specialists
- Financial management specialists
- Environmental specialists
- Social specialists
- Construction and maintenance

With the challenge of tens of thousands of Tunisians entering the labour market every year, there is only a limited role that RE can play in job creation. However, the following occupations are beginning to emerge and have capacity for growth (Schafer, 2016):

- Installer of photovoltaic solar systems
- Electrician for maintenance of PV solar systems
- Electrotechnician in renewable energies
- Technician for development of RE systems
- Project manager of RE projects
- RE researcher/scientist (e.g. solar researcher)
- Wind farm project manager

Many engineering schools are present in the country (chemical, electrical, mechanical, energy etc.), providing in general good educational and theoretical knowledge. Seven universities offer degrees directly specialising in the energy field, and various other institutions offer training related to energy. Three engineering schools offer a higher degree in the energy sector and four universities have master's degrees in this domain. On the other hand, the number of graduates has decreased in the last 8 years, with an average decrease rate of 4% per year (EBRD, 2020b). Master's level graduates in energy are increasing but at a slow pace. In any case, the market is not absorbing these graduates: the number of employees in engineering sectors is stagnating, with a loss of 1% of the workforce in recent years (EBRD, 2020b).

Also, the energy training offer is not very diversified at degree and master's level. Energy is mainly studied as a module in other courses in most engineering schools. The contribution of the private sector at the master's level is marginal. Medium-level technical competences are instead in high demand, but the offer is less able to keep pace with companies' needs and desires, especially because of the need for specific skills (e.g. laser welding) still lacking in the workforce.

Vocational training in Tunisia involves several public and private stakeholders. The agencies of the Ministry of Vocational Training and Employment manage 136 vocational training institutions covering 13 sectors, while energy courses cover 12 specialisms. Initial vocational training is provided both by the public sector and by 930 private establishments, but there is no training specifically dedicated to the field of energy; the courses offer general scientific knowledge (EBRD, 2020b). On the other hand, continuous training, mostly delivered by private providers with about 2 700 training structures overall, is one of the pillars of the country's human resources development system (EBRD, 2020b). Indeed, continuous education programmes in the energy sector are also organised by companies and other institutions and organisations such as ANME.

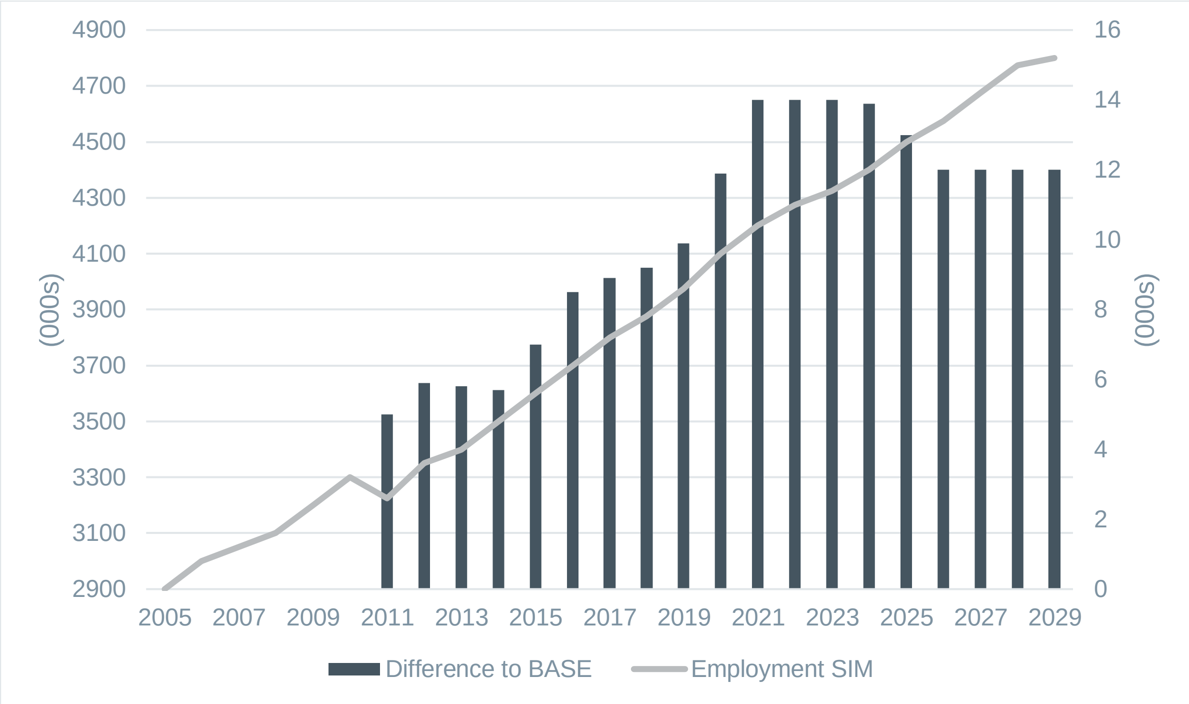
A mix of both traditional and 'green' education is needed to upskill potential entrants into the energy market. The issue is keeping the curricula up to date with the market needs. Training is required for both the creation of green jobs and for the greening of old jobs. Tunisia ought to connect its 1 000 vocational training centres to new green projects to create a successful flow of workers into the industry. 35% of Tunisian graduates are qualified in STEM subjects, a talent pool ready for a growing RE sector.

A spill-over effect can be anticipated with an increased RE sector. This can occur both upstream, through the manufacturing of machinery and components, and downstream, within the communities where maintenance is delivered. RE investment is expected to have a spill-over effect into other related sectors such as waste management, recycling, engineering, and other sub-industries. For example, neighbouring Algeria's national RE plan involves a mirror manufacturing plant to aid photovoltaic cell efficiency (Schäfer, 2016).

Tunisia has included the right to a clean environment and sustainable development in its new constitution. This necessitates a cohesive understanding of developments in the energy sector. For example, energy efficiency measures at the consumer end of the cycle are also important, not just the supply end. Therefore, energy efficiency is the second pillar of the Tunisian Solar Plan (TSP). This pillar will be achieved through effective marketing, labelling and energy consulting to make people aware of the benefits of insulating homes and purchasing low-carbon white goods.

According to a GIZ report in 2012, the combined investments in renewable energy and energy efficiency (RE+EE) can create more than 10 000 additional jobs from the Tunisian Solar Plan if large parts of the systems are imported. In a scenario of lower imports, employment could rise to more than 20 000, or more than 0.6% of overall employment. This is a very optimistic case and can be considered the maximum attainable employment (Lehr, 2016). However, if the Tunisian economy achieves higher integration rates and manages to produce most parts of the RE systems within the country, employment may increase by almost 30 000 jobs. Figure 4.11 illustrates an optimistic forecast whereby employment follows the pattern of investment and rises to 14 000 (read from the scale on the right axis of the graph) (GiZ, 2012).

Figure 4.11: Total employment (differences compared to the baseline scenario)



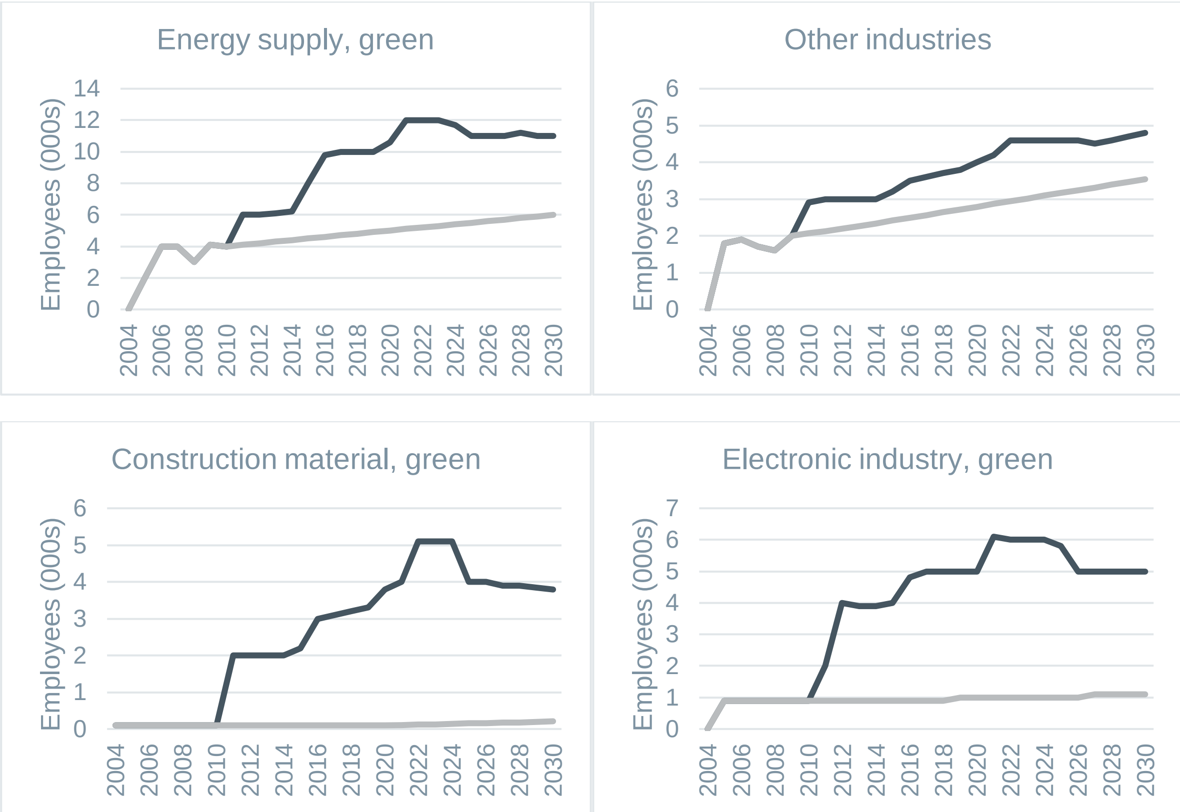
Source: Green Jobs in Tunisia, ILO (2018)

Different scenarios have been considered to analyse the impact of local integration and exports on employment. An additional sensitivity analysis has been carried out to show which sectors are the most promising from an employment perspective. The answer to this question is not as straightforward as one might hope, since it depends on a variety of factors. By comparing the employment generated per TND 100 million invested, we can conclude that energy efficiency in buildings generates the most employment, followed by solar water heaters and photovoltaic installations. Wind energy and energy audit activities follow. These results were obtained in light of the specific import structure of the respective industries.

Solar water heaters have been successfully implemented in the PROSOL framework and lead to the second-largest employment figure per TND 100 million invested. The photovoltaic sector generates the third-largest figure for employment, though sizeable Tunisian production of solar modules is not anticipated. Tunisia should benefit from falling photovoltaic prices and seize the employment opportunities available in the installation and production of electric and electronic components of photovoltaic systems. Wind energy does not contribute as many jobs as the first three technologies but provides opportunities for technological development.

The following figures show some sectors that particularly benefit from the RE sectoral growth.

Figure 4.12: Employment impacts in different sectors (thousands of employees)



Source: Green Jobs in Tunisia, ILO (2018)

According to ILO (2018), in the long-term a total of 272 000 green jobs could be created in Tunisia by 2030 (International Labour Organization, 2018). The development of the photovoltaic sector alone is expected to generate more than 3 000 jobs for each 1 000 MW produced annually. The cost of investments in the sector is very high: the total investment needed in renewable energy is TND 8.28 billion (about EUR 4.15 billion). In 2012, 3 390 people were employed in the RE sector in Tunisia, including RE production (1 445), RE-related activities (975), and energy efficiency (930). In the long term, the Tunisian Government plans to accelerate the process of industrial integration and to export photovoltaic installations and solar boilers. If this plan is successful, new jobs could be created in manufacturing, sales, and consultancy services. For instance, according to the EBRD, in 2015 nearly 2 900 jobs were created in the energy sector, the majority being supply and installation jobs. Of these, 823 were created via investments in energy efficiency programmes, while 2 052 were created thanks to the RE programme, particularly in the solar energy sector. Based on these numbers, the EBRD estimates that around 12 000 jobs could be created by 2030 according to the baseline, or around 25 000 jobs under a more optimistic scenario (EBRD, 2020b).

Green jobs could be created in construction, the electronics industry, construction materials and the electricity sector itself. The impact on construction derives from investment in wind farms and other RE-based electricity generation systems, as well as from the increased energy efficiency of homes.

Main findings from the Section

- The Tunisian energy sector overwhelmingly relies on fossil fuels for its energy needs.
- Tunisia began conceptualising a more sustainable energy system in the 1980s with the creation of an agency for energy management – ANME.
- STEG, the state monopoly energy provider, has overseen extensive household coverage through the electricity grid but with falling efficiency in recent years due to increasing output losses.
- Under its commitment to the COP 21 agreement, the Tunisian Government has agreed to increase the percentage of energy from renewables in its energy mix to 30% from its current 2%.
- The main regulatory development in renewable energy in Tunisia came with the 2015 Law establishing a legal framework governing the development of renewable energy projects. The financial pillar is split into three distinct forms: direct subsidies, credit lines and tax advantages.
- Tens of thousands of Tunisians enter the labour market every year; in this context, changes in the energy sector can only be expected to play a modest role in job creation. The total level of expected employment will ultimately depend on the amount of renewable energy inputs produced in the country.
- The EBRD estimates that around 12 000 jobs in renewable energy could be created by 2030 according to the baseline, or around 25 000 under a more optimistic scenario.

5. KEY DRIVERS OF CHANGE in the SECTOR

KEY ISSUES COVERED

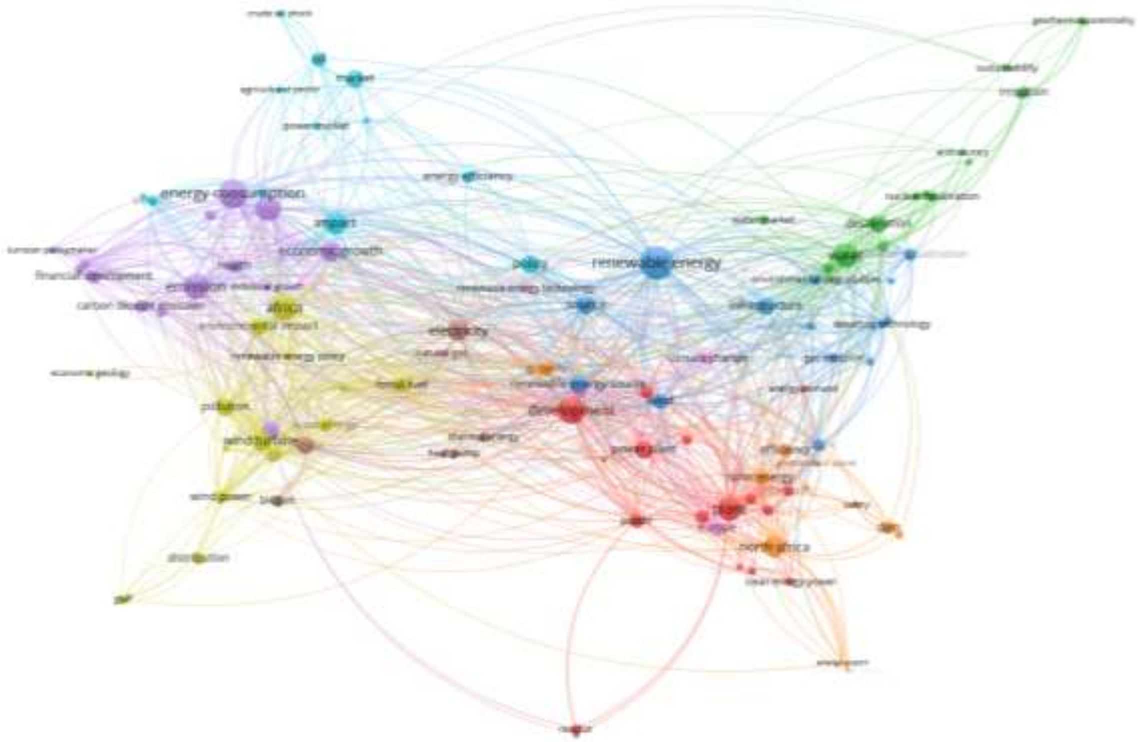
- Analysis of the main drivers of change currently shaping the sector (e.g., climate change, energy efficiency, new technologies, international regulations).

The preceding chapter has outlined the broad contours of skills demand in the energy sector. In moving towards a more detailed analysis of skills needs – i.e., what are the actual skills that people use in their jobs and how are they likely to change? – it is important to understand the factors driving the change and the technologies associated with that change.

5.1 Identifying the drivers of demand

Fast technological development is a major factor influencing the demand for skills. But technology does not account for everything. There are many other factors, such as social, economic, and environmental one, which shape future skill needs; among others, in recent times greening policies have become particularly prominent on the agendas of governments. In order to study all the possible drivers of change, the entire Scopus and Web of Science databases were scanned to find scientific papers related to the energy sector in Tunisia; next, the most relevant keywords were extracted and mapped using a network diagram. Figure 5.1 provides a snapshot of the network.

Figure 5.1: Network diagram of keywords related to the energy sector in Tunisia from the analysis of scientific papers



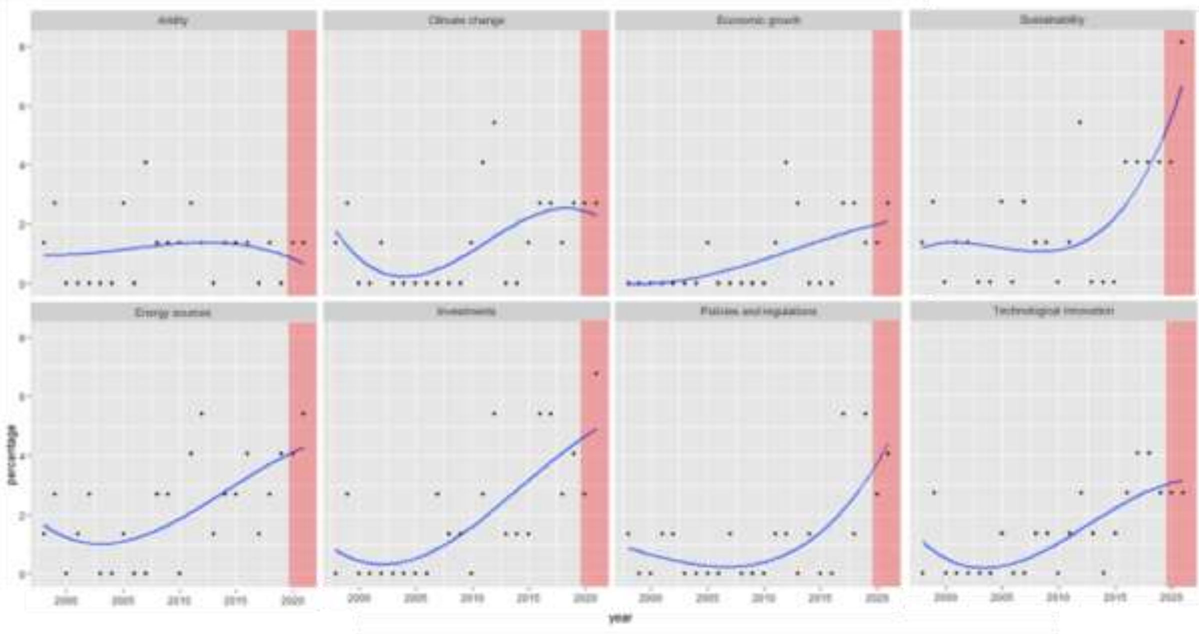
Browsing the network of correlations between the topics provides an understanding of the relationships between them. The nodes represent the topics found in the papers, while arcs are formed when two topics are mentioned within the same paper. The bigger the node, the higher the frequency with which that concept appears in papers. For instance, in the network diagram in Figure 5.1, three main nodes and their related clusters can be seen:

- **energy consumption** in the purple area in the top-left part of the diagram;
- **renewable energy** as a blue node in the top-central part of the diagram;
- the **development** node, in red in the bottom-central part of the diagram.

As can be seen from the links in the purple cluster, energy consumption is linked to the country's economic growth, which presumably has led to an increase in overall energy use in both the industrial and residential sectors, and is connected to the presence (or absence) of the country's financial development (small purple node in the top-left part of the diagram). The network also confirms the importance of renewable energies as a strategy for the future development of the country's energy sector. The red cluster shows the importance of the development issue for the Tunisian energy sector, which is directly linked to power plant facilities and the generation of clean energy, as well as of course to the correlated expected increase in energy consumption. The inspection of all clusters in the overall network provides the basis for identifying potential drivers of change.

A driver of change is considered to be a factor that strongly influences the evolution of future scenarios. By combining the clustering with an analysis of change over time (i.e. the number of scientific papers each year) it is possible to determine whether the observed phenomena are increasing (see Figure 5.2 as an example), and thus their impact will extend in the years to come.

Figure 5.2: Distribution over the years of key concepts identified from the analysis of scientific papers on energy



Note: a red screen covers the last year in the plots, since the number of articles related to that specific topic is not final (due to the review and publication process).

