



International  
Energy Agency

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# Morocco 2014

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Energy Agency

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# Morocco 2014

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## INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its primary mandate was – and is – two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply, and provide authoritative research and analysis on ways to ensure reliable, affordable and clean energy for its 29 member countries and beyond. The IEA carries out a comprehensive programme of energy co-operation among its member countries, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The Agency's aims include the following objectives:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
  - Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
    - Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations and other stakeholders.

IEA member countries:

Australia  
Austria  
Belgium  
Canada  
Czech Republic  
Denmark  
Estonia  
Finland  
France  
Germany  
Greece  
Hungary  
Ireland  
Italy  
Japan  
Korea (Republic of)  
Luxembourg  
Netherlands  
New Zealand  
Norway  
Poland  
Portugal  
Slovak Republic  
Spain  
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The European Commission also participates in the work of the IEA.

## FOREWORD

I am delighted to introduce this energy policy review of Morocco. It is the result of nearly two years of intensive collaboration between our staff here at the International Energy Agency and their counterparts in Rabat at the Ministry of Energy, Mines, Water and Environment.

In recent years, the International Energy Agency (IEA) has worked hard to strengthen its relations with partner countries. Now that more than half of global energy demand rests with countries outside the Organisation for Economic Co-operation and Development (OECD), it is increasingly important for us to understand the energy challenges and energy policies of countries around the world. Today's energy problems – security of energy supply, affordability and sustainability – are more widely shared and call for international solutions based on international co-operation. The risks associated with climate change also attract particular attention at this time.

Morocco, like most of the members of the IEA, is highly dependent on imported energy supplies. Given today's international oil and gas prices, this adds up to a sizeable import bill. Some supplies – like bottled gas – are subsidised, which can also weigh heavily on the national budget. Despite a long history of careful use of hydroelectricity, Morocco is also very dependent on coal, oil and gas, leading to a relatively high level of greenhouse gas emissions.

Over the last ten years or so, under political direction from the very top level, Morocco has moved to address these challenges with determination and consistency. The government has taken steps to diversify the energy mix, especially in electricity, while persevering with opening up the power sector to foreign investment. The oil sector has also been liberalised and recent measures have been taken to reduce progressively the level of subsidies for transport fuels. Energy efficiency has been elevated to a national priority, and co-operation with United Nations agencies on the climate change agenda is widely seen as exemplary.

Morocco has also shown a readiness to play to its strengths. Its geography is extremely favourable to both wind and solar power, and the Kingdom has set very ambitious targets in this area. It also benefits from an electricity interconnector with Spain, while generating additional power with gas from neighbouring Algeria. New coal-fired power stations will use cleaner and more efficient technologies and should also benefit from relatively low and stable coal prices in international markets.

So our judgment is that the National Energy Strategy set out in 2009 has moved Morocco very much in the right direction, including important decisions on reducing fuel subsidies that were taken while our review was in progress. More effort could be put into energy efficiency, including on the research and development (R&D) side – as is the case for a number of countries, not least many members of the IEA. The world of renewable energy is changing very fast, particularly with regard to the costs of photovoltaics and the techniques for deploying concentrating solar power, so we recommend additional attention in that area. We have also been most impressed by the Kingdom's progress in

co-ordinating and focusing the R&D effort in renewables, which should enable its institutions to play a leading role in the region in this important field. Additional commitment of funds and human resources would be money well spent.

This is the first such study we have made of any country in the Middle East-North Africa area. I hope that the report, which we are publishing in French and English, will attract a wide readership not only in Morocco, but throughout North Africa and the Mediterranean, among all those who share Morocco's energy challenges and who share an interest in the development of energy systems in the region as a whole.

The Agency is most grateful to the staff of the Ministry of Energy, Mines, Water and Environment in Rabat for their diligence, as well as to their colleagues in other government institutions. Colleagues at the multilateral and bilateral aid funds that are pursuing development projects in the country, as well as their counterparts at the European Union, provided most valuable advice and support.

This report is published under my authority as Executive Director of the IEA.

Maria van der Hoeven  
Executive Director  
International Energy Agency

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## 1. EXECUTIVE SUMMARY AND KEY RECOMMENDATIONS

### EXECUTIVE SUMMARY

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This is the first in-depth review the International Energy Agency (IEA) has conducted of the energy policy of Morocco. Indeed, it is the first the Agency has conducted for any country in the Middle East and North Africa region.

Working on the review has much improved the Agency's understanding of Morocco's energy situation and the policies the government has adopted. It has also improved the Agency's energy data. The review process has involved a productive dialogue on numerous aspects of energy policy, some fruits of which are already becoming apparent.

Unlike some of its neighbours in the region, Morocco is highly dependent on imported energy. Over 91% of energy supplied comes from abroad: coal, oil and oil products from world markets; gas from Algeria; and imported electricity. This is a significant burden on the balance of payments, and, insofar as some energy supplies are subsidised, a drain on the budget.

The high dependence on imports also raises questions about the security of energy supply, while the strong dependence on carbon fuels sustains a relatively elevated level of greenhouse gas (GHG) emissions. Morocco, therefore, shares many of the same energy challenges that are faced by the majority of IEA member countries: affordable energy supply, security of supply and sustainability.

Morocco has long recognised that it is vulnerable to the impacts of climate change. The government ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1995 and the Kyoto Protocol in 2002. In 1996 a National Committee on Climate Change was established, and in 2009 the National Plan to Combat Climate Change set the first targets for reducing GHG emissions in the energy and industry sectors.

Since the 1990s, the government of Morocco has emphasised the central role of energy in economic and social development. An ambitious programme has been in place since 1995 to extend access to electricity to the general rural population. The network now covers 164 000 kilometres and embraces 98% of the population, compared with 18% two decades ago – a very impressive achievement for which the government of Morocco deserves enormous credit. This development has contributed to a consistent economic growth rate of between 4% and 5% per year, although it has also led to a strong increase in electricity demand.

Morocco has also largely liberalised its market in oil products, privatising the distribution sector in 1995 and allowing imports free of duty since 2002. The first agreement on a foreign-invested power supplier (at Jorf Lasfar) dates back to 1994. In 1995 plans were laid for an electricity interconnection with Spain which began to operate at full capacity (1 400 megawatts [MW]) in 2005. Also in 2005, the first natural gas-fired power plant was commissioned using royalty gas from the Maghreb-Europe Gas Pipeline. Morocco

works with its partners in the Maghreb Union (the Maghreb Electricity Committee [COMEELEC], set up in 1992) to promote regional grid integration, as well as with counterparts in the European Union. Combining market liberalisation with regional integration has been a leitmotif for Morocco's energy policy, and the government hopes that a more integrated and liberalised European market will facilitate future Moroccan energy exports to Europe. Morocco has also maintained very attractive investment terms for upstream oil and gas exploration.

In 2009, the Moroccan government developed a National Energy Strategy setting clear and precise objectives. This strategy covers five main strands: optimise the fuel mix in the electricity sector; accelerate the development of energy from renewable sources, especially wind, solar and hydropower; make energy efficiency a national priority; encourage more foreign investment in the energy sector; and promote greater regional integration.

Significant achievements have been made since the strategy came into effect. In the power sector, an additional 2 gigawatts (GW) of coal-fired power capacity has been signed up. This should significantly reduce the average cost of base load power.

In renewables, the overall target of 2 GW of wind power, 2 GW of solar power and an increase to 2 GW of hydropower capacity by 2020 is designed to take advantage of Morocco's highly favourable conditions for both wind and solar power, as well as its long-established hydropower sector. On that basis, renewables should represent 42% of installed capacity by 2020. The first wind farms are up-and-running (at 600 megawatts [MW], with over 1 000 MW in planning or construction), and the first commercial concentrating solar power project has been launched at Ouarzazate with foreign investment and the support of multilateral development agencies.

A legal and institutional framework has been established in parallel. Its goals are to implement stricter standards in energy efficiency; to allow private industry to supply power to the grid (at high voltage initially); to lay the foundation for an electricity and gas sector regulator, to provide support for energy efficiency and renewable energy programmes (through the Agency for the Development of Renewable Energy and Energy Efficiency); to promote solar power (the Moroccan Agency for Solar Energy); and to promote research and development (R&D) in renewables (the Institute for Research into Renewable and Solar Energies). These programmes are now established and funded; they are beginning to have an impact on the development of the whole renewable energy sector, as well as on the country's R&D activity.

On the upstream oil and gas side, a sustained period of high prices and some discoveries in similar geology in neighbouring countries have aroused considerable international interest once more in the Moroccan offshore. The drilling programme this year is expected to be significant. Further, the substantial onshore deposits of oil shale may also prove attractive in due course. Most recently, important steps were taken in late 2013 and early 2014 to eliminate the effective subsidy on gasoline and fuel oil, as well as to reduce significantly the subsidy on diesel fuel, and in June 2014 to eliminate the subsidy on fuel used for electricity generation. Although there still remains a high level of subsidy in the socially very sensitive area of bottled gas (butane), the measures announced so far will have a far-reaching impact on the budget cost of subsidies and (to a lesser extent) on energy consumption.

Lastly, a number of measures have been taken specifically to reduce GHG emissions in the energy sector. The government has worked closely with multilateral and bilateral development agencies to put in place programmes designed to improve environmental management. It has also advanced a number of projects that can benefit from the United

Nations Clean Development Mechanism, as well as a Technology Action Plan to identify technologies best suited for climate change mitigation. Morocco submitted its second National Communication to the UNFCCC in 2010: the third, for 2014, is in preparation.

The main message of this report is that the 2009 National Energy Strategy is being implemented in accordance with the deadlines set at its launch. Major progress has been made both at the institutional level and in terms of major project development, and important reforms have been taken in hand. In the last five years, sustained high prices in most world energy markets have served to reinforce the wisdom of the main strands of the policy: the benefits of improving energy efficiency are more obvious (in terms of controlling energy costs and maintaining industrial competitiveness and of reducing GHG emissions), as are the costs of failing to do so. The competitiveness of renewable technologies has increased significantly and needs to be recognised through a more flexible and innovative approach, particularly towards photovoltaics. Restructuring the power sector, beginning with an internal re-organisation of the national power supplier, will be an important next step in liberalising the electricity market. Likewise, the establishment of an energy regulator, decided by the Moroccan government, will be essential in order to underpin a liberalised market.

Further, attractive investment terms in the upstream need to be maintained in order to provide incentives for international donors and investors. The progress towards decompensation of retail oil products needs to be followed up with a strategy to tackle subsidised butane, including measures to compensate the least affluent. Finally, the institutional revolution in the approach to R&D needs to be supported with increased central government funds so that Morocco can be well placed to become a regional leader in technologies where its geography gives it a natural advantage.

## KEY RECOMMENDATIONS

*The government of Morocco should:*

- *Sustain recent progress in reducing the level of fuel subsidies.*
- *Reinforce the current energy efficiency strategy through clear regulation and incentives, while taking care to measure progress to date and learn from others' experience, e.g. in the European Union.*
- *Optimise the deployment of solar power, maximising the use of concentrated solar power at peak hours and facilitating the use of photovoltaics, by accelerating work in the medium and low voltage area currently under way in Morocco – including access to the grid.*
- *Accelerate the establishment of an energy regulator to supervise an even more open power market and encourage wider use of gas.*
- *Maintain the confidence of foreign investment and domestic industry, while also encouraging more R&D in new energies and the transfer of technology.*



**PART I**  
**POLICY ANALYSIS**





## 2. GENERAL ENERGY POLICY

### Key data (2012)

**TPES:** 18.8 Mtoe (oil 67.6%, coal 16.1%, biofuels and waste 7.4%, natural gas 5.7%, electricity net imports 2.2%, hydro 0.7%, wind 0.3%), +58.2% since 2002

**TPES per capita:** 0.6 toe (IEA average: 4.5 toe), +42.6% since 2002

**TPES per GDP:** 0.09 toe/USD 1 000 PPP (IEA average: 0.13 toe/USD 1 000 PPP), -1.4% since 2002

**Electricity generation:** 27.3 TWh (coal 43.4%, oil 25.3%, natural gas 22.7%, hydro 6%, wind 2.7%), +79.4% since 2002

**Electricity generation per capita:** 0.8 MWh (IEA average: 9.3 MWh)

## COUNTRY OVERVIEW

The Kingdom of Morocco lies in northwest Africa, with a coastline on both the Mediterranean and the North Atlantic. The capital is Rabat; the largest city, Casablanca, has 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. The landscape is dominated by the Atlas Mountains, which rise more than 4 000 metres (Jbel Toubkal, the high point, reaches over 4 167 metres) and separate the coastal plain from the much drier interior.

Morocco was a protectorate of France from 1912 until 1956. The present monarch, King Mohammed VI, succeeded his father, King Hassan II, in 1999. He is both commander-in-chief of the armed forces and spiritual leader of his people, *amir al-mu'mineen* or Commander of the Faithful; the dynasty is directly descended from the Prophet.

The Parliament, which first sat in 1963, has grown more influential in recent years.

## CONSTITUTIONAL DEVELOPMENT

Since 30 July 1999, when King Mohammed VI came to the throne, the Kingdom of Morocco has undergone significant reforms in the political, social and economic arenas.

These include the reform of the Family Code, which has had a revolutionary and far-reaching impact on the status of women in society, the launch of the National Initiative for Human Development and the reform of the justice system. These reforms culminated in the reform of the Moroccan Constitution in 2011.

This constitution is an original Moroccan model, which reflects the characteristics of the Moroccan state while emphasising a commitment to the parliamentary nature of the political system. The constitution establishes a citizen monarchy within the framework of a new contract between the state and the people.

The constitution guarantees the recognition of Amazigh as an official language of Morocco, alongside Arabic. The new constitution advocates promoting all Moroccan linguistic and cultural expressions, including the Hassani, reflecting Morocco's attachment to its Saharan roots.

The constitution is based on the fundamental principle of the separation of powers. The constitutional status of the Prime Minister has been promoted to that of Head of Government, appointed from within the political party that wins the majority of seats in parliamentary elections. It is noteworthy in this respect that the constitution gives the Head of Government the right to dissolve the House of Representatives. Besides this, the constitution confirms the principle of the consultation of the Head of Government by His Majesty the King, before declaring a state of emergency or the dissolution of Parliament.

One of the most fundamental issues introduced by the new constitution is the strengthening of the Parliament's legislative and supervisory powers. The constitution also stipulates the establishment of a judiciary power independent of the executive and the legislature through the creation of the Supreme Judicial Council, a constitutional body chaired by the King. On the other hand, to confirm the supremacy of the constitution and the law, the Constitutional Council has been transformed into a Constitutional Court and its composition has been expanded.

In order to ensure good governance and effective implementation of the founding principles of the constitution, a number of bodies have been incorporated, including notably the Supreme Council of Magistracy, the National Agency on Probity, Prevention of Graft and the Fight against Corruption, the Supreme Council of Security and the Advisory Council for Youth and Associative Action.

The present House of Representatives was elected in 2011, and the next elections are due in 2016. Constitutional reforms implemented in 2011 gave more authority to the Head of Government, who is usually the leader of the largest party in the House. Mr Abdelkader Amara was appointed Minister of Energy on 10 October 2013.

Morocco has adopted sectoral reforms allowing it to address the global economic problems of recent years. The government has been assisted by strong foreign investment as well as by concessional financing from international development agencies such as the European Investment Bank, the African Development Bank and national agencies, particularly in the United States and Europe. In August 2012, the International Monetary Fund (IMF) opened a Precautionary and Liquidity Line of just over 6 billion USD (United States dollars) that has helped underpin Morocco's international financial position and its economic reform agenda.

Since 2011, Morocco has managed to follow through on its commitments to improve housing and agriculture while at the same time reducing the fiscal deficit. According to the IMF, the deficit has declined from 7.4% of gross domestic product (GDP) in 2012 to 5.4% in 2013, assisted by a strong rebound in agriculture and lower international commodity prices. Agriculture represents about 15% of GDP and employs just over 40% of the population. Tourism represents about 20% of GDP and is the second-largest foreign exchange earner after the export of phosphates.

Overall growth reached 4.5% in 2013 and could remain close to 4% in 2014, with inflation comfortably below 2.5%. Meanwhile, the current account deficit should continue to decline in 2014 to come in below 7% of GDP. Since Morocco is 91% dependent on imported energy in various forms, the energy sector will carry considerable weight.

Morocco signed a bilateral free trade agreement with the United States in 2006 and an advanced status agreement with the European Union in 2008. Morocco's co-operation with the Organisation for Economic Co-operation and Development (OECD) goes back at least ten years. Morocco has subscribed to a number of OECD international instruments, such as the Declaration on International Investment and Multinational Enterprises (2009) and the Declaration on Transparency in Business and International Finance (2012). Since 2009, Morocco has also sat on the executive board of the OECD Development Centre, and discussions are currently underway on establishing a partnership programme. In 2007, the Ministry of Energy and Mines and the IEA signed a memorandum of understanding on co-operation in the field of energy policy.

## SUPPLY AND DEMAND

### SUPPLY

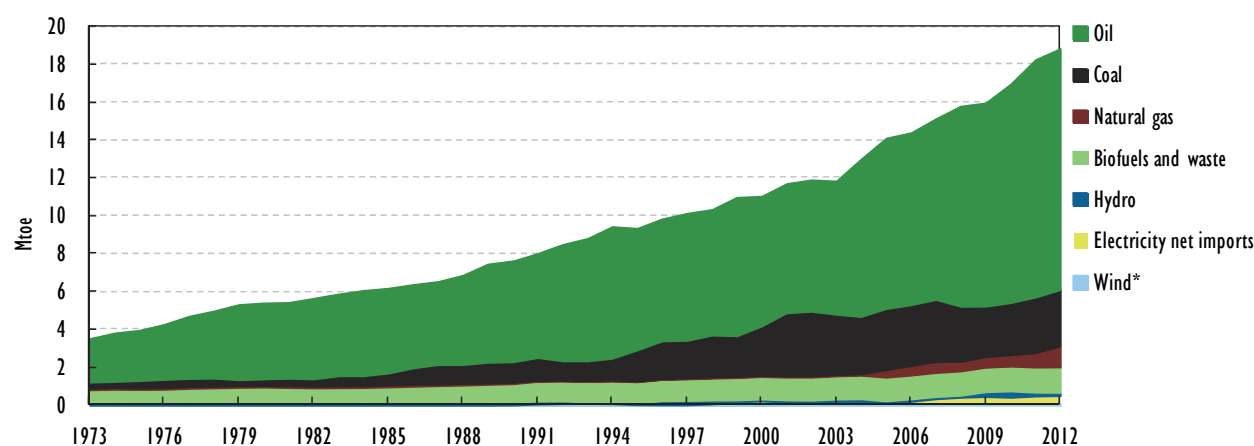
Total primary energy supply (TPES) in Morocco reached 18.8 million tonnes of oil-equivalent (Mtoe) in 2012. Energy supply has grown considerably during the past decade, increasing by a total of 6.9 Mtoe (about 58%) since 2002.

Morocco's energy mix is dominated by oil, which represents 67.6% of TPES. Coal accounts for a further 16.1%, followed by biofuels and waste (7.4%), natural gas (5.7%), electricity net imports (2.2%) and, to a small extent, hydropower (0.7%) and wind (0.3%).

Since 2002, the supply of natural gas in Morocco has surged, increasing 30 times over from negligible levels (from 30 million cubic metres [m<sup>3</sup>] to 900 million m<sup>3</sup> per year). The supply of oil and hydropower has nearly doubled, while wind power generation has tripled in output. The slowest growth came from biofuels and waste, which increased by 10.8% from 2002 to 2012. Conversely, coal supply decreased by 12.4% over the same period, significantly reducing its share of TPES from 29% in 2002.

