

ENERGY POLICIES BEYOND IEA COUNTRIES

Morocco 2019



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Morocco 2019

INTERNATIONAL ENERGY AGENCY

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Foreword

The International Energy Agency (IEA) has conducted in-depth peer reviews of its member countries' energy policies and beyond since 1976. Recently, the IEA has modernised the reviews by focusing on some of the key energy challenges relating to the countries' energy transitions and energy security.

As the IEA has opened its doors to emerging economies, in-depth reviews have come to play an increasingly prominent role in our bilateral collaborations. In 2016, Morocco became an Association country. After a first review in 2014, the government of Morocco's request for a second in-depth review acknowledges the importance of a comprehensive energy policy review to support policy development and to facilitate an exchange of learning, on both sides, from international experience.

It is impressive that Morocco's population now has full access to electricity, one of the key pillars of the United Nations Sustainable Development Goal 7 on energy. Morocco is also leading the deployment of renewable energy in North Africa and the Mediterranean with an impressive track record in developing solar technologies, most notably concentrating solar power (CSP) and hybrid technologies with solar photovoltaic at the world's largest CSP park in Ouarzazate. Morocco has increased the hours of storage in its CSP plants and is investing in new interconnections and market integration with European neighbours, thus ensuring greater security, efficiency and flexibility of the power system.

Morocco is pursuing an ambitious energy transition pathway. More investments will be needed from both the private and public sectors to meet its renewable and energy efficiency targets. We can commend Morocco for phasing out most of the fossil fuel subsidies, beginning to create the basic institutional framework for an effective power market, and setting up the national regulatory authority.

On energy efficiency, it is particularly noteworthy that Morocco has announced its ambitions to scale up its efforts towards 2030, which now have to be rooted in the upcoming National Energy Efficiency Strategy and related action plan. Our report offers insights into how the country can address its electricity sector challenges and design an effective energy efficiency policy, alongside recommendations to promote cleaner transport and mobility.

It is my hope that this second in-depth review will guide Morocco in its energy transition and help it achieve the energy policy goals of providing affordable, secure and clean energy to its population, while adapting to a fast-changing, international energy landscape.

Dr. Fatih Birol

Executive Director

International Energy Agency

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1. Executive summary

Energy and climate policy in Morocco has seen major developments since the first International Energy Agency (IEA) in-depth review (IDR) of the country in 2014 and the IEA Clean Energy Technology Assessment of Morocco in 2016. Since 2014, the government of Morocco has proceeded with energy reforms based on the priorities outlined in its 2009 National Energy Strategy to enhance energy supply diversification; foster the development of Morocco's industry and economy in the sectors of renewable energy and energy efficiency; integrate with regional and international markets; make energy efficiency a national priority; and encourage the development of indigenous resources.

The government has stepped up its role in international action on climate change, ratifying the Paris Agreement, setting a new national climate policy and hosting the United Nations Conference of Parties (COP22) summit in Marrakesh in 2016.

The development of renewables is helping to improve energy security as well as deliver on Morocco's clean energy and climate change commitments. Morocco is making strong progress towards affordable, reliable, sustainable and modern energy in line with the United Nations Sustainable Development Goals (SDG 7). The government has achieved almost full access to electricity for its rural population, and it is developing the country's significant renewable energy resources. However, progress in reducing the energy intensity of Morocco's economy is more difficult to achieve. While the share of renewables in electricity is progressing fast, its share in total final consumption (TFC) decreased considerably over the past decade, given the expanding energy demand. Morocco has only renewable energy targets for electricity. With a view to meet SDG 7, which seeks a substantial increase in the share of renewable energy in the global energy mix (measured in TFC) by 2030, the government is encouraged to set targets for the use of modern renewables in residential and transport. This will strongly promote the reduction of fossil fuel use across the economy. As Morocco continues to rely on coal, oil, and gas imports for most of its energy needs, opportunities abound to reduce imports by developing domestic energy resources to reduce oil and coal use.

In this context, the phase-out of energy subsidies is an important step in encouraging more efficient energy use and reducing GHG emissions. Morocco is to be commended for taking advantage of a period of low oil prices in 2014-15 to successfully phase out fossil fuel subsidies – petrol and diesel fuels are free now (formed by international prices) – with the exception of butane, which remains heavily subsidised.

Climate policy and renewable energy deployment contribute to the development of the economy, attract foreign investment, create employment, and boost its industrial sector. With its ambitious clean energy transition, Morocco is attracting international green finance and is becoming a partner in the Mediterranean region and in Africa. Morocco needs substantial investment in the energy sector in the years ahead, an estimated

USD 30 billion alone is needed to reach its renewable target for 2030. The government is aiming to improve the investment climate to attract private investors to the energy sector. Nevertheless, challenges remain in implementing policies and measures to enhance energy efficiency, in creating an open power market with an independent regulator, and in unbundling the electricity utility ONEE (Office National de l'Électricité et de l'Eau Potable) in favour of an independent transmission system operator.

Institutional reforms supported the implementation of the National Energy Strategy, notably the creation of the national regulatory authority (ANRE) and the Moroccan Agency for Sustainable Energy (MASEN). MASEN acts as a major actor dedicated to the development of integrated renewable energy projects, which create synergies of pre-operational R&D, capacity building, training, industrial competitiveness and local development. The Institute for Research in Solar Energy and Renewable Energies (IRESEN) carries out a broad range of energy RD&D activities in close collaboration with the private sector. The Agence Marocaine pour l'Efficacité Énergétique (AMEE) is now in charge of implementing energy efficiency programmes. Human and financial resources and good co-ordination across government will be critical for tracking progress, delivering the National Strategy, and ensuring the success of Morocco's energy transition. The change in the status of the Energy Investment Company (SIE) as an ESCO adopted at the Board of Directors' meeting on 4 October 2018 progress to be made in the control of energy efficiency for government projects.

Energy system transformation

Under the Paris Agreement, Morocco's government is committed to reducing GHG emissions by 17% below business-as-usual (BAU) levels by 2030. If international support is available, Morocco aims to reduce emissions by an additional 25% by 2030 compared with BAU, taking the total to 42%. This is an ambitious pathway for 2030 and the government is also beginning work on a long-term low-carbon development strategy to 2050. Thanks to the appropriate implementation of the national energy strategy and the enthusiasm of private investors and developers for renewable energy projects, the government has increased its ambitions over time.

Morocco has excellent prospects for the cost-effective expansion of the share of renewables in and beyond the power sector, to replace oil and coal use and move to sustainable industrial growth. The National Energy Strategy of 2009 envisaged an expansion of renewable electricity to a share of 42% of installed capacity by 2020, an ambition which was raised in 2015 to 52% by 2030. Today, Morocco aims to reach beyond 52%.

The MASEN tenders attracted private developers and investors to invest in renewable energy projects through a model of public debt, state guarantees, and concessional loans. New financing models and the diversification of financing sources (green bonds) are critical to boost private investment and commercial bank loans. The country has made good use of the best available technologies in its large-scale concentrated solar power (CSP) projects, and pioneers innovative hybrid solutions, with photovoltaic and thermal solar storage. Moreover, the prospects for renewables will benefit from cutting-edge technologies such as battery storage, hydrogen technologies and waste-to-energy or desalination plants powered by renewables.

The government is to be commended for the work done so far to open the electricity market to competition and investment in renewables. A regulatory framework to allow grid access has been established by law, notably with the creation of the National Electricity Regulatory Authority (ANRE) in 2016 and the appointment of its Director in 2018. The privatisation of electricity distribution in large cities has improved efficiency. Further progress will depend on the regulatory authority being empowered to engage more broadly with the distribution sector, which is largely public, on access to the grid, grid codes, and a clear roadmap for tariff design and reforms.

A national policy priority since 2009, energy efficiency is perhaps the policy area that is facing the most significant implementation challenges. From an institutional perspective, it requires close collaboration between several ministries and good overall co-ordination as well as adequate budgetary allocations for energy efficiency programmes. Residential electricity demand (cooling, appliances and cooking) is expected to drive future energy use, thus, new policies and compliance and implementation of existing policies remain critical. Total final energy consumption has increased by 32.4% since 2006. In the light of this fast growth, Morocco targeted initially energy savings of 12% for 2020 and of 15% for 2030. The National Energy Efficiency Strategy for the period out to 2030 was presented to the Council of the Government on 22 June 2017, complemented by an action plan of AMEE. The government will also look at revising the implementing rules of the Law 47-09 on Energy Efficiency and boost the public procurement of energy services. In the light of the new strategy and related action plan, the government aims to scale up the target for 2030 to 20%, which is a strong commitment to a more robust energy efficiency programme: the challenge now is to deliver on it.

Morocco has been able to transition to more efficient products and appliances, thanks to its ban of the import of old cars, improved thermal regulations for new buildings, and local awareness raising initiatives such as the Green Mosque Programme, which targets the promotion of increased energy efficiency and increased use of renewable energy in Mosques and other public buildings. Current energy efficiency measures will however not be enough to meet energy and climate objectives. Turning AMEE into a fully-fledged energy efficiency agency, equipped with programmes and financial resources, will make a step change. A new energy efficiency programme is being developed by the government in consultation with several key ministries and AMEE, which presents an opportunity. The government should swiftly implement actions for 2020 and present the National Energy Efficiency Strategy 2030.

Energy security

Heavy reliance on imports for all fossil fuels has clear implications for Morocco's energy security and on its economy. Morocco's energy mix is composed largely of fossil fuels, which account for almost 90% of total primary energy supply (TPES) and 80% in electricity supply. Oil accounted for 62% of TPES in 2017, followed by coal (22%) and natural gas (5%). The country's energy import bill rose to MAD 69.5 billion in 2017 (USD 7.3 billion, EUR 6.3 billion). To date, indigenous production is negligible but the oil and gas exploration programme managed by the *Office National des Hydrocarbures et des Mines* (ONHYM) promotes upstream investment. The discovery of gas in the Tendirra permit area by the United Kingdom's Sound Energy and the offshore deepwater exploration by Italy's Eni are promising developments.

Besides crude oil imports, Morocco is now importing all of its oil products needs. In 2015, the only remaining oil refinery in Morocco, Samir, was placed into judicial liquidation. The non-use of oil product storage facilities of the Samir refinery, together with the non-respect of oil distributors to comply with their oil products stockholding obligations for several years, points to the need to improve oil products security. The government introduced oil products stockholding obligations on industry decades ago, but compliance has been low in spite of the different financing mechanisms (levies, taxes, etc.) used in the past. The closure of the country's only refinery, Samir, has clear implications for the security of oil supply. Morocco's exposure to global supply chain risks is thus increasing, and its stock cover falls far below the legal requirements for all products. The government is to be commended for working to increase oil products storage capacities and for its monitoring mechanism of all oil products supplies, including the quantity and quality of the products. In order to strengthen oil security arrangements, the government needs to improve oil stocks data collection, while securing the future use of oil storage tanks at the Samir refinery and improving the resilience of port infrastructure.

Supplies of natural gas from Algeria will depend on the decision that will be taken to maintain the arrangements on the Maghreb–Europe Gas Pipeline and extend the current contract beyond 2021. Morocco plans to expand the share of natural gas in the longer term. Several new gas supply routes are being discussed, including imports of natural gas from a gas pipeline with Nigeria, and the construction of an LNG terminal, which can provide access to contract and source flexibility. The investment case would need to be justified by volumes much higher than the current gas demand in Morocco of over 1 bcm/y in 2017. The regulatory framework, which forms a fundamental basis for all actors in the sector, will be crucial for the business case. The Government's draft law on gas has been submitted to the General Secretary of the Government.

Electricity demand is expected to grow on average by 5% per year to 2021, notably peak demand amidst hotter summers and growing cooling needs. While capacity margins are robust at 10%, the power system has to withstand seasonal droughts and rising peak demand in summer (with high demand from air conditioners). As larger shares of the population are increasing electricity use, Morocco is likely to face a more important rise in demand from air conditioners and appliances in the future and the quality and stringency of energy efficiency standards for products and demand-side management will play a critical role in managing peak demand in a sustainable and climate-friendly manner.

Commendably, Morocco's power system has strong flexibility options, thanks to pumped storage hydropower, CSP plants with integrated storage and power imports (which have doubled over the past ten years). Morocco is planning a third interconnector with Spain and a new one with Portugal. However, power system balancing needs will increase, with the share of variable renewables expected to rise to 15% by 2030 in electricity generation as a result of the government's ambitious wind and solar programmes. There are opportunities to increase power system efficiency and remove constraints on operations. The government should support ONEE in improving the independent system operation and balancing, with more demand-side response, flexible thermal power plants, and more investment in grids and interconnections. ONEE is encouraged to develop energy system-wide planning, under the guidance of ANRE, in co-ordination with MASEN and other stakeholders, to improve the common vision for the medium-term power sector outlook.

Morocco is making inroads in addressing the socio-economic impact of climate change given its exposure to water scarcity, coastal storms, and erosion. The focus has been on agriculture, fisheries, and tourism with a range of solar energy applications (cooling, solar water pumps in agriculture). A major improvement comes with the installation of dry cooling technologies in the new CSP plants. The government should assess overall progress in addressing the energy-water nexus to improve the resilience of energy infrastructure (ports, grids, and power plants).

International and regional energy partnerships

Morocco, an active international energy partner, has developed a broad range of partnerships, with a focus on energy transitions, renewable energy, climate change, and regional trade. Morocco has been able to attract climate finance and technical assistance. Commendably, the government is active in advancing regional market integration with Europe and Africa.

At the COP22, Morocco held the Africa Action Summit that brought together African heads of state which led to the establishment of three dedicated sub-regional committees: the Sahel Region, the Island States Commission, and the Congo Basin Commission. As a member of both the League of Arab States and the African Union, Morocco's engagement with Africa offers perspectives for South-South cooperation, trade and economic development. Based on its close bilateral and multilateral co-operation (with the African Energy Commission and Economic Community of West African States), Morocco can draw on its own energy transition experience with a view to supporting clean energy transitions in the countries of Sub-Saharan Africa, supporting their sustainable development, energy access, and resource development.

Morocco wants to establish links with the energy markets of oil-rich and gas-rich African countries, and it concluded an agreement with Nigeria for the construction of a gas pipeline. Equally, Morocco seeks to facilitate the trade in renewable electricity (and hydrogen) with Europe and its regional neighbours in Africa. The roadmap for sustainable electricity trade between Morocco and the European internal energy market was signed between Morocco and Germany, France, Spain and Portugal on 19 December 2018 in Brussels. With Africa, regional collaboration opportunities may arise with the creation of the West African Power pool.

Key recommendations

The government of Morocco should:

- Drive the implementation of the country's clean energy transitions and increase private investment in clean energy by completing electricity and gas market reforms and by making operational the planned regulatory authority.

- Make energy efficiency a priority by implementing existing legislation, adopting cost-effective energy efficiency policies and standards, and moving quickly to agree and implement a national energy efficiency strategy for 2030 to deliver the government's 2030 targets, supported by the financial resources necessary to deliver it.
- Strengthen energy security to manage risks from import dependency by revising policies for oil stockholding, taking steps to secure future natural gas imports and to strengthen power system operation and energy system planning in a system with higher shares of variable renewables.
- Accelerate renewable technology development and innovation beyond the power sector to drive sustainable cooling and heating, transport, and water management.
- Focus on ensuring effective governance and inter-ministerial co-ordination, on prioritising the most important and urgent actions, and on ensuring that planned commitments are translated into delivery on the ground, underpinned by analysis to identify the most cost-effective solutions and data to measure progress.

2. General energy policy

Key data

(2017)

TPES: 20.5 Mtoe (oil 62.0%, coal 21.7%, biofuels and waste 6.5%, natural gas 5.0%, electricity 2.5%, wind 1.3%, hydro 0.5%, solar 0.5%), +32% since 2007

TPES per capita: 0.57 toe/cap (IEA average: 4.1 toe)

TPES per unit of GDP: 77 toe/USD million PPP

Total final consumption (TFC): 16.1 Mtoe (oil 74.1%, electricity 17.3%, biofuels and waste 8.1%, natural gas 0.4%, coal 0.1%), +34% since 2007.

Energy production: 1.9 Mtoe (biofuels and waste 71.3%, wind 13.9%, solar 5.8%, hydro 5.4%, natural gas 3.3%, crude oil 0.2%), -8% since 2007

Exchange rate: 1 Moroccan Dirham (MAD) = EUR 0.09 = USD 0.11 (as of 16 May 2018)

Country overview

The Kingdom of Morocco (hereafter Morocco) is located in northwest Africa, with coastlines on the Mediterranean Sea and the Atlantic Ocean. The capital is Rabat. As of 2017, Morocco's population was 34.8 million, and the largest city, Casablanca, had a population of nearly 4 million. Other major cities are Agadir and Kenitra, on the Atlantic coast; Tangier, Tetouan, Nador, Oujda and Fes in the north; and Marrakesh in the interior.

Political system

Morocco is a monarchy with a constitution and an elected parliament. The current monarch, King Mohammed VI, is both the commander-in-chief and spiritual leader, while executive power is vested in the government led by the Prime Minister and the Cabinet. A bicameral Parliament (House of Representatives and the House of Councillors) exercises legislative power. In 2011, King Mohammed VI introduced constitutional reforms that gave more power to elected politicians, in the wake of the so-called Arab Spring in the region. Nevertheless, the King retains ultimate control over many instruments of government. The October 2016 parliamentary election saw the Islamist Party of Justice and Development (PJD) win, but short of an overall majority. After a period of 6 months, the coalition government was formed in April 2017 with a comfortable majority of 240 seats out of 395 in the House of Representatives.

The economy

Between 2007 and 2017, the economy grew at an average annual rate of 3.9%. Economic growth is projected to be 3% in 2018 down from 4% in 2017, and up from 1.2% growth in 2016 when the agriculture sector suffered a severe drought (World Bank, 2018a and 2017). In 2018, Morocco had a gross domestic product (GDP) of USD 121 billion in current prices (IMF, 2018). The general consensus is that the economic outlook for Morocco over the medium to long term is positive, provided the government can sustain its commitment to progressive macro-economic reforms (World Bank, 2018b).

The government is implementing the vision of King Mohammed VI for a new economic growth model, while continuously pursuing the reforms started under the previous government, most importantly the programmes that focus on social protection and reducing economic disparities across Morocco.

Thanks to the country's improved business climate and the development of its infrastructure, ports and railways, Morocco has attracted significant levels of FDI compared with the rest of the region and the continent. The renewable energy sector has drawn large FDI supported by funding and advice from international financial institutions such as the African Development Bank, EIB and EU funds, the World Bank (for instance through the Clean Technology Fund) and IFC as well as from national agencies as German KfW and GIZ, and Agence Française de Développement.

In 2017, a new investment charter set out Morocco's Industrial Acceleration Plan. This includes plans to develop the industry sector (including automotive) through an influx of foreign direct investment, joint ventures, and local industrial integration, building on the experience of the renewable energy sector.

Improvements in the government investment-saving balance and the fall in global oil prices led to significant reductions in both current account and fiscal deficits in recent years. With continuous inflows of foreign direct investment (FDI), Morocco's foreign exchange reserves rose to reach the equivalent of 6.4 months of imports of goods and services by the end of 2016. With an exchange rate pegged to a basket of euro and US dollar, inflation stayed below 2% throughout 2016 and is expected to remain stable. The removal of subsidies on most energy products which started in 2013, when oil prices were low, has helped the government achieve fiscal stability and reduce debt. The completion of subsidy reforms, coupled with solid fiscal management and stringent financial oversight, contributed to reducing the fiscal deficit to 3.5% of GDP in 2017 as well as stabilising public debt at around 65.1% of GDP (in line with plans to reach 60% in 2021).

The services sector accounted for just over half of GDP in 2017. Agriculture represents roughly 15% of GDP and employs just over 40% of the population, with other key sectors being manufacturing, mining, and construction. Morocco's geographical position gives it ready access both to Europe and to the African continent, and it is working to expand its industrial, manufacturing and transport sectors to serve key markets in both.

Morocco relies on imports for almost all of its energy requirements, in the form of oil, natural gas and coal. Such heavy reliance on fossil fuel imports has prompted a strong drive by the government to reduce imports, switch to renewable energy sources and to launch energy efficiency policies in the face of higher demand in a growing economy.

International energy and climate relations

The 22nd Conference of the Parties to the United Nations Framework Convention on Climate Change (COP22 of the UNFCCC), held in Marrakech in November 2016, marked Morocco's increasing presence in the global arena, its leadership in the deployment of clean energy technologies, and its role as an advocate for Africa and for least developed countries. Conscious of the magnitude of challenges faced by the African continent, Morocco is now pursuing several co-operation initiatives, including the creation of excellence centres to serve African countries in the energy and climate fields.

As a member of both the League of Arab States and the African Union, its strong engagement with Africa has potentially many opportunities for trade and economic development, not least in the field of energy. Morocco's stated ambition is to be a locomotive for growth in the African continent and act as a bridge between Europe and Africa, turning itself into a regional energy hub. From an energy perspective, Morocco wants to establish links with the energy markets of oil-rich and gas-rich African countries, and it has recently concluded an agreement with Nigeria for the construction of a gas pipeline.

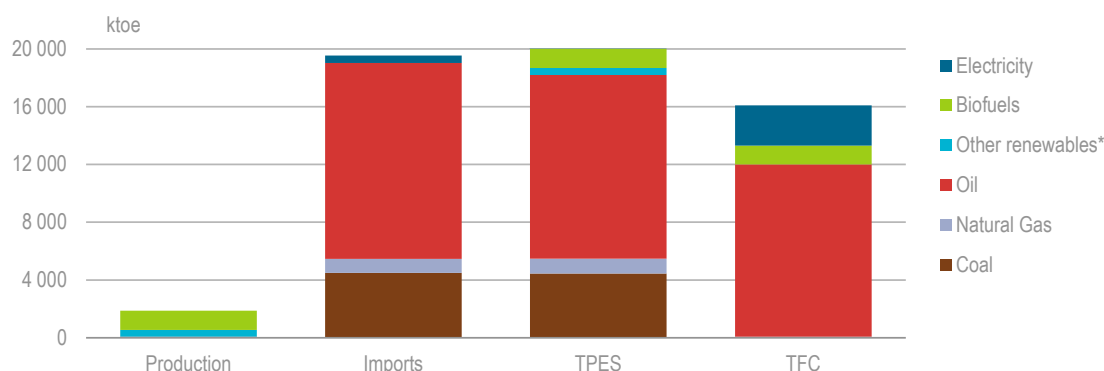
Morocco wants to draw on its own knowledge and experience with a view to support the clean energy transition in countries of Sub-Saharan Africa. With its abundant renewable resources, Morocco seeks to integrate its electricity markets and foster power trade with Europe and Africa for the benefit of greater system integration of variable renewables. Moreover, Morocco is also studying the possibility of producing hydrogen and exporting it to Europe on top of using it for its own needs, notably the production of fertilisers.

The government has stepped up its international energy relations, entering into several bilateral partnerships with France, Germany, the EU and its Mediterranean neighbours. Morocco signed an Association Agreement with the European Union (EU) in 2000, and benefits from EU funds and assistance under the European Neighbourhood Policy (ENP) and the related European Neighbourhood Instrument (ENI), the most important being financing of renewable energy projects. Under this ENI, France and Germany put forward an EU twinning programme for Morocco that was activated in April 2018 and officially initiated in July 2018.

In November 2016, Morocco became an IEA Association country alongside the People's Republic of China (China), Indonesia, Thailand, and Singapore. In June 2017, Morocco and the IEA signed a three-year Joint Programme of Work to deepen bilateral co-operation in the areas of energy security, energy efficiency, renewable energy, capacity building and data and statistics. The work programme is tailored to Morocco's specific needs as it transitions to a low-carbon economy.

Energy supply and demand

Morocco's energy sector is highly carbon-intensive, with fossil fuels accounting for almost 90% of total primary energy supply (TPES). Oil remains the strongest driver of TPES growth, accounting for 62% of TPES in 2017, followed by coal (22%) and natural gas (5%). Almost all fossil fuels are imported, and this heavy reliance on energy imports has clear implications for Morocco's energy security.

Figure 2.1 Overview of energy production, TPES and TFC by fuel, 2017

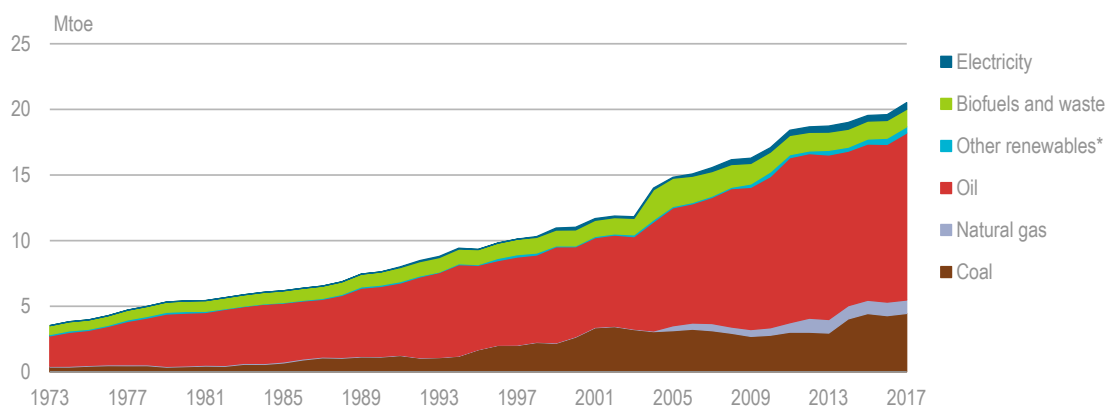
*Other renewables include hydro, wind and solar.

Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

Primary energy supply

As figure 2.2 shows, total primary energy supply (TPES) in Morocco reached 20.5 million tonnes of oil-equivalent (Mtoe) in 2017, a 32% increase from 15.6 Mtoe in 2007. TPES has grown on average 2.4% annually over the last decade in line with the overall economic growth of the country.

The gross supply of fossil fuels saw a 37% growth from 2007 to 2017. A significant increase of natural gas supply (87%) was supported by large imports from Algeria between 2005-12. Gas use, however, plateaued after 2012 at around 1.22 billion cubic metres per year (see Chapter 9 on Natural Gas). The remainder of TPES consisted of biofuels and waste (7%), electricity imports (2%), and small shares of hydro, wind and solar (2% together). Renewable sources are however growing rapidly from a low base. Over the past decade, hydro grew by 29%, while solar and wind together increased 15 times. The supply of biofuels and waste declined by 29%.

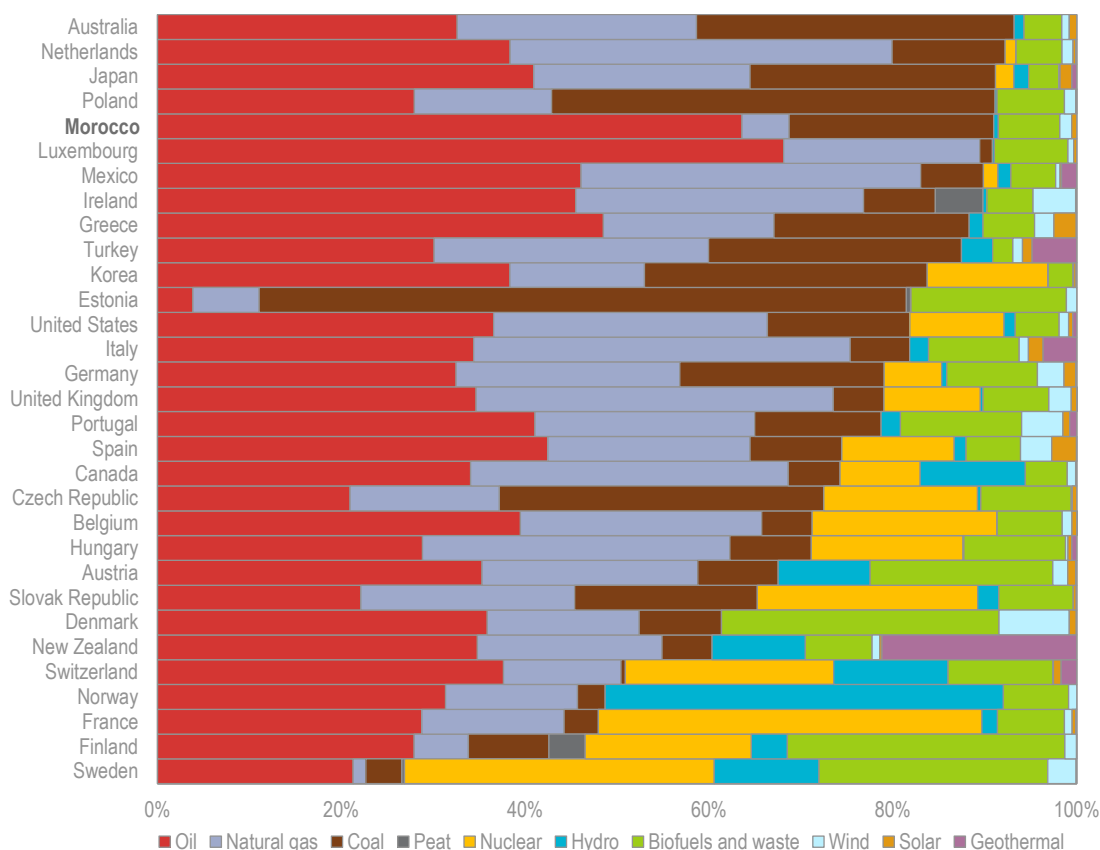
Figure 2.2 TPES by source, 1973-2017

*Other renewables include hydro, wind and solar.

Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

As Figure 2.3 shows, in 2017 Morocco had the fifth-highest share of fossil fuels in TPES when its share is compared with that of the 30 IEA countries. This rank is similar to the 2014 review.

Figure 2.3 Breakdown of TPES in IEA member countries, 2017

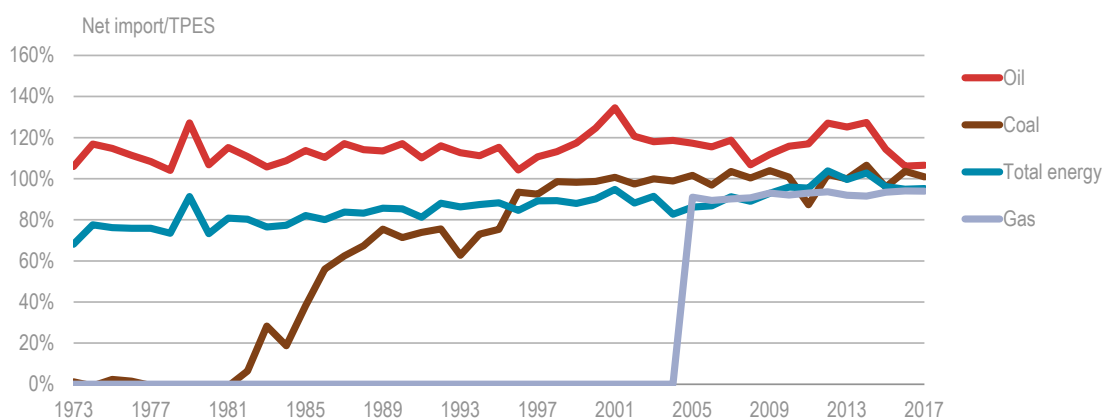


*Estonia's coal is represented by oil shale.

Note: Electricity imports or exports are not included.

Source: IEA (2018a), *World Energy Balances, 2018*, www.iea.org/statistics/.

Figure 2.4 Import dependency by fuel, 1973-2017



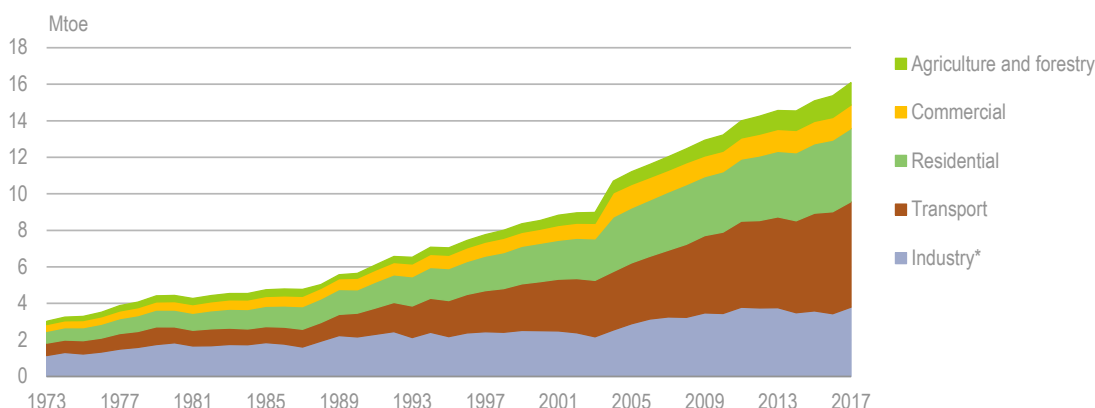
Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

As Morocco does not produce any coal or oil and only a small amount of gas, Morocco is very heavily dependent on energy imports (see Figure 2.4). In 2017, total energy imports of Morocco stood at 19.5 Mtoe, equivalent to 95% of TPES. Electricity imports have also grown by 73% over the last decade, notably to match demand peaks.

Energy consumption

Morocco's total final consumption (TFC) reached 16.1 Mtoe in 2017, a 34% increase from 12.06 Mtoe in 2007. TFC is largely dominated by three sectors – transport (36%), residential (25%) and industry (24%), which together account for over four-fifths of TFC. These are all sectors with high growth rates. Since 2007, the transport sector has grown by 58%, residential by 26% and industry by 16%.

Figure 2.5 TFC by sector, 1973-2017



*Industry includes non-energy consumption.

Note: Change in data definitions for oil consumption led to a break between residential and commercial in 1978.

Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

Oil remains the dominant fuel, accounting for 74% of total consumption in 2017, followed by 17% from electricity. While biofuels and waste constitute the third largest source of TFC, accounting for 8%, their consumption has declined by 30% from 2007 to 2017. Over the same period, the consumption of electricity rose by 58%, oil by 43% and natural gas by 215%. Road transport accounted for the majority of transport energy consumption, for which diesel made up 87% and gasoline the remaining 13% in 2017.

Institutional framework in the energy sector

The Ministry of Energy, Mines, and Sustainable Development (*Ministère de l'Énergie, des Mines et du Développement Durable*, MEMDD) has primary responsibility for Morocco's overall energy policy and is in charge of safeguarding security of supply, setting rules for energy markets, and managing the low-carbon transition by promoting energy efficiency and renewable energy. It also has responsibility for authorising and supervising energy projects. ONEE, MASEN and other energy sector agencies (AMEE, IRESEN) report to the MEMDD.

The Ministry of General Affairs and Governance is the administrative authority responsible for price and competition policy in Morocco, which also regulates electricity and fuel prices. Before final approval, the proposed tariffs are reviewed by an inter-ministerial tariff committee that includes the Ministry of Economy and Finance and the MEMDD.

The Ministry of Interior is responsible for the organisation, policy, control and oversight of the electricity distribution (and water/sanitation) companies, the seven public municipal water and electricity distribution companies in large urban areas, the so-called *régies autonomes* and the Ministry has oversight of the four private distribution companies, the so-called delegated authorities.

The Ministry of Economy and Finance oversees the financial side of the energy sector. It approves the investment plans of state-owned utility ONEE (see below) and other state-owned entities.

The Ministry of Industry, Investment, Trade and Digital Economy is indirectly involved in the implementation of energy policy, as the Ministry i) designs and implements industrial strategies (i.e. through local content components), and ii) works to enhance the competitiveness of Moroccan industry, including through efficiency improvements.

The Ministry of Equipment and Transport is responsible for policies related to the transport infrastructure: roads, highways, railways, airports and ports. These policies can influence energy consumption in the transport sector.

The National Agency for Electricity and Water (*Office National de l'Électricité et de l'Eau Potable*, ONEE) is the state-owned vertically integrated utility that owns the transmission network and generation assets. It acts as a single buyer of electricity generated by other parties, it imports electricity and is responsible for electricity distribution (either directly or through private and public distribution companies). The planned restructuring and unbundling of ONEE is ongoing, and ONEE has to transfer its renewable energy assets to the newly created MASEN.

The National Authority for Electricity Regulation (*Autorité nationale de régulation de l'électricité*, ANRE) was created in August 2018 – in accordance with Law 48-15, adopted in 2016 – with a mandate to organise the open and competitive segment of the electricity sector. The Director of ANRE has been appointed. (The Ministry of General Affairs will remain responsible for tariff setting in the regulated segment of the electricity market). ANRE's functions will include regulating access to networks, setting the tariffs for the utilisation of transmission and medium-voltage grid and ensuring the efficient functioning of the market.

The National Agency for Energy Efficiency (*Agence marocaine pour l'efficacité énergétique*, AMEE) is in charge of implementing Morocco's energy efficiency policy. In 2016, it replaced the previous National Agency for Renewable Energies and Energy Efficiency (ADEREE), the successor of the Center for the Development of Renewable Energy in 2010.

The Institute for Research into Solar and Renewable Energies (*Institut de Recherche en Énergie Solaire et Énergies Nouvelles*, IRESEN) was created in 2011 as one of the main RD&I bodies for energy. IRESEN is responsible for identifying research priorities

and projects in the fields of renewable energy and energy efficiency. In addition to financing and implementing research and development projects, it also disseminates research findings and promotes their effective use by businesses.

The Moroccan Agency for Sustainable Energy (MASEN) is a limited company with public shareholders and responsible for leading and managing the deployment of renewable energy. MASEN develops integrated projects at the technical, economic and financial level, and coordinates activities through a one-stop-shop. It was previously responsible only for implementing the national solar power plan, but in 2016 its responsibilities were extended to the promotion of all renewable energy technologies. MASEN contributes to the emergence of a national renewable energy industry through training and capacity building, local development and industrial integration, pre-operational research, development and demonstration (in pre-operational phases) in Morocco's renewable energy sector, including in Africa and beyond. The mission of MASEN also includes the promotion and development of renewables at the African continental level and beyond.

The National Office of Hydrocarbons and Mines (*Office national des hydrocarbures et des mines*, ONHYM) is responsible for managing upstream hydrocarbon resources.

The Moroccan Limited Company of the Refining Industry (*Société Anonyme Marocaine de l'Industrie du Raffinage*, SAMIR) was processing, producing and supplying refined oil products until it was shut down and placed under receivership in 2016-17.

Energy data

As an IEA Association country, Morocco submits annual energy statistics to the IEA. The collection and use of energy statistics in Morocco is based on the following legal provisions:

- National Statistical Law of 1968
- Law No. 1-72-255 (1973) on the import, export, refining, recovery in refinery and filling station, storage and distribution of hydrocarbons; and Decree No. 2-72-513 (1973) implementing this law. In September 2011, Decree No. 2-11-355 amended and supplemented the implementation Decree No. 2-72-513
- Draft Law No. 109-14 concerning the National Statistical System
- Draft Law for the collection of energy statistics and related secondary legislation (under preparation).

Morocco does not have a law allowing the collection of data from private enterprises. However, there is a constitutional right allowing access to private data by government administrations, ministries and departments. The organisations that collect data relevant to the energy sector include:

- High Commission for Planning
- Ministry of Energy, Mines and Sustainable Development
- Ministry of Economy and Finance
- Ministry of Industry, Investment, Trade and the Digital Economy, and
- MASEN.

A system for developing energy efficiency indicators has been established in Morocco in collaboration with the French environment and energy management agency ADEME (ADEREE, 2013). At present, the Directorate of Observation, Cooperation and Communication within MEMDD compiles every year energy efficiency indicators for all sectors using the energy balance and the results of sectoral energy consumption surveys. About 30 indicators have been developed (see Chapter 4 on Energy Efficiency).

MASEN collects, produces and monitors data related to renewable energy, including data on i) renewable energy resource mapping; ii) existing and planned power generation capacity from renewable energy sources (on the basis of the multi-year programme developed by the national system operator), and iii) the performance of renewable energy plants.

National Energy Strategy and policy objectives

In 2009, Morocco adopted a National Energy Strategy as a roadmap for the transition to a low-carbon energy system that reconciles economic development and social and environmental objectives. The Energy Strategy set five priorities for the energy policy of Morocco: they relate to the development of a diversified and optimised energy mix; the mobilisation of domestic resources, including the use of renewable energy (wind/solar); making energy efficiency a national priority; stronger regional co-operation with Europe's and Africa's energy markets; and industrial integration, which promotes the development of local industrial capabilities at all levels of the green technology value chain (see Figure 2.6).

Figure 2.6 Strategic objectives of Morocco's energy policy



Source: SIEM (2009).

Since then, several aspects of the energy strategy have been updated:

- Morocco is pursuing an ambitious climate change policy based on the Climate Change Policy (March 2014), the National Sustainable Development Strategy (November 2017), and the Nationally Determined Contribution (NDC) submitted to UNFCCC when Morocco ratified the Paris Agreement on 21 September 2016. By 2030, Morocco has committed to reducing greenhouse gas (GHG) emissions across the entire economy by 17% below BAU levels, and to reducing them by an additional 25%, conditional on international support.

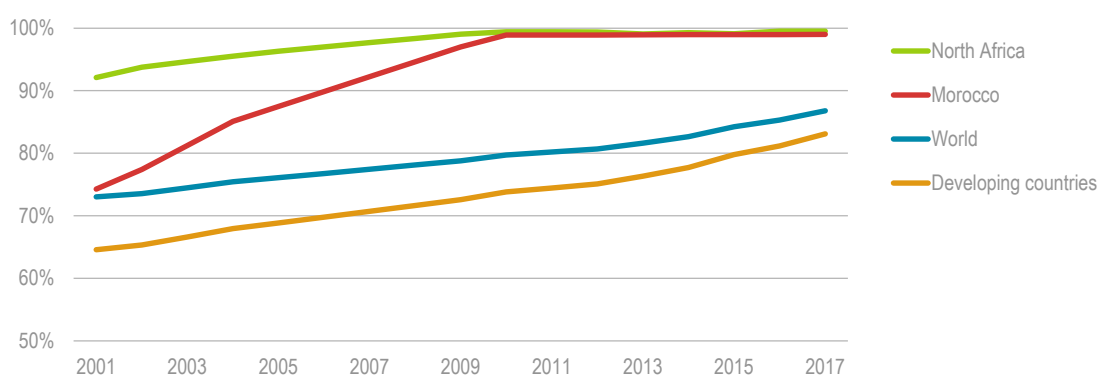
- The renewable energy objectives have become more ambitious: the 2030-target envisages at least 52% of installed power capacity from renewable sources (see Chapter 5).
- Energy savings of 5% by 2021 are envisaged and 15 to 20% by 2030, in particular through the implementation of a new energy efficiency plan across the economy, notably industry, transport and buildings. The agency for energy efficiency, AMEE has identified an energy savings potential of 25% by 2030.
- Significant investment is being deployed in the field of energy technology research and development and innovation (RD&I) (Chapter 6); and
- Natural gas is seen now as an important component of the future power mix, and the aim is to increase its share with the installation of an additional 2400 MW of capacity of combined-cycle technology by 2030.

Sustainable development of Morocco

In line with United Nations' Sustainable Development Goals (SDGs) and the target to ensure access to affordable, reliable, sustainable and modern energy for all – known as SDG 7 - , Morocco progressed access to electricity and clean cooking (SDG 7.1) as well as SDG targets on renewables (SDG 7.2) and energy efficiency (SDG 7.3).

Morocco has made impressive progress in electrification. In 2018, the share of the rural population having access to electricity reached 99.43%, compared with just 48.1% in 1990 (Figure 2.7). As part of the successful energy access programme, Morocco has achieved the modernisation of the existing power system. The challenge now is to upgrade the system to drive economic activities (especially in remote rural areas) and improve quality of life and affordability. Access to clean cooking in Morocco stood at 98.5% in 2017, thanks to a subsidy programme, which however, comes at a significant cost for the finances of the Kingdom.

Figure 2.7 Access to electricity in Morocco, North Africa and the world, 2001-17



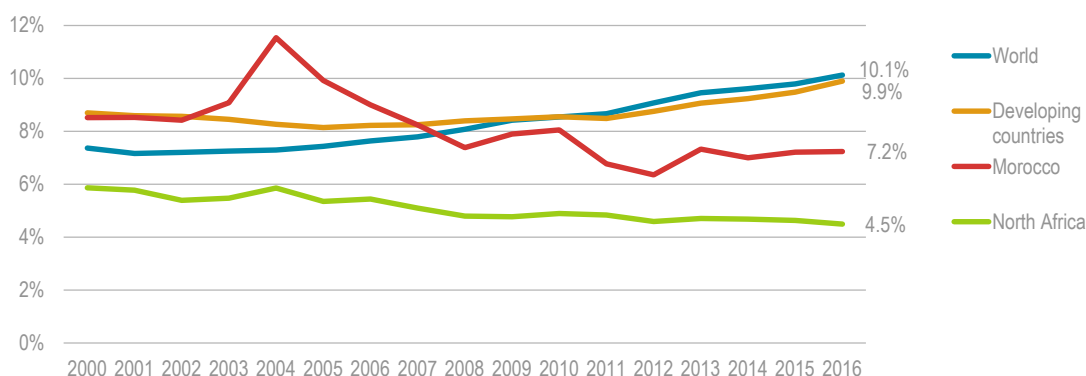
Note: Population is defined as villages not people.

Source: IEA (2018b), *World Energy Outlook, 2018*, www.iea.org/statistics/.

At global level, the growth of modern renewables, which excludes the traditional use of biomass, has outpaced the increase of energy consumption in recent years. This has resulted in an increase in the share of modern renewables in total final energy consumption, reaching over 10% in 2016. In 2016, Morocco has achieved a share of 7.2% of renewable energy in total final consumption (TFC), much above regional averages in North Africa (4.5%), and close to global trends. Amid rising energy demand, the penetration of renewables in sectors beyond electricity generation, in heat and transport, can increase the share of RES in overall TFC (see Figure 2.9).