With the exception of the 'aridity' driver, an overall increasing trend for all the main drivers of change can be observed within the scientific papers. This is an indication of the fact that the energy sector in Tunisia has been the subject of increasing research, investment and debate over the last few years. The fastest-growing trends are those related to sustainability, energy sources (in particular renewables), investments and policies; clearly these topics are all interconnected, as the network analysis also shows. On the other hand, despite the attention gained in the scientific literature in 2005 and 2010 respectively, the interest in issues related to water scarcity and climate change seems to have slowed down recently.

Going into detail for each driver, it is possible to better understand its significance and identify the skills that are becoming more relevant within the energy sector.

Environmental sustainability

This is the driver that appears most frequently within scientific papers and has grown the fastest in recent years. Indeed, environmental sustainability has become one of the most common themes in energy production. The increase in CO_2 emissions and the issue of global warming have spurred greater attention to the environmental consequences of human activities. Energy transitions in developing countries, among which Tunisia is considered, mainly consist of achieving a more sustainable framework by integrating a wider adoption of renewable energies with the use of energy efficiency solutions. The sustainability factor pushes the country to seek solutions different from the fossil fuels on which it is historically most dependent.

Investments in energy facilities

Thanks to its potential in renewable energy sources, Tunisia is seeking to encourage national and foreign capital to enter the energy sector, with the goal of accomplishing its targets for the diversification of energy production and the reduction of emissions. Groups of investors see great potential for investments in Tunisia, and in the coming years are planning to contribute substantial additional funds needed for a green economic recovery post-COVID-19 and to reach global climate objectives.

Policies and regulations in the energy sector

The adoption of national and international regulations is increasingly affecting the energy sector. After ratifying the Kyoto Protocol in January 2003, Tunisia is among the states that committed to ratify the Paris Agreement in 2017. National policies encouraging green energy production have also been developed to keep the country in line with the worldwide commitment to reduce global warming. Furthermore, the Tunisian Government is actively pursuing two main courses of action to secure power supply: energy efficiency and energy mix diversification.

Availability of energy sources

Due to its climate conditions, the country has great potential to introduce renewable energies such as solar and wind into its energy mix, to complement the traditional use of fossil fuels. Apart from renewables, there have been plans to build a nuclear power plant in the country, although this has not happened yet. In any case, the installation of power plants, which are not related to the energy sources traditionally used by the country, requires the development of new professional roles, skills and competences.

Increased electricity consumption

A more recent but constantly growing trend is electricity consumption. The overall improved economic conditions the country is experiencing are leading to higher electricity consumption by both households and industry. According to recent studies, Tunisia’s annual growth in energy consumption is around 5%. Power generation projects and solutions will need to meet the projected doubling of electricity demand over the next 15 years. Not only must the production of energy be considered, but transmission and distribution facilities must also be upgraded accordingly. All this requires an increase in skills along the entire energy production-transmission-distribution chain in the country.

Technological innovation

Although the growth of this driver has slowed down slightly in recent years, its relevance is still high. Innovation practices in the energy sector are particularly related to the introduction of renewable sources management. In order to adapt to international standards and enable better efficiency and effectiveness control, new energy production and transmission solutions are required. To ensure the correct implementation, use and maintenance of technologies, new skills will be increasingly required by the energy sector to support technological innovation.

Climate change

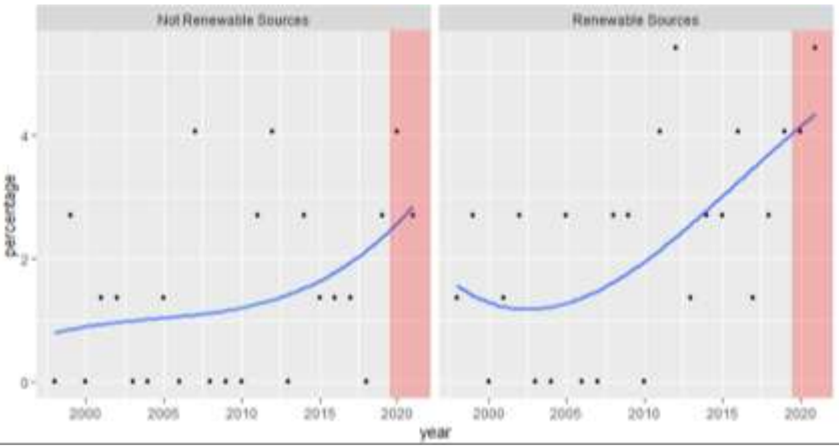
After a few years of growth in the early 2010s, the issue of climate change related to energy production in Tunisia seems to have slowed down in the scientific debate. Climate change is certainly one of the driving factors for the introduction of new renewable energy sources. The Kyoto Protocol first and the subsequent Paris Agreement have allowed developing countries to participate in the international fight against climate change, through the implementation of projects to reduce greenhouse gas emissions. Yet, it seems that this assumption is starting to be accepted; consequently, the discussion is now moving towards other drivers of change.

Aridity

Despite the decreasing trend in the debate, in a country suffering from severe drought the problem of aridity has serious repercussions for the economy. As illustrated by the network diagram, water desalination can be an important solution for irrigation in a country with scarce water resources. The energy sector can make an important contribution, since solar energy can be used to generate the energy needed for this purpose.

It is possible to deepen the analysis for each cluster. For example, for the available energy sources, Figure 5.3 establishes a comparison between *renewable energy sources* and *fossil fuels*.

Figure 5.3: Trends of the available energy sources found in papers



The comparison between the two trends shows that despite the increasing interest in renewable solutions, which is a worldwide trend, non-renewable sources still represent an important sub-sector on which the country relies, as indicated by scientific literature. Although the deployment of renewable solutions is predicted to increase due to sustainability and energy mix reasons, they are not expected to replace more traditional sources, but rather to complement them.

A similar comparison between the various possible sources of renewable energy clearly indicates that solar and wind are the most debated solutions in scientific literature for the production of energy in Tunisia. Other sources such as biofuels and hydropower receive much less attention.

5.2 The role of innovation

The following discussion is about technology as a driver of change. It is important to remark that the focus is not on technology per se but on its potential to influence, through its adoption, the demand for employment and skills. From a methodological point of view, the interest is in the functional use of technology rather than its performance or actual content. Every type of technology exists to fulfil a purpose for the user, to solve a real-life problem, or to provide an advantage. In the theory of engineering design, the purpose is referred to as the function of the technology.

Current literature on the future of work and skills focuses more on the potential of new technologies, but the existing empirical evidence on the actual impact of technology use in companies is very limited. By looking at the functional use of the technology – i.e. the actual problem it solves or the actual beneficial uses it enables – it is possible to study its real impact in the real world. Moreover, even if a specific technology is not eventually adopted, if the need addressed by its functional use is real, in the long term another substitute technology will appear. In this sense, the functional approach makes it possible to understand the obsolescence and/or resilience of certain jobs or occupations and to forecast or even design the shifts occurring between jobs, and the trajectory of skills from one job to another.

In order to map technological evolution, we analysed patents to determine how the identified key drivers of change are connected to emerging technologies. It is worth noting that there is a strong rationale behind the choice of using patents for this analysis, since they are relevant data sources when it comes to technology extraction. In detail:

- Patents are a significant cost for companies, and thus are filed to protect innovations that are considered relevant to the company and are very likely to be produced on a large scale in the future. Hence, their analysis can provide valuable insight into how technologies are changing and possibly provide an answer on the causes behind these changes and, even more importantly, on how such technologies will affect future skills needs.
- Patents are an important data source for studying applied technology evolution. In addition, existing literature (Terragno, 1979; Kütt, 1998) has shown that about 80% of the technical information contained in patents is unavailable elsewhere due to company policies. Even though this percentage might have changed in recent years, it still makes patents an important source that complements traditional technical and scientific literature.
- Patents as a unique source of technical information are able to capture better than any other source the trends of innovation and technological evolution that can have a real impact on the demand for skills.

The analysis of patents presented in the following paragraphs is divided into two subsections:

- Tunisian patent activity in all sectors: this part provides a general understanding of the investments in new technologies in the country (using the number of inventions as an indicator);
- in-depth analysis of patents filed in the energy sector: this part analyses the innovation trends over time specifically related to the energy sector and the most relevant topics.

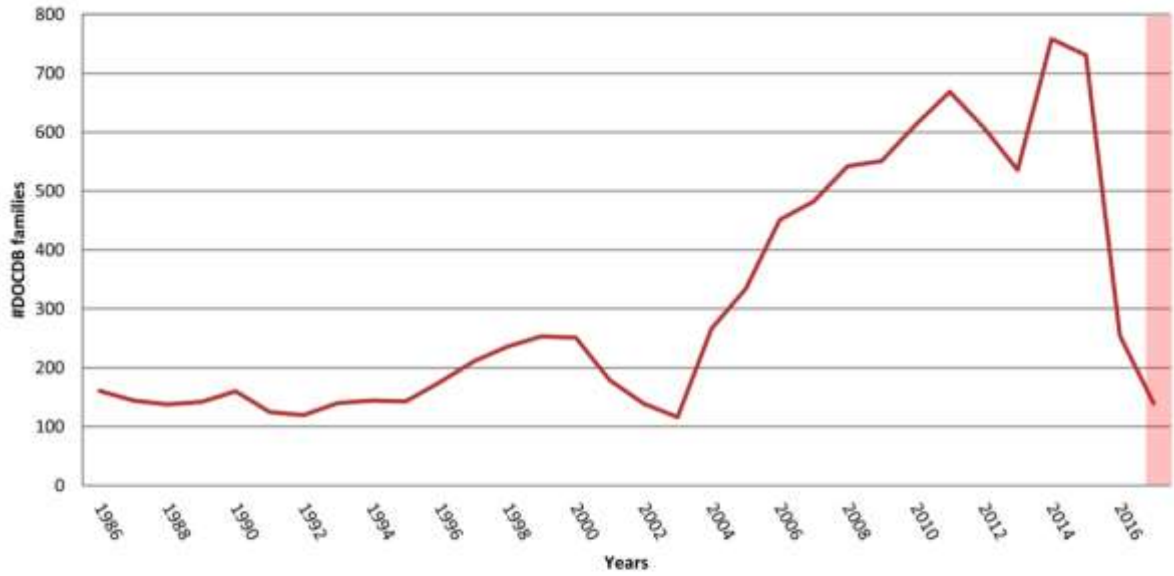
Tunisian patent activity

An initial study can be carried out on the number of patents filed in Tunisia without any restrictions in terms of sectors. This information is useful at the beginning of the analysis to understand the tendency of a country to create innovation internally. More precisely, it is possible to analyse the growth in the number of patents filed in Tunisia over the years (in all sectors).

As for the timespan, the most relevant period for the prediction of future skills needs is the last 10-15 years (considering the rather long cycle of innovation generation and adoption for the technologies in the field, compared, for example, to the much shorter cycles of pure ICT). At this stage, it is interesting to look back in time over a longer period (1986-present) to better understand the dynamics of change that are not strictly technological but, being linked to social and economic developments, take place over a longer time frame.

Figure 5.5 shows the number of patents either filed at the Tunisian National Patent Office or issued internationally by companies located in Tunisia (both national companies and local branches of multinationals), over the years and in all sectors of economic activity.

Figure 5.5: Tunisian patents in all sectors filed over the years



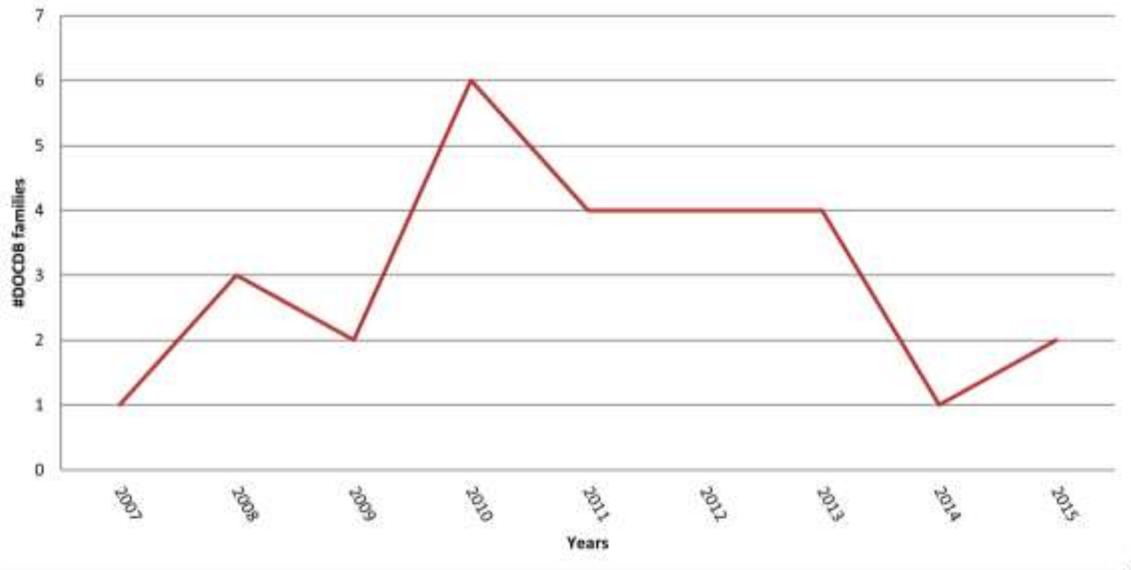
Note: The last 1.5 years of each graph is shaded red, since the number of patents filed cannot be considered final, due to the 18month period of secrecy before a patent application is published. Considering the last 2 years in the analysis without keeping this in mind would lead to wrong and distorted interpretations. The same holds for all subsequent plots that have the time dimension on the x-axis.

The analysis indicates a non-negligible number of patents originating from the country in the last 35 years. The total number of patents relating to Tunisia between 1986 and 2017 is 9 912 in all sectors. The first interesting feature of Figure 5.5 is the steep and steady increase in inventive activity since 2003, with the exception of a dip around 2011 that could be related to a period of instability linked to the Arab Spring. The second feature worthy of note is the sharp decline in 2016, which suddenly interrupted the previous years' growth, and could be related to the recent economic crisis. These trends are an indication that there is good potential for innovation within the country, but its deployment is not self-sustained and is still heavily influenced by political and economic instability.

In-depth analysis

Investigating the energy sector more specifically, a total of just 27 patents were filed with the Tunisian patent authority between 2007 and 2015. Their trend, shown in Figure 5.6, is consistent with the overall innovation scenario depicted in Figure 5.5 and is discussed immediately thereafter.

Figure 5.6: Tunisian patents in the energy sector filed over the years



Although the total number of documents cannot be considered statistically significant for the purpose of this study (i.e. to ascertain the most innovative technologies adopted in the sector), specifying the sub-sectors to which the innovation belongs could provide interesting clues about which sub-sectors are more active compared to others, also in relation to internal drivers and capabilities. The higher innovative activity of a sub-sector suggests where investments are more focused and the most likely present and future direction of the Tunisian energy sector. It also indicates the sub-sectors in which the country can, at least to a certain extent, rely on internal resources in terms of high-level skills and competences.

It is therefore interesting to note the distribution of the 27 patents among the various energetic sub-sectors, as shown in Table 5.1.

Table 5.1 – Subsectors to which Tunisian energy patents refer

Subsector	Number of patents
Solar energy	20
Wind energy	5
Energy distribution	2

Table 5.1 clearly indicates the relevance of the solar energy sector for the development of new technological solutions, especially when considering the country's internal innovation capabilities. The energy mix diversification plan, together with the findings shown in Figure 5.4, suggest that solar energy will be the main alternative source of energy to fossil fuels, which are historically the most used in the country. The findings related to wind energy are also consistent with the results of the analysis of scientific papers. The two patents concerning energy distribution refer to solar collectors and pipeline systems. As major energy losses usually occur along the distribution system, these patents indicate research into solutions to improve energy efficiency.

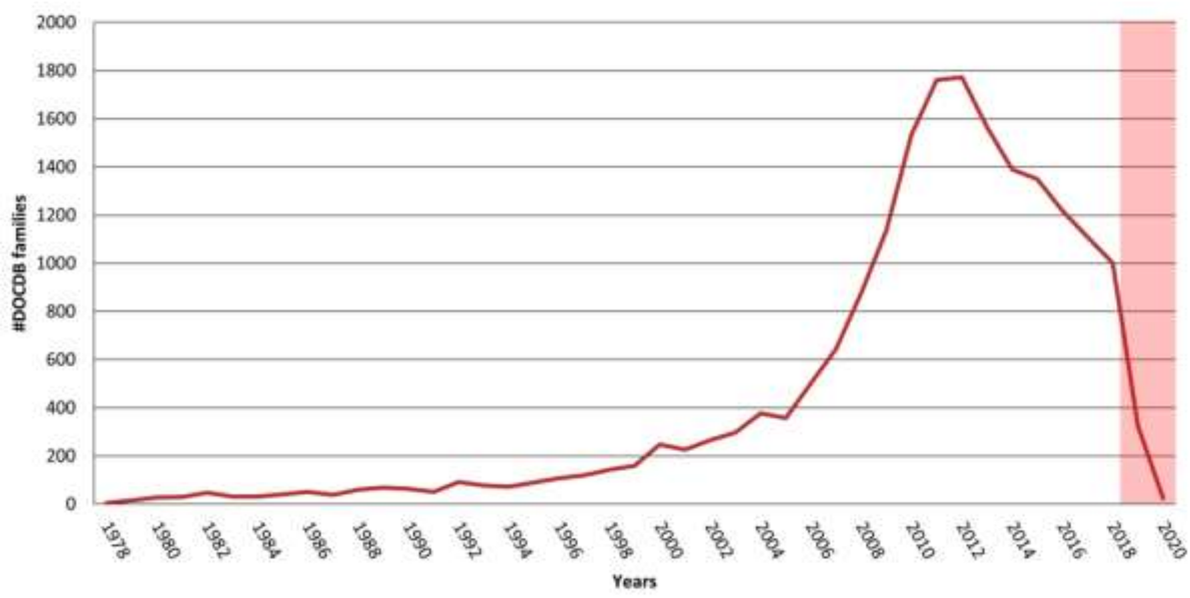
For a specific focus on the technologies that are likely to shape the future of the sector, a patent set that could be more significant from a statistical point of view must be parsed. With particular reference to the energy sector, the development of technologies can be assumed to be a global process that involves global players. Once a beneficial technology has been discovered, it is reasonable to assume that it will be quickly and extensively adopted in every country.

In view of the small number of solutions patented in Tunisia, it is likely that the country will rely on technologies patented in foreign countries to support the technical development of the sector in the coming years. Indeed, wind farms or solar plants could be built in the country using equipment designed and manufactured abroad, and the skills needed to build and operate these facilities are the same as those needed anywhere else in the world.

For this study, European patents (i.e. patents filed with the EPO – European Patent Office) related to the energy sector have been considered, assuming that those technologies are most likely to be a reference point for the country. Apart from the geographical proximity, this assumption is based on the ties that historically link Tunisia to EU Member States. Not only do the EU and Tunisia have close and long-standing relations, but the EU is Tunisia's largest trading partner[5].

Figure 5.7 shows, for comparison purposes, the inventive activity related to the energy sector in Europe. The trend is very clear: up to 2011, the number of patents filed had been growing exponentially for over 30 years, before the innovation rate started to slow down. The period of technological innovation in the energy sector reached a peak around 2010 (mainly due to research in wind turbines and solar panels), and is now reaching a maturity stage with limited, incremental innovation. Thus, no significant changes are expected in the skills needed to master the state of the art for energy technologies in the near future, at least until new, breakthrough technologies are invented.

Figure 5.7: European patents filed in the energy sector over the years



Due to the relative scarcity of inventive activity in the sector at national level, the growth that the Government intends to pursue will have to rely mainly on technologies imported from abroad (e.g. Germany). In terms of skills and competences, it is likely that they will need to be sought abroad, at least in the introductory phase of the new technologies. Facilitating the establishment of organisations and structures that foster the sharing of know-how will be essential in this regard.

On the other hand, the national output of innovation in the solar field is an indication that highly skilled and creative profiles, able to invent new solutions, are present in the country and are an asset to be taken into account and capitalised on, especially in light of the policy focus on renewable sources.

After obtaining a general overview of the energy sector, we turned to the information from desk research and from the big data analysis on scientific papers about the sub-sectors that are , or may become, significant for Tunisia, to select the subset of energy-related European patents that actually

5 https://ec.europa.eu/trade/policy/countries-and-regions/countries/tunisia/

regard these sub-sectors. This subset was then parsed and the following thematic clusters identified (Table 5.2).