Electricity net imports have increased by 252% between 2002 and 2012, increasing their share of TPES from 1% in 2002 to 2.2% in 2012 (Figure 2.1).

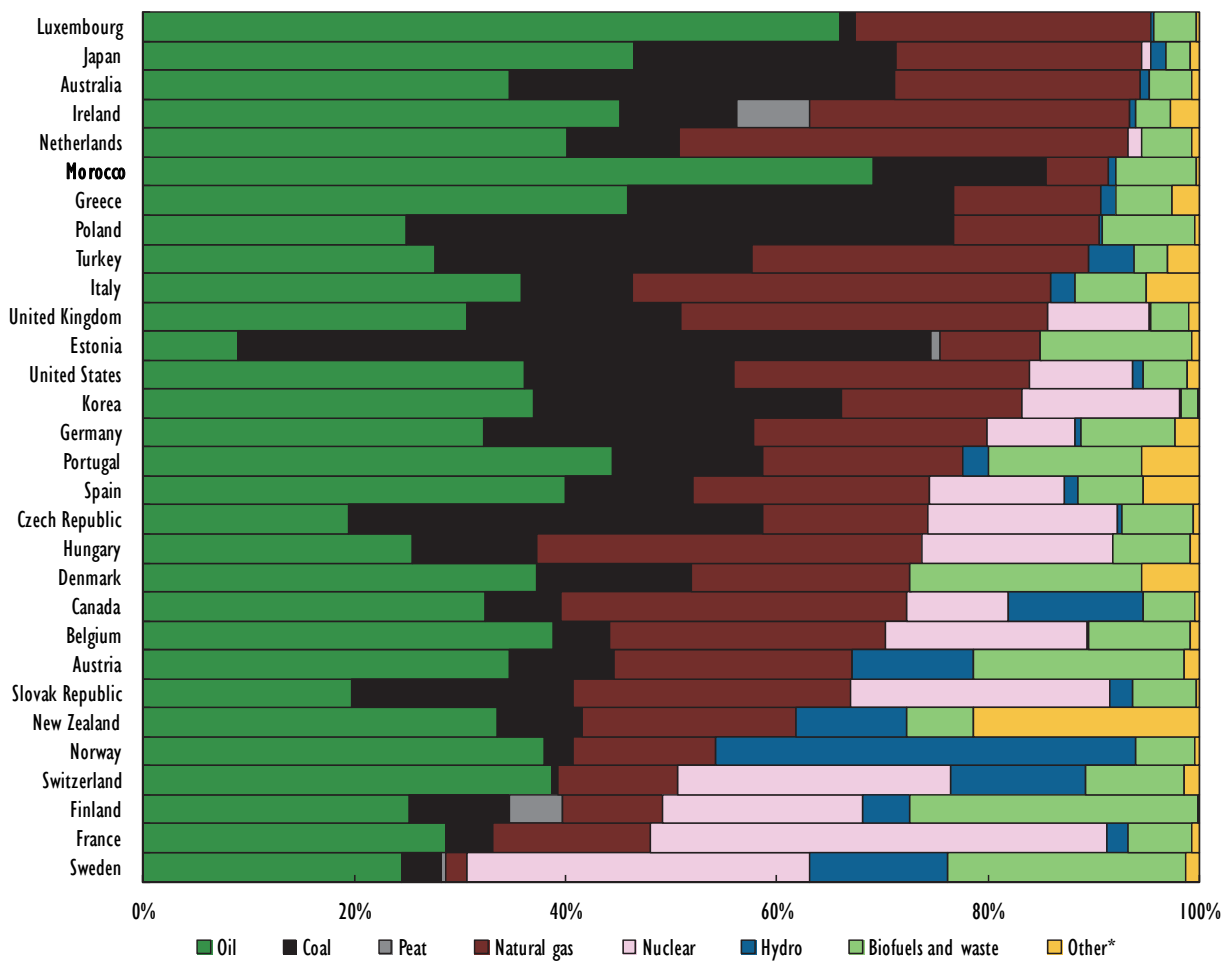
Figure 2.1 TPES, 1973-2012



\* Negligible.

Source: IEA (2013b), *Energy Statistics of Non-OECD Countries 2013*, OECD/IEA, Paris.

**Figure 2.2** Breakdown of TPES in IEA member countries, 2012

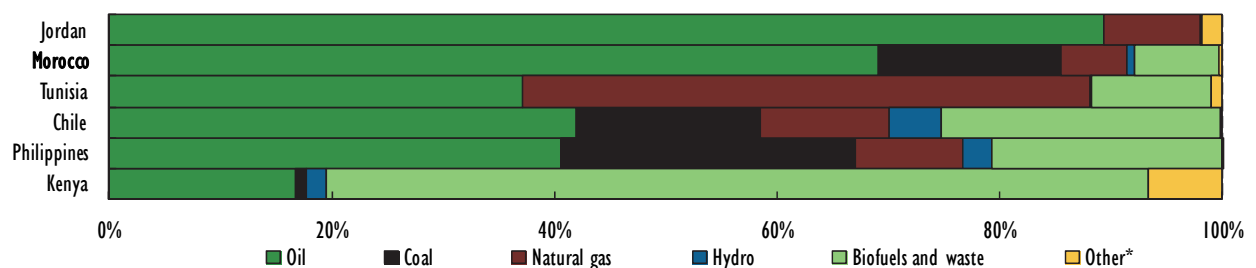


\* Other includes geothermal, solar, wind, and ambient heat production.

Sources: IEA (2013b), *Energy Statistics of Non-OECD Countries 2013*, OECD/IEA, Paris; IEA (2013a), *Energy Balances of OECD Countries 2013*, OECD/IEA, Paris.

As shown in Figure 2.2, Morocco would have the sixth-highest share of fossil fuels in TPES if compared with IEA members, lower only than Luxembourg, Japan, Australia, Ireland and the Netherlands. A comparison with some IEA non-member countries that are also significantly import-dependent shows that Morocco is still relatively oil-dependent but might benefit from diversifying its energy mix by increasing the share of gas (Figure 2.3).

**Figure 2.3** Comparison of Morocco with some other import-dependent countries, 2012



\* Other includes wind, solar, geothermal and ambient heat.

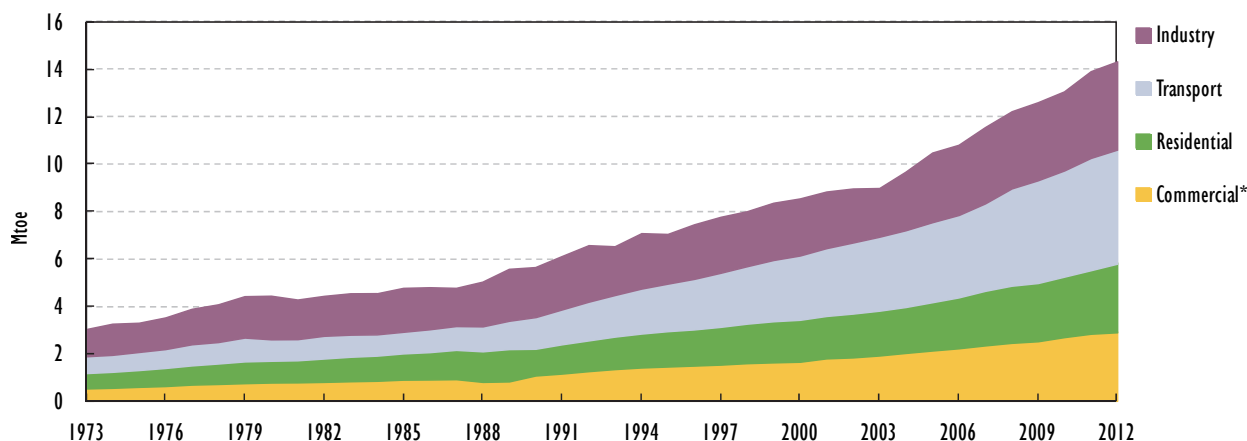
Source: IEA (2013b), *Energy Statistics of Non-OECD Countries 2013*, OECD/IEA, Paris.

## DEMAND

The transport sector and industry are the largest consumers of energy in Morocco, together accounting for nearly 60% of total final consumption (TFC). Transport accounted for 33.2% in 2012, and industry for 26 % (see Figure 2.4).

The residential and commercial sectors represent 20.4% of TFC each. The commercial sector includes mainly agriculture and other commercial and public services. Energy demand increased by 60% from 2002 to 2012, with demand in all sectors growing at a similar rate.

**Figure 2.4** TFC by sector, 1973-2012



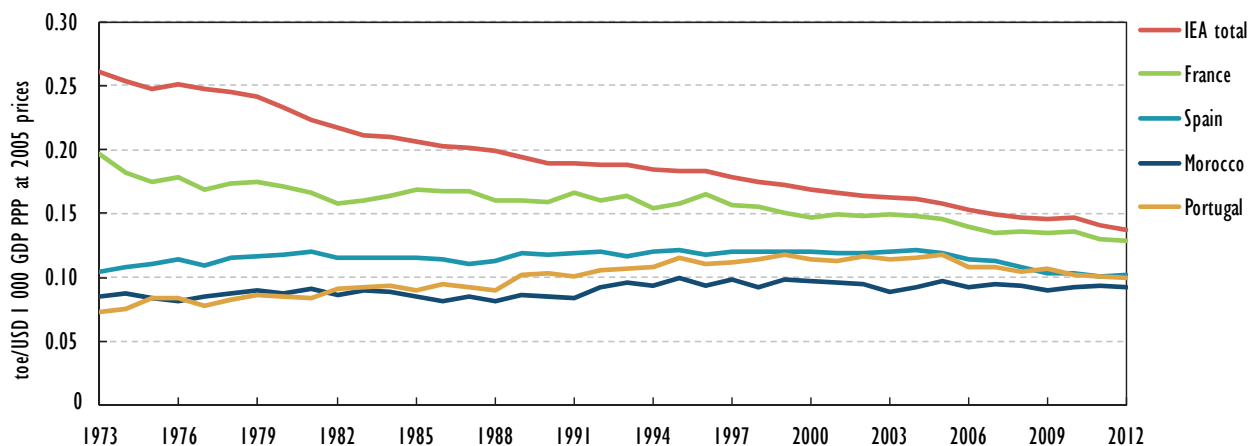
\* Commercial includes commercial and public services, agriculture/forestry and fishing.

Source: IEA (2013b), *Energy Statistics of Non-OECD Countries 2013*, OECD/IEA, Paris.

## ENERGY INTENSITY

Energy intensity in Morocco, measured as TPES compared to gross domestic product at purchasing power parity (GDP PPP), was 0.09 toe/USD 1 000 GDP PPP in 2012. This is relatively low compared to most IEA countries and is still below the IEA average (see Figure 2.5). However, energy intensity has remained at around the same level for nearly two decades. Unlike its close neighbours, Spain and Portugal – and unlike the IEA average – it has shown no signs of falling in the last five years.

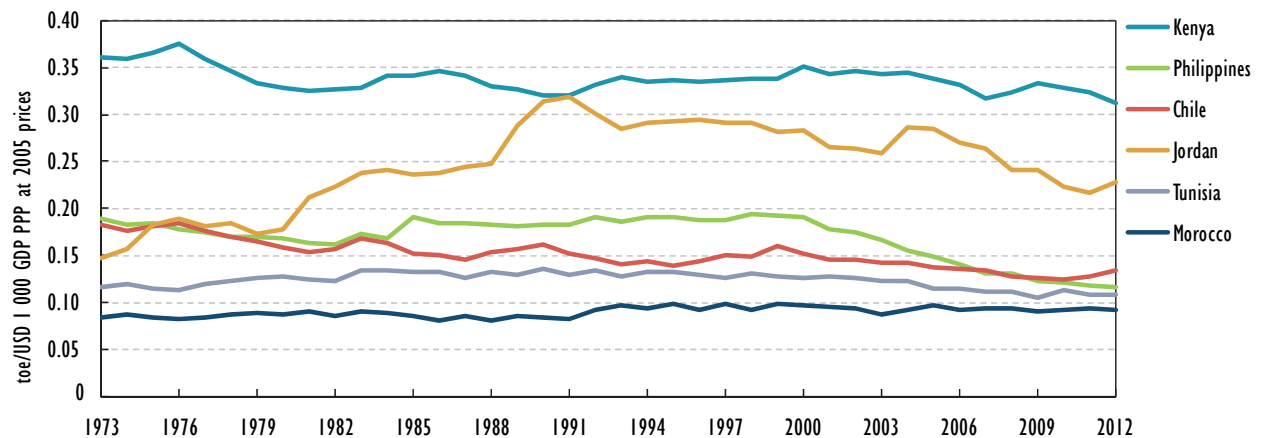
**Figure 2.5** Energy intensity in Morocco and selected IEA member countries, 1973-2012



Sources: IEA (2013b), *Energy Statistics of Non-OECD Countries 2013*, OECD/IEA, Paris; IEA (2013a), *Energy Balances of OECD Countries 2013*, OECD/IEA, Paris.

Morocco's energy intensity has remained stable and relatively low with regard to these countries, though it has not seen the improvement experienced in recent years by Jordan and the Philippines, for example (see Figure 2.6).

**Figure 2.6** Energy intensity compared with some other IEA non-member countries, 1973-2012



Source: IEA (2013b), *Energy Statistics of Non-OECD Countries 2013*, OECD/IEA, Paris.

## INSTITUTIONS

Primary responsibility for energy policy rests with the Ministry of Energy, Mines, Water and Environment<sup>1</sup> (**MEMEE**), which is entrusted with executing government policy on security of supply, diversifying energy sources, developing renewable energy and improving energy efficiency.

MEMEE is supported in this work by a number of institutions set up in the past decade to further the objectives of the government's energy policy:

**ADEREE**: the National Agency for Renewable Energies and Energy Efficiency<sup>2</sup> (ADEREE) was set up in 2010 as a successor to the Centre for the Development of Renewable Energy.

**IRESEN**: the Institute for Research into Solar and Renewable Energies<sup>3</sup> (IRESEN) was created in 2011.

These institutions are supported in the renewables sector by:

**MASEN**: established in 2010, the Moroccan Agency for Solar Energy<sup>4</sup> is a corporation charged with promoting and participating in renewable energy projects.

**SIE**: The state-funded Energy Investment Company<sup>5</sup> was set up in 2009.

A **Secretary of State** is in charge of environmental affairs and answers to the Minister of Energy.

1. [www.mem.gov.ma](http://www.mem.gov.ma).

2. [www.aderee.ma](http://www.aderee.ma).

3. [www.iresen.org/en](http://www.iresen.org/en).

4. [www.masen.org.ma/index.php?Id=undefined&lang=en#](http://www.masen.org.ma/index.php?Id=undefined&lang=en#).

5. [www.siem.ma/index.php/en](http://www.siem.ma/index.php/en).

Responsibility for the upstream hydrocarbon sector rests with:

**ONHYM:** the National Office of Hydrocarbons and Mines.<sup>6</sup>

There is one refinery in Morocco operated by:

**SAMIR:** Société Anonyme Marocaine de l'Industrie du Raffinage.<sup>7</sup>

The national electricity grid is operated by:

**ONEE:** the National Agency for Electricity and Water.<sup>8</sup>

Electricity and fuel prices are still regulated and are set by: **the Minister for General Affairs and Governance**,<sup>9</sup> in conjunction with **the Minister of the Economy**<sup>10</sup> and the Minister of Energy. Competition issues are under the responsibility of the Ministry of General Affairs and Governance.

A price indexing system for oil products was established in January 1995. However, the transmission of fluctuations in international prices onto domestic prices was suspended in September 2000 for some key products to reduce rising domestic prices. With rising prices over the last decade in the international market for oil products, the domestic retail price in Morocco has progressively moved further away from international prices.

Although prices for oil products remain administered, the Moroccan government decided to decompensate fully prices of premium gasoline and fuel destined for industry, beginning on 1 February 2014. On 1 June 2014, similar steps were taken for special fuel oil for electricity generation. Only butane and diesel now remain publicly subsidised.

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## ENERGY STRATEGY CHALLENGES AND OPPORTUNITIES

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Morocco is nearly 91% dependent on imported energy. This includes oil, oil products and coal from international markets, gas from Algeria and electricity from Spain. Despite a long history of onshore and offshore exploration, only very small quantities of gas, and no commercial sources of oil, have been developed. The last coal mines in the northeast went out of production in 2004. Until recently, the only remaining domestic energy supplies have been biofuels and waste energy, as well as hydro-electricity, which in an average year provides about 7.5% of domestic electricity supply. Other renewables have begun to be developed, namely wind power since 2001 and solar power since 2010. Nevertheless, in recent years Morocco's carbon intensity (in terms of carbon dioxide [CO<sub>2</sub>] emissions per USD GDP) has remained stubbornly higher than in neighbouring IEA countries (e.g. Spain and Portugal).

In these circumstances, Morocco has shown an impressive readiness to face up to the three principal challenges of modern energy policy: security of supply, affordability and sustainability. Over the last 15 years, the electricity fuel mix has successfully been diversified to include more coal and more gas-fired power, as well as electricity imported from Spain. In addition, great strides have been taken in improving access to electricity across the country. The rural electrification rate is now over 98%, compared with only

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6. [www.onhym.com/en](http://www.onhym.com/en).

7. [www.samir.ma](http://www.samir.ma).

8. [www.one.org.ma](http://www.one.org.ma).

9. [www.affaires-generales.gov.ma](http://www.affaires-generales.gov.ma).

10. [www.finances.gov.ma/en](http://www.finances.gov.ma/en).

18% in 1995. With relatively strong economic growth – even since the financial crisis of 2008 – electricity demand and overall energy demand have continued to rise strongly. The energy import bill still weighs heavily on the balance of payments, and fuel subsidies, although they are currently being significantly reduced, have weighed heavily on the national budget. The last three years of sustained high international oil and product prices have brought the challenge into sharp focus.

A new National Energy Strategy was developed in 2009 aiming to:

- Optimise the electricity fuel mix.
- Accelerate the development of renewables – particularly wind and solar power, in which Morocco enjoys considerable natural advantages and has considerable potential. This will help reduce import dependency and diversify the nation's industrial base.
- Establish energy efficiency as a national priority.
- Encourage exploration and the commercial exploitation of oil and gas deposits, including oil shale.
- Improve integration into the regional electricity and gas grids, thereby strengthening network resilience and reducing costs.

The government has also devoted increased resources to energy-related R&D, particularly in renewables and energy efficiency.

This in-depth review attempts to evaluate the current strategy in the different areas of the energy sector and the outcomes it has achieved so far. It will also assess the implications of a number of recent international developments in the field of energy and ways in which the Moroccan strategy might need to adapt. For example:

- Sustained high oil prices have highlighted the importance of reducing the fuel import bill and reducing the burden of fuel subsidies.
- These higher energy prices have also raised the level of international interest in upstream oil and gas exploration.
- They have increased the benefits of improving energy efficiency, but also increased the costs of failing to do so. There are new standards and guidelines in energy efficiency developed in the European Union and by the IEA from which Morocco could also benefit.
- The international market in renewable energy technologies, especially solar energy, and in particular photovoltaics, has evolved dramatically. There are also new ways of optimising the exploitation of large-scale solar power capacity.
- At the international level, attention is being focused more urgently on global warming and the risks of climate change, both in terms of mitigation and adaptation. National governments are also preparing their positions carefully for the next round of international negotiations.