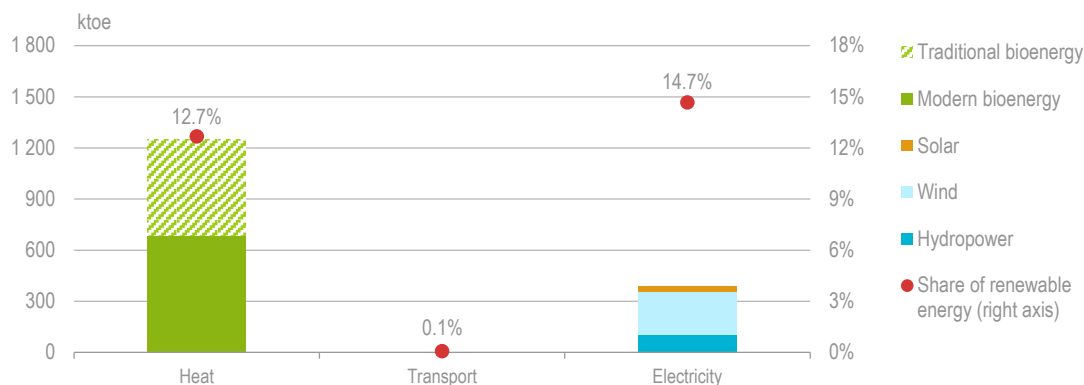
Thus, Morocco still has untapped potential to boost the role of RES through sector coupling, including the greater electrification of transport and end-uses. Morocco is also encouraging the deployment of renewable energy generation to accompany development of rural and isolated areas, notably through local content policy and joint ventures or other partnerships.

Figure 2.8 Renewable energy as a share in total final consumption, 2000-16

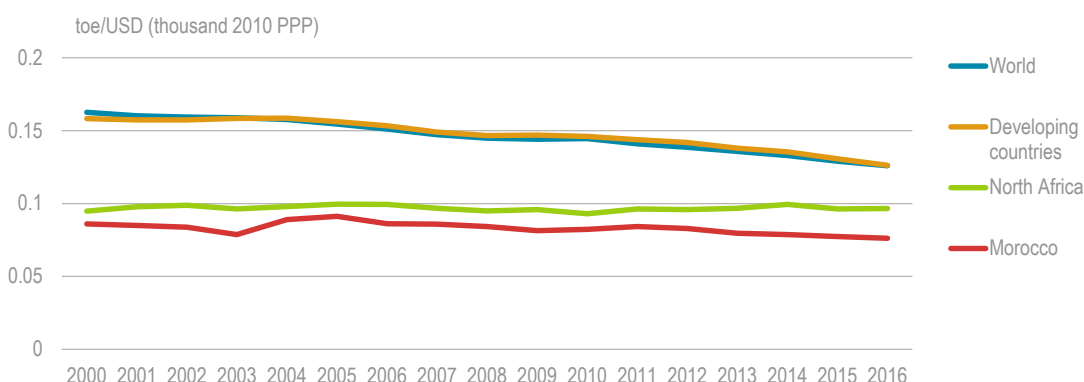


Source: IEA (2018a), *World Energy Balances*, 2018, www.iea.org/statistics/.

Morocco aims to foster the integration of rising shares of variable wind and solar PV in the power system, while at the same time ensuring the availability of sufficient generation capacity to meet its energy needs, making use of imports as well as demand side participation. Strengthening the power grids and making current thermal plant contracts more flexible can boost the flexibility of Morocco's power system. Higher shares of renewable electricity also create opportunities for greater electricity use in other key end-use sectors, like transport, buildings, and agriculture (particularly as regards water management). The use of renewable energy in sectors beyond electricity is progressing. Examples include solar water pumps used in agriculture and a desalination project using solar PV and solar thermal technologies, commissioned in 2016. Pursuing such examples would enable even greater use of renewable energy across the economy via increased electrification of different sectors.

Figure 2.9 Renewable energy supply by sector and source, 2016

Source: IEA (2018a), *World Energy Balances, 2018*, www.iea.org/statistics/.

Figure 2.10 Energy intensity (primary energy per GDP), 2000-16

Note: GDP in 2010 USD prices and PPP (purchase power parities).

Source: IEA (2018a), *World Energy Balances, 2018*, www.iea.org/statistics/.

In 2016, in Morocco, energy intensity stood at 0.08 toe per 1000 USD GDP, and progress has been slower than targeted and below the regional Northern Africa average (0.097 toe/1000 USD of GDP) but much in line with global energy intensity, defined as the ratio of primary energy supply to GDP¹. The world has fallen short of its goal of an annual reduction of 2.6% until 2030. The required global rate of intensity improvement has risen to 2.7%. This trend is expected to continue, because the rate of improvement in energy intensity slowed to around 1.7% in 2016.

Subsidy reforms

During 2013-15, the government has made a significant effort to phase out subsidies for fossil fuels. Since December 2015, the prices for most refined products are now free

¹ Note: Morocco tracks progress towards the energy efficiency in the share of energy use in total primary energy supply (TPES).

(and follow international prices). Butane gas, largely used by households and agriculture, remains subsidised. A 12-kg bottle was priced at MAD 40 (around EUR 3.60) in 2018 (Caisse de Compensation, 2018), whereas the market price would be MAD 96.64. In 2017, the energy subsidy bill stood at MAD 9.9 billion, (nearly EUR 1 billion), up from MAD 7.1 billion in 2016 (due to the increase in international oil prices and higher consumption), constituting a significant strain on the national budget.

The government intends to reform this subsidy system and limit the subsidy to only low-income households in the future. However, the reform of the subsidy on butane has proved difficult to effect because of the social and political ramifications of such a move. The government is also concerned about possible deforestation if consumers switch from butane to wood for cooking. It has started creating a country-wide database of households and their payment capacity, as a first step towards phasing out the subsidies for butane and introducing targeted support for the most vulnerable consumers. AMEE is also considering the deployment of electric cooking based on distributed PV (on and off grid) in an EU-supported project with the IEA.

Electricity tariffs have increased since 2014 but remain below generation costs for some consumer groups, with households paying between 0.9 and 1.44 MAD per kWh depending on monthly consumption levels (social tariff scheme). After the merger of the water and electricity companies under ONEE in 2011, there is considerable cross-subsidisation between water and electricity. Reducing the remaining subsidies and cross-subsidies between different consumer groups is, however, politically challenging.

Assessment

The government of Morocco is committed to a clean energy transition along the lines of the 2009 National Energy Strategy and to Morocco's ambitious climate targets set out in its Nationally Determined Contribution (NDC) under the Paris Agreement. As Morocco is implementing its targets, challenges abound with regard to the cost-effective implementation of the targets, the regulatory framework for investment, the institutional governance, and the capacity to maintain and grow public and private investment in the energy sector.

The National Energy Strategy adopted in 2009 provided a road map for the transition to an energy future with greater energy security and lower carbon emissions in an effort to reduce dependence on imported energy. Its objectives included enhancing energy supply security; diversifying and optimising the electricity fuel mix; accelerating the deployment of renewables; making energy efficiency a national priority; and encouraging the exploration and exploitation of indigenous oil and gas.

The first IEA In-depth review of Morocco's energy policy in 2014 judged that the 2009 energy strategy "went very much in the right direction", and noted that major progress had been made, and important reforms taken in hand. Since 2014, the government has adopted ambitious energy and climate targets and policies for the horizon to 2030 with a view to strengthen the sustainable development of the country, building on these strong foundations.

The benefits of energy efficiency and renewables development in terms of reduced costs, reduced carbon emissions and greater energy security remain as strong as they

were, as do the arguments for greater diversity of types and sources of energy, and the potential scope for new jobs and competitiveness gains. The 2009 strategy remains central to the implementation of Morocco's post COP 21 climate change commitments. Therefore, the strategic orientations of the Moroccan energy policy set out under the 2009 Strategy remain valid; its implementation through related strategies, plans and policies remains a challenge.

Implementing a comprehensive set of energy and climate policies and measures requires the prioritisation of actions and a focus on the most important tasks. In this context the role of a robust cost-benefit analysis will be very important, so that the government has the best possible information available about the extent to which potential actions will help to deliver particular goals (for example, strengthening energy security; boosting local industry; and protecting the environment), and the costs of each, thus enabling their decisions to be informed by considerations of cost-effectiveness.

Legislation has been put in place to provide a basis for implementation of elements of the 2009 Strategy, including the creation of an independent electricity market regulator in 2016 (whose director was appointed in 2018) and plans for further market opening. In particular, notable progress has been made in taking forward the deployment of large-scale wind and solar programmes and in energy technology R&D infrastructures.

Morocco is going to need a great deal of investment in the energy sector in the years ahead, including an estimated USD 30 billion to meet the renewables target of 52% of installed capacity by 2030. Government expenditure and concessionary finance have important roles to play, but the bulk of finance will have to come from the private sector. This will require clear and predictable rules and well performing markets. Government objectives in areas such as the creation of local supply chains and jobs, and subsidies for social reasons should be achieved in a transparent way, which is consistent with those rules. While the current business model has moved Morocco a long way forward, it will need to continue to evolve to unlock significant private sector investment and fully meet Morocco's closely linked energy and climate goals.

To foster private investment, the government will need to complete the reforms in the electricity sector, notably the further opening of the electricity market at the medium and low voltage levels, under the lead of the national regulatory authority (ANRE). The EU twinning programme has been launched and Morocco will be able to tap into expertise of EU regulators, notably the French Conseil de Régulation de l'Énergie (CRE). With the creation of the regulatory framework, private sector investments will support the emergence of new industries, supply chains and skills in areas such as solar PV construction and operation, and energy efficiency in buildings and renovation works.

The affordability of energy prices is a major concern for the government, alongside financial stability of the state budget. Commendably, the government has successfully phased out the bulk of fossil fuel subsidies. In the long run, significant private sector investment in renewables, energy efficiency and new technologies has the potential to lead to lower prices. Such investment will be facilitated by a system in which energy prices generally reflect the costs of provision, including the costs of investment. The government may wish to continue to provide subsidies in some cases for entirely legitimate social or other reasons. In these cases, it makes sense for the subsidies to be provided in a transparent way, and to be targeted as tightly and accurately as possible.

The creation of the Ministry of Energy, Mines and Sustainable Development, which brings together climate and energy policies reflects the government's priorities of the clean energy transition. The government has completed an institutional reform, with the restructuring of two dedicated agencies - MASEN for the implementation of renewable energy projects and AMEE for energy efficiency. A number of ministries other than the energy ministry are involved in the implementation of the 2009 Strategy and energy and climate policies, including the ministries of General Affairs and Governance, Industry, Transport, the Economy, and the Interior, as well as a number of agencies. There is inevitably a risk that different interests and assessments of trade-offs will impair implementation. It is therefore important to ensure that there is clarity about what each Ministry and agency will deliver, and who is accountable for progress in each, and that the arrangements in place to ensure effective coordination work effectively, supported by regular monitoring and reporting of progress.

Morocco's energy transition has started with the transformation of the electricity sector. Thanks to the ambitious renewable energy programme, the government has created a strong momentum to support the transformation of the entire energy system and the economy. Using renewables in other sectors through sector coupling offers opportunities to make even greater use of renewable energy, connecting the power sector with heating and cooling, transport and water management. Examples include power-to-heat, the use of electric vehicles for grid stabilisation, or the use of PV for water management, purification and desalination. System integration involves different energy carriers, such as electricity, fossil fuels, or hydrogen providing energy to different applications. Morocco has yet to develop a more integrated vision for its energy sector and should boost the active engagement of consumers in the entire process.

Recommendations

The government of Morocco should:

- Building upon the 2009 Energy Strategy, develop further energy sector plans and policies, in the light of the development of higher ambitions for renewable energy, energy efficiency and climate change, as reflected in Morocco's NDC.
- Focus strongly on implementation of the strategy, with a particular emphasis on prioritisation, cost-effectiveness and opportunities to unleash more private sector investment to boost economic development and job creation.
- Ensure effective coordination of plans and delivery across Ministries, regional authorities and agencies, notably for the upcoming Energy Efficiency Strategy, with effective governance and oversight of progress of its implementation.
- Explore opportunities to accelerate the use of renewable energy beyond electricity in heating and cooling, transport and water management.

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3. Energy, climate change and the environment

Key data

(2016)

CO₂ emissions from fuel combustion: 55.3 MtCO₂, +36% since 2006, +181% since 1990

CO₂ emissions by fuel: oil 64.2%, coal 30.7%, natural gas 4.4%, other 0.8%

CO₂ emissions by sector: power generation 39.1%, transport 30.9%, industry 12.9%, residential 11.7%, commercial and public services including agriculture 5.4%

CO₂ intensity per capita: 1.57 tonne CO₂/capita (IEA average 9.11)

CO₂ intensity per GDP: 0.22 kgCO₂/USD GDP PPP (IEA average 0.24)

Notes: Refers to energy-related CO₂ emission from fuel combustion.

Overview

Morocco ratified the 1992 United Nations Framework Convention on Climate Change (UNFCCC) in 1995 and the 1997 Kyoto Protocol in 2002. Climate change is a priority for Morocco in its multilateral engagement. The government acted as a host of COP7 in 2001, where the Marrakech Agreement was reached, and the COP22 in 2016 in Marrakech, where the Paris Agreement has been ratified. Lately, Morocco has acted as a powerful advocate for Africa at COP23 in Bonn and at the COP24 in Katowice.

The policy framework is set out through the Moroccan Climate Change Policy of 2014 (Government of Morocco, 2014) and the National Sustainable Development Strategy of 2017 (adopted in June 2017). More specific mitigation and adaptation measures are outlined in the Nationally Determined Contribution (NDC) submitted to UNFCCC when Morocco ratified the Paris Agreement on 21 September 2016. Morocco is concerned with both mitigation of and adaptation to climate change, recognising the risks posed by increasingly extreme weather events, and the importance of water supplies. Measures focus on a broad range of sectors, including energy, agriculture, coastal areas, tourism, transportation, health, fisheries, water, waste, forestry, industry, housing and infrastructure.

By 2030, Morocco is committed to reducing greenhouse gas (GHG) emissions across the entire economy by 17% below business as usual (BAU) levels. Morocco is also ready to achieve an additional reduction of 25%² compared to BAU levels, conditional on international support. Morocco's climate target is in line with the Paris Agreement. The conditional target supports efforts to limit the temperature increase well below 2 degrees to 1.5 degrees Celsius (CAT, 2017). Morocco's NDC is detailed and transparent in terms of planned measures (for conditional and unconditional action) and their costs.

The government estimates that USD 50 billion in total funding is needed to achieve this overall 42% emission reduction target, including USD 24 billion in international support, for example through international climate finance mechanisms, such as the Green Climate Fund. Morocco is already making use of international measures, such as the Clean Development Mechanism (CDM) under the Kyoto Protocol, and has tapped into climate finance to support its ambitions to deploy large-scale renewable energy projects.

The energy sector accounted for over half (56%) of total GHG emissions in Morocco in 2012, according to the latest available data (UNFCCC, 2016) and is considered of great importance for meeting climate targets. Emissions reductions in the energy sector are expected from an expansion of renewables; an expansion of the use of natural gas; and greater energy efficiency (including through reduced energy subsidies). Policies to deliver emissions reductions are already being implemented in these areas, including the wind and solar plans and a range of energy efficiency projects.

Morocco is also striving to reduce the impact of energy production and consumption on the environment, including through several measures to reduce air pollution.

Box 3.1 Morocco on the International Climate Change Scene

Morocco has positioned itself as an active player in international climate change negotiations. It hosted the 22d session of the Conference of the Parties to the United Nations' Convention on Climate Change (COP22) in November 2016, which also served as the 12th meeting of the Parties to the Kyoto Protocol (CMP12), and the first meeting of the Parties to the Paris Agreement (CMA1). The Conference demonstrated that implementation of the Paris Agreement was underway in a constructive spirit of multilateral co-operation. Several important initiatives and new assessment tools were launched, including on energy, cities, businesses and transport. COP22 welcomed the Marrakech Partnership for Global Climate Action, constructed with input from non-state actors, which brings together stakeholders in collaborative actions, showcases initiatives, and tracks progress. Among other initiatives, Morocco issued "The Marrakech Action Proclamation for Our Climate and Sustainable Development" at COP22. This marked a shift towards "a new era of implementation and action on climate," and urged non-state actors to join governments in actions to mitigate climate change and launched the Adaptation of African Agriculture (3A) at COP22 and continued to be an effective advocate for African concerns" at COP23. In September 2017, Morocco also hosted the Climate Chance Summit for non-government organisations in Agadir.

Sources: UNFCCC, PMR (2018) and press reports

² Emissions reductions include contributions from agriculture, forestry and other land use or AFOLU.

Institutions

The institutional framework related to climate change has been progressively developed in Morocco to meet the requirements of the UNFCCC.

Morocco's **National Committee for Climate Change**, composed of representatives of public and private stakeholders, has been established to oversee climate-related activities. The Secretary of State for Sustainable Development in the Ministry of Energy, Mines, and Sustainable Development (MEMDD) chairs this Committee and serves as the national focal point for the UNFCCC. An **Inter-ministerial Monitoring Committee** (*Comité Interministériel de Suivi, CIS*) has been set up to review and validate the studies and reports prepared by Morocco as part of its UNFCCC commitments (NAP-GSP, 2017), including work relating to Morocco's NDC and related communications, through an inter-agency coordination process led by MEMDD. A **National Adaptation Committee** has also been established by the Secretary of State for Sustainable Development, and has invited CIS institutions to designate focal points on adaptation. The **National Scientific and Technical Committee of Climate Change** (*CNST-CC*), composed of national experts (public institutions, universities, consulting firms) covers different topics related to climate change.

Morocco has a Designated National Authority for the Clean Development Mechanism (CDM) which evaluates and approves national CDM projects in the framework of the Kyoto protocol and serves as a focal point for the Green Climate Fund. The **Moroccan Competence Centre for Climate Change** (*Centre de Compétences Changement Climatique du Maroc*, 4C Maroc) provides capacity building and knowledge exchange on climate change across national and international stakeholders; it has a regional and African outreach. The **National Environment Observatory** (*l'Observatoire National de l'environnement du Maroc*, ONEM) and Regional Observatories of the Environment and Sustainable Development (*Observatoires régionaux de l'environnement et du développement durable*, OREDD) establish and manage national and regional databases on climate change (projections/scenarios), extreme events, the vulnerability of communities and the inventory of GHG emissions. Morocco also has a **National Air Quality Monitoring and Surveillance Committee** as well as Regional Committees that monitor air quality.

Strategic framework

The policy directions, measures and initiatives related to climate change and the environment are set out in several strategic documents that have been developed and updated over the past decade.

Following the release of Morocco's 2009 National Plan to Fight against Global Warming (*Plan National de Lutte Contre le Réchauffement Climatique*, PNRC), the country adopted the Moroccan Climate Change Policy (*Politique du Changement Climatique au Maroc*) in March 2014, which is the main policy document. It provides the operational framework for developing a medium and long-term climate change strategy (up to 2040) and constitutes the basis for coordinating different measures and initiatives, based on four pillars: economic, social, environmental and governance.

The Climate Change Policy includes mitigation and adaptation components, as well as cross-cutting horizontal actions, including measures to:

- strengthen the legal and institutional framework
- improve knowledge and observation
- consider regional specificities and promote the active involvement of communities
- prevent and reduce climate risks
- raise awareness, empower individuals, and strengthen capacities, with communication and education campaigns being put in place to inform public and private actors on climate change impacts, good practices and possible actions to take
- promote research, innovation and technology transfer (see Chapter 5).

The National Charter for Environment and Sustainable Development (*Charte Nationale de l'Environnement et du Développement Durable*) was developed in 2009 and translated into a framework law (Law 99-12) in 2014. Article 14 of the Charter laid the foundation for the National Sustainable Development Strategy (*Stratégie Nationale du Développement Durable*), adopted in November 2017.

More specific mitigation and adaptation measures are outlined in the Intended Nationally Determined Contribution (INDC) submitted to UNFCCC in June 2015 and the Nationally Determined Contribution (NDC) submitted in September 2016. Morocco also submitted national communications to the UNFCCC in 2001, 2010 and 2016. The Third National Communication (2016) includes GHG emissions projections to 2040.

Morocco is implementing actions to support the adaptation to climate change impacts, including through the National Water Strategy and Plan; National Plan for the Protection against Floods; Green Morocco Plan (focusing on the agriculture); National Action Programme to Combat Desertification; National Strategy for the Planning and Development of Oases; and the Halieutis Plan (focusing on fishery).

Morocco has not yet adopted a mid-century strategy, as outlined under the Paris Agreement. Since 2015, the government has been working on a National Low-Carbon Development Strategy (*Stratégie Nationale de Développement Sobre en Carbone*), and a National Adaptation Plan up to 2030 (*Plan National d'Adaptation au Changement Climatique*).

Targets and objectives

In its NDC, Morocco commits to reducing GHG emissions by 42% by 2030 compared to business as usual (BAU) emissions. Morocco is committed to an unconditional reduction target of 17% below BAU levels by 2030, including a 4% reduction in Agriculture, Forestry, and Other Land Use (AFOLU actions), and a conditional target of an additional 25% reduction, subject to provision of technical and financial international support.

The government estimates that USD 50 billion in total funding is needed to achieve its targeted total 42% emissions reductions between 2010 and 2030, including USD 24 billion in new sources of finance and additional support compared to that received over the past years to meet the conditional components of the target. The unconditional mitigation considers the implementation of 24 actions, including 9 AFOLU actions. The conditional mitigation assumes the implementation of 31 additional actions

over the period 2010–2030, including 11 AFOLU actions. The mitigation scenarios also take into account the additional GHG reductions coming from the reforms linked to eliminating public fossil fuels subsidies.

Figure 3.1 Projected GHG emissions in different mitigation scenarios

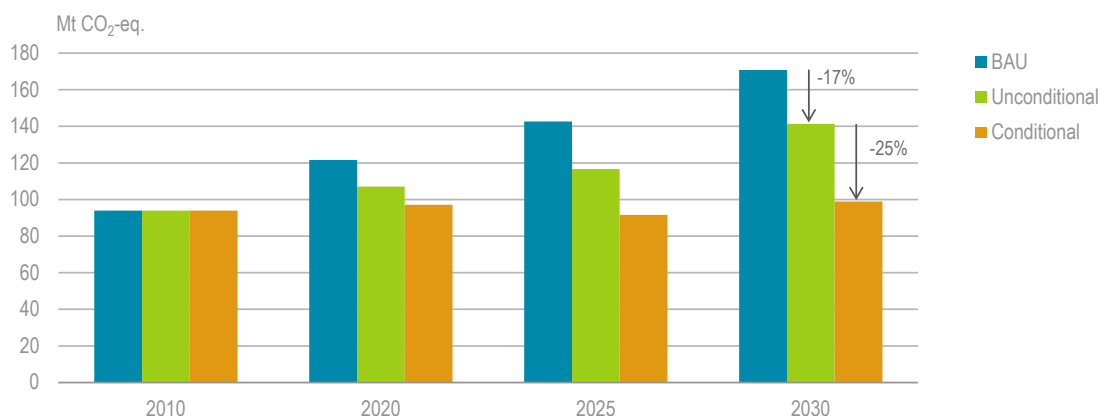


Figure 3.1 shows different GHG emissions scenarios:

- In the BAU scenario, total emissions grow from 93.9 MtCO₂-eq per year in 2010 to 121.6 MtCO₂-eq in 2020 and 170.8 MtCO₂-eq in 2030.
- In the most ambitious – Conditional Scenario (with AFOLU) – the annual emissions grow to 97.2 MtCO₂-eq in 2020 and 98.9 MtCO₂-eq in 2030, leading to the peaking of GHG emissions reductions.

The total emissions over the period 2020-30 are forecasted to be 1 061.3 MtCO₂-eq in the Conditional Scenario (with AFOLU), 1 326.9 MtCO₂-eq in the Non-Conditional Scenario (with AFOLU) and 1 584.8 MtCO₂-eq in BAU. The implementation of all conditional measures would lead to a reduction of 524 MtCO₂-eq between 2020 and 2030, while the implementation of non-conditional measures (with AFOLU and without international aid) would only slow down the growth of emissions by 258 MtCO₂-eq over the same period, compared to BAU.

Climate change mitigation

The government expects to meet its non-conditional target through the mitigation measures already firmly planned in different sectors of the economy. It has evaluated the cost-effectiveness of all existing mitigation measures. It has also included detailed actions to meet its conditional targets in its 2016 NDC. The NDC and other strategic documents envisage that the achievement of the 42% GHG reduction target compared to BAU will rely to a considerable extent on the transformation of the country's energy sector, supported by international aid, although mitigation efforts are also planned in agriculture, water, waste, forestry, industry, housing and infrastructure.

In 2019, the following high-level objectives have been set for this energy sector transformation by 2030:

- reducing fossil fuel and energy subsidies
- providing at least 52% of installed electrical power capacity from renewable sources by 2030
- achieving 20% energy savings by 2030, compared to current trends, by reducing energy consumption in buildings, industry and transport
- installing by 2030 additional capacity of 3 900 MW of combined-cycle gas plants
- supplying major industries with liquefied and regasified natural gas (LNG) by pipeline.

An evaluation of Morocco's progress under the NDC is contained in Chapters 4 and 5 of this report which provide more details on the mitigation measures related to energy efficiency and renewable energy. Morocco's measures related to transport are discussed in the Chapter 4 on energy efficiency.

Pricing and taxation

The reduction of energy subsidies (see Chapter 2) has been an important factor in encouraging more efficient energy use and reducing GHG emissions.

Law 99-12 of March 06, 2014 (which introduced new rules for green growth) established two core principles of environmental taxation (see more at Falhaoui, 2016):

- Taxes and royalties need to focus on activities with a significant environmental footprint, i.e. activities that result in significant pollution and consumption of natural resources (Article 30 of the Law 99-12).
- Tax exemptions and reductions can encourage the protection of the environment (Article 28 of the Law 99-12).

A feasibility study on the creation of a carbon market in Morocco was presented at COP23 in Bonn, prepared under the Partnership for Market Readiness (PMR) initiative of the World Bank (Box 3.2).

Climate finance and projects

Morocco attracts considerable international climate finance directed to MENA region; notably from the African Development Bank (AfDB), the European Bank for Reconstruction and Development (EBRD), the European Investment Bank (EIB), the International Bank for Reconstruction and Development (IBRD), the German Development Bank (KfW), Clean Technology Fund (CTF), and European Commission (EU) through the Neighbourhood Investment Facility (NIF) and the French Development Agency (AFD).

Morocco has a portfolio of 16 projects under the Clean Development Mechanism (CDM) within the framework of the Kyoto protocol. They are expected to reduce GHG emissions by 5.9 MtCO₂.eq per year. Morocco has registered the first CDM project in Africa, which is the Lafarge Wind Farm (10 MW, 28 651 tCO₂.eq per year). It has also registered the first biomass project among the African and the MENA countries: the COSUMAR project (31 653 tCO₂.eq per year). About 60% of the 16 registered projects

are being developed by the public sector. Renewable energy projects account for 65% of the total; biomass energy projects and liquid and solid waste projects account for 17.5% each (Government of Morocco, 2016b).

Box 3.2 Partnership for Market Readiness project in Morocco

The World Bank's Partnership for Market Readiness (PMR) supports Morocco, as well as other countries, to assess, prepare, and implement carbon pricing instruments to scale up greenhouse gas mitigation. It also serves as a knowledge-sharing platform. The PMR project in Morocco focuses on three sectors, one of which is power generation. Besides capacity building and communication components, the project's key activities are as follows:

- Identify appropriate governance, regulatory frameworks, and institutional systems, to increase readiness for market-based instruments (MBIs) in Morocco as part of a broader package of climate policy instruments.
- Support the development of a sectoral crediting mechanism, to allow Morocco's participation in the carbon market(s) through the cooperative mechanisms established under the Article 6 of the Paris Agreement.
- Support the establishment and piloting of a monitoring, reporting and verification (MRV) system for GHG emissions in each target sector.

A study conducted by the project suggests that the introduction of market-based instruments in Morocco could be based on a phased ("two-speed") hybrid model:

"The first step could consist in introducing a carbon tax to achieve a short-term impact on GHG emissions, and allow a progressive set-up of critical elements for GHG management, such as infrastructure, governance and capacity building for emitters. In the longer term, an emission trading mechanism (ETS) could be introduced to ensure a more sustainable impact on emissions. A precondition for efficient emissions trading in Morocco (due to the limited number of participants and high concentration of emission sources) would be to orientate the national ETS towards integration/linking with the EU-ETS. The proposed carbon pricing approach would need to be complemented by other policy instruments, such as investment subsidies and grants."

Source: <https://www.thepmr.org/country/morocco-0> accessed on 31 May 2018 and PMR (2018)

Energy-related CO₂ emissions

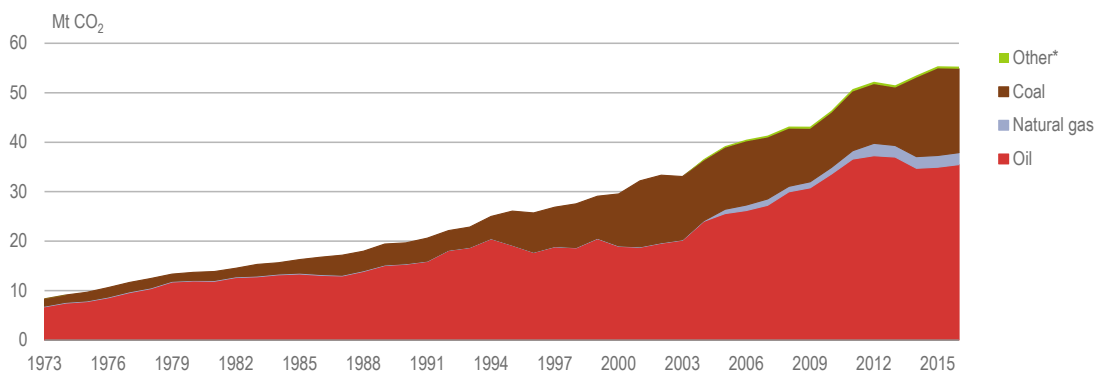
Over the decade 2006-16, total energy-related CO₂ emissions increased by over a third to 55.3 MtCO₂ and by 181% since 1990.

In 2016, oil was responsible for 64% and coal for 31% of total emissions, with the rest from natural gas and other sources (Figure 3.2). Oil is consumed across many sectors, whereas emissions from coal use stem from power generation.

Power generation and transports account for most of energy related CO₂ emissions in Morocco. In 2016, the power sector emitted 39% and the transport sector 31% of total emissions. The rest came from industry (13%), residential and commercial buildings (12%), and agriculture (5%). Emissions have increased rapidly across all sectors in the

last decade, except in industry, which has remained quite stable. Between 2006 and 2016, emissions increased by 31% in power generation, 63% in transport, 1.5% in industry, 58% in residential and commercial, and 58% in agriculture.

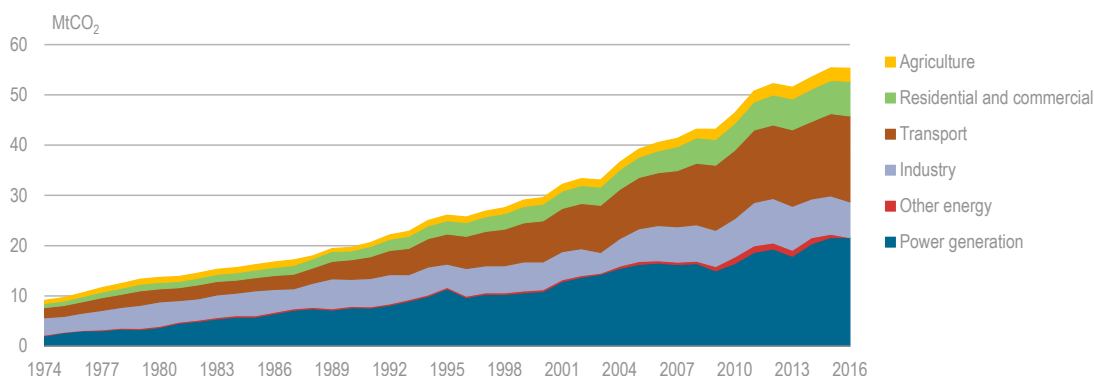
Figure 3.2 Emissions by fuel, 1973-2016



* Other includes biomass and waste.

Source: IEA (2018), *CO₂ Emissions from Fuel Combustion 2018*, www.iea.org/statistics/.

Figure 3.3 Emissions by sector, 1973-2016

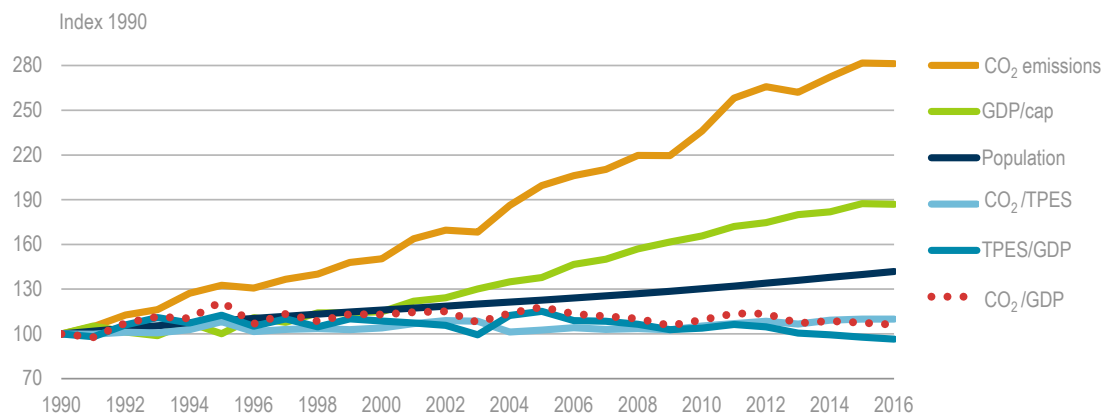


Source: IEA (2018), *CO₂ Emissions from Fuel Combustion 2018*, www.iea.org/statistics/.

Since 1990, CO₂ emissions in Morocco have been driven by population growth (40%) and growth in GDP/capita (90%) (Figure 3.4). Morocco's economic growth and CO₂ emissions are closely related, albeit emissions have recently grown at a slower growth rate than the economy.

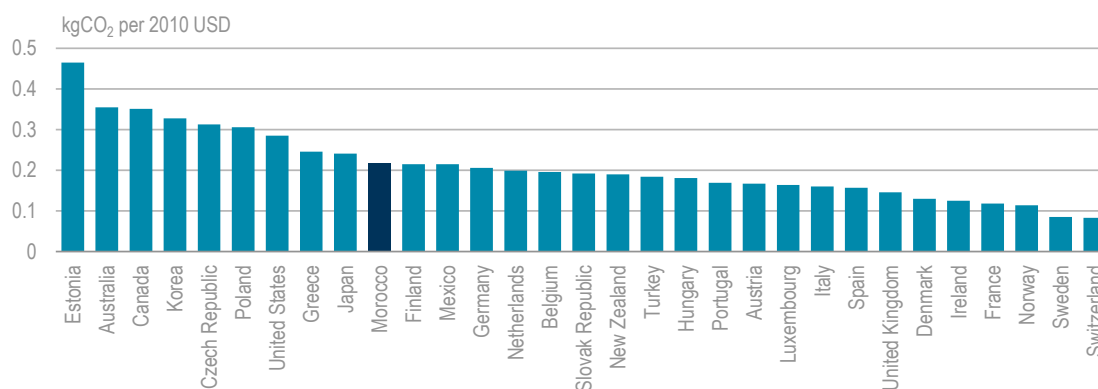
Compared to IEA member countries, Morocco's economy has a relatively high level of carbon intensity (Figure 3.4) but per-capita emissions are much lower than those of any IEA member, as a result of low energy consumption per capita (Figure 3.6).

Amidst the growth of renewable energy and natural gas use in power generation, Morocco experienced a 7% drop in carbon intensity in 2011-16.

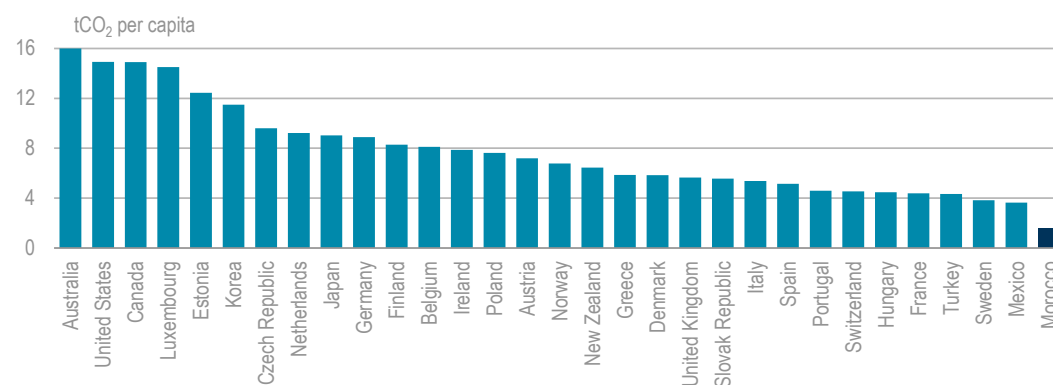
Figure 3.4 Energy-related CO₂ emissions and main drivers, 1990-2015

Note: Real GDP in USD 2010 prices and PPP.

Source: IEA (2018), *CO₂ Emissions from Fuel Combustion 2018*, www.iea.org/statistics/.

Figure 3.5 Energy-related CO₂ emissions per unit of GDP in Morocco and IEA member countries, 2016

Source: IEA (2018), *CO₂ Emissions from Fuel Combustion 2018*, www.iea.org/statistics/.

Figure 3.6 Energy-related CO₂ emissions per capita in Morocco and IEA member countries, 2016

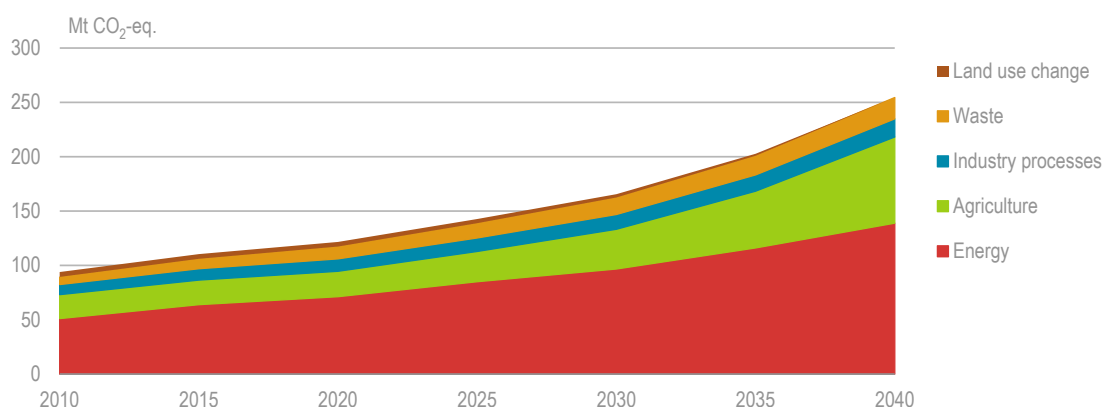
Source: IEA (2018), *CO₂ Emissions from Fuel Combustion 2018*, www.iea.org/statistics/.

Long-term energy and climate scenarios

Overall energy consumption is likely to increase in line with per capita energy consumption and population growth. Morocco's population is expected to grow at an average annual rate of 0.82% to reach 40 million by 2040 (Government of Morocco, 2016b). According to the *Third National Communication* submitted to the UNFCCC in 2016, Morocco's energy-related GHG emissions are expected to grow at an annual rate of 3.38% and account for around 55% of total GHG emissions.

Under a baseline scenario, GHG emissions from energy sector activities are expected to grow from 51 MtCO₂-eq in 2010 to 139 MtCO₂-eq in 2040. As illustrated in Figure 3.7, energy sector emissions, in particular from energy use in the transport sector (27% in 2010) are expected to be the main driver of future GHG emissions growth. Assuming the achievement of the non-conditional target, energy-related GHG emissions would only double to 106 MtCO₂-eq in 2040, meeting emissions below the BAU (Figure 3.8).

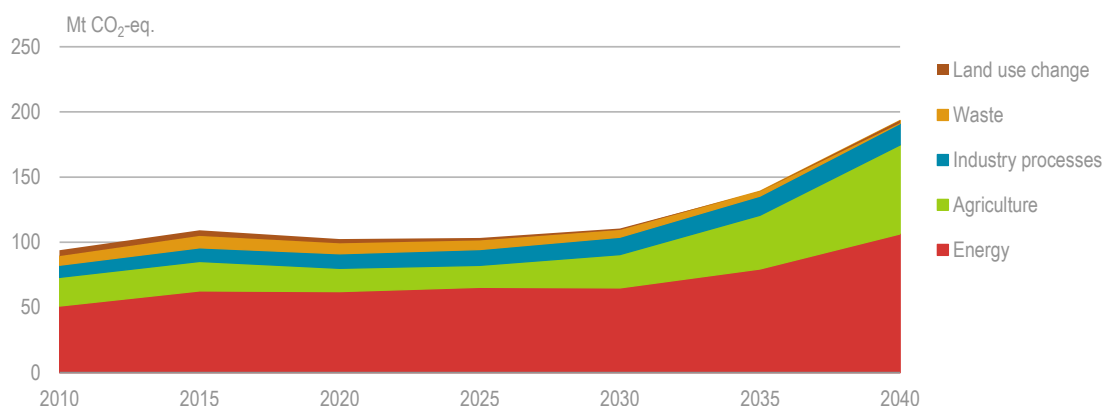
Figure 3.7 Morocco's GHG emissions by source in the baseline scenario



Notes: "Energy" - Energy use in the end-use sectors (buildings, transport, industry, agriculture, etc.) and energy transformation (power generation etc.); "Agriculture" – N₂O and CH₄ emissions from agricultural soil and agricultural processes such as fermentation and animal manure.

Source: Government of Morocco, Third National Communication to the UNFCCC, 2016.

Morocco will have to boost mitigation actions, notably through greater energy efficiency, renewable energy, and the reduction of the carbon intensity of its energy supply in order to meet its ambitious emissions reductions targets, notably the conditional target of its 2016 nationally determined contribution (NDC) under the Paris Agreement. Achieving such a conditional target would require a much steeper effort, which has not been modelled in Morocco's *Third National Communication*.

Figure 3.8 Morocco's GHG emissions by source in the non-conditional scenario

Notes: "Energy" - Energy use in the end-use sectors (buildings, transport, industry, agriculture, etc.) and energy transformation (power generation etc.); "Agriculture" - N₂O and CH₄ emissions from agricultural soil and agricultural processes such as fermentation and animal manure.

Source: Government of Morocco, Third National Communication to the UNFCCC, 2016.

Climate change adaptation

Adaptation to climate change is a serious challenge for the country. The 4th Assessment Report of the United Nations Intergovernmental Panel on Climate Change (IPCC) identified Morocco as a country which is vulnerable to climate change impacts. Morocco is already experiencing a warmer climate and reduced rainfall. Average temperatures have gradually been rising (by around 1 to 1.8 degree Celsius) and precipitation declining (between 3 to 30% depending on the year) since 1960. Water availability per capita has declined from 2 600 m³ in 1960 to about 700 m³ today. Major climate change risks in Morocco are well identified in the country's Third National Communication (Government of Morocco, 2016b) and its NDC (Government of Morocco, 2016c). Projections show further reduction in precipitation and a further increase in temperature, especially along the Mediterranean coast. This will have a very negative impact on water availability, agriculture production, and aridity, and will threaten the overall sustainability of national ecosystems, posing significant risks in particular to the vulnerable population in rural areas and to the urban poor.

Between 2005 and 2010, Morocco dedicated 64% of its total climate spending to adaptation efforts, a value equivalent to 9% of its total investment spending (NDC, 2016). This reflects the scale of the challenge. Morocco forecasts that, between 2020 and 2030, the implementation of adaptation programmes will cost at a minimum USD 35 billion for the most vulnerable sectors - water, forestry and agriculture. Morocco's Strategy for Sustainable Development 2030 and other national policy documents recognise the need to build resilience to limit the impact of climate change. The country's adaptation efforts, which are set out in the NDC, are focused on agriculture, water, forests, and fisheries, and include clear targets in each sector for 2020 and 2030.

Following the adoption of the Moroccan Climate Change Policy, the country started preparing its National Adaptation Plan (NAP). In 2015-16, the Ministry of Environment, supported by the German development aid agency (Deutsche Gesellschaft für Internationale Zusammenarbeit, GIZ), analysed how adaptation had been considered up till now in sectoral planning in water, agriculture, forestry, tourism, road infrastructure and

human health. A draft of the Roadmap for the development of a NAP was developed in late 2016, and public consultations were organised in 2017. As of April 2018, the NAP had not yet been finalised.

Morocco's long-term economic growth agenda requires the integration of climate change adaptation measures into energy sector planning, notably because of the dependence of hydro, solar and thermal generation on water availability. Some initiatives by ONEE, AMEE and MASEN have started to address the sector's vulnerability to climate change. For example, measures are being taken to reduce water consumption at concentrated solar power (CSP) plants, and several studies to further optimise water consumption are being undertaken.

Air quality

Morocco has adopted several laws and regulations to reduce the emissions of air pollutants from transport and from stationary sources. The government is considering emission limit values for certain industrial sectors, including for thermal power stations. However, the implementation of the existing environmental legislation is often problematic in Morocco because of insufficient secondary regulations and/or a lack of systematic compliance monitoring (UNECE, 2014).

Morocco has a comprehensive legal framework for air quality in place, based on Law 13-03 of 12 May 2003 on the fight against air pollution and Decree 2-97-377 of 28 January 1998, supplementing the Decree of 24 January 1953 on traffic and transport. Decree No. 2-09-286 of 8 December 2009 sets standards for air quality and air monitoring procedures. Decree No. 2-09-631 of 6 July 2010 fixed the limit values for the release of emissions or discharges of pollutants into the air from fixed sources of pollution and the procedures for their control. Decree No. 2-12-172 laid down the technical requirements for the disposal and processes of the recovery of waste by incineration. Order 532-01 of 9 March 2001 put in place the control of instruments for measuring the exhaust gases from diesel engines. Order 3750-14 of 29 October 2014 established vigilance thresholds, information, alerts and emergency measures and Order 1653-14 of 8 May 2014 sets calculations for the air quality indicator.