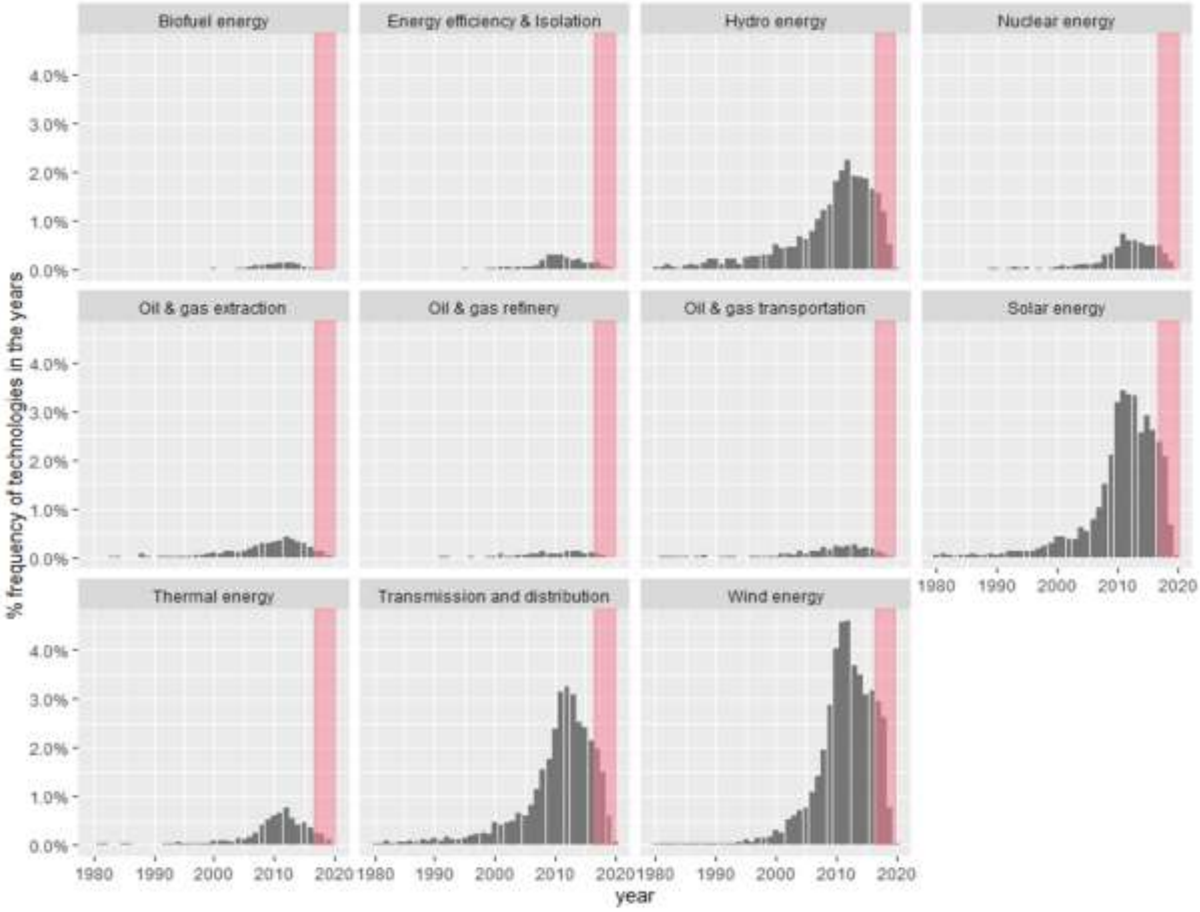
Table 5.2 – Macro-families (clusters) of European energy patents

Number of patents	Clusters
Wind energy	8 692
Solar energy	7 150
Transmission and distribution	6 598
Hydro energy	5 408
Nuclear energy	1 366
Thermal energy	1 352
Oil and gas extraction	946
Oil and gas transportation	641
Energy efficiency	625
Oil and gas refinery	326
Biofuel energy	300
Total number of patents	**33 404**

From the number of patents in each cluster, it is clear that the first four clusters are particularly relevant for the energy sector from the point of view of innovation. According to the patent analysis, among specific energy sources, wind is the one with the greatest inventive activity in recent years, followed by solar and hydroelectric energy technologies (the latter, however, is less relevant for Tunisia). Due to the low number of patents, activities related to the oil and gas sub-sector, concerning extraction, transportation or refining seem to rely mainly on standard technologies. Other energy sources such as nuclear energy, thermal energy and biofuels have fewer patents than those mentioned above and may be of less interest, at least as far as the pace of innovation is concerned.

For a more complete view, a representation of all the clusters' temporal trends is shown in Figure 5.8.

Figure 5.8: Trends in filed patents (EPO) related to the above-identified clusters



In Figure 5.8, the bar chart represents the distributions of patents in each cluster over the years. This shows that wind energy, solar energy, transmission and distribution, and hydro energy have more patents than the others. The trend lines confirm that the top clusters in terms of total numbers are also those that have grown the most in recent years. The gap in the total number of filed patents is even more evident when comparing the graphic representation of the bars: as far as the smaller clusters are concerned, not only do they have fewer patents filed, but their scattering over the years shows no peak of interest.

Based on the identified categories, the most relevant technologies can be described separately. Each cluster has a short description of the relevance of that technology for the country, hence the reason why it has been chosen for the analysis. A shortlist of the most relevant technologies related to each cluster is also provided.

Biofuel energy

Although relatively few patents have been filed in the biofuel energy sub-sectors, interviews with Tunisian companies have revealed that some of them are investing in this technology, which could represent a very promising sector for the future. Following the TSP, which includes biofuel and biomass solutions in the energy mix for 2030, there is an intention at national level to create some biorefineries operating with the same principles and processes as the fossil fuel industry. More generally, bioenergy is gaining relevance in Tunisia as it would solve two problems at the same time: energy consumption and waste production. To date, a few pilot projects have been implemented but not yet scaled up.

The main relevant technologies for this cluster are related to:

- Biogas reactor
- Biogas flow control system

- Gasification unit
- Hydrocarbon feedstock
- Fuel inlet manifold
- Biomass container and fermenter
- Cellulosic material
- Hydrogasification reactor
- Trans critical heat pump
- Biofuel cell

Hydro energy

Even though hydropower was the first renewable resource exploited in Tunisia during the 1950s, due to the country's climate conditions hydropower plants cover a tiny fraction of total energy demand. In the context of renewable energies, solar and wind energies are the most relevant for the country, both as sources and as investments. Nevertheless, the hydropower sector is still active, as indicated by a Tunisian consulting company interviewed: besides solar and wind energy consultancy, as a part of its internal diversification strategy, the company has started to provide consultancy services also for hydropower solutions, not only in Tunisia but to all the countries in the sub-Saharan region.

The main relevant technologies for this cluster are related to:

- Hydraulic pump
- Water turbines and wheels
- Heat exchanger
- Hydraulic actuator
- Hydraulic circuit
- Water treatment system
- Heat pump
- Hydroelectric turbine
- Heating/cooling system
- Pump turbine
- Hydraulic power unit

Nuclear energy

Although nuclear energy was proposed as a solution to reduce Tunisia's energy dependence on the importation of gas from neighbouring countries, no projects have been launched so far. STEG, the state-owned company, receives directions for the development of new technologies: in the past, STEG has also worked on feasibility studies for nuclear projects that, however, have never been implemented due to the Government's unclear strategy and the lack of investment funding.

The main relevant technologies for this cluster are related to:

- Control device
- Radiation detector
- Energy metering component
- Energy accumulator
- Energy generation component
- Protective layer
- Radiation protection equipment
- Reactor container
- Heat insulator
- Atomisation unit
- Nuclear reactor
- Radiation source

Oil and gas extraction

During the 1970s, Tunisia had proven oil reserves of around half a billion barrels and had oil production from both onshore and offshore fields. Later, exploration activities continued. Currently, more than 50 oil and gas production licences and over 20 exploration permits are managed by foreign companies, most of them in association with the Tunisian National Oil Company (ETAP). In recent years, exploration of oil- and gas-based resources has declined, mainly due to the natural drying up of some fields in the country. Although the production of petroleum and other liquids has been steadily declining from its peak in the mid-1980s, Tunisia's oil production continues to be an important part of the country's economy. Due to the current availability of nationally sourced fossil fuels, Tunisia has to import part of the gas it needs for electricity production from Algeria.

The main relevant technologies for this cluster are related to:

- Production well
- Extraction pipe, pump, well
- Heat exchange tube
- Submersible pump
- Crude oil pump
- Connector appliance
- Oil-gas well
- Oil pumping drill
- Heater well

Oil and gas refinery

Tunisia has one oil refinery with crude oil distillation, but it is not enough to meet domestic demand. As a result, Tunisia imports the majority of the petroleum products it consumes. Tunisia has proposed building a second refinery with foreign investors (Qatar Petroleum and the Libyan Government). However, given the unrest and political uncertainty in Libya, it is unlikely that the Libyan Government will take part in the project anytime soon.

The main relevant technologies for this cluster are related to:

- Gas refining unit
- Natural gas distiller
- Crude oils refining tool
- Distillation equipment
- Transport channel
- Petroleum treat equipment
- Fuel oil distiller

Oil and gas transportation

Between 1977 and 1983, the Trans-Mediterranean Pipeline was built, a 740 km gas pipeline that connects Algeria to the Sicilian Channel after crossing Tunisia. The trans-Tunisian gas pipeline consists of two lines approximately 370 km long and with five compressor stations. In place of transit fees, Tunisia receives natural gas as a royalty. In addition, Tunisia has a well-established internal pipeline transportation system that connects most of its oil and gas fields.

The main relevant technologies for this cluster are related to:

- Transmission pipeline
- Branch pipeline
- Pipeline bundle
- Pipeline network
- Storage tank
- Insulation of pipelines
- Subsea pipeline
- Pipeline seal system
- Thermal energy fluid pipeline

Solar energy

solar energy is undoubtedly the energy source on which the country is focusing most for its energy transition plan and to reach the target of 30% of energy produced from renewables by the end of 2030. This programme would reduce Tunisia's current dependence on imported gas. Many companies are growing in the solar panel business that has increased over the last 5 years. This sub-sector mainly relies on the installation of photovoltaic panels for residential and tertiary sector use, while the number of large solar power projects implemented to date is limited. There was a project to create a solar park in Tripoli for producing energy, but it did not come to fruition due to financial issues.

The main relevant technologies for this cluster are related to:

- Solar panel, solar collector, solar cell
- Heat exchanger
- Photovoltaic module, cell, panel, circuit, array
- Photovoltaic power generation system
- Light receiving surface
- Solar receiver
- Heat collector
- Photoelectric conversion element
- Storage battery
- Heat absorption body
- Reflective layer
- Thermoelectric generator
- Electrical energy storage device
- Float energy collection device
- Heat exchange device
- Solar thermal power generation

Thermal energy

Virtually all Tunisian electricity is produced by thermal power plants burning imported natural gas. The combined-cycle power plant is also fuelled by natural gas and is operated by the Tunisian state-owned electric and natural gas utility company. There is already one large thermal power plant in the country, while another will be commissioned shortly. This power project is expected to increase the demand for professional profiles and generate both permanent and temporary jobs.

The main relevant technologies for this cluster are related to:

- Thermal turbine
- Heat pipe
- Heat accumulating pipe
- Roast chamber
- Energy accumulator
- Heat exchanger
- Gas turbine
- Heat pump
- Heat accumulator
- Roaster module
- Steam turbine
- Heating system

Transmission and distribution

The electric power supply network has been extended to meet the higher electricity demand arising from evolving user needs. The strengthening and reinforcing of the Tunisian transmission network also consists in the construction of 16 to 17 new substations and the expansion of various existing substations over the next few years. The Tunisian network is interconnected with the Algerian and Libyan ones; several cross-border interconnection projects with a number of African and European countries are also planned, to undertake regional power exchange to boost industrial growth and improve energy security without overloading the existing transmission network. As for future investments, the country intends to strengthen the electricity transmission network and to distribute the power from the proposed renewable energy power plant; moreover, it plans to improve performance by monitoring and metering consumption by electricity customers in real time and improving the collection rate from private customers.

The main relevant technologies for this cluster are related to:

- Smart grid network
- Electric storage unit
- Power transmission and storage unit
- Smart meter/server
- Transmission and connection systems
- Wireless mesh network
- Energy transfer and storage devices
- Communication networks and devices

- Remote terminal unit
- Shift device
- Energy conversion device
- Energy lift device

Wind energy

Tunisia is moving towards wider adoption of renewables for the energy production, as indicated in the TSP. Although the plan indicates that in 2030 wind energy will make up the largest share of energy production, up to now solar energy seems to be the most common type. Solar and wind energy can be seen as complementary sources, and both can be developed at the same time. In addition, according to the interviews, despite the large number of wind energy projects, the perception is that the introduction of wind farms is moving more slowly than that of solar plants.

The main relevant technologies for this cluster are related to:

- Wind turbine generator
- Rotor blades
- Wind turbine rotor
- Wind air engine
- Horizontal axis wind turbine
- Speed increasing gearbox
- Rotary shaft
- Synchronous generator
- Wind turbine nacelle
- Rotating hub
- Gearbox housing, input shaft
- Wind turbine tower
- Wind power plant
- Power generating tower

Energy efficiency

The Tunisian Government is actively pursuing two main courses of action to secure power supply: energy efficiency and energy mix diversification. The Government has already invested extensively in upgrading infrastructure and constructing new substations. In addition to continuing these actions, the next stage will include the spread of monitoring and control systems near the point of use and awareness-raising actions to promote good practices and energy-saving solutions among users.

The main relevant technologies for this cluster are related to:

- Power consumption regulator
- Power efficiency controller
- Control units and systems
- Operation mode control unit
- Power storage device
- Energy controller
- Storage unit
- Energy consumption controller
- Measurement units and meters
- Electronic control timepiece
- Electric power information management
- Control determination unit
- Energy consumption value selection control
- Wireless communication module

Hydrogen energy

In addition to the sources of energy that have been found with the patent analysis, interviews with companies have yielded some interesting indications concerning the future use of hydrogen as a source of energy for the country. As the generation of energy from hydrogen is still very expensive and the projects very complex, the role of banks is very important, and their involvement is crucial for the development of this source. In the long term, green hydrogen is expected to become less expensive, and in the long term its widespread adoption could replace the use of fossil fuels as energy sources by producing hydrogen directly from renewable energy sources. According to the interviewees, it will be possible to export hydrogen to other countries as well, by using the infrastructures that are present in the country for the fossil fuel industry (i.e. the pipeline that is currently used for gas transportation, TransMed).

5.3 Transversal and more disruptive technologies

Technologies found or used in multiple clusters with transversal applications have a higher relevance compared to technologies that are unique to only one cluster. Demand for job profiles with specific skills increases if a technology is found and applied in multiple clusters.

Among the technologies listed in each of the above clusters, besides the obvious electrical ones, mechanical technologies are the basis for the development of solutions for the energy sector. Ranging from valves to transmission systems and from shafts to bearings, mechanical technologies support the design and production of innovation in the energy sector in a transversal way, from renewable sources to fossil sources. Another transversal topic is made up of the technologies related to IT innovation, digitisation, communication and data processing applied to the energy sector: these can include both digital communication devices and the telecommunication networks on which these devices operate, smart grids, control systems, and management and decision-making tools, which are all becoming increasingly relevant for efficiency and sustainability purposes.

As concerns more recent and innovative technologies, for solar panel solutions or wind turbines, the technology is mainly imported from abroad (e.g. Germany), while local companies carry out marketing, installation and maintenance activities. The country needs stability to attract investors and facilitate the creation of enterprises that can develop innovative solutions.

According to the companies interviewed, energy transmission and distribution technologies are needed to move forward and to accelerate the energy transition with batteries and energy storage solutions. The introduction and upgrading of smart grids along the chain make it possible to control all the resources and have become an essential tool for the sector.

One of the most interesting applications of renewable technology is the production of energy for seawater desalination plants. As the country suffers from aridity (as indicated among the drivers of change at the beginning of the chapter) and at the same time has more than 300 days of sun per year, the exploitation of solar energy to operate desalination plants, which are extremely energy-consuming, is an interesting use of renewable energy facing adverse climatic conditions.

Renewable energy can also be used to produce hydrogen gas locally, and then transport it using existing infrastructures (for example, natural gas pipelines such as the TransMed pipeline) to carry it to other parts of the country or export it abroad. Using hydrogen as a substitute for fossil fuel would solve the pollution problem at the point of use, while the production of hydrogen from renewable sources would overcome two of the main drawbacks of solar and wind energy production, namely the intermittent availability of both sources and the issue of storage.

Technologies for the production and distribution of energy require a much faster process of internal development. In addition, the use of IT technologies for simulating scenarios or supporting managerial and monitoring activities is spreading across the country. The adoption of IT solutions refers to control system, management and decision-making tools to facilitate monitoring and control tasks.

Many software solutions have been adopted not only by energy companies, but also by energy-intensive manufacturing companies, which are using new IT solutions to monitor the energy consumption of their processes in real time. The company's processes are monitored by a control programme, and the operator in the control room monitors all the parameters, including the real-time energy consumption of every engine or machine in operation.

For industrial environments, SCADA (supervisory control and data acquisition) solutions are also expected to become a promising business for companies in the coming years. Their adoption has already increased during the COVID-19 pandemic as remote-control digital systems have become more widespread under remote working conditions.

As concerns the monitoring of energy consumption in buildings, one of the most popular recent technologies is the new generation of BMS (building management system) solutions to manage the energy consumption and maintenance of mechanical and electrical apparatus.

Main findings from the Section

- Several factors are influencing the evolution of the sector, from the need to reduce dependency on gas imported from abroad to an increased awareness of sustainability issues. The transition phase calls for the rapid adaptation of the regulatory framework by the Government. The importance of the energy sector for Tunisia requires a clear definition of long-term energy strategies.
- Many factors, such as growing consumption, the need to increase energy efficiency from production to distribution, and the large potential in terms of renewable energy sources, make Tunisia particularly favourable for creating new job positions in the sector.
- A wide range of technologies can be a solution for enhancing production performance and reducing energy losses. Many technologies, particularly those related to wind and solar energy, show a positive trend of innovation at sectoral level. If Tunisia decides to pursue a strategy of internal production of energy, possible implications for the related jobs profiles and skills should be considered.
- According to the interviewees, certain technologies, such as digital control systems, have the potential to improve energy production efficiency.
- Transversal technologies (i.e. those required by various sub-sectors) are the basis for the development of the sector, but their adoption leads to the need for a more diversified set of skills.

6. CHANGING JOB AND SKILLS DEMANDS IN THE SECTOR

KEY ISSUES COVERED

- An analysis of the main occupational profiles used in the sector, and of the evolution of the skills content of some occupations as a result of the changes occurring in the sector.
- An analysis of the new tasks and functions that have emerged in the jobs and/or occupations in this sector, as well as old ones that have disappeared (or are likely to disappear).
- The impact of the drivers of change on labour and skills demands in the sector, and whether these changes require higher levels of the same skills or completely new sets of skills.

This chapter focuses on the implications of change drivers for labour. The results from data mining and interviews have revealed that three groups of occupations are in higher demand as a result of technological and policy changes introduced in the energy sector. These groups will be discussed in dedicated subsections:

- technical or technology-related occupations (see sub-section 6.1);
- business services and related occupations (see sub-section 6.2);
- expert positions for reforming the energy sector (also in sub-section 6.2).

Sub-section 6.3 analyses the general trends in the labour market that can be derived by combining the results from the data mining and the interviews; it compares new emerging job profiles with obsolescent ones; and lastly, it discusses the role of soft skills in adapting to technological change.

6.1 Technology-related occupations

From technological developments to the demand for skills and occupations

Technology-related occupations are carried out by people who are competent in managing and using a given technology. The key assumption is that the growing interest in a certain technology will lead, sooner or later, to a growing need for professionals able to use that technology. The scale of the demand may vary for a number of reasons, but if that technology is adopted in Tunisia, the related competences and occupations will be needed at least to a certain extent.

There are various possible ways to link the information on technologies derived from text mining to the possible future skills needs. In this study, the list of relevant technologies extracted from literature (Section 5.2) has been compared, using semantic matching algorithms (i.e. algorithms able to find semantic connections between different concepts based also on contextual information), to the occupations listed by ESCO, the European classification system. Each occupation in the ESCO database includes a description and a list of competences, skills and knowledge considered relevant (either essential or optional) for that occupation. The semantic algorithm looks for matches of each technology with all the concepts associated with an occupation. When a match is found, the occupation is considered associated with that technology. The entire process is automated using ESCO's API (see the glossary), which allows occupational data to be downloaded. Table 6.1 provides a few examples of the matching process.

Table 6.1: Example of the process matching patent topics to ESCO skills and occupations

Technological concept	ESCO knowledge/skill	Type	Correlated ESCO occupation	Relevance
Solar cell	calculate solar panel orientation	skill	solar energy engineer	essential
Solar cell	design solar energy systems	skill	energy engineer	optional
Solar cell	provide information on solar panels	skill	renewable energy consultant	essential
Solar cell	install photovoltaic systems	skill	solar power plant operator	essential
Solar cell	solar energy	knowledge	energy assessor	optional
Solar cell	types of photovoltaic panels	knowledge	solar energy engineer	essential
Solar collector	renewable energy technologies	knowledge	energy engineer	optional
Wind turbine	test wind turbine blades	skill	wind energy engineer	essential
Wind turbine	inspect wind turbines	skill	wind turbine technician	essential
Wind turbine	inspect wind turbines	skill	wind energy engineer	essential
Wind turbine	provide information on wind turbines	skill	renewable energy consultant	essential
Wind turbine	design wind turbines	skill	wind energy engineer	essential
Wind turbine	research locations for wind farms	skill	wind energy engineer	essential
Wind power plant	maintain power plant machinery	skill	power plant control room operator	essential
Power supply	maintain electrical equipment	skill	power distribution engineer	optional
Power supply	maintain electrical equipment	skill	electrical cable assembler	optional
Power supply	install hardware	skill	automation engineer	optional
Smart grid	mechatronics	knowledge	electrical engineer	optional
Power transmission	ensure safety in electrical power operations	skill	power distribution engineer	essential

Power transmission	develop strategies for electricity contingencies	skill	energy engineer	optional
Gas pipeline	repair pipelines	skill	gas transmission system operator	optional
Gas pipeline	types of pipelines	knowledge	gas processing plant supervisor	optional
Gas pipeline	inspect pipelines	skill	gas processing plant supervisor	optional
Gas pipeline	ensure regulatory compliance in pipeline infrastructures	skill	gas processing plant operator	optional
Natural gas distiller	natural gas liquids fractionation processes	knowledge	gas processing plant supervisor	optional
Natural gas distiller	natural gas liquids recovery processes	knowledge	gas processing plant supervisor	optional
Natural gas distiller	gas dehydration processes	knowledge	gas processing plant control room operator	optional
…	….	…	…	…

The table should be interpreted as follows: going from left to right, each technological concept in the first column appears in recent patents; thus, it can be expected to be relevant in the future for certain workers in the sector; the knowledge or skills in the second column are needed to master and properly use the technology; the third column specifies whether it is a skill or knowledge; the fourth column identifies the occupation for which the skill/knowledge is relevant; and the fifth column indicates whether the skill/knowledge is essential or optional for that occupation, according to ESCO.