At the same time, maintaining continuity in the general lines of national energy policy will be an important feature of the Energy Strategy going forward. It will allow the major national economic actors to plan for the long term, as well as provide reassurance to potential foreign investors. Continued expansion of the energy mix will contribute to both economic stability and security of supply.



## CURRENT POLICY PRIORITIES

### Energy subsidies

Despite the recent reduction in the annual budget deficit and the improvement in the balance of payments, the energy import bill remains around MAD 90 billion (Moroccan dirhams) to MAD 100 billion and financial support for oil products still represents around MAD 28 billion per year – about two-thirds of the annual budget deficit. The government made an important start at the beginning of 2014 by reducing the level of subsidy in transport fuels.

These products are sold at prices indexed on international prices (since 1 February for premium gasoline and industrial fuel and since 1 June 2014 for electrical fuel), except for diesel, which is being decompensated gradually. These subsidies have mainly benefitted the higher income strata. In the electricity sector, efforts to bring prices closer to the cost of power production will continue. Graduated tariffs are already in place, but these can be increased step by step.

Steps will also be needed to reduce gradually the subsidy on butane, largely used for domestic heating and cooking. The cost of the subsidy is currently about MAD 15 billion per year, representing about 30% of the government's budget deficit. For social reasons, the price of a 12 kilogramme bottle has been kept at MAD 45 since 1990. The government currently covers about two-thirds of the cost per bottle of butane. A gradual process of price rises might need to be accompanied by a public information campaign, as well as by a programme to provide financial compensation to the lowest income strata.

### Demand-side management

The government has elevated energy efficiency into a national priority. Graduated electricity tariffs can act both to restrain demand and reduce the cost of subsidies. The campaign to promote the use of compact fluorescent lamps (CFLs) has made considerable progress. Similarly, regulations on heating and cooling standards in buildings should come into force soon; and much more can be done with appliance labelling to improve levels of efficiency.

At the power generation stage there are also significant efficiency gains yet to be made. The next phase of coal-fired power units at Jorf Lasfar, the introduction of more combined cycle gas turbines and the development of hybrid solar/gas generation could lead to considerable gains in the medium term.

In transport, there is scope to improve the efficiency of the vehicle fleet by tightening standards on imported vehicles (especially in the second-hand market) and by expanding the public transport network.

In industry, energy audits have been made compulsory for energy-intensive industries and can be financed by development banks. Their evaluation and follow-up could lead to significant innovation and improvements in efficiency. Meanwhile, industry can already benefit from special tariffs if they avoid using electricity at peak hours.

### Diversifying energy sources

The level of dependency on imported oil products can be reduced by restoring a higher level of coal-fired power generation. An additional 700 MW at Jorf Lasfar this year and 1 300 MW at Safi by 2017 should increase coal-fired power capacity by 150%. The

supercritical combustion technology to be introduced at Safi will provide increased efficiency, while relatively low and stable international coal prices should moderate the fuel import bill in the medium term.

Maximum use of the 1.4 GW interconnector with Spain – which now supplies 15% of annual electricity demand – has also allowed Morocco to diversify power supplies and reduce costs. In addition, the first gas purchase contract with Algeria in 2011 has allowed gas-fired power generation to rise to 20% of annual electricity demand. The next development is expected to be the introduction of liquid natural gas imports on the Atlantic coast which will diversify gas supplies and allow the creation of a nationwide gas grid.

A major plank in the diversification strategy will be the progressive rollout of renewable energy technologies. Morocco is blessed with highly favourable climatic conditions for both wind and solar power and an existing hydropower infrastructure that can be further developed, including by pumped storage some of which could use solar photovoltaic units.

The target is to achieve 2 GW each of wind, solar and hydropower by 2020, which would then represent 42% of installed capacity. Hydro capacity is currently at 1 400 MW and should benefit from the addition of major pumped storage projects, as well as a programme of mini-hydro plants (3 MW capacity on average) that is being promoted as part of Morocco's strategy to combat climate change.

Wind power capacity lies currently at around 300 MW, with the next major wind farm of a further 300 MW capacity, at Tarfaya, coming on stream in the course of 2014. Solar power is presently modest; the first project is a 20 MW combined gas/solar plant at Ain Beni Mathar. However, the first concentrating solar power project at Ouarzazate (Phase I, 160 MW) is underway and should be operational by the end of 2015.

Wind and solar power currently require soft financing. However, they deliver significant strategic benefits:

- low running costs
- reduced fuel import bill
- diversified power supplies, enhancing energy security
- reduced CO<sub>2</sub> emissions
- foreign investment in the power sector
- technology transfer and the development of an indigenous energy industry
- employment gains
- regional development opportunities.

Very soon – if not already – photovoltaic screens will be competitive against most alternative electricity options in Morocco and could be encouraged in a variety of applications: low-level industrial heating, pumped storage, local distributed energy systems and private co-generation opportunities.

### **Developing indigenous resources**

As well as rolling out renewable energy technologies, Morocco is working to develop both on- and offshore hydrocarbon resources. Current exploration and production terms for international oil companies are attractive by regional standards. The National Agency

for Hydrocarbons and Mines (ONHYM) expects to see a significant rise in offshore drilling this year, with two offshore blocks seeing farm-ins by international majors. In addition, onshore oil shale deposits and the residual coal seams at Oujda could be developed with new technology (which might include the production of coalbed methane).

### Research and development (R&D)

Current spending on R&D is modest at 0.8% of GDP. However, the government is giving priority to research on renewable energy technologies in order to underpin Morocco's own renewable energy programme and also to allow it to play a prominent role in this field at a regional level.

R&D activity is co-ordinated by IRESEN, established in 2011, which also co-operates with international partners, including institutions in France, Germany and Spain.

The first phase of projects launched in 2012 focused on solar heating and related solar technologies. The programme has an overall budget envelope of 250 million MAD and has been extended with the 2013 and 2014 projects to include solar photovoltaic, wind and biomass research.

MASEN is also developing a research capability and recently launched a "Solar Cluster" at Casablanca in partnership with Moroccan industry. It will be important to sustain the research effort in this way in order to optimise the performance of Morocco's renewable energy projects and maximise the benefits in terms of technology transfer and industrial development.

### Climate change

Morocco ratified the 1992 United Nations Framework Convention (UNFCCC) in 1995 and the Kyoto Protocol in 2002. Since then, it has worked closely with the UNFCCC on its first and second National Communications. A current priority is the finalisation of the third National Communication, due at the end of 2014.

The policy framework is set out in the National Plan for Combating Climate Change, launched in 2009. As far as the energy sector is concerned, the plan focuses on accelerating the renewable energy programme, promoting energy efficiency (including through reduced energy subsidies), improving clean coal combustion and increasing the share of natural gas in the energy mix.

At the same time, projects supported by the Clean Development Mechanism have rapidly expanded in recent years, as have international projects on technological development and capacity building – supported by the United Nations Development Programme, the United Nations Environment Programme and the German Development Agency – covering both mitigation and adaptation strategies.

## RECOMMENDATIONS

*The government of Morocco should:*

- *Continue to update its 2009 National Energy Strategy, while maintaining its emphasis on diversifying energy sources, especially through gas and renewables.*
- *Accelerate the implementation of energy efficiency measures, including regulation, standards and assessments.*

- *Promote further investment in renewable technologies through research and deployment in industry, power generation and private use.*
- *Complete the progressive reduction in energy subsidies.*
- *Encourage a more effective domestic market in both electricity and gas through the establishment of an electricity and gas regulator.*
- *Retain attractive investment terms for the exploration and production of oil and gas resources.*

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### References

IEA (2013a), *Energy Balances of OECD Countries 2013*, OECD/IEA, Paris.

IEA (2013b), *Energy Statistics of Non-OECD Countries 2013*, OECD/IEA, Paris.

### 3. CLIMATE CHANGE

#### Key data (2012)

**CO<sub>2</sub> emissions from fuel combustion:** 51.8 Mt, +56.4% since 2002

**Emissions by fuel:** oil 72.6%, coal 22.7%, natural gas 4.8%

**Emissions by sector:** electricity generation 36.7%, transport 27.9%, industry 14.7%, commercial 10.6%, residential 7.6%, other transformations and own use 2.4%

**Carbon intensity:** 0.25 tCO<sub>2</sub>/USD 1 000 PPP (IEA average: 0.31 tCO<sub>2</sub>/USD 1 000 PPP), -2.5% since 2002

#### OVERVIEW

Morocco, like all countries around the world, is suffering the effects of climate change, compounded by the special characteristics of its geographic location and ecosystems.

As a country located in North Africa, Morocco has seen a clear progression of the semi-arid climate towards the north – a trend which, according to climate predictions, will worsen throughout the 21st century.

Morocco has suffered increasingly regular droughts, colliding with growing demand for water resources every year. Over the past 30 years, despite a sporadic succession of dry and wet years, the net total rainfall has decreased by a range of 3% to 30%.

As the National Plan to Control Climate Change explains: “The real challenge lies in the ability to reach the right compromise between the requirements of development and the need to reduce gas emissions and ensure rational use of natural resources; hence the need to promote a green growth dynamic and adopt the appropriate measurement tools.”

Indeed, climate change today poses a real challenge to the country’s economy as a whole. Infrastructure investments in urban, coastal and tourist zones, as well as in certain strategic sectors already subject to natural hazards, are increasingly threatened by the higher frequency of extreme weather phenomena. Agriculture – a promising sector of the national economy – will be the most affected by climate change. According to estimates by the Ministry of Agriculture, climate change could cause rain-fed agriculture to decrease by about 10% and the probability of crop failure to increase by 10% or more.

According to the 2007 report of the Intergovernmental Panel on Climate Change, greenhouse gas (GHG) emissions are 90% responsible for climate change. It follows that climate change mitigation measures consist in reducing GHG emissions. Given that GHG emissions are largely linked to fossil fuel consumption, climate change mitigation measures will mainly involve improving energy efficiency and producing renewable energies.

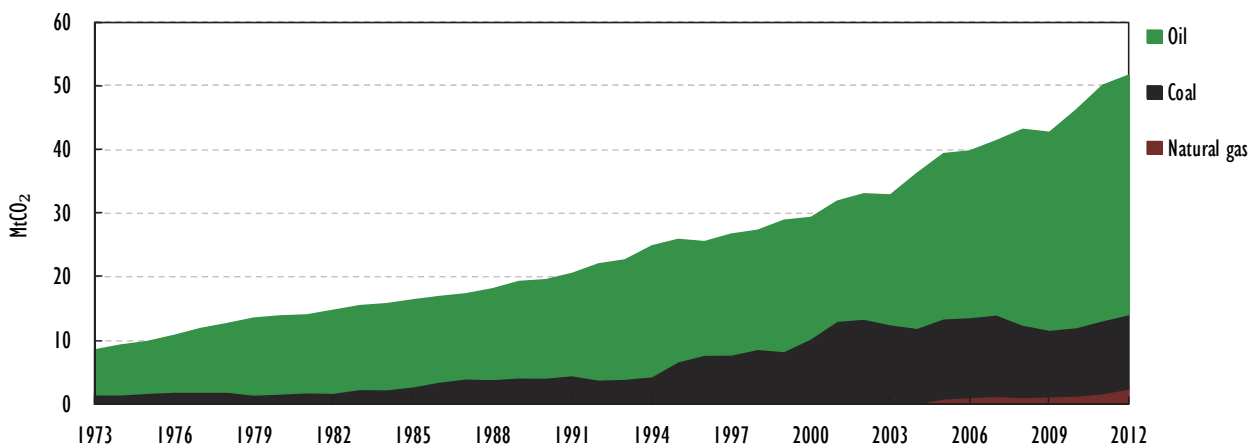
## ENERGY-RELATED CARBON DIOXIDE (CO<sub>2</sub>) EMISSIONS

### SOURCES OF CO<sub>2</sub> EMISSIONS

CO<sub>2</sub> emissions from combustion fuels amounted to 51.8 million tonnes (MtCO<sub>2</sub>) in 2012 and have grown without interruption in the past three decades. GHG emissions have increased by 70.5% since 2000, in parallel with a similar increase in energy consumption.

Oil consumption remains the main source of CO<sub>2</sub> emissions in Morocco – 72.6% of total emissions – followed by coal (22.6%) and natural gas (4.8%). However, the strongest increase in emissions came from natural gas, as a consequence of significant consumption growth (30 times over) compared with 2002. Over the same period, emissions from oil doubled, while emissions from coal decreased by 12.4% (Figure 3.1).

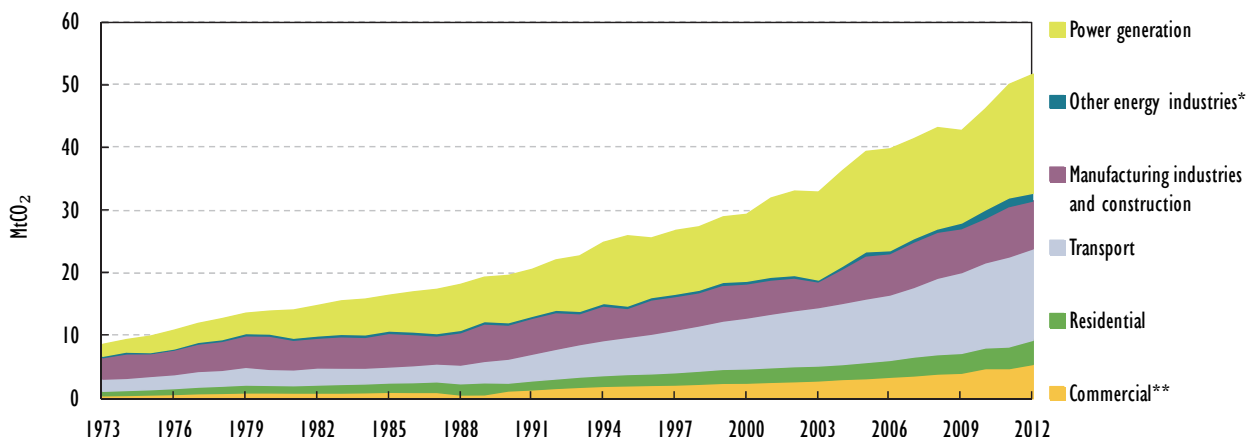
**Figure 3.1** CO<sub>2</sub> emissions by fuel, 1973-2012



Source: IEA (2013a), *CO<sub>2</sub> Emissions from Fuel Combustion*, OECD/IEA, Paris.

The sectors that emit the most CO<sub>2</sub> in Morocco are electricity generation (36.7% of total emissions in 2012) and transport (27.9%). Both sectors have seen similar growth in emissions, at a rate similar to that of the whole energy sector (Figure 3.2).

**Figure 3.2** CO<sub>2</sub> emissions by sector, 1973-2012



\* Other energy industries include refining and energy own-use.

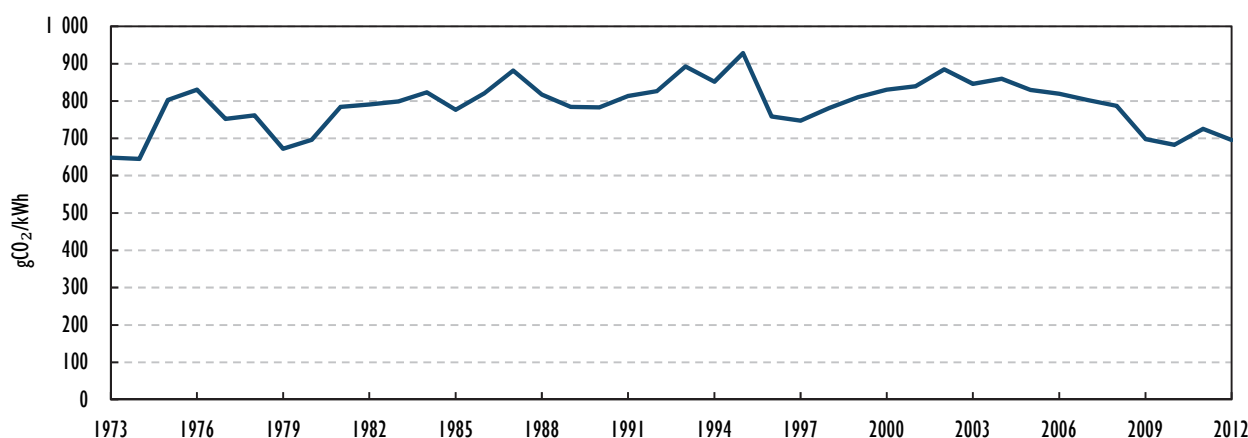
\*\* Commercial includes commercial and public services, agriculture/fishing and forestry.

Source: IEA (2013a), *CO<sub>2</sub> Emissions from Fuel Combustion*, OECD/IEA, Paris.

Even though electricity remains the main source of CO<sub>2</sub> emissions, many efforts to develop renewable energies and use cleaner fuels in thermal power plants have been made in Morocco so as to reduce the unit emissions rate of electricity production. The graph shows how, beginning in 2009, the sector registered a significant (11.6%) decrease in emissions, from 786.7 gCO<sub>2</sub>/kWh in 2008 to 695.5 gCO<sub>2</sub>/kWh in 2012. Except for 2011, which posted a slight decrease in hydro generation, this trend continued through 2012 (Figure 3.3). That said, Morocco has a relatively high unit rate of CO<sub>2</sub> emissions compared to other countries in the region.

The sectors with the highest emissions from fuels are industry (14.7%), the commercial sector (10.6%) and the residential sector (7.6%). Industrial CO<sub>2</sub> emissions have grown by 47.5% since 2002 – which is slow compared to total energy emissions. Owing to the growth in commercial activity, emissions from the tertiary sector almost doubled over the same period; the residential sector, on the other hand, only increased proportionally to total emissions. The transformation sector, including refining, accounts for 2.4% of total emissions today – a share that is twice as high as in 2002; emissions grew three times over during that period.

**Figure 3.3** CO<sub>2</sub> emissions per electricity generation, 1973-2012



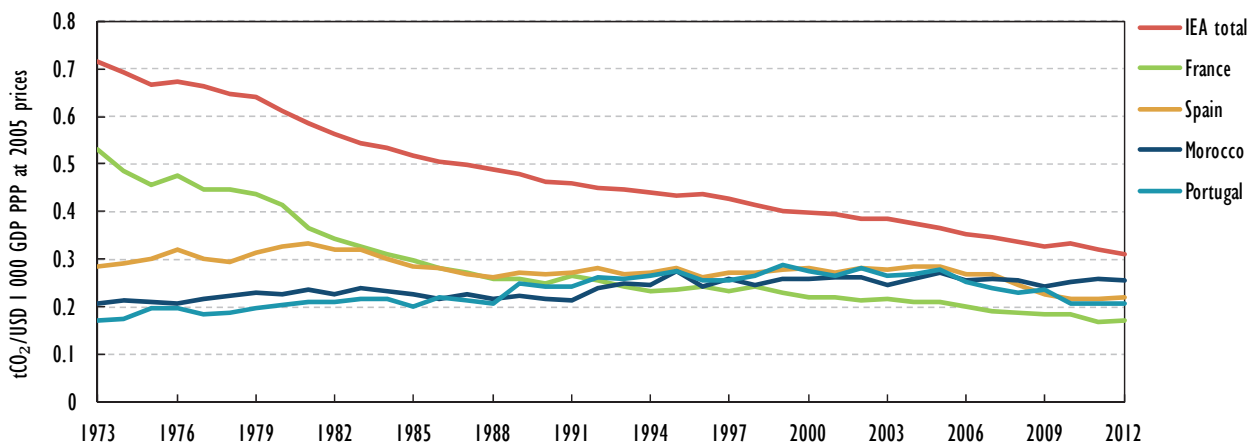
Note: gCO<sub>2</sub>/kWh = gramme of CO<sub>2</sub> per kilowatt hour.