Because legislation does not provide clear inspection and enforcement powers for the environmental authorities, they prioritise negotiations, consensus-building and voluntary approaches, which are not always effective.

Morocco started to monitor air quality in 1997, with the first campaigns conducted by the Ministry for the Environment in the urban area of Rabat. At present, its Air Quality Monitoring Network consists of 29 fixed stations and 3 mobile stations operating in 15 cities, in collaboration with the National Meteorological Directorate, the Mohammed VI Foundation for the protection of the Environment (programme Qualit'Air), city administrations, and the Environment Department of the MEMDD. The 29 fixed stations, spread over the largest cities, measure and forecast the air quality and inform the public, local authorities and decision makers. The three mobile laboratories are used to complement the monitoring performed by the fixed stations, select locations of new fixed stations, check whether the existing stations are representative, and respond to local concerns. The data collected by the laboratories is also used for modelling to understand better the interactions between polluting emissions, weather conditions and

pollution levels, as well as to evaluate the effectiveness of existing policies, understand air pollution phenomena and design long-term measures to reduce air pollution.

The Environment Department within MEMDD has started a programme to create an inventory of atmospheric pollutants in the country's biggest cities. The programme covers sulphur dioxide (SO₂), nitrogen oxides (NO_x), carbon oxides (CO and CO₂), suspended particulates (MPS), methane (CH₄), volatile organic compounds non-methane (NMVOC), HF, NH₃, benzene (C₆H₆) and heavy metals (Pb, Cd). This work includes conducting an inventory of atmospheric emissions; analysing emissions trends for the medium term; evaluating the impact of these trends on the population's health; and developing an action plan to reduce air pollution from transport and industrial activities.

Assessment

Morocco is to be praised for its efforts to combat climate change. It not only has ambitious national targets backed by policies to combat climate change, but also plays a leading role in international climate initiatives, positioning itself as an active advocate of the global climate change agenda and local actions, including across the African continent.

Morocco has committed, in its nationally determined contribution (NDC), to reducing its emissions by 17% below the business as usual (BAU) levels by 2030. If international support is available, Morocco aims to go further and reduce emissions by an additional 25% by 2030 compared to BAU, making 42% in total. Morocco's NDC is ambitious: with conditional efforts, Morocco would be able to peak GHG emissions, while with unconditional efforts it can achieve only a slowdown of the expected growth. The country's NDC is exemplary in being transparent and detailed about the actions and costs needed for the implementation of these ambitions.

Over the past few years, Morocco has started making impressive steps towards achieving its very ambitious targets, benefitting from available climate finance from multilateral and bilateral support institutions.

As the energy sector is a large GHG emitter, Morocco has rightly built its climate policy to a large extent on the transformation of the energy sector. It has adopted a consistent and coherent approach in aligning the energy-related policies and measures outlined in the NDC with the revised objectives of the 2009 National Energy Strategy.

Morocco aims to have 52% of the installed electric power capacity using renewable sources by 2030, to achieve 20% energy savings by 2030, and to increase gas-fired power generation and boost the use of natural gas in industry so as to reduce the use of more carbon-intensive fuels, such as coal and oil. As well as reducing GHG emissions, meeting these targets would help Morocco to diversify energy supply sources, reduce import dependency, enhance the country's competitiveness, boost local development, and improve people's well-being.

Morocco's NDC and mitigation measures are ambitious and detailed, based on a thorough analysis of the costs of different measures and their mitigation potential. There are, however, questions related to the criteria used to select specific measures and initiatives under the NDC and their cost-effectiveness. As an example, many

energy efficiency measures deliver large cost-effectiveness; however, they are not prioritised in the list of actions.

To improve the government's choice of national policies and measures a thorough cost-benefit analysis of different mitigation options is critical, taking into account both positive and negative impacts on energy supply security, environmental and social sustainability, economic competitiveness, equitable local development, among others. This would enable the government to take fully informed decisions about priority measures, and give it scope to reduce the overall costs of meeting multiple national policy objectives simultaneously.

Morocco is currently working to develop a low-carbon development strategy for 2050, and that timeframe makes good sense. In deciding which measures to prioritise, it is important to have a long-term perspective in mind, because some options might be cost-efficient in the short term but lock in investments in ways that would not make sense or be cost-efficient in the longer term. This is one of the reasons why most countries are adopting 2050 mid-century strategies, as stipulated by the Paris Agreement. For example, investments in new coal-fired power generation could be incompatible with the 2050 target for net zero emissions. At the same time, a longer-term perspective might show that the growth of ever more cost-competitive renewable energy could provide cheaper and faster mitigation than other measures.

Emissions of air pollutants should be included in the cost-benefit analysis because the energy sector has a large impact on air quality. Air pollution is a major public health problem, resulting in millions of premature deaths worldwide (IEA, 2016b). Inefficient and unregulated combustion of fuels (especially coal) is the principal man-made source of air pollutant emissions such as particulate matter, sulphur oxides and nitrogen oxides. Fuels used for transport (particularly diesel) generate nitrogen oxides, which can trigger respiratory problems and the formation of hazardous particles and pollutants. Burning wood and other solid fuels indoors (for cooking) also causes air pollution. Air pollution is an especially serious challenge in cities because they concentrate people, energy use, construction activity and traffic. It is therefore very important that Morocco introduces and enforces regulations to encourage reductions of air pollutants from coal power plants, vehicles and industrial processes with fuel combustion. A transition to electricity-based or natural gas-based cooking, particularly using local renewable energy sources – rather than burning butane or wood – will also improve indoor air quality.

Some policies and measures reduce both local air pollution and GHG emissions. Morocco is already taking such actions, for example encouraging the use of electric vehicles, supporting replacement of old and inefficient taxis and buses, and expanding the railway network. The government should effectively implement its commendable initiatives related to transport and think about more ambitious efforts to reduce emissions in the transport sector in the longer term. Modernising older coal-fired power plants and phasing out the oldest ones is another example of policy that could address both environmental and climate change challenges.

Adaptation to climate change is a serious challenge for the country, as it relies on agriculture, fisheries and tourism. It makes sense for Morocco to place a lot of emphasis on adaptation measures, as it is already experiencing warmer temperatures and reduced precipitation, which are expected to make water scarcer, among other adverse effects. Morocco's recent policy documents related to climate change and the environment – the

Climate Change Policy, the NDC, the Third National Communication and the National Sustainable Development Strategy – have rightly focused on agriculture, water, forests, and fisheries in the context of adaptation. Measures are taken to reduce water consumption of CSP plants, with decision to use exclusively dry cooling systems (NOOR Ouarzazate II and NOOR Ouarzazate III CSP plants) to optimise water consumption. The government is encouraged to continue to address climate change impacts on the energy sector and boost the resilience of the infrastructure or water needs. It would be worth updating the analysis of the energy-water nexus in the future, given the importance of energy to the economy and to the government's climate change goals.

Climate change has the potential to influence the Moroccan energy sector in many ways. The proximity of most energy infrastructure to the coastline means that the sector may be vulnerable to increases in seawater levels as well as to extreme events, such as severe storms. The fact that cargos transporting oil cannot unload at the port of Mohammedia when the waves there are strong is one example of the impact of natural events on the oil distribution sector. Given the current use of hydropower and its planned expansion, there is a very strong case to evaluate the possible impacts of climate change on the availability of water resources. This also includes the large cooling needs of the thermal power plants (coal or gas), in the context of decreasing precipitation and increasing scarcity of water. Therefore, the IEA encourages the government to carry out a comprehensive assessment of impacts of climate change on the energy sector with a view to develop adequate adaptation measures.

Recommendations

The government of Morocco should:

- Develop a rigorous and robust analysis to identify the most effective climate change mitigation measures with a view to prioritise actions and thereby reduce the overall costs of meeting national policy objectives.
- Use this analysis as a starting point to consider the scope for increasing the use of cleaner fuels in power and transport and to evaluate technology options and policy measures under a new long-term low-carbon development strategy.
- Evaluate the possible impacts of climate change on the energy sector, with a particular focus on the link between energy and water, and in the light of this develop appropriate policies and measures for inclusion in government adaptation plans.

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4. Energy efficiency

Key data

(2017)

Total final consumption (TFC): 16.1 Mtoe (oil 74.1%, electricity 17.3%, biofuels and waste 8.1%, natural gas 0.4%, coal 0.1%), +34% since 2007.

Consumption by sector: transport 35.9%, residential 24.9%, industry 23.6%, commercial and public services 8.0%, agriculture and forestry 7.6%.

Energy consumption (TFC) per capita: 0.45 toe/capita (IEA average: 2.9), +17% since 2007.

Energy intensity (TFC/GDP): 61 toe/USD million PPP (IEA average: 75), -9% since 2007.

Overview

Morocco's energy consumption has seen a steady rise in recent years, with an average annual growth rate of 5%. This reflects economic growth and a rising population which has now gained universal energy access. At the same time, Morocco has seen a gradual decoupling of economic growth and energy consumption, with an overall 9% reduction of its energy intensity since 2007.

Following the adoption of ambitious national targets to reduce energy consumption, a comprehensive and stringent energy efficiency framework Law 47-09 was adopted in 2011. However, the implementation of the target and framework has raised challenges because of the need for coordination across government, the lack of financial resources for energy efficiency programmes, and significant difficulties in the adoption of the necessary secondary legislation. Although a package of secondary legislation has already been developed, it has not yet been adopted.

The government prepared an Energy Efficiency Strategy for 2030, targeting a broad range of measures in the key energy-end use sectors in line with a more ambitious 2030 target of 20%, which was presented to the Council of Ministers in June 2017.

Achieving the government's targets will require strong overall governance, including close coordination and sustained stakeholder engagement, notably with the private sector. The Energy Efficiency Strategy builds on an action plan, which is being consolidated with all the stakeholders concerned, including the territorial communities and the large number of private sector initiatives. The new Energy Efficiency Agency (AMEE) is in charge of leading on the implementation of the action plan across industry, transport and buildings. The Ministry of Energy, Mines, and Sustainable Development has launched a consultation with the stakeholders involved in the preparation of energy

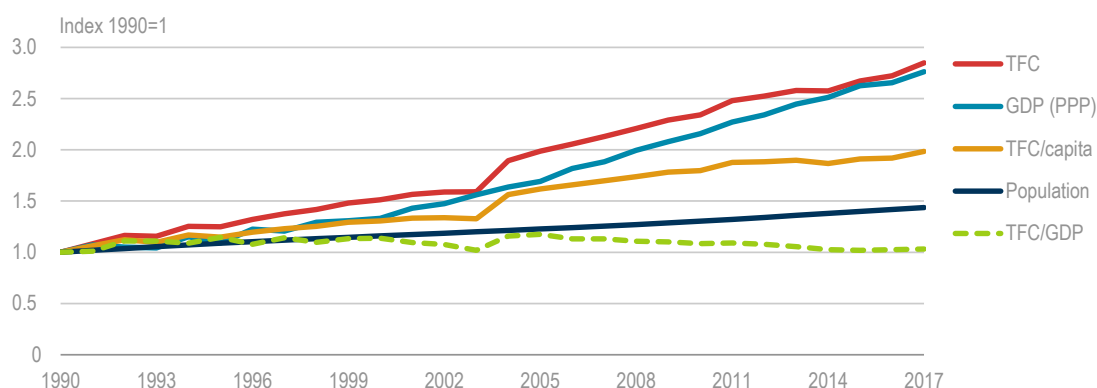
efficiency plan across government. Once the Energy Efficiency Strategy is adopted by the government, the Department of Energy and Mines will take all the necessary measures. To accompany this large undertaking, the implementing rules of the Law 47-09 on Energy Efficiency are being revised.

Energy intensity

In 2017, Morocco's total final consumption (TFC) reached 16.1 Mtoe, a 34% increase from a decade before. TFC is largely dominated by three sectors – transport, residential and industry - which not only accounted for over four-fifths of total final consumption but also showed high growth rates.

Although Morocco's energy demand has increased in step with the country's economic development, energy intensity (TFC/GDP) has decreased by 9% from a decade ago (see Figure 4.1). Energy intensity, measured as the ratio of TFC per unit of real gross domestic product adjusted for purchasing power parity (GDP PPP), was 60.5 tonnes of oil-equivalent (toe) per USD million GDP PPP in 2017.

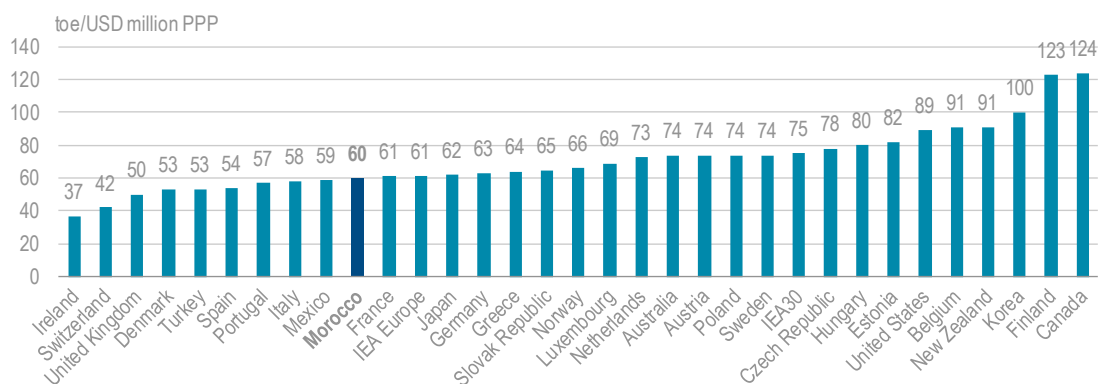
Figure 4.1 Energy demand and drivers, 1990-17



Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

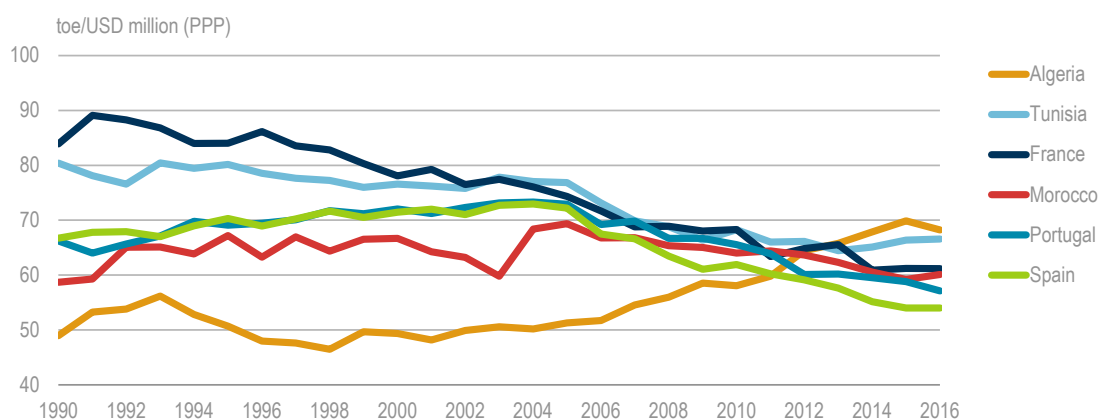
When Morocco is compared with IEA member countries, the level of Morocco's energy intensity is the tenth-lowest, lower than the IEA average and just below the IEA Europe average (Figure 4.2).

In 2016, the Moroccan population consumed 0.4 toe per capita on average, which is less than any IEA member country. The IEA 30 countries' average was 2.9 toe/capita in the same year (see Figure 4.4).

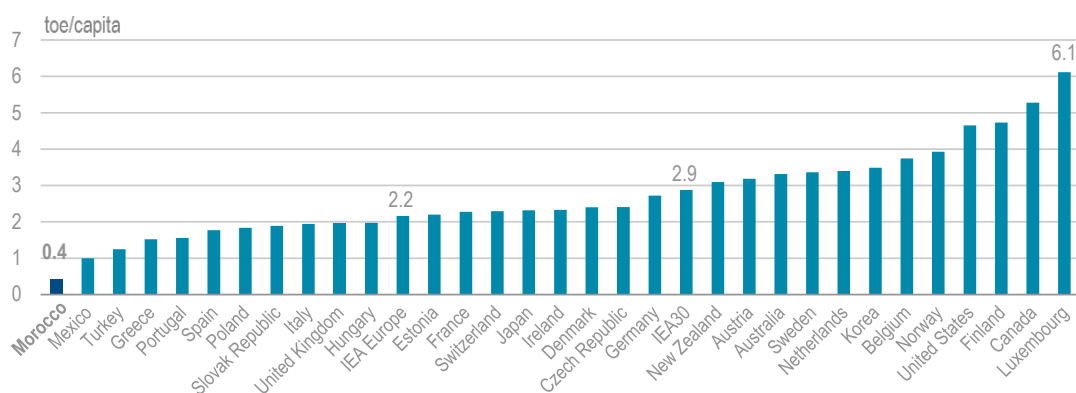
Figure 4.2 Energy intensity (TFC/GDP) in IEA member countries, 2016

Source: IEA (2018a), *World Energy Balances*, 2018, www.iea.org/statistics/.

Morocco's energy intensity has been decreasing over time (Figure 4.3), and within the Mediterranean region, Morocco has a unique energy consumption profile.

Figure 4.3 Energy intensity in Morocco and selected countries, 1990-2016

Source: IEA (2018a), *World Energy Balances*, 2018, www.iea.org/statistics/.

Figure 4.4 Energy consumption (TFC) per capita in IEA member countries, 2016

Source: IEA (2018a), *World Energy Balances*, 2018, www.iea.org/statistics/.

Energy consumption by sector

Morocco's energy consumption has shown a sharp increase over the last decade. Transport accounts for the biggest share of consumption, followed by the residential and industrial sectors.

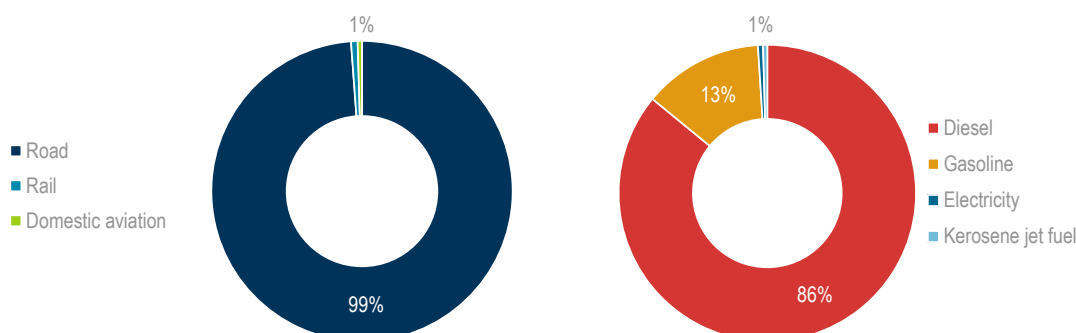
Over the past decade, energy consumption increased significantly in transport and agriculture, and at a lower rate in the residential and industry sectors, while it remained almost flat in commercial and public services.

Oil is the largest fuel and electricity the second largest in all sectors except for commercial sector, where biofuels dominate.

Transport

In 2017, the transport sector consumed 5.8 Mtoe, accounting for the largest share of Morocco's TFC. Transport energy consumption has risen by 58% since 2007 and grew more than four-fold since 1990. Oil is the predominant fuel in Morocco's rapidly growing transport sector, with no role for electricity or biofuels.

Figure 4.5 Transport energy demand by transport mode and fuels, 2017



*Negligible

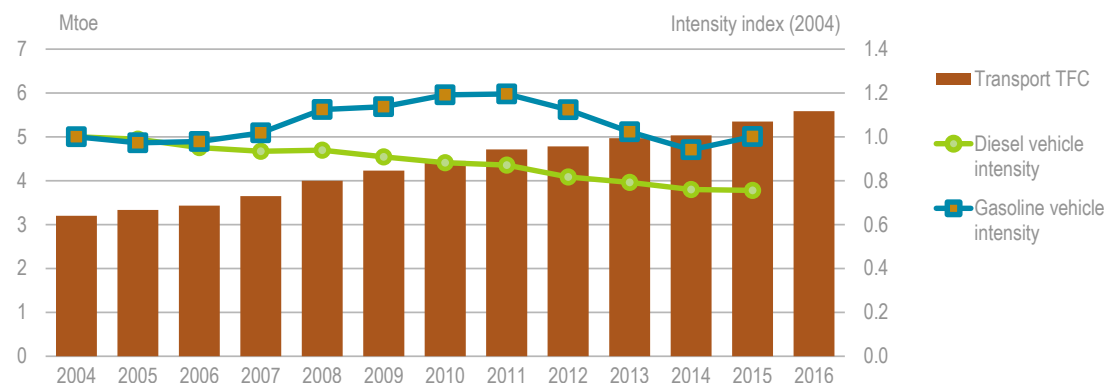
Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

Road transport accounts for 99% of transport energy consumption, of which around 86% comes from diesel and the rest from gasoline (see Figure 4.5). Morocco's transport consumption is driven by freight, passenger vehicles and taxis, as well as commercial vans. A steady increase in the total vehicle stock reflects Morocco's GDP per capita growth as well as the government's aspiration to become a regional hub for the automotive industry.

Despite the rise in transport TFC, transport energy intensity improved in 2004-16 (see Figure 4.6), at least partly as a result of more efficient vehicles and policies to foster the renewal of the vehicle fleet. Important factors are the ban on importing old vehicles (above 5 years) and the phase out of diesel subsidies by 2015. This has created a strong market preference for more efficient cars with higher fuel efficiency, leading to the declining trend in energy intensity in recent years. An increase in the share of less

efficient gasoline cars (including by a new fleet of private taxis) was responsible for a rise of gasoline vehicle intensity in 2009-12 (CEDARE, 2015).

Figure 4.6 Transport consumption and energy intensity, 2004-16

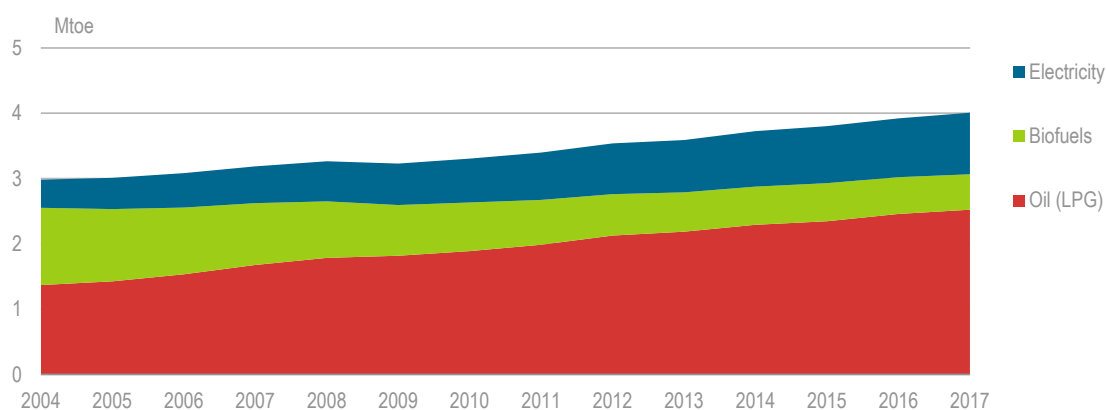


Source: IEA (2018a), *World Energy Balances, 2018*, www.iea.org/statistics/.

Residential sector

In 2017, the residential sector consumed 4.0 Mtoe, an increase by 26% from 2007. Oil, mostly liquefied petroleum gas (LPG or butane), is the dominant fuel with 63% of total consumption in the sector, followed by electricity (23%) and biofuels (14%) (Figure 4.7). From 2007 to 2017, LPG consumption increased by 50% and electricity consumption by 67%, replacing solid biofuels that were the major source for cooking and heating. The consumption of traditional forms of biomass (wood and charcoal) decreased by 43% in the residential sector over the period. This reflects efforts by the Moroccan government to promote alternatives to biomass, so as to prevent the deforestation and health problems associated with their use, including chronic respiratory diseases.

Figure 4.7 TFC in residential sector by source, 2004-17

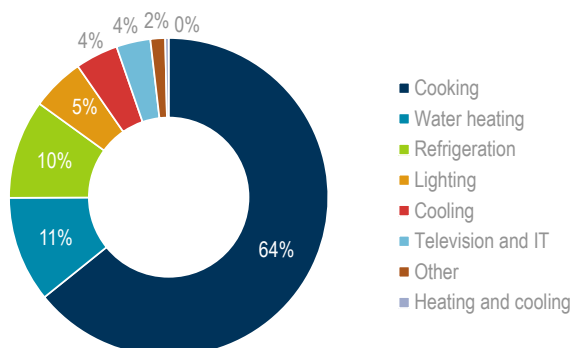


Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

In Morocco, cooking accounts for around two-thirds of total energy demand in the residential sector, which is very high compared to most IEA member countries. The other main energy demands in the residential sector are for water heating, refrigeration,

lighting and electric appliances. Space heating and air conditioning represent a very small share of total residential energy consumption, as illustrated in Figure 4.8.

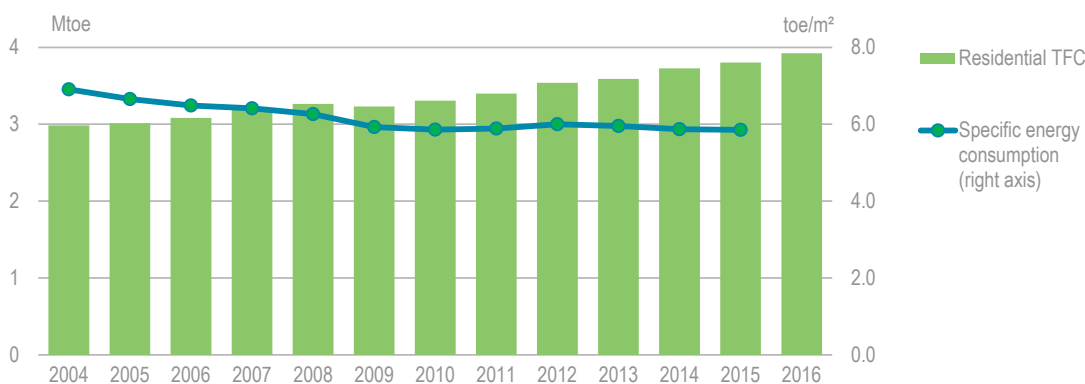
Figure 4.8 Residential energy consumption by end-use, 2015



Source: DOCC (Direction de l'Observation, de la Coopération et de la Communication) (2015), Indicateurs de l'Efficacité Énergétique au Maroc, 2004-2013 [Energy Efficiency Indicators for Morocco, 2004-2013], Rabat, Morocco.

While residential consumption increased by 27% between 2006-16 in step with population growth, energy consumption per building area has decreased slightly over the same period, reflecting the renewal of the buildings stock with new more energy-efficient constructions (see Figure 4.9).

Figure 4.9 Residential consumption and energy intensity, 2004-16



Source: IEA (2018a), *World Energy Balances*, 2018, www.iea.org/statistics/.

Oil use still accounts for 63% of Morocco's residential energy consumption, which is exceptionally high compared to most IEA countries (IEA average: 13%). Morocco still subsidises the consumption of butane (LPG) for cooking and residential uses, but the government has plans to phase out the butane subsidies after 2021 in favour of targeted social support to vulnerable consumer groups (see Chapter on Oil).

Morocco has achieved universal access to electricity of its rural population, which is encouraging greater electricity use and the spread of modern appliances, notably to satisfy cooling needs. IEA projects that about 40% of households could be using air conditioners and electric fans by 2030 (see Box 4.1).

Box 4.1 Opportunities for energy-efficient cooling system in Morocco

Air conditioners (ACs) and electric fans account for nearly one-fifths of total electricity consumption in buildings around the world today, and this trend is set to grow as the world's economic and demographic growth becomes more focused in hotter countries like Morocco.

Morocco's residential AC ownership is estimated to be around 18% today, a significant increase from the 2% level in the early 2000s. Given the country's warm climate and its projected economic development, the IEA projects that about 40% of households could have ACs by 2030.

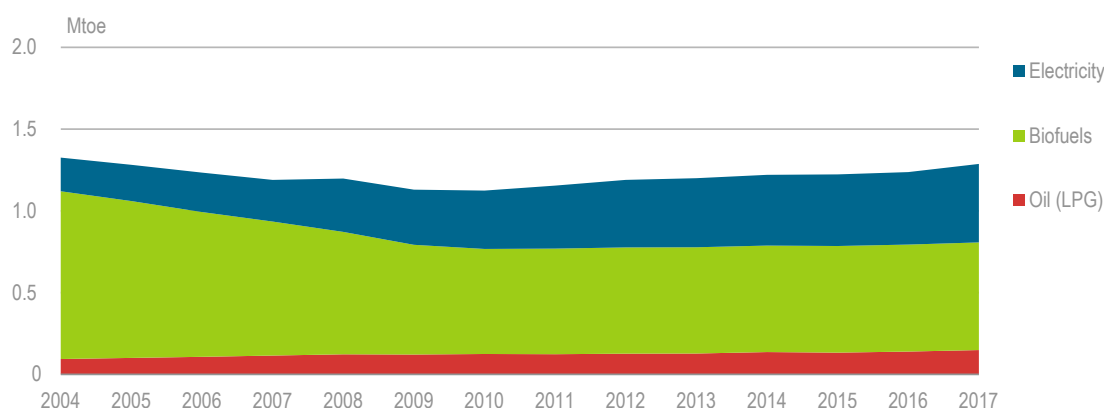
Such a trajectory would significantly raise Morocco's future electricity demand, particularly since average AC efficiency is rather low at the moment. Morocco could minimise the level of the increase and boost energy efficiency by aligning its energy efficiency regulations and standards with those at regional and/or global level to allow easier market access for the most energy-efficient products, promote business development, and accelerate technological advancement.

Source: IEA (2018b), The Future of Cooling - opportunities for energy-efficient air conditioning, OECD/IEA.

Commercial sector

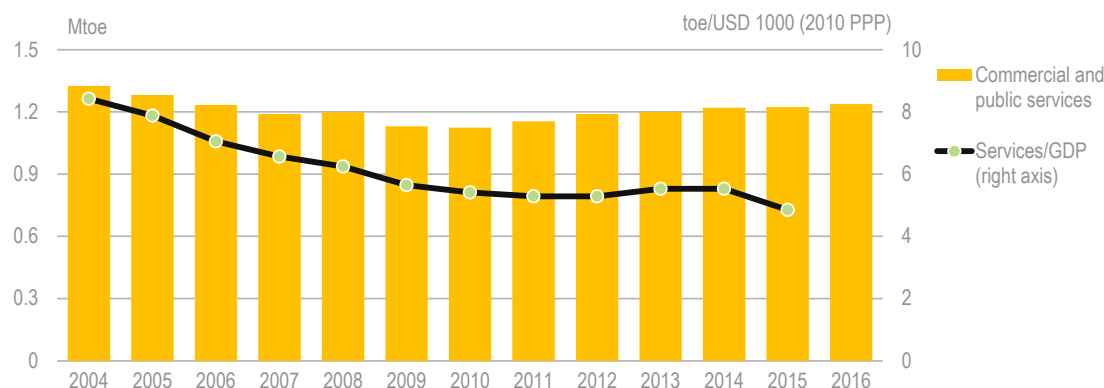
Energy consumption in the commercial and public services sector has been stable over the past decade. In 2017, Morocco's commercial and public service sector consumed 1.3 Mtoe (see Figure 4.10), mainly for cooking and water heating in public and commercial buildings, such as restaurants and hotels. Solid biofuels still accounted for over half of total energy demand in the sector, followed by electricity with over one-third of total demand. With greater electrification, electricity demand increased by 88% from 2007 to 2017, and biofuels demand declined by 20%. Oil products represent a significantly smaller share than in the residential sector. In 2017, oil accounted for 12% of total energy consumption in the sector, two-thirds of which was liquefied petroleum gas and one-third heating oil (gas/diesel oil). Diesel oil consumption is high in the public sector, notably public administration and schools (IEA, 2016).

Changing consumption patterns in both the residential and commercial sectors demonstrate how policies to drive fuel switching can have a significant impact on energy demand. The use of biofuels (wood) is decreasing in Morocco's overall TFC amidst rising concerns about deforestation and air quality. The government strengthened efforts to reduce direct combustion of wood, for instance with programmes for hammams (Turkish baths) (IEA, 2016). Fuel switching from traditional solid biomass or LPG to electricity can improve energy efficiency in final energy consumption, and it explains the reduced energy intensity in the service sector in the past decade (see Figure 4.11).

Figure 4.10 TFC in commercial and public services by source, 2004-16

*Oil consumption includes liquefied petroleum gases and light heating oil.

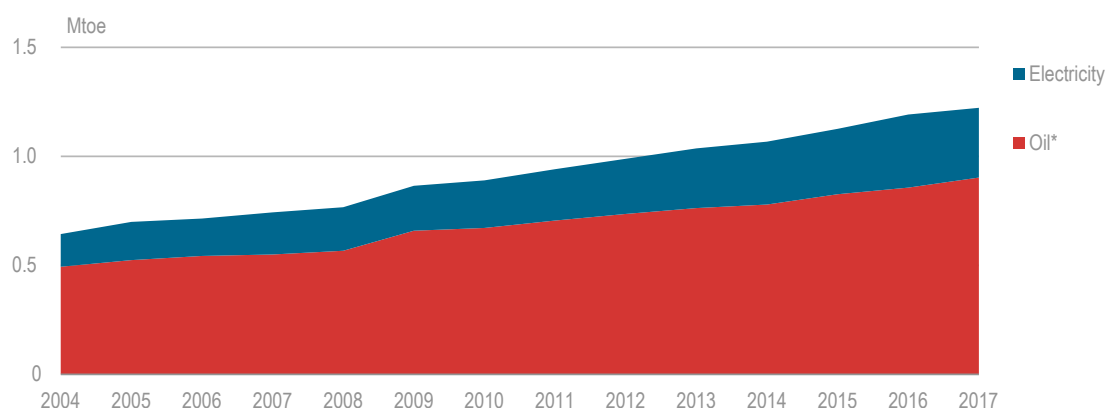
Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

Figure 4.11 Services consumption and energy intensity, 2004-16

Source: IEA (2018a), *World Energy Balances, 2018*, www.iea.org/statistics/.

Agriculture

Agriculture is very important for Morocco. In 2017, the agricultural sector accounted for over one-third of total employment in the country, and 13% of total GDP (World Bank, 2018a). The sector is growing in terms of both value added and energy consumption. In 2017, agricultural energy consumption was 1.2 Mtoe, of which 74% was oil and 26% electricity (Figure 4.12). From 2007 to 2017, energy consumption in agriculture increased by 65%, whereas value added increased by 33% in USD 2010-values (World Bank, 2018b).

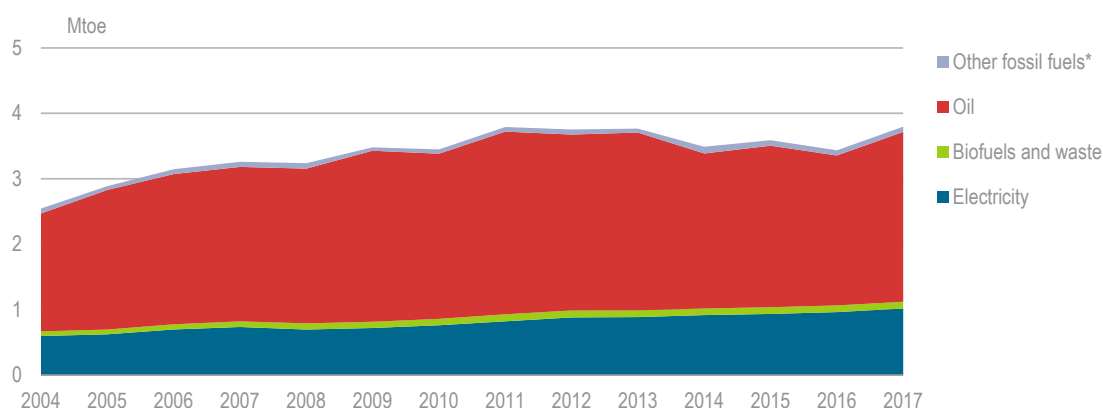
Figure 4.12 TFC in agriculture by source, 2004-17

*Oil consumption includes diesel and a small share of gasoline.

Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

Industry

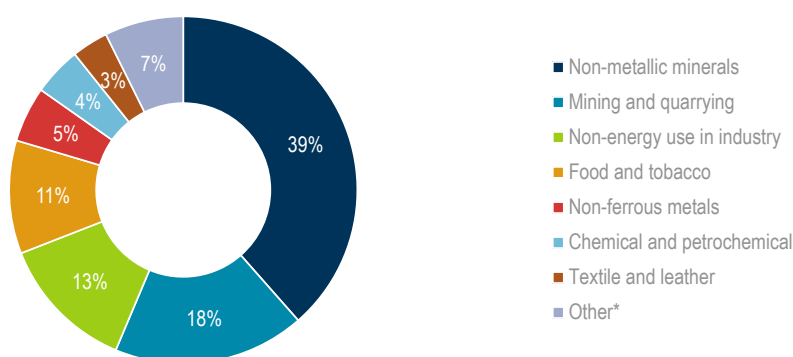
Oil and electricity use dominates industrial energy consumption in Morocco (see Figure 4.13). Fuel oil (petroleum coke) and other oil products are by far the largest source, accounting for 68% of consumption in 2017, followed by 27% from electricity, 3% from biofuels and waste, and 2% from natural gas. In 2017, industry TFC reached 3.8 Mtoe, from the same level as the peak of 2011-13. Oil use has been in decline from 2013 onwards as fossil fuel subsidies were phased out but increased again in 2017.

Figure 4.13 TFC in industry by source, 2004-17

*Includes natural gas and a small share of hard coal.

Notes: Includes non-energy consumption.

Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

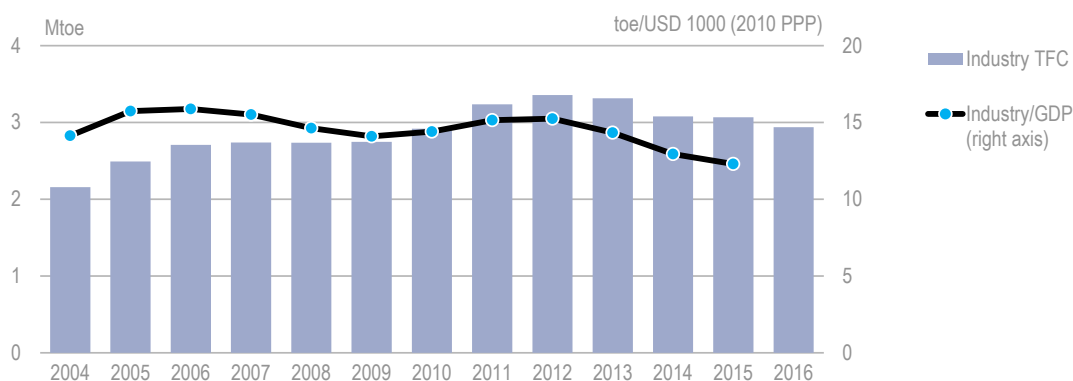
Figure 4.14 TFC in industry by sector, 2016

*Others includes construction, paper, machinery, transport equipment and woods.

Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

The non-metallic mineral industry and mining and quarrying are the two largest industries in terms of energy consumption, making up nearly 60% of total consumption in the sector. The cement industry (Lafarge, Ciments de Maroc) alone is responsible for a third of total industry consumption, mainly in the form of petroleum coke use for clinker production. Morocco's phosphate rock mining and chemical processing (OCP) provides for more than 20% of industrial energy consumption and generates 50% of total GDP. Chemical production includes the processing of phosphate into fertilisers and other chemical products. Other industrial activities include process industries, notably paper & pulp, food (sugar production) and tobacco processing, textiles and leather production (Figure 4.13).

Although industrial energy consumption increased by 41% during 2004-15, its energy intensity decreased by 13% over the same period (see Figure 4.15). A decline in intensity in terms of energy consumption per unit of GDP can be explained by either more energy-efficient industrial processes or structural changes in the country's industry. In the case of Morocco, the cement industry is relatively energy efficient by international comparison (IEA, 2016), while sugar production and paper and pulp remain energy-intensive, relying on steam-based production, using fossil fuels.

Figure 4.15 Industrial consumption and energy intensity, 2004-16

Source: IEA (2018a), *World Energy Balances, 2018*, www.iea.org/statistics/.

Institutions

The Ministry of Energy, Mines, and Sustainable Development (*Ministère de l'Énergie, des Mines et du Développement Durable*, MEMDD) is responsible for Morocco's overall energy policy, including energy efficiency. The responsibility for energy efficiency policy lies with the Division for Renewable Energy and Energy Efficiency, which has two divisions. MEMDD is also in charge of designing the national energy efficiency strategies and policy directions.

The National Agency for Energy Efficiency (*Agence marocaine pour l'efficacité énergétique*, AMEE) is the new agency in charge of implementing Morocco's energy efficiency strategy. AMEE was set up in 2016, based on Law 39-16 to replace the previous National Agency for Renewable Energies and Energy Efficiency (ADEREE).

The **Ministry for Urbanisation** leads on urban planning and energy efficiency standards. The **Ministry of Industry, Investment, Trade and Digital Economy** and the **Ministry of Equipment, Transport, Logistics and Water** are involved in the implementation of energy efficiency policies in the sectors under their responsibility. The **Ministry of General Affairs and Governance** regulates electricity and fuel prices. The **Moroccan Institute of Standardisation** (IMANOR) is the national organisation for standardisation established by Law No. 12-06 on standardisation, certification and accreditation under the supervision of the Ministry of Industry, Investment, Trade and Digital Economy.

The **Institute for Research into Solar and New Energies** (*Institut de Recherche en Énergie Solaire et Énergies Nouvelles*, IRESEN) is financing several R&D and innovation projects, involving universities and Moroccan companies, which aims to support the development of new products, services and processes in the field of energy efficiency in building, agriculture, transport, industry and mining. IRESEN has a new research facility "Green and Smart Building Park" in Ben Guerir to promote green houses, energy efficiency, smart grid and sustainable mobility.

The **Energy Development Fund**, created in 2009 by bilateral donors, finances renewable energy and energy efficiency actions to support energy security and low-carbon growth. The **Clean Energy Technology Fund** (CTF) boosts these efforts.

Policies and regulations

Strategic objectives

Energy efficiency has been a national policy priority since 2009, in the context of the National Priority Action Plan (*Plan National d'Actions Prioritaires*, PNAP) for the energy sector 2008-12 and the National Energy Strategy in 2009.

In March 2013, the energy efficiency/renewable energy agency ADEREE launched a national debate and assessment of Morocco's energy efficiency trends and opportunities (*États Généraux de l'Efficacité Énergétique*, ADEREE, 2014) with the objective of developing a new national energy efficiency strategy by 2030, along with action plans for the short, medium and long term. ADEREE proposed a 20% target for 2030 with a sectoral break down for the reduction of energy consumption in buildings (20%) and transport

(35%), and a reduced energy intensity in industry (2.5% per year) and in agriculture and fisheries (0.2% per year). Based on this assessment and reviews by AMEE and MEMDD, in coordination with other relevant stakeholders, the Ministry is currently proposing the following energy efficiency targets: the 2020 target was adjusted to 5% energy savings target by 2021, while for 2030 a 20% target is envisaged, as an indication of increased ambition for the future.

Work is under way towards a new **National Energy Efficiency Strategy to 2030**, which was presented at the Government Council of 22 June 2017 but has not yet been officially adopted at the time of writing. The draft strategy contains about 100 legislative, regulatory fiscal and other measures to improve energy efficiency in industry; construction and technology; buildings; transport infrastructure; street lighting and domestic lighting. It also contains actions for increasing awareness, and for education and capacity building. Positive economic, environmental and societal benefits have been considered in developing this strategy.

A comprehensive action plan (financial “contract-programme”) is under preparation in 2018 to implement actions over five years involving the regions, AMEE, MEMDD, and the sectoral Ministries, including the Ministries of Housing, Interior, Agriculture, Industry, Transport and Finance.

Legal framework

Law 47-09 on energy efficiency, adopted in September 2011, created a legal framework for improving energy efficiency across the economy, in buildings (residential and commercial), transport and industry. It introduced energy performance requirements for buildings, equipment and appliances; compulsory energy audits for businesses and facilities exceeding a certain consumption threshold; a requirement to conduct energy impact assessments for urban development and construction projects in which anticipated consumption exceeds a certain threshold; and provisions on technical control, compliance and penalties. Secondary legislation is required to implement Law 47-09. By 2018, the first implementing decree had been adopted, establishing thermal regulations for buildings (see section on buildings). Several other decrees have been prepared including:

- The creation of an authorisation scheme for ESCOs as enterprises under Moroccan law, which will need to fulfil certain technical, logistical, organisational and operational conditions.
- The adoption of new energy performance standards of appliances and equipment.
- A regulatory decree for the design of energy impact assessments of any projected urban planning or building construction project.

Energy efficiency indicators

A system for developing energy efficiency indicators has been established in Morocco by the government and the former energy efficiency agency, ADEREE in collaboration with ADEME (the French environment and energy management agency), Alcor and EnerData in 2013 (ADEREE, 2013). In 2018, the Directorate of Observation, Cooperation and Communication of MEMDD compiled energy efficiency indicators for all sectors using the energy balance and the results of sectoral energy consumption surveys. About 30 indicators have been developed (IEA, 2016) as part of an energy efficiency indicator

database. The database will be updated by AMEE in collaboration with ADEME and the Mediterranean Association of National Agencies for Energy Management (MEDENER).