Skills required by technological professions – deepening the analysis

As well as looking at the occupations that are associated with technological change, it is necessary to know which skills within those occupations are likely to be in demand. This can be done by looking at the skills listed for the occupation by ESCO. For example, a solar energy technician must know about *electricity* and how to *use measurement instruments, maintain solar energy systems*, etc... This process is illustrated in Table 6.2 below.

Table 6.2: Occupational skills needs related to a given technology

Starting technology	Related occupation (ESCO match)	Related skills (ESCO match)
Solar cell	Solar energy technician	Electricity
		Use measurement instruments
		Maintain solar energy systems
		Calculate solar panel orientation
		Solar panel mounting systems
		Types of photovoltaic panels

However, there are limitations to using ESCO. In many cases, it lists general skills (e.g. electricity), while specific competences (e.g. knowledge of different types of photovoltaic panels), which make it possible to go into deeper detail, are less well covered. Additionally, the competence level required (e.g. what extent of knowledge/skills in photovoltaic panels is required for each of the various occupations in which it appears) is another critical factor that is not specified in existing classification systems.
Furthermore, the introduction of disruptive technologies may result in a demand for people to work in jobs or occupations that are new and not classified by ESCO, ISCO or other job classifications.

To address the limitation described above and obtain a more complete picture of the knowledge needed to master a given technology, additional information was obtained from Wikipedia (chosen for its accessibility, the comprehensive amount of information it contains, and the structured way in which it presents information). More precisely, for every topic (most recurrent terms found in patents) the corresponding Wikipedia page was downloaded using web scraping. Reversing this strategy, it is then possible to provide a more in-depth analysis of the specific skills that will be required in various technical jobs (as shown in Table 6.3 below). As in the previous example, the *solar cell* technology has been matched to the occupation of *Solar energy technician* and its associated skills (according to ESCO), but here the occupation has been further linked to more detailed information about the skills required to master photovoltaic panels.

Table 6.3: Expanding the occupational skills data provided by ESCO

Starting ESCO occupation	Skills associated by ESCO	More detailed knowledge required, as inferred from Wikipedia
Solar energy technician	Electricity	Power optimiser
	Use measurement instruments	Thin-film solar cell
	Maintain solar energy systems	Solar micro-inverter
	Calculate solar panel orientation	PV junction box
	Solar panel mounting systems	Solar tracking mechanism
	Types of photovoltaic panels	Etc.

It is important to note that not all topics/technologies that emerged from the patent analysis have been matched to ESCO competences and occupations. For example, the *solar cell array* technology did not find a direct match. This is another indication that existing classifications may not yet encompass references to all the new technologies. That said, to complement the above analyses, job profiles related to technologies can also be extracted from online job postings. For example, it is possible to search for all job offers mentioning 'solar array' (we performed the search on global employment website monster.com) and extract details of the occupations where this technology is mentioned. Since this approach yields results that are not readily comparable with standard occupational classifications, it has not been pursued further in the study, but Table 6.4 illustrates the possible outcomes using the solar array example.

Table 6.4: Selection of job profiles extracted from online job postings related to solar array (job postings from monster.com, technologies from patent analysis)

Technology not matched in ESCO	Matched occupational profiles in job postings
Solar cell array	Solar Array and Battery Engineering Manager

	Roofing Technician
	Senior Design Engineer
	Install Tech
	PV Solar Installer
	Engineering Technician III – Solar Array Assembly
	Solar Panel Installers
	Construction Electrical Foreman
	Solar Surveyor

Ranking occupations according to potential demand

In the case of technology-related occupations or jobs, data mining results can be used not just to list occupations, but also to estimate their relevance in the future labour market based on the technological trends described in Chapter 5. The relevance of an occupation is predicted on the basis of:

- the technological transversality of the occupation, i.e. its importance grows if it has skills related to more than one technology or topic;
- whether the associated skills are essential or optional (as defined by the ESCO classification);
- the weighting of the technologies to which the occupation has been matched, in terms of potential future use, as expressed by the normalised number of patents it appears in, further adjusted for its relevance in the country's energy planning and perspectives.

To assign an importance value to each job profile, the three conditions must intersect, as shown by the following formula:

$$\boldsymbol{Importance\ of\ job\ profile\ j(y_j) = \sum_{i=1}^{m} T_{ij} E_{ij} W_i}$$

Where:

$$\boldsymbol{T_{ij} = \begin{cases} 1\ if\ technology/topic\ i\ is\ linked\ to\ job\ profile\ j \\ 0\ otherwise \end{cases}}$$

$$\boldsymbol{E_{ij} = \begin{cases} 1\ if\ technology/topic\ i\ is\ essential\ to\ job\ profile\ j \\ 0.5\ otherwise \end{cases}}$$

$$\boldsymbol{W_i = Importance\ of\ the\ technology/topic\ i}$$

- The values for T_{ij} are based on the analysis of Table 6.1; the higher the number of correlations the job profile has with the technologies, the higher the Tij value. This value represents the number of appearances of a specific job profile in relation to the technologies that have been extracted from the patents.
- The values for E_{ij} are set at 1 if a specific technology is essential for a job profile, or at 0.5 if it is not essential. The value of 0.5 has been set based on a sensitivity analysis[6].

[6] Sensitivity analysis is an iterative procedure for defining the 'strength' of the link between the technology/topic and the job profile. In comparing the ranks obtained from the iterations, the lower value is set to 0.5 in order to generate a rank that is consistent with the association between job profiles and technologies.

- The values for W_i are a combination of two weightings: one is the intensity of the signal for the given technology derived from the patent analysis (see Section 5.2 and Figure 5.8), the other is related to the extent to which the sub-sectors to which the technology belongs is considered relevant to the country's future planning (the values are estimated by combining data mining, desk research and interviews – for example, all solar-related technologies receive a higher weight than hydro-related ones since future demand for skills is expected to grow in the former but not in the latter sector).

Once the scores have been calculated for all occupations, it is possible to plot a bar chart that provides a visual representation of the most relevant occupations, for both the sector as a whole and for each of the energy sub-sectors relevant to Tunisia.

Due to its breadth, an overview of the entire energy sector would be too general. Moreover, different categories have different needs in terms of technologies and, therefore, skills. The relative importance of the various technologies for the specificity of the situation in Tunisia has already been discussed in the previous section; for each cluster of technologies, the above algorithm for matching technologies with occupations and skills has been iterated. Specific results for each sub-sector can be found in Annex 1.

Starting from the results obtained for each sub-sector, since various occupations appeared in more than one chart, it is interesting to combine the analysis in an overall ranking, to assess which occupations will emerge as more relevant for the entire sector (and could therefore be expected to be in higher demand overall).

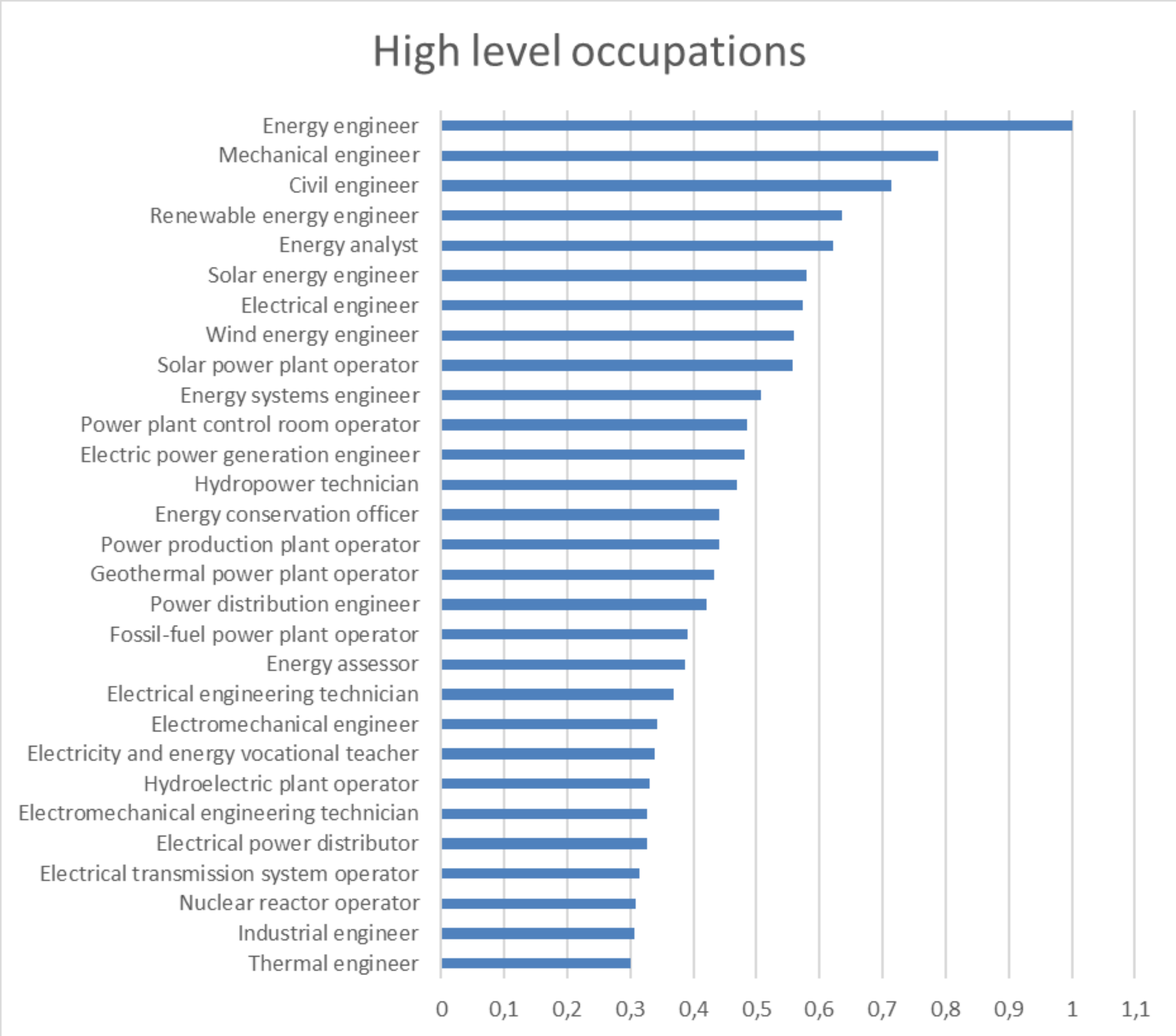
With reference to the International Standard Classification of Occupations[7], job profiles can be clustered into groups according to the tasks and duties undertaken in the job. Based on the results obtained from the above formula, three groups have been created in line with the ISCO classification:

- technical professional and associate professional occupations;
- technical medium- and low-skilled occupations (e.g. trade workers and machine operators);
- business services and related occupations.

The first ranking is for highly to medium-skilled professional profiles (ISCO Groups 21 - Science and Engineering Professionals, and 31 – Science and Engineering Associate Professionals). The first profiles of the table thus generated relating to high-level occupations are shown below in Figure 6.8 (relevance scores are normalised based on the highest score, and the profiles with a value over a threshold of 0.3 have been shown). The ranking in Figure 6.8 is indicative of which job profiles are of potential interest, but does not provide an exact order or score. A full-scale analysis of the demand for jobs would require a more thorough investigation and the use of a range of different approaches, thus it is beyond the scope of the present study. This study, however, provides interesting insights: from the plot it is clear that there will be a high demand for energy engineers, mechanical engineers, and civil engineers, which are all considered transversal occupations. Also in high demand will be solar energy engineers and wind energy engineers, etc., and, in general, a mix of more specialist profiles in the two main areas of renewable energies planned for the country: solar and wind.

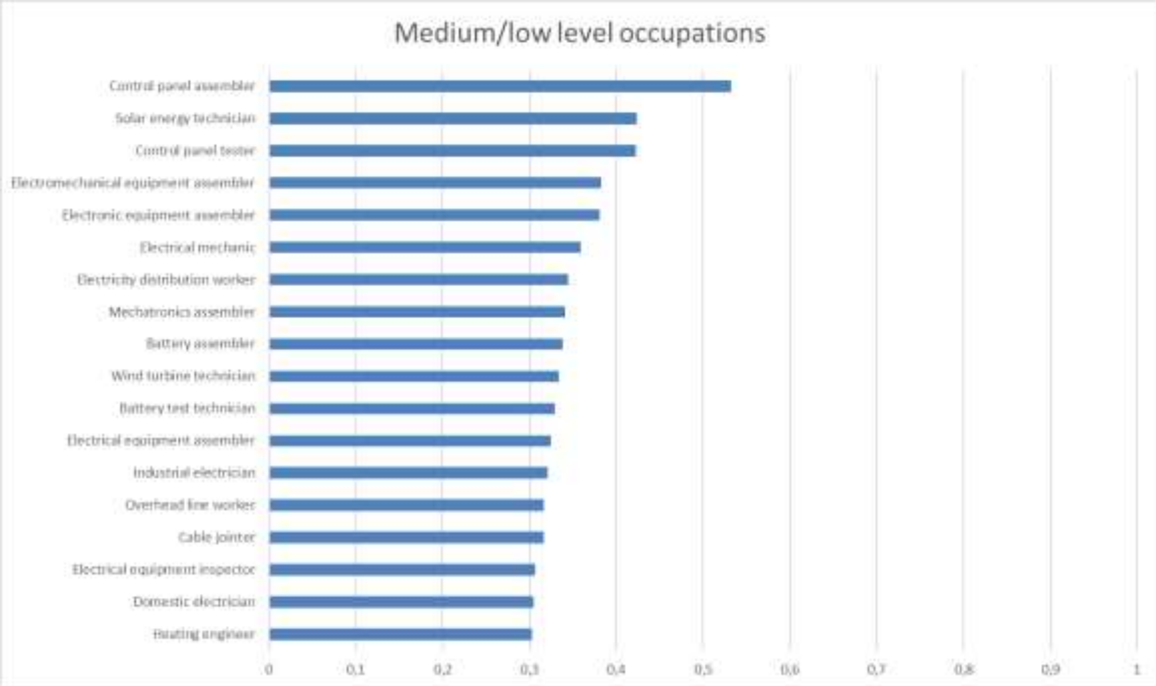
Figure 6.8: Ranking of relevance for professional and associate professional occupations from ESCO (on the basis of the technologies with which they correlate)

[7] https://en.wikipedia.org/wiki/International_Standard_Classification_of_Occupations



A similar analysis can be repeated for trade workers and machine operators (ISCO 7 – Craft and Related Trades Workers and ISCO 8 – Plant and Machine Operators and Assemblers). A selection of the output list generated by the algorithm is shown in Figure 6.9 below. Due to the normalisation carried out, it should be noted that the average score for medium- and low-skilled occupations is lower when compared to high-skilled occupations.

Figure 6.9: Ranking of relevance for medium- and low- skilled occupations from ESCO (on the basis of the technologies with which they correlate)



Here again there is a mix of occupations with skills relevant to many sub-sectors and more specialised profiles.

In addition, we can look in more detail at each occupation by analysing how they differ from each another based on which ESCO competence they are connected to. For instance, taking *Control panel assembler*, *Electrical engineer*, *Energy engineer*, *Fossil-fuel power plant operator*, *Renewable energy engineer*, *Solar Energy technician* and *Wind turbine technician*, a bubble chart (see Figure 6.10) can be used to visualise the skills or sets of knowledge associated with the occupations (according to the ESCO classification) and their importance based on the technology/topic to which they are connected (based on the association with technologies provided by the patent analysis)

In Figure 6.10, the horizontal axis lists the six ESCO occupations, which are then matched on the vertical axis with the competences that ESCO associates with them. Each competence is associated with a technology according to the procedure described at the beginning of this section, while the size of the bubble at the intersection indicates the relevance of the technology as determined by its occurrence in patents.

Figure 6.10: Comparison of seven job profiles in terms of their skills, and which competences are the most relevant for each occupation

Note: each point in the plot represents an association between a competence and an occupation, whereas its size is proportional to the weight of the technology to which the competence of interest is linked (the importance of a technology depends on the related patent filing activity).

Figure 6.10 shows the distribution of competences across occupations and allows for a better understanding of why certain profiles have the ranks given in Figures 6.8 and 6.9.

For instance, a job profile such as *Fossil fuel power plant operator* has a rather vertical set of skills, meaning skills and knowledge that are very specific and do not go beyond their field of study. At the same time, Figure 6.10 clarifies the reasons behind the high score given to engineering profiles (such as *Energy engineer* or *Renewable energy engineer*): these profiles have a large number of horizontal skills related to the technologies shown by patent analysis to have significant filing activity, and are therefore relatively more important than the others in the innovative scenario of the energy sector.

From a different point of view, the graph identifies some skills that are transversal to multiple profiles, such as knowledge of *Electricity* or *Maintaining electrical equipment*. Other skills are instead more specific to certain professions, such as *Solar panel mounting systems,* which is specific to the occupation of *Solar energy technician*.

Combining the above discussion with the information linked to the size of each point, the bubble chart provides a three-directional indication: read along the columns, it gives an insight into which skills and knowledge are most important for each job profile; read along the rows, it identifies which skills are more transversal, i.e. shared by several professional roles; finally, by combining the number and size of the dots on the rows, it is possible to assess which skills will be more in demand in the near future. For example, competence in how to *Control steam flows* (one small dot) is not expected to be as important as knowledge of how to *Research location of wind farms* (one large dot) *or Power electronics* (several small dots).

6.2 Business services and related occupations

The analysis also identifies a second category of profiles: non-technological jobs linked more closely to business aspects such as management, marketing and sales, or export and trade. These professions, which are related to energy sub-sectors rather than technologies, are relevant to the business models that companies adopt and the way in which they organise production (cf. work organisation). These professions affect the adoption and use of technology in the energy sector.

The following business service occupations emerged:

- Manufacturing manager
- Energy manager
- Renewable energy consultant
- Operations manager
- Solar energy sales consultant
- Renewable energy sales representative

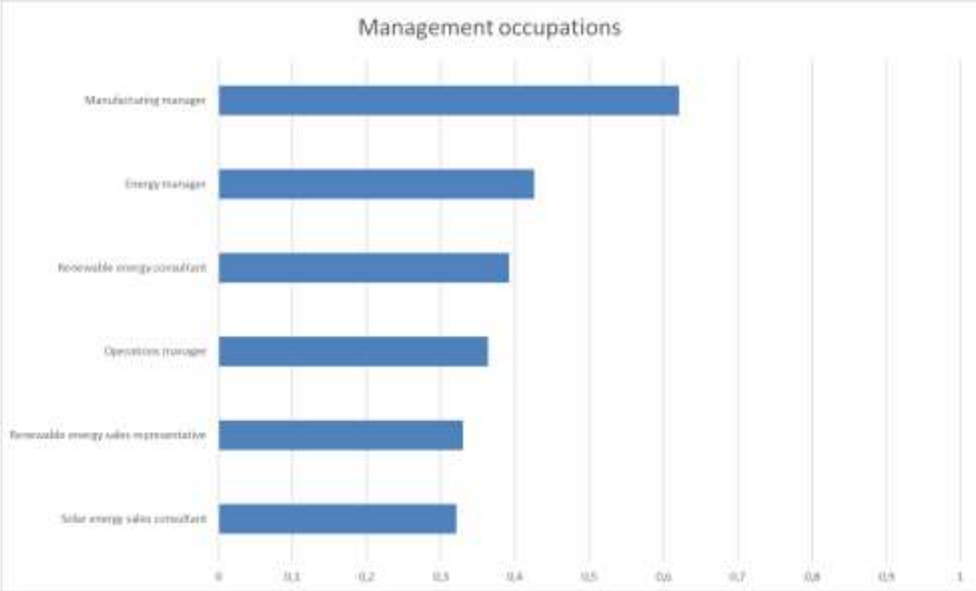
The list spans from business professionals and associated professionals (ISCO Group 24 – Business and Administration Professionals and ISCO Group 33 – Business and Administration Associate Professionals) to manager profiles (ISCO Group 12 – Administrative and Commercial Managers and ISCO Group 13 – Production and Specialized Services Managers).

From the point of view of functions performed, two main groups can be identified:

- business and administration professionals related to the management of the operational aspect of plants, such as manufacturing manager, energy manager and operations manager;
- market-oriented consultants and representatives, such as renewable energy consultant, solar energy sales consultant and renewable energy sales representative.