Source: IEA (2013a), *CO<sub>2</sub> Emissions from Fuel Combustion*, OECD/IEA, Paris.

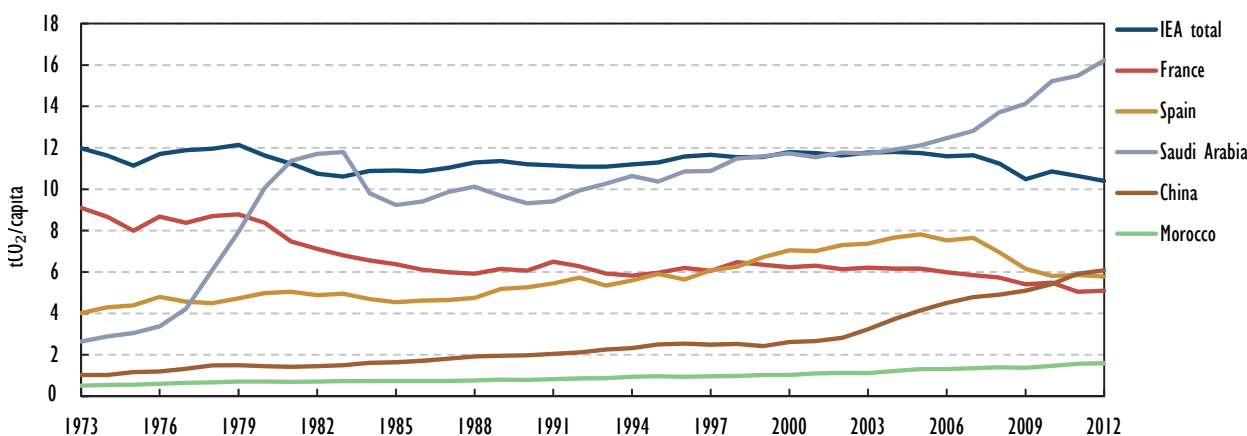
## CARBON INTENSITY

Morocco emitted 0.25 tonnes of carbon per USD 1 000 of gross domestic product at purchasing power parity (per USD 1 000 GDP PPP) (tCO<sub>2</sub>/USD 1 000 PPP) in 2012. This is still lower than the IEA member country average of 0.31 tCO<sub>2</sub>/USD 1 000 PPP and placed Morocco in twelfth-lowest position in carbon intensity, or close to median level. The carbon intensity in Morocco declined by 2.5% in the ten years after 2002, whereas the average in IEA countries dropped by 19.1% (see Figure 3.4).

At the same time, a comparison based on CO<sub>2</sub> emissions per capita shows that Morocco still registers far fewer emissions per capita than the average IEA member country (see Figure 3.5). Some IEA members like France and Spain have achieved steady reductions per capita in recent years, while Morocco's have gradually increased. But compared with other developing countries such as Saudi Arabia or China the level is still very low and the growth rate quite modest.

**Figure 3.4** Carbon intensity in Morocco and in the IEA, 1973-2012

Sources: IEA (2013a), *CO<sub>2</sub> Emissions from Fuel Combustion*, OECD/IEA, Paris; OECD (2013b), *National Accounts of OECD Countries*, OECD, Paris.

**Figure 3.5** Morocco's CO<sub>2</sub> emissions per capita compared with the IEA and some other countries, 1973-2012

Sources: IEA (2013a), *CO<sub>2</sub> Emissions from Fuel Combustion*, OECD/IEA, Paris; OECD (2013b), *National Accounts of OECD Countries*, OECD, Paris.

## MEDIUM-TERM FORECAST

The wind, hydro and solar development programmes culminating in 2020 will help raise the share of renewable energies in the installed electric capacity. They aim to install 2 GW of wind and 2 GW of solar energy by 2020 – 42% of the installed power capacity. The two additional plants at Jorf Lasfar (2 x 350 MW) and the new plant at Safi (2 x 660 MW), which should start producing between 2013 and 2015, will also use coal more efficiently. Furthermore, the deployment of programmes to increase energy efficiency in the various economic sectors – construction, industry and transport – will help reduce GHG emissions significantly by 2020.

## ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

To strengthen the national framework for environmental protection and sustainable development, Morocco launched a national charter, which was approved and enacted as a framework law in 2014. The objectives of Framework Law 99-12 on the National Charter for the Environment and Sustainable Development include introducing sustainable development into sectoral public policies and harmonising the national legal framework with international standards and conventions. Law 99-12 outlines the institutional, economic, financial and



cultural reforms required for environmental governance and defines the commitments of the state, local authorities, public establishments and state companies, private enterprises, associations and citizens with regard to environmental protection and sustainable development. It also promotes the active participation of companies, civil society organisations and the population in designing and implementing environmental protection and sustainable development policies. It focuses on three main areas:

- environmental upgrading, which consists in implementing agreements between the government and the regions by 2015
- designing a national strategy for the environment by 2020, which will include environmental preservation and protection measures and environmental monitoring
- implementing the National Strategy for Sustainable Development by 2020.

## INSTITUTIONS

Morocco signed the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 and ratified it in 1995. The country also hosted the Seventh session of the Conference of the Parties (COP 7) in Marrakech in 2001, which enacted the Kyoto Protocol; it ratified the Protocol in 2002.

The Directorate of Planning and Perspective in the Department of the Environment is the focal point for contact with the UNFCCC. Following ratification of the UNFCCC, Morocco established a National Committee on Climate Change in 1996. The National Scientific and Technical Committee on Climate Change was established in 2001.

The country also relies on three other key structures at the environmental level:

- the Climate Change Unit, created in 2001
- the Clean Development Mechanism Designated National Authority, created in 2002
- the Information Centre on Sustainable Energy and Environment.

The United Nations considers Morocco as a leader among developing countries in terms of National Communications to the UNFCCC. Morocco submitted its first National Communication in 2001 and its second National Communication in 2010. The third National Communication is in preparation and is expected in late 2014.

In the context of the negotiations under the Convention and Protocol, Morocco belongs to the “Africa” group as an African country and to the “G77 and China” group as a developing country. It contributes to the positioning of these groups. While it is a low emitter of GHG, it is strongly affected by climate change.

**The National Plan to Control Climate Change** set the first targets of a strategy to reduce GHG emissions in the energy and industrial sectors. It was designed during preparations for the 15th Conference of the Parties (COP 15), held in Copenhagen in December 2009.

## THE ENERGY SECTOR

### POLITICAL FRAMEWORK

In 2009, Morocco launched a National Energy Strategy aiming to support the energy sector as a whole by transitioning towards a low-carbon society and reducing the country’s energy dependence. The main goals of the National Energy Strategy are to ensure the security of supply and availability of energy, as well as generalised access to energy at

reasonable prices, demand restraint and environmental protection. To achieve these goals, the strategic priorities adopted and implemented in short, medium and long-term action plans defined the required guidelines to satisfy growing energy demand:

- **Build an optimised electricity mix** around reliable and competitive technologies. Clean coal – the most easily available technological option offering the most stable prices and producing the least expensive kWh – is the main production base. Options for natural gas, nuclear energy and direct combustion of oil shale remain open and their implementation conditional on their long-term accessibility and availability, as well as their technical feasibility and competitiveness.
- **Develop and exploit renewable energies**, whose considerable potential will allow Morocco to cover a substantial share of its energy needs, as well as lessen its energy dependence and reduce GHG emissions.
- **Set energy efficiency as a national priority**, as it is the fastest and least expensive means to make better use of energy, achieve energy savings and lower the energy bill.

## INSTITUTIONAL FRAMEWORK

The institutional framework of the energy sector has been reinforced by the creation of:

**ADEREE:** The National Agency for Renewable Energies and Energy Efficiency (ADEREE) replaced the Centre for the Development of Renewable Energies in March 2010 (Law 16-09). Its mission is to develop and promote renewable energies and energy efficiency.

**MASEN:** The Moroccan Agency for Solar Energy (MASEN) is a limited liability company with a supervisory board. Its mission is to carry out a programme for developing integrated solar power generation projects with a minimum 2 000 MW in total capacity.

**SIE:** The Energy Investment Company (SIE) is a national interest company created to finance green growth.

**IRESSEN:** The Institute for Research into Solar and Renewable Energies (IRESSEN) was created in 2011 to consolidate the needs of the various industry stakeholders and ensure that the different research projects on energy efficiency and renewables are developed and implemented to best effect.

**Energy Development Fund:** His Majesty King Mohammed VI decided to create the Energy Development Fund, endowed with USD 1 billion (United States dollars) stemming from contributions by the Kingdom of Saudi Arabia and the United Arab Emirates, as well as the Hassan II Fund for Economic and Social Development.

## INITIAL SHORT-TERM ENERGY EFFICIENCY MEASURES

In recent years the Government of Morocco has adopted a number of measures to reduce power consumption particularly at periods of peak demand.

The programme to generalise the use of CFLs aimed to replace 22.7 million incandescent light bulbs with CFLs by 2012. This programme is still being implemented by the electricity suppliers: the National Agency for Electricity and Water (ONEE), the utilities and the delegated management authorities. At the end of December 2012, 7 million CFLs had been fitted.

According to ADEREE, about 48 000 square metres (m<sup>2</sup>) worth of solar water heaters were installed in 2010, raising the total installed to almost 300 000 m<sup>2</sup>. Accompanying measures are being developed to generalise the use of solar water heaters and install 1.7 million m<sup>2</sup> by 2020.

**Table 3.1** Short-term energy efficiency measures and their impacts

	Compact fluorescent lamps (CFLs)	“-20-20” rate	Super-peak rate	GMT + 1
<b>Measures</b>	A total of 7 million low-energy light bulbs installed by the end of 2012; 10 million are now being distributed.	Establishment of a special “-20-20” type of incentive rate (20% discount in the event of a 20% reduction in consumption).	Optional rate for very high-voltage (VHV) and high-voltage industries as an incentive for customers to lower their consumption during peak demand hours.	Passage to GMT +1; adopted on trial basis since 1 June 2008.
<b>Impacts</b>	Savings: 172 MW (peak shaving); accumulated energy savings of 591 gigawatt hours (GWh).	Bonuses paid: MAD 260 million (Moroccan dirhams). Savings: 1 474 GWh.	Savings: 76 MW decrease in demand during peak hours.	Savings: 80 MW decrease in demand during peak hours.

## NATIONAL ENERGY EFFICIENCY PROGRAMME

The government also launched an energy efficiency programme covering four areas:

- energy efficiency in the residential and commercial sectors
- energy efficiency in the industrial sector
- energy efficiency in the transport sector
- energy efficiency in public administration.

Several energy savings measures are being executed in, or are planned for, administrative buildings, collective and individual housing, public companies and the economic and social sectors.

The programme has a specific governance structure, with a national orientation committee chaired by the Prime Minister and a steering committee for supervising the execution of the plan, headed by the Ministry of Energy, Mines, Water and the Environment (MEMEE).

### In the field of electricity

A pragmatic and economically sustainable programme has been established for the medium and long term. It rests on both basic and alternative options advocating the use of clean coal as the main source of basic production, and royalty gas for peak and semi-basic production, while exploring the possibilities of extending the Maghreb-Europe Gas Pipeline (GME) and introducing liquefied natural gas. In this respect, coal will be used in the two additional plants at Jorf Lasfar (2 x 350 MW) and the new plant at Safi (2 x 660 MW), which will begin production between 2013 and 2015. The Ain Beni Mathar thermal solar plant (470 MW capacity), commissioned on 12 May 2010, is fired by royalty gas from the GME for its combined cycle component; it will rely on concentrated solar power technology for 20 MW worth of its capacity.

## RENEWABLE ENERGIES

### Moroccan Integrated Solar Energy Generation project

Installed capacity: 2 000 MW (38% of current installed capacity).

Yearly production capacity: ≈ 4500 GWh (18% of current yearly production).

Estimated cost: USD 9 billion.

Five sites selected, totalling 10 000 hectares: Ouarzazate, Ain Beni Mathar, Foug Al Oued, Boujdour and Sebket Tah.

Dates of commissioning: first power plant in 2015, completed project at the end of 2019.

Annual savings: 1 million tonnes of oil-equivalent (Mtoe).

Emissions savings: 3.7 million tonnes of carbon dioxide per year (tCO<sub>2</sub>/yr).

### **Moroccan Integrated Wind Energy project**

Development of wind farms with an installed capacity of 2 000 MW (38% of current installed capacity).

Annual energy production: 6 600 GWh (26 % of current national production).

Estimated cost: USD 3.5 billion.

Impacts: annual savings of 1.5 Mtoe; emissions savings of 5.6 million tCO<sub>2</sub>/yr.

The first wind farm is being commissioned in 2014 and the complete programme will be operational in 2020.

## **INTERNATIONAL COMMITMENT**

The national governance framework on climate change is being reviewed through several initiatives led by MEMEE and supported by international partners, set out in Table 3.3.

**Table 3.2** Initiatives in climate change framework review

United Nations Development Programme (UNDP)	"Low Emission Capacity Building" (LECB) and Third National Communication projects; development of the energy efficiency construction code; other mitigation projects (transport, etc.).
German aid agencies (Deutsche Gesellschaft für Internationale Zusammenarbeit [GIZ] and Kreditanstalt für Wiederaufbau Bankengruppe [KfW])	Financial support (wind programme, solar programme, etc.); technical assistance (climate financing, Competence Centre for Climate Change, National Committee on Climate Change, etc.); Environmental Management and Protection Programme under the aegis of the Federal Ministry for Co-operation and Economic Development (Germany).
The World Bank	Partnership for Market Readiness (PMR); financing of the solar programme.
United Nations Environment Programme (UNEP)	"Facilitating Implementation and Readiness for Mitigation" (FIRM) project (energy).
African Development Bank	Financing of renewable energy and energy efficiency projects.
French Agency for Development	Financing of the tramway and high-speed line; financing of the solar programme.

Source: government of Morocco.

### **UNDP – Low Emission Capacity Building (LECB) project**

The LECB project rests on an integrated approach of planning for development and climate change while reducing CO<sub>2</sub> emissions against a benchmark level, thanks to the participation of all the relevant sectors and stakeholders.

The project aims to provide the stakeholders who have a stake in GHG emission mitigation in Morocco with the technical support and capacity development required to:

- i) develop and implement policies and strategies derived from a low emissions development strategy
- ii) identify and support the implementation of the nationally appropriate mitigation actions (NAMAs) supported by the country's development strategies

iii) implement monitoring, reporting and verification (MRV) systems for the policies, plans and mitigation programmes, particularly for the NAMAs

iv) share knowledge and communication on actions and policies for GHG mitigation.

This comprehensive strategy aims to co-ordinate Morocco's development of the NAMAs in the listed sectors while strengthening the MRV. The Ministry of the Environment estimated a potential 50.9 million (tCO<sub>2</sub>/yr) savings from the energy-related NAMAs:<sup>1</sup>

- Three NAMAs on renewable energies and waste management already developed thanks to the support of the World Bank; three others developed and presented by ADEREE.
- NAMA for the overall implementation of the Moroccan thermal regulation in the construction sector.
- NAMA for nationwide solar photovoltaic (PV) irrigation pumping.
- NAMA for a solar PV kit national distribution programme connected to the low-voltage/medium-voltage grid.

### **UNEP – Technology Needs Assessment (TNA) project**

The TNA project aims to help developing countries identify and analyse their main technological needs, as a basis for developing a portfolio of environmentally friendly technological projects and programmes. The goal is to facilitate the transfer of green technologies and knowledge, with a view to implementing Article 4.5 of the UNFCCC.

The TNAs are essential to helping the Parties to the Convention ensure technology transfer and evaluate constantly evolving needs for new equipment, techniques, and the practical knowledge and competences crucial to mitigating GHG emissions and/or lessening the adverse effects of climate change on economic sectors and livelihoods.

Under the aegis of MEMEE, the TNA – Morocco project essentially aimed to:

- Identify and prioritise technologies that can contribute to the countries' climate change mitigation and adaptation goals, by relying on participative projects led by the countries seeking to achieve their national sustainable development goals and priorities.
- Identify major obstacles to the acquisition, deployment and diffusion of priority technologies.
- Develop Technological Action Plans (TAPs) describing the appropriate activities and framework conditions for overcoming obstacles and facilitating the transfer, adoption and diffusion of the selected technologies in participating countries.

At the conclusion of the TNA project, a number of mitigation and adaptation projects were selected.

### **Selected climate mitigation projects**

After consultation with the stakeholders, the project developers and officials from MEMEE on the chances of completing and implementing the pre-selected technologies, the four TAP mitigation technologies that were rated as the highest priority and considered achievable in the short or medium term are as set out in Table 3.4.

1. Wind energy, solar energy, solar heating, low energy light bulbs, green cities, energy efficiency in buildings, industry, public lighting.

**Table 3.3** Four TAP mitigation technologies

Energy efficiency	Use of energy efficiency technologies in the context of the social housing programme (insulation, efficient lighting and use of solar energy)
Renewable energy	Production and use of melted salts as a heat transfer fluid in solar thermal power plants
	Use of concentrated photovoltaic at solar power plants
	Use of hydropower technology for electricity generation

Source: government of Morocco.

### Selected adaptation projects

The TAP for climate adaptation selected 12 technologies – seven for water treatment and five for agriculture.

The final ranking of the climate adaptation technologies selected at the conclusion of the prioritisation process is as follows:

- **Water resources (technologies recommended by the State Secretary for Water and the Environment)**
  - storm water collection
  - flood warning system
  - inflatable dam
  - artificial recharge of groundwater.
- **Drinking water (technologies recommended by the National Drinking Water Agency)**
  - desalination of sea water and demineralisation of brackish water in order to produce drinking water
  - combination of desalination and renewable energy
  - elimination of toxic cyanobacteria at the level of the drinking water treatment units.
- **Agriculture**
  - localised irrigation techniques
  - fitting of new irrigated perimeters
  - development of an information system for irrigation agriculture and diffusion of good practice for farming on dry land
  - climate adaptation technologies for small-scale farmers in support of the Green Morocco Plan
  - direct seeding technique.

### UNEP – FIRM (energy) project

The FIRM project is implemented by UNEP and financed by Denmark and the UNEP Risø Centre on Energy, Climate and Sustainable Development on behalf of eight countries, including Morocco. The main goal of the project is to contribute to international efforts to reduce GHG emissions.

The project provides technical assistance and help in building the capacities of national institutions (and other stakeholders) to implement climate mitigation initiatives in the context of both the NAMAs and a Low-Carbon Development Strategy.

The main objectives at the national level are as follows:

- Contribute to developing the conceptual and practical bases of the concept of low-carbon density in the national energy context.
- Contribute to developing the conceptual and practical bases of the concept of NAMAs in the national energy context.
- Contribute to developing the analytical and methodological approaches to implementing the NAMAs and developing a framework for the MRV in the national energy context.

### **GIZ – Environmental Management and Protection Programme (PGPE)**

This initiative is being carried out in the context of co-operation with GIZ on strengthening the governance framework by establishing a new Institutional Framework for Climate Change. The programme has five main strands: advice on climate and environmental policy, environmental training, management of industrial and toxic waste, industrial environmental management and community environmental management.