Energy efficiency financing

Until now, energy efficiency programmes have been financed by international funds, including the Morocco Sustainable Energy Financing Facility (MorSEFF – see Box 4.), the EBRD, GIZ, and KfW. Most of the funds aim to finance the development and promotion of both renewable energy and energy efficiency measures. Traditional financing can be obtained from Moroccan banks (e.g. Banque Centrale Populaire, Chaabi International Bank Offshore, and BMCE Bank), and there are several mechanisms available to facilitate project implementation and help reduce financial risks (GIZ, 2017).

Energy prices and subsidies

Energy prices have a major impact on energy consumption levels and patterns. By 2016, the Moroccan government had successfully phased out fossil fuel subsidies, with the exception of the large subsidies for LPG (butane) use. Electricity prices have been increased, but there are still subsidies and cross-subsidies within the electricity sector and between electricity and water. The lack of cost-reflective electricity pricing reduces overall incentives for efficient use of energy. But there are now differentiated electricity tariffs for households according to their consumption level. Morocco also has peak and off-peak pricing for industrial consumers, incentivising production during off-peak hours.

Box 4.2 Morocco Sustainable Energy Financing Facility (MorSEFF)

The Morocco Sustainable Energy Financing Facility (MorSEFF) was established in 2015 by EBRD, EIB, KfW and AFD to promote investments in energy efficiency and renewable energy in Morocco. It has EUR 110 million available for loans, EUR 15 million for incentives (an EU grant), and EUR 5 million for technical assistance. MorSEFF provides to prospective borrowers:

- Financing of up to MAD 3 000 000 for small-scale projects available through a pre-approved List of Eligible Materials and Equipment (LEME) and of up to MAD 50 000 000 for larger or more complex investment projects.
- Investment incentives of 10% of financing amount funded by grants from the EU Neighbourhood Investment Facility (EU NIF).
- Free-of-charge technical assistance for project assessment and implementation by a dedicated Project Consultant, and verification of projects post-implementation by a Verification Consultant; both funded by grants from the EU NIF and the SEMED Multi-Donor Account.
- Local distribution through Moroccan Participating Banks - Banque Centrale Populaire and BMCE Bank.

As of April 2018, total disbursement to projects amounted to EUR70 million (out of EUR 110 million available).

Sources: <http://www.morseff.com/> and EBRD (2018)

Buildings

Because of rapid urbanisation and a construction boom, controlling energy consumption in buildings is a key focus of Morocco's energy strategy. Morocco had around 6.4 million of residential dwellings at the end of 2016. The number of new dwellings built has been growing by 150 000 per year (AMEE, 2017). In addition, there has been a steady growth in the construction of new non-residential buildings (hotels and holiday apartments, and educational facilities).

Thermal regulation

The thermal regulation code (decree No. 2-13-874) was adopted in October 2014 and introduced minimum technical requirements in terms of thermal performance for new constructions for residential and tertiary use (social housing and freestanding buildings in the residential sector and hotels, offices, educational facilities and hospitals in the commercial sector). Each of Morocco's six climate zone has its own specific thermal requirements. Their implementation became mandatory in December 2015. The labelling of buildings in terms of thermal performance is voluntary seeing this as adding value. For existing buildings, there are no measures to stimulate renovation to higher energy efficiency performance in private buildings.

The thermal regulation is based on a two-tier approach: 1) A «performance-based» approach to the maximum energy consumption for the building's heating and air conditioning, expressed in kWh/m²/year; and 2) A «prescriptive» approach which sets targets for the thermal properties of the various components of the envelope (roofs, exterior walls, windows, floors, etc.), according to the climate zone and window ratio (AMEE, 2017).

Application and compliance

Supported by international technical assistance, AMEE is implementing an action plan for the application of the thermal regulation, which includes training of the key actors in the construction sector, standardisation of construction materials, and awareness raising and education campaigns. For instance, AMEE has developed BINAYATE, a free software application to assist architects and thermal performance evaluators in carrying out regulatory thermal calculations of buildings.

Compliance with the thermal regulation and enforcement of the regulation remain a challenge. Despite the existence of penalties for non-compliance under Law 47-09, some new constructions reportedly do not comply with the regulation. Local agencies under the Ministry of Housing issue construction permits but do not perform checks during and after the construction. AMEE is mandated to carry out selective checks of compliance with the thermal regulation but these checks are not systematic. The Ministry of Interior is developing amendments to the existing urban construction regulations to introduce stricter monitoring, control and enforcement practices.

One key reason for non-compliance relates to the potential increase in the total construction cost. For the construction of social housing the developer has a contract with the government and must not exceed a regulated real estate price per m². By the end of 2017, seven demonstration projects had been implemented in different climatic zones to demonstrate energy efficiency and renewable energy use in residential and commercial buildings. They suggest that the increase in the construction cost due to the

implementation of the thermal regulation is between 5% and 7%, although this is likely to decrease as the sector's experience grows.

Energy impact studies may be helpful in this context. The Energy Efficiency Law imposes a strict requirement to conduct energy impact assessments, going beyond environmental screening. Energy impact studies have been conducted for several new cities, including Sahel Lakhyayta and Chrafate where a contract on promoting energy efficiency and renewable energy in the housing and urban planning sector was signed between the government and real estate developers (IEA, 2014).

Research, development and innovation

IRESEN is financing several R&D and Innovation projects, involving universities and Moroccan companies, with the aim to support the development of new products, services and processes oriented to the market, in the field of energy efficiency in building, agriculture, transport, industry and mining.

IRESEN's new platform "The Green & Smart Building Park" in partnership with the UM6P University in Benguerir, thanks to financial support of the Korean cooperation Agency (KOICA). The project will host the first researchers in late 2019 to innovate in the fields of green buildings, energy efficiency, smart grids and sustainable mobility through experimentation, training and research. This platform aims to create the ecosystem required for the development of the future sustainable Moroccan and African city.

Box 4.3 Green mosques and buildings

In 2014, the Ministry of Energy (MEMDD) and the Ministry of Religious Affairs initiated the project "Green Mosques" in co-operation with SIE and AMEE with the objective of improving the energy performance of 15 000 existing mosques - new mosques have to comply with Morocco's recent thermal performance regulation. Over the period 2015-21, the MEMDD is implementing the programme with support from the German Federal Ministry for Economic Cooperation and Development (BMZ) and GIZ, focusing on mosques and public buildings, as part of the BMZ Special Initiative for Stability and Development in the MENA Region. The energy systems of 100 mosques have been modernised and works are under preparation in 600 more mosques. In the town of Tadmamt, the project supported the construction of an energy-plus mosque, and surveys of the existing energy situation of almost 1 000 mosques have been carried out by employees of the Ministry of Religious Affairs. The programme has achieved improvements thanks to efficient lighting, insulation, and solar water heating and solar PV technologies. A labelling system has been developed by AMEE and will be deployed in all the mosques, which are involved in the programme.

Source: GIZ, <https://www.giz.de/en/worldwide/32825.html>.

Commercial and residential

To implement Law 47-09 on energy efficiency, a regulation was adopted on 28 March 2019 to introduce an obligation on businesses to report their installed power capacity and

energy consumption as well as perform mandatory energy audits, if consumption reaches above 500 tonnes of oil-equivalent (toe) per year.

Appliances

Morocco's product regulation (NM 14.2.300) requires the labelling of electrical products and household appliances³ (IEA, 2014), but does not mandate minimum performance standards. To update the regulation in line with new products, the Moroccan Institution for Normalisation (IMANOR) launched in early 2017 a public consultation process and approved an amended labelling regulation in its decision of 12 October 2017.

The government is developing minimum performance standards with assistance from international financial institutions. The EBRD is providing technical assistance to AMEE to introduce minimum energy performance standards (MEPS) for equipment and appliances. The project develops technical assessment and drafts MEPS and labelling regulations for four priority equipment types – electric motors, transformers, refrigerators, and air conditioners. It is also initiating the development of a monitoring, verification and enforcement (MVE) protocol (EBRD, 2018).

The introduction of standards and labelling requirements is expected to generate 8% net savings in national electricity consumption within 15 to 20 years. The potential net cumulative emission reduction is projected to reach 36 Mt CO₂ by 2037 (EBRD, 2018). AMEE plans campaigns to raise awareness to promote the replacement of appliances by more efficient ones and to inform the public about the benefits of using appliances complying with higher efficiency standards.

Lighting

The largest electricity consuming segment of the commercial sector in Morocco is public lighting. The Moroccan government launched a programme promoting the use of compact fluorescent lamps (CFLs) in public buildings and public lighting in 2010. The electricity providers were tasked with selling CFLs to the end users, supported by low-interest loans from international financial institutions. By early 2018, 15 million CFLs had been distributed in the residential sector by the National Agency for Electricity and Water (ONEE). Morocco has also implemented daylight savings; with the adoption of the GMT+1 time zone during the summer months (May-July, September-October) to make better use of natural sunlight.

The government plans to introduce an obligation on municipalities to report their energy consumption and expenditure on public lighting (investment and exploitation). AMEE is setting up an information platform to help municipalities manage the energy performance of public lighting. The platform is expected to include a database that provides the consumption information collected from the municipalities.

After the completion of a pilot public lighting project powered by solar energy in the region of Fez, the first Local Development Corporation (SDL) was established in Salé as

³The regulation covers cooling appliances (refrigerators, freezers and air conditioners), cooking appliances (electric ovens), cleaning appliances (dishwashers, washing machines and clothes dryers) and household electric lamps (incandescent and fluorescent lamps with/without integrated ballast).

a Public-Private Partnership (PPP) for the management of lighting. The model of SDL Salé as PPP is expected to be replicated in other Moroccan cities, with the aim of:

- Renovating the public lighting installations in the city.
- Extending the public lighting network to the entire urban territory.
- Reducing the impact of energy costs on the Communal budget (consumption and maintenance).
- Establishing a preventive and corrective maintenance regime to ensure that equipment is maintained in optimum technical and economic conditions.

Industry

To implement Law 47-09 on energy efficiency in the commercial sector, a regulation has been adopted to introduce an obligation on businesses to report their installed power capacity and energy consumption as well as perform mandatory energy audits, if consumption reaches above 1500 tonnes of oil-equivalent (toe) per year.

Voluntary audits in large companies have already been carried out, often with the support from international development institutions, including the European Investment Bank and the African Development Bank. The audited companies do not have a legal obligation to implement energy efficiency measures after the audit, but many of them reported that the audits enabled them to identify some low-cost opportunities to reduce operational costs and improve competitiveness. AMEE, supported by UNIDO, also carried out training sessions for large companies to help businesses optimise and rationalise their energy use. The first audit results showed that approximately 360 out of the 8000 companies audited accounted for about 70% of industrial energy consumption. Such large concentration of energy use in less than 5% of facilities demonstrates that there may be opportunities to achieve large energy savings by targeting a relatively small number of individual facilities (IEA, 2016).

The industrial sector in Morocco is very responsive to peak electricity tariffs. The preferential tariff for industries (known as “super-peak”) invites companies voluntarily to shift their energy consumption away from peak periods so they can take advantage of a much lower tariff during the low-demand hours. Many energy-intensive companies, including in the steel industry, have joined this programme to reduce their energy bills. The pricing is part of the connection/supply agreement with ONEE which requires energy-intensive industrial sites to disconnect from high voltage networks during evening peak hours (see Chapter on Electricity).

Morocco’s environmental regulations are intended to provide incentives for energy efficiency improvements by setting limits on air pollutant emissions for industry, and several successful pilot projects have been implemented over the last two decades by UNDP, UNEP and UNIDO to reduce the atmospheric emissions of industry. The enforcement of these regulations is however challenging (see Chapter on Environment and Climate Change). Energy efficiency improvements reduce emissions but end-of-pipe technologies and changes in combustion characteristics as well as quality of fuels can achieve even more, usually at the expense of some increase in energy consumption.

The Ministry of Industry and AMEE, in co-operation with UNIDO, are developing the concept of a demonstration project “Model factory” – a service centre providing different services to industrial companies on different aspects of sustainable development, including energy efficiency. The Ministry of Industry is also considering introducing “energy quotas” for some key energy-intensive industrial processes such as cement production to reduce energy consumption per unit of industrial output to improve the competitiveness of the local industry, although there are no firm plans or proposals yet.

The key driver for energy efficiency in industry is the expected economic benefits from the energy savings to be achieved. Several industrial energy efficiency projects are being implemented in Morocco to deliver such savings; some of them are financed by IFIs such as EBRD.

Agriculture

In the agricultural sector, ADEREE (now AMEE) carried out a voluntary energy audit programme for agricultural producers. The programme aimed to evaluate the potential for energy savings and local energy production from renewable sources, with the goal of reducing operating costs and improving the competitiveness of the agricultural sector. A public-private partnership between ADEREE and the Crédit Agricole group in Morocco was established to provide technical assistance to farms involved in the project.

Morocco has been using the subsidy programme PROMASOL to support the introduction of solar water heating and solar water pumps as well as other initiatives to encourage the use of renewable energy in agriculture, with the aim of reducing the use of fossil fuels (LPG use for water pumping) and improving the sector’s competitiveness (see Chapter on Renewable Energy).

In 2018, with the support of UNDP and GEF, AMEE launched a project to promote the adoption of photovoltaic pumping systems for drip irrigation in Morocco along four components:

- demonstration of the technical and economic viability of solar pumping for irrigation
- development of the implementation framework and standards for solar pumping practices and drip irrigation systems
- identification and design of funding support and incentive mechanisms, and
- capacity building of stakeholders.

Transport

The transport sector employs 10% of the urban workforce, and accounts for around 5% of Morocco’s GDP, 38% of its total final energy consumption, and 23% of its greenhouse gas emissions. Road transport accounts for 99% of the total energy consumption of the

transport sector. Aviation and maritime transport each account for 1.8% and 1.7% respectively, and rail transport for 0.3 %⁴ (Government of Morocco, 2016a).

The overarching strategy of the Ministry of Equipment, Transport, Logistics and Water (METLW) for 2017-2021 emphasises sustainable, economically and socially efficient transport systems that are safer, more energy efficient and more environmentally and user friendly. The National Strategy for Developing the Competitiveness of Logistics of Morocco sets the objective of reducing energy consumption by 2030 and promoting multi-modal transport and switching to less polluting modes.

According to METLW, several existing measures targeting road transport have already resulted in significant CO₂ reductions (METLW, 2018). Morocco's Nationally Determined Contribution (NDC) and the Third National Communication submitted to UNFCCC list the existing and planned transport-related measures, outlined below, that are expected to lead to further emission reductions by 2030.

Supported by the German development institutions (GIZ), METLW has started to build on this by developing a national Roadmap for Sustainable Mobility, inspired by the global roadmap of the Paris Process for Mobility and Climate (PPMC). The draft roadmap (Figure 4.15) has been released for public consultation.

Electric mobility

Morocco has started several initiatives to encourage the development of electric mobility. Through its funding agency, IRESEN has also financed several R&D projects during last four years, involving universities and Moroccan companies in the field of sustainable mobility.

Box 4.4 GEF-Transport Technical Assistance project

The four-year technical assistance project "Integration of climate change in the national strategy for developing competitiveness of logistics and in the implementation of integrated logistics platforms" was launched on 28 March 2016 by the Ministry of Equipment, Transport, Logistics and Water in partnership with UNDP and the financial support of the Global Environment Facility (GEF).

The objective of the project is to contribute to the greenhouse gas emissions mitigation efforts in the transport sector. The project's key activities include:

- Institutional strengthening and capacity building for low-carbon development of the transport sector;
- Training of trainers in eco-driving;
- Partial financing for the acquisition and installation of 1.5 MW photovoltaic solar panels on the refrigerated warehouses of the Zenata logistics platform;
- Design and implementation of a survey and inventory of GHG emissions from the railway and road freight fleets;

⁴ Energy consumption by agricultural machinery (tractors, harvesters, threshers, etc) is accounted as consumption by the agriculture sector.

- Feasibility analysis of policy measures to mitigate GHG emissions in the freight sector and proposal of a regulatory framework to promote their implementation

The project is expected to result in direct emission reductions of 1.5 MtCO₂ per year.

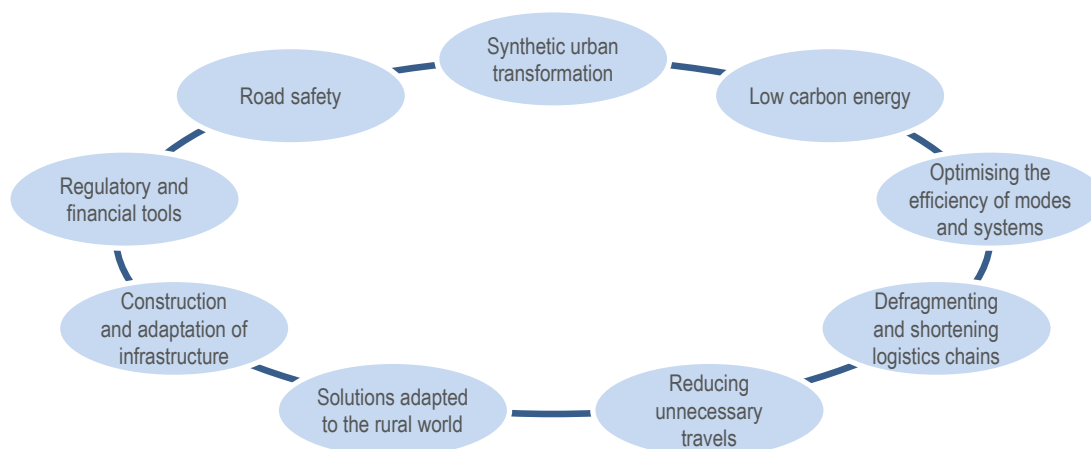
Source: METLW, 2018

IRESN is pursuing, in line with the government's vision towards decarbonising the transport sector, demonstration and R&D projects covering the complete value chain and ranging from the charging infrastructure up to the electric vehicles. IRESN is investigating the integration of renewable energies in the charging networks, the impact of local conditions on the charging processes, the sharing platforms as well as other promising technologies and applications in the field of electric mobility.

One example is the Green MILES programme - it aims to develop a fleet of electric vehicles (EVs); a network of charging stations for EVs; innovative business models for recharging services and mobility as a service involving electric vehicles and innovative charging solutions, supported by an information system for data collection and analysis. In May 2017 an agreement was signed between the National Highway Company of Morocco (ADM), IRESN and Schneider Electric to install 37 charging stations for EVs during the pilot phase of the Green MILES programme along the national highway from Tangier to Agadir. This will involve 74 charging points to cover more than 800 km highway with one charging station per 60 km. IRESN aims at expanding this initiative to the highway between Rabat and Fes and aims to implement a global approach including autonomous chargers coupled to photovoltaic panels. Furthermore, the charging stations will be equipped with smart meters and communication modules in order to centralise data and manage the charging process. The data collected and monitored will be a valuable asset for research purposes such as studying the impact of initial investment on electric mobility and traffic modelling.

Another project initiated by IRESN, in collaboration with the region of Marrakech – Safi, Schneider Electric and GIZ relates to the implementation of charging points in the city of Benguerir, deployed at the Green Energy Park, the municipality and the University Mohammed VI Polytechnic. The initiative was a first step towards providing the whole region with the needed infrastructure for electrical mobility using different capacities from 7 kW up to 22 kW. A study was conducted, in collaboration with ONEE and AMEE to assess the impact of this electric mobility infrastructure on the national grid. Different scenarios of the use of electric vehicles in Marrakech were studied. The city has already provided itself with electrical buses using renewable solar energy sources to make a first step towards developing electrical mobility.

In April 2016, the Groups Renault Maroc, Nissan Motors Egypt, Schneider Electric and M2M created a consortium to develop a mobility ecosystem in Morocco using different technologies, intelligent infrastructures and digital services. In December 2017 a Protocol was signed to build an EV manufacturing plant close to Tangier. There are plans to encourage switching to electric vehicles as part of the modernisation of the state-owned fleet.

Figure 4.16 Key Axes of the Draft Roadmap for Sustainable Mobility in Morocco

Source: METLW, 2018.

Public transport and railways

The Moroccan government is investing in tram systems in major cities to improve urban public transport and reduce traffic and congestion. The extension of the tram systems in Casablanca and Rabat – costing USD 1 600 and USD 157 million – is expected to result in annual GHG emissions reductions of 5.915 MtCO₂e and 0.465 MtCO₂e respectively (Government of Morocco, 2016c). There are plans to install trams in other big cities (Marrakech, Fez, Tangier, and Agadir).

The government plans to improve intercity public transport through the construction of a fast train network. The first high-speed rail line (the first on the African continent) from Tangier to Casablanca was inaugurated on 15 November 2018 by King Mohammed VI of Morocco. Other lines to be constructed between now and 2035 include Casablanca-Marrakech-Agadir and Casablanca-Fès-Oujda. By reducing the travel time between major cities, trains will offer a service that is competitive with private vehicles for long journeys, which is likely to have a significant impact on annual vehicle passenger-kilometres per person (IEA, 2016). METLW is also introducing several other measures to increase the role of rail transport and to reduce its emissions and/or improve its efficiency, including:

- ISO 14001 certification of the sites of the National Railway Office, ONCF (*Office National des Chemins de Fer*), ISO 9001 certification of its activities and compliance with ISO 9004
- use of photovoltaic energy, LED lighting and automatic electricity management systems in ONCF stations and buildings
- systems to recover braking energy in trains
- eco-driving training for the train crew
- energy saving measures and the use of renewable energy at ONCF's power substations; optimising the use of substations according to day / night needs.

METLW is also planning initiatives to reduce energy consumption and GHG emissions in the aviation and maritime transport in the future.

Vehicle fleet renewal

Morocco has imposed a ban on importing vehicles that are older than 5 years, which is considered a critical measure to reduce emissions (around 60 MtCO₂ over five years) and increase the vehicle fleet efficiency.

Morocco also has a programme to support the renewal of the taxi fleet. By the end of 2015, around 8 000 used category 2 taxis and around 2 800 of category 1 (larger) taxis were replaced by new vehicles, as the result of a government subsidy offer (MAD 50 000 for category 1 and MAD 80 000 for category 2) (IEA, 2016). Efforts are continuing to replace large taxis by vehicles with lower emissions. There are also plans to stimulate the upgrade of commercial vehicles 20 years and older between 2025 and 2030 (Government of Morocco, 2016c). As with the taxi fleet renewal scheme, the Department of Transport manages a freight transport and bus fleet renewal scheme, which offers incentives for upgrading or retiring old vehicles.

Taxation of vehicles

Vehicles are subject to several taxes upon their first registration in Morocco. The vehicle registration taxes are determined by the horsepower: the larger the horsepower, the higher the tax paid by the owner. In addition, the “vehicle value tax” is determined according to the vehicle value: a tax rate of 5% is applied to the cheapest cars and the rate grows to 20% for the most expensive cars. This taxation regime has incentivised the purchase of smaller, cheaper cars. Customs duties must be paid on imported cars except those imported from the EU; excise duties have been reduced to 2.5% for hybrid vehicles (IEA, 2016).

Vehicles standards, labelling and regulations

On 1 January 2015, Morocco introduced Euro 4 emissions standards for all new light-duty vehicles sold in Morocco, whether imported or manufactured in Morocco. Pollutant emission control is carried out within the framework of the technical inspection of vehicles. There are plans to i) introduce mandatory vehicle fuel efficiency labels for all new cars sold in Morocco; ii) set mandatory energy performance standards for motorbikes and transport scooters; and iii) impose an obligation on owners and managers of fleets of more than 20 vehicles (and more than 10 vehicles starting from 2020) to report their energy consumption. Speed limits on national motorways and roads are also expected to lead to reductions in fuel consumption in road transport.

Training for efficient driving

In partnership with the Office of Professional Training and the Promotion of Work (OFPPT), AMEE is developing an eco-driving training course for professional drivers of buses and trucks. The course focuses on teaching heavy-duty vehicle users how to drive efficiently and use less fuel, through methods such as anticipating speed changes and turning off the engine for stops longer than 30 seconds (IEA, 2016a).

There are plans to integrate eco-driving courses into the training for obtaining the general driver's licence and running communication campaigns to change drivers' behaviour.

Assessment

Morocco has been making energy efficiency a priority since the 2009 National Energy Strategy and has set an ambitious energy efficiency target for 2030, thus demonstrating a clear long-term commitment.

Short-term progress is expected to remain limited up to 2020, based on the energy efficiency target of 5% and the energy efficiency action plan, which is being finalised, together with a contract framework programme for 2018-21 to support ongoing energy efficiency programmes across several sectors, in support of the 5% savings target.

In the medium term, a draft Energy Efficiency Strategy for 2030 was presented to the Government Council in 2017 with a focus on several key sectors, notably transport, industry, buildings, agriculture and the public sector, including public lighting. The strategy has been under development for several months and benefited from significant stakeholder engagement and consultation, including with AMEE, public institutions and non-governmental organisations. It is pending formal adoption with the government.

The implementation of the legal framework for energy efficiency in Morocco has been in progress since the adoption of Energy Efficiency Law 47-09, which requires a range of implementing regulations. Progress has been slower than expected, but an important positive point is that the government has gained valuable experience from a large number of successful energy efficiency projects, thanks in part to international funding, including projects concerning 'green mosques', more efficient public lighting, the renewal of the vehicle fleet, the promotion of solar water heaters and solar pumps in agriculture, alongside many awareness raising campaigns.

Faster progress will be aided by government action to continue to develop a legislative, regulatory and compliance framework, while creating an incentive framework for consumers and businesses, through energy efficiency subsidy programmes, taxation, technology support and energy service companies as well as more cost-reflective energy pricing. It will also be aided by more effective action to monitor compliance, and where necessary to enforce compliance, though the intention should be to minimise the need for enforcement action by providing carefully targeted incentives to promote compliance, as well as by undertaking other supporting actions such as awareness raising activities and the promotion of appropriate training.

In transport, a range of measures is being pursued, including eco-driving training, fleet upgrade (a subsidy incentive for the upgrade of older taxis, and a prohibition on imports of older vehicles). There is a focus on improving the commercial fleet; logistics optimisation; and public transport (new inter-city services, improved train efficiencies and modal shift to reduce individual vehicle use). Excise duties have been reduced for hybrid and electric vehicles. There may be merit in looking at the potential benefits of introducing a vehicle taxation system based on energy efficiency or emissions standards of vehicles rather than the current horsepower and value system – an approach used to good effect to incentivise uptake of more efficiency vehicles in other countries.

In the buildings sector, the focus is largely on new buildings with new regulations introduced in 2015 expected to deliver energy efficiency benefits. There has been training for architects as well as construction personnel, and further training is in development. However, the implementation of this regulation is not systematic, as the

expected new standards are not always delivered in practice. There is a need to strengthen enforcement of compliance with thermal regulations, including through targeted inspections, building certification, and training of all relevant actors in the sector in what is required of them to meet the standards. International best practice may also provide some useful examples of how to achieve this.

The government found that the cost of implementing the thermal regulation can lead to an increase in the cost of living. While this would only marginally increase construction cost for the commercial sector which can be passed through to businesses, affordability of social housing might create concerns for vulnerable citizen and the government should lead on social housing renovation/construction and adjust its allowed support levels.

Energy use in residential and commercial is expected to rise quickly, in particular for space cooling and the use of electric appliances. While the government has put in place labelling requirements, there are no mandatory standards for minimum performance of appliances, notably for imports. The adoption of such standards would however greatly improve energy efficiency in the coming decade and is a no-regret policy option.

There is not yet a focus on retrofit of the existing building stock to improve energy efficiency or adopting minimum energy performance standards for appliances. It is good that all Ministries and public institutions are developing energy efficiency strategies in their buildings with the support of the AMEE. It is also good that energy audits are being introduced in industry and the commercial sectors for users over certain consumption thresholds (which will be lowered over time). Although there is currently no obligation envisaged on companies to act on audit recommendations, some voluntary actions can be seen towards greater cost-effectiveness, and there are some supports planned to encourage such action (such as the “Model Factory”). There is however a significant broader opportunity here. An assessment of how best to improve the energy efficiency performance of existing buildings should be considered, looking at issues including feasibility and cost-effectiveness.

There is no particular focus on improving the energy management and performance of energy-intensive industries, and few if any are pursuing international standards such as the ISO50001 energy management standard and certification, a process which would assist them in improving efficiency as well as competitiveness. With about 70% of industrial consumption concentrated in a relatively small number of entities there would appear to be a good opportunity to achieve significant efficiencies at low cost. This could be achieved by establishing a voluntary network of energy-intensive industries that can work together, accessing and developing expertise supported by the government through guidance and advice to assist them to improve their energy management and inspire others to do likewise. This is a low-cost but potentially high-impact approach, used successfully elsewhere, for example in the Large Industry Energy Network (LIEN) operated by the Sustainable Energy Authority in Ireland.

Awareness, communication and education is a key element in achieving energy efficiency, particularly in making decision makers aware of the benefits and the opportunities available to them so they are more likely to make decisions that result in improved energy efficiency outcomes. The benefits from energy efficiency are well understood and frequently articulated. However, the wider benefits, such as reducing emissions which improve climate action outcomes (on which Morocco has since COP22 in 2016 taken a prominent lead role) as well as air quality (to the benefit everyone in

society) could be emphasised more frequently. The full spectrum of benefits should be included in developing future communications. The mosques programme is an example of a project with the potential to reach a very significant numbers of people. “Energy efficiency Days” evidenced a similar popularity. The role of education in schools also offers a valuable opportunity to develop a strong awareness of energy efficiency and its associated climate action benefits in the younger generation, leading to improved choices and outcomes in the medium term.

Regular monitoring and reporting across several sectors will be critical in ensuring progress is made towards the achievement of targets. There are a number of areas where energy use reporting requirements are being introduced, for example for private tertiary buildings over certain thresholds, and for fleet owners/managers. This represents a good start and a foundation to achieve further impact by targeting information and aid to those with potential to improve, and potentially setting or incentivising efficiency improvement targets. However, for the government to evaluate progress, the maintenance and expansion of the energy efficiency indicators work of ADEREE and MEMDD remains critical.

Electricity prices in Morocco do not reflect all costs, despite welcome strong efforts to phase out subsidies to fossil fuels over the past years. There is however little incentive from market pricing mechanisms to increase the efficiency of electricity use. And the price of butane has, still under government subsidy, not increased in over 20 years, meaning that its price has fallen in real terms. This undermines efforts to incentivise efficiency, especially in the market for solar water heaters and solar pumping.

To achieve its objectives, the government will need to create an effective institutional framework for the co-operation of several Ministries and agencies on energy efficiency. AMEE was set up as a dedicated agency for energy efficiency – it has a very challenging task. Given the ambitious 2030 target of 20% energy savings and the wide scope of measures envisaged in the forthcoming strategy it will be important to ensure AMEE has sufficient human and financial resources and the full range of expertise needed to optimise its prospects of successfully achieving national energy efficiency goals.

Recommendations

The government of Morocco should:

- Build AMEE as a dedicated energy efficiency agency by enhancing its expertise and its human and financial resources in order to optimise the prospects for continued effective policy development and for the successful delivery of national energy efficiency goals.
- Adopt, ensure adequate resourcing for implementation, and then implement energy efficiency standards, regulations and technology development programmes to support and accelerate the uptake of energy efficiency policies across the economy, and to ensure compliance with standards and regulations.
- Take further steps to incentivise energy efficiency through more cost-reflective pricing, while addressing social impacts through targeted measures.

- Strengthen enforcement of compliance with new building standards, including through targeted inspections, building certification, and training, and assess how best to improve the energy efficiency performance of existing buildings. Reconsider the allowed costs for social housing in the light of these increased construction costs after the implementation of the thermal regulation.
- Establish a voluntary network of key energy-intensive companies who can work together, supported by the government through guidance and advice, to improve their energy management and inspire others, using international experience and benchmarking of industry.
- Set up a dedicated energy efficiency fund, based on a levy, to finance energy efficiency programmes.

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5. Renewable energy

Key data

(2017)

Total supply*: 1.7 Mtoe (8.5% of TPES) and 4.6 TWh (14.1% of electricity generation).

IEA total*: 9.5% of TPES and 23.6% of electricity generation.

Biofuels and waste**: 1.3 Mtoe (6.5% of TPES)

Electricity generation (2017)

Hydro: 1.2 TWh (3.6%)

Solar: 0.4 TWh (1.3%)

Wind: 3.0 TWh (9.2%)

*Not including non-renewable waste.

**Includes non-renewable industrial waste, which accounts for 5% of total biofuels and waste.

Overview

Morocco has great potential for renewable energy (RE) production, thanks to large wind and solar resources. RE accounted for 34.5% of installed power capacity in 2017. The government is on track to achieve its targeted 42% for the share in installed capacity by 2020 and has increased the ambition to at least 52% by 2030. Recent growth in wind and solar power has raised the share of renewable energy sources to almost 16% of total electricity generation; but the bulk of power generation is produced from fossil fuels.

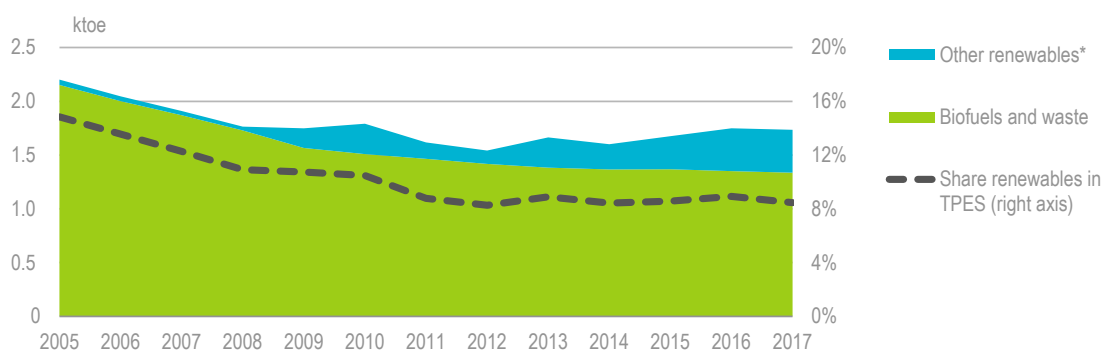
Renewable energy prospects are therefore good, and Morocco is an attractive destination for international investment in renewable energy, notably solar and wind energy. The creation of an institutional and legal framework for renewable energy has helped investors, notably the creation of MASEN as a 'one stop shop' (Law 57-09 as amended by Law 37-16 with the expansion of its scope to all renewable energies) and the adoption of the RE Law (Law 13-09 as amended and completed by Law 58-15 provisions). Morocco's renewable energy policy has made the country a key global player within only a few years, and Ernst & Young ranked Morocco #14 in its renewable energy country attractiveness index in May 2016. The quality of Moroccan renewable energy resources and the attractive investment climate have resulted in lower costs for wind and solar photovoltaics (PV), which are now competitive with the price of fossil fuel-based electricity.

To continue its ambitious objectives and maintain momentum in the renewable sector in Morocco, the government aims to attract more private investment and facilitate the market and system integration of renewable energy. The use of renewables beyond the power sector in heating, industry, agriculture and transport, remains a potential growth area.

Renewable energy supply

Despite the recent growth in wind and solar power, biofuels and waste account for the largest share of renewable energy sources in total primary energy supply (TPES). Most of this is solid biofuels (wood) used for heating in the residential and the commercial and public service sectors. In the last decade, however, supply of biofuels and waste fell by 29% after a sharp decline in consumption in the residential sector. In recent years, growth in wind and solar have gained ground, and the share of renewable energy in TPES has been stable around 8-9% (Figure 5.1).

Figure 5.1 Renewable energy and waste in TPES, 2005-17

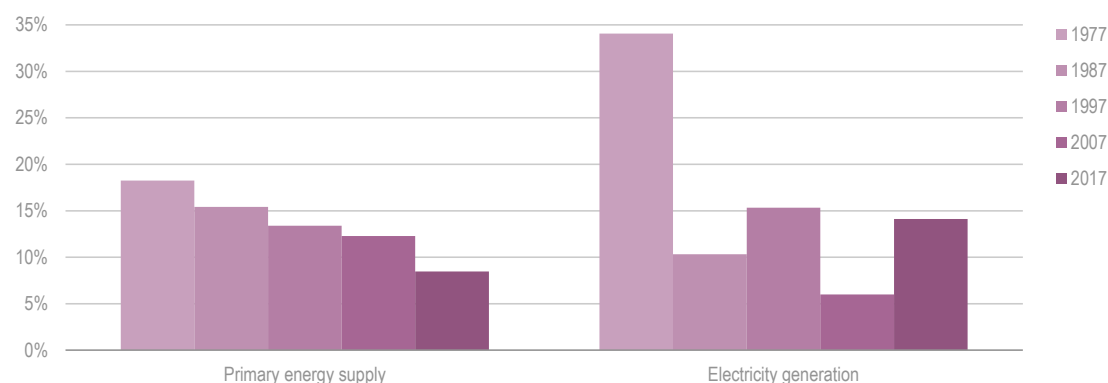


*Includes electricity generation from hydro, wind and solar.

Note: Includes non-renewable waste in TPES.

Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

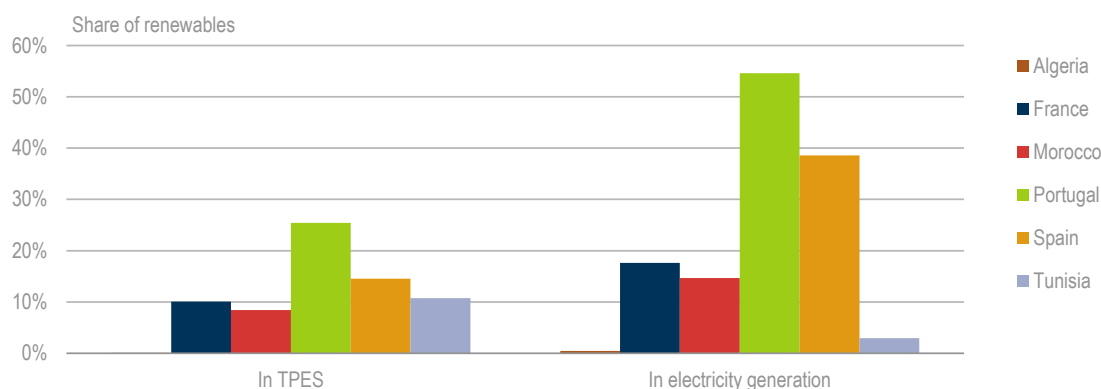
Figure 5.2 Share of renewable energy in the energy and power mix, 1977-2017



Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

While the share of renewable energy in TPES has stabilised after having declined for a decade, Morocco has significantly increased its renewable electricity generation over the past decade. Renewable energy accounted for 8.5% of TPES in 2017 and 14.1% of electricity generation in Morocco in 2017 (Figure 5.2). These shares are similar to those in France and Tunisia, but significantly lower than in Spain and Portugal (Figure 5.3).

Figure 5.3 Renewable energy and waste in TPES and electricity generation in Morocco and neighbouring countries, 2016

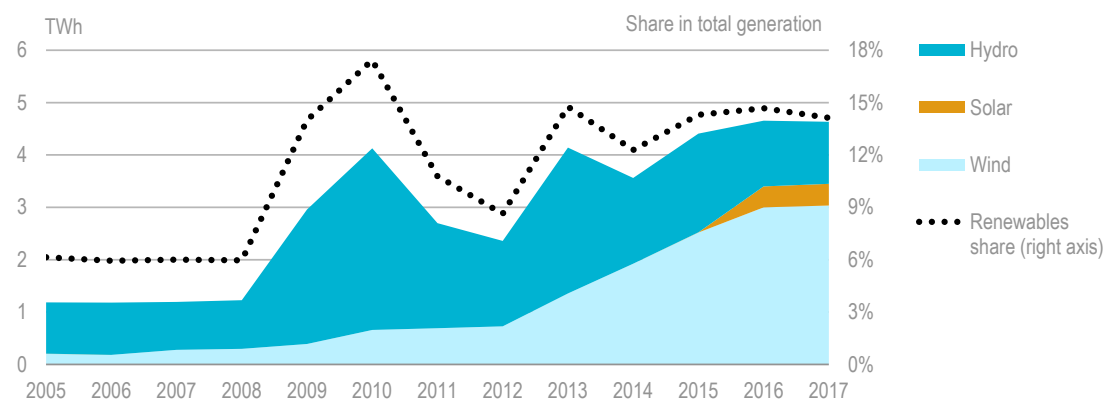


Source: IEA (2018a), *World Energy Balances, 2018*, www.iea.org/statistics/.

Electricity from renewable energy

Morocco has made significant progress in terms of renewable electricity generation in recent years. In 2017, total power generation from renewable sources was 4.6 TWh, three times higher than in 2007. Wind power generation increased rapidly from 0.3 TWh in 2007 to 3.0 TWh in 2017, making it the largest renewable power source. In recent years, Morocco has also installed large concentrated solar power (CSP) plants, and solar has become another important power source with 0.4 TWh generated in 2017. Solar plays still a very small role with 1.3% in the power mix; however, the potential is large. Hydropower has shown a different trend. Despite stable installed capacity, the actual contribution of hydro in power generation has varied significantly during the decade (Figure 5.4), as water availability and precipitation levels have fluctuated. The government of Morocco highlights the decreasing water availability as one of key impacts of climate change (GoM, 2016), raising concerns about the future of hydropower generation in the longer term.

Figure 5.4 Renewable energy and waste in electricity generation, 2005-17



Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

According to MASEN, in 2017, Morocco had an installed RE capacity of around 3000 MW in total, with 1 770 MW of hydro, 1015 MW of wind and a solar capacity of 180 MW. By the end of 2018, Morocco reached already an installed solar capacity of 705 MW.

Institutions

The Ministry of Energy, Mines, and Sustainable Development (MEMDD) is responsible for Morocco's energy policy, including policy on renewable energy (see Chapter on General Energy Policy).

The Moroccan Agency for Sustainable Energy (MASEN) is a limited company with public shareholders responsible for the deployment of renewable energy. Originally created to implement the Moroccan solar energy programme, its responsibilities were broadened in 2016 to cover all renewable energy technologies, including solar, wind, hydro and any other renewable energy source. MASEN's integrated model was established to develop renewable energy projects while contributing to the development of a renewable energy ecosystem (see Box 5.1). Under Law 57-09 as amended by Law 37-16, MASEN's tasks range across the whole value chain and include RE resource assessment, generation capacity planning in collaboration with ONEE, the development of integrated renewable energy projects, the promotion of a national industry, development of applied and pre-operational R&D by national and international research laboratories, the promotion of innovation and capacity building in the renewable energy sector as well as the contribution to local development. The mission of MASEN also includes the promotion and development of REN at the African continental level and beyond.

The Institute for Research into Solar and Renewable Energies (*Institut de Recherche en Énergie Solaire et Énergies Nouvelles*, IRESEN) was created in 2011 as an agency for energy research, development and innovation (RD&I) to support the national energy strategy through applied research and innovation, to ensure fast technology transfer and the translation of research results into innovative products in the fields of renewable energies, energy efficiency and new energies. IRESEN is responsible for identifying RD&I priorities and projects by providing funding and creating shared research platforms and excellency centres, involving universities and industries in Morocco, as well as by disseminating research findings and promoting their effective use by businesses.

The National Agency for Electricity and Water (*Office National de l'Électricité et de l'Eau potable*, ONEE) is a state-owned vertically integrated utility which emerged from the merger of the public water and electricity companies in 2011. Its responsibilities include planning (in collaboration with MASEN) the renewable energy capacity to be installed and guaranteeing the stability of the grid. Following institutional reforms of 2016, ONEE must transfer all its renewable energy assets to MASEN, within five years, except those used for balancing, such as hydro pumped storage, and projects for the generation of electricity from renewable sources by the provisions of the Law 13-09 relating to renewable energy.

Policy and regulation

Strategic objectives

The 2009 National Energy Strategy set out an ambition for 42% of the total installed power capacity to come from renewable energy in 2020. This was expected to require the commissioning of new plants to bring the total capacity to 2000 MW of solar, 2000 MW of wind and 2000 MW of hydro by 2020.

In 2015, during the 21st session of the UNFCCC's Conference of the Parties (COP21), Morocco announced a further planned increase in the renewables capacity to reach 52% of the total by 2030 (20% solar, 20% wind, 12% hydro). To meet the 2030 target, the country aims to add around 10 GW of RE capacities between 2018 and 2030, consisting of 4560 MW of solar, 4200 MW of wind, and 1330 MW of hydropower capacity⁵.

The investment cost for meeting the 52% target is estimated at USD 30 billion by 2030. These are very ambitious targets, considering the installed RE capacity of around 3GW by end of 2017. In 2018, Morocco has announced ambitions to go beyond 52%.

According to the latest Equipment Plan (the strategic planning document for the electricity sector), it will be necessary to commission an additional 4600 MW of RE generation capacity during the period 2017-2021 in order to meet electricity demand (expected to grow at 5% per year). New renewable capacity under the Plan is expected to consist of around 1400 MW of wind (of which 356 MW to be developed under Law 13-09), around 600 MW of hydro (including the 350 MW Abdelmoumen pumped storage project and 197 MW developed by the private sector under Law 13-09) and around 2600 MW of solar PV and CSP capacity. Between 2021 and 2030, the Equipment Plan envisages the installation of additional 6000 MW of renewable capacity, but the split between the technologies is under review in order to optimise synergies between technologies.

Overview of the support schemes

Morocco has been developing its support mechanisms for renewable energy – primarily in the electricity sector – for over two decades, since the adoption of Law No 2-94-503 in 1994 that allowed private electricity generation. At present, several financial contracts for renewable energy plants (and ownership structures) exist in parallel which are described in more detail in the following sections: i) public plants owned by ONEE, developed under EPC contracts ii) Independent power producers (IPP) projects developed with long-term power purchase agreements (PPAs) between private investor and ONEE, iii) competitive IPP tenders by MASEN for a specified site and capacity, based on a public-private partnership - these are the majority of projects coming online in the next five years - iv) self-generation projects: the construction of renewable energy facilities to generate electricity for own use (with possible sale of surplus to ONEE); and v) a competitive market for private (“corporate”) PPAs between IPPs and end users under Law 13-09.

⁵ Morocco bases its renewable targets on installed capacity figures; in 2019 all capacity targets are being reviewed in order to optimise synergies between technologies.

Chapter 6 on Electricity provides more details on the structure and legal framework of the electricity market in Morocco.