The relevance ranking – assigned through the correlation with technologies according to the formula in Section 6.1 – can be applied here to show which business professions are more likely to be affected as a result of technology, as determined by the data analysis (Figure 6.11).

Figure 6.11: Relevance ranking for managers, salespersons and services workers from ESCO (on the basis of the technologies to which they correlate)



The ranking in Figure 6.11 is indicative of which managerial or sales occupations are likely to be related to the technological changes expected over the coming years. The occupation of manufacturing manager, for example, acquires a relevant position in the ranking and indicates the importance of process design within the electricity production sector. In this sense, both a systemic approach and an overall vision of the processes favour better management of power resources with a consequent reduction in losses and an increase in energy efficiency.

6.3 General trends in the demand for skills

As already widely discussed, the Tunisian energy sector is experiencing a phase of transition. Therefore, in order to support the transition, a mix of traditional profiles and new kinds of profiles that were not present before in the country are in high demand.

Tunisia has a solid basis in the education system for training Tunisian engineers. There are many engineering schools in the country (chemical, electrical, mechanical, energy, etc.), which provide good education and theoretical knowledge. The interviews confirmed that, in the future, the profiles in highest demand among companies will be in the main fields of engineering: mechanical, electrical, energy, electronic and hydraulic, as well as all IT profiles.

Medium-level technical competences are also in high demand, but the supply is less able to keep pace with companies' needs. For example, the construction and maintenance of pipelines is an important sub-sector for the country, and many companies experience difficulties in finding specialist welders (such as laser welders) and pipefitters on the market. As the renewable energy sector related to solar energy is expected to increase in the coming years, there will also be increased demand for technicians for installing and maintaining solar power plants. According to the people interviewed, as wind power plants are not as widespread as solar ones, the country still lacks professional profiles specialising in wind energy (e.g. wind turbine experts); therefore, no specific training programmes have been developed to date.

Similarly, the presence of IT in the sector requires, on the one hand, the introduction of specific profiles for the sector with strong vertical skills in applications, and on the other hand, technical profiles for instrument maintenance in the field (sensors, plc, servers, etc.).

A relevant category: expert profiles

To guide and take full advantage of the transition, managerial profiles and specialist consultants will play a key role. In fact, the country is moving towards the development of expert profiles such as *Energy Managers* and *Environmental Mangers*.

Environmental Manager is a professional occupation that will be in higher demand in the future, together with *Waste Manager*, both of which will be needed to ensure sustainable energy production (from waste in the case of the waste manager). However, when compared to standard safety manager profiles, environmental managers are currently not as widespread in Tunisia.

Another example of such experts are *Energy Managers* (see Figure 6.11), who are particularly important for medium-sized and large companies, as they can monitor energy consumption, detect energy waste and losses, and know what measures and strategies to taken to use energy more efficiently. In the short term, according to the interviews with companies, the energy manager profile is expected to be the most demanded, but a specific plan still has to be put in place for their training. Indeed, most large companies operating in energy production and distribution in Tunisia do not yet have an energy manager or a energy-efficiency-related profile on their staff.

Due to the need to improve energy efficiency, the profile of *Energy Assessor* is also increasingly in demand. With similar competences to those of an energy manager, the energy assessor performs energy audits on buildings and plants. In recent years, energy auditors have played an important role in assessing the energy efficiency of industrial plants and commodities.

Transversal occupations vs specialisation

Section 6.1 presented an aggregated overview of technical profiles for the entire sector, while the details for each sub-sector are reported in Annex 1. Comparing these two different points of view make it possible to identify further useful elements. The first evidence that can be derived from the comparison is that the study has identified a wide range of high-skilled professional occupations, some with vertical competences related to a specific subsector (such as hydro, solar or wind energy) and others with more transversal competences covering more or all sub-sectors. A second finding is that, notwithstanding the technical innovations being introduced, the sector still relies, and will continue to rely in the future, on medium- to low-skilled key figures, including assemblers, maintenance workers, technicians and installers, as confirmed by the companies interviewed.

Profiles with competences in various fields are very important in the energy sector. For example, the *mechanical engineer* profile has expertise in turbines, gears and shafts, which can be applied to different sub-sectors, from gas to wind power.

Some professional figures have competences covering many different technological clusters (see the charts in Annex 1) that are the main current or potential sources of energy for Tunisia (solar, wind, nuclear, biofuel, oil and gas), and their relevance is also reflected in their high positions in the overall rankings (Figures 6.8, 6.9 and 6.11):

- Civil engineer, Energy analyst, Energy engineer, Energy systems engineer, Manufacturing manager, Mechanical engineer, Renewable energy engineer.

Profiles that ranked as relevant but are instead related to a specific energy field are listed below. It is interesting to note that almost all the medium- and low-skilled profiles identified in the analysis are present in only one cluster, i.e. they are not transversal, unlike some high-skilled profiles:

- wind energy engineer and wind turbine technician for the wind energy cluster;
- solar energy engineer, solar power plant operator, solar energy technician, and control panel assembler and tester for the solar energy cluster;
- liquid fuel engineer, drilling engineer and gas service technician for the oil and gas extraction cluster;
- oil refinery control room operator, gas processing plant supervisor and pipeline route manager in the oil and gas transportation cluster;

- electricity distribution worker, electrical power distributor, cable jointer, electrical transmission system operator and substation engineer in the energy transportation and distribution cluster.

Among the profiles listed in Annex 1, the oil and gas extraction cluster has the largest number of exclusive profiles (12 out of 15) while the oil and gas refinery and the biofuel energy clusters have the largest number of profiles shared with other technological clusters (only 3 out of 15 are exclusive to those clusters).

The rankings also reveal the key figures that will be able to guide the country through the energy transition and towards a wider introduction of energy efficiency solutions:

- Energy engineer, energy analyst, energy assessor, energy manager.

This is also confirmed by the result of the poll taken during the workshop and the interviews with companies, as explained in the next paragraph.

Combining the results from the data mining and interviews

In accordance with the results obtained from data mining (Figure 6.8), interviews and the results from the poll confirmed the role of **energy engineer to be the most relevant profile for the future of the sector**. In addition to energy engineer, the poll highlighted the importance of renewable energy engineers. The importance of the energy engineer profile, which received more votes, is related to the upgrading of the smart grid and the more efficient and sustainable management of energy throughout the chain, from production to consumption. The renewable energy engineer profile received some votes; but not as many as the energy engineer profile. In terms of support for the transition, Tunisian companies and stakeholders have indicated that the increase in energy efficiency is the most relevant for the future. The findings from the interviews are also interesting because certain profiles, such as civil engineers, are considered not particularly relevant, while the data mining gave different findings.

As regards medium-low skills, installers and maintenance workers will still be required in significant numbers in the renewable energy sector. Considering the whole energy sub-sector, some traditional medium-skilled profiles are hard to find, such as welders and pipefitters, who are needed in the gas and oil sub-sector. In some cases, companies must hire international workers as those profiles are not present in the country.

Lastly, participants in the workshop noted the absence of some very specific profiles from the list of professions, such as geologists and geoscientists, who are significant for the shale gas sector but did not emerge from the data mining.

Emerging skills needs

The expected growth of renewable energy sub-sectors will obviously require the related competences and create new jobs. Even if the number of Tunisian patents is limited, the concentration mainly on the solar sector and secondly on the wind and transportation and distribution sectors (pipelines) confirms the relevance of these three specific sub-sectors for the country from a research point of view (as indicated in Table 5.1). The professional profiles linked to these three sub-sectors are therefore those that may be of greatest interest to the country if domestic innovation capacity is strengthened. The specific rankings of the professional profiles related to the sub-sectorsolar, wind and transportation sub-sectors can be found in Annex 1.

On the other hand, the introduction of digital technologies in the entire energy sector will require many different profiles, both technical and business-related, to possess increasingly transversal skills related to the IT field. In the future, skills related to ICT, cybersecurity, security testing and interconnection will be increasingly needed. Having skills for example in the IoT, data science, AI or VR, in addition to electrical or mechanical competences, will be important for future engineers and technicians. In the coming years, people will be expected to have more digital skills, while still maintaining basic knowledge. More specifically, engineers specialising in the IoT will be able to implement better management solutions and monitor the newest technologies.

Additionally, due to the contingency of the pandemic, some professions and jobs have appeared recently on the market. This is the case for many jobs in IT and electronics, linked to the introduction of SCADA systems and VPNs, as the remote control of processes has become more common as a result of more people working from home.

As already mentioned, another category of new skills and profiles that is emerging is that of experts who can support the energy transition, such as energy managers and energy efficiency auditors. While professional profiles are theoretically present in the country, the interviews revealed that companies are lacking specific competences and skills specifically related to renewable energies, managerial tasks and energy efficiency. Renewable energy engineers focused on solar and wind will be in higher demand in the sector, as the country's strategy is focusing on greener energy production and less dependency on the importation of gas from abroad.

As confirmed by the people interviewed, professional profiles specialising in energy efficiency already exist in Tunisia, while profiles related to renewable energies are relatively new to the country.

Medium-sized and large companies are currently lacking high-skilled professional profiles with skills in managing energy projects (how to reduce costs, how to promote projects, etc.). In the future energy managers and engineering profiles will be expected to have more managerial competences. The need to increase the presence of energy efficiency profiles is aligned with the country's priority of strengthening the distribution network and improving energy efficiency along the entire production chain.

The energy sector is experiencing the progressive introduction of new IT-related technologies and, according to the people interviewed, the greater digitisation or automation of processes may lead to a reduction in the workforce required and will cause some professions to become obsolete. In particularly, as processes and tasks are currently executed and controlled from a remote control room, the number of operators working in the field has been reduced and the remaining operators working remotely have been upskilled.

At the same time, as concerns renewable energies, all kinds of professional profiles will be in great demand. In the coming years, as more solar and wind power plants are expected to be built, more installers, maintenance workers and technicians will be required by the market. These workers will be alerted to interventions or maintenance activities directly through applications on tablets or smartphones. Manual operating activities are slowly decreasing because activities are becoming more digitised, with interventions that can be carried out remotely. Due to the increasing adoption of process automation, maintenance and operative workers will have to be ready for this change.

In addition, since the development of a new regulatory framework requires the introduction of managerial and administrative roles, more people are more likely to be needed for these roles instead, in both the private and public sectors.

In conclusion, the introduction of IT solutions requires some adaptation by the workforce in the sector, in terms of both numbers and competences. Considering the energy sector as a whole, the simultaneous increase in the adoption of renewable energy solutions and in the demand for managerial competences across the sector are expected to offset job losses or even create more jobs in the near future.

The role of soft skills

Soft skills are not well defined or described, even in literature. Thus, they are often understood and interpreted, while also continuously evolving. Soft skills are given various names in the literature: transversal or soft skills, personality traits, character skills, 21st-century skills, life skills, key competences, new mindset or social/emotional skills. This is because these skills relate to individual attributes in many instances. They refer, among other things, to teamwork, communication, initiative, sociability, empathy, collaboration, emotional control and positivity, open-mindedness, openness to learn and change, flexibility, curiosity, innovation, creativity, entrepreneurship, resilience, planning/organisation, responsibility, persistence, etc.

The feedback received from the interviews is that soft skills are becoming very important for Tunisian companies, as they are one of the main factors a company looks for during recruitment. In addition to managerial competences such as time and cost management, the focus on the approach to the job and a positive attitude with customers are important for companies. Risk management is also a skill that is particularly appreciated for profiles with managerial tasks. However, many interviewees stated that soft skills were often lacking, especially in terms of people's mentality: in order for the transition to green energy to be successful, the mindset of the people working in the sector must change to give way to new priorities and indicate the strategies to address them.

Main findings from the Section

- The three main categories of job profiles growing in demand are technology-related occupations, business services-related occupations and expert profiles. Among the technological roles are transversal profiles such as mechanical, civil or energy engineers, and various technical specialisations for the sub-sectors that are expanding or expected to do so. Among the business-oriented roles, the demand is for managerial profiles and salespeople specialising in the energy field. Particular opportunities are available for experts able to support the country's energy transition.
- One general trend is that workers will need a wider set of skills, with particular significance given to digital skills.
- Stakeholders believe that increased automation and digitisation will not reduce the overall level of employment in the future, also due to the current and expected growth in the renewable energies market and the need for managerial competences.
- Stakeholders value soft skills highly. Thus, the debate on future skills needs is not just about technical skills but the mix of technical and soft skills.

7. SECTOR INITIATIVES TO MEET CHANGING SKILL DEMANDS

KEY ISSUES COVERED

- How the changes due to the introduction of technologies affect 'skills utilisation'.
- Whether the education and training system is adapting to the ongoing changes and whether it provides an adequate answer to companies' needs in terms of competences and skills.

This chapter focuses on companies' and sectors' strategies to address and meet their new skills needs and looks at existing initiatives and concrete actions. ***Note that all the findings presented in this section come from the in-depth interviews and focus group discussions conducted with companies and key stakeholders in the sector***.

7.1 Limiting factors to the adoption of new technologies

The strong dependence of electricity production on imported gas creates significant dependency issues. Due to the growth of internal energy consumption, Tunisia has already put in place a plan (TSP, 2015) for the diversification of energy production to include renewable sources such as solar and wind, which offer great potential thanks to the country's favourable climatic conditions. Even if solar and wind power are used more in the future, it is unrealistic to expect the country to become fossil fuel-free. It is more likely that there will be greater integration to diversify the supply and ensure that it meets demand even in peak periods. According to the current national plan renewable energy is expected to account for 30% of energy consumption by 2030. Although the energy diversification strategy still has to be put in place on a large scale, in the opinion of the companies operating in the sector, the solar energy market has started to grow, particularly in the residential and tertiary sectors. This growth has been fostered by the recent approval of the regulatory framework for net metering (March 2020), which allows private renewable power producers to generate electricity for self-consumption and to sell excess power to large energy consumers and national power utility provider STEG.

The change in energy sources that the country is experiencing inevitably leads to consideration of the factors that could slow down the diversification process or hinder the adoption of new technologies. The following is a list of the possible limiting factors that emerged from the interviews.

Macroeconomic instability: Although Tunisia has successfully established robust democratic institutions, the country has faced macroeconomic challenges since the 2011 revolution. As concerns political and economic instability, it should be taken into account that the country is a part of a geopolitical system that comprises the North African area; consequently, its stability does not depend solely on the national situation. The country's economic and political instability has led to negative consequences for specific economic sectors. The lack of continuity in the national energy strategy has had serious repercussions, in particular delays in legislative adaptation, leading to gaps in the legislation on renewable energy sources. This creates market pessimism, to the extent that many local experts and investors look to foreign markets.

Regulatory framework: Tunisia has taken positive action towards increasing its energy independence and promoting renewable energies. In 2015, the Parliament passed laws to boost private sector investments and liberalise regulations to facilitate the production, grid access and export of electricity generated from renewables. Despite these developments, the existing regulations inhibit the sale of renewables-produced electricity to STEG. The state utility firm is still the only entity licensed to make final energy sales to domestic consumers. The companies interviewed stated that the Government needed to further clarify and stabilise the institutional framework in order to reassure investors of likely returns and to effectively promote the development of the solar energy industry in Tunisia. This is even more important in the energy sector, where huge investments are required.

Lack of investment: Another problem for developing renewable projects in Tunisia is financial: Tunisia has a low rate of implementation of energy-related solutions compared to other countries. It is not just a problem of subsidies or incentives; the country also needs to create more trust by developing the market and putting in place different kinds of supporting actions. For example, the existing gap between energy auditing and the sector's development does not build trust between investors, banks and facility owners. Both political stability and the development of a regulatory framework for the production of energy from renewables would make Tunisia more attractive to internal and external investors. The problem of insufficient investments was also indicated by the participants in the workshop as the primary factor hampering the development of the energy sector.

High costs of technologies: The low participation of banks and foreign investors in financing the energy sector in Tunisia leads in turn to excessive costs of technologies. The high cost of technologies and energy production plants is linked to the need for national and international investments. The lack of investments impedes the development of medium-large projects and consequently leads to a lack of skills, such as specialist profiles for the management of big renewable energy-related projects. In the survey carried out during the workshop, sector operators identified the high cost of technologies as one of the top three obstacles to the development of the energy sector in Tunisia.

Lack of skills: As mentioned, the lack of a regulatory framework to resolve the disputes currently present in the field of energy production from renewable sources discourages the development of large renewable power plant projects. The absence of large projects in both the wind and solar power sectors and the lack of investments translate into a general absence of specialist and experienced profiles in large renewable energy projects. Where there is a need for specific skills, as in the case of renewable energy projects, national companies might rely on collaborations with international organisations. Consequently, local professionals are not involved and the experience gap in certain types of projects increases instead of being addressed. Emigration is another important factor contributing to the shortage of skills in the country, as many skilled professionals go abroad for better economic conditions and job opportunities.

A related gap exists between the energy auditing process and the current low rate of implementation of the recommended solutions. This lack of implementation may be due to the shortage of the practical skills needed to address specific problems. In turn, it reduces the overall trust in the continuous improvement approach and innovative solutions. Moreover, even if a solution is installed, most companies are then left on their own, without the support of experts and consultants. Due to the lack of a proper commercial strategy and expertise, follow-up activities by Tunisian experts are uncommon and the absence of specialists hinders the reliability of the sector.

7.2 More about the education system

The lack of people with experience and skills is undoubtedly a factor that limits the growth of the energy sector. The interviews provided various insights into the implications of this shortage and its possible causes.

Universities and professional training institutions are available in Tunisia and the quantitative offer of engineering and high-skilled professional profiles is considerable. According to some interviews, the Tunisian education system caters for well-trained engineering profiles (at least in terms of theoretical knowledge), while medium- and low-skilled profiles, such as technicians and operators, are not as well trained as high-skilled profiles.

Although the education system is well structured, the unemployment rate is high: according to an evaluation performed by ONEQ, the integration rate of students in the job market is 70% for professional schools and 25% for new university graduates. This data reveals an imbalance between labour market demand and supply, caused by a number of factors. On the one hand, students cannot find job offers in line with their studies, due to the absence of a generational turnover between older and younger people. On the other hand, the education system's offer is not aligned with companies' demand and, at the same time, companies do not provide any input to the system regarding their needs.

According to the companies interviewed, people leaving the education system lack practical know-how. To try to overcome this issue, engineering schools are looking to introduce periodical 2-hours visits to workplaces during the period of study. Students need to spend more time in the workplace to understand the practical aspect of their future jobs.

In addition, the companies claim that the curricula are not updated to match the latest technologies: students are taught theoretical knowledge rather than its application in the energy field. At the same time, training providers complain that once a training session is completed, companies rarely provide feedback, confirming poor collaboration on the part of the private sector in giving indications on how to enhance the training service.

There are three engineering schools in the country (ENIM[8], INAT[9] and ULT[10]) that specialise in the energy sector; other national engineering schools offer training that leads to an energy engineering-related diploma. Specifically for renewable energies, there are four master's degrees in the country, two of which (at ENIM and ENIT) are not very accessible as they are quite expensive and are taught exclusively in English.

Specific financial schools are needed for developing skills in trading and business. Although there are programmes on renewable energy, many of the companies interviewed pointed out the absence of entrepreneurship and business-related skills. Managerial competences such as time and cost management are lacking in the country.

7.3 Companies' training and recruiting strategies

As discussed in the previous section, many companies believe that the education system has not yet adapted to the needs of the sector. From both the interviews and the workshops, the lack of practical skills in the sector emerged as one of the most serious obstacles to the development of the sector, and most companies organise further training for new recruits or to upskill existing employees.

As for recruiting strategies, very few companies have a structured recruitment process, with a technical department providing selection criteria to the HR (Human Resources)department. Most of the companies interviewed are less structured and follow informal recruitment strategies, such as recruitment through acquaintances at the university.

Regardless of the recruitment channel used, all companies provide their new employees with a specific internal training course that is made essential by their lack of practical skills. In fact, internal training is the most common strategy used by companies to address the lack of experience and practical skills in the sector.

Less commonly, companies may rely on external training providers. This process is typical of more structured companies. It is based on the companies' initiative and is not continuous over time.

According to some interviews, the Government is not attempting to build any kind of connection between the private and the public sector. At present, due to the absence of a supporting structure, the definition of and search for suitable professional profiles is left to the companies' own initiative. In

[8] National School of Engineers of Monastir.

[9] National Agronomic Institute of Tunis.

[10] Tunisia Private University.

turn, since companies lack a structured HR department, they turn to the job market only in case of need and have a poor understanding of the professional profiles they require and the skills and competences associated with them. Only a few more structured companies perform a regular skills gap analysis of their staff to identify the competences they need.

At national level, there are no specific government incentives for internship programmes. There is an ALMP (active labour market policy) that only grants the insufficient amount of around TND 35 per month for the first year, and is only open to school students. There are no incentives whatsoever for recruiting highly-skilled profiles such as engineers.

Another national financial incentive from the Government is given to companies that hire recent graduates. According to the companies interviewed, the total sum is inadequate, since for a salary of approximately TND 1 800 (around EUR 550), the Government covers only TND 200 (around EUR 60).