GIZ has been working with the department of Environment and with MEMEE since 2007 focusing on capacity building and quality management. Among their aims have been improved transparency and better flow of information. The current programme aims to set up a centre for climate competence, strengthening capacity in areas such as international financial management for climate related projects.

### **The World Bank – Partnership for Market Readiness (PMR)**

The Moroccan energy sector will soon be affected by a new market mechanism under the aegis of the World Bank that will be implemented beginning in 2015. The PMR programme was created to help developing countries implement market mechanisms by providing them with financial and technical aid and sharing information between developed and developing countries. The programme, co-ordinated by the Department of the Environment, initially focused on selecting the sectors to be included in the market requirements. The following three sectors were selected for their potential importance in terms of GHG mitigation:

- electricity production – ONEE
- cement production – Cement Association of Morocco
- extraction and treatment of phosphates – Sharifian Phosphate Office (OCP).

For the second phase of the programme, the following sectors could be considered:

- energy efficiency in the building sector
- transport
- public lighting.

Following approval by the board of directors of the PMR, Morocco should receive a variable amount of USD 3 million to USD 8 million in the coming years.

The first activity should focus on setting GHG reduction goals in the three identified sectors. This situation will need to be perfectly aligned with the strategies already established at the national level, taking into account that none of the three sectors is currently bound by mandatory objectives.<sup>2</sup>

The second activity will be to create a national register and implement the MRV.

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2. The two listed objectives have already been met in the electricity sector.

## ASSESSMENT

Morocco has relatively low emissions of GHG. However, the country is also vulnerable to changes in seasonal temperatures or rainfall, which could have considerable impacts on agriculture, tourism and, by inference, the overall economy.

At the same time, the Moroccan energy sector is registering relatively high CO<sub>2</sub> intensity. The government of Morocco should be commended for engaging so early on and directly with the UNFCCC authorities and establishing so quickly the institutions necessary to set a coherent and effective national climate change policy.

On the one hand, the new Energy Strategy should maintain its focus on reducing CO<sub>2</sub> intensity in the sector by shifting the energy mix and elevating energy efficiency to the level of national priority. On the other hand, the government of Morocco should take advantage of its international commitments to develop its institutions, follow the relevant aid programmes and facilitate international investments in projects that help reduce GHG emissions.

## RECOMMENDATIONS

*The government of Morocco should:*

- *Prepare quantified and detailed objectives on the energy savings to be achieved in each sector thanks to the development of the energy efficiency programme, and deploy a highly detailed sectoral action plan.*
- *Prepare quantified and detailed objectives on the GHG emissions in each sector and on the efficiency-related energy savings to be achieved.*
- *Strengthen administrative capacity in the relevant government departments to accelerate preparation of the third National Communication to the UNFCCC so that it is completed in 2014 and may contribute to the multilateral treaty negotiations that must follow the Kyoto Protocol.*
- *Prepare quantified and detailed objectives on GHG emissions based on which Morocco can establish – if appropriate – national requirements for combating climate warming, in keeping with progress already made by the country in this area.*

## References

IEA (2013a), *CO<sub>2</sub> Emissions from Fuel Combustion*, OECD/IEA, Paris.

OECD (2013b), *National Accounts of OECD Countries*, OECD Publishing, Paris.



## 4. ENERGY EFFICIENCY

### Key data (2012)

**Energy supply per capita:** 0.58 toe (IEA average: 4.5 toe), +42.6% since 2002

**Energy intensity:** 0.09 toe/USD 1 000 GDP PPP (IEA average: 0.14 toe/USD 1 000 GDP PPP), -1.4% since 2002

**TFC:** 14.3 Mtoe (oil 73.5%, electricity 16.5%, biofuels and waste 9.5%, natural gas 0.5%, coal 0.1%), +60% since 2002

**TFC by sector:** transport 33.3%, industry 26%, residential 20.4%, commercial including agriculture 20.3%

### OVERVIEW

Morocco's recent accelerated economic development has had the positive corollary of providing access to energy services to over 98% of the population, leading to a strong increase in energy demand. This demand has accentuated the country's energy dependence (over 91%) and increased its energy bill.

In fact, Morocco's energy consumption grew by nearly 50% between 2004 and 2012, increasing the share of gross domestic product (GDP) related to energy expenditures from 5.3% to 12.9% during the same period.

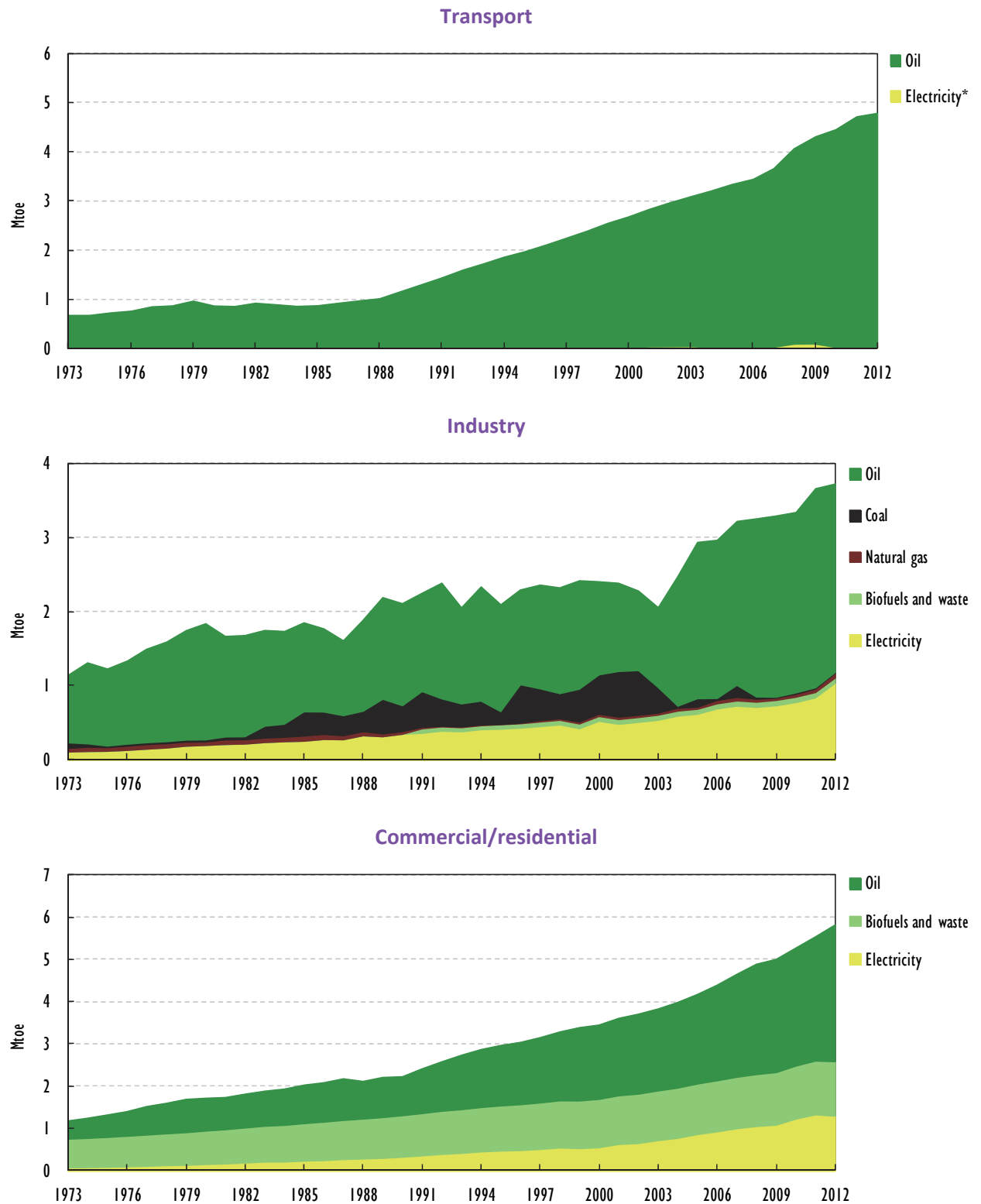
The country's economic development plans cannot alone explain the strong increase in the Kingdom's energy demand. Indeed, an analysis of the efficiency of the energy systems in use in Morocco shows that considerable progress is required to reach the level of energy efficiency observed in OECD countries. For example, Morocco's thermal power plants have a 32% efficiency level for fuel-fired power plants and 48% efficiency level for natural gas-fired power plants, while the efficiency levels of thermal power plants installed in OECD countries sometimes exceed 50%. This applies to all sectors, as will be seen later in the chapter.

### FINAL ENERGY CONSUMPTION

The total final energy consumption (TFC) of the Kingdom of Morocco amounted to 14.3 million tonnes of oil-equivalent (Mtoe) in 2012. The total increase in energy consumption since 2002 is 59.9% (Figure 4.1).

All the economic sectors have seen an increase in energy demand. In 2012, transport accounted for 33.3% of TFC, industry for 26%, residential for 20.4% and commercial/services for 20.3%. Transport and industry are the two sectors that have seen the greatest increase in final energy consumption since 2002.

**Figure 4.1** Final energy consumption by sector and energy source, 1973-2012



\* Negligible.

Source: IEA (2013b), *Energy Statistics of Non-OECD Countries 2013*, OECD/IEA, Paris.

A detailed analysis of the evolution of energy consumption by sector between 2004 and 2011 (MEMEE, 2013) showed that:

- Final energy consumption in the industry sector grew by 35%, an average annual growth rate of 4.38%.
- Likewise, the residential sector experienced approximately 47% growth in final energy consumption, even though the number of households only grew by 16.4% during the same period. This increase in energy consumption is related both to a strong penetration of household appliances (which have now become available to the vast majority of the population) and to the weak efficiency of the household appliances sold on the Moroccan market.
- Final energy consumption in the commercial sector increased by around 53%, an average annual growth of 6.5%. Since the value-added of the sector was 40% over the same period, it can be concluded that the commercial sector also needs to improve its energy efficiency.
- Energy consumption in the transport sector also grew over the same period by more than 50%, an average annual growth of 5.9%. This increase can be explained by the 59% growth of the vehicle fleet, of which 61% are diesel vehicles.
- As for the agricultural sector, its share in the country's final energy consumption was around 6% in 2011, but its energy intensity also grew strongly.

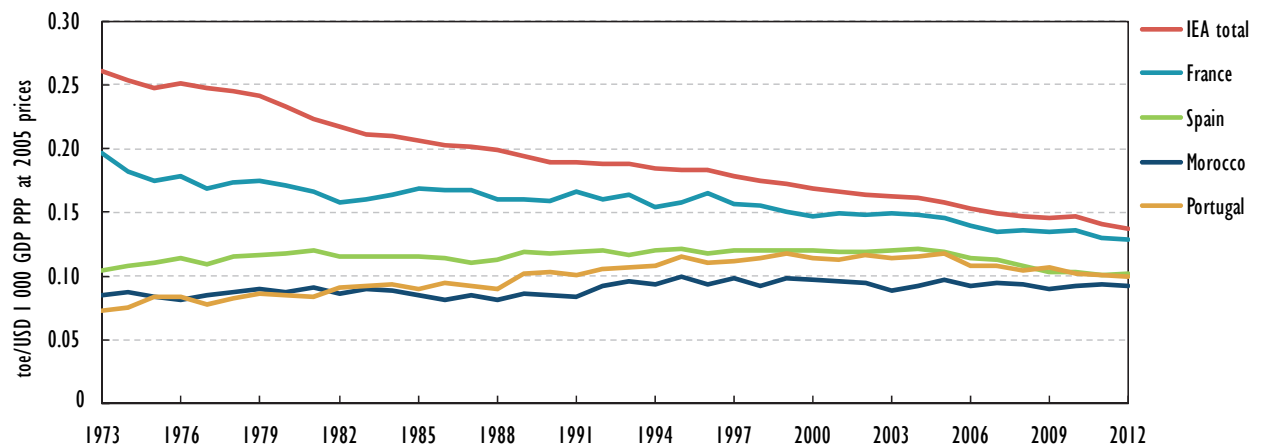
Oil is the main energy source used in Morocco, accounting for over 73% of TFC, and is used mainly for transport and industry. Demand for oil has increased by 78.7% from 2002 to 2012 while demand for electricity has nearly doubled. Electricity is mainly used in the residential and commercial sectors, accounting for 16.5% of final energy consumption in 2012.

Biofuels and waste, natural gas and coal represented 9.5%, 0.5% and 0.1% of TFC in 2012, respectively, and were used mainly in the industrial and residential sectors. Demand for natural gas has increased by 85.5% since 2002 while demand for biofuels and waste was slower at 10.9%. Coal consumption, which accounted for 6.7% of final consumption in 2002, is now negligible.

## ENERGY INTENSITY

Energy intensity, measured as the ratio of energy supply to gross domestic product purchasing power parity (GDP PPP), was 0.09 tonnes of oil-equivalent (toe) per USD 1 000 GDP PPP in 2012, lower than the IEA average of 0.14 toe per USD 1 000 GDP PPP, and at the third-lowest intensity level of IEA member countries (Figure 4.2). Morocco's energy intensity has remained relatively unchanged compared to 2002, with moderate volatility during the decade. Total energy supply compared with real GDP has risen by 9.4% since 1973, unlike the average IEA intensity, which decreased by 47.4% over the same period.

The Moroccan government has set the target of achieving energy savings of around 12% by 2020 and 15% by 2030.

**Figure 4.2** Evolution of energy intensity of Morocco compared with selected IEA countries, 1973-2012

Sources: IEA (2013b), *Energy Statistics of Non-OECD Countries 2013*, OECD/IEA, Paris; IEA (2013a), *Energy Balances of OECD Countries 2013*, OECD/IEA, Paris.

## PLANNED AND/OR IMPLEMENTED ENERGY EFFICIENCY POLICES AND MEASURES

To meet its goal of improving energy intensity, in 2009 Morocco adopted a new National Energy Strategy establishing energy efficiency as a national priority.

From a legislative and regulatory point of view, in 2011 Morocco adopted Law 47-09 (known as the “Law on energy efficiency”), whose main purpose is to strengthen energy efficiency in the key economic sectors.

Two energy efficiency measures have since been implemented in the industrial sector. The first measure is the introduction under Law 47-09 of the obligation for energy-intensive industries to undergo energy audits. To date, 58 energy audits have been initiated, of which eight were financed by the European Investment Bank and 50 by the African Development Bank. The second energy efficiency measure implemented in the industrial sector is the establishment of a preferential tariff (known as “super-peak”) for industries that voluntarily shift their energy consumption away from peak periods. The steel industry has already joined in this voluntary programme to reduce its energy bills.

In the (residential and commercial) building sector, Morocco has adopted a building energy code (BEC) for new constructions and has established an energy audit programme for existing buildings. In essence, Morocco’s BEC aims to reduce energy needs for heating and cooling. According to ADEREE, its implementation should lead to a reduction of between 39% and 64% of heating and cooling needs in the residential sector and between 32% and 73% in the commercial sector compared to current needs.

Along with the draft BEC, Morocco has enforced the application of Moroccan standard NM 14.2.300 for the labelling of electrical products and household appliances (*Bulletin officiel*, 2012). The appliances requiring mandatory labelling are 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).

In addition to mandatory energy labelling of lamps, a programme aiming to generalise the use of compact fluorescent lamps (CFLs) in public buildings and lighting has been launched. In the residential sector, the installation of 22.7 million low-energy light bulbs by

2012 was launched in 2010. Electricity providers were tasked with selling to the end user CFLs financed by low-interest loans from international organisations. To date, 7 million CFLs have been distributed in the residential sector by the National Agency for Electricity and Water (ONEE).

Due to the rapid rate of urbanisation and the launch of several sustainable city projects Morocco also plans to consider energy efficiency requirements in urban construction projects. In fact, Law No. 47-09 requires undertaking an energy impact study on any projected urban planning or building construction programme, regardless of use. A list broken down by specific thresholds for thermal and/or electric energy consumption in each project category is provided in the regulation. In this context, energy impact studies for the new cities of Sahel Lakayta and Chrafate are underway and a contract on promoting energy efficiency and renewable energies in the housing and urban planning sector has been signed between the government and real estate developers.

In the transport sector, many urban transport projects have been completed, such as the Rabat and Casablanca tramways. Morocco has initiated a process to rejuvenate the vehicle fleet by prohibiting the import of vehicles older than five years and renewing the freight transport fleet. A sticker licence has also been introduced for gas guzzlers and excise duties have been reduced to 2.5% for hybrid vehicles.

In the agricultural sector, a voluntary energy audit programme for agricultural producers has been launched by ADEREE. The programme aims 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. Ten farms, located in different regions of Morocco, have been selected as part of the voluntary audit programme. The expected reduction in carbon emissions amounts to 100 tonnes, which is equivalent to an energy saving of 130 000 kWh. A public-private partnership between ADEREE and the Crédit Agricole group in Morocco has been established within this context with the purpose of providing technical assistance to farms involved in the project. This partnership has helped strengthen technical expertise in the field of energy efficiency and renewable energy production systems in farms.

In addition to the previously described sectoral measures, cross-cutting measures have also been initiated and/or implemented in Morocco, including tiered pricing, decompensation and daylight savings. The decree of 25 February 2009 regulates the tariff structures and sales tariffs for electrical energy (*Bulletin officiel*, 2009). It defines tiered tariffs for electrical energy according to the consumption range (from 0 kilowatts (kW) to 100 kW, 100 kW to 200 kW, 200 kW to 500 kW, > 500 kW). Where state aid to support energy access and use is concerned, Morocco plans to limit its subsidies of energy bills to the lowest income families only. As for the measure regarding the introduction of daylight savings, its goal is to ensure a shave-off of power demand. For example, the adoption of the GMT+1 time zone during the periods covering 2 May to 20 July and 20 August to 30 September 2012 yielded an average shave-off of 80 megawatts (MW) of power demand and an energy gain of around 60 gigawatt hours (GWh). The avoided cost in fuel oil thus stands at around MAD 43 million (Moroccan dirhams).

## INSTITUTIONS

**MEMEE:** The Ministry of Energy, Mines, Water and Environment (MEMEE) is the ministry in charge of Morocco's Energy Strategy. However, the energy efficiency policy is developed in co-ordination with the Ministry of Economics and Finance, the Ministry of General

Affairs and Governance and the Ministry of the Interior. Energy efficiency programmes are led by committees that are chaired by MEMEE and include representatives from other ministries.

MEMEE also has a Directorate of Observation and Programming (DOP), whose role is to facilitate preparation and follow-up of the Moroccan Energy Strategy by providing regular detailed statistics and forecasting in particular. DOP proposes three indicator categories to evaluate progress in the area of energy efficiency: macroeconomic indicators, transformation sector indicators and sectoral indicators (industry, transport, residential, commercial and agriculture).

**ADEREE:** The National Agency for Renewable Energies and Energy Efficiency (ADEREE) was created in 2010. ADEREE replaced the Centre for Renewable Energy Development. Its mission is to develop and promote renewables and energy efficiency. In order to benefit from the experience of European countries in developing and implementing energy efficiency policies, a three-year twinning with the French Environment and Energy Management Agency (ADEME) is underway.

**ONEE:** The National Agency for Electricity and Water (ONEE) was created in 2011 from the merger of ONE (electricity) and ONEP (drinking water). ONEE is the main energy supplier, which has also distributed CFLs to consumers.

**SIE:** The Energy Investment Company (SIE) was created in 2009 to help accelerate the deployment of efficient energy solutions. SIE has a capital of MAD 1 billion (around EUR 89 million) and should ultimately be vested with over EUR 700 million. One-quarter of SIE investments are related to energy efficiency, while the remaining three-quarters relate to renewables.