EPC contracts

Historically, ONEE commissioned turnkey projects with engineering, procurement and construction (EPC) contracts. The rules and conditions for procuring such projects, including their management and control, were set out in the regulations governing ONEE. The EPC contracts can be awarded through a competitive tender or a negotiated procedure whereby a bargaining commission selects the contractor after consulting one or more competitors and negotiating the terms and conditions. The plants were built under BTO (Build, Transfer, and Operate) schemes, and are owned by ONEE.

Independent power producers

In 1994, Moroccan legislation was passed (Law 2-94-503) to allow private power production up to 10 MW capacity to be developed in a contract with ONEE. Independent power producers (IPPs) developed their facilities with ONEE which contracts the power through long-term power purchase agreements (PPAs). These IPP plants included renewable energy (mostly wind) and were based on BOOT (Build, Own, Operate and Transfer) schemes, with ONEE exploiting the electricity production but the investor owning the plant.

Over the decades, Morocco has significantly drawn on the know-how of the private sector and secured large investments through project finance for IPPs, with financial arrangements that combine domestic and foreign public and private funds. The financing for RE projects comes from a variety of sources: private business, the government budget, the Hassan II Fund for Economic and Social Development, the Energy Efficiency Fund (FEE), the Energy Development Fund, and the ONEE's own funds. RE projects benefit from donor funding through concessional loans, thanks to state support and guarantees. Morocco receives financial support from International Financial Institutions, Export Credit Agencies, including the Clean Technology Fund (CTF), the African Development Bank (ADB), the German development bank KfW (*Kreditanstalt für Wiederaufbau*), the German Climate Technology Initiative (*Deutsche Klima und <https://webstore.iea.org/Admin/CustomRoleRequest/ListDKTI>*), the World Bank, the European Commission, the European Investment Bank, the Agence française de développement (AFD), Saudi Arabia and the United Arab Emirates.

MASEN model

Since the creation of MASEN in 2009, RE development and investment in solar power plants has been supported through MASEN's institutional framework offering a 'one stop shop' for private project developers, bringing together permitting, land acquisition and financing aspects as well as securing a state guarantee for the investment. The arrangements differ from those in classic ONEE's IPPs up to 2009. MASEN organises tenders, signs PPAs with the IPPs and then sells RE electricity to ONEE, taking responsibility for the difference in price. Under MASEN Law, the government guarantees the financial sustainability of the Solar Plan. MASEN's creates an innovative public-private partnership (PPP) scheme with favourable financing conditions and risk allocation that contributes to the reduction of the price per kWh and provides more visibility and certainty to market players (investors, developers, financiers). The PPAs with MASEN guarantee the purchase of electricity during the life of the plant and the payment to the

project company, including in case of early termination of the PPA. The government issues a letter of support to guarantee the payment. The tenders have resulted in significant cost reductions and also introduced CSP technology, which increases the flexibility of the power system because it is able to contribute to generation during peak hours thanks to integrated storage.

Box 5.1 MASEN's integrated approach

MASEN is taking an integrated approach to developing the country's renewable energy sources. This approach is based on five pillars: electricity generation, training and capacity building and industrial development, R&D, and local development. In addition to developing RE projects and raising the funds to finance them, MASEN seeks to act as a catalyst for the development of a competitive economic network for renewable energy. It strives to ensure that renewable energy projects stimulate industrial development and enable job creation by increasing the need for resources and introducing new professions. At the same time, MASEN encourages the development of applied research and the promotion of technological innovation. The integrated approach is reflected particularly in MASEN's local development strategy that helps the regions which host its projects to achieve territorial equity and sustainable growth. Finally, MASEN's entire approach is based on the need to protect the environment and reduce greenhouse gas emissions.

Source: MASEN's website accessed on 6 May 2018

The main features of MASEN's innovative project financing scheme are as follows. MASEN prepares the project, and provides related studies to the developers. MASEN also acquires the land and develops common infrastructures required for the plants constructions and operations. The winner of a tender (an independent power producer) creates a project company (a special purpose vehicle, SPV), in which MASEN becomes a shareholder. MASEN also acquires a stake in the capital of the Operation and Maintenance Company of the project. The SPV gets access to the land and the key infrastructure at the project site. The financing of the investment is done by the SPV's own funds and by concessional debt (with state guarantee), mobilised from the donors to MASEN, and retroceded to the SPV. For example, in the NOOR Ouarzazate I project, MASEN has a 25% equity share and a private investor has a 75% share. Debt financing is provided through MASEN at a very low-cost debt (concessional loans from IFIs).

For NOOR solar PV projects (NOOR PV I), MASEN issued green bonds to finance the debt of NOOR Laayoune I and NOOR Boujdour I. The bonds (1 150 million MAD) were guaranteed by the Moroccan Government and were certified as "Green" by third party entities (Vigeo and Climate Bonds Initiative (CBI)). The CBI certified the environmental and social benefits of the financed projects as well as MASEN's performance in the responsible management. MASEN also injected its own equity to finance three NOOR PVI projects. To finance the CSP/PV NOOR Midelt plants, MASEN will use financing from the African development bank (ADB), the World Bank, the Clean Technology Fund, the French Development Agency (AFD), the German development bank KfW, the European Investment Bank (EIB) and the European Union, in addition to the equity financing to be brought by the private-sector partners.

Local content and industrial development

The creation of a national renewable energy industry is a key policy objective for Morocco (see Chapter on General Energy Policy). The tenders organised by MASEN do not have obligatory local content requirements but encourage developers to study the local supply chain and to propose an offer that includes competitive local content. As the overall objective of the tenders is to procure RE electricity at least cost, the local content component can include any cost-effective elements, whether civil works, engineering, components, or anything else. For the first tenders, the target for local content was 30% of the total project cost. This target was exceeded: the local content reached 35% and more in the solar plants in Ouarzazate, and more than 65% in the 850 MW wind programme, because it included the construction of wind blade manufacturing plant in Tangier worth EUR 100 million. MASEN also organises professional national and local training on plant operation and maintenance, which supports job creation.

Innovation and business partnerships

MASEN is active in applied and pre-operational R&D and the promotion of innovation in the renewable energy sector. For example the R&D platform in Ouarzazate offers and accelerated path for industrialisation of applied renewable energy R&D backed by industrial projects. It gives real operating conditions, a demonstration environment that creates industrial opportunities for innovative solutions. In addition, the Solar Cluster, created with multisector institutions and companies, provides assistance to project development, industrial integration, B2B networking between industrials and institutional research laboratories, skills & capacity enhancement and market intelligence services (see also Chapter 5 on RD&I).

IRESSEN funding also plays a role in supporting the completion of innovation processes, notably by funding the initial phase, during which financing is the most difficult to obtain. From early stage research needs' assessment to technology demonstration projects, IRESSEN has undertaken significant R&D&I activities, with the objective to identify strategic topics to guide the research, build joint projects, and create critical research maps. The final objective is to develop an innovation ecosystem by launching annual calls for R&D&I collaborative projects through two instruments, the Green Inno-Project call for applied research and the Green InnoBoost for incubation and acceleration of SMEs that cover technology readiness levels between 4 and 8 and contribute to strengthen the capacity building and technology transfer. IRESSEN is building a network of green technology platforms dedicated for renewable energies and energy efficiency topics as a bridge between universities and industries for the development of innovative products, services and processes oriented to the market, business and job creation.

Regulatory framework

Self-generation

A few industrial producers, including mines, phosphate processing plants, sugar refineries and cement factories, have developed their own power generation, including renewable. Today, industrial self-producers account for less than 1% of electricity generation (see Chapter 6 on Electricity). In 2008, Law 16-08 raised the threshold for the maximum allowed self-generation capacity from 10 MW to 50 MW and allowed the sale of occasional surpluses to ONEE. In 2015, Law 54-14, amending Law 16-08, allowed private-to-private transactions of self-producers of electricity (installed capacity of over

300 MW and not only renewable generators) and access to the transmission network of ONEE to transport power from the production sites to consumption sites at the very high and high voltage levels. Self-generators are now part of the new open market for electricity.

Open market for renewables

Morocco liberalised the RE sector in 2009 with a view to meeting the ambitious RE targets set for 2020 and 2030 and is in the process of creating a market for private-to-private transactions. Law 13-09 introduced three licensing regimes for RE projects depending on their size: a free regime for projects with capacity below 20 kW; a declaration regime for projects with capacity between 20 kW and 2 MW; and an authorisation regime for projects above 2 MW. This law allows private developers to produce electricity on behalf of a consumer or a consortium of consumers having access to very high voltage (VHV), high voltage (HV) and under certain conditions to medium voltage (MV). Law 58-15 adopted in 2015 complemented and amended Law 13-09 allows independent RE generators (including hydropower plants above 30 MW) to sell the surplus produced to ONEE or to a distribution system operator. The detailed conditions for selling the surplus electricity are expected to be fixed by decree, amending Law 13-09.

The implementation of the RE Law 13-09 was carried out by two main decrees with regard to authorisation and grid access. Decree 2-10-578, adopted in 2010, specified the procedures and rules for declaration and authorisation, as well as the provisions related to accessing HV and VHV networks. Decree 2-15-772 set out conditions and rules for progressive opening of the medium voltage network to RE generation: it was however adopted only in 2015 and has not been fully implemented yet. An implementing decree on low voltage has been developed but was not approved yet at the time of writing.

Legislation requires distribution companies (discos), which can be either private and public companies in Morocco, to determine the so-called “RE envelopes”, *i.e.* the amount of RE generation that can be integrated in the low and medium voltage networks in each distribution zone (between 5% and 10% of the total generation in each zone). Many discos have not implemented this requirement yet. The MEMDD and the Ministry of Interior are expected to use these “envelopes” to determine jointly the trajectory for opening up the MV and LV networks over the next 10 years. As the distribution grid has not been opened and access/connection/tarification rules remain unclear, there is to date no development of distributed generation in Morocco. Since the entry into force of the Law 13-09 in 2011, four companies were authorised for the completion of 856 MW of HV/VHV wind power generation projects, of which 420 MW are already in operation and four other companies are authorised to carry out 20 small hydropower projects totalling more than 260 MW. Since there are only few such large off takers - mostly industrial clients - the HV and VHV market has become quickly saturated; access to medium and low voltage has become essential for further development of a competitive RE market. Existing plants (both thermal and renewable) have long-term PPAs with ONEE and MASEN and benefit from priority dispatch. New independent RE plants have no guaranteed offtake, unless agreed in their PPA. In the case of oversupply and/or network constraints, new plants could be the first to be curtailed, which has a negative impact on the projects’ economics and bankability.

Other challenges in developing private RE projects in the open market include: hurdles and delays with land acquisition; insufficient information available to developers; and

insufficient experience with PPAs between two private entities (they are different from the PPAs signed with MASEN). MEMDD has launched the process of overhauling the legislative and regulatory framework for renewable energies taking into account the improvement of the bankability of projects, the strengthening of the reliability and competitiveness of the national electricity system and the simplification of procedures investment in the field of renewable energies.

Progress towards meeting the targets

Solar Programme

Morocco has an average global solar horizontal irradiance of 5 kWh/m²/day. Before the launch of the national solar plan in 2009, solar energy was primarily used to supply remote villages in the framework of the Moroccan rural electrification programme. The 2009 plan envisaged that, by 2020, the installed capacity of both CSP and PV would be at least 2 000 MW. Table 5.1 lists the major projects completed, in process, or planned on sites, with total investment needs estimated at approximately USD 9 billion through to 2020. ONEE is developing several PV power plants, which will be transferred to Masen (as Law 38-16 specifies within 5 years starting from 2016). ONEE PV plants include the NOOR Tafilalet (120 MW), expected to be commissioned Q2 2019; and NOOR Atlas in 2020 and NOOR Argana Dades (200 MW each), expected to be commissioned after 2020, respectively.

In Morocco, the recent large-scale solar PV projects are already competitive with thermal generation: the cost of electricity generated by the NOOR Ouarzazate IV plant will be less than 5 USD cents/kWh. The average production cost at the NOOR Ouarzazate site (CSP) is 14 USD cents/kWh, but it largely competes with diesel fuel and special fuel for gas turbines at peak times, and further cost reductions can be expected due to the current trends in prices and the excellent natural conditions in Morocco.

Table 5.1 Overview of Morocco's Solar Projects

Site/Plant	Power in MW	Technology	Commissioning
Ouarzazate	Total: 580		2016
NOOR Ouarzazate I	160	CSP+ 3h storage	2018
NOOR Ouarzazate II	200	CSP + 7 h storage	2018
NOOR Ouarzazate III	150	CSP (Solar Tower) + 7h storage	2018
NOOR Ouarzazate IV	72	PV	
NOOR MIDELT (Phase 1)	Up to 800	CSP / PV**	2021
NOOR TATA	More than 500	CSP / PV**	After 2020
AIN BENI MAHTAR	20	CSP / Gas*	2010
NOOR Laayoune I	80	PV	2018
NOOR Boujdour I	20	PV	2018

Site/Plant	Power in MW	Technology	Commissioning
NOOR PV II (total at several sites) <i>Laayoune II, Boujdour II, Taroudant, Kelaa des Sraghna, Bejaad, Ain Bni Mathar, El Hajeb, Guercif, Sidi Bennour</i>	800	PV	2020
NOOR <i>Tafilalet</i>	120	PV	Q2 2019
NOOR <i>Atlas</i>	200	PV	2020
NOOR <i>Argana</i>	200	PV	After 2020

* Solar-gas hybrid power station of 420 MW (20 MW in CSP and 400 MW in gas)

** The exact distribution between CSP and PV has not yet been determined. The distribution between CSP with built-in thermal storage (5 hours minimum) and PV is partly left to the discretion of the developer, but the PV capacity cannot exceed the night-time net capacity from CSP by more than 20%.

Source: MASEN (2018)

Wind Programme

With a coastline of 3 500 km, Morocco has significant wind potential, which is estimated at around 5 000 TWh/year. At the end of 2018, the commissioned wind power capacity totalled 1207 MW (Table 5.2). The Integrated Wind Energy Programme adopted in 2010 (known as the “wind plan”) aims to bring total wind power capacity to 2 000 MW by 2020. The required investment is estimated at around USD 3.5 billion by 2020. Table 5.3 lists the projects in development. Additional capacity of 2600 MW is planned for 2030. MASEN is responsible for the integrated wind energy programme.

Table 5.2 Commissioned wind power plants

Project	Capacity	Year of commissioning
Amougdoul	60 MW	2007
Tanger I	140 MW	2009
Torres / Koudia Al Baida	50 MW	2000
Cimar	5 MW	2011
Lafarge	32 MW	2005 (10 MW) 2009 (22 MW)
Tarfaya	300 MW	2014
Akhfenir*	100 MW	2014
Akhfenir (extension)*	100 MW	2016
Foum Al Oued*	50 MW	2014
Haouma*	50 MW	2014
Jbel Khalladi*	120 MW	2018
Aftissat*	200 MW	2018
Total	1207 MW	

*Law 13-09 projects.

Source: MASEN (2018).

Table 5.3 Wind Power projects in development

Site/Plant	Power in MW	Expected Commissioning
TAZA	150	2020
PEI 850 - MIDELT	180	2019
PEI 850 - TISKRAD	300	2020
PEI 850 - TANGER II	70	2020
PEI 850 - JBEL LAHDID	200	2020
PEI 850 - BOUJDOUR	100	2019
Law 13-09 - Oualidia	36 MW	2019
Law 13-09 Safi	200 MW	2021
Repowering Koudia	100 MW	2021

Source: MASEN (2018).

Hydropower

Development of hydropower began in Morocco in the 1960s. The total capacity installed by 2017 was 1770 MW, and generation is highly dependent on precipitation levels. The existing hydro resources are already well exploited, and there is limited potential for new large-scale plants. In the short term, Moroccan government expects the focus to be on the construction of additional small or micro power plants. Additional sites capable of accommodating small or micro-power plants have been identified, with a total potential of approximately 300 MW. These sites are also available for development by private power producers. Morocco is actively developing hydro pumped storage technologies, whose potential is estimated at 6 GW. The Abdelmoumen pumped storage station (2x175 MW) is expected to be constructed by 2021, and 20 private hydro projects are planned for commissioning by 2021 with a total capacity of 263 MW. Other hydropower complex projects are scheduled beyond 2021.

Biomass

Morocco has an important agricultural sector that can provide feedstock for biomass and biogas projects. In addition, a large share of Moroccan municipal waste consists of organic components. This biomass could in theory be used to replace fuel oil in the industrial sector. However, its potential has not yet been the subject of national strategies, although some small companies are already active in this field. Given its new prerogatives, MASEN has started exploring the various opportunities and models in particular waste-to-energy projects.

For this purpose, a study was launched by MEMMD to develop a national strategy for the energetic valorisation of biomass, which will be implemented through short, mid and long-term regional action plans.

A 10 MW landfill biogas plant was commissioned in Oujda 2009 as a CDM project implemented with support of the World Bank. The World Bank and Moroccan Fonds d'Équipement Communal launched in 2015 the Landfills' Gas Capture, Flaring and Use Programme, which aims to minimise methane emissions at several new or rehabilitated landfills by capturing the biogas produced by solid waste, and flaring or using this gas for energy production.

IRESSEN commissioned in February 2018 a prototype combining solar thermal collectors and biomass for electricity production (as part of the European funded project REELCOOP). A mapping of biomass sources was made in order to identify the most promising feed stocks. IRESSEN is currently working to upscale the technology. IRESSEN is also funding two R&D projects coupling solar energy and biomass, a solar-driven digester tank for the valorisation of organic wastes from the paper industry and a hybrid public bath co-fed by solar thermal concentrators and biomass boilers for water and space heating.

As part of the financing agreement for the energy sector reform programme, signed in 2009 between Morocco and the European Commission, a study for the development of a national strategy for energetic valorisation of biomass was launched by the Department of Energy and Mines. The objective of this study is to set targets and put in place action plans to achieve sustainable use of biomass in Morocco. The theoretical, technical and economic potentials of biomass will be determined for Agriculture, Forestry, Waste (Existing or Scheduled controlled dumps) and Wastewater (existing or planned water treatment plants) fields.

The study will be conducted in three phases:

- Phase 1: Diagnosis of the biomass chain
- Phase 2: Proposal for a draft of a national strategy for energetic valorisation of biomass
- Phase 3: Proposed short-term (2016-2020), medium (2021-2025) and long-term (2026-2030) action plans for the implementation of this strategy.

System integration of variable renewable power

The integration of variable wind and solar PV generation into the Moroccan power system is supported by various flexibility sources: interconnections, pumped storage hydropower (STEP), CSP with storage, and gas-fired generation. Morocco benefits from CSP technologies as well as hybrid CSP+PV plants as they are dispatchable and contribute to system flexibility. The first CSP project Ouarzazate, designed to have three hours of storage capacity, actively contributes to meeting peak demand. NOOR Ouarzazate II and III will have storage capacity of 7 hours. The Midelt project will also be designed with a major portion of solar production with storage capabilities. Today, around 10% of the power mix comes from variable renewable energy, and there are no major system integration concerns.

However, with rising shares of variable renewables, notably wind power, system integration will grow in importance. Investment in grid expansion and demand side flexibility will have a significant part to play. Morocco also has plans to strengthen interconnections, notably with Spain and Portugal, and to construct an LNG terminal to expand flexibility from natural gas use in power generation (as well as to use it for industrial processes and in the urban residential sector in substitution of LPG).

ONEE believes system integration will become an important issue when the share of wind power in total generation has grown further. The main concern is the economics of more flexible capacity from thermal plants (coal, natural gas) and the management of peak demand. Natural gas-fired power plants are planned under the Gas to Power project.

The MEMDD, ONEE and Masen are developing a detailed plan of the electricity mix by 2030, which will take into account the balance between all renewable and non-renewable energy sources (particularly natural gas) so as to ensure that the system has sufficient flexibility. Chapter 6 on Electricity has a more detailed discussion of system integration of variable renewable energy sources.

Renewables beyond the electricity sector

Water pumping and desalination

Morocco has launched a national solar pumping programme that aims to reduce the use of fossil fuels (especially butane and related subsidies) in agriculture, to save water and energy, and to improve the output and productivity of farmers. The programme provides for a subsidy from the Energy Development Fund for water pumps running on electricity produced from solar panels. Originally only small farmers with land up to 5 ha were eligible for support under this programme. The government has decided to extend it to larger farms if they use “drop-by-drop” irrigation to save water.

In 2017, the Ministry of Agriculture launched an auction to install irrigation and desalination systems powered by wind at the 5 000 ha agricultural zone in Dakhla. In 2016, IRESEN commissioned, as a demonstration project, Morocco's first solar-powered desalination plant in the Green Energy Park of Ben Guerir near Marrakech. The plant can desalinate five cubic metres of water per hour using photovoltaic (PV) and thermal solar technologies. IRESEN financed two R&D projects for the development of different prototypes of desalination and treatment of sea water with the aim to locally produce low coast solar water heating SWH technologies, which are adapted to the Moroccan context.

Solar water heating (SWH)

To promote solar water heating in Morocco, the government implemented a comprehensive programme - PROMASOL - Development of the Moroccan SWH market (*Développement du marché marocain des chauffe-eau solaires*) in two phases in 2000-2008. Given its success, the programme has been extended; it aims at installing 1.7 million m² of solar heating surface in 2020 and 3 million m² of by 2030. This programme is expected to avoid emissions of 920 000 tonnes of CO₂ per year and create 920 permanent jobs. This programme has mobilised resources of about USD 1 billion from various institutions. The Energy Investment Company (SIE) has been making investments in SWHs and encouraging private companies to do the same. IRESEN and its partners work on reducing the costs of locally produced SWH.

Renewable energy use in industry

IRESEN is developing a 1 MW CSP-ORC plant with thermal storage that represents a potential solution for industrial heating and power needs. There might be significant potential for greater uptake of renewable heat or electricity at various temperature levels, and electricity in industry.

MASEN has also acquired a solar technology that provides at the same time electricity, heat, cooling and desalinated water and that can respond to the needs of various sectors. A reference project is currently under development.

IRESN is working on the promotion of activities in the field of solar heat for industrial processes. The institute and OCP Group are working together in developing solutions based on CSP technologies for heat production in Phosphate drying process.

In 2019, the Ministry of Energy, Mines, and Sustainable Development is setting up a national commission to design a 'Power to X' roadmap. IRESN is also undertaking studies, in collaboration with the Fraunhofer Group, aimed to evaluate the opportunity and the economic and environmental benefits of 'Power-to-X' sectors in Morocco, notably for green hydrogen and green ammonia industries. Morocco's OCP Group, the world's largest exporter of phosphates, and IRESN have pledged to work together to boost the use of renewable raw materials in the fertiliser industry and the two sides are developing a research platform with the support of Fraunhofer IMWS.

Cooking

Morocco may have significant potential for using renewable energy in cooking. Possible options could include solar cooking through heat, solar cooking with distributed PV and electric induction cooking devices (e.g. "rice cookers" and similar), efficient bioenergy cooking stoves and others.

Assessment

Since the first IEA's in-depth review of Morocco in 2014, several new wind and solar projects have been commissioned, which is a positive development, boosting Morocco's progress towards its 2020 targets. By end of 2017, renewable energy represented 34.5% of total installed power capacity and 16% in total power generation.

The deployment of the renewable energy plans (solar and wind plans) in Morocco rely mainly on large-scale projects, and MASEN has launched several competitive tenders. From a solar perspective, several projects are either in operation or about to be commissioned (NOOR Ouarzazate Complex, NOOR Laayoune, Boujdour and NOOR Tafilalet), and a new programme (NOOR PV II) with a total capacity exceeding 800 MW to be operational by 2020. The next Complex NOOR Midelt is also under development. From a wind perspective the construction of the 850 MW integrated wind programme has been launched with the involvement of commercial banks.

After 2020, the government has set an ambitious longer-term renewable energy target (52% of the total installed power capacity in 2030 which translates into an increase of RE capacity by 10 GW over a decade), taking advantage of the country's very favourable conditions for both wind and solar power besides contributions from hydropower. In 2018, the government stated its ambition to deploy at least 52% of renewable capacity by 2030.

Morocco is successfully taking advantage of the low cost of solar solutions by developing large-scale concentrated solar power (CSP) and photovoltaic (PV) plants. Morocco oriented the production of CSP plants towards coverage of consumption peaks after sunset, in line with the grid energy needs and with the recommendation in the previous IEA's review, increasing the storage duration of every new plant: plant at Ouarzazate NOOR I has a storage capacity of 3 hours, while NOOR II and NOOR III are able to provide more than 7 hours storage capacity, with NOOR III taking advantage of the technology of the point-focus receptor (central receptor system or « tower »).

This development of solar energy has been facilitated through the creation of MASEN as a dedicated agency with strong support from the government and ability to mobilise grants and concessional financing through public-private partnerships and to manage siting, permitting and tendering processes in a well-structured way as a one-stop-shop. In 2016, MASEN's responsibilities were extended to cover all renewable technologies, including solar, wind and hydropower, as well as any other renewable energy sources, as a means to increase synergies between these technologies and to simplify the institutional landscape. The success of Morocco's plans for renewable energy clearly depends on MASEN being strongly led and supported, and having the skills and resources it needs.

The significant level of investment required to achieve the 2030 targets (estimated at around US 30 billion by the MEMDD) raises questions about the financing sources, which may require part of public debt, state guarantees and concessional loans depending on the maturity level of the technology. However, with the continuous decrease of renewable costs, other sources of commercial financing are also being considered. Because of the growing understanding of the need to diversify financing sources, NOOR PV I was partially financed by government-issued green bonds. The diversification of financing sources is key and deserves further study.

Private projects have been made possible through Law 13-09 which grants operators the right to generate electricity from renewable energy sources to supply individual consumer or groups of consumers connected to the MV, HV or VHV grid. However, since the implementation of this Law in 2010, only nine projects have been launched. Clear rules regarding curtailment, metering and selling of the surplus electricity produced, along with harmonised grid access need to be adopted without delay to unlock project development. Siting issues have also been identified as difficulties to overcome for these projects. The implementation of a one-stop shop for siting and permitting, with good local connections, would be an option to accelerate deployment and thus spur private projects investment in renewables under Law 13-09.

For smaller-scale projects, the opening of the medium and low voltage levels has been launched but not yet fully implemented. A decree published in 2015 set the conditions for a progressive access of renewable energy to the medium voltage grid, with each electricity distributor being asked to define 5% to 10% of its energy capacity to be opened for renewables. Only some distributors have defined the required capacity so far, and complementary acts are still needed to complete the liberalisation of that part of the market. Law No. 58-15 introduced in 2016 the basis of the opening of the low voltage network. This offers huge potential for small-scale projects like distributed photovoltaic, and for associated job creation: the implementation decree for renewable energy connection to low voltage has however not yet been approved, and progress on this is necessary to unlock the potential here.

Numerous specific applications for solar energy to be developed have been identified, including solar water heaters for the residential and commercial sectors, and PV pumping for irrigation in agriculture which could reduce the use of subsidised butane. A first deployment of solar pumping through subsidies was launched in 2013 for small-scale agriculture (parcels below 5 hectares). A new strategy for developing solar pumping in agriculture between 2018 and 2030 is being developed by AMEE and may involve bigger installations. As for solar water heaters, an ambitious target of 3 million m² installed in 2030 has been set and a deployment programme is being designed.

Morocco might have a significant potential for greater uptake of renewable heat at various temperature levels, and renewable electricity in industry. This potential should be investigated in detail. Similarly, various options could be considered to replace the use of bottled gas, which is heavily subsidised, in cooking. They include solar cooking through heat, solar cooking with distributed PV and electric induction cooking devices (e.g. “rice cookers” and similar), efficient bioenergy cooking stoves and others. Experiments could be conducted to find appropriate solutions in the Moroccan context.

Morocco could also consider going one step further in exploiting its excellent renewable energy resources in the context of the global efforts to mitigate climate change. Other countries, especially in Europe, might be interested in importing clean energy from Morocco in various forms – electrons, hydrogen-rich chemicals as energy fuels or feedstocks, or other electro-intensive raw or semi-transformed materials. These options are worth further exploration (see Philibert, 2018).

An ecosystem for R&D&I has been developed, notably through IRESEN and MASEN, in which universities, research institutes, and business work together. A substantial accumulation of human capital is reflected in the large number of scientific publications generated and the innovative products and technology solutions made in Morocco.

Recommendations

The government of Morocco should:

- Boost private sector investment in renewable energy by completing and implementing the regulatory framework for open and transparent access to both medium and low voltage grids, including through harmonised permitting, connection and tariff structures.
- Diversify the financing models of renewable projects, including by developing the capacity of commercial banks, in order to reach the significant level of investment required to achieve the ambitious targets set for 2030.
- Develop a one-stop shop for siting, permitting, access and licensing for all private sector renewable energy investment under Law 13-09.
- Explore the use of renewable energy in industry and the potential for developing the export of renewable energy as electricity, hydrogen-rich chemical and fuels or other raw or semi-transformed products.
- Encourage research and innovation, in relation to the applications of renewable energies (especially solar) and information technologies in industry, residential, transport, mining and the nexus of water, renewable energies and agriculture.

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6. Energy research, development and innovation

Overview

Morocco's policy on energy research, development and innovation (RD&I) aims to support its national energy policy priorities, boosting the use of renewable energy technology, and helping to develop a local manufacturing industry.

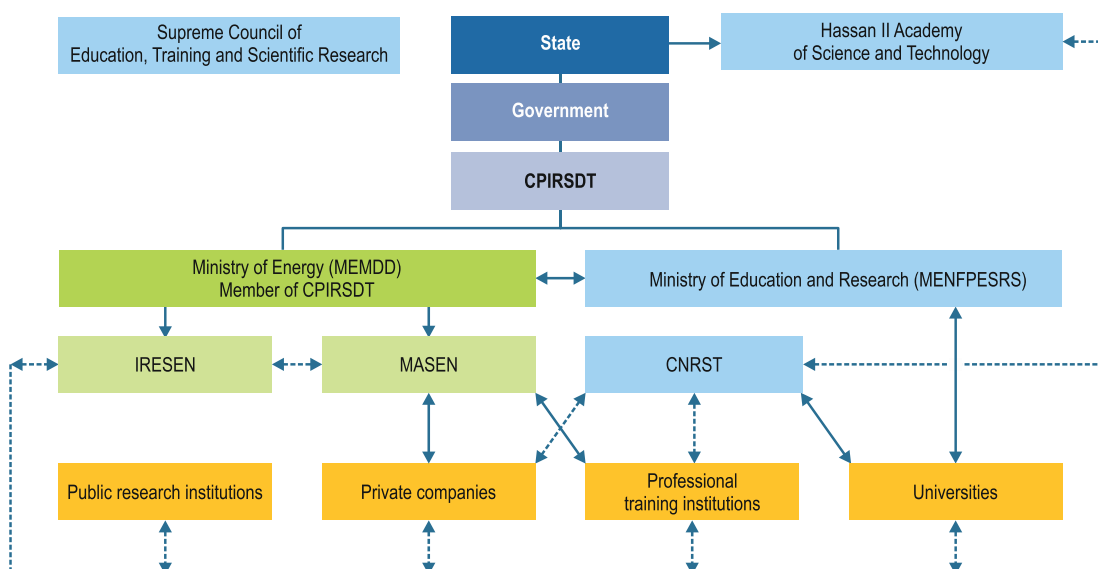
Morocco has an active energy RD&I landscape. The Research Institute for Solar Energy and New Energies (IRESEN) is one of the institutions responsible for implementing RD&I projects in support of the government priorities: solar and wind energy, biomass and biogas, thermal/electric storage, hydropower, smart grids, sustainable mobility and energy efficiency. IRESEN is one in charge of identifying strategic topics to guide the research, build joint R&D projects, and create critical research maps. Under its legal remit, the Moroccan Agency for Sustainable Energy (MASEN) counts among its core mission to conduct pre-industrial, market oriented research on all RE sources. The full-scale operationally oriented R&D initiatives of MASEN have resulted in industrial scale pilot RE generation projects. Both IRESEN and MASEN have leveraged significant international co-operation and funding for energy technology, including from private industry partners.

Based on the ongoing project implementation, the government will need to review progress, evaluate priorities and the organisation of the RD&I governance, as well as its funding structures to maximise the success of Morocco's energy transition for the horizon 2030.

Institutional framework

Several institutions are involved in the development and priority setting of RD&I policies in Morocco, including legislation, priority setting, funding and evaluation.

Created in 2006, and placed under the responsibility of the Prime Minister, the **Hassan II Academy of Science and Technology** contributes to setting the general orientations for scientific and technological development, funding scientific and technical research programmes, and contributing to the integration of scientific and technical research in the national and international collaborative activities and socio-economic development. The **Permanent Inter-ministerial Committee on Scientific Research and Technological Development (CPIRSDT)**, which is chaired by the Prime Minister, is the core body to coordinate RD&I activities across government, including on energy, supported by the **Supreme Council of Education, Training and Scientific Research**.

Figure 6.1 Institutional landscape for energy R&D and innovation

CNRST: National Centre for Scientific and Technical Research

CPIRSDT: Permanent Interministerial Committee on Scientific Research and Technological Development

IRESEN: Institute for Research into Solar and New Energies

MASEN: Moroccan Agency for Sustainable Energy

MENFPESR: Ministry of National Education, Vocational Training, Higher Education and Scientific Research

MEMDD: Ministry of Energy, Mines and Sustainable Development

The Ministry of National Education, Vocational Training, Higher Education and Scientific Research is responsible for setting the policy on fundamental research in 12 (out of 15) universities and research centres. It works closely with other Ministries, including MEMDD, to promote innovation and is subject to the financial control of the Ministry of Economy and Finance.

The Ministry of Energy, Mines, and Sustainable Development (*Ministère de l'Énergie, des Mines et du Développement Durable*, MEMDD) is responsible for Morocco's overall energy policy and contributes to technology priority setting as a member of the CPIRSDT and the implementation by energy agencies, MASEN and IRESEN.

The **National Centre for Scientific and Technical Research** (CNRST) is in charge of coordinating research programmes among universities and scientific institutions. The CNRST is also responsible for establishing and maintaining connections and collaborative programmes with research institutions in foreign countries.

The Institute for Research into Solar and New Energies (*Institut de Recherche en Énergie Solaire et Énergies Nouvelles*, IRESEN) is a dedicated institute in charge of applied energy R&D. It is responsible for identifying research priorities and projects which are aligned with national energy policy objectives, such as renewable energy and energy efficiency. IRESEN functions as both a funding agency that organises competitive calls for R&D projects and a research centre that provides access to research and innovation infrastructure, such as the Green Energy Park and Smart Buildings Park, among others.

The Moroccan Agency for Sustainable Energy (MASEN) is responsible for leading and managing the deployment of all renewable energy technologies (see Chapter on Renewable Energy). As a core mission, MASEN supports the development of a national renewable energy industry in Morocco, including through development and demonstration activities. MASEN launches calls for proposals for innovative start-up projects and offers targeted competitive funding for industry-universities consortia. The R&D platform at the heart of the world's biggest CSP complex in Ouarzazate is an industrial scale pilot project testing environment and a significant asset for accelerating renewable energy innovative technologies time to market.

The private sector in Morocco is very active and has developed energy RD&I infrastructures in collaboration with IRESEN and MASEN. OCP R&D organisation is one of the largest R&D groups in Morocco (UNECWA, 2016) with activities along the entire phosphates value chain. Renewable energy investors have supported local content and the creation of jobs and local industries in Morocco, supported by research institutions.

Strategic priorities

Innovative research and training, and environmental protection and clean energy are among the five strategic objectives of the National Energy Strategy of 2009 (see Chapter on General Energy Policy).

In June 2014 the Permanent Inter-Ministerial Committee for Scientific Research, Innovation and Technological Development approved several national priorities for scientific and technological research, one of them being natural resources and renewable energy.

Morocco's industrial policy promotes technology transfer and the development of forward-looking, high-technology industries in the country. Morocco is seeking to position itself as a technological hub between Europe and Africa.

Public Funding

The majority of public R&D expenditure is dedicated to fund fundamental research in universities (65%), while energy and agriculture sector R&D activities receive around 9% each, with the remainder of the budget being shared by all other sectors. The funding is centrally controlled by the Ministry of Finance under heavy and long financial procedures (UNECWA, 2016).

In 2012-2017, IRESEN spent MAD 250 million on energy R&D, and it plans to spend a further MAD 300 million in 2018-2023 (IRESEN, 2018b). It aims at doubling the funding allocated to calls for R&D projects by 2030. Thanks to its close collaboration with industry, IRESEN's spending leverages private co-financing: it has been calculated that each MAD spent on RD&I attracts approximately 2 MAD from the private sector (IRESEN, 2018a).

MASEN allocates a yearly budget of MAD 70 to 100 million dedicated to various R&D programmes that support infrastructure investment, innovative technologies pilot deployment and industrial innovation programmes.

Programmes and initiatives

IRESEN funding agency

IRESEN is both an implementing and funding agency. The priority areas for IRESEN's implementing activities are aligned to the national energy policy objectives and include: solar energy; wind energy; biomass & biogas; storage (thermal & electric); hydropower; smart grids; sustainable mobility and energy efficiency.

IRESEN's funding aims to develop centres of excellence and highly specialised research units as well as to create knowledge and know-how through innovative and collaborative projects. IRESEN also puts in place research infrastructures, besides implementing some projects directly (see below section on projects). The principal funding areas of IRESEN include solar energy (thermal, PV); bioenergy & biomass; smart grids & green cities; energy efficiency; storage; wind and sustainable mobility. It funds collaborative projects and shared research platforms. Each project aims to obtain processes, services or products with high commercial potential that are 100% Moroccan. Since its creation, the funding agency has launched three annual calls for R&D projects involving universities and Moroccan business, covering different topics in the fields of renewable energy and other new energy technologies, (IRESEN, 2018b):

- Annual R&D call **“Green INNO-PROJECT”**, specifically dedicated to supporting collaborative R&D projects with a strong potential for developing new market-oriented products, services or processes. The maximum duration of projects is three years. Depending on the project, the maximum financial contribution for each funded collaborative R&D project is 300 000 Euros.
- Annual R&D JOINT call **“INNO-ESPAMAROC ENERGY”**, with the Spanish Government, between IRESEN and CDTI (SPAIN), specifically dedicated to supporting collaborative R&D projects. The maximum duration of projects is three years. Depending on the project, the joint financial contribution for each funded collaborative R&D project is about 1 000 000 Euros.
- Annual Innovation call **“Green INNO-BOOST”** is dedicated to support developers in the incubation or acceleration phases, mainly entrepreneurs (Young companies and SMEs) who want to innovate, in partnership with a university or a research centre, having already developed an innovative product, service or process with high commercialisation potential and added value. The funding is provided in the form of a grant and credit at 0%, according to the project specifications. The maximum duration of the project is two (2) years. The maximum financial contribution for each collaborative R&D project is 300 000 Euros in the form of maximum 30% subsidy and maximum of 70% loan at 0% rate.

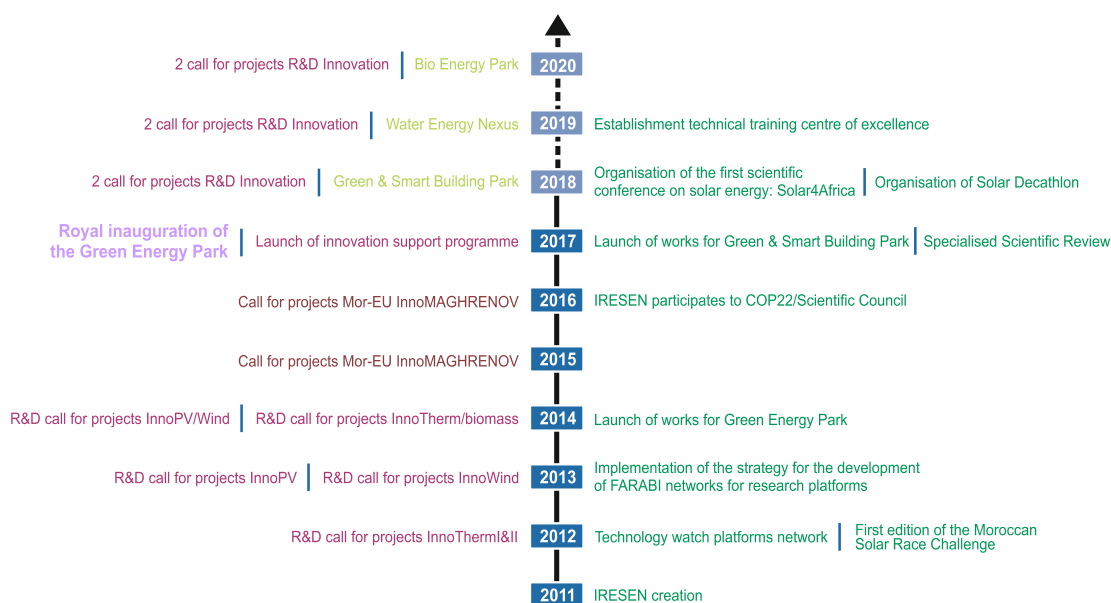
Across the innovation chain, IRESEN's calls **“Green INNO-PROJECT”**, **“INNO-ESPAMAROC ENERGY”** and **“Green INNO-BOOST”** are supporting different stages along the technology readiness levels for the following thematic areas:

- renewable energies (new technological developments, new applications aimed at industrial and social integration and adaptations to climate change)
- energy efficiency in building, agriculture, transportation and industry
- integration of renewable energies into the electricity grid
- nexus: Water / Renewable Energies / Agriculture

- sustainable mobility (road of tomorrow, vehicle of tomorrow, transformation of road traffic into energy, digitisation)
- energy storage (new sources of energy storage, new storage materials adapted to extreme weather conditions, new forms of energy storage, new methods of reducing the storage cost)
- Moroccan city of the future (neighbourhood of tomorrow, intelligent energy management, smart grids)
- green industries and mines and new energies.

Since its creation in 2011, IRESEN has enabled the setup of 12 laboratories in universities across Morocco, has financed 140 lecturer-researchers, 361 doctoral and masters' students as well as 74 engineers in Moroccan universities and engineering schools for work relating to renewable energy. It contributes to the transfer of knowledge and know-how through financing of scientific training sessions and seminars abroad and promotes the dissemination of research project results by providing financial support to researchers and PhD students for their participation in scientific events (IRESEN, 2018a and 2018b, see Figure 6.2).

Figure 6.2 IRESEN's energy RD&I infrastructure in line with technology readiness



Source: IRESEN, 2018a.

IRESEN research facilities

IRESEN is also building a network of applied research platforms to serve researchers and innovators actors and to develop and provide access to research infrastructures and expertise at optimum costs. These are research infrastructures that provide universities and enterprises with testing, researching and training services:

- **The Green Energy Park**, operational since 2017, is a renewable energy platform for testing, researching and training based in the town of Benguerir, next to Mohamed VI

Polytechnic University. The facility was built in collaboration between IRESEN and the OCP Group. This is the first R&D platform of its kind in Africa. It is designed to create synergies and partnerships between different Moroccan research institutions, and to support the various partner universities as well as Moroccan industries in acquiring knowledge and know-how.

- **The Green and Smart Building Park (GSBP)** is conceived as research and education platform dedicated to green buildings, energy efficiency, the integration of renewable energy sources in the building sector and sustainable mobility. It aims to bring together various institutions and local actors in the building sector (research centres, universities, development agencies, SMEs, etc.), and to encourage research in energy efficiency and savings in the built environment.
- **The Water-Energy Nexus** platform is due to be launched in 2019. It will be dedicated to water desalination, water treatment and the linkages between the energy and water sectors.
- **The Bioenergy-TIC and Storage Park** is due to be launched around 2020. It will focus on biomass, bioenergy and energy storage.
- **The Morocco-Ivory Coast Energy Park (MICEP)** is a collaborative effort of IRESEN and INPHB institute in Yamoussoukro (Ivory Coast) bringing together various institutions from Morocco and the Ivory Coast (research centres, universities, development agencies, and small and medium-sized business) to promote training, knowledge transfer and innovation in renewables and energy efficiency.

Table 6.1 IRESEN's energy RD&I infrastructures: Network of research and innovation platforms in clean energy and green technologies

Platform	Technologies	Timeline
Green Energy Park	Solar photovoltaic and solar thermal	Launched in 2017
Green and Smart Building Park	Green building, energy efficiency, smart grid and electric vehicles	Launch in 2019
Agro Energy Tic Valley	Bio energy, biomass and energy storage	Launch in 2020
Water Energy Nexus Project	Desalination, water treatment and water-energy nexus	Project
Morocco-Ivory Coast Energy Park	Solar photovoltaic and solar thermal	Launched in 2018

Source: MASEN (2018).

MASEN

Under Law 37-16, MASEN has a strong lead in the development of applied research and the promotion of technological innovations in the area of renewable energy, including through local content incentives for MASEN investment projects. The Ouarzazate R&D platform, with an area of 200 ha, is located at the heart of the world's biggest CSP complex. The complex is gradually being populated with leading edge pilot and demonstrators of various solar technologies, thanks to MASEN's partnerships.

MASEN's R&D platform in Ouarzazate provides research institutions, industries and developers optimal conditions for a solar site and within a utility-scale solar complex connected to the grid, in order to test solar components and systems performance and innovative solutions. Pilot projects include for instance a dish-sterling testing demonstration project, the SUMITOMO 1MW demonstration project (CPV). MASEN is

also an R&D partner in several EU funded projects, such as the Horizon 2020 (H2020) project “RESLAG”, which aims to valorise steel waste in energy-intensive industries (ceramics, glass, etc.), the H2020 project “WASCOP” which develops an integrated and innovative solution to optimize water management in CSP plants in order to achieve a significant reduction in water consumption (up to 70% to 90%), thanks to turbine batch cooling and solar field optical surface cleaning systems. MASEN is also involved in the H2020 project “SuperPV” which aims at optimization of the full PV value chain. MASEN has also entered in partnerships with international R&D and industrial institutions, such as French CEA, and companies, like Siemens and CMI.