Despite the persisting lack of a structured interconnection between the public and private sectors, there are a few encouraging examples and good practices. This is the case for some companies that have come together to create specific training for the skills they lack. As some skills are difficult to find in the country (such as pipefitters and specialist welders), for certain large projects involving several companies , a common training centre has been established to create a common pool of trusted technicians to draw from. This way, opportunities can be put in place to develop work-based learning solutions. Specifically, the introduction of internship opportunities has the double advantage of reducing the current lack of practical skills and developing a partnership system between the private and public sectors.

7.4 Other findings from the interviews

The Tunisian Government's decision to decarbonise 30% of the national energy demand by the end of 2030 is an ambitious goal. It demonstrates the country's willingness to comply with international agreements to reduce CO_2 emissions. The introduction of green strategies represents a twofold opportunity for the country: the diversification of the energy mix currently dependent on imported gas and the greater exploitation of the renewable energy potential available to the country. The will for change must, however, be followed up by specific action plans and national energy strategies.

According to the interviews, the main complaint is that a systematic approach for developing skills based on the companies' needs is missing. In recent years, some organisations have carried out forecast studies for sector skills, but the energy sector was not included among those analysed because of a lack of statistical reference data. On the other hand, companies are not integrated in a structured network, and the recruitment process is based on impromptu needs. The whole sector, including both private and public, is acting independently and without a structured integration.

The search for qualified personnel presents companies with new challenges. The lack of skills largely affects all levels of training specialisation and has several causes: the fact that the renewable sector is relatively new in the country, the emigration of the most skilled people, and the lack of experts due to the temporary block on large-scale renewables projects.

However, the difficulty in finding specific professional profiles is not limited to the renewable sector: companies often go abroad to find profiles such as welders. At the same time, the country is facing a high rate of youth unemployment, which, according to the interviewees, affects especially university graduates (whose employment rate stands at 25%, compared to 70% of young people from vocational schools).

Among the challenges that the sector must face in the future, one will certainly be low renewable energy prices: while they encourage the reduction of dependence on fossil fuel sources, they also make it difficult to employ certain professionals, especially those who can operate in different fields, as they can receive a better salary in the fossil fuel sector for the same work.

Nevertheless, the sector has started to make progress. According to the interviewees, significant gains are being made in energy efficiency, as energy loss is becoming one of the most relevant issues to be

Main findings from the Section

- There are various factors that may hamper the growth of the energy sector, ranging from the shortage of technical profiles and skills to a lack of investment. A common perception is that there is a lack of interaction between the parties within the skills creation and development processes.
- According to the interviews, the demand for specialist technical profiles such as pipefitters must be addressed, in particular for renewable energy projects for which salaries are lower. Among high-skilled profiles, managerial skills are those most lacking.
- Reasons indicated for the shortage are: lack of practical skills and knowledge in line with new technological developments among people leaving the education system; emigration of skilled professionals due to more attractive working conditions abroad; absence of generational turnover; absence of a regular skills needs analysis mechanism for anticipating and planning initial and continuous training programmes.
- Companies mainly react to the skills shortage by providing internal training to new recruits, less often turning to external training, and sometimes outsourcing the activities.
- Where present, the connection between public and private players is neither structured nor continuous.
- Some progress and good practices are in place, such as the Government's introduction of a certification for photovoltaic installers. A possible suggestion could be to implement a broader internship and apprenticeship programme between the public and private sectors, which currently takes place sporadically and on a voluntary basis.

tackled and its assessment is mandatory for companies. Furthermore, the country is issuing certifications for photovoltaic technicians, installers and auditors, which are mandatory at national level. However, following the initial assessment phase, a systematic approach for monitoring the auditors' recommendations, according to a logic of continuous improvement, is still missing.

By defining a more systematic approach to the analysing skills needs, national key players can translate that information into action, both in the long term (vocational schools) and in the short term (initial and continuous training). This should be considered a full-scale structural process, involving stakeholders, institutions, instruments and procedures. Systematic interventions that stakeholders can take should be defined accordingly.

There is a need to upgrade university programmes. A strategy to allow Tunisian students to network with skilled foreign peers and keep abreast with changing technologies should also be developed.

In view of the lack of practical knowledge and skills among graduates and jobseekers, another suggestion is to put in place a structured internship programme, which the country is currently lacking. Apart from filling the gap between theoretical knowledge and the current needs of the market, such a scheme would strengthen the connection between the public and private sectors.

To conclude, as a foundation for the correct development of the sector, the country needs to have a clear medium- and long-term policy agenda defining how it is going to reach the promised target of 30% energy consumption from renewables in 2030. It is hoped that these findings will raise awareness among policymakers and practitioners of the changings skills needs in the energy sector and provide food for thought, especially on the ability of the education and training systems to prepare workers who are ready for the new jobs and occupations.

ANNEX 1 – RANKING BY ENERGY SUB-SECTOR

Section 6 provides an overview of skills and occupations that are most likely to be in demand in the near future for the energy sector. However, since each sub-sector has its own specific characteristics, we present here a more detailed analysis and possible relevance ranking of the occupational profiles (at all skill levels and including technical and business occupations) specific to the various sub-sectors.

In line with the ESCO classification, the lists presented in this section include both technical-professional and associate professional professions (e.g. ISCO Groups 21 – Science and Engineering Professionals, 31 – Science and Engineering Associate Professionals) and medium- and low-level professions. The latter are represented by workers (ISCO 7 – Craft and Related Trades Workers), machine operators (ISCO 8 – Plant and Machine Operators and Assemblers) and elementary workers (ISCO 9 – Elementary Occupations).

The following occupations emerged as being related to technological change in the energy sector. Please note that the list does not imply a ranking of intensity of demand and only the most relevant profiles have been listed for the sake of brevity.

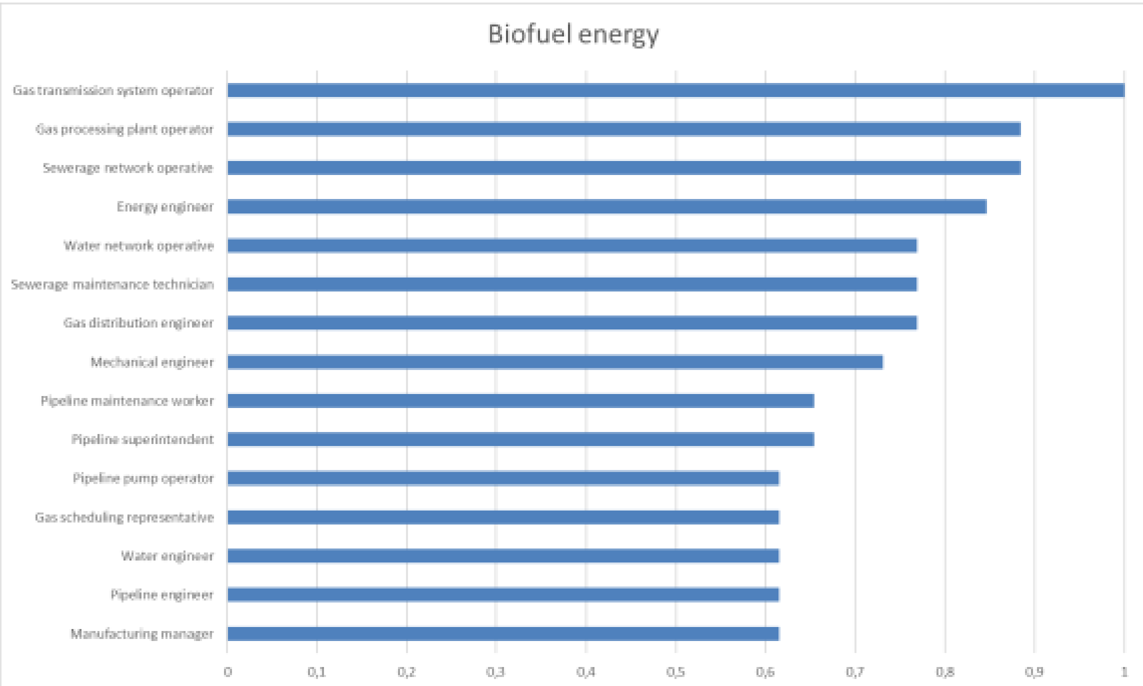
Biofuel energy

Based on the technologies extracted from patents as relevant for the sub-sector, the main ESCO occupations can be grouped according to three main branches of the occupational classification:

- Science and engineering professionals such as Pipeline engineer, Water engineer, Mechanical engineer, Gas distribution engineer and Energy engineer.
- Science and engineering associate professionals such as Sewerage maintenance technician and Gas processing plant operator.
- Medium- and low-skilled occupations, including Pipeline pump operator, Pipeline maintenance worker, Water network operative and Sewerage network operative.

Among all the possible solutions that can be considered biofuels (such as bioethanol, biodiesel, etc.), technologies related to biogas production seem to emerge from the analysis. From the list of professions, it is evident that technological innovations are mainly centred on biogas production. For this reason, the ranking includes some professions that were already present within the *Oil and gas transportation cluster*, such as for example *Gas transmission system operator* and *Sewerage maintenance technician*.

Figure A.1: Ranking of relevance of job profiles for the biofuel energy cluster (on the basis of the technologies with which they correlate)



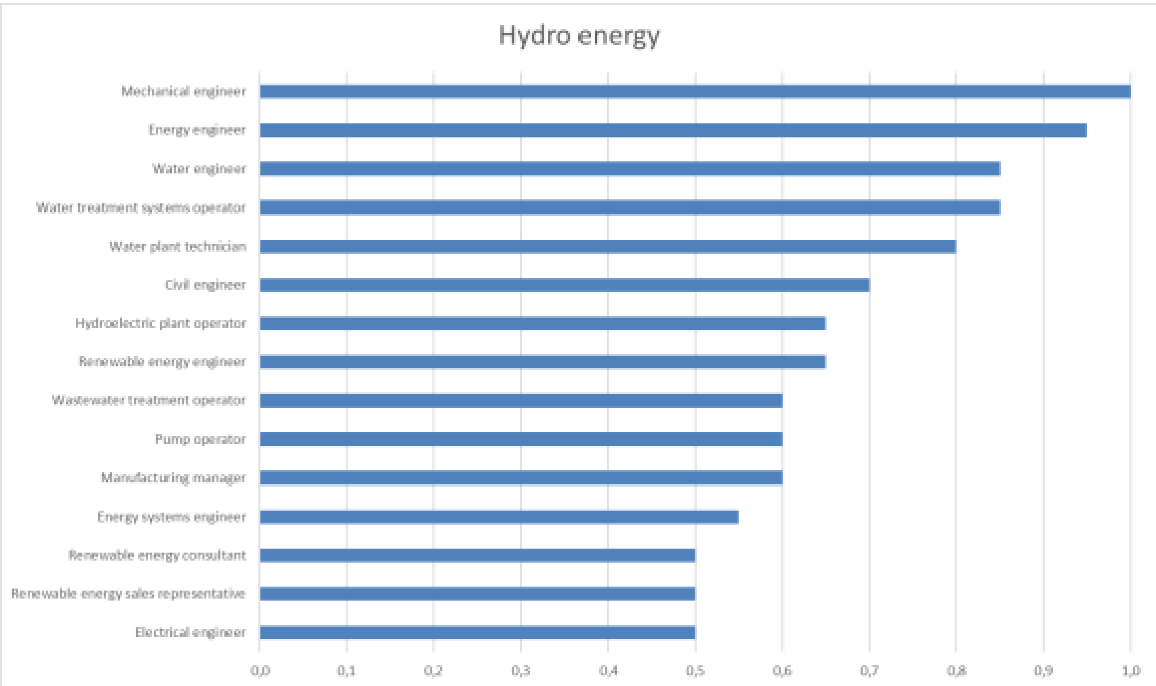
Hydro energy

Based on the technologies extracted from the patents, the main ESCO occupations with reference to the hydroelectric sector can be grouped according to four main branches of the occupational classification:

- Engineering professionals, including various branches of engineering such as Electrical engineer, Energy systems engineer, Renewable energy engineer, Civil engineer, Water engineer, Energy engineer and Mechanical engineer.
- Associate professionals such as Wastewater treatment operator, Hydroelectric plant operator, Water plant technician and Water treatment systems operator.
- Medium- and low-skilled occupations, including service workers such as Pump operator.
- Managers and business-related profiles such as Renewable energy sales representative, Renewable energy consultant and Manufacturing manager.

Also for the hydro energy cluster, *Mechanical engineer* and *Energy engineer* are the first two profiles that appear in the ranking. Compared to other clusters, there are many profiles that are specific to the generation of power from hydro sources and the management of the resource of water itself. They are: *Water engineers*, *Water plant technicians*, *Hydroelectric plant operators*, *Wastewater treatment operators* and *Pump operators*. The presence and integration of all of these profiles would allow the country to benefit from the availability of hydro sources that, although relatively scarce, contribute in a small part to Tunisia's electricity generation.

Figure A.2: Ranking of relevance of job profiles for the hydro energy cluster (on the basis of the technologies with which they correlate)



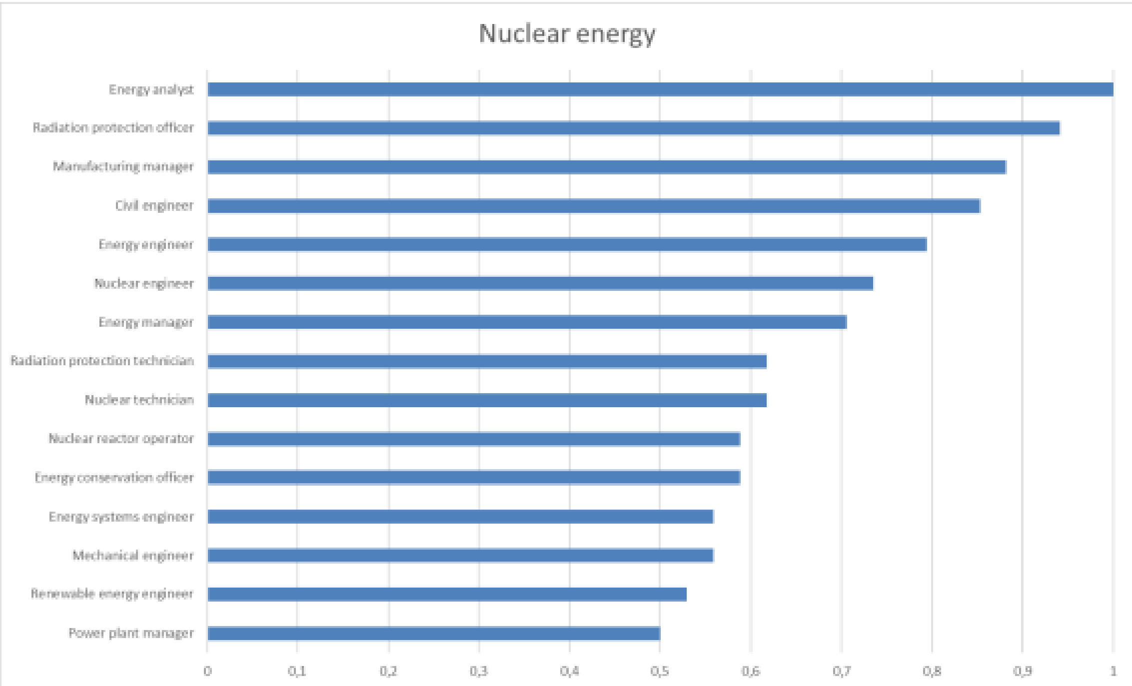
Nuclear energy

Based on the technologies extracted from the patents, the main ESCO occupations with reference to the nuclear energy cluster can be grouped according to three main branches of the occupational classification:

- Science and engineering professionals, including Renewable energy engineer, Mechanical engineer, Energy systems engineer, Nuclear engineer, Energy engineer and Civil engineer.
- Science and engineering associate professionals such as Energy conservation officer, Nuclear reactor operator, Nuclear technician, Radiation protection technician and Energy analyst.
- Managers and business-related profiles such as Power plant manager, Energy manager and Manufacturing manager.

Over the years, the country has considered introducing nuclear power as an additional energy source and a nuclear power plant was at one point intended to be built in 2020. Should the country invest in this direction and acquire the most recent and advanced technologies for the construction of nuclear plants, this study has found the occupations listed below to be the most relevant for its effective implementation. The presence of professional profiles such as *Radiation protection officer* and *Radiation protection technician* testify to the prominence of safety issues in the occupational profiles related to nuclear energy.

Figure A.3: Ranking of relevance of job profiles for the nuclear energy cluster (on the basis of the technologies with which they correlate)



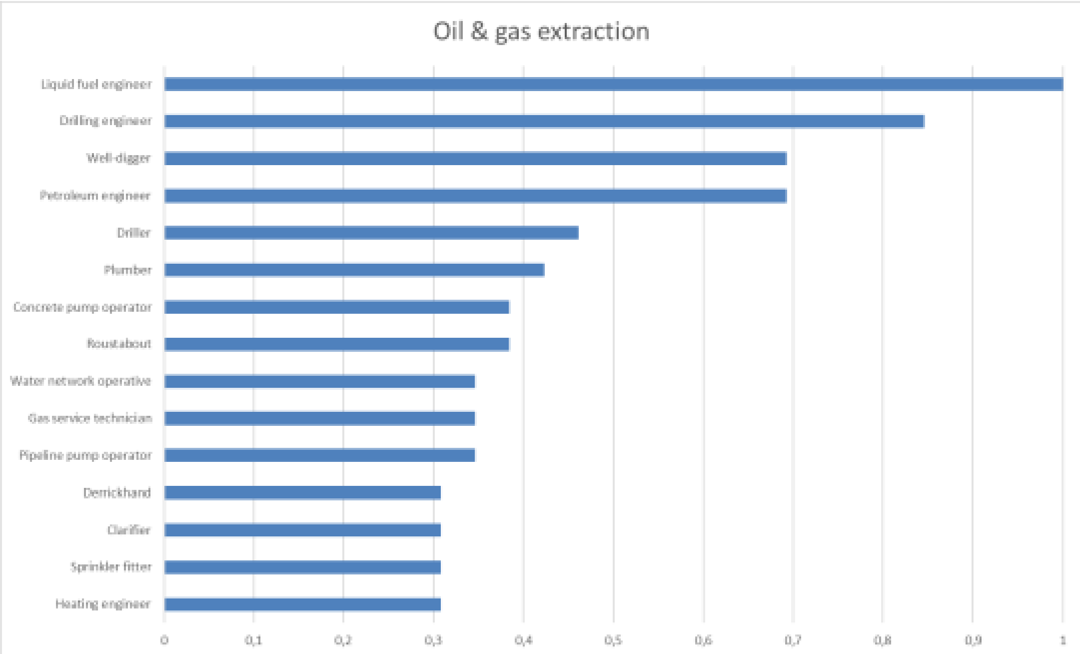
Oil and gas extraction

Based on the technologies extracted from the patents, the main ESCO occupations with reference to the oil and gas extraction cluster can be grouped according to two main branches of the occupational classification:

- Science and engineering professionals, including Petroleum engineer, Drilling engineer and Liquid fuel engineer.
- Medium- and low-skilled occupations, including service workers such as Heating engineer, Sprinkler fitter, Clarifier, Derrickhand[11], Pipeline pump operator, Gas service technician, Water network operative, Roustabout, Concrete pump operator, Plumber, Driller and Well-digger.

The analysis of the technologies for the oil and gas extraction cluster indicates that the workforce of the future will still comprise professional profiles that can be considered traditional for the sub-sector. Not only high-skilled profiles such as *Liquid fuel engineer*, *Drilling engineer* and *Petroleum engineer*, but also medium- to low-skilled profiles such as *Well-diggers*, *Drillers* and *Plumbers* are among the top positions in the rankings. This means that in the future the sub-sectors will still rely on some traditional occupations, although technological changes and innovations may require the progressive upskilling and reskilling of their competencies.