**IRESEN:** The Institute for Research into Solar Energy and Renewable Energies was created in 2011 to consolidate the needs of the various industry stakeholders and ensure that the different research projects on energy efficiency and renewables are developed and implemented to best effect. Current research projects underway at IRESEN focus mainly on renewable energy.

## FINANCING OF ENERGY EFFICIENCY MEASURES

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Energy efficiency measures are either financed by the Energy Development Fund set up in 2009 or by the SIE, or co-financed by international funds (the Global Environment Fund, development banks, etc.). Most of the funds aim to finance the development and promotion of both renewable energy and energy efficiency measures. However, renewable energy draws more financing than energy efficiency measures. For example, only one-quarter of SIE investments cover energy efficiency measures.

## ASSESSMENT

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Morocco's adoption of an energy efficiency strategy is a great step forward in its energy policy. However, an analysis of corporate actions to date shows the need to speed up adoption of the enforcement decrees under Law 47-09 relating to energy efficiency so that the proposed measures are implemented as soon as possible.

The following presents a brief assessment of the energy efficiency measures implemented in Morocco. This assessment is based on the knowledge we have today of good practice in OECD countries and emerging economies.

In terms of energy production, energy efficiency in OECD countries is around 44% for coal plants, 38% for gas plants and 59% for combined cycle gas plants. The energy efficiency of plants installed in Morocco is around 35% on average (34% for coal plants and 48% for natural gas plants).

In terms of the industrial sector, the IEA can only encourage Morocco to pursue its mandatory energy audit programme. However, it would be useful to document the actual impact of the proposed measures.

With regard to the building sector (residential and non-residential buildings), an analysis of the Moroccan BEC project shows that it has two components – a passive component and an active component – in line with good practice. The passive component is based on an energy performance requirement for heating and cooling needs. Experience shows that this approach maximises energy savings. However, the draft legislation also allows for prescriptive requirements only for the building envelope. Experience shows that if both (performance-based and prescriptive) approaches are proposed together, and project managers are allowed the ability to choose, the prescriptive approach is usually selected because it is easier to implement and harder for the authorities to verify.

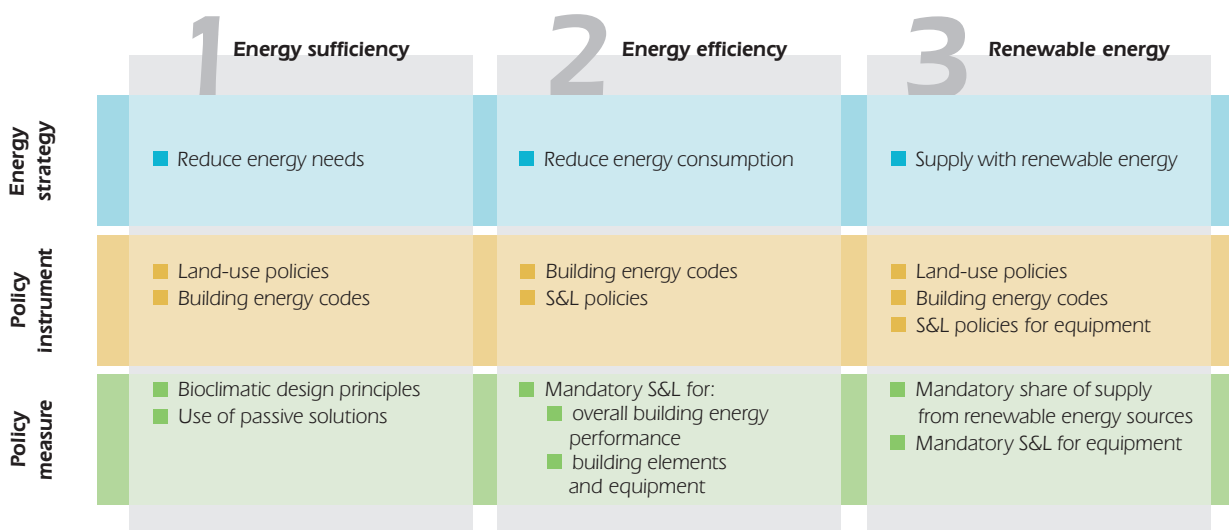
In OECD countries, the prescriptive approach was used in the 1970s at the time when thermal computation software barely existed. Today, a performance-based approach to heating, cooling and lighting needs, combined with prescriptive requirements for bioclimatic design, is considered good practice.

The active component of Morocco's BEC project sets minimal requirements only for the energy performance of heating and cooling systems and no energy performance requirement at all for the overall project (building and equipment). An analysis of BECs in OECD countries and emerging countries such as Tunisia shows that in hot countries with high construction rates – such as Morocco – it is imperative to consider a performance-based approach in order to reduce both energy needs and overall energy consumption (building and equipment). Such measures, if accompanied by bioclimatic design requirements, enable the immediate construction of high energy performance buildings. Furthermore, modern BECs include requirements for energy production through renewable sources incorporated into the building or established in its immediate vicinity.

Figure 4.3 below summarises the modern approach to be adopted in order to develop BECs and enable the immediate construction of high energy performance buildings. The effective implementation of a BEC will require accompanying measures, such as pilot projects, technical controls and enforcement in case of non-compliance. To date, the secondary legislation relative to technical controls and enforcement has not yet been adopted.

With regard to electrical equipment, the energy labelling implemented in Morocco since 2010 is based on European energy labelling. However, there are some inconsistencies between the energy performance requirements set out in Morocco's BEC and those provided for in the labelling. Indeed, a combined analysis of BEC and labelling shows that BEC is intended to eliminate the use of inefficient air conditioners in new buildings located in urban areas, while labelling authorises all types of devices. The minimum authorised air conditioner's energy performance in BEC amounts to the "D" class in labelling. But since BEC will initially only apply to new buildings in urban areas, there is a concern that existing buildings and buildings (whether new or existing) located in rural areas will be equipped with "E", "F" and "G" class air conditioners, since they are authorised on the Moroccan market.

Figure 4.3 Best approach for successful BECs



Source: IEA/UNDP (2013), *Modernising building energy codes to secure our global energy future*, Policy Pathway, IEA/UNDP, Paris.

Another possible source of confusion is that the BEC includes energy performance requirements only for “split” and “multi-split” air conditioners and monoblocks, while labelling includes energy performance requirements also for single-duct units, which are very inefficient in practice. A decree under Law 47-09 on Energy Efficiency envisages the establishment of minimum performance standards for energy equipment, particularly air conditioners.

The estimate of energy performance applied to air conditioners seem to be based on the former European standard EN 14511, which did not take into account the seasonal performances of the appliances. This standard has since been updated to introduce (as has been the case in the United States for nearly 40 years) the seasonal performance of cooling units. The reason for this update lies in the fact that air conditioning appliances only rarely function at full load (100%), and thus their actual performance should be based on consumption at partial load. This is particularly true in hot climates, hence the introduction of partial-load performance in the new European energy performance requirements for air conditioners.

The new European labelling is associated with a gradual elimination of less-efficient appliances. This new policy, known as Standards and Labels (S&L), is implemented today in most OECD countries, as well as in emerging economies including China and India. Moreover, there is probably a need for Morocco to adjust the appliances’ testing temperatures to the temperatures of the Moroccan climate, which are (for obvious reasons) not factored into European standards.

Where refrigerators and freezers are concerned, labelling features two different indicators: “indicator I<sub>α</sub>”, used for energy classes A++ and A+, and “indicator I”, used for energy classes A to G. The existence of two different indicators could create some confusion in the market. Performance requirements also seem to be modelled on European requirements, which are based on the European testing standard and take into account European lifestyles and kitchen temperatures. Measurement campaigns in North Africa have shown that temperatures in the kitchens of Maghreb are higher than temperatures in European kitchens, hence the need to adapt test standards to living and climatic conditions in Morocco. For example, Tunisia applies a corrective coefficient to the European



standard for cooling appliances that factors in differences in climate and usage. Moreover, as with air conditioners, OECD countries and emerging countries today combine energy labelling policies with policies aimed at gradually phasing out the most inefficient appliances (S&L). Morocco would do well to consider this good practice.

Where lighting is concerned, Morocco has embarked on the “en.lighten” project, which aims to implement energy efficiency policies that will eventually phase out incandescent light bulbs from the Moroccan market. Morocco has also embarked on a campaign to supply CFLs before these energy efficiency measures are implemented. There is a concern that the CFLs distributed will be replaced with incandescent light bulbs at the end of their life cycle, as has happened in many other countries. Given the importance of lighting consumption – particularly at peak hours – the IEA recommended as early as 2004 that its member countries implement energy efficiency policies aiming to gradually remove from the market the inefficient light bulbs. In the case of Morocco, which imports both inefficient light bulbs and CFLs, a decision to eliminate incandescent light bulbs from the market will not have a negative impact on the local industry but will have a positive impact on reducing lighting-related energy needs, particularly during peak hours. The “en.lighten” project aims to provide those countries participating in the project with technical assistance to implement this type of energy efficiency policy. It is strongly recommended that Morocco step up implementation of this project and stop the distribution of CFLs until the phase-out policy is in place.

Energy labelling is also provided for electric stoves. While this measure can be understood in Europe given the high number of electric cooking appliances, in the case of Morocco, it would be relevant to consider labelling gas-fired cooking appliances (as is the case in Latin American countries, such as Chile and Argentina, where cooking is done mainly with gas appliances).

In the transport sector, the energy efficiency measures introduced relate to the renewal of the vehicle fleet. However, this measure does not appear to include an energy consumption or carbon emission requirement for vehicles authorised on the Moroccan market. It should be noted that IEA analyses of the energy consumption of new vehicles on the global market show a great disparity in energy consumption depending on the vehicle size and brand. In order to limit energy consumption – and hence, transport-related pollutant emissions – OECD countries have introduced an energy/carbon label with minimum thresholds that allow gradual phasing out from their market of inefficient vehicles. Morocco should also consider introducing a consumption/emission requirement for the vehicles put into circulation.

An analysis of energy efficiency measures in the agricultural sector is not feasible to date given the lack of data on the planned energy audits, as well as their status and the actions undertaken to reduce energy consumption in this sector.

Where energy efficiency policies on cross-cutting measures are concerned, the discussion on the revision of tiered pricing with the goal of better targeting the beneficiaries of the first two tiers seems to be a good measure. However, international experience shows that it is preferable to help low-income families replace their inefficient appliances with the most efficient appliances available on the market than to subsidise their energy bills.

An analysis of the documents provided to date does not yield an understanding of how the government of Morocco plans to verify energy performance requirements and the enforcement of the regulation. The procedures and organisation for the operation of technical controls on the area of energy efficiency will be covered by decrees under

Law 47-09 in accordance with Article 18. Yet international experience shows that countries that do not provide for verifying energy performance requirements on the ground do not reduce their energy consumption and that their established energy efficiency policies lose credibility.

More generally, ADEREE, being an offshoot of the Renewable Energy Development Centre (CDER), seems much more invested in its renewable energy mission than in its energy efficiency mission. A training programme for the short and medium term to complement existing skills and better prepare Moroccan experts for the challenges of implementing energy efficiency policies should perhaps be considered.

The same goes for the financing of Morocco's Energy Strategy: three-quarters of SIE investments are earmarked for renewables. There is again a need to adjust and establish dedicated financing for energy efficiency so as to foster the deployment of the most effective energy solutions.

Where R&D is concerned, the research projects launched to date by IRESEN do not consider energy efficiency. Research projects focusing on energy efficiency would ensure better control over the most advanced technological solutions.

## RECOMMENDATIONS

*To optimise the potential sources of energy savings, the government of Morocco should:*

- *Establish a national energy efficiency action plan, including targets for reducing energy consumption per sector in addition to the overall target of improving energy efficiency, which describes in detail the measures to be implemented and indicators necessary for subsequent evaluation of the impact of the recommended measures.*
- *Ensure the coherence of the energy performance requirements among the different policy instruments in use (e.g. BEC and labelling of certain appliances) to ensure credibility of the overall energy efficiency strategy.*
- *Do things in order: first design energy efficiency policies, then allocate financial subsidies or distribute efficient equipment (e.g. establish a phase-out policy for inefficient light bulbs before distributing CFLs).*
- *Align on international good practice and avoid destroying potential sources of energy savings by considering obsolete energy efficiency policies (e.g. preferring the performance-based approach to the prescriptive approach for BEC).*
- *Accelerate the adoption and implementation of decrees and implementing acts and their accompanying measures, particularly as concerns the BEC.*
- *Align as much as possible on European legislation on reducing the energy consumption of household and lighting appliances and vehicles. The goal is to eliminate inefficient products from the Moroccan market.*
- *Create a dedicated energy efficiency fund supported by international energy efficiency funds as well as by national funds (taxes, etc.). The fund would serve to finance the development and implementation of energy efficiency measures, training, stakeholder education and R&D.*
- *Evaluate financial incentive programmes to ensure that the intended socio-economic categories are the actual beneficiaries.*

- *Plan awareness-raising campaigns aimed at national financial institutions and citizens to ensure that as many stakeholders as possible support the government's energy efficiency strategy.*
- *Provide for procedures to check energy performance on the ground and enforce penalties for non-compliance.*

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**PART II**  
**SECTOR ANALYSIS**



## 5. ELECTRICITY

### Key data (2012)

**Installed capacity:** 6 692 MW

**Total electricity generation:** 27.3 TWh, +79.4% since 2002

**Electricity generation by source:** coal 43.4%, oil 25.3%, natural gas 22.7%, hydro 6%, wind 2.7%

**Consumption by sector:** industry 43.6%, residential 32.8%, commercial and other services 22.4%, transport 1.2%

### OVERVIEW

Morocco's electricity sector has developed enormously since 1990, by diversifying generation, improving security of supply and attaining almost universal access to electricity, despite sustained electricity demand growth (6% to 7% per year) fostered by the country's economic development. Nevertheless, the sector must continue to develop to face the current and future challenges of constantly growing demand, rising fuel prices and the heavy investments needed to increase generating capacity, particularly in renewable energies. The reforms undertaken, notably to liberalise the sector and to deploy renewables, could help Morocco emerge as an innovator in the region's electricity sector and benefit the country's entire economy.

### MARKET AND REGULATORY FRAMEWORK

#### REGULATORY FRAMEWORK

The electricity market is structured around a national utility, the National Agency for Electricity and Water/Electricity Branch (ONEE), placed under the administrative and technical control of the Ministry of Energy, Mines, Water and the Environment. This vertically integrated utility operates in certain regions of the Kingdom throughout the electricity value chain, including generation, transmission, distribution, calling forward capacity and balancing the grid. ONEE is therefore responsible for generating and delivering electricity to all of its subscribers, as well as to any natural or legal person requesting a subscription. ONEE is the sole buyer and seller – and the sole importer and exporter – of centralised electricity. Since 1999, it has also been operating on the Spanish electricity market, which is interconnected with Morocco's.

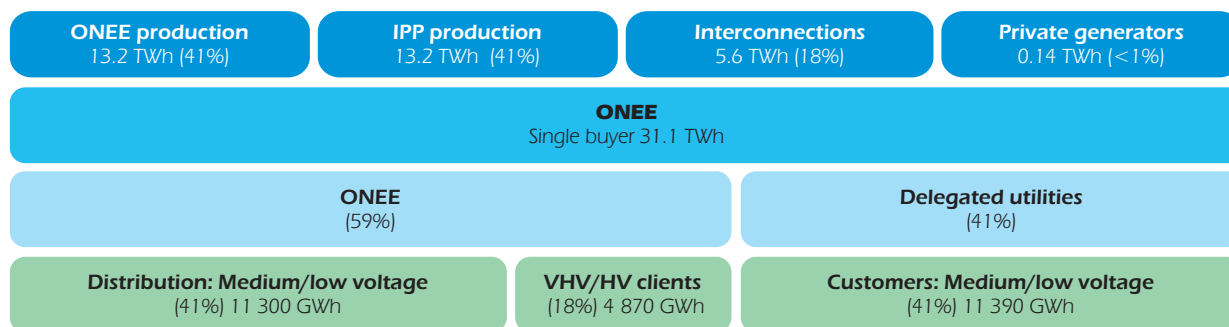
The dominant role of ONEE should, however, become weaker and the market structure should begin to break up in the very near future. In 2012, Morocco adopted a national regulatory framework for the electricity sector, which provides for a free market for the exchange of electricity from renewable sources among producers and customers connected to the very high-voltage and high-voltage (VHV/HV) Moroccan electricity grid. This development is based on Law 13-09 on renewable energy, which envisages by 2014 a national regulatory authority for independent energy and the separation of the

organisational and accounting elements of transmission activity from those of ONEE other activities (generation and distribution). As far as regulation is concerned, a study is now underway on the establishment of a National Energy Regulatory Authority (ANRE) to regulate the markets in both electricity and gas. This includes preparing a draft law to cover the creation of the ANRE, defining the principles governing the regulation of the two sectors and setting out the documentation by which they will be applied.

## MARKET STRUCTURE

As the sole buyer, ONEE supplies the national market through its own plants (41%), through those of independent power producers (IPPs) (also 41%), through imports (18%) and through a number of private industrial producers (0.4%) (see Figure 5.1).

**Figure 5.1** Overview of the electricity market in Morocco, 2012



Source: government of Morocco.

IPPs comprise three plants, two of which are the largest in the country: the Jorf Lasfar Energy Company (JLEC) (coal, 1 320 megawatts [MW]), the Electrical Energy Company of Tahaddart (gas, combined cycle, 380 MW) and the Compagnie Éolienne du Détroit (CED) (wind, 50 MW). A tender process – during which the price per kilowatt hour (kWh) is an important criterion – serves to select electricity producers, who are then bound to ONEE by long-term contracts, such as power purchase agreements (PPAs).

The private industrial producers are mining concessions and processing plants for phosphates, sugar and cement. They can install generation capacities not exceeding 50 MW, mainly intended for their own use, and benefit from energy transmission from the production site to the consumption site. Cement manufacturers have thus banked on wind energy to reduce their energy bills: Lafarge, in particular, has built a 32 MW wind farm next to Tetouan and Cement of Morocco/Cimar has built a 10 MW wind farm at Safi. Private producers are billed a maximum of MAD 0.08 per kilowatt hour (Moroccan dirhams) (MAD/kWh) for using the grid. Excess production is sold exclusively to ONEE at a preferential rate. In addition, producers of renewable energy connected to VHV/HV can sell directly to industrial customers who are also connected to VHV/HV. For the moment, medium and low-voltage producers do not have the right to access the grid, hindering the installation of photovoltaic energy in the residential and commercial sectors. Moreover, electricity transmission, including grid planning and dispatching, is a monopoly of ONEE.

The distribution of electrical energy is ensured either directly by ONEE or by the local utilities and delegated authorities. The 2006 Law on delegated management<sup>1</sup> guarantees

1. With delegated management, the state or public authority entrusts the management and financing, and sometimes the performance of a public service, to a private, public or mixed operator.



clear and transparent procedures, as well as equal access to and treatment of concession contracts, private domestic and foreign operators. The distribution grid is managed by the local utilities, under the control of the Ministry of the Interior in seven cities: RADEEMA in Marrakech, RADEEF in Fes, RADEEM in Meknes, RAK in Kenitra, RADEEJ in El Jadida, RADEES in Safi and RADEEL in Larache. The management of the distribution grid is delegated to private companies on the basis of delegated management contracts in four cities: Casablanca, Rabat, Tangiers and Tetouan. Some local utilities and delegated authorities are also responsible for the management of water and sanitation.