Energy RD&I flagship projects

Morocco is leading globally in the deployment of large-scale solar thermal applications and related RD&I, based on concentrated solar plants’ (CSP) ability to store energy for generating electricity during the evenings, a decision the IEA has advocated in the past (IEA, 2014). Despite the cost advantages from fast declining prices of PV panels, Morocco chose to prioritise thermal technologies in the first phase of large-scale solar plants. There is scope for RD&I in the solar industry sector with potential cost reductions. IRESEN and MASEN lead multiple projects in close collaboration with the private sector, supported by international and private funding.

Small-scale CSP units for heat and power in industry were launched at the Green Energy Park by IRESEN in collaboration with OCP Group, including financial support.

IRESEN has launched extended research of **water saving in CSP plants**, targeting water saving in condensers as well as mirrors cleaning optimisation, financed through a grant agreement with EU Horizon 2020 programme.

Several projects are being taken forward at the IRESEN Green Energy Park and other IRESEN facilities with regard to **thermal energy storage**, including laboratory-scale research of the materials, prototype scale work, funded by the Ministry of Education and Research through the National Center for Technical and Scientific Research, and an industrial pre-commercial pilot funded from grants under the European Union’s Horizon 2020 programme. In January 2018, MASEN and the Swedish solar technology company Cleanergy signed a co-operation agreement to develop jointly a thermal energy storage system using the Cleanergy CSP-Stirling-based solar electricity technology. Cleanergy and MASEN also plan to develop a storage system for solar energy, with the objective of producing distributed renewable electricity at a competitive cost (CSP Focus, 2018).

MASEN R&D platform hosts the first 1MW CPV Sumitomo Electric pilot plant in the world and was inaugurated in 2016 during the COP22. Since then the plant has generated over 1GWh of green electricity and created the adequate conditions for at-scale testing of this emerging technology.

IRESEN and MASEN are together conducting tests of solar performance in desert conditions in order to better understand how excessive dust build-up on PV panels and thermal reflectors may affect performance. MASEN R&D platform in Ouarzazate provides research institutions, industrial companies and developers with an opportunity to test solar components and systems’ performance and devise innovative solutions. Pilot projects demonstrate new technologies, such as the operational pilot Sumitomo 1 MW CPV project. The Green Energy Park is the first integrated research hub for solar energy in Africa. It covers all the R&D value chain in

the field of solar by incorporating 3100 m² of advanced research laboratories in the field of photovoltaic and CSP besides the facilities for testing and prototyping as well as pilot and full-scale projects.

Education and training

The Ministry of Energy, Mines and Sustainable Development, in collaboration with the State Secretariat in charge of Vocational Training, initiated the creation of three institutes for vocational training in renewable energy and energy efficiency in Oujda, Tangier and Ouarzazate. The first Institute opened in Oujda at the end of 2015. The competency framework and the training programme for trainers were developed with the GIZ technical support (GIZ Energy, 2018). A new CSP master degree oriented to R&D was created between IRESEN, the University Cadi Ayyad of Marrakech and CIEMAT (Spain). MASEN regularly organises a summer school (MASEN Talent Campus) for the training of engineering school and university students in the latest renewable energy technologies.

Monitoring and evaluation

IRESEN has a scientific council that consists of prominent researchers and experts, chaired by the Minister of Energy. The Council's mission is to review and evaluate the programme and management processes carried out by the Institute, in order to ensure the quality and scientific relevance of the projects, as well as their relevance to the mission of IRESEN. After the first five years of its operation (2012-17), IRESEN commissioned an assessment of the Institute's results. This evaluation has demonstrated very good progress on the research side, evidenced by an increased number of publications in international scientific magazines and an increased number of students and researchers. However, the results were not so good as regards the commercialisation of innovative technologies (for example only about 15 patents registered over the five years). Against this background, IRESEN has created two new calls for applied R&D and Innovation, in 2018: "INNO-ESPAMAROC ENERGY" and "Green INNO-BOOST", aimed to develop new products, services and/or processes and boosting the incubation, the acceleration of innovative projects and the market deployment of green technologies, notably in SMEs and start-ups.

International collaboration

IRESEN has put in place a network called Green Africa Innovation Network (GreenAIN) that brings together 16 African institutions in the field of training, research and development and innovation in renewable energy in Africa. In the framework of GreenAIN, IRESEN has organised two editions of Green Africa Innovation Booster (Marrakech 2017 and Yamoussoukro 2018), an event to encourage excellency in clean energy and support research and innovation in Africa. IRESEN's village of innovation (GREEN TECH VILLAGE) offers exhibition spaces for start-up companies from Africa, Europe, Asia and America to present their most innovative new products/processes/services with high potential for introduction in the market.

An IEA Association country since 2016, Morocco participates in two IEA technology co-operation programmes. MASEN and IRESEN are members of IEA's SolarPACES – an international network of researchers and industry experts for the development and marketing of concentrating solar thermal power systems and solar chemistry technologies (<http://www.solarpaces.org/>). And IRESEN is also now a member of the IEA

Photovoltaic Power Systems Programme (<http://www.iea-pvps.org>) - a technology co-operation programme with 27 member countries that represent close to 90% of the PV market and industry.

IRESN also takes part in several international projects with national and European funding and in collaborative bilateral projects with partners representing the industry, academia and research centres. IRESN's academic partners include the Universities of Porto and Evora (Portugal), the University of Yasar and University of Ankara (Turkey), Reading (UK), Rome – Sapienza (Italy), Stellenbosch (South Africa), Mines ParisTech and École Polytechnique de Paris (France) and ENIT (Tunisia).

Co-operation at industrial level includes partnerships with companies from Italy (Enerray, Soltigua, Kiwa and Exergy), Germany (Kelvion GmbH, Pi Berlin and ENEXIO) Finland (Merinova), USA (First Solar), the Netherlands (DSM) and South Africa (Kelvion thermal solutions ZA). IRESN is joining forces with some of the major research centres and networks in Europe such as ENEA (Italy), Fraunhofer CSP, Fraunhofer ISE and DLR (Germany), CIEMAT, KIC Innoenergy and CIC Energigune (Spain), and Ait (Austria).

IRESN has also signed collaboration agreements with several African institutes, including Agence des Énergies Renouvelables (Mali), Académie Nationale des Sciences Arts et Lettre du Bénin, ANSOL, Université Cheikh Anta Diop (Senegal), Université Félix-Houphouët Boigny (Côte d'Ivoire) and Université de Ouagadougou (Burkina Faso) (MEMDD, 2018).

MASEN is a member of the EUROSUNMED project⁶, of the H2020 projects RESLAG (since September 2015) and WASCOP (since January 2016), and of the Organizing Committee of the International conference IRSEC⁷. MASEN also collaborates on projects with various foreign public and private institutions such as CEA (*Commissariat à l'Énergie atomique et aux énergies alternatives*). In 2016, MASEN and CEA signed a new agreement to examine issues such as the durability of solar plant components and to evaluate other technologies such as those used in the design of effective desalination plants.

Other Moroccan institutions also take part in international collaboration activities. For example, the National Center for Scientific and Technical Research (CNRST), the Mohamed V University of Rabat, the Cadi Ayyad University of Marrakech, and the Mohamed Premier University of Oujda have joined the research project "Energy, Environment and Sustainable Development" ("E2D2") under the ARCUS programme (Actions in Regions of University and Scientific Cooperation), launched by the French Ministry of Foreign Affairs in partnership with three French universities and institutions from Lebanon, the Palestinian Territories and Morocco.

⁶ www.eurosunmed.eu

⁷ <http://medspace.org/irsec/>

Assessment

Morocco aims at developing a national renewable energy industry, as it is diversifying its energy supply and increasing significantly the share of renewable energy (RE) in the electricity mix. Morocco seeks to become a major player in regional markets and has supported the development of cutting edge technologies, notably in the area of solar and solar thermal energy.

Achieving its ambitious climate and renewables objectives requires not only massive investments in the construction of new power generation facilities and smart grids but also well targeted investments in the research and development (R&D) of clean energy technologies. While research and innovation is part of the 2009 National Energy Strategy, Morocco has not defined a dedicated energy RD&I agenda, with priority areas, to boost areas where the country has a competitive advantage. Today, RD&I activities are driven by an industrial policy agenda, private investment in renewable energy and technology transfer programmes through a bottom-up approach.

The lack of a strategic vision for the energy sector is partly reflected in the design of the overall R&D budget which is not well distributed among sectors of national importance. The main R&D budget is dedicated to university research. The share of energy-specific R&D in total public R&D spending is small, compared to its importance in the Moroccan R&D landscape and national policy priorities.

Morocco has undertaken significant R&D activities in recent years, in particular since the creation of IRESEN in 2011 and by MASEN as highlighted above. Thanks to these activities an ecosystem for R&D has developed, in which universities, research institutes, and business work together. A substantial accumulation of human capital is reflected in the large number of scientific publications generated and the first prototypes of innovative products made in Morocco.

There may be a case for fiscal incentives to support SMEs and start-ups in commercialising the innovations, given that bringing innovations to the market remains a challenge. The government should therefore consider increasing budget allocations and simplify budget processes to scale up energy innovation, while improving the effectiveness of the public spending and to encourage further co-funding of public activities by the private sector, building on the success to date in attracting co-funding from private industry.

On behalf of the Ministry of Energy, Mines and Sustainable Development, IRESEN is responsible for the development of R&D in the fields of renewable energy and energy efficiency.

MASEN is involved in an increasingly broader portfolio of energy technology of energy technology R&D and commercialisation as per its prerogatives under law 57-09 and 37-16. It will be important to ensure that there is close coordination and co-operation between the different bodies involved, so as to make the most of the resources available for energy R&D and to maximise synergies.

Morocco has fostered a dynamic community of clean energy R&D players with the technical and organisational ability to deliver positive results. The outcome and the impact of R&D should be regularly evaluated in order to provide feedback to policy makers and relevant institutions and enable them continually to improve and get the

most from expenditure on R&D. There is no overarching process for the structured and regular review of the overall energy RD&I priorities, funding and results by the Ministry of Energy (MEMDD), based on indicators and assessment methodologies. The Strategy Committee of IRESEN, which is presided by the Minister of Energy, meets regularly to advise the government on the definition of priorities and the themes for the call for proposals.

IRESEN's plans to double expenditure in R&D in line with the objectives of Mission Innovation are praiseworthy and should be implemented. To foster this objective, increased participation in IEA Technology Collaboration Programmes (TCP) and Mission: Innovation activities for non-members could be explored further.

Recommendations

The government of Morocco should:

- Evaluate the R&D activities carried out since 2011 across the energy sector, with a view to updating and revising its R&D policy, priorities, and funding for the horizon 2030.
- Improve public funding of innovation and commercialisation of clean energy technology, to leverage larger private and international innovation funding, in line with priorities of the national energy strategy, technology progress and global Mission: Innovation goals.
- Strengthen the coordination of energy technology R&D programmes across government, universities and other agencies to avoid duplication of activities and exploit synergies for commercialisation.
- Boost Morocco's clean energy innovation ecosystem and technology development in the fields of renewable energy and energy efficiency by developing stronger synergies between the business and science.

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7. Electricity

Key data

(2016/17)

Total electricity generation (2017): 32.8 TWh, +65% since 2007

Electricity generation mix (2017): coal 53.5%, natural gas 18.6%, oil 9.1%, wind 9.5%, hydro 4.0%, solar 1.3%, industrial process heat 4.1%.

Electricity net imports (2016): 5.2 TWh (imports 5.3 TWh, exports 0.1 TWh)

Installed capacity (2016): 8.3 GW

Peak demand (2016): 6 GW

Electricity consumption (2017): 32.5 TWh (industry 36.4%, residential 33.8%, commercial 17.2%, agriculture 11.5%, transport 1.1%)

Overview

Electricity generation in Morocco has grown by 65% over a decade (at an annual average of around 5%) as a result of population growth, economic development and efforts by the government to ensure that everyone in Morocco, notably those living in rural areas, has access to electricity. In 2016, 99.43% of the population had access to electricity. Electricity generation is dominated by fossil fuels – principally coal, but also oil and gas - accounting for 81% of electricity generation. However, renewable energy, wind and concentrating solar power, continued to see significant growth.

Boosting and diversifying electricity capacity is a priority for Morocco, in line with its goal of having 52% renewables in total installed capacity by 2030 and securing electricity supply. In 2009, the government started a programme to promote the deployment of renewables. Legislation has been passed to establish a legal framework for an open power market and an independent regulatory authority (ANRE). In 2018, the Director of ANRE was appointed, and the regulation and transfer of ONEE's renewable energy assets to MASEN is underway, besides the launch of several studies for the development of a grid code. The full implementation of grid access, tariff setting, trading of electricity and network planning is critical to maintain the attractiveness of Morocco's energy sector for private investors, notably for distributed generation, and to support Morocco's ambitions of greater regional integration into the EU and Mediterranean power market. As shares of variable renewables increase, Morocco is using more flexibility from power imports, most of it coming from Spain. These imports have become the most economic source for system flexibility to manage rising electricity peak demand, besides load management of industry at peak price hours, and energy storage at concentrating solar power plants.

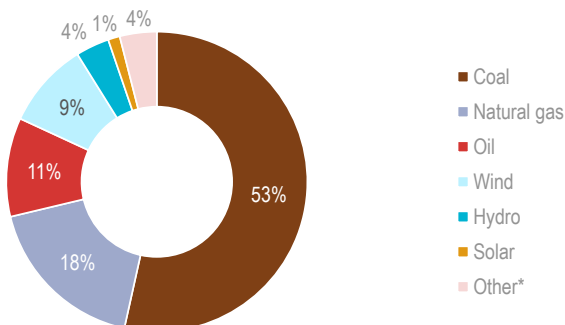
Supply and demand

Electricity generation from diverse sources

Coal remains the most important fuel source for electricity generation in Morocco, accounting for 54% of total domestic power generation in 2017 (Figure 7.1). Coal power has grown rapidly since the mid-1990s, and increased by 41% between 2007 and 2017 (Figure 7.2).

Natural gas power was introduced in 2004, when Morocco began importing gas from Algeria to fuel power plants. Since then, gas power has increased significantly and more than doubled in the last decade, and accounted for 19% of total power generation in 2017.

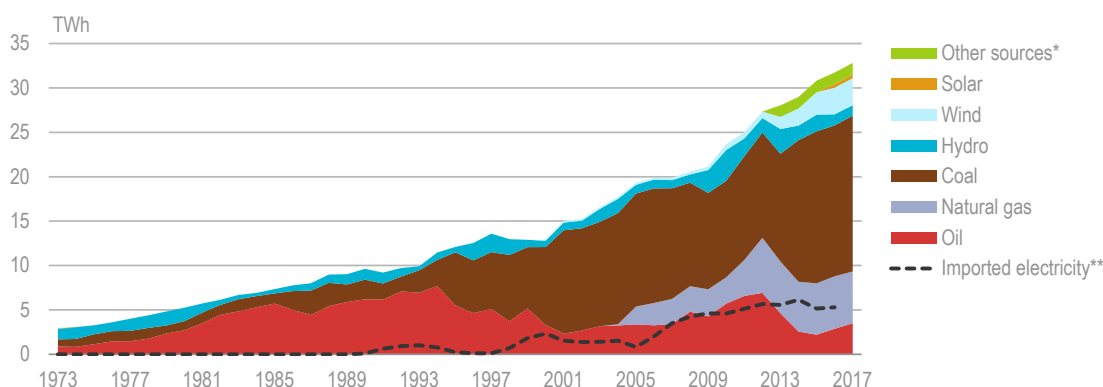
Figure 7.1 Electricity generation by source, 2017



*Other sources: heat from chemical processes (auto producers).

Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

Figure 7.2 Electricity generation by source, 1973-2017



*Other sources: heat from chemical processes (auto producers).

**Data on imported electricity not available for 2017.

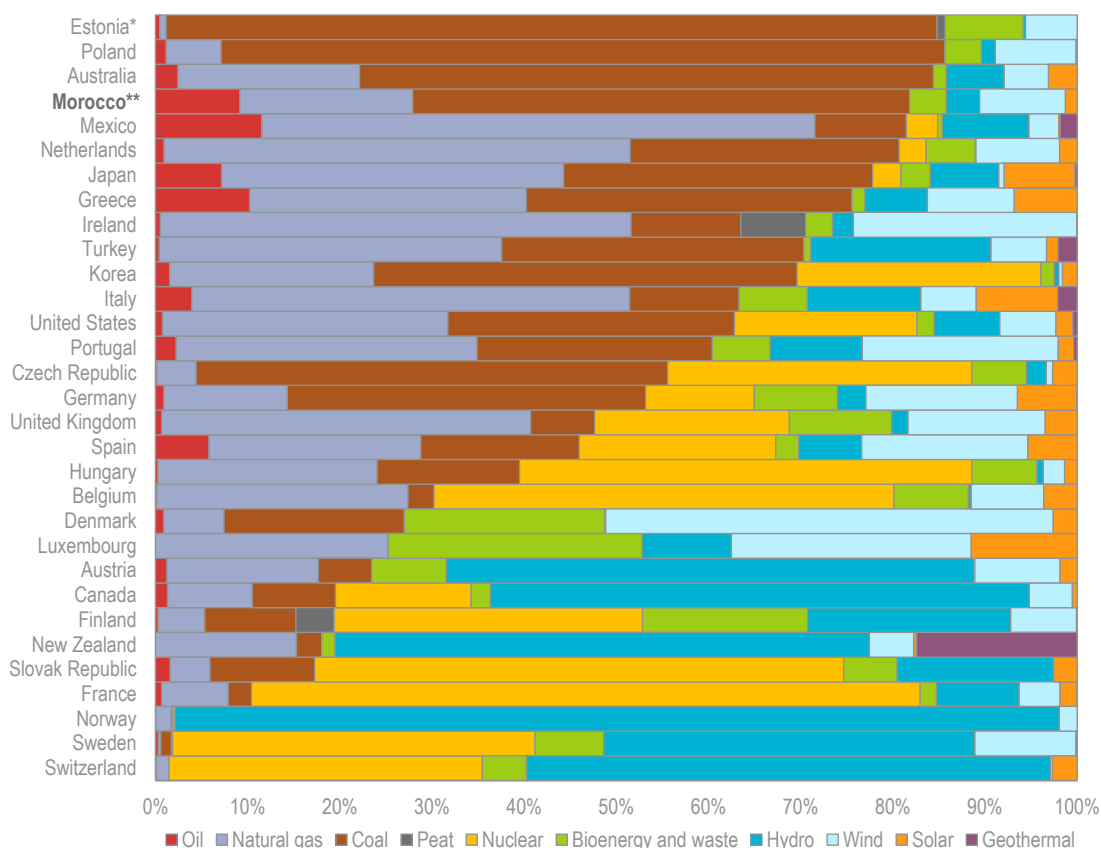
Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

The role of oil in overall electricity generation has decreased in the last decade, with natural gas generation tending to displace oil (Figure 7.2). Today, however, a large amount (9%) of power generated still comes from oil, mainly in rural isolated areas.

Compared to the shares of IEA members, this would be the third highest share of oil use in power generation, behind Mexico and Greece.

In 2017, fossil fuels (coal, gas, oil) accounted for 82% of total electricity generation, and renewables and waste heat made up the remainder. Morocco's total share of fossil fuels in power generation ranks as the fourth highest when it is compared with those of IEA members (Figure 7.3), behind Estonia, Poland, and Australia; although the carbon intensity of power generation has declined in Morocco thanks to investment boom in renewable energy and natural gas.

Figure 7.3 Electricity generation by source in Morocco and IEA countries, 2017



*Estonia's coal represents oil shale. Hydro pumped storage excluded.

**Morocco's biofuels and waste represents electricity from industrial waste heat.

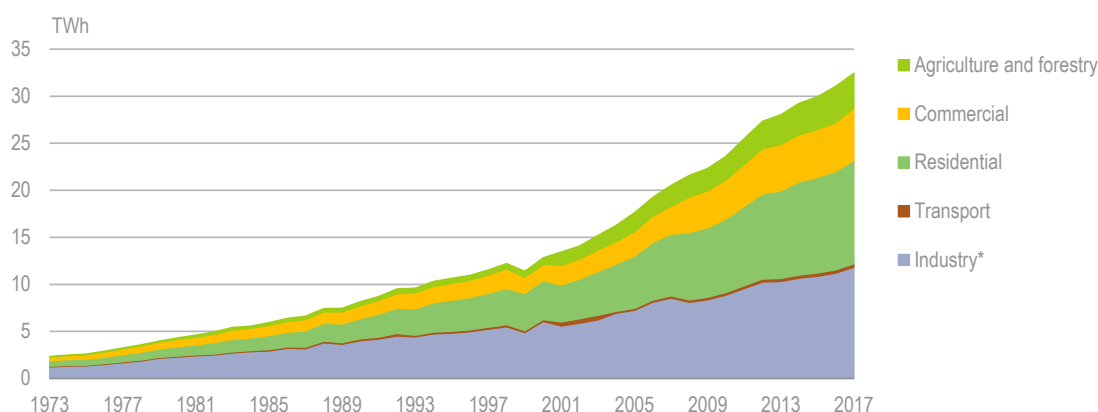
Source: IEA (2018b), *World Energy Balances, 2018*, www.iea.org/statistics/

Renewables have seen substantial growth in the last decade, starting from a low level. Wind power now supports 9.5% of power production, hydro 4.0%, and solar 1.3%. Since 2007, wind power generation has increased more than ten-fold, and it overtook oil in electricity generation in 2015. Solar power has grown rapidly with the solar PV projects (Noor IV, Noor Laayoune I and Noor Boujdour I) and concentrated solar power (CSP) projects NOOR Ouarzazate I, II and III. Several new solar projects are being developed (i.e. CSP at Midelt and PV at NOOR Ouarzazate IV, NOOR Laayoune, NOOR Boujdour as well as NOOR PVII projects) to increase solar capacity.

Growth in electricity consumption

Electricity consumption saw an annual average growth of 5.4% over the period 2002-16. In 2017, the industrial sector remained the largest consumer of electricity in Morocco, accounting for 11.8 TWh or 36% of the total (Figure 7.4). The residential sector was the second largest, with 11.0 TWh or 34%, followed by the commercial and public services sector, with 5.2 TWh or 17%, and agriculture with 3.7 TWh or 12% of total electricity consumption.

Figure 7.4 Electricity consumption (TFC) by consuming sector, 1973-2017



*Commercial includes commercial and public services, agriculture and forestry.

Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

As a rising population in rural areas has gained access to electricity, now accounting for 99.43%, electricity consumption has accelerated. In the last decade, consumption grew in agriculture grew by 66%, the commercial and public services sector by 88%, residential by 67% and industry by 38%.

Electricity imports

Morocco has been importing increasing amounts of power through interconnections with Spain (and to a lesser extent with Algeria) which helped meet rising electricity demand, notably peak demand. Net imports more than doubled from 2 TWh in 2006 to 5.3 TWh in 2016, accounting for 14% of the total electrical supply. Morocco plans to expand existing interconnections and to add new interconnectors to Spain (third interconnector) and Portugal (first) (see below section on network adequacy).

Institutional framework

State-owned **National Office of Electricity and Drinking Water** (*Office National de l'Électricité et de l'Eau Potable, ONEE*) is the main player in the Moroccan electricity sector. ONEE was created through the merger of the country's water/sanitation (ONEP) and electric (ONE) utilities in 2011. This vertically integrated company owns, plans and operates the power system, the transmission and a large amount of the distribution grids, and is responsible for imports/exports (including of natural gas). As such, ONEE is de facto the single buyer of almost all power generation which it retails and supplies.

The Ministry of Energy, Mines, and Sustainable Development (MEMDD, Electricity Department) is responsible for the legal framework of Morocco's power sector and the governance of related institutions. ONEE falls within MEMDD's administrative and technical supervision under Law 40-09.

The **Ministry of the Interior** (Directorate of Public Utilities and Concessions, *Direction des Régies et des Services Concédés*) is responsible for the development of the general policy, control and monitoring of the electricity distribution (and water/sanitation) companies: the seven public municipal water and electricity distribution companies in large urban areas, the so-called *regies autonomes*: RADEEMA in Marrakech, RADEEF in Fes, RADEEM in Meknes, RAK in Kenitra, RADEEJ in El Jadida, RADEES in Safi and RADEEL in Larache. The Ministry also has oversight of the four privatised distribution companies, the so-called delegated authorities in the major cities, who operate under transferred management and concession agreements in the cities of Casablanca, Rabat, Tangiers and Tetouan. However, further restructuring of the power distribution sector is being planned, as the government has plans to create regional multi-service agencies in charge of drinking water and electricity distribution and urban sanitation.

The Moroccan Agency for Sustainable Energy (MASEN) is a limited company with public shareholders and responsible for leading and managing the deployment of renewable energy. MASEN develops projects at the technical, economic and financial level, and coordinates activities through a one-stop-shop. MASEN contributes to the emergence of a national renewable energy industry through training and capacity building, local development and industrial integration, research, development and demonstration in Morocco's renewable energy sector, including across the African continent. In the electricity sector, MASEN's tasks include renewables resource assessment, and generation capacity planning, in collaboration with ONEE. Following institutional reforms in 2016, ONEE must transfer all its renewable energy assets to MASEN within five years, except those used for balancing, such as pumped storage hydro. In 2018, ONEE has a 25% stake in MASEN.

The Research Institute for Solar Energy and New Energies (IRESEN) was created in 2011 under the initiative of the Ministry in charge of Energy as well as the national, public and private actors of the energy sector in order to support the national energy strategy through applied research and innovation. The aim is to ensure fast-track technology transfer and translation of research results into innovative products in the fields of renewable energies and new energies.

The **Ministry of General Affairs and Governance** establishes the sales tariffs for electricity, based on an opinion by the Interministerial Awards Committee (Commission des Prix), in application of Law No. 06-99 on freedom of prices and competition and related regulations.

The **Ministry of Economy and Finance** (Public Enterprises and Deprivation Department) exercises economic and financial control over the investment and financial management of ONEE and local electricity distribution, in application of Law No. 69-00.

The National Authority for Electricity Regulation (*Autorité nationale de régulation de l'électricité*, ANRE) has been created in 2018 in accordance with Law 48-15 adopted in 2016, and its Director appointed in August 2018.

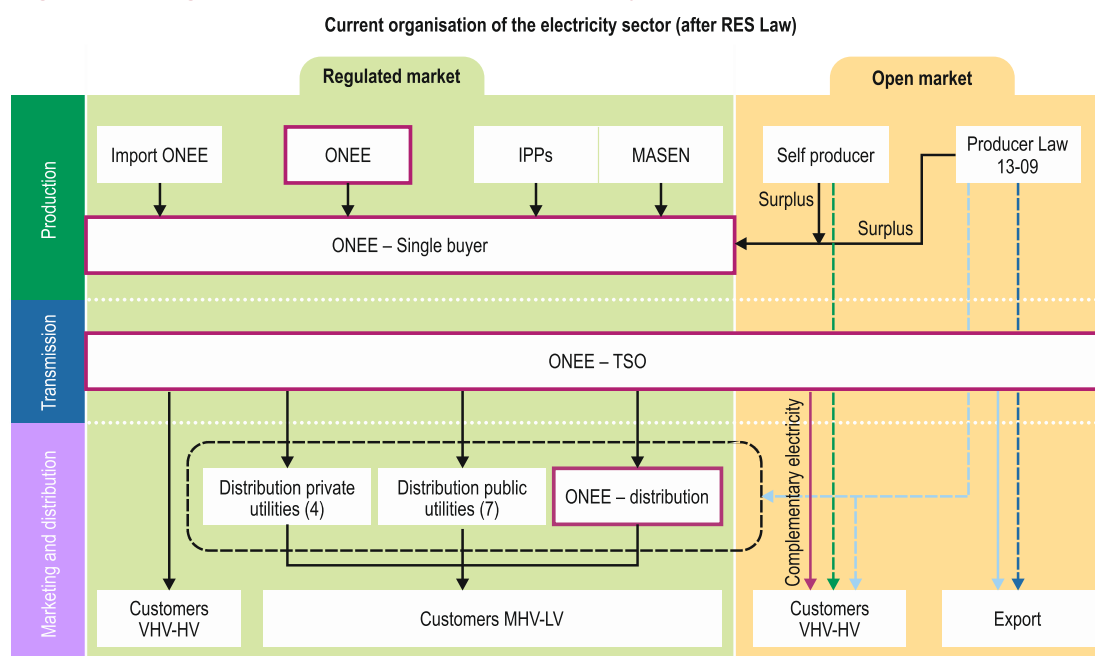
Electricity market organisation

Starting in the 1990s, Morocco has carried out power market reforms over several decades. As in other emerging economies, the power sector is going through a transition period towards full liberalisation, with renewables development the first area where liberalisation is taking place.

Generation was liberalised in 1994, when Decree-Law No 2-94-503 allowed private electricity generation, which created the basis for investment from independent power producers (IPPs). In 2008, a liberalised self-production regime was created under Law 16-08, allowing private generation of electricity for the purpose of self-consumption, mostly by large industrial users) for plants below a capacity of 50 MW and the sale of a limited surplus electricity to ONEE (without specifying the quantity).

Morocco's electricity market has a hybrid structure with two main markets, as illustrated in Figure 7.5: on the one side, the regulated power market with IPPs, public-private partnerships of MASEN besides ONEE's own generation; and on the other side, the open market for renewable generators and self-generators which is being set up.

Figure 7.5 Organisation of Morocco's electricity sector



In 2009, the government started the process of creating a competitive market for renewable energy which is now open for private investors under Law 13-09 (see also Chapter on Renewable Energy). Private-to-private power transactions are allowed for renewable energy projects under Law 13-09 and third party access to ONEE's transmission network is required. Moreover, the regime for self-generators (not only renewables) was opened up, as the 50 MW ceiling for self-generation was removed (Law 13-09), making it part of the new 'open' market. Law 13-09 also allows small renewable projects to sell their surplus electricity to ONEE, sell to exports and large industry clients at VHV/HV level or distribution utilities. However, the ability of private renewable generators to find large customers remains limited. The actual share of the competitive

market segment and investment and shareholdings of the private sector are small in comparison to the regulated market, where long-term contracts and public-private partnerships dominate (see Chapter 5 on Renewable Energy).

While generation and distribution were opened to private investors, Morocco does not have an organised wholesale electricity market and no financial exchange of electricity trades is done outside of ONEE's de-facto function as sole buyer and seller. Rules for the trading of surplus electricity, as foreseen under the legislation for self-consumption and Law 13-09, remain unclear and will be an essential requirement for market reform.

Market structure

ONEE is the main player in the electricity market in Morocco; de-facto it is the sole buyer and in charge of power imports and exports and the purchase of electricity produced by independent power producers (IPPs), surplus electricity from self-generators and all renewable electricity generation from projects developed by MASEN. ONEE holds long-term power purchase agreements (PPAs) with these entities. ONEE also owns generation plants, including coal, gas and wind (which will be transferred to MASEN by 2021). ONEE's own generation market share has decreased, with the growth of renewable energy projects developed by MASEN. Under Law 38-16, ONEE has to transfer all renewable energy generation assets within five years to MASEN (with the exception of pump storage hydro plants, plants that are critical for the national electricity supply security and plants under Law 13-09). In terms of market shares in 2016, ONEE supplied power to the national market from its own plants (29.2%), and through IPPs (52.9%) and imports (14.6%), with power from private industrial producers accounting for the remainder (3.3%) – see Figure 7.6.

Figure 7.6 Electricity market structure (ownership)

Production	ONEE own production (29.2%)	IPP production (52.9%)	Interconnections (14.6%)	Self-generation (3.3%)
Trade	ONEE is the single buyer of electricity in Morocco (35.4 TWh).			
Transmission	ONEE operates and manages the transmission of electricity.			
Supply	ONEE (58%)		Delegated Utilities (42%)	
Distribution	Distributed: medium and low voltage levels (45%)	Clients at very high voltage and high voltage levels (13%)		Customers at medium and low voltage levels (42%)

ONEE owns and manages the entire transmission network (very high and high voltage lines of 400 kV and 225 kV) and some medium and low voltage of 60 kV networks. ONEE is also in charge of the balancing, grid and system services, supported by ONEE's own pump storage power plants and its role as power importer/exporter. ONEE is tasked with the planning of the power system and its adequacy through the planning of investment in generation (Plan d'Équipement) and transmission.

ONEE supplies 58% of all electricity to the final customer. The remainder (42%) is supplied by private distribution utilities which were created during the privatisation of the sector in the 1990s. Under a 30 year concession contract, these private utilities manage power (and sanitation and water) supplies and carry out the investment while the public

authority (municipality/Ministry of the Interior) sets the objectives, investment programme and regulates social and environmental outcomes.

The account unbundling of ONEE's transmission and generation activities is foreseen as part of the creation of an independent regulator (see below section on grid access).

Electricity transmission and interconnections

Morocco's electricity grid covers the entire country with the exception of a small isolated network in the south of Morocco. A major programme for rural electrification and the strengthening of the power system has been completed by ONEE over three decades since 1996 *Programme d'Électrification Rurale Généralisé*.

ONEE manages a well interconnected national transmission grid of very high, high and medium voltage lines (400 KV, 225 KV, 150 KV and 60 KV). Under Law 13-09, private companies can build direct transmission lines for their own use, where the capacity of the national transmission grid or interconnection is insufficient (thus allowing for the export of renewable electricity). Morocco's grid is well interconnected to neighbouring countries, but commercial trades remain limited.

- Morocco and Spain are connected by two subsea 400 kV interconnectors with a total capacity of 1400 MW but a more limited commercial exchange capacity of 900 MW. Morocco trades electricity bilaterally with Spain, and ONEE has had a licence to operate in the Spanish power market since 1999.
- Morocco and Algeria are connected by two 225 kV transmission lines with a total capacity of 400 MW, together with a third 400 kV line which takes total capacity up to 1200 MW, but they have a limited commercial exchange capacity of 200 MW. The exchange of electricity between Morocco and Algeria is done on a zero-balance basis under an emergency supply contract between ONEE and SONELGAZ of Algeria.

Regulation of grid access

In 2012, Morocco established a new framework for the electricity sector on the basis of Law 13-09 (*RES Law*) for private renewable generation (and related Law 58-15), requiring independent access to the grids. Morocco has laid the ground for the creation of an electricity regulatory authority under Law 48-15 which will supervise grid access in the competitive market.

Law 13-09 opened up access to the very high, high and medium voltage levels for large-scale renewable projects. Access to the very high voltage level allows private renewable developers also to export their electricity. Implementing decree 2-10-578 details the access rules for the high voltage levels. For this level, Law 13-09 foresees zoning plans for renewable energy. To date, only large-scale wind zones have been established, while large-scale solar zones are still under development. In total, nine wind projects have been authorised under this new framework.

In 2015, decree 2-15-772 expanded the scope of the renewable energy production and set out the rules for access to the medium voltage level. The implementation of open access requires the development of so-called envelopes for a ten year horizon, providing

for very limited trajectories of capacity expansion per electricity distribution zone of a minimum of 5% and a maximum of 10% of the energy consumption of the zone. As of July 2018, not all public distribution companies (*régies autonomes*) have yet set out plans for the expansion of renewable energy, as some grid companies will have to address a number of technical issues, like power quality, voltage regulation, and the scope for reverse flows.

Law 58-15 amended and complemented Law 13-09 and allows renewable generators to sell surplus generation to ONEE (but only up to a maximum of 20% of their monthly generation) or to sell directly to a distribution company. Thereby, the Law opened the low voltage (distribution) electricity market for renewable generators. However, the implementing decree for low voltage access is still under development. At distribution level, to date, there are no legal rules in place for the grid connection, as there is no grid code for medium and low voltage levels. A grid code for low voltage is under preparation (with support by the EBRD). This so-called new open market consists of the 'surplus electricity', exports and retail to distributors.

The electricity regulatory authority

Law 48-15 (adopted on 7 July 2016) established the national regulatory authority for electricity (ANRE). ANRE has a mandate (for six years with a council of ten members) to regulate the open segment of the electricity sector under Law 13-09. As ANRE's mandate covers the "free market", the Ministry of General Affairs will remain responsible for tariff setting in the regulated segment of the electricity market. ANRE's functions include the supervision of the account separation of the national transmission system operator, the approval of standards and regulations governing the sector (grid codes), regulating access to and the utilisation tariffs of national transmission grid and controlling and monitoring the efficient functioning of the open market. In August 2018, ANRE's Director General was appointed, but the institution has not yet started its work.

Electricity distribution and retail

Electricity retail prices are still regulated in Morocco. ONEE supplies electricity to all 11 distribution companies in Morocco, which can be divided in two types of distribution companies: seven publicly owned municipal distribution system operators (the *régies*) which manage electricity, water and sanitary services as delegated authorities under the supervision of the Ministry of the Interior; and four private utilities which hold concessions in the main cities. The *régies* and the private distribution utilities have relatively low distribution losses and low debt-equity ratios: the figures for ONEE are much higher (Amegroud, 2015).

Electricity pricing

The final electricity price is regulated by the government in a uniform manner across the various distribution companies, which means that prices do not reflect any differences in distribution network connections or operating costs. The merger of water and electricity services under ONEE in 2011 has also encouraged further cross-subsidies between these services with only a slight improvement of ONEE's financial situation. ONEE still has to shoulder large debt, from private and international loans, as the government

required it to invest in major infrastructure expansion (electricity and water) without providing government budget, while its revenues are low because of subsidised tariffs.

Since 2012, the Moroccan government has been working to reduce its expenditure on energy consumption subsidies by reforming the country's Compensation Fund (Caisse de Compensation), and energy subsidies have been reduced significantly. In 2014, they were phased out for gasoline, diesel and kerosene, and reduced for electricity tariffs. Electricity prices have seen a corresponding increase since August 2014.

Tariffs are regulated for consumer groups: administrative public lighting, private lighting, domestic use (private dwellings), and driving forces. Private domestic use has several bands (see Table 7.1).

Electricity retail prices in Morocco are high by comparison with other countries in the MENA region, many of which still provide expensive subsidies to reduce prices to end consumers (Choukri et al, 2017). However, electricity tariffs remain still below generation costs, according to World Bank data (Figure 7.7), households paying between 0.9 and 1.44 MAD per kWh depending on six bands of monthly consumption levels within a social tariff scheme.

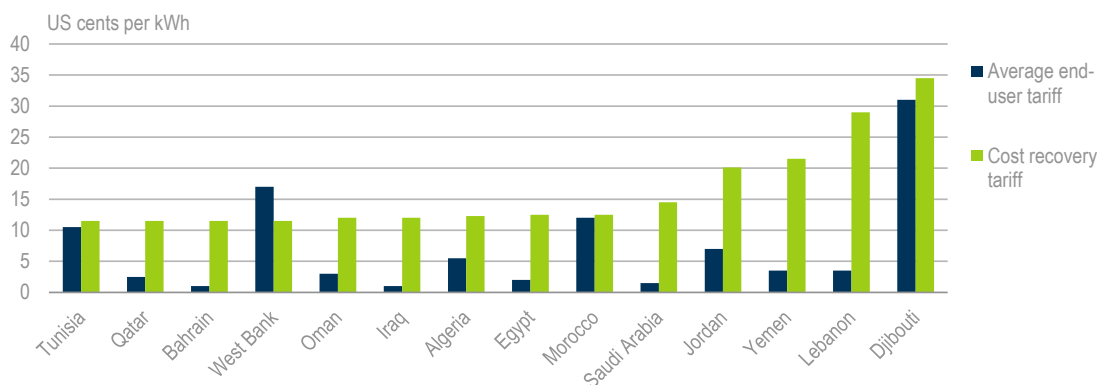
Table 7.1 Electricity prices for private domestic use, 2015

Consumption bands per month	kWh price
0–100 kWh	0.9010
101–150 kWh	1.0732
151–200 kWh	1.0732
201–300 kWh	1.1676
301–500 kWh	1.3817
> to 500 kWh	1.5958

Notes: The above prices are quoted in dirhams inclusive of VAT (VAT is 14%). 1 euro = 10.83 MAD in April 2015.

Source: Choukri et al, 2017.

Figure 7.7 Comparison of average end-user and cost-recovery tariffs in MENA, 2013



Source: World Bank Group (2017).

Security and flexibility of the electricity system

Over the past decade, Morocco has seen remarkable investment in new generation and transmission/distribution, which has much improved security of electricity supply. New challenges arise from the growing electricity consumption in agriculture, industry and the rising penetration of electric appliances among a population that has recently gained access to electricity.

Moreover, Morocco's power system has to deal with seasonal droughts affecting its hydropower resources and with rising peak demand to cover cooling needs. Morocco has now to manage the summer and winter peaks. On 7 August 2018, the system had to withstand the historic peak demand of 6.31 GW.

While Morocco's power system benefits from flexibility of regional interconnections, they have only limited scope for power exchange. The current power system lacks liquidity at the contractual level as most of generation is tied into long-term contracts.

The peak load is occurring from 7pm to midnight in summer, and 5 to 10pm in the winter period. The quality of power supply will improve with the installation of CSP plants which are now adapted to production at peak hours.

Generation adequacy

After a strong growth in early 2000s, electricity demand growth has risen from 31 TWh in 2012 to 35.4 TWh in 2016, with growth driven by population and economic development. 99.43% of Morocco's population now has access to electricity, compared with 88% in 2008 and 22% in 1996. The progress made in extending access is extremely impressive. Yet the annual average electricity consumption per capita is still low, at around 1000 kWh, and Morocco's growing population and economy will further increase electricity demand in the future.

By 2020, ONEE expects electricity consumption to reach an estimated 40 TWh to 45 TWh with growth rates around 4.5-5% towards 2030, as illustrated in Table 7.2.

Table 7.2 Forecasted annual electricity demand and peak demand (2014-21)

Year	Demand (GWh)	Peak demand (MW)	Annual Growth Rate of demand (%)
2014	33 530	5670	4.7
2015	34 413	5860	2.6
2016	35 415	6050	2.9
2017	37 070	6180	5.1
2018	38 835	6460*	4.8*
2019	40 852	6778*	5.2*
2020	42 967	7096*	5.2*
2021	45 275	7471*	5.4*

(*): These values apply to a scenario of average conditions

Source: MEMDD, 2018.

As Morocco's power demand is rising faster than additions from dispatchable CSP and coal, the capacity reserve margin, an indicator for generation adequacy, is expected to fall in the coming years, below 10% in 2020, (if derated for unavailability of wind power).

After 2021, the margin is going to increase again thanks to additional capacity coming online, mainly the coal-fired generation from the new Safi plant (see Figure 7.8).

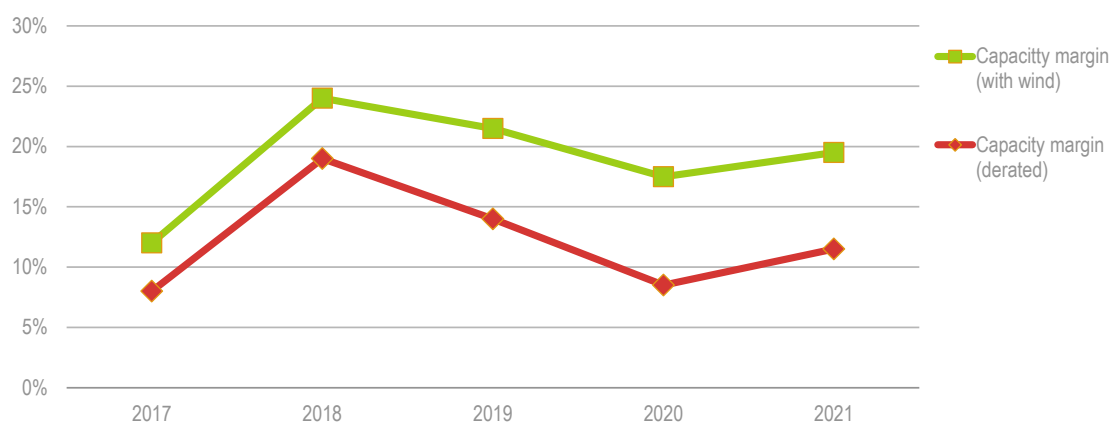
In order to respond to the steady evolution of demand for electricity, ONEE has a generation investment plan in place (the so-called Equipment Plan) for the period 2018-21, aiming at a total investment of 6 811 MW of additional capacity, according to data by the MEMDD. This includes new investment in coal (1386 MW), fuel oil/diesel (22 MW), wind (1 356 MW of which 356 MW to be implemented under Law 13-09), hydropower (272 MW to be implemented under Law 13-09) and pumped storage hydro (350 MW) and solar power (3 425 MW of solar PV/CSP).

Most of ONEE's baseload capacity comes from its coal plant fleet (65%). In 2017, ONEE manages three middle-sized coal-based power plants, including two in Mohammedia with a total capacity of 300 MW and one in Jerada (320 MW). COAL TAQA, a subsidiary of Abu Dhabi National Energy Company PJSC (TAQA), operates the Jorf Lasfar coal-fired power plant (with a capacity of 2056 MW), which is the largest in the MENA region and provides almost 50% of Morocco's power needs. Many units will need to retire in the coming decade. New coal investment is coming online with the Safi ultra-supercritical coal-fired power plant (with two units of 693 MW each) which is due online in late 2018, and the upgrade of the Jerada sub-critical coal-fired power plant to replace the old 320-MW coal-based power plant built in the 1970s. Safi is being built by a consortium of Morocco's Nareva, Japan's Mitsui and France's Engie for a total investment of EUR2.1bn based on a 30-year electricity purchase agreement with ONEE.

In 2018, ONEE is preparing a new energy plan with different scenarios towards 2030.

ONEE expects the closure of its oldest coal plants in the coming decade, as Safi and Jerada upgrades come online. Under the government Gas to Power project, natural gas is expected to play a larger role in power generation after 2028 (see Chapter 8 on Natural Gas, and Hamane (2016)) with the planned investment in an LNG terminal and related infrastructure as well as 2400 MW of CCGTs.

Figure 7.8 Forecasted evolution of the net capacity margin, 2017-21



Source: ONEE.

Network adequacy

Electricity trade and imports have gained importance and imports of electricity today are the main source of flexibility for Morocco, followed by pumped hydro, CSP and gas-fired power plants. ONEE prioritises the import of electricity, depending on economic arbitrage. With an ambitious renewable generation expansion programme, Morocco has plans to integrate its market with the European Union, through interconnections with Spain and Portugal and its regional neighbours in Africa. Power trade is likely to increase; network adequacy will become a more important part of ONEE's power system management.