Figure A.4: Ranking of relevance of job profiles for the oil and gas extraction cluster (on the basis of the technologies with which they correlate)



[11] Derrickhands guide the positions and movements of drill pipes. They control the automated pipe-handling equipment. They are often responsible for the condition of drilling fluids, or 'mud'. (https://ec.europa.eu/esco/portal)

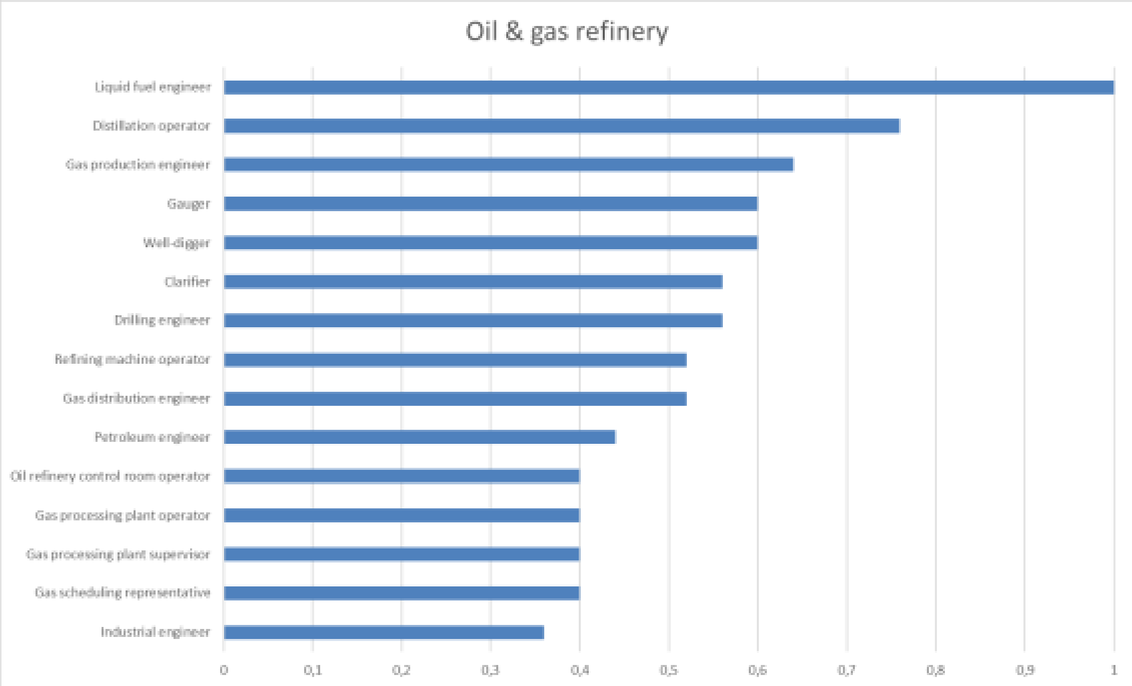
Oil and gas refinery

Based on the technologies extracted from the patents, the main ESCO occupations with reference to the oil and gas refinery cluster can be grouped according to two main branches of the occupational classification:

- Science and engineering professionals, including Petroleum engineer, Drilling engineer and Liquid fuel engineer.
- Medium- and low-skilled occupations, including service workers such as Heating engineer, Sprinkler fitter, Clarifier, Pipeline pump operator, Gas service technician, Water network operative, Roustabout, Concrete pump operator, Plumber, Driller and Well-digger.

Similarly to the oil and gas extraction cluster, the analysis of the oil and gas refinery cluster includes both high and medium-low qualifications in the top positions in the ranking. According to the technologies that have been extracted, in the future the sub-sectors will still rely on professional figures such as *Liquid Fuel Engineers* and *Gas Production Engineers*, as well as *Distillation Operators*, *Gaugers*, *Well-diggers* and *Clarifiers*, since production and refining activities are not expected to change in the future. Although job profiles will not change, skills and abilities may need to be improved based on technological innovation (e.g. digitisation), which may disrupt daily activities to an even greater extent than at present.

Figure A.5: Ranking of relevance of job profiles for the oil and gas refinery cluster (on the basis of the technologies with which they correlate)



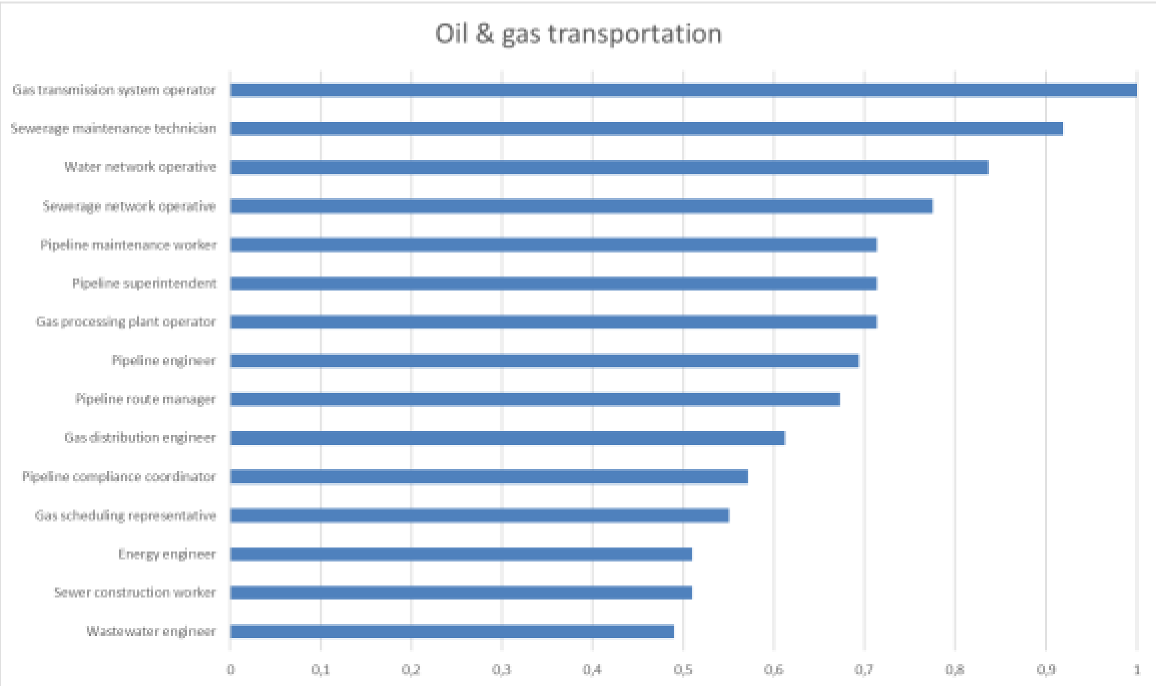
Oil and gas transportation

Based on the technologies extracted from the patents, the main ESCO occupations with reference to the oil and gas transportation cluster can be grouped according to four main branches of the occupational classification:

- Science and engineering professionals, including Wastewater engineer, Energy engineer, Gas distribution engineer and Pipeline engineer.
- Science and engineering associate professionals such as Pipeline compliance coordinator, Gas processing plant operator and Sewerage maintenance technician.
- Medium- and low-skilled occupations, including Sewer construction worker, Pipeline maintenance worker, Sewerage network operative and Water network operative.
- Managers and business-related profiles such as Gas scheduling representative, Pipeline route manager, Pipeline superintendent and Gas transmission system operator.

The main technologies related to the oil and gas transportation cluster refer to pipeline infrastructure. It is interesting to note that these technologies relate in the ESCO database not only to energy-related job profiles such as *Gas transmission system operators* and *Gas distribution engineers*, but also profiles that are related to sewerage and water network management such as *Sewerage maintenance technicians*, *Water network operatives* and *Sewerage network operatives.* In these cases, the algorithm suggests potential synergies in terms of skills that may be present and therefore exploited within the labour market.

Figure A.61: Ranking of relevance of job profiles for the oil and gas transportation cluster (on the basis of the technologies with which they correlate)



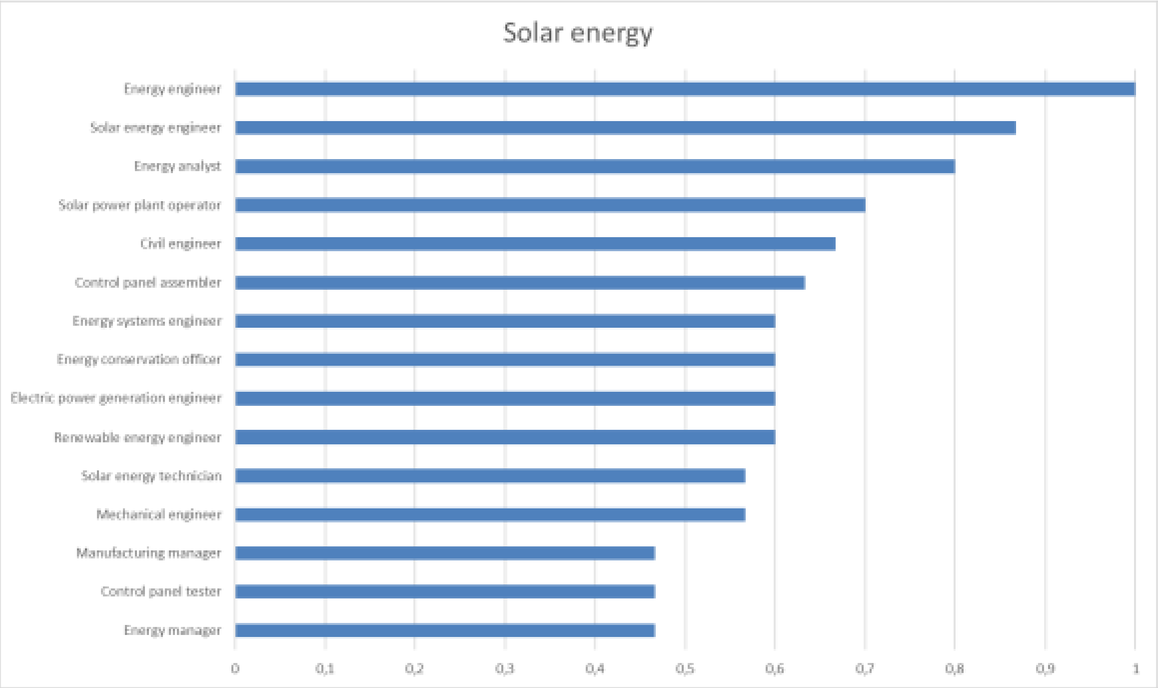
Solar energy

Based on the technologies extracted from the patents, the main ESCO occupations with reference to the solar energy cluster can be grouped according to four main branches of the occupational classification:

- Science and engineering professionals, including Mechanical engineer, Renewable energy engineer, Electric power generation engineer, Energy systems engineer, Civil engineer, Solar energy engineer and Energy engineer.
- Science and engineering associate professionals such as Energy conservation officer, Solar power plant operator and Energy analyst.
- Medium- and low-skilled occupations, including Control panel tester, Solar energy technician and Control panel assembler.
- Managers and business-related profiles such as Energy manager and Manufacturing manager.

Energy engineer and *Solar energy engineer* are the two most relevant profiles within the ranking of the solar energy cluster. While the first has knowledge of solar energy production systems, the second is specifically skilled in those technologies. It is interesting to note that the algorithm indicated *Energy analyst* as one of the most relevant profiles for this cluster. This profile is linked to the evaluation of the adoption of cost-saving energy alternatives and to the issues related to improving energy efficiency. Other profiles that focus on solar energy are *Solar power plant operators* and *Solar energy technicians*, who would help to carry out and monitor solar plant operations in the country's future workforce.

Figure A.7: Ranking of relevance of job profiles for the solar energy cluster (on the basis of the technologies with which they correlate)



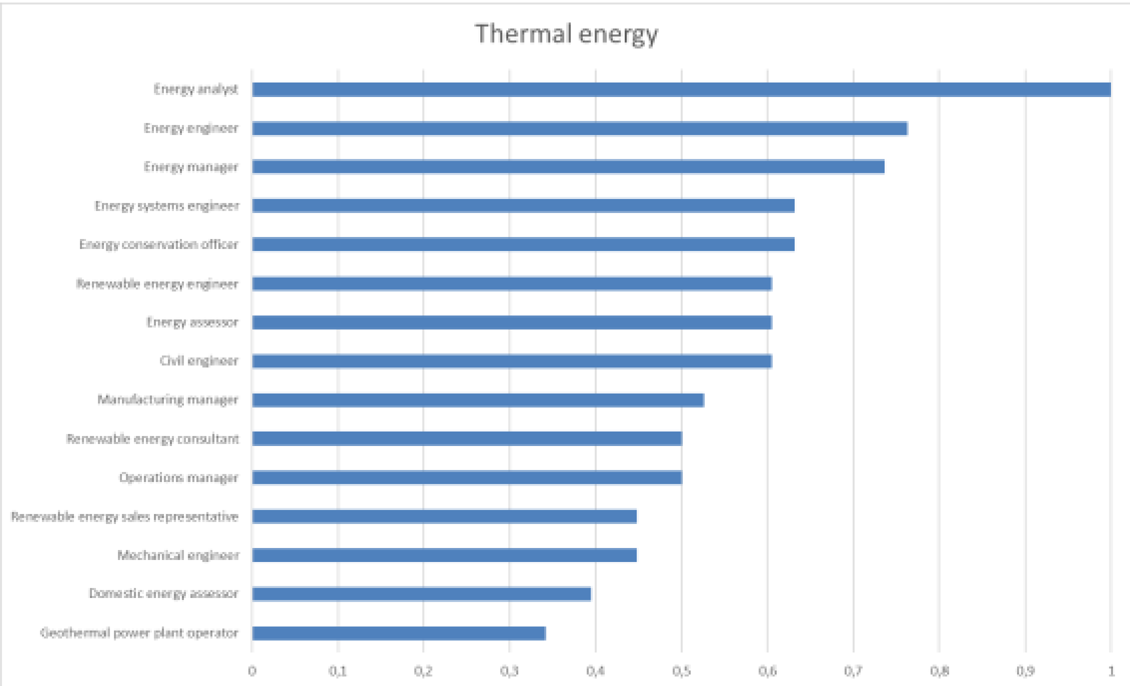
Thermal energy

Based on the technologies extracted from the patents, the main ESCO occupations with reference to the thermal energy cluster can be grouped according to four main branches of the occupational classification:

- Science and engineering professionals, including Mechanical engineer, Civil engineer, Renewable energy engineer, Energy systems engineer and Energy engineer.
- Science and engineering associate professionals such as Geothermal power plant operator, Domestic energy assessor, Energy assessor, Energy conservation officer and Energy analyst.
- Managers and business-related profiles such as Renewable energy sales representative, Operations manager, Renewable energy consultant, Manufacturing manager and Energy manager.

The analysis of the technologies related to the thermal energy cluster indicates professions that are transversal to the energy sector such as *Energy analysts* and *Energy engineers*, which hold the top positions in the relevance ranking. In addition to *Energy manager*, the role of *Energy conservation officer* is interesting. While the former coordinates energy use within an organisation and aims to implement energy sustainability policies, the latter promotes energy conservation by advising on how to reduce power consumption. It is interesting to note the presence of many profiles linked to renewable energies, since traditionally gas-fired thermal power plants can be converted and powered by renewable sources such as biogas.

Figure A.8: Ranking of relevance of job profiles for the thermal energy cluster (on the basis of the technologies with which they correlate)



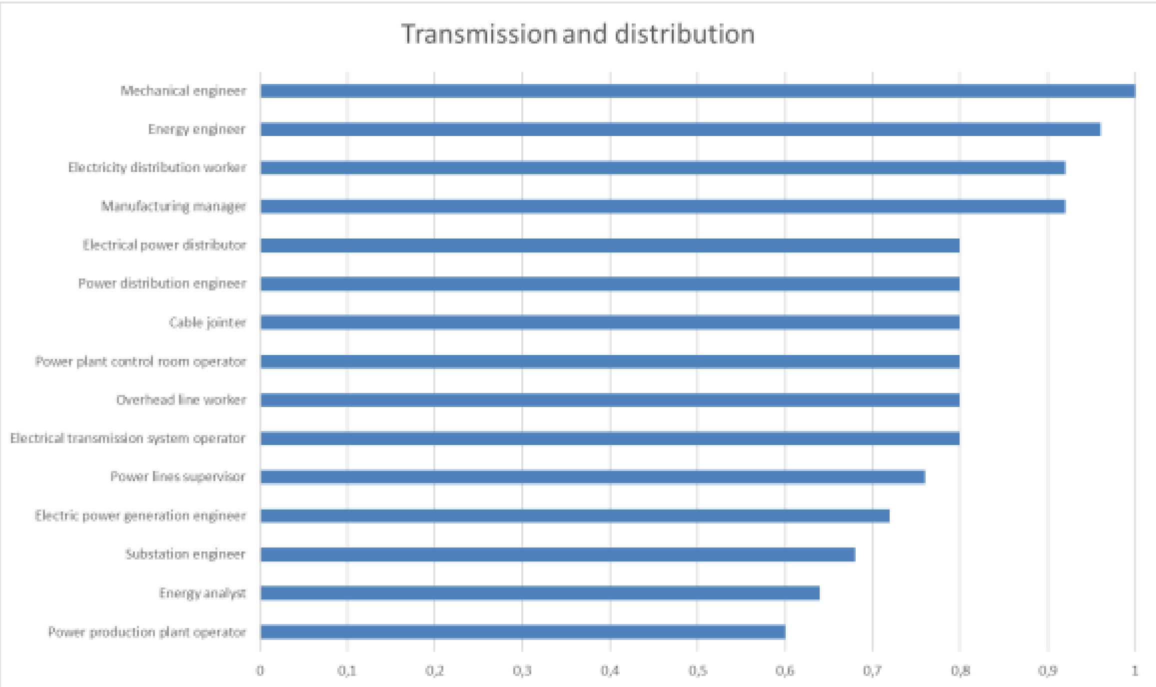
Transmission and distribution

Based on the technologies extracted from the patents, the main ESCO occupations with reference to the transmission and distribution cluster can be grouped according to four main branches of classification:

- Science and engineering professionals, including Substation engineer, Electric power generation engineer, Power distribution engineer, Energy engineer and Mechanical engineer.
- Science and engineering associate professionals such as Power production plant operator, Energy analyst, Power lines supervisor, Electrical transmission system operator, Power plant control room operator and Electrical power distributor.
- Medium- and low-skilled occupations, including Overhead line worker, Cable jointer and Electricity distribution worker.
- Managers and business-related profiles such as manufacturing manager.

Compared to other clusters, many of the job profiles in the transmission and distribution cluster are more similar in value: this can be a sign of a high interchangeability in terms of skills and profiles for the technologies indicated within this cluster. In this case, *Mechanical engineer* is in first position in the ranking, followed immediately by *Energy engineer.* The next highest-ranking role, *Manufacturing manager*, indicates that managerial skills are also important in transmission and distribution operations. *Electricity distribution workers* provide skills related to the repair and maintenance of the power lines and their compliance with safety regulations.

Figure A.9: Ranking of relevance of job profiles for the transmission and distribution cluster (on the basis of the technologies with which they correlate)



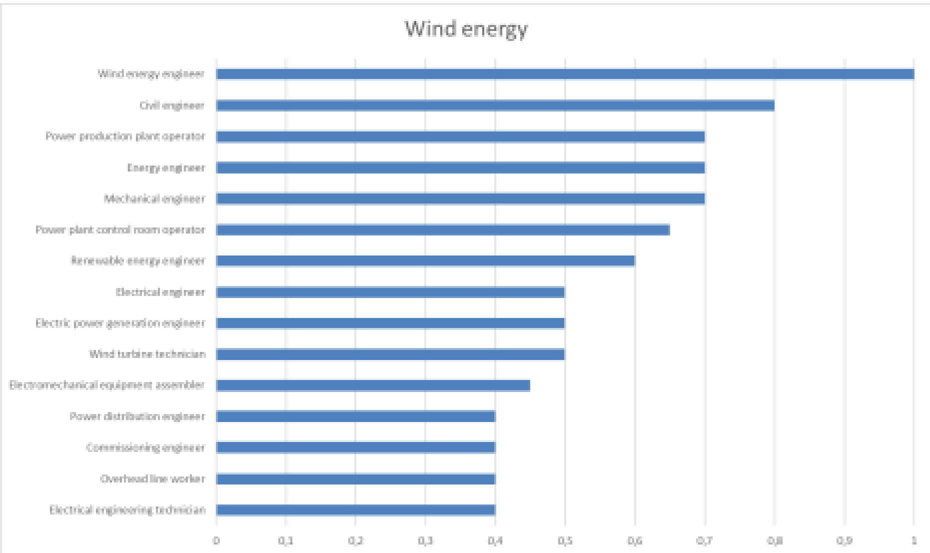
Wind energy

Based on the technologies extracted from patents as relevant for the sub-sectors, the main ESCO occupations with reference to the wind energy cluster can be grouped according to three main branches of the occupational classification:

- Science and engineering professionals, including Commissioning engineer, Power distribution engineer, Electric power generation engineer, Electrical engineer, Renewable energy engineer, Mechanical engineer, Energy engineer, Civil engineer and Wind energy engineer.
- Science and engineering associate professionals such as Electrical engineering technician, Power plant control room operator and Power production plant operator.
- Medium- and low-skilled occupations, including Overhead line worker, Electromechanical equipment assembler and Wind turbine technician.

The analysis of patents related to the wind energy cluster shows both specialist profiles for wind-specific technologies and more generic (transversal). profiles. Among the former is *Wind energy engineer*, in top position in the ranking. According to the ESCO classification, the Wind energy engineer's skills are necessary for the correct design and implementation of wind turbines, and are related not only to the installation of the system but also to the search for the most suitable locations and to testing activities to improve performance. It is interesting to note that the adoption of wind solutions requires not only personnel for the operation, installation and maintenance of wind turbines and blades, but also professionals for supporting actions, such as the construction of plants or the correct functioning of gears. In this sense, the algorithm adopted helps in taking into consideration profiles such as *Civil engineers*, who based on initial analysis might be considered less relevant for the sector. *Mechanical engineer* is also an interesting finding, particularly for the competences related to technologies such as rotors and shafts (and their production), which are essential components of a wind power plant.

Figure A.10: Ranking of relevance of job profiles for the wind energy cluster (on the basis of the technologies with which they correlate)



ANNEX 2 – KEY STAKEHOLDERS CONSULTED

The following table lists all the stakeholders that we met with during the project, either during the focus group discussions or through bilateral online interviews with Tunisian representatives.