## PRICING

Electricity rates are not uniform. The rates for customers connected to the ONEE distribution grid are set and reviewed by Order of the Minister Delegate to the Head of Government in charge of General Affairs and Governance, on the advice of an Interministerial Pricing Committee. The rates applied by private delegated management authorities to their customers are set and reviewed in keeping with the delegated management contracts but remain similar to ONEE rates and thus will not be presented in detail.

Rates are differentiated by voltage and consumer category. Household rates are incremental, based on monthly consumption, but do not take into account the household's socio-economic situation: MAD 0.901/kWh for a monthly consumption of 0 kWh to 100 kWh, MAD 0.9689/kWh for 101 kWh to 200 kWh, MAD 1.0541 for 201 kWh to 500 kWh and MAD 1.4407 for consumption above 500 kWh. ONEE also offers pricing based on a prepaid meter exclusively available to rural populations and whose rates, depending on the type of use and consumption bracket, fluctuate between MAD 1.07/kWh and MAD 1.391/kWh. The bi-hourly pricing which is optional for users whose consumption exceeds 500 kWh aims to reduce consumption during peak hours by encouraging discounted use during normal business hours. Industrial rates are generally lower than residential rates and are split into three categories: off-peak, regular and peak hours. In addition, an optional super-peak rate has been introduced to encourage large industrial companies to further reduce their consumption during very high demand hours (two hours out of the five peak hours). This rate comprises three options, depending on the annual duration of power use (see Table 5.1).

**Table 5.1** Hourly variations of electricity prices (industrial sales)

	<b>Winter (from 1/10 to 31/03)</b>	<b>Summer (from 1/04 to 30/09)</b>
Super-peak hours	18:00 to 20:00	19:00 to 21:00
Peak hours	17:00 to 18:00 and 20:00 to 22:00	18:00 to 19:00 and 21:00 to 23:00
Regular hours	7:00 to 17:00	7:00 to 18:00
Off-peak hours	22:00 to 7:00	23:00 to 7:00

Source: ONEE (2014), [www.one.org.ma/](http://www.one.org.ma/) (accessed 4 April 2014).

The rates are below the real average costs of production and transmission, which amounts to a hidden subsidy to final consumers estimated at around MAD 0.30/kWh, in addition to the subsidy already granted upstream by the Compensation Fund for special fuel oil sold to electricity producers (although by decision of the government, payments for this fuel oil were discontinued as of 1 June 2014 – see Chapter 7). This subsidy translates into losses and a precarious financial situation for ONEE. A review of the rates,

which have not changed since 2009, is currently underway. The creation in the short term of an independent regulatory energy authority will boost market openness, help ensure the effective separation of activities within ONEE/Electricity Branch and guarantee the transparency and impartiality of the transmission grid operator. This could guarantee the grid operator a stable income by enforcing a rate system for using the grids. These measures would increase cost transparency and set pricing reflective of the production value. To ensure that electricity rates remain affordable, the oil subsidy could be redistributed to protect the poorest households from price increases.

## DEMAND

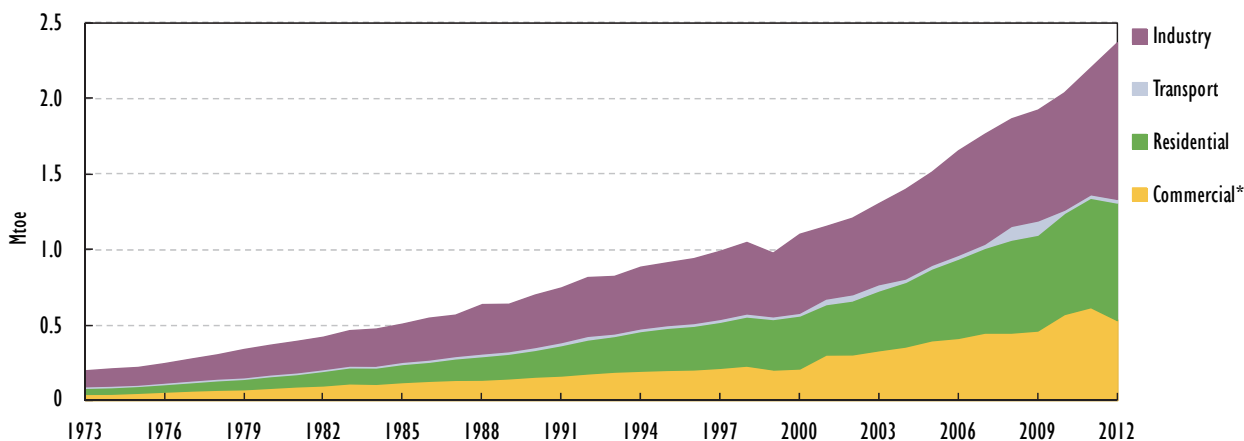
One challenge for the sector is sustained demand, which has doubled in the space of a decade and should double again in the next 10 to 20 years. Electricity demand increased from 16 TWh in 2002 to 31 TWh in 2012. This strong growth – averaging 7% per year – is largely due to demographic and socio-economic development. In terms of the gross domestic product (GDP), Morocco is now the fifth-largest economy on the African continent and its economic growth, which has a direct impact on electricity demand, indeed goes in step with growth in electricity consumption. Morocco's electrification rate now exceeds 98%, a real exploit compared with the electrification rates of 50% only ten years ago and only 18% in 1995, when Morocco launched its Global Rural Electrification Programme (PERG). Yet the annual average electricity consumption per capita is still low, at around 850 kWh, versus 8300 kWh on average in OECD countries. In 2030, it is expected to range between 2 000 kWh and 3 000 kWh per capita.

By 2020, demand will reach an estimated 44 TWh to 55 TWh, underscoring the great need for additional electricity generation. Faced with this growth and the significant time required to build power infrastructures, a long-term strategy becomes paramount.

## SECTOR DEMAND

The main users of electricity are the industrial (43.6%), residential (32.8%) and commercial (including agriculture) (22.4%) sectors (Figure 5.2).

**Figure 5.2** Electricity consumption by sector, 1973-2012



\* Commercial includes commercial and public services, agriculture/fishing and forestry.

Source: IEA (2013), *Electricity Information*, OECD/IEA, Paris.

The transport sector, which only accounts for 1.2% of demand, has nevertheless grown rapidly, especially between 2003 and 2009, thanks to the expansion of railway electrification. With a rail grid connecting the main urban centres, passenger and freight transport should increase. The first African high-speed train (TGV), which will connect Tangiers and Casablanca by 2030, is being planned; the first Tangiers-Kenitra segment is scheduled to enter into service by the end of 2015. Cities are keen to electrify transportation, as evidenced by the opening of the Rabat-Sale tramway in 2011. Since 2002, electricity demand has enjoyed significant growth of 7% per year. The residential sector posted the strongest growth of 8% per year, followed by industry (7.4% per year) and the commercial sector (5.8% per year).

## DAILY AND ANNUAL DEMAND CURVE

Since electricity cannot be stored – except to a limited extent in pumped storage power stations – demand and production must constantly be in balance. The daily, monthly and annual load curve, therefore, serves as an important clue to optimising electricity generation. Demand peaks are influenced mainly by the climate, the demand breakdown by sector and consumer consumption and behaviour. The maximum annual peak in 2012 was almost 5.3 gigawatts (GW). Over the course of one year, monthly peaks during the summer tend to be more pronounced due to the gradual installation of air conditioners. Peak daily demand in Morocco occurs in the evening, between 20:00 and 22:00, depending on the season.

The demand peak is therefore not synchronous with the sunlight peak, which means that solar energy cannot deliver peak electricity without being stored. The tender for the concentrated solar power plant at Ouarzazate applies this logic and includes the requirement to supply a three-hour storage capacity to allow using solar power during peak hours. Indeed, solar power could be particularly competitive during these peak hours, since peaks in Morocco are supplied by oil plants with high marginal costs. If Morocco intends to develop photovoltaic energy, it will need to make accessing the grid a priority to allow it to be used for daytime electricity generation.

The energy efficiency policies implemented by Morocco are an essential tool to reduce growing demand (see chapter on energy efficiency) as well as peak demand:

- Incentive and social pricing – known as the “-20/-20 rate” – aims to encourage households and licensees to reduce their monthly consumption by at least 20% compared with the same month of the previous year. In return, they can enjoy not only reduced direct electricity costs, but also a discount on their next bill equivalent to 20% of the value of the volume reduced.
- An optional super-peak rate for VHV/HV industrial users has been introduced. The Holcim Settat and Holcim Oujda cement plants adopted this pricing in 2009 and the two SONASID steel plants, Jorf Lasfar and Nador, adopted it in 2011, resulting in a 96.4 MW shave-off of super-peak hours. Since 2012, the Guemassa Mining Company Draa Lasfar has shaved off an additional 0.78 MW of super-peak consumption.
- Optional dual-meter pricing is available for households and private lighting – a demand driver responsible for over 500 kWh of average monthly consumption.

In order to take advantage of natural lighting and reduce consumption in the commercial and services sector, as well as in public lighting, daylight saving time (GMT+1) was introduced in 2008. According to the government of Morocco, the adoption of the

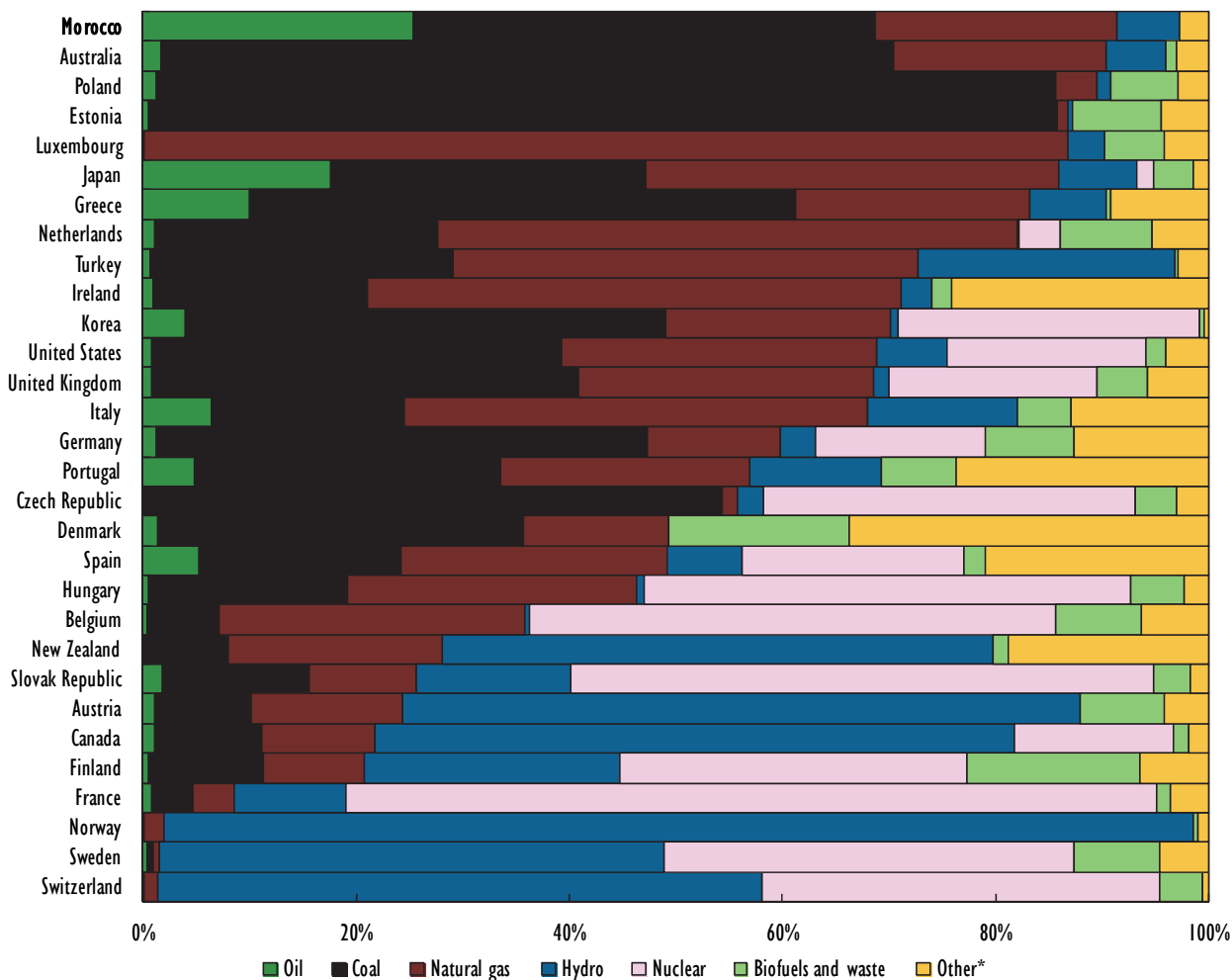
GMT+1 time zone from 2 May to 20 July 2010 and 20 August to 30 September 2012 reduced power demand by 80 MW and produced an average energy gain of around 60 GWh. The avoided cost in fuel (oil) is around MAD 43 million.

**NATIONAL PRODUCTION**

**STATUS QUO**

To satisfy this strong demand, electricity generation increased in parallel by 6% per year between 2002 and 2012, culminating in 27.3 TWh of electricity generated in 2012.

**Figure 5.3** Electricity production by source in Morocco and IEA countries, 2012



\* Other includes wind, solar, geothermal and ambient heat.  
 Source: IEA (2013), *Electricity Information*, OECD/IEA, Paris.

Coal is the main source of power generation, accounting for 43.4 % of national electricity production (2012). Oil and natural gas account for 25.3 % and 22.7 %, meaning that 90 % of electricity is produced by fossil fuels (Figure 5.3). Natural gas was first used for electricity generation in 2005 to limit the growth of coal; at the time, however, it only accounted for 10% of installed power – compared with 66% for coal. Today, natural gas

generation accounts for 12.7% of installed power (Tahaddart, 380 MW and Ain Beni Mathar, 470 MW, both combined cycle) – compared with 26.6% for coal – and electricity generation using natural gas has doubled (Figure 5.4). The role of oil in the energy mix, however, has not evolved, since electricity rates do not make it possible to cover marginal production costs. The important role of oil in the energy mix is also the main differentiator compared to IEA countries (Figure 5.3).

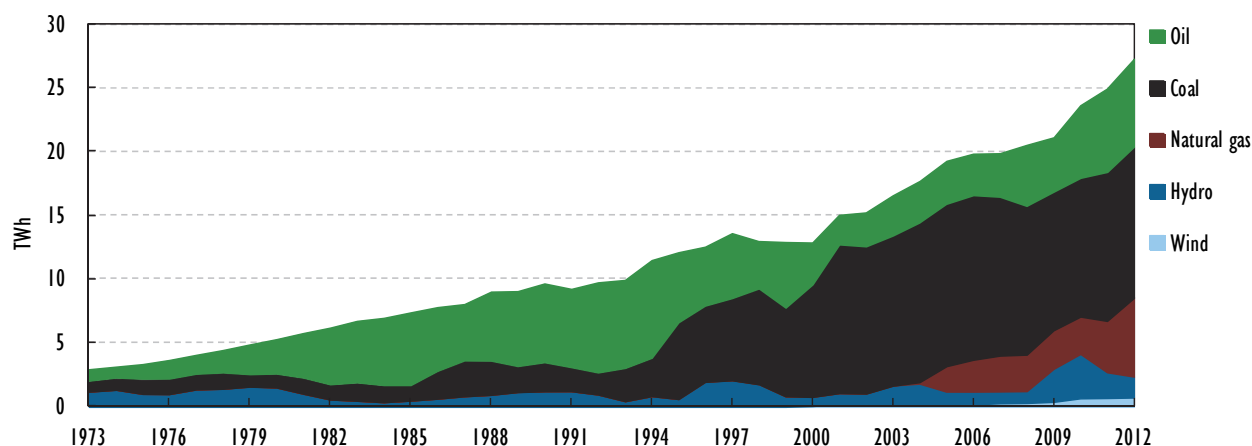
Renewable energy generates the remainder of the electricity. Hydropower effectively remains the main source of renewable energy, but is strongly dependent on the climate. Hydro power has accounted for 7.6% of national power generation on average since 2002. In 2012, hydropower only accounted for 6.85%, compared with 14.7% in 2010 – a record year – while wind accounted for 2.7%. Solar power, on the other hand, remains negligible.

## FUTURE DEVELOPMENTS

Ambitious plans to increase the renewable production capacity to 2 GW for solar, 2 GW for wind and 2 GW for hydroelectric by 2020 have been launched. The share of renewables in installed power should reach 42%. In terms of annual generation, this corresponds to about 25% of projected demand. In the long term, Morocco is also considering developing its oil shale, the main reserves of which are in two sites, Timahdit and Tarfaya. ONEE considered building a pilot plant in Tarfaya with a 100 MW capacity, powered by oil shale, and issued a call for tender to attract interested companies, but to no avail.

The public sector, as well as private domestic and foreign investors, should finance the renewables project. The Energy Development Fund – with assets of USD 1 billion (United States dollars), largely from Saudi Arabia and the United Arab Emirates – will also contribute. Several such projects are already under construction or in the material planning stages, thanks to the stable framework that Morocco has managed to establish for investors.

**Figure 5.4** Electricity production by source, 1973-2012



Source: IEA (2013), *Electricity Information*, OECD/IEA, Paris.

The electricity production equipment plan for 2013-17 underscores the government's determination to reach this objective by 2020. Some projected power plants are already under construction, and the production capacity should increase by almost 68%, or 4 480 MW, by 2017:

- coal: Jorf Lasfar 5 and 6 (2 x 350 MW, 2014), SAFI (2 x 693 MW in 2017) and Jerada (320 MW in 2016)
- oil: Tiznit and Dakhla diesel generators (90 MW)
- hydro: Mdez El Menzel (170 MW in 2017)
- wind: Tarfaya, Taza, Midelt, Koudia Al Baida (repowering and expansion) and Tanger II wind farms and private wind farms (1 420 MW)
- solar: Ouarzazate (phase I (160 MW) beginning in 2015, phase II (340 MW) in 2017).

Looking beyond 2020, Morocco is currently only projecting demand through 2030. As things now stand, the government has left all options open regarding the production required to meet the projected demand over the long term. However, it would be prudent to draw up detailed scenarios and long-term plans for electricity production beyond 2020, so as to strengthen the atmosphere of trust established by the government of Morocco.

## NATIONAL INTERCONNECTIONS GRID

### IMPORTS AND EXPORTS

Domestic production only covers 85% of Moroccan consumption (2012). Morocco is a net importer of electricity (4.8 TWh in 2012), with 5.6 TWh imported and 0.8 TWh exported (see Table 5.2). Almost all of the electricity is imported from Spain, which is connected synchronously by a 400 kilovolt (kV) interconnection with a 1.4 GW capacity. This double underwater alternating current line connects the Moroccan grid to the Spanish grid under the Strait of Gibraltar. The synchronous interconnection with the Algerian grid has a 1.2 GW capacity. Its use, however, is limited to mutual assistance in balancing the grid and is not based on overall economic optimisation. In terms of volume, imports and exports to Algeria are just about balanced. Algeria and Tunisia, as well as Tunisia and Libya, are also physically interconnected. Morocco is also studying the possibility of interconnecting with Mauritania. The 400 kV Spain-Morocco-Algeria-Tunisia line is the first segment of a Mediterranean grid that could expand to Italy – if the plan for interconnecting Tunisia and Italy is realised – and to Egypt – if the required improvements to the Libyan grid are made.