Morocco aims to reinforce the interconnection with Spain through a third 400kV subsea interconnector with a view to increasing technical capacity and allowing for better integration of the Euro-Maghreb regional electricity markets. A feasibility study for this third interconnector is being conducted by the operators ONEE in Morocco and Red Electrica de Espana (REE) in Spain. MEMDD has signed a Convention with the Portuguese Ministry in charge of energy to conduct a feasibility study for an interconnection with Portugal. A tender for the technical-financial feasibility study was launched in June 2016 by ONEE and the General Directorate of Energy and Geology in Portugal and awarded to DNV GL on 2 May 2017.

With regard to the power exchange with the EU, several countries (France, Germany, Portugal and Spain) are working on the implementation of the "Roadmap for Sustainable Electricity Trade between Morocco and the European Internal Energy Market" (SET Roadmap), a declaration which was signed in November 2016 during the COP22 in Morocco and was officially launched in December 2017⁸.

A continuous interconnection between Morocco and Mauritania is planned to allow commercial trade between two electricity systems and enhance the regional integration of the electricity systems of the Maghreb and African countries. Preliminary technical studies have been conducted to consider the possibility of an interconnection between Nouadhibou and Dakhla, taking into consideration reinforcement projects being realised in southern Morocco. This will allow Morocco to participate in the newly created West African Power Pool.

Flexibility of the power system and system integration

Morocco's electricity system has to deal with rising peak demand. It amounted to 6.31 GW in 2018, a new historic record and is expected to reach 7.4 GW in 2021, according to ONEE. In 2016, wind and solar power made up around 11% of power generation in Morocco.

To meet demand peaks, ONEE relies on demand reductions from industrial users (though peak/off-peak pricing) and power imports, besides benefitting from peak production and storage at concentrating solar power plants, pumped hydro and combined-cycle gas turbines.

⁸ <http://www.mem.gov.ma/SitePages/CP2017/CP06sept17.aspx>.

- Imports have started playing a more important role in the balancing and system operation during peak demand. Net imports increased from 2 TWh in 2006 to 5.3 TWh in 2016, accounting for 14% of the total electrical supply.
- The government maintains peak and off-peak regulated tariffs for industrial users, as a means to reduce power demand in peak periods. These regulated prices are also part of ONEE's supply agreements with the power generators/users. Large industrial users indeed do not produce during peak demand periods (5-9pm).
- Morocco is already leading with the deployment of concentrating solar power with integrated energy storage (3 hours, in the future CSP plants 5-7 hours), which is fed into the grid at peak demand hours.

The share of variable renewables is expected to rise to 15% by 2030 as a result of the government's ambitious renewable energy expansion plan (Morocco aims at a share of RES in installed capacity of 42% by 2020 and at least 52% by 2030). This should not cause any systems integration problems but opportunities abound to further increase power system flexibility, efficiency and remove constraints in the current power system operation, including through the creation of a larger set of balancing services, notably broad technology energy storage, more flexible PPA contracts of thermal plants and investment in grids.

First, cooling needs will rise and make a strong case for investment in energy-efficient cooling, based on solar and other renewables and cold storage.

Second, Morocco's power grid requires network reinforcements between south and north where wind and solar resource potentials are the highest. ONEE is focused on expanding the grid in this regard, which will also be critical to support interconnections for exports, notably northwards across the Mediterranean. A long-term vision of the grid in Morocco and its planning as well as related investment needs under different scenarios will be critical for system integration of renewable electricity. Building on the Equipment Plan, work on the energy system and network planning under the guidance of ANRE and the participation of the Ministry, ONEE, MASEN and private companies is critical for securing supply/demand adequacy towards 2030.

Third, all balancing and system services are organised by ONEE in the absence of a balancing or trading market mechanism. ONEE holds long-term contracts with IPPs and dispatches electricity from MASEN PPAs for renewable energy projects based on take-or-pay clauses. IPPs are technically dispatchable but their contracts do not have flexibility options for the lower use of capacity today. MASEN PPAs have some flexibility/dispatchability when they are equipped with thermal storage. But, large shares of ONEE's plants are therefore in 'must-run' mode. This limits ONEE's ability to manage the power system. Experience in other emerging economies shows PPA contracts need to be adjusted to ensure power system flexibility, as the shares of renewable energy increase in the mix (IEA, 2018). The independent system operation by ONEE is a critical requirement towards greater flexibility.

Fourth, current electricity prices incentivise peak/off-peak electricity consumption. ONEE prioritises this indirect voluntary load shedding (of industrial demand), before using low price imports from Spain or domestic electricity storage as peak shaving sources. However, as electricity tariffs do not reflect the cost of production or transmission, they are therefore not incentivising an efficient operation of the power system. Morocco does

not have an effective demand response programme and no analysis is available on the potential contribution from demand response to the power system flexibility.

Last but not least, the current grid code of ONEE governing extra high and high voltage levels will need to be upgraded to technically allow the integration of larger shares of variable renewable electricity.

Assessment

Since the last review in 2014, Morocco has progressed market opening and the promotion of a regulatory framework of the electricity sector, in parallel with reforms for the deployment of renewable energy sources (RES). Among others, new laws and regulations were adopted for the establishment of a national regulatory authority (ANRE) for the electricity sector (Law 48-15), for the development of RES electricity projects by private promoters (amending Law 13-09 by Law 58-15), and for the reconfiguration of MASEN and ONEE (Law 37-16 and 38-16).

With the planned expansion of renewable energy capacity out to 2030 (going beyond the 2020 target), Morocco is well placed to continue its clean energy transition. As Morocco's power mix is still strongly driven by fossil fuels, including a large share of heavy oil use in rural areas, Morocco has still many benefits to reap from a cleaner power mix. Wind power has seen a strong growth and solar power is deployed at large scale by integrating CSP and solar PV technologies.

The excellent reforms and institutional restructuring need to continue to meet the challenges and opportunities arising from the evolution of the electricity sector. In this regard, it is necessary to complete the regulatory framework by setting up the work of the regulator, adopting the regulations needed and implementing legislation, including for distributed generation (which amidst falling technology costs is increasingly cost-competitive).

In this context, it is timely to assess progress and consider various reform options to advance the implementation of an efficient, transparent and well-functioning electricity system.

Morocco is currently in a transition phase of its power sector reforms, where the future direction of travel is still under discussion. To secure investment and stimulate the role of private investors, a roadmap setting out the milestones of electricity reforms would be a useful tool. This can ensure clarity, stability and long-term visibility for investors.

Wholesale electricity market

Institutions

No wholesale electricity market has been established, as the main market is still under long-term contracts, regulated tariffs and public-private partnerships. ONEE remains the main counterparty of electricity exchanges (Amegroud, 2015). However, the actual role of ONEE in power generation has been reduced (ONEE holds 30% of the country's total generation versus 41% in 2012.) and is expected to be reduced further, based on the required transfer of renewables assets to MASEN in the next years. ANRE will have to

supervise the account unbundling of ONEE into a national TSO and generation business. The future role of ONEE will be important as operator and planner of the system.

However, further restructuring is necessary to achieve greater efficiency. ONEE's day-to-day operational and management decisions are overseen by different institutions, including the Ministry of Interior (public electricity distribution), Ministry of General Affairs and Governance (tariffs), Ministry of Economy and Finance (investments), and Ministry of Energy, Mines, and Sustainable Development (administrative and technical supervision). This makes it challenging to coordinate and manage power system and network planning and operations. The institutional framework is complex, as generation and transmission activities are governed by the Ministry of Energy (in establishing the regulatory framework and the main policy guidelines) and by the Ministry of Economy and Finance (financial and economic control) as well as the Ministry of the Interior for the distribution.

The regulatory authority ANRE, tasked with regulating the electricity sector, will have a key role in the new context of the Moroccan electricity sector, as well as in strengthening the integration of Morocco in the Mediterranean regional electricity market. Its role will be to ensure competition, transparency, and the functioning of the electricity sector so as to boost private sector investment.

To make ANRE more effective, the government should assess future extension of its mandate and tasks to:

- Tackle the issues related to network access, including tariffs, at transmission and distribution level.
- Oversee the whole value chain in the electricity sector, including all generation, transmission and distribution activities.
- Extend its role to the natural gas sector.

Generation

Morocco has implemented a series of positive reforms since the last In-Depth Review in 2014, which enabled new producers to enter the sector, in particular for RES. As already explained, the government has promoted measures such as Law 38-16, under which some renewable electricity generation assets have to be transferred from ONEE to MASEN. MASEN is a central body in the development of new RES projects and their integration into the market. However, the small number of projects developed under Law 13-09 in the so-called open market shows that there is a need to streamline regulation that can boost investments in this category, notably through the introduction of one-stop-shop permitting procedures and transparent access to the networks by means of cost-reflective electricity network charges.

Transmission

Even though Law 13-09 envisages the separation of the organisational and accounting elements of ONEE's distribution activities from the generation and transmission activities, no steps have been taken so far to implement this separation.

ONEE has the key responsibilities here, and these include responsibility for grid planning and dispatch. System planning and operation tasks are critical in guaranteeing a transparent, non-discriminatory and efficient access to the market for all grid users; the

smart integration of the increasing share of renewables in the networks; and the proper operation of the electricity system, including the balancing regime to satisfy flexibility needs. These aspects remain critical in the context of increased opening of electricity generation to new entrants.

The establishment of ANRE will be helpful in moving things in this direction. As a first step towards the implementation of an electricity market, it would be beneficial for ANRE to assess at an early stage how to improve the efficiency of system operation by integrating economic and technical criteria for dispatching and balancing the system, while continuing to ensure a safe, reliable and secure electricity supply.

Morocco's electricity system also has to be able to integrate an increasing proportion of electricity from renewable sources, including decentralised generation. This requires detailed system planning on the basis of a long-term vision covering electricity production, capacity and demand, as well as interactions with other sectors. Scenarios developed as part of this planning would serve as a tool to establish and resolve future system capacity needs to cover demand and maximise flexibility associated with the integration of RES. This exercise would help to bring about an orderly and clean transition towards a more decarbonised electricity sector and guide investments at the distribution level, where currently renewable deployment is capped at 10%. In 2018, ONEE is preparing a new energy system outlook for 2030.

Morocco's plans to expand interconnections with both Europe (Spain and Portugal) and Mauritania could be useful to help meet demand, and in particular peaks in demand. At present the existing interconnectors are mostly used to import electricity to cover demand. Their future role will depend on the evolution of the electricity mix. As a consequence, the need for new interconnectors will need to be considered in the context of integrated electricity planning for Morocco's grid. It will also need to take account of trading rules: Morocco's discussion with EU partners on a strategic roadmap will be helpful.

Distribution of electricity and retail

Morocco has 11 distribution utilities of which four are private utilities and seven public ones. Grid usage tariffs are not separately regulated in a clear and transparent way in line with the costs, but set by the Ministry of General Affairs as part of the final regulated power prices. The real costs of grid access for different energy producers are not known. The establishment of a common or harmonised methodology to determine the network tariffs at distribution level would be helpful. ANRE would be best placed to do this, although this would require its mandate to be extended to cover all distribution networks.

Although Law 58-15 allows electricity developers' access to the grid at all voltage levels, neither the medium nor the low voltage market has been opened for renewable energy producers yet due to the absence of a grid code and grid access and pricing rules. The decree for access to the medium voltage grid has been adopted, but not yet implemented, and for the low voltage network no decree is in place yet. In conjunction with regulated retail tariffs (below operating costs), this is jeopardising private sector investment, amidst the curtailment rate (up to 10%) and lack of investment in strengthening of the network. The Ministry is currently considering an amendment to the Law 13-09 to unlock the situation, notably when it comes to grid access at the low and medium voltage levels, the definition of surplus electricity sales.

According to information obtained during the review, distribution grid operators often do not favour the development of RES in their relevant grids. However, if costs for grid access were to be visible and transparent and transposed into a tariff system for use of the grid, this could create a stable income for grid operators. This in turn would encourage them to adopt a more impartial position regarding the connection of different energy producers and grid users and, as a consequence, facilitate access to the network for electricity produced from RES.

While Morocco has been successful in phasing out fuel subsidies and increasing electricity tariffs, the government still regulates final electricity rates. After the phase-out of subsidies for oil-fired power plants, ONEE is also running a huge deficit in generation costs. For some categories of consumers these are still slightly below real average total costs of production, transmission and distribution. In addition, electricity generation costs are not calculated independently of those of the networks, as there is no regulated grid access pricing in place. This prevents cost transparency, thus making it impossible to allocate costs accurately. There is a need to assess how to separate the different costs of electricity supply in order to better reflect the actual cost of electricity for consumers, which will help to provide price signals. The role of ANRE will be central to this process.

Transparent grid access rules and pricing will also promote greater system integration of more distributed generation at the medium and low voltage levels. Distribution operator's performance (technical and financial) should be included in the mandate of the ANRE, which is not the case to date.

System integration of renewable energy and power system flexibility

Morocco's power system has around 10% of variable renewables, and system integration issues will become more important as this percentage rises to an estimated 15% by 2030, with many new wind power projects coming online in the next five years.

The integration of variable renewable energies in the electricity sector of Morocco implies the need for a greater number of flexibility tools, including dispatchable generation capacities, interconnections, demand response, and storage. The cost and benefits of each of these flexibility tools should be analysed, taking into account environmental, economic and social factors.

Since the last Morocco review in 2014, several measures have been taken to facilitate the integration of variable renewables into the grid, including the improvement of existing interconnections, mainly with Spain, and the start of negotiations and plans for a new interconnection with Portugal and Mauritania; developing short period storage of CSP plants and long period pumped hydro storage, with many projects under way and more being planned. Morocco is commended for taking leadership in this area.

Natural gas, pumped hydro storage and CSP already provide some flexibility; coal-fired power plants are less flexible. ONEE's power purchase contracts remain inflexible, limiting its ability to manage the system, at times when variability increases. The government could consider adjusting and re-negotiating these inflexible PPA contracts of ONEE to create a more transparent balancing regime. International experience suggests that an adjustment of the contracts would be practicable and will bring benefits (IEA,

2018). On the other side, the new coal plants can be technically operated in a much more flexible manner, which will improve ONEE's balancing capabilities.

Morocco currently relies on imports as main source of flexibility besides voluntary demand reductions from large industry users, based on peak pricing for industrial users at peak demand hours. The government should seek to develop a proper demand response mechanism, and ensure industry tariffs are rather reflective of transmission cost than the hour of consumption.

In addition, government should consider the case for investing in cooling based on solar power and cold storage to expand the contribution from energy storage as well as increasing the flexibility of ONEE's PPAs.

Recommendations

The government of Morocco should:

- ❑ Ensure that the National Regulatory Authority (ANRE) becomes fully operational as soon as possible, and that its staff has the necessary skills and political backing to ensure the creation of a competitive and well-functioning electricity sector.
- ❑ Extend ANRE's mandate to regulated access to all networks through cost-reflective tariffs, at transmission and distribution levels, and to overseeing the whole value chain in the electricity sector. Enable ANRE to cover the natural gas sector.
- ❑ Evaluate the current functioning of the electricity sector and assess reform options in order to create a level playing field and to spur private sector investment and the competitiveness of the industry, building on the planned separation of the transmission activity from generation within ONEE.
- ❑ Look at how to strengthen systems operation by integrating flexibility mechanisms based on the evaluation of their costs and their contributions to electricity system security, and in particular take action to:
 - > Adjust the contracts of ONEE power plants to allow for system flexibility;
 - > Invest in the strengthening of power exchange, domestic power grids and interconnections;
 - > Strengthen incentives for demand response and demand side management;
 - > Develop a broad set of energy storage options, including cold storage.
- ❑ Develop a long-term vision of the grid in Morocco covering production, capacity and demand through the independent system operator, taking account in particular of the need for the system integration of renewable electricity, transparent and cost-reflective tariffs and the future role of interconnection and the promotion of energy storage.

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8. Oil

Key data

(2017)

Crude oil production: 0.004 Mtoe

Imports of crude oil: 0 Mtoe

Oil products production: 0 Mtoe

Net imports of oil products: 13.6 Mtoe

Share of oil: 62.0% of TPES and 74.1% of TFC

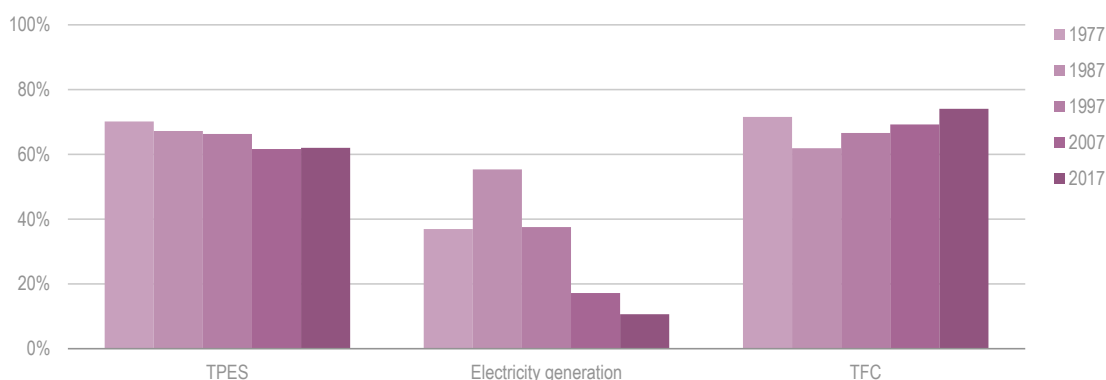
Consumption by sector: 12.7 Mtoe (transport 45.0%, industry 20.4%, residential 19.8%, commercial and agriculture 8.3%, power and heat generation 6.6%)

Overview

Oil has the largest share of the energy mix in Morocco. In 2017, oil accounted for over 60% of total primary energy supply (TPES) and over 70% of total final consumption (TFC) of energy, more than in any IEA member country. Oil is still heavily used in residential (20%), industry (20%), agriculture (7%) and power/heat generation (7%).

The government's decision to scrap energy subsidies on all fuels except butane has helped to slow demand growth. Despite this recent slowing in oil demand growth, and a reduction in the use of oil in electricity generation, the short-to-medium term trend is towards increased consumption in most sectors, driven by economic growth and continued heavy reliance on fossil fuels by transport and industry, the two largest consumers of energy.

Since the closure in 2015 of its only operating oil refinery, Samir, Morocco has had to import all its refined product requirements. The refinery's closure also resulted in the loss of the use of over 60% of the country's storage capacity; however, the oil storage infrastructure is still intact. The government has decided to take steps to ensure that it has sufficient oil stocks for security of supply purposes by reviewing compliance with the current stockholding regime, with a view to either confirming and enforcing existing stockholding obligations, which are currently not being met, or by putting in place a new emergency stockholding structure.

Figure 8.1 Share of oil in Morocco's energy system, 1977-2017

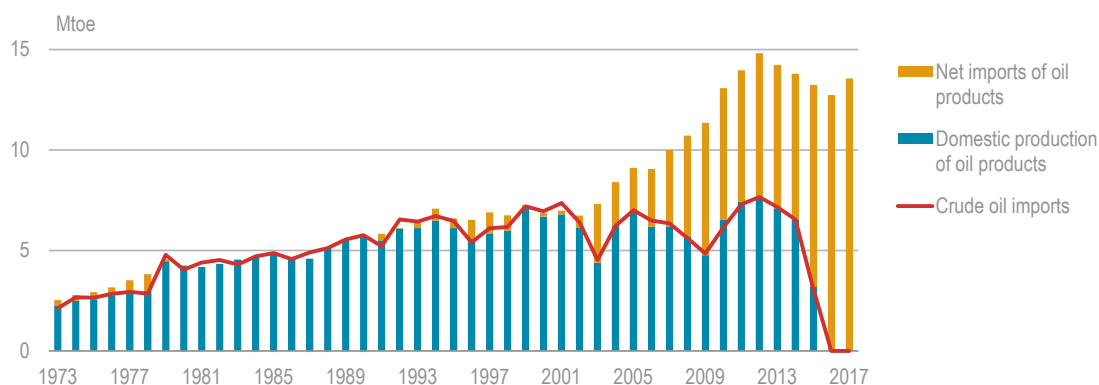
Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

Supply and demand

High dependence on oil product imports

Morocco's crude oil production is negligible but until 2000, the country was broadly self-sufficient in refined products while the Samir refinery in Mohammedia was operating. From the early 2000s, oil product imports increased significantly to meet rapidly growing domestic demand while the refinery struggled with financial problems and its production declined.

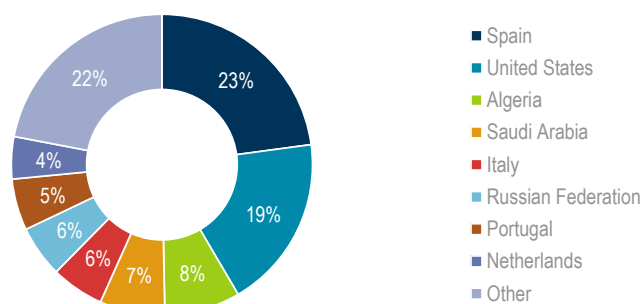
In 2015, the refinery, which had 200 000 b/d of throughput capacity, was shut down completely after 56 years of operation, and Morocco now imports all its refined product's needs (Figure 8.2). The closure of the refinery resulted in the loss not only of processing capacity but also of over 60% of the total oil storage capacity available in the country (see later section on stockholding obligations). The future of the Samir refinery remains uncertain. On March 2016, the Casablanca Commercial Court placed the refinery into juridical liquidation, but no buyer has yet been identified, amidst an excess of refining capacity globally.

Figure 8.2 Oil products supply 1973-2017

Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

Morocco buys oil from more than 30 countries as part of a policy of diversification. Spain, the United States and Algeria accounted for roughly half of Morocco's oil imports in 2016 (Figure 8.3). The provisional net energy bill for refined oil products in 2017, after deducting a negligible volume of exports, totalled MAD 67.6 billion, up from MAD 52.5 billion in 2016.

Figure 8.3 Oil products imports by country, 2016

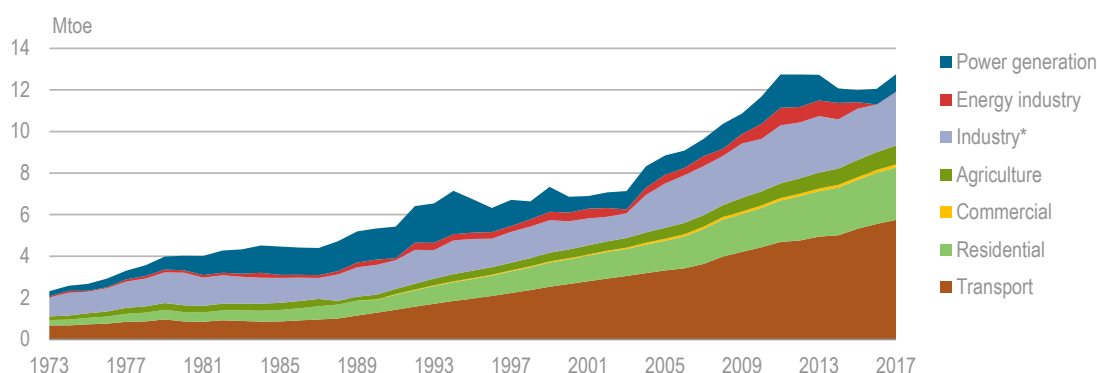


Source: IEA (2018), *Oil information*, 2018, www.iea.org/statistics/.

Oil consumption growth has stalled, but may pick up again

Oil consumption increased rapidly in the decade after 2000, growing by 88% in the period 2001-11. The rate of growth has slowed since then, largely as a result of the gradual removal of fuel subsidies starting in 2013. In recent years, oil consumption has declined in power generation but increased in the transport, agriculture and residential sectors. In the outlook, overall oil demand in Morocco is expected to increase, as the country's economy grows.

Figure 8.4 Oil consumption by sector, 1973-2017



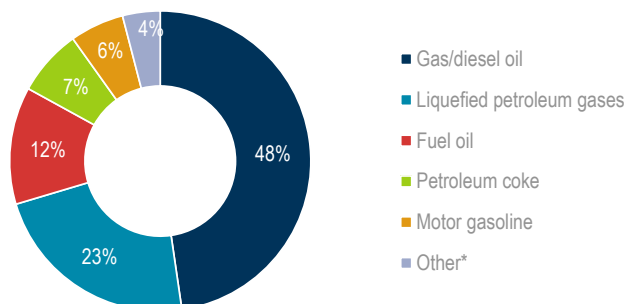
*Industry includes non-energy consumption.

Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

The transport sector is the largest oil consumer and accounts for nearly half of total oil demand. From 2007 to 2017, oil consumption in transport grew by 58%, accounting for the largest increase of oil consumption. However, oil use increased in other sectors as well: by 50% in the residential sector, 64% in agriculture and 29% in commercial and public services (Figure 8.4).

Diesel fuel is the main transport fuel, accounting for 86% of total energy demand in the transport sector in 2015. The agriculture sector also consumes significant volumes of diesel. In 2015, diesel made up half of total final oil consumption in Morocco (Figure 8.5). Morocco has cut the sulphur content of diesel from 50 ppm to 10 ppm.

Figure 8.5 Oil consumption by product in TPES, 2016

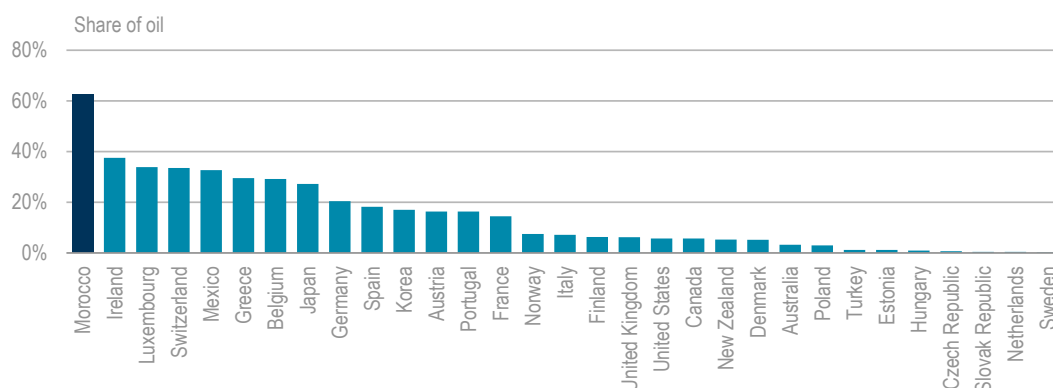


*Other oil products includes bitumen, lubricants, kerosene type jet fuels and paraffin waxes.

Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

Liquefied petroleum gas (LPG, or butane), which accounts for over 20% of total oil product consumption, is used mainly in the residential sector for cooking and heating, and in the farming sector for operating pumps. LPG accounts for more than 60% of total energy demand in the residential sector, a percentage that is far higher than in IEA member countries. (Figure 8.6)

Figure 8.6 Oil's share in residential energy consumption in Morocco and IEA member countries, 2016



Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

Over the past five years, LPG consumption has grown rapidly, in particular in the residential sector, encouraged by a generous state subsidy. Industry is also a large oil consuming sector, accounting for nearly 20% of total oil demand. Petroleum coke in the non-metallic minerals industry accounts for nearly half of total oil consumption in industry. Other large oil consuming industries are mining and quarrying and the food industry, both of which consume mostly fuel oil. Unlike the other large sectors, however, industry has seen its use of oil remain stable over the past decade.

Institutions

The **Ministry of Energy, Mines and Sustainable Development** (*Ministère de l'Énergie, des Mines et du Développement Durable*, MEMDD) is in charge of oil security and related emergency policies, including the oil stockholding regime.

The **National Office of Hydrocarbons and Mines** (ONHYM) was established in 2005 as a result of the merger of the Bureau of Research and Mining Participations (BRPM) and the National Office for Research and Petroleum Explorations (ONAREP). ONHYM promotes the exploration and exploitation of Morocco's hydrocarbons and minerals reserves by conducting research of deposits, providing access to databases on soil and national subsoil information and related administrative, financial and legal arrangements. ONHYM supports negotiations with potential partners in accordance with the contractual terms and applicable legal provisions, including by taking stakes in the upstream development.

The **Compensation Fund** (*Caisse de compensation*) is the public body to administer the public price support (subsidies) to households for the purchase of essential products (currently LPG, sugar, and flower). The Fund was created in 1941 and reorganised in 1977 and 2013 and operates under the authority of the Prime Minister. The subsidies are fixed at the beginning of each month, based on the international oil prices. The Fund compensates oil importers or producers at filling centres for the difference between the import price they pay plus transportation cost and the subsidy fixed by the Fund.

Oil upstream exploration and production

After the drop in international oil prices from their record high in 2014, Morocco has seen a relative decline and restructuring of oil exploration investment, with new investors (Eni, Sound Energy) entering into joint ventures with international oil companies and ONHYM.

The fiscal regime for E&P activities in Morocco grants incentives, notably a corporate tax holiday for a period of ten years beginning at the start of commercial production for each exploitation concession. All the expenditures relating to royalty, bonuses, rental, training, exploration and production activities are tax deductible. Exploration expenses and intangible assets may be amortised over a period between 2 and 10 years. Tax exemptions are also granted including withholding tax on profits, value added tax, business activity tax, urban tax and tax on non-developed urban areas. Licence holders, their contractors and sub-contractors have also the right to import, duty-free, the equipment and material used for petroleum operations as well as personal effects of foreign employees. Transfer of capital, profits and dividends are free of restrictions and taxes. No royalty is due for the first volumes of hydrocarbons produced until a certain level 300-500 thousand tonnes of oil and 300-500 mcm of gas, depending on the location of the field. The Hydrocarbons Law of 2000 stipulates that the State, through ONHYM, must hold a stake of no more than 25% in upstream contracts.

ONHYM has identified more than 800 prospects and leads in different onshore and offshore plays, including pre-salt play, salt related play, platform play, turbidite play and thrust related play. Although Morocco's prospective basins lie in areas close to oil and gas discoveries, the country remains under-explored – only 0.04 wells/100 km² have been drilled. However, the Moroccan basins have shown non-commercial oil and gas

discoveries in offshore and modest gas discoveries in onshore. ONHYM's work in identifying prospects is supported by the seismic data it has collected (ONHYM, September 2018). To date, it has acquired 56 131 km of 2D seismic data and 2,096 km² of 3D seismic data and has drilled 305 exploratory wells onshore. Offshore, it has acquired 174 267 km of 2D seismic data and 68 103 km² of 3D seismic data and has drilled 44 wells (42 in the Atlantic and two in the Mediterranean).

Morocco evaluated the potential for oil shale in the 1980s and 1990s. ONHYM has identified ten areas where oil shale deposits are indicated – in the Rif, the Atlas and the Southern provinces. The reserves are located in the fields of Timahdit and Tarfaya, with reserves estimated respectively at 15 billion barrels and 23 billion barrels. The country's total oil shale resources are estimated at 57 billion barrels, with Morocco ranking sixth globally in terms of oil shale resources. The characteristics of oil shale and the high cost of extraction have discouraged rapid development of this resource.

Oil mid- and downstream infrastructure

The two main oil import terminals in Morocco are Jorf Lasfar and Mohammedia.

The port of Mohammedia is the country's main port of entry for oil products and the site where Morocco's refinery of Samir (Société Anonyme Marocaine de l'Industrie du Raffinage) is located. Located on the Atlantic coast, Mohammedia features four dedicated berths for refined products and LPG, and has the largest oil storage capacity of any import terminal in Morocco.

Privatised in 1997 and sold to Corral Petroleum Holding, Samir refinery halted production in August 2015 after suppliers stopped crude oil delivery to the indebted company. The Court of Casablanca placed Samir into receivership in March 2016. The liquidation and potential sale of the refinery is ongoing. A trustee appointed by the Casablanca Commercial Court is now in charge of administering the process.

Jorf Lasfar, a deepwater port which is also located on the Atlantic Coast, is another port of entry for oil products. It primarily serves the growing industrial sector, and is being considered as the receiving terminal for a proposed Liquefied Natural Gas (LNG) facility.

Oil market structure

As of 2017, there were 20 oil distribution companies, including 11 importing companies. Oil distribution is private with three large players, Morocco's Afriquia, Vivo Energy (under Shell licence) and Total Maroc besides many smaller companies. These companies share an integrated distribution network for retail sales consisting of 2 500 service stations.

Prices and subsidies

In 2012, the government began reforming the Compensation Fund (Caisse de Compensation) with a view to phasing out energy subsidies. Subsidies to gasoline were abolished in 2014 and diesel in January 2015. By December 2015, all refined products,

except butane, were indexed to international prices. Today, butane is the only fuel to still benefit from subsidies. A 12-kg bottle was priced at MAD 40 (around EUR 3.60) in 2018 (Caisse de Compensation, 2018), whereas the real price would be MAD 96.64. Provisional data for 2017 from the Moroccan statistical agency (MEMDD, 2018) put the energy subsidy bill at MAD 9.9 billion, (nearly EUR 1 billion), up from MAD 7.1 billion in 2016 (due to the increase in international oil prices and higher consumption). By 2020/21, the government is planning to phase out the remaining butane subsidy and replace it with targeted subsidies for the most vulnerable section of society. It plans to conduct a survey to identify the lowest-income households eligible for support.

Because of its high level of dependence on oil imports, Morocco is vulnerable to market disruptions and price volatility. As a result, the government has made the development of domestic resources a priority. The government has maintained its support for the upstream exploration and development. According to the 2016 annual report of the Office National des Hydrocarbures et Des Mines (ONHYM, 2016), Morocco allocated around MAD 117 million (about EUR 10 million) to oil and gas exploration in that year, while its foreign partners invested ten times more, with their investment totalling MAD 1 117 billion (about EUR 100 million).

Emergency policies and oil stockholdings

Morocco has been working to expand its oil storage and distribution capabilities to improve its security of supply. In 2012, Morocco completed construction of the 0.508 mcm Horizon Tangier terminal (EIA, 2018). Additional storage and distribution terminals are under development in the port of Jorf Lasfar.

In order to improve the country's resilience in the event of any disruption to oil supplies, the Moroccan government imposed stockholding obligations on oil distributors and importers; since 2014 they have to be equivalent to two months (60 days) of oil product sales. The government also imposed stockholding obligations on refiners, equivalent to one month (30 days) of their crude oil needs.

According to the latest MEMDD data, total storage capacity for liquid petroleum products held by oil distribution companies (outside of the 1.2 mcm at the Samir refinery) is 1.3 million cubic metres or 48 days of average supply, of which 92% is held at ports.

The storage capacity is divided between different oil products as follows:

- Gasoline – 166 000 cubic metres representing 68 days of national consumption
- Diesel – 919 000 cubic metres or 50 days
- Jet fuel – 109 000 cubic metres or 48 days
- Fuel oil – 94 000 cubic metres or 24 days

Even if these storage facilities were filled to their maximum, the volumes would fall well short of the 60-day requirement imposed on distributors for all main fuels, with the exception of gasoline. A December 2016 report by the Court of Accounts, the independent auditor of public finances, found that stock levels of some petroleum products in some instances were far below what was required by the government stockholding obligation. (Court of Accounts, 2016).

The closure of the Samir refinery resulted in the loss of the use of around 2 million cubic metres (mcm) of storage capacity at the refinery (consisting of around 1.2 mcm of crude oil and 1 mcm of various refined products – together they were enough to meet one month of oil demand). This has a direct impact on oil security and is a cause of concern for the government. The vast majority of Morocco's remaining storage capacity is concentrated at the ports, where there is limited infrastructure to transport oil products by pipeline or rail to the main demand centres.

The government is aware of the need to address the shortage of storage capacity infrastructure and has expressed an interest in scaling up storage capacity to better respond to possible supply disruptions. Private companies are now finding Morocco attractive as a 'storage hub', to gain access to the Moroccan and North African market, without having a distribution business in Morocco.

One option is to ensure that the physical oil storage infrastructure at the Samir refinery is maintained in the future, regardless of the ownership structure of the refinery or secondly, by building new storage which would involve higher costs. However, the liquidation of Samir refinery has not been finalised and its outcome remains uncertain, including the ownership of the oil storage tanks.

The different oil stock financing mechanisms in the past have shown their limits (see Court of Accounts (2016)). Between 1961 and 1980, oil companies which were obligated to hold stocks received a tax rebate on the total value of their stock. However, companies did not create the obligated stocks and the rebate was abolished. Between 1980 and 1997, a levy was imposed on fuel prices to finance petroleum stocks. The levy was collected by the distributors as a margin on the final fuel price. Distributors were required to set aside the margin as a long-term debt to the Caisse de Compensation. And those distributors that did not create public stocks were required to pay every month the levy they collect to the Compensation Fund. The levy was abolished in 1997 because of non-compliance by distributors with the agreed stockholding obligations; except for butane. An unresolved dispute continues over the investment costs of holding obligated stocks and the debt accumulated by the distributors during the time of the public levy.

Resilience of oil infrastructure remains critical: high waves can prevent tankers from docking at Morocco's ports and delay deliveries, adding to supply side vulnerability.

Assessment

Morocco imports some 95% of its energy. Oil plays a major and growing role in the energy mix, all of which is now imported following the closure of the Samir refinery. The import bill and dependency provide a strong incentive for Morocco to reduce demand for oil, to maintain its oil and gas exploration programme and to diversify its energy sources by tapping into its solar and wind potential. Such actions will bring significant energy security benefits and help Morocco meet its emissions reduction targets.

Morocco has been spending a significant sum on oil imports, which put the public budget under pressure notably during the periods of high subsidies. The government is commended for removing subsidies on all petroleum products, and this has moderated demand, and reduced the cost of subsidies to the public finances. Butane however remains heavily subsidised for social reasons and is not well targeted. The subsidy is

available to anyone who uses bottled butane, regardless of income. The government proposal to move to more targeted subsidy, based on surveys, is a welcome effort to reduce the subsidy bill by 2020/21 and to encourage people to shift to alternative heating and cooking methods, while addressing concerns of vulnerable households and income groups. India has gained considerable experience in reducing fossil fuel subsidies for LPG/propane and can provide an interesting learning case for Morocco.

Developing domestic sources of energy would also help alleviate the overall costs of imports. Though there have been no major oil or gas discoveries to date and indigenous production is negligible, ONHYM is supporting industry efforts by providing further exploration and seismic surveys which may yield results. Italy's Eni recently drilled a first exploration well offshore Morocco, at a water depth of 1100 metres, though it is too early to assess the results. ONHYM has also reported a recent gas discovery in the south of the country, though it is not yet known if this will prove to be commercially viable.

Morocco has always been dependent on imports for its crude oil but since the closure of its only refinery in August 2015, it has stopped crude purchases and imports all its refined oil product needs. Heavy reliance on imported oil makes the country more vulnerable to possible supply disruptions, and underlines the importance of adequate emergency oil stocks.

Companies do not comply with the existing oil stock holding requirements and – after the loss of associated storage capacity and the (likely) loss of the crude oil storage capacity at the Samir refinery at the port of Mohammedia – there is no infrastructure capacity for them to do so. By 2018, the chances to relaunch the refinery have been reduced considerably, as the process of restructuring presented numerous challenges. The government should ensure the process for the restructuring of the Samir refinery safeguards oil stock tanks and keeps options open to potentially revitalise the refinery, in the interest of country's security of oil supply.

Although stock data is not collected on a regular basis, work done by the Court of Accounts indicates that the legally mandated level of 60 days of stock cover is not being met by distributors. The Court of Accounts found companies in non-compliance and stocks much below the required levels (with the exception of gasoline). The report by the Court recommended establishing a new stockholding system and the gradual build-up of stocks, starting with 30 days of cover and building up towards 90 days, on a par with IEA members. It also recommended expanding port infrastructure to allow large tankers to dock. Increasing the resilience of the port infrastructure at Jorf Lasfar and Mohammedia should be a priority alongside strengthening of the stockholding regime.

Morocco's current oil stock levels are unknown, and this in itself is a significant problem. Having clear and comprehensive information on the current state of stockholding by companies in the country is a critical prerequisite for rectifying the shortcomings of the current stockholding system. Regular collection of information on stock levels should be established. Morocco already participates in the Joint Organisation Data Initiative (JODI) on oil, and better information would also enable the government to provide timely monthly data submissions, including on stock levels for each product.

Recommendations

The government of Morocco should:

- ❑ Reduce the country's dependence on imported oil, including by continuing to promote the development of domestic energy sources and by restructuring butane subsidies into more targeted support to vulnerable consumers.
- ❑ Review the emergency oil stockholding system, taking account of international best practice in order to take urgent action to ensure sufficient storage capacity is available and ensure full compliance with stockholding obligations with the minimum delay practicable.
- ❑ Ensure proper process for maintaining the use of oil storage tanks at Samir refinery to improve energy security. Strengthen the resilience of port infrastructure.
- ❑ Take steps to improve timeliness and coverage of monthly oil data collection, including data on stocks of each oil product, using JODI oil data reporting as a guide to good practice.

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9. Natural gas

Key data

(2017)

Natural gas production: 0.09 bcm, +38% since 2007

Imports: 1.14 bcm, +98% since 2006

Share of natural gas: 5.0% of TPES and 17.8% of electricity generation

Consumption by sector: 1.03 Mtoe (heat and power generation 94.0%, industry 6.0%)

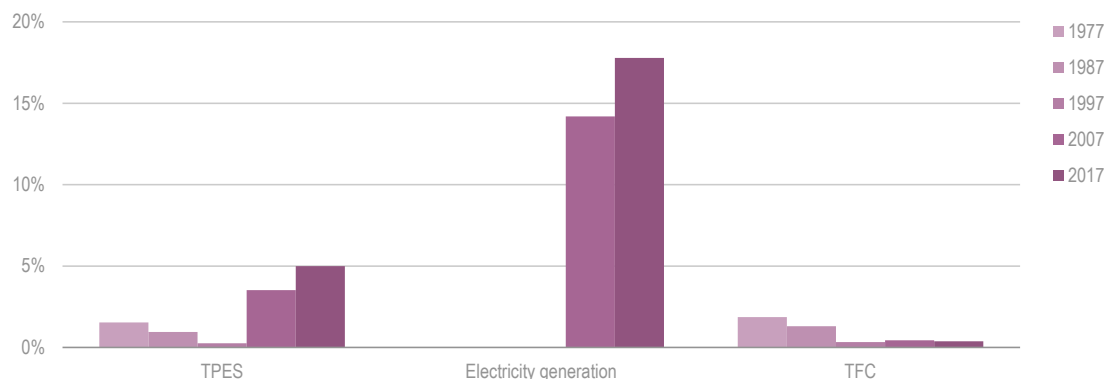
Overview

Natural gas makes up a small but growing part of Morocco's energy system. In 2017, the share of natural gas in total primary energy supply (TPES) was just 5%. If Morocco was a member of the IEA, it would be its second lowest user of gas. No gas is used in the residential and commercial sectors in Morocco, but small amounts in Morocco's industry (ceramics and phosphate producers). Gas plays an increasingly strong role in power generation. Demand for natural gas has increased in recent years with investment in combined-cycle gas turbine (CCGT) power plants. In 2017, natural gas accounted for 18% of total electricity generation, and the government has plans to build additional CCGT plants as part of its effort to diversify energy sources, ease reliance on liquid fuels, and reduce CO₂ emissions.

The vertically integrated electricity utility ONEE imports all of Morocco's natural gas needs, which come today from Algeria via the Maghreb-Europe-Pipeline.

Continued growth in the use of natural gas in the power sector has the potential to improve the flexibility of the electricity system, and to diversify fuel supply, as power generation is still heavily dependent on oil and coal. The government's plans to import gas for use in the industrial sector will also enhance energy diversity and security. However, this requires investments in new infrastructure and a clear regulatory framework that will encourage private sector investment.

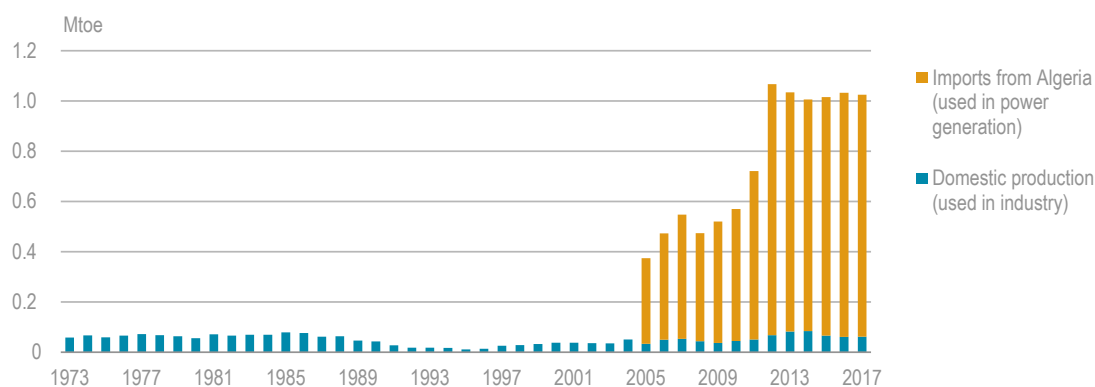
Morocco continues to pursue oil and gas exploration and is making a determined bid to attract foreign investors by offering attractive fiscal and contractual terms. It also hopes to tap into its shale gas resources and has identified four basins with shale gas potential.