NO	ORGANISATION (alphabetical order)
1.	Agence Nationale pour l'Emploi et le Travail Indépendant (ANETI)
2.	Agence Tunisienne de la Formation Professionnelle (ATFP)
3.	Agency for Promotion of Industry and Innovation (APII)
4.	Agence de Promotion des Investissements Agricoles (APIA)
5.	Association des banques Tunisiennes (APTBEF)
6.	Biome Solar Industry
7.	Carthage Power Company (CPC)
8.	CDC (public organisation)
9.	Centre National de Formation Continue et de Promotion Professionnelle
10.	Centre National de Formation de Formateurs et de l'Ingénierie de Formation (CENAFFIF)
11.	Centre International des Technologies de l'Environnement de Tunis (CITET)
12.	CONECT (employers' association)
13.	Directrice générale – Observatoire Méditerranéen de l'Energie (OME)
14.	Ecole Nationale Des Sciences Et Technologies Avancées Borj Cedria-Enstab
15.	Ecopark Technopole Borj Cedria
16.	Energy Research and Technology Centre (CRTEn)
17.	ENI Tunisia
18.	GIZ Tunisia
19.	Mediterranean Renewable Energies Centre (MEDREC)
20.	Ministère de la Jeunesse, des Sports et de l'Intégration
21.	Ministry of Energy, Mines and Energy Transition
22.	Ministry of Higher Education and Scientific Research
23.	Ministry of Industry and SMEs
24.	National Agency for Energy Management (ANME)
25.	National Agency for Waste Management (ANGED)
26.	National Engineering School of Bizerte (ENIB)

27.	Natural Resource Governance Institute (NRGI) Tunisia
28.	Pireco
29.	Pôle de compétitivité de l'énergie renouvelable à Sfax
30.	Regional Centre for Renewable Energy and Energy Efficiency
31.	Shell
32.	SOFTEN
33.	STEG (Tunisian Electricity and Gas Company)
34.	STEG Renewable Energy
35.	Technical Centre for Mechanical and Electrical Industries (CETIME)
36.	Tunis Engineering School (ENIT)
37.	Tunisian Agency for Vocational Training (ATFP)
38.	Tunisian Coalition for Transparency in Energy and Mining (CTTEM)
39.	Tunisian Enterprise for Petroleum Activities (ETAP)
40.	Tunisian Photovoltaic Union Chamber (CSPV)
41.	UNDP
42.	World Bank Tunisia

ANNEX 3 – GLOSSARY

API –application programming interface (API), a computing interface that defines and allows interactions between multiple pieces of software without the need for human intervention.

Artificial intelligence – a general term used to describe a variety of technologies and approaches that allow computers to solve complex tasks (usually associated with higher cognitive levels), such as recognising objects or patterns; classifying entities; simulating and modelling situations; predicting future behaviours; and generating constructs similar to existing ones.

Cognitive bias – a systematic pattern of deviation from the norm or rationality in judgement. Cognitive biases are considered by many authors to be linked to the normal functioning of the human brain, and thus can arise in any activity involving human judgement.

Competence – 'the proven ability to use knowledge, **skills** and personal, social and/or methodological abilities, in work or study situations and in professional and personal development"' (European Qualifications Framework). While sometimes used as synonyms, the terms **skill** and competence can be distinguished according to their scope. The term **skill** refers typically to the use of methods or instruments in a particular setting and in relation to defined tasks. The term competence is broader and refers typically to the ability of a person – facing new situations and unforeseen challenges – to use and apply knowledge and skills in an independent and self-directed way.

Cross-sectoral (knowledge, skills or competences) –one of the four levels of **skills** reusability identified by the **ESCO** initiative, whereby reusability means how widely a knowledge, skill or competence concept can be applied in different working contexts. Cross-sectoral knowledge is relevant to occupations across several economic sectors, whereas sector-specific or occupation-specific knowledge is restricted to one specific sector or **occupation**. See also **Transversal knowledge**.

Cross-sectoral technology – adopting the concept of **cross-sectorality** from **ESCO**'s **skills** reusability levels, the term indicates a technology that finds application in many different economic sectors (e.g. control units or sensors).

ESCO – the **E**uropean multilingual classification of **S**kills, **C**ompetences and **O**ccupations. ESCO works as a dictionary, describing, identifying and classifying professional **occupations**, **skills** and qualifications relevant for the EU labour market and education and training, in a format that can be understood by electronic systems. It lists over 3 000 occupations and 13 000 skills and competences). For more info, see https://ec.europa.eu/esco/portal/home.

ISCO – the International Standard Classification of Occupations, an International Labour Organization (ILO) classification structure for organising information on labour and jobs. It is part of the international family of economic and social classifications of the United Nations. It contains around 7 000 detailed jobs, organised in a four-level hierarchy that allows all jobs in the world to be classified into groups, from 436 lower-level groups up to 10 major groups.

Job –a set of tasks and duties performed, or meant to be performed, by one person (ISCO-08).

Job profile –the description of a particular work function, developed by the employer or by the HR department of a company, that includes all the elements deemed necessary to perform the corresponding **job**. In particular, it includes the general tasks, duties and responsibilities, and required **qualifications**, **competences** and **skills** needed by the person in the job.

Job title –the identifying label given by the employer to a specific job, usually when looking for new candidates to the position. In the absence of standardised nomenclature, it can coincide with either a description of the **job**, or the **occupation** group to which the job belongs.

NACE – a four-digit classification providing the framework for collecting and presenting a large range of statistical data according to economic activity in the fields of economic statistics, provided by

Eurostat. Economic activities are divided into 10 or 11 categories at high-level aggregation, while they are divided into 38 categories at intermediate aggregation.

Natural language processing (NLP) – an interdisciplinary field at the intersection of linguistics, computer science and information engineering. NLP deals with the interactions between computers and human (natural) languages, in particular how to program computers to process and analyse large amounts of natural language data, starting from the identification of the grammatical and logical parts of speech within a sentence, up to the complex representation of semantic relationships between words.

Occupation – according to ESCO, an occupation is 'a grouping of jobs involving similar tasks, and which require a similar **skill** set.' Occupations should not be confused with **jobs** or **job titles**. While a job is bound to a specific work context and executed by one person, occupations group jobs by common characteristics (for example, being the 'project manager for the development of the ventilation system of the Superfly 900 aircraft"' is a job. 'Project manager', 'aircraft engine specialist' or 'heating, ventilation, air conditioning engineer' could be occupations, i.e. groups of jobs to which this job belongs).

Occupational profile – an explanation of the **occupation** in the form of a description, scope, definition and list of the knowledge, **skills** and **competences** considered relevant for it. Each occupation in the **ESCO** database also comes with an occupational profile that further distinguishes between essential and optional knowledge, skills and competences.

Profession – an **occupation** requiring a set of specific **skills** and dedicated training.

Qualification – the 'formal outcome of an assessment and validation process which is obtained when a competent body determines that an individual has achieved learning outcomes to given standards' (European Qualifications Framework).

Regulated profession – a profession whose access, scope of practice, or title is regulated by law.

Semantic matching – a technique used in computer science to identify information that is semantically related.

Skill – 'the ability to apply knowledge and use know-how to complete tasks and solve problems' (European Qualifications Framework). Skills can be described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments). While sometimes used as synonyms, the terms skill and **competence** can be distinguished according to their scope. A skill refers typically to the use of methods or instruments in a particular setting and in relation to defined tasks. A competence is broader and refers typically to the ability of a person – facing new situations and unforeseen challenges – to use and apply knowledge and skills in an independent and self-directed way.

Soft skills –usually associated with **transversal skills** and considered the cornerstone of personal development, also within the context of labour and employment. To distinguish them from other knowledge-based basic skills, soft skills are often referred to as social or emotional skills. They can be further classified into personal skills (e.g. problem-solving, adaptability) or interpersonal ones (e.g. teamwork, leadership).

Text mining –a general term indicating a variety of techniques that allow computers to extract, discover or organise relevant information from large collections of different written resources (such as websites, books and articles). The first part of any text-mining process involves transforming texts into structured representations useful for subsequent analysis through the use of **natural language processing** tools. **Artificial intelligence** techniques are sometimes used to perform text-mining tasks more effectively.

Transversal (knowledge, skills or competences) – the highest of the four levels of **skills** reusability identified by the **ESCO** initiative, whereby reusability means how widely a knowledge, skills or competence concept can be applied in different working contexts. Transversal skills are relevant to a broad range of **occupations** and sectors. They are often referred to as *core skills*, *basic skills* or *soft* *skills*, the cornerstone for personal development. Transversal knowledge, skills and competences are the building blocks for the development of the 'hard' skills and competences required to succeed in the labour market.

Transversal technology – adopting the concept of **transversality** from **ESCO**'s **skills** reusability levels, a transversal technology is relevant to a broad range of **occupations** and sectors and is a building block for more specific technologies (e.g. computerised image analysis).

ANNEX 4 – LIST OF ACRONOMYS

AI	Artificial intelligence
ALMPs	Active labour market policies
ANETI	National Agency for Employment and Independent Work (Agence Nationale pour l'Emploi et le Travail Indépendant)
ANME	National Agency for Energy Management (Agence Nationale de Maitrise de l'Energie)
API	Application Programming Interface
BMS	Building Management System
CAIP	Labour Market Access and Employability Programme
COP 21	21st Conference of the Parties
CSPIE	Higher Commission for Independent Electricity Production (Commission Supérieure de la Production Indépendante d'Electricité)
CTER	Technical Commission for Private Production of Electricity from Renewable Energies (Commission Technique de production privée d'électricité à partir des Energies Renouvelables)
EBRD	European Bank for Reconstruction and Development
EE	Energy efficiency
ENIM	National School of Engineers of Monastir (École Nationale d'Ingénieurs de Monastir)
ENIT	National Engineering School of Tunis (École Nationale d'Ingénieurs de Tunis)
ENR	Engineering News-Record
EPO	European Patent Office
ESCO	European Skills, Competences and Occupations
ETAP	Tunisian National Oil Company (Entreprise Tunisienne d'Activités Pétrolières)

EU	European Union
FDI	Foreign direct investments
FNME	National Fund for Energy Management (Fonds National de Maitrise de l'Énergie)
FTE	Energy Transition Fund (Fonds de Transition Energétique)
FTI	Tunisian Investment Fund (Fonds Tunisien de l'Investissement)
GDP	Gross domestic product
GIZ	German Society for International Cooperation (Deutsche Gesellschaft für Internationale Zusammenarbeit)
HFCs	Hydrofluorocarbons
HR	Human resources
ICT	Information and communications technology
IEAQA	National Authority for Evaluation, Quality Assurance and Accreditation (Instance Nationale de l'Evaluation, de l'Assurance Qualité et de l'Accréditation)
ILO	International Labour Organization
INAT	National Agronomic Institute of Tunisia (Institut National Agronomique de Tunisie)
IoT	Internet of Things
ISCED	International Standard Classification of Education
ISCO	International Standard Classification of Occupations
IT	Information technology
LPG	Liquefied petroleum gas
MENA	Middle East and North Africa
MVTE	Ministry of Professional Training and Employment

NACE	Statistical Classification of Economic Activities in the European Community (Nomenclature statistique des activités économiques dans la Communauté européenne)
NDC	Nationally determined contribution
NEET	Not in employment, education or training
OECD	Organisation for Economic Co-operation and Development
ONEM	National Observatory of Energy and Mines (Observatoire National de l'Energie et des Mines)
PROSOL	Solar Promotion Programme
PV	Photovoltaic
R&D	Research and development
RE	Renewable energy
SCADA	Supervisory control and data acquisition
SER	STEG Énergies Renouvelables
SIS	STEG International Services
SMEs	Small and medium-size enterprises
STEG	Tunisian Company of Electricity and Gas (Société Tunisienne de l'Électricité et du Gaz)
STEM	Science, technology, engineering and mathematics
SVIP	Professional Internship Programme
TND or TD	Tunisian dinar
TSP	Tunisian Solar Plan
ULT	Tunisia Private University (Université Libre de Tunis)
UNFCCC	United Nations Climate Change Secretariat
UNIDO	United Nations Industrial Development Organization

VAT	Value added tax
VET	Vocational education and training
VPN	Virtual private network
VR	Virtual reality

REFERENCES

African Development Bank (2017). Tunisia Country Strategy Paper 2017-2021. https://www.afdb.org/en/documents/document/tunisia-country-strategy-paper-2017-2021-96778

Alcidi, C., Laurentsyeva N. and Wali A. (2019). Legal migration pathways across the Mediterranean: Achievements, obstacles and the way forward, EMNES Policy Brief.

Ayadi, M., Mattoussi, W. (2014). Scoping of the Tunisian economy (No. 2014/074). WIDER Working Paper. https://www.wider.unu.edu/publication/scoping-tunisian-economy

Beylis & Cunha (2018). Why are energy subsidy reforms so unpopular? https://blogs.worldbank.org/latinamerica/why-are-energy-subsidy-reforms-so-unpopular

Boghzala, M. (2018). Tunisian migration and brain drain. Mondopoli. http://www.mondopoli.it/wp-content/uploads/2018/05/Mongi-Boughzala-TUNISIAN-MIGRATION-AND-BRAIN-DRAIN.pdf

EBRD (2020a). Transition Report 2020-21. https://2020.tr-ebrd.com/countries/#

EBRD (2020b). Évaluation des compétences et des emplois pour la production et les services relatifs à l'énergie en Tunisie. Livrable PHASE 1: Analyse macroéconomique des compétences et des emplois dans le secteur de l'énergie. May 2020.

EBRD (2021). Transition report 2021-22. https://2021.tr-ebrd.com/countries/#

El Jafari, M. (2012). Determinants and Impacts of Migration and Remittances: The Case of Palestine and Tunisia. FEMISE Research Programme, 2012. www.femise.org/wp-content/force-download.php?file=uploads/2013/12/FEM33-161.pdf

Enerdata (2019) https://www.enerdata.net/estore/energy-market/tunisia/

ETF (2014). Employment policies and active labour market programmes in Tunisia. https://www.etf.europa.eu/en/publications-and-resources/publications/employment-policies-and-active-labour-market-programmes-0

ETF (2019). Tunisia: Education, Training and Employment Developments 2018. https://www.etf.europa.eu/sites/default/files/2019-03/Tunisia%202018.pdf

ETF (2020). Big Data for Labour Market Information (LMI) In Tunisia. tunisia_big_data_lmi_analysis_2020_web.pdf (europa.eu)

ETF (2021), Case studies on the future of skills: Methodological note for conducting case studies, March 2021, Turin, Skills for the future case studies, methodology.

European Commission (2021). https://ec.europa.eu/trade/policy/countries-and-regions/countries/tunisia/

GIZ (2012). Energie renouvelable et efficacité énergétique en Tunisie: emploi, qualification et effets économiques. http://papers.gws-os.com/GIZ_Emploi_ER_EE_Tunisie.pdf

GIZ (2015). Solar Plan: to produce 30 per cent of electricity from renewable energy sources. https://www.giz.de/en/worldwide/60432.html

Institut national de la statistique (2019a). http://www.ins.tn/statistiques/73

Institut national de la statistique (2019b). http://www.ins.tn/statistiques/72

International Energy Agency (2020). Tunisia Profile. https://www.iea.org/countries/tunisia

International Labour Organization (2018). Green Jobs in Tunisia: Measuring Methods and Model Results. https://www.ilo.org/global/topics/green-jobs/WCMS_631705/lang--en/index.htm

International Labour Organization (2021). ILOSTAT database. Available at https://ilostat.ilo.org/data/

International Monetary Fund (2020a). https://www.imf.org/en/Countries/TUN/tunisia-qandas

International Monetary Fund (2020b). https://www.imf.org/en/Countries/TUN

International Trade Administration (2021). https://www.trade.gov/country-commercial-guides/tunisia

IRENA (2020). Scaling up renewable energy investment in Tunisia. https://coalition.irena.org/-/media/Files/IRENA/Coalition-for-Action/Publication/Scaling-up-Renewable-Energy-Investment-in-Emerging-Markets/IRENA-Coalition-for-Action_Tunisia_2020.pdf?la=en&hash=59F4AC24BE11F02E0D874F75A4A17F8DDA17C90C#:~:text=The%20Tunisian%20Solar%20Plan%20has,3%20815%20MW%20by%202030

Jeune Afrique (2015). COP21 : la Tunisie et 6 autres nouveaux pays africains présentent leurs engagements pour le climat. http://www.jeuneafrique.com/267644/societe/cop-21-tunisie-ghana-6-autres-pays-africains-presentent-a-tour-leurs-engagements-climat/

Kütt, W., & Schmiemann, M. (1998). Quick Scan: a novelty search service in the framework of Euro-R&D programmes. World Patent Information, 2(20), 146-147.

Leaders (2019). Lancement de la formulation de la Stratégie Nationale pour l'Emploi. https://www.leaders.com.tn/article/27084-lancement-de-la-formulation-de-la-strategie-nationale-pour-l-emploi

Lehr, U. et al. (2016). Employment from renewable energy and energy efficiency in

Ministère de l'Énergie et des Mines (2021). https://www.energiemines.gov.tn/fr/tc/a-la-une/news/impact-du-covid-19-sur-la-demande-de-lenergie-en-tunisie/?tx_news_pi1%5Baction%5D=detail&tx_news_pi1%5Bcontroller%5D=News&cHash=3822d009d1a0a193269b687bdfc228c4

Ministère de la Formation Professionnelle et de l'Emploi (2021). La stratégie nationale pour l'emploi. http://www.emploi.gov.tn/fr/100/strategie-nationale-pour-lemploi

Morsy et al. (2018). Tunisia Diagnostic paper: Assessing Progress and Challenges in Unlocking the Private Sector's Potential and Developing a Sustainable Market Economy. https://www.semanticscholar.org/paper/Tunisia-Diagnostic-paper%3A-Assessing-Progress-and-in-Morsy-Kamar/cd23287bb30a6c9de6a90dacfcd10f1a3d6d3b39

Musette, M. S. (2016). Brain drain from the Southern Mediterranean. IEMed Mediterranean Yearbook. Barcelona: European Institute of the Mediterranean. https://www.iemed.org/observatori/arees-danalisi/arxius-adjunts/anuari/med.2016/IEMed_MedYearBook2016_Southern%20Mediterranean%20Brain%20Drain_Mohammed_Saib.pdf

OEC (2020). The Observatory of Economic Complexity. https://oec.world/en/profile/country/tun

OECD (2017). Compact for Economic Governance, Stocktaking Report: Tunisia. http://www.oecd.org/mena/competitiveness/Stocktaking-Report-Tunisia-Compact-EN.pdf

OECD (2018). Economic Surveys Tunisia. https://www.oecd.org/economy/oecd-economic-surveys-tunisia-2018-eco-surveys-tun-2018-en.htm

OECD (2021). National Accounts data files.

Rodgers, G. (2007). Labour Market Flexibility and Decent Work, United Nations Economic and Social Affairs Working Paper.

Schäfer, I. (2016). The Renewable Energy Sector and Youth Employment in Algeria, Libya, Morocco and Tunisia. https://www.afdb.org/en/documents/document/the-renewable-energy-sector-and-youth-employment-in-algeria-libya-morocco-and-tunisia-90018

See Terragno, P. J. (1979). Patents as technical literature. IEEE Transactions on Professional Communication, (2), 101-104.

Tunisia – new insights, new results. Elsevier.

United Nations (2011). PROSOL- Solar Programme. https://sustainabledevelopment.un.org/index.php?page=view&type=99&nr=39&menu=1449

Whiteshield Partners for the EBRD (2013). Knowledge Economy Assessment of Tunisia. https://www.ebrd.com/downloads/news/tunisia-knowledge-report.pdf

World Bank (2014a). The Unfinished Revolution. Development Policy Review. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/658461468312323813/the-unfinished-revolution-bringing-opportunity-good-jobs-and-greater-wealth-to-all-tunisians

World Bank (2014b). Tunisia: breaking the barriers to youth inclusion. https://www.worldbank.org/content/dam/Worldbank/document/MNA/tunisia/breaking_the_barriers_to_youth_inclusion_eng.pdf

World Bank (2016). Tunisia Poverty Assessment, 2015. http://documents1.worldbank.org/curated/en/871051468103158275/pdf/TUNISIA-PovertyAssessment2015-POST-REVIEW-MEETING-March2016-CLEAN.pdf

World Bank (2017). Impact of Libya crisis on the Tunisian economy. https://openknowledge.worldbank.org/handle/10986/26407

World Bank (2019). Energy Sector Improvement Project. http://documents1.worldbank.org/curated/en/296941561687292260/pdf/Tunisia-Energy-Sector-Improvement-Project.pdf

World Bank (2020a). Overview. https://www.worldbank.org/en/country/tunisia/overview

World Bank (2020b). Tunisia Economic Monitor. http://documents1.worldbank.org/curated/en/194331608565600726/pdf/Tunisia-Economic-Monitor-Rebuilding-the-Potential-of-Tunisian-Firms-Fall-2020.pdf

World Bank (2020c). Human Capital Index. https://www.worldbank.org/en/publication/human-capital

World Bank (2021). National accounts data.

World Economic Forum (2019). The Global Competitiveness Report. http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf

Worldometer (2016) https://www.worldometers.info/co2-emissions/tunisia-co2-emissions/

Where to find out more

Website	www.etf.europa.eu
ETF Open Space	https://openspace.etf.europa.eu
Twitter	@etfeuropa
Facebook	facebook.com/etfeuropa
YouTube	www.youtube.com/user/etfeuropa
Instagram	instagram.com/etfeuropa/
LinkedIn	linkedin.com/company/european-training-foundation
Email	info@etf.europa.eu