Figure 9.1 Natural gas share in Morocco's energy system, 1977-2017

Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

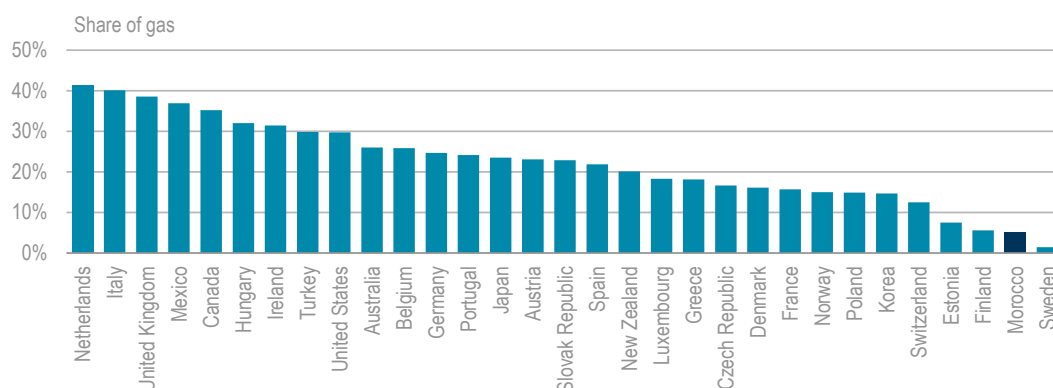
Supply and demand

In 2017, Morocco's gas supply totalled 1.0 Mtoe, of which 94% was imported gas from Algeria for power generation (Figure 9.2). Imports of natural gas began in 2005 with the first CCGT plant at Tahaddart, which has the capacity to produce 384 megawatt of electricity (MW_e). In 2009, Morocco completed a second CCGT plant in Ain Beni Mathar, of 452 MW_e, which is combined with a 20 MW solar-thermal power plant. In 2016, the CCGT plants together produced 5.9 TWh - 18% of total electricity generation.

Figure 9.2 Natural gas supply by source, 1973-2017

Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

Despite the increased use of gas in the power sector, the share of gas in the Moroccan energy mix remains low by international standards. If Morocco was an IEA country, its share of natural gas in TPES would be the second lowest after Sweden (Figure 9.3). There is a low level of gas consumption in the industrial sector, and none in the residential and commercial sectors. The small volume of gas produced domestically is just enough to meet demand from the ceramics industry.

Figure 9.3 Natural gas share of TPES in Morocco and IEA member countries, 2017

Source: IEA (2019 forthcoming), *World Energy Balances 2019 preliminary edition*, www.iea.org/statistics/.

Gas infrastructure and imports

Pipelines

Morocco relies on Algeria for all its imported natural gas. It imports directly around 0.6 bcm by pipeline and receives a further 0.5 bcm as a transit fee for the Algerian gas transported through the Maghreb-Europe Gas Pipeline (MEG) to Spain and Portugal. Morocco signed a 10-year purchase contract with Algeria's Sonatrach in 2011. In 2018, Morocco, Spain and Algeria reached an agreement to extend the import agreement with Sonatrach beyond 2021.

Natural gas development strategy

Today, all gas is imported via pipeline. In the natural resource sector, Morocco wants to establish links with the energy markets of oil-rich and gas-rich African countries. In 2018, Morocco concluded an agreement with Nigeria for the construction of a gas pipeline which would involve 15 countries and potential gas exports to the European Union.

As part of the natural gas development strategy (see below), the government plans to import LNG via an onshore terminal. The government is promoting growth in demand for natural gas in power generation and in industry as part of the 2009 National Energy Strategy and its goal to diversify energy supply and ease dependence on liquid fuels. The Ministry of Energy, Mines and Sustainable Development (*Ministère de l'Énergie, des Mines et du Développement Durable, MEMDD*) pursues a two-phased natural gas strategy: Gas to Power and Gas to Industry. The horizon of the strategy has been shifted from 2021 to 2028.

In the first phase, Morocco plans an integrated approach that would involve construction of an LNG import facility - originally slated for a 2023 completion but the deadline has been pushed back to 2028 - two new combined-cycle CCGT plants by 2030 (1200 MW each), and an integrated transmission and distribution network for every region to deliver natural gas to industrial hubs. Further ahead, an additional 3500 MW of CCGT capacity was identified.

In the second phase, the plan envisages using gas for industries such as the automotive, phosphates, steel, cement and sugar industries, starting in 2030. The industrial sector is highly dependent on oil products, and greater use of natural gas would serve to diversify energy supply and may yield a competitive advantage. There is an option in this second phase for a further two gas-fired power plants by self-producers, under Law 13-09 and Law 54-14, which allows for installed capacity of up to 300 MW.

The government has not yet launched a tender, although MEMDD has been in discussion with several possible investors and suppliers. The original plans also required the construction of a 400 km gas pipeline to link the LNG terminal to the Maghreb-Europe Gas Pipeline and serve Casablanca, Mohammedia, Kenitra and the northern regions. The cost of the Gas to Power Project was estimated at USD 4.6 billion to be developed as a single package broken down into four sub-components as follows (White and Case, 2017):

Sub-component 1 – LNG terminal:

A maritime jetty

- located north of the port of Jorf Lasfar
- reception and unloading of LNG tankers
- estimated cost: USD 600 million
- estimated construction duration: 36 months.

An onshore LNG regasification unit

- located north of the port of Jorf Lasfar
- total capacity of 5 bcm
- estimated cost: USD 800 million
- estimated construction duration: 48 months.

LNG storage tanks

- estimated cost: USD 400 million.

Sub-component 2 - gas pipelines:

- 400 km high pressure transportation pipelines;
- will connect the LNG terminal to the Maghreb-Europe pipeline;
- will deliver natural gas to proposed CCGTs (see sub-components 3 and 4 below);
- estimated cost: USD 600 million; and
- estimated construction duration: 36 months.

Sub-components 3 and 4 - new CCGTs:

- CCGT of Jorf Lasfar (1200 MW)
- CCGT of Dhar Doum (1200 MW) located 120 km south of Tanger

- estimated cost: USD 2.2 billion
- estimated construction duration: 36 months.

Ancillary Infrastructures:

- The construction of distribution lines for the evacuation of the produced electricity are not in the scope of the development of the Gas to Power Project.
- ONEE will carry out the construction of distribution lines, but no further details or timeline have been disclosed by ONEE yet.
- No other ancillary infrastructure or incentive has been disclosed by ONEE at this stage

In 2015 ONEE issued a call for expressions of interest from companies interested in developing the Gas to Power Project and selected the technical consultant, financial adviser, commercial and legal adviser for the project in 2017.

Upstream developments

ONHYM and its foreign joint venture partners are pursuing an exploration programme with the objective of making commercial discoveries that would boost domestic natural gas supply. The exploration effort has been stepped up and there have been some discoveries of substantial gas reserves.

Onshore

The most significant development in the Moroccan gas sector in recent years has been the discovery of gas in the Tendirara permit areas by the UK's Sound Energy. In June 2018, Sound Energy submitted a development application to MEMDD after completing its exploration drilling programme. Sound Energy says that it expects the discovery to produce some 60mcf/d of natural gas (1.7 mcm/d). The company had earlier awarded a contract to an international consortium for front-end engineering work, construction and financing of infrastructure, including a 120 km spur line to connect to the Maghreb-Europe Gas Pipeline which runs near Tendirara discovery.

According to Sound Energy, resources estimates indicate a range of potential volumes across the entire Tendirara permit areas, with a 327 bcf (9 bcm) low case for unrisks original gas in place (gross). If all the key elements of the petroleum system's model prove to be present, an upside case of 796 bcf (22.5 bcm) of unrisks original gas could be in place (gross).

In the Gharb onshore basin, 57 wells have been drilled, leading to 35 small commercial discoveries. According to ONHYM, production in the area is highly profitable with costs at just under USD 2 per MMBTU; the region has an extensive pipeline network and strong demand from the automotive industry and construction materials plants.

In 2018, the European Bank for Reconstruction and Development (EBRD) supports the enhancement of upstream gas production and related gas transport infrastructure to Kenitra industrial zone customers in the Gharb region (EBRD provided a loan of up to EUR 10 million to SDX Energy Morocco).

In the Essaouira onshore basin, where gas and condensates have been produced since 1985, the most recent activities revealed higher reserves than previously estimated.

Offshore

Morocco has also started to attract the interest of oil majors such as Repsol and Eni. Eni drilled a first exploration well offshore Morocco in early 2018 at a water depth of 1 100 metres, though it has not yet assessed the potential of the reservoir. Recent exploration activity in the Gharb Offshore prospect resulted in a non-commercial discovery by Repsol. In the Tarfaya-Agadir offshore segment, seven wells have been drilled, of which four were in deep waters. Three of the wells encountered oil and gas confirming working petroleum systems. Also offshore, ONHYM has reported the discovery of gas and condensate in the Boujdour prospect, covering 200 000 km². Only one well was drilled in the area in 2014. So far, none of these discoveries have been declared commercial.

Shale gas

Morocco has geologically working shale gas plays with resources that it could tap into if the economics were favourable. Morocco has 20 trillion cubic feet and 200 million barrels of technically recoverable shale gas and oil resources, respectively (EIA, 2013, 2015). These include resources in the Tindouf basin, with smaller amounts in the Tadla basin.

Market regulation

The key players in the gas sector are ONEE, sole buyer of gas imported from Algeria, which accounts for all of Morocco's gas imports, and ONHYM, in charge of supporting upstream investment and the main gas users, the phosphate producers, the Office Cherifien des Phosphates (OCP) and other local industries which use gas.

Almost all of the gas which is being imported at the moment is being used for electricity, and its use for this purpose is adequately covered by the existing regulatory framework. If imported gas is going to be used to any significant extent in industry and in the residential and commercial sectors, a regulatory framework and market rules and regulations will be required. There is currently no regulatory authority in Morocco charged with the regulation of the gas networks and the market rules. The national regulatory authority for electricity (ANRE) has been recently established, but has no mandate on natural gas. A new draft Law on Natural Gas to govern gas activities is being prepared in consultation with the main operators and other interested parties and will be submitted to the approval procedure in government by the end of 2018.

Assessment

Morocco has a small but growing gas demand, which is satisfied by imports from Algeria. The role of gas is important in power generation with two combined-cycle (CCGT) plants. There is no use of gas in the residential sector, and little in industry, although Morocco imports significant quantities of ammonia made from natural gas steam reforming for its fertiliser industry. Current arrangements for gas imports from Algeria will remain in place also beyond 2021, as the Algerian contract for gas supply to Spain will be renewed.

Morocco still relies on coal (55%) and oil (9%) in the power mix, and natural gas could play an important role in further decarbonising the energy mix, alongside investment in renewable energy.

Over the past years, the government has been looking at boosting the use of natural gas. In 2014, the Ministry of Energy laid out the gas development strategy (worth EUR 4.1 billion) which consists of two phases: The first is the Gas to Power project to supply two new CCGT plants by 2025 based on supplies by LNG. The second envisages the supply of natural gas to industrial plants by 2030. Despite considerable interest in the tender of the first phase, no final investment decision has been taken for the “Power to Gas” project. The government has been considering one integrated tender for a fixed LNG terminal and associated infrastructure, estimated to cost USD 4.6 billion. As ONEE is the main importer today, the gas development strategy also implies the potential restructuring of the gas import licensing.

However, natural gas demand for electricity production is not expected to rise considerably in the medium term, as electricity imports (from Spain) and energy storage from solar power plants have increased their role as provider of flexibility. However, natural gas has a role to play: given the cost and environmental advantage of using natural gas rather than oil products in industry and power generation and also to some extent in the residential sector.

Against this background, the government should speed up the process of securing future gas supplies. Several options are being discussed including an LNG terminal with a send-out-capacity of five bcm per year or third, import natural gas from Spain through MEG via reverse flow or the Nigeria gas pipeline. A clear regulatory framework will be needed to support diversity of supply and investment in natural gas infrastructure as Morocco’s gas needs evolve. A ‘Draft Law on Natural Gas’ exists, but there has been limited progress towards finalising it, a recommendation of the 2014 IEA In-depth Review. Law 48-15 established the national regulatory authority for electricity (ANRE) in 2016, but its mandate does not include natural gas. The government is considering extending the mandate of ANRE to natural gas. In August 2018, the Director General of ANRE was appointed. The government should swiftly set up ANRE (see Chapter on Electricity) and start work on the extension of its mandate to natural gas, having in mind the regulations and rules needed to support a diverse import portfolio and cost-effective infrastructure investment.

Recommendations

The government of Morocco should:

- ❑ Based on the evaluation of the gas development strategy, swiftly assess the feasibility, costs and timeframe of different options for natural gas imports into Morocco in the medium-term to ensure security of gas supply and timely investment in gas supply and related gas infrastructure in the longer term.
- ❑ Clarify the legal and regulatory framework for natural gas with a view to accommodating different sources of gas imports and facilitating private sector investment.

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ANNEX A: Organisations visited

Review criteria

The Shared Goals, which were adopted by the IEA Ministers at their 4 June 1993 meeting in Paris, provide the evaluation criteria for the in-depth reviews (IDRs) conducted by the IEA. The Shared Goals are presented in Annex C.

Review team and preparation of the report

The IDR team visited Rabat from 26 to 30 March 2018 and held discussions with government officials, energy companies, non-governmental organisations, international financial institutions and other stakeholders. The IEA Secretariat drafted the report based on the official response to the IEA policy questionnaire and other information provided by the government authorities of Morocco and the discussions at the visit of the review team. The IEA wishes to express sincere appreciation to Minister of Energy, Mines and Sustainable Development Mr Aziz Rabbah, who met the review team and Mr Mohammed Ghazali, Secretary General of the Ministry of Energy, and Dr. Maya Aherdan, Head of the Directorate of Observation and Programming, for their support and helpful advice. The IEA wishes also to thank the European Commission for their support as well as the numerous stakeholders who offered their time and shared their expertise.

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Ms Elena Merle-Beral, Consultant

The review was co-ordinated by Sylvia Beyer and Kate Dourian with the invaluable assistance of Elena Merle-Beral who supported the review as consultant. Kate Dourian drafted the chapters on natural gas and on oil. Elena Merle-Beral prepared the chapters on climate, on energy efficiency, on renewables and on technology research and development. The chapters

on general energy policy and on electricity were drafted by Sylvia Beyer who also oversaw the preparation of the entire report.

The report was prepared under the guidance of the team leader Mr Edmund Hosker and IEA head of energy policy and security division, Mr. Aad van Bohemen. Valuable comments were provided by the review team members and the IEA staff, including Mr Cedric Philibert, Mr Carlos Fernandez, Ms Yasmina Abdelilah and Mr Jason Elliott.

Special thanks go to the IEA Secretariat with regard to the data, editing and publication. Importantly, the report has benefited from the support of timely and comprehensive data from Ms Laila El-Ashmawy, Mr. Remi Gigoux, and Mr. Oskar Kvarnström and IEA energy statistics and energy balances. Mr. Oskar Kvarnström and Mr. Bertrand Sadin ensured the preparation of the design of figures, maps and tables. The IEA Communication and Digital Office (CDO), in particular its Director Ms Rebecca Gaghen for the essential support in the report's production and launch. The author thanks for the time and dedication of the editor Ms Kristine Douaud, and the CDO team, Ms Astrid Dumond, Ms Isabelle Nonain-Semelin who managed the production process, and Ms Therese Walsh who ensured the editorial finalisation of the report. The authors are also grateful for Ms Claire Carrion who ensured the translation of the executive summary into French.

The IEA thanks all stakeholders that have supported the IEA review, notably the EU delegation in Rabat, Mr Philip Mikos, France Ministry of Economic Affairs and Finance, Mr Richard Lavergne and GIZ, Mr Gunnar Lorenz, among the many organisations we have consulted.

Organisations visited

- Ministry of Energy, Mines, Water and the Environment (MEMDD)
- Ministry of General Affairs and Governance
- Ministry of Interior
- Ministry of Transport
- Ministry of Industry
- National Office of Hydrocarbons and Mines (ONHYM)
- National Agency for Energy Efficiency (AMEE)
- National Agency for Electricity and Water (ONEE)
- Moroccan Agency for Solar Energy (MASEN)
- Institute for Research in Solar Energy and Renewable Energies (IRESEN)
- Moroccan Petroleum Industry Association/ Groupement des Pétroliers du Maroc
- Akwa Power
- Paltinum Power
- Maghreb Steel
- TAQA
- Sharifian Phosphate Office (OCP)
- Moroccan Association of Solar and Wind Industries (Amisole)
- The World Bank
- European Bank for Reconstruction and Development
- European Investment Bank
- Kreditanstalt für Wiederaufbau (KfW)
- Delegation of the European Union to the Kingdom of Morocco
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
- EU Twinning Coordination & partners (CRE, Ministère des Économies et Finances, BMWi, ADEME)

ANNEX B: Energy balances and key statistical data

Energy balances and key statistical data

		Unit: Mtoe						
SUPPLY		1973	1990	2000	2010	2015	2016	2017
TOTAL PRODUCTION		1.24	1.45	1.35	1.92	1.82	1.89	1.87
Coal		0.36	0.30	0.02	-	-	-	-
Peat		-	-	-	-	-	-	-
Oil		0.04	0.01	0.01	0.01	0.01	0.01	0.00
Natural gas		0.06	0.04	0.04	0.05	0.07	0.06	0.06
Biofuels and waste ¹		0.68	0.99	1.22	1.51	1.37	1.35	1.34
Nuclear		-	-	-	-	-	-	-
Hydro		0.10	0.11	0.06	0.30	0.16	0.11	0.10
Wind		-	-	0.01	0.06	0.22	0.26	0.26
Geothermal		-	-	-	-	-	-	-
Solar/other ²		-	-	-	-	0.00	0.10	0.11
TOTAL NET IMPORTS³		2.14	6.22	9.61	15.66	17.97	17.78	18.67
Coal	Exports	0.02	-	-	-	-	-	-
	Imports	0.02	0.81	2.62	2.81	4.26	4.44	4.49
	Net imports	0.01	0.81	2.62	2.81	4.26	4.44	4.49
Oil	Exports	0.05	0.56	1.42	0.63	0.46	0.01	-
	Imports	2.45	6.25	8.53	13.33	13.61	12.75	13.57
	Int'l marine and aviation bunkers	-0.27	-0.29	-0.32	-0.73	-0.82	-0.82	-0.86
Net imports		2.13	5.40	6.80	11.98	12.33	11.92	12.71
Natural Gas	Exports	-	-	-	-	-	-	-
	Imports	-	-	-	0.53	0.95	0.97	0.96
	Net imports	-	-	-	0.53	0.95	0.97	0.96
Electricity	Exports	-	-	-	0.06	0.01	0.01	0.01
	Imports	-	0.01	0.20	0.39	0.44	0.46	0.52
	Net imports	-	0.01	0.20	0.34	0.43	0.44	0.51
TOTAL STOCK CHANGES		0.16	-0.05	0.05	-0.49	-0.25	-0.06	-0.03
TOTAL SUPPLY (TPES)⁴		3.52	7.62	11.02	17.08	19.54	19.60	20.52
Coal		0.37	1.13	2.65	2.79	4.45	4.28	4.45
Peat		-	-	-	-	-	-	-
Oil		2.31	5.34	6.85	11.52	11.90	12.02	12.72
Natural gas		0.06	0.04	0.04	0.57	1.02	1.03	1.03
Biofuels and waste ¹		0.68	0.99	1.22	1.51	1.37	1.35	1.34
Nuclear		-	-	-	-	-	-	-
Hydro		0.10	0.11	0.06	0.30	0.16	0.11	0.10
Wind		-	-	0.01	0.06	0.22	0.26	0.26
Geothermal		-	-	-	-	-	-	-
Solar/other ²		-	-	-	-	0.00	0.10	0.11
Electricity trade ⁵		-	0.01	0.20	0.34	0.43	0.44	0.51
Shares in TPES (%)								
Coal		10.6	14.9	24.0	16.3	22.8	21.9	21.7
Peat		-	-	-	-	-	-	-
Oil		65.6	70.0	62.1	67.4	60.9	61.3	62.0
Natural gas		1.7	0.6	0.3	3.3	5.2	5.3	5.0
Biofuels and waste ¹		19.3	13.0	11.0	8.8	7.0	6.9	6.5
Nuclear		-	-	-	-	-	-	-
Hydro		2.9	1.4	0.6	1.7	0.8	0.6	0.5
Wind		-	-	0.1	0.3	1.1	1.3	1.3
Geothermal		-	-	-	-	-	-	-
Solar/other ²		-	-	-	-	0.0	0.5	0.5
Electricity trade ⁵		-	0.1	1.8	2.0	2.2	2.3	2.5

0 is negligible, - is nil, .. is not available, x is not applicable. Please note: rounding may cause totals to differ from the sum of the elements.

Unit: Mtoe

DEMAND							
FINAL CONSUMPTION	1973	1990	2000	2010	2015	2016	2017
TFC	3.02	5.65	8.54	13.22	15.09	15.37	16.09
Coal	0.08	0.35	0.53	0.02	0.02	0.02	0.02
Peat	-	-	-	-	-	-	-
Oil	2.01	3.58	5.68	9.64	11.10	11.30	11.92
Natural gas	0.06	0.04	0.04	0.05	0.07	0.06	0.06
Biofuels and waste ¹	0.67	0.97	1.19	1.49	1.34	1.32	1.30
Geothermal	-	-	-	-	-	-	-
Solar/other ²	-	-	-	-	-	-	-
Electricity	0.20	0.70	1.10	2.03	2.57	2.67	2.79
Heat	-	-	-	-	-	-	-
Shares in TFC (%)							
Coal	2.7	6.1	6.2	0.2	0.1	0.1	0.1
Peat	-	-	-	-	-	-	-
Oil	66.6	63.4	66.5	72.9	73.5	73.5	74.1
Natural gas	2.0	0.8	0.4	0.3	0.4	0.4	0.4
Biofuels and waste ¹	22.0	17.2	14.0	11.2	8.9	8.6	8.1
Geothermal	-	-	-	-	-	-	-
Solar/other ²	-	-	-	-	-	-	-
Electricity	6.7	12.5	12.9	15.4	17.1	17.4	17.3
Heat	-	-	-	-	-	-	-
TOTAL INDUSTRY⁶	1.15	2.17	2.51	3.45	3.59	3.44	3.80
Coal	0.07	0.35	0.53	0.02	0.02	0.02	0.02
Peat	-	-	-	-	-	-	-
Oil	0.91	1.43	1.36	2.52	2.47	2.29	2.60
Natural gas	0.06	0.04	0.04	0.05	0.07	0.06	0.06
Biofuels and waste ¹	-	-	0.07	0.10	0.10	0.10	0.10
Geothermal	-	-	-	-	-	-	-
Solar/other ²	-	-	-	-	-	-	-
Electricity	0.11	0.35	0.52	0.76	0.93	0.96	1.02
Heat	-	-	-	-	-	-	-
Shares in total industry (%)							
Coal	6.3	16.0	21.1	0.6	0.5	0.5	0.5
Peat	-	-	-	-	-	-	-
Oil	79.5	66.0	54.1	73.2	68.8	66.7	68.4
Natural gas	5.2	2.0	1.5	1.3	1.9	1.8	1.6
Biofuels and waste ¹	-	-	2.6	2.8	2.9	3.0	2.7
Geothermal	-	-	-	-	-	-	-
Solar/other ²	-	-	-	-	-	-	-
Electricity	9.2	15.9	20.7	22.1	26.0	28.0	26.8
Heat	-	-	-	-	-	-	-
TRANSPORT⁴	0.68	1.30	2.68	4.45	5.35	5.58	5.78
OTHER⁷	1.20	2.18	3.35	5.32	6.15	6.35	6.52
Coal	0.01	-	-	-	-	-	-
Peat	-	-	-	-	-	-	-
Oil	0.43	0.87	1.66	2.69	3.31	3.46	3.58
Natural gas	-	-	-	-	-	-	-
Biofuels and waste ¹	0.67	0.97	1.13	1.39	1.24	1.22	1.20
Geothermal	-	-	-	-	-	-	-
Solar/other ²	-	-	-	-	-	-	-
Electricity	0.09	0.34	0.57	1.25	1.61	1.68	1.74
Heat	-	-	-	-	-	-	-
Shares in other (%)							
Coal	0.9	-	-	-	-	-	-
Peat	-	-	-	-	-	-	-
Oil	36.1	39.9	49.5	50.5	53.7	54.4	54.9
Natural gas	-	-	-	-	-	-	-
Biofuels and waste ¹	55.5	44.5	33.6	26.1	20.1	19.2	18.4
Geothermal	-	-	-	-	-	-	-
Solar/other ²	-	-	-	-	-	-	-
Electricity	7.5	15.6	16.9	23.4	26.2	26.4	26.7
Heat	-	-	-	-	-	-	-

Unit: Mtoe							
DEMAND							
ENERGY TRANSFORMATION AND LOSSES	1973	1990	2000	2010	2015	2016	2017
ELECTRICITY GENERATION⁸							
Input (Mtoe)	0.63	2.31	2.95	4.96	6.33	6.46	6.70
Output (Mtoe)	0.25	0.83	1.11	2.04	2.65	2.73	2.82
Output (TWh)	2.88	9.63	12.86	23.67	30.82	31.73	32.81
Output Shares (%)							
Coal	27.5	23.0	68.3	45.9	55.5	53.5	53.5
Peat	-	-	-	-	-	-	-
Oil	31.0	64.4	25.6	24.1	7.2	9.1	10.6
Natural gas	-	-	-	12.5	18.8	18.6	17.8
Biofuels and waste ¹	-	-	-	-	-	-	-
Nuclear	-	-	-	-	-	-	-
Hydro	41.5	12.7	5.6	14.7	6.1	4.0	3.6
Wind	-	-	0.5	2.8	8.2	9.5	9.2
Geothermal	-	-	-	-	-	-	-
Solar/other ²	-	-	-	-	-	1.3	1.3
TOTAL LOSSES	0.51	1.90	2.49	3.96	4.50	4.26	4.45
of which:							
Electricity and heat generation ⁹	0.38	1.48	1.85	2.92	3.68	3.73	3.88
Other transformation	0.03	0.17	0.30	0.25	0.09	0.03	0.03
Own use and transmission/distribution losses ¹⁰	0.10	0.25	0.35	0.79	0.73	0.50	0.54
Statistical Differences	-0.00	0.07	-0.02	-0.10	-0.06	-0.03	-0.02
INDICATORS	1973	1990	2000	2010	2015	2016	2017
GDP (billion 2010 USD)	18.36	43.19	57.52	93.22	113.38	114.66	119.35
Population (millions)	17.05	24.88	28.85	32.41	34.80	35.28	35.74
TPES/GDP (toe/1000 USD) ¹¹	0.19	0.18	0.19	0.18	0.17	0.17	0.17
Energy production/TPES	0.35	0.19	0.12	0.11	0.09	0.10	0.09
Per capita TPES (toe/capita)	0.21	0.31	0.38	0.53	0.56	0.56	0.57
Oil supply/GDP (toe/1000 USD) ¹¹	0.13	0.12	0.12	0.12	0.11	0.10	0.11
TFC/GDP (toe/1000 USD) ¹¹	0.16	0.13	0.15	0.14	0.13	0.13	0.13
Per capita TFC (toe/capita)	0.18	0.23	0.30	0.41	0.43	0.44	0.45
CO ₂ emissions from fuel combustion (MtCO ₂) ¹²	8.3	19.7	29.6	46.4	55.4	55.3	58.2
CO ₂ emissions from bunkers (MtCO ₂) ¹²	0.8	0.9	1.0	2.2	2.5	2.5	2.6
GROWTH RATES (% per year)	73-90	90-00	00-10	10-14	14-15	15-16	16-17
TPES	4.6	3.8	4.5	2.7	2.8	0.3	4.7
Coal	6.8	8.9	0.5	9.7	10.1	-3.6	3.9
Peat	-	-	-	-	-	-	-
Oil	5.0	2.5	5.3	0.5	1.1	1.0	5.8
Natural gas	-1.8	-1.2	31.1	15.3	1.0	1.7	-0.8
Biofuels and waste ¹	2.2	2.1	2.2	-2.4	0.1	-1.2	-1.1
Nuclear	-	-	-	-	-	-	-
Hydro	0.1	-5.1	17.0	-17.1	14.9	-33.3	-5.6
Wind	-	-	25.2	30.4	31.5	18.9	1.2
Geothermal	-	-	-	-	-	-	-
Solar/other ²	-	-	-	-	-	10300.0	3.8
TFC	3.7	4.2	4.5	2.4	3.8	1.8	4.7
Electricity consumption	7.6	4.6	6.3	5.5	2.3	3.8	4.5
Energy production	0.9	-0.7	3.6	-2.1	3.2	3.7	-0.7
Net oil imports	5.6	2.3	5.8	2.1	-5.3	-3.3	6.6
GDP	5.2	2.9	4.9	3.9	4.5	1.1	4.1
TPES/GDP	-0.5	0.8	-0.4	-1.1	-1.7	-0.8	0.6
TFC/GDP	-1.3	1.3	-0.5	-1.4	-0.7	0.7	0.6

Footnotes to energy balances and key statistical data

1. Biofuels and waste includes solid biofuels and industrial waste. Data are often based on partial surveys and may not be comparable between countries.
2. Other includes solar photovoltaic and solar thermal.
3. Total net imports include coal, oil, natural gas and electricity trade.
4. Excludes international marine bunkers and international aviation bunkers.
5. Total supply of electricity represents net trade. A negative number in the share of TPES indicates that exports are greater than imports.
6. Industry includes non-energy use.
7. Other includes residential, commercial and public services, agriculture/forestry, fishing and other non-specified.
8. Inputs to electricity generation include inputs to electricity-only plants. Output refers only to electricity generation.
9. Losses arising in the production of electricity and heat at main activity producer utilities and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiencies of approximately 33% for solar thermal and 100% for hydro, wind and solar photovoltaic.
10. Data on “losses” for forecast years often include large statistical differences covering differences between expected supply and demand and mostly do not reflect real expectations on transformation gains and losses.
11. Toe per thousand US dollars at 2010 prices and exchange rates.
12. “CO₂ emissions from fuel combustion” have been estimated using the IPCC Tier I Sectoral Approach from the *2006 IPCC Guidelines*. In accordance with the IPCC methodology, emissions from international marine and aviation bunkers are not included in national totals. Projected emissions for oil and gas are derived by calculating the ratio of emissions to energy use for 2017 and applying this factor to forecast energy supply. Projected emissions for coal are based on product-specific supply projections and are calculated using the IPCC/OECD emission factors and methodology.

ANNEX C: International Energy Agency “Shared Goals”

The member countries* of the International Energy Agency (IEA) seek to create conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and to the well-being of their people and of the environment. In formulating energy policies, the establishment of free and open markets is a fundamental point of departure, though energy security and environmental protection need to be given particular emphasis by governments. IEA countries recognise the significance of increasing global interdependence in energy. They therefore seek to promote the effective operation of international energy markets and encourage dialogue with all participants. In order to secure their objectives, member countries therefore aim to create a policy framework consistent with the following goals:

1. Diversity, efficiency and flexibility within the energy sector are basic conditions for longer-term energy security: the fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil fuels, particularly nuclear and hydropower, make a substantial contribution to the energy supply diversity of IEA countries as a group.

2. Energy systems should have the ability to respond promptly and flexibly to energy emergencies. In some cases this requires collective mechanisms and action: IEA countries co-operate through the Agency in responding jointly to oil supply emergencies.

3. The environmentally sustainable provision and use of energy are central to the achievement of these shared goals. Decision makers should seek to minimise the adverse environmental impacts of energy activities, just as environmental decisions should take account of the energy consequences. Government interventions should respect the Polluter Pays Principle where practicable.

4. More environmentally acceptable energy sources need to be encouraged and developed. Clean and efficient use of fossil fuels is essential. The development of economic non-fossil sources is also a priority. A number of IEA member countries wish to retain and improve the nuclear option for the future, at the highest available safety standards, because nuclear energy does not emit carbon dioxide. Renewable sources will also have an increasingly important contribution to make.

5. Improved energy efficiency can promote both environmental protection and energy security in a cost-effective manner. There are significant opportunities for greater energy efficiency at all stages of the energy cycle from production to consumption. Strong efforts by governments and all energy users are needed to realise these opportunities.

6. Continued research, development and market deployment of new and improved energy technologies make a critical contribution to achieving the objectives outlined above. Energy technology policies should complement broader energy policies. International co-operation in the development and dissemination of energy technologies, including industry participation and co-operation with non-member countries, should be encouraged.

7. Undistorted energy prices enable markets to work efficiently. Energy prices should not be held artificially below the costs of supply to promote social or industrial goals. To the extent necessary and practicable, the environmental costs of energy production and use should be reflected in prices.

8. Free and open trade and a secure framework for investment contribute to efficient energy markets and energy security. Distortions to energy trade and investment should be avoided.

9. Co-operation among all energy market participants helps to improve information and understanding, and encourages the development of efficient, environmentally acceptable and flexible energy systems and markets worldwide. These are needed to help promote the investment, trade and confidence necessary to achieve global energy security and environmental objectives.

(The Shared Goals were adopted by IEA Ministers at the meeting of 4 June 1993 Paris, France)

* Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States.

ANNEX D: Glossary and list of abbreviations

In this report, abbreviations and acronyms are substituted for a number of terms used within the International Energy Agency. While these terms generally have been written out on first mention, this glossary provides a quick and central reference for the abbreviations used.

Acronyms and abbreviations

4C Maroc	<i>Centre de compétences changement climatique du Maroc</i> (Centre for Climate Change Competencies of Morocco)
AAGR	average annual growth rate
AC	air conditioners
ADEME	<i>Agence de l'environnement et de la maîtrise de l'énergie</i> (France's Environment and Energy Management Agency)
ADEREE	<i>Agence nationale pour le développement des énergies renouvelables et de l'efficacité énergétique</i> (National Agency for Renewable Energies and Energy Efficiency)
ADM	<i>Autoroutes du Maroc</i> (National Highway Company of Morocco)
AFD	<i>Agence française de développement</i>
AfDB	African Development Bank
AFOLU	agriculture, forestry and other land use
AFREC	African Energy Commission
AMEE	<i>Agence marocaine pour l'efficacité énergétique</i> (National Agency for Energy Efficiency)
ANRE	<i>Autorité nationale de régulation de l'électricité</i> (National Authority for Electricity Regulation)
ARCUS	<i>Actions en régions de coopération universitaires et scientifique</i> (Regional Initiatives of Academic and Scientific Cooperation)
B2B	business to business
BAU	business as usual
BEIS	Business, Energy and Innovation Strategy
BMCE	<i>Banque marocaine du commerce extérieur</i>
BMZ	German Federal Ministry for Economic Co-operation and Development
BOOTBMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung
BOO	build, own, operate and transfer
BTO	build, transfer, operate
C ₆ H ₆	benzene
CBI	Climate Bonds Initiative
CCGT	combined-cycle gas turbine
Cd	cadmium
CDM	Clean Development Mechanism
CEA	<i>Commissariat à l'énergie atomique et aux énergies alternatives</i>
CEDARE	Center for Environment and Development for the Arab Region and Europe
CFL	compact fluorescent lamp

CH ₄	methane
CIEMAT	<i>Centro de investigaciones energéticas, medioambientales y tecnológicas</i>
CDO	Communication and Digital Office (IEA)
CIS	<i>Comité interministériel de suivi</i> (Interministerial Monitoring Committee)
CNRST	<i>Centre national pour la recherche scientifique et technique</i> (National Centre for Scientific and Technical Research)
CNST-CC	National Scientific and Technical Committee of Climate Change
CO	carbon oxides
CO ₂	carbon dioxide
COP	Conference of the Parties
CPIRSDT	Permanent Interministerial Committee on Scientific Research and Technological Development
CPV	concentrator photovoltaic
CRE	<i>Commission de régulation de l'énergie</i> (France)
CSP	concentrating solar power
CTF	Clean Technology Fund
disco	distribution company
E2D2	Energy, Environment and Sustainable Development project
EBRD	European Bank for Reconstruction and Development
EC	European Commission
ECOWAS	Economic Community of West African States
EIA	energy impact assessment
EIBEI	European Investment Bank
e-mobility	electric mobility
ENEA	<i>Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile</i> (National Agency for New Technologies, Energy and Sustainable Economic Development)
ENI	European Neighbourhood Instrument
ENIT	<i>École nationale d'ingénieurs de Tunis</i> (National Engineering School of Tunis)
ENP	European Neighbourhood Policy
EPC	engineering, procurement and construction
ESCO	energy service company
ETS	emissions trading system
EU	European Union
EUR	euro
EV	electric vehicle
FDI	foreign direct investment
GB	Green Building Park
GDP	gross domestic product
GEF	Global Environment Facility
GHG	greenhouse gas

GIZ	<i>Deutsche Gesellschaft für Internationale Zusammenarbeit</i> (German Corporation for International Cooperation GmbH)
GreenAIB	Green Africa Innovation Booster
GreenAIN	Green Africa Innovation Network
HDV	heavy-duty vehicle
HF	hydrogen fluoride
HV	high voltage
IBRD	International Bank for Reconstruction and Development
IDR	in-depth review
IEA	Energy Agency
IFC	International Finance Corporation
IFI	international financial institution
IMANOR	<i>Institut marocain de normalisation</i> (Moroccan Institute for Standardisation)
INDC	Intended Nationally Determined Contribution
INPHB	<i>Institut national polytechnique Houphouët-Boigny</i>
IPCC	Intergovernmental Panel on Climate Change
IPP	independent power producer
IRESEN	<i>Institut de recherche en énergie solaire et énergies nouvelles</i> (Institute for Research into Solar and Renewable Energies)
IRSEC	International Renewable and Sustainable Energy Conference
JODI	Organisation Data Initiative
KfW	<i>Kreditanstalt für Wiederaufbau</i> (German development bank)
LDV	light-duty vehicle
LED	light-emitting diode
LEME	list of eligible materials and equipment
LIEN	Large Industry Energy Network
LNG	liquefied natural gas
LPG	liquefied petroleum gas
MAD	Moroccan dirham
MAScIR	Moroccan Foundation for Advanced Science, Innovation and Research
MASEN	Moroccan Agency for Sustainable Energy
MBI	market-based instrument
MCINET	<i>Ministre de l'industrie, de l'investissement, du commerce et de l'économie numérique</i> (Ministry of Industry, Investment, Trade and Digital Economy)
MENA	Middle East and North Africa (region)
MEDENER	Mediterranean Association of National Agencies for Energy Management
MENFPESR	Ministry of National Education, Vocational Training, Higher Education and Scientific Research
MEG	Maghreb-Europe Gas Pipeline
MEMDD	<i>Ministère de l'énergie, des mines et du développement durable</i> (Ministry of Energy, Mines and Sustainable Development)

ANNEXES

MEPS	minimum energy performance standards
METLW	Ministry of Equipment, Transport, Logistics and Water
MHV	medium-high voltage
MICEP	Morocco-Ivory Coast Energy Park
MorSEFF	Morocco Sustainable Energy Financing Facility
MRV	monitoring, reporting and verification
MV	medium voltage
MVE	monitoring, verification and enforcement
NAP	National Adaptation Plan
NAP-GSP	National Adaptation Plan Global Support Programme
NDC	Nationally Determined Contribution
NGO	non-governmental organisation
NIF	Neighbourhood Investment Facility (EU)
NH ₃	ammonia
NMVOC	non-methane volatile organic compound
NO _x	nitrogen oxides
OCP	<i>Office chérifien des phosphates</i> (Sharifian Phosphate Office)
OFPPT	Office of Professional Training and the Promotion of Work
ONCF	<i>Office national des chemins de fer</i>
ONE	<i>Office national de l'électricité</i> (National Electricity Office)
ONEE	<i>Office national de l'électricité et de l'eau potable</i> (National Agency for Electricity and Water)
ONEM	<i>Observatoire National de l'environnement du Maroc</i> (National Environment Observatory)
ONEP	<i>Office national de l'eau potable</i> (National Water Office)
ONHYM	<i>Office national des hydrocarbures et des mines</i> (National Office of Hydrocarbons and Mines)
ORC	Organic Rankine Cycle
OREDD	<i>Observatoires régionaux de l'environnement et du développement durable</i> (Regional Observatories of the Environment and Sustainable Development)
Pb	lead
PJD	Party of Justice and Development
PMR	Partnership for Market Readiness
PNAP	<i>Plan national d'actions prioritaires</i> (National Priority Action Plan)
PNRC	<i>Plan national de lutte contre le réchauffement climatique</i> (National Plan to Fight Global Warming)
PPA	power purchase agreement
ppm	parts per million
PPMC	Paris Process for Mobility and Climate
PPP	purchasing power parity
PV	photovoltaic
R&D	research and development

RADEEL	<i>Régie autonome intercommunale de distribution d'eau et d'électricité de la Province de Larache</i>
RADEEMA	<i>Régie autonome de distribution d'eau et d'électricité de Marrakech</i>
RD&D	research, development and demonstration
RD&I	research, development and innovation
REE	Red Electrica de Espana
RES	renewable energy source
S&T	scientific and technological
SAMIR	<i>Société anonyme marocaine de l'industrie du raffinage</i> (Moroccan Refining Industry Company Limited)
SDGs	UN Sustainable Development Goals
SDL	<i>société de développement local</i> (local development corporation)
SEMED	southern and eastern Mediterranean
SIE	<i>Société d'investissements énergétiques</i> (the Energy Investment Company)
SMEs	small and medium-sized enterprises
SO ₂	sulphur dioxide
SPM	suspended particulate matter
SPV	special-purpose vehicle
SWH	solar water heating
TCPs	Technology Collaboration Programmes
TFC	total final consumption
TPES	total primary energy supply
TSO	transmission system operator
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNESCWA	United Nations Economic and Social Commission for Western Asia
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
USD	United States dollar
VAT	value-added tax
VHV	very high voltage
WSCOP	Water Saving for Concentrated Solar Power

Units of measurement

bbl	barrel
bcm	billion cubic metres
CO ₂ -eq	carbon dioxide-equivalent
GW	gigawatt
GWh	gigawatt hour

ANNEXES

h	hour
ha	hectare
kg	kilogramme
km	kilometre
km ²	square kilometre
kV	kilovolt
kW	kilowatt
kWh	kilowatt hour
m ²	square metre
m ³	cubic metre
MBtu	million British thermal units
Mm ³	million cubic metres
Mt	million tonnes
Mtoe	million tonnes of oil-equivalent
MW	megawatt
MWe	megawatt electrical
t	tonne
toe	tonne of oil-equivalent
TWh	terawatt hour

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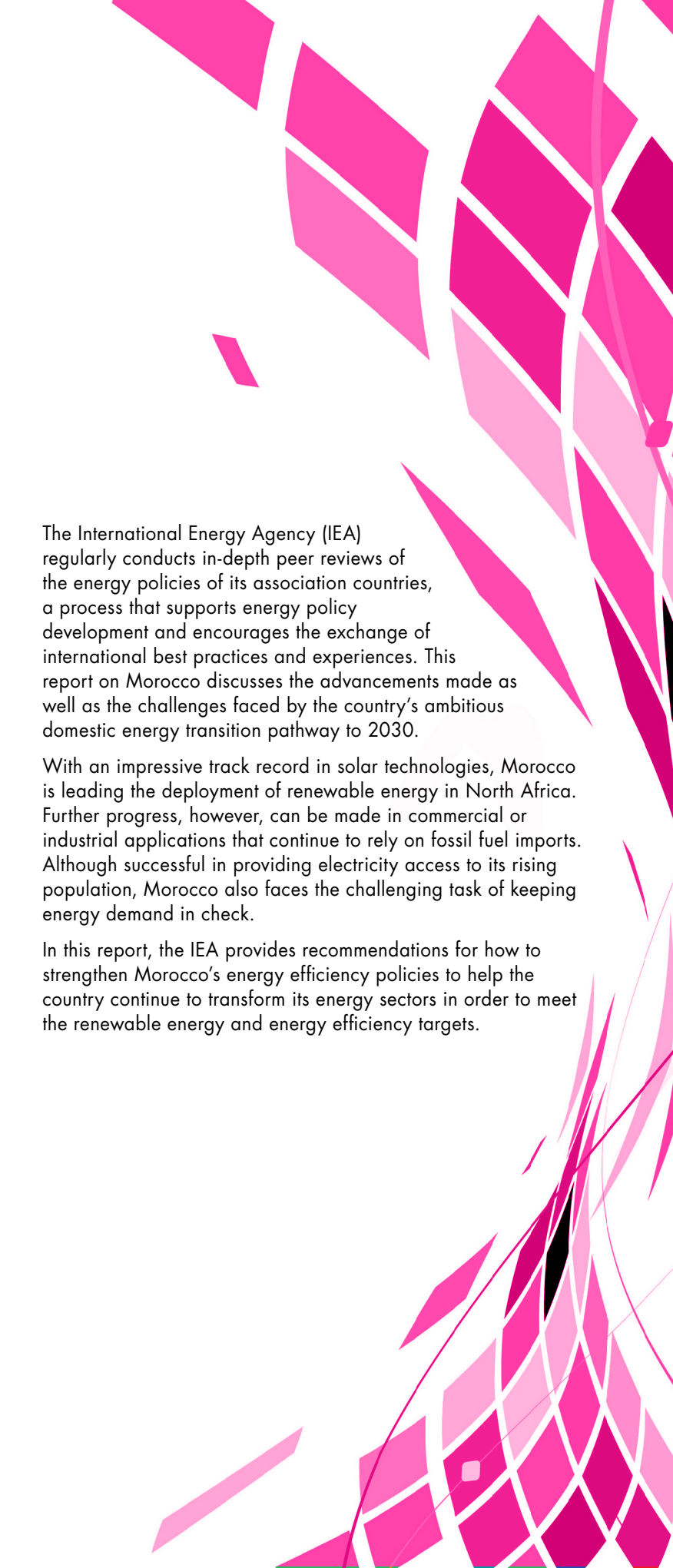
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ENERGY POLICIES BEYOND IEA COUNTRIES

Morocco 2019

The International Energy Agency (IEA) regularly conducts in-depth peer reviews of the energy policies of its association countries, a process that supports energy policy development and encourages the exchange of international best practices and experiences. This report on Morocco discusses the advancements made as well as the challenges faced by the country's ambitious domestic energy transition pathway to 2030.

With an impressive track record in solar technologies, Morocco is leading the deployment of renewable energy in North Africa. Further progress, however, can be made in commercial or industrial applications that continue to rely on fossil fuel imports. Although successful in providing electricity access to its rising population, Morocco also faces the challenging task of keeping energy demand in check.

In this report, the IEA provides recommendations for how to strengthen Morocco's energy efficiency policies to help the country continue to transform its energy sectors in order to meet the renewable energy and energy efficiency targets.