From an institutional standpoint, the Maghreb Electricity Committee (COMELEC), following the signing of the Marrakesh Treaty by the Heads of State of the Arab Maghreb Union,<sup>2</sup> was entrusted with the responsibility of co-ordinating the integration of the Maghreb electricity grid. The Treaty of Athens (2003) signed with the European Commission further underscores the political will to integrate the Maghreb's electricity markets. Even if the electricity trade among countries of the Maghreb is low, the construction of physical interconnections and the creation of political institutions demonstrate that a true Maghreb grid could emerge. Morocco could drive this integration in the context of COMELEC, not only because it is physically interconnected with the region, but also thanks to its efforts to liberalise the electricity markets. It is obvious that despite many positive steps, several more remain to be taken to integrate the electricity market of the Maghreb.

More concretely, Morocco is evaluating the possibility of exporting renewable energy to Europe by 2020 or 2030, particularly by developing its existing physical interconnection

2.The Arab Maghreb Union comprises Algeria, Libya, Mauritania, Morocco and Tunisia.

with Spain and the presence of ONEE on the Spanish market. Article 9 of the European directive on the promotion of the use of energy from renewable sources (Directive 2009/28/EC, 23 April 2009) authorises third countries to sell electricity from renewable sources on the European market and allows member countries importing it to include it in their 20% quota of electricity from renewable sources to be achieved by 2020. Yet the financial crisis that has affected Europe since 2008 is having a particularly strong impact on Spain, with electricity demand decreasing by 8% between 2008 and 2013. The Spanish system is now at overcapacity, with 102 MW of generation capacity and a demand peak of 40 MW.

Moreover, the Spanish grid is only weakly interconnected with France and, therefore, the rest of Europe (1.4 GW). The development of this interconnection also has strategic importance for Morocco if it is to access the European market. In 2014, the commissioning of a new interconnection east of the Pyrenees will double the interconnection capacity from 1.4 GW to 2.8 GW. Another interconnection, this time through the Gulf of Gascony, is currently under consideration and could be commissioned by 2020. The interconnection capacity would thus total at least 4 GW – though still below the minimum 10% installed capacity recommended by the European Union (ENTSO-E (2013) – Scenario outlook and adequacy forecast).

Faced with Spain's overcapacity and strong demand growth in Morocco, net exports from Morocco to Spain by 2020 are unlikely. Nevertheless, Morocco should continue its effort to integrate, thereby improving its security of supply and regional co-operation.

**Table 5.2** Moroccan imports and exports with Spain and Algeria

Year	IME imports (MWh)	IME exports (MWh)	Balance
2005	835 590	51 641	783 949
2006	2 030 001	28 179	2 001 822
2007	3 500 749	21 376	3 479 373
2008	4 226 921	14 925	4 211 996
2009	4 594 855	7 981	4 586 874
2010	3 936 227	33 706	3 902 521
2011	4 509 881	15 614	4 494 267
2012	4 903 143	5 051	4 898 092
	IMA imports (in MWh)	IMA exports (in MWh)	Balance
2012	756 442	813 254	-56 812

Notes: IME = Morocco-Spain interconnection; IMA = Morocco-Algeria Interconnection.

Source: MEMEE/DEER.

## NATIONAL GRID

The electricity grid – which comprises an HV and VHV transmission grid and a medium-voltage and low-voltage distribution grid – is an essential and critical component of the electricity infrastructure to guarantee security of supply and ensure access to electricity. The Moroccan transmission grid, which spans 21 854 km (2012), comprises all the VHV 400 kV, 225 kV and 150 kV electrical lines (which are currently disappearing from the

national grid), the 60 kV HV lines and 400/225 kV and 225/60 kV transformer stations. The losses of the transmission grid represent 4.4% of the power injected into the grid (2012).

Electricity transmission is a monopoly of ONEE, which is in charge of developing, enhancing and managing it, and is responsible for national dispatching, with the goal of optimising the costs from the various sources.

Grid enhancements to connect new plants under construction are already programmed, evidence of well-co-ordinated planning between generators and grid. The extension and enhancement of the transmission grid amounts to an investment of MAD 12 billion by 2017. ONEE recently launched a production and transmission study to assess the grid's ability to receive renewable energies by 2025.

The distribution grid connects consumers to the transmission grid. In the framework of the PERG, the total length of the low-voltage grid grew from 27 000 km in 1996 to 164 000 km in 2012.

The distribution of electrical energy is ensured either by ONEE – especially in rural areas and in several cities (Agadir, Oujda, Nador, Settat, etc.) – or by local utilities and IPPs (under the control of the Ministry of the Interior for the large urban centres).

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## ASSESSMENT

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Morocco faces numerous challenges in the electricity sector: sustained demand growth, mainly due to the country's economic growth (6% to 8%); a strong increase in the price of oil, which represents an overly large share in the energy mix, especially compared to OECD countries; and the need to diversify its energy mix to include renewable energies in order to guarantee security of supply and long-term economic competitiveness.

The country should be commended, however, for its readiness to tackle these future challenges and its successes over the last decade, especially with regard to doubling the power supply in ten years and supplying electricity to nearly the entire population.

To increase transparency in the sector, Morocco should pursue its efforts to liberalise the sector, in accordance with its new Energy Strategy launched in 2009, which includes re-organising its electricity sector and establishing an independent regulator to ensure reasonably priced and transparent access to the grid. On the long term, complete openness to market competition could be envisaged in order to render the market even more technically and economically efficient. A competitive power generation market could also help exploit differences in the temporal and financial structure of electricity generation and consumption between Morocco and the interconnected countries. This would allow Morocco to gradually implement a pricing system that reflects the actual production costs and mitigate the excessive role of oil, which is still effectively subsidised by ONEE. Nevertheless the removal of support from the Compensation Fund for fuels destined for power generation announced on 1 June 2014 is a major step forward. To ensure that electricity prices remain affordable for poorer households, the oil subsidy could be redistributed for this purpose.

The financial situation of ONEE remains a growing source of concern for the sector as a whole. ONEE is faced on one hand with rising oil prices and significant investment requirements, and on the other hand with relatively low administered resale prices which have not been adjusted since 2009. In this precarious situation, the deficits engendered by the electricity supply sector affect the entire group. Any recapitalisation



aiming to make up for the accumulated deficits should absolutely be accompanied by structural measures to balance the accounts. In addition, increasing the transparency of ONEE accounts, and especially doing separate accounting for the production, supply, transmission and distribution activities, is essential. With this in mind, it is advisable to isolate the loss-making supply activities in a separate accounting entity and to guarantee the grid operator a stable income thanks to a system for charging all users to use the grids.

Morocco has a vested interest in maximising the use of the interconnection with the Spanish grid during peak hours in order to reduce oil consumption – especially considering that the Spanish system is currently at overcapacity. Developing a North African and Mediterranean grid is a long-term project (which is, nevertheless, developing physically) that would benefit from a renewed expression of political will on the part of the heads of state of the Maghreb.

Both the construction and planning of new electrical plants seem well managed by Moroccan institutions with a view to 2020. To strengthen the climate of trust that the Moroccan government has built for its foreign investors, Morocco should launch a national debate on the long-term vision and set out detailed scenarios for electricity generation post-2020.

## RECOMMENDATIONS

*The government of Morocco should:*

- *Continue to implement the Energy Strategy set in 2009, and especially establish in the short term a legislative framework for reasonable and transparent pricing of grid access and the introduction of an independent regulator. It could consider completely opening the market in the longer term.*
- *Engage in a gradual process to reach electricity prices that reflect actual costs, while protecting the more vulnerable households, and replace artificially low electricity rates with targeted subsidies for poorer households.*
- *Separate production, transmission and distribution activities – at least at the functional, organisational and accounting level – in order to increase price transparency; this restructuring of ONEE should help ensure its financial viability.*
- *Continue to regionally integrate electricity systems – particularly with Spain, which is currently at electricity overcapacity – in order to maximise trade opportunities, which would allow (among other things) lowering the oil-related cost of peak supply.*
- *Develop, in addition to the existing demand, different scenarios for electricity supply and a more concrete vision of the Energy Strategy over the long term (beyond 2020), especially as regards electricity production.*

## References

IEA (2013), *Electricity Information*, OECD/IEA, Paris.

ONEE (National Agency for Electricity and Water) (2014), [www.one.org.ma/](http://www.one.org.ma/) (accessed 4 April 2014).



## 6. RENEWABLE ENERGY

### Key data (2012)

**Share of renewable energy:** 8.5% of TPES and 8.7% of electricity generation

**Biofuels and waste:** 7.4% of TPES

**Hydropower:** 0.7% of TPES and 6% of electricity generation

**Wind:** 0.3% of TPES and 2.7% of electricity generation

### OVERVIEW

The domestic energy context is facing significant challenges. Demand for primary energy is growing by nearly 5% on average per year, while electricity consumption has grown by 6.5% on average over the past ten years due to the quasi-generalisation of rural electrification and the dynamic growth of the national economy, as evidenced by the major projects in infrastructure, industry, agriculture, tourism, social housing, etc.

For Morocco, energy transition is a strategic decision geared towards numerous social, economic and environmental challenges. Several projects have been undertaken to ensure this transition. In the field of renewable energies, the launch of two integrated programmes for solar and wind energy, each with a 2 000 megawatts (MW) capacity and slated for completion by 2020, has strongly driven the large-scale development of these domestic sources of renewable energy. Once they are completed, the share of renewable energies in total installed electrical power will have increased to 42%, allowing savings of 2.5 million tonnes of oil-equivalent (Mtoe) in fossil fuels and avoiding the emission of close to 9 million tonnes (Mt) of carbon dioxide (CO<sub>2</sub>).

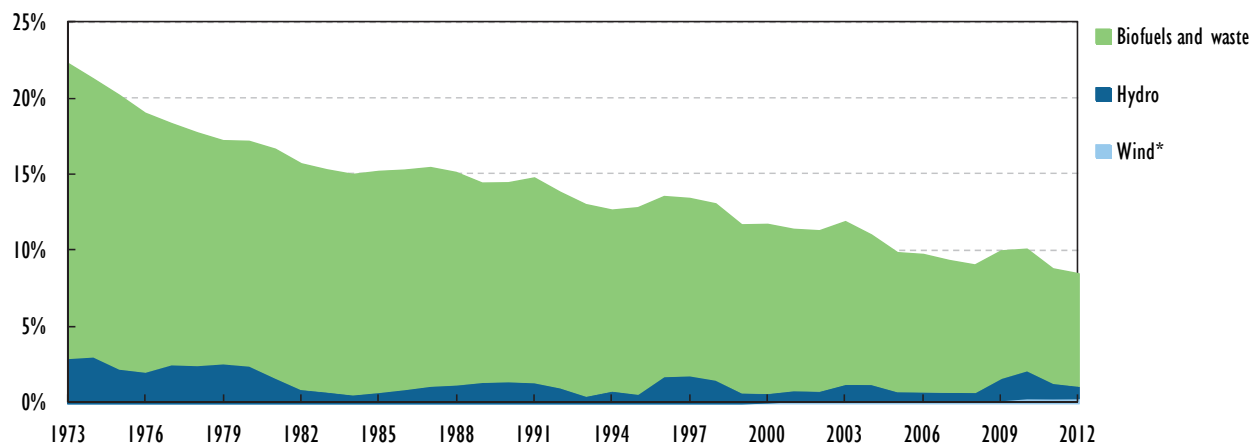
With these two integrated and proactive programmes, Morocco of course aims to correct its vulnerability, but also to appropriate promising technologies in order to develop renewable energy resources and a national industrial fabric capable of accompanying their development, ensure the competitiveness required for export and give a strong impetus for research and technological development and innovation geared towards sustainable development.

### SUPPLY AND DEMAND

Renewable energies in Morocco contributed nearly 1.6 Mtoe in 2012 – 8.5% of total primary energy supply (TPES). As shown in Figure 6.1, the share of renewables in the TPES over the last two decades varied between 8% and 12%, mainly because of volatility in annual rainfall.

The total supply of biofuels and waste and hydropower has increased since 1973, but more slowly than fuel supply.

Biofuels – the main source of renewable energy in Morocco – dropped from 10.5% of TPES in 2002 to 7.4 % in 2012 (see Figure 6.1).

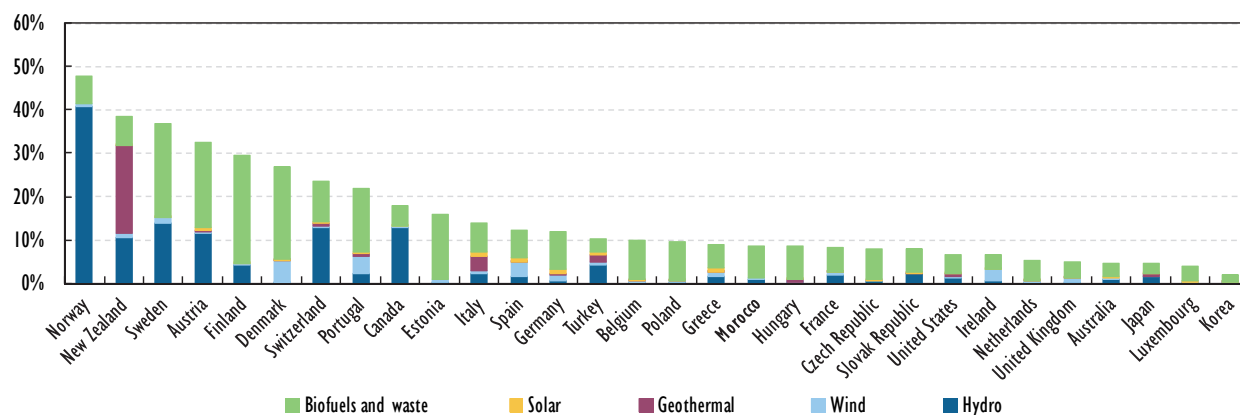
**Figure 6.1** Renewable energies as a percentage of TPES, 1973-2012

\* Negligible.

Source: IEA (2013b), *Energy Statistics of Non-OECD Countries 2013*, OECD/IEA, Paris.

Hydropower ranged from 0.6% in 2002 to 1.8% in 2010, but only accounted for 0.7% in 2012. Wind power was initiated in 2000 and almost tripled in 2012.

Compared with International Energy Agency (IEA) member countries, Morocco is close to a median level of renewables in TPES, ranking 18th (see Figure 6.2).

**Figure 6.2** Renewable energies as a percentage of TPES in Morocco and IEA member countries, 2012

Sources: IEA (2013b), *Energy Statistics of Non-OECD Countries 2013*, OECD/IEA, Paris; IEA (2013a), *Energy Balances of OECD Countries 2013*, OECD/IEA, Paris.

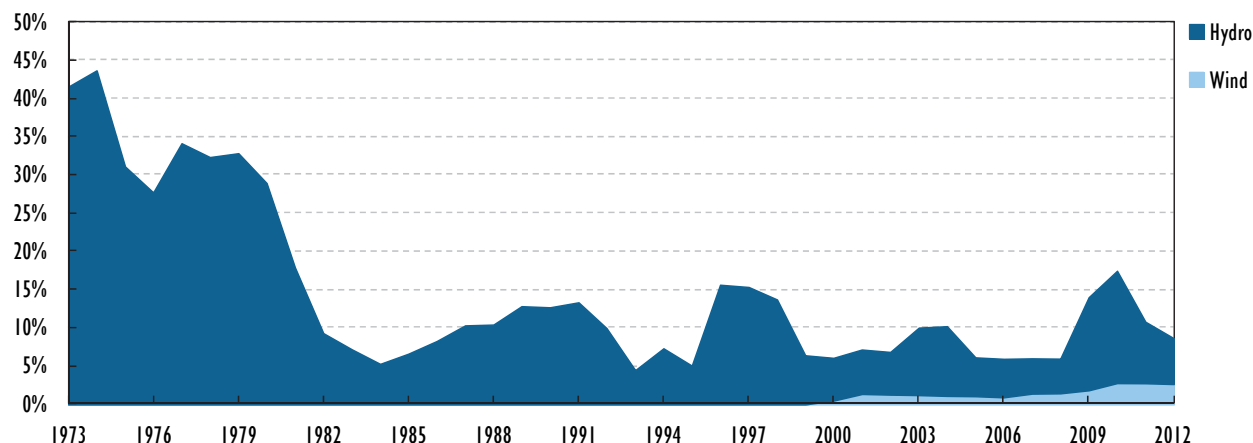
## ELECTRICITY GENERATION

In 2012, electricity generation from renewables was 2 359 gigawatt hours (GWh), representing 8.6% of total generation – a decrease from 10.8% of total generation in 2011. The share of hydropower decreased by 18.7% from 2011, down to 1 631 GWh in 2012. Wind power increased by 5.2%, up to 728 GWh (see Figure 6.3). Other sources of renewable energy are still negligible. During the decade 2002-12, the share of hydropower in domestic production was 7.6% on average.

Very early on, Morocco focused its energy policy on diversifying its supply sources and developing its domestic resources by promoting all available forms of renewable energy.

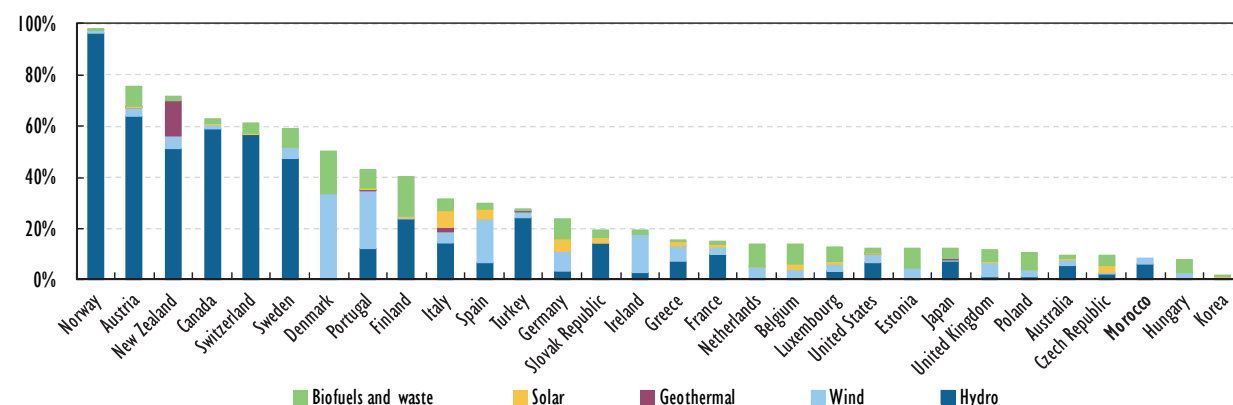
Since 2009, the development of renewable energies has been part and parcel – like the deployment of energy efficiency – of the Moroccan energy policy priorities. Even though hydropower has long been established in Morocco – and was, indeed, at the origin of the deployment of its electricity grid – it is relatively limited today. On the other hand the country has excellent wind and solar resources.

**Figure 6.3** Electricity generation from renewable sources as percentage of total generation, 1973-2012



Source: IEA (2013b), *Energy Statistics of Non-OECD Countries 2013*, OECD/IEA, Paris.

**Figure 6.4** Electricity generation from renewable sources as percentage of total production in Morocco and IEA member countries



Sources: IEA (2013b), *Energy Statistics of Non-OECD Countries 2013*, OECD/IEA, Paris; IEA (2013a), *Energy Balances of OECD Countries 2013*, OECD/IEA, Paris.

As early as 1994, Decree Law No. 2-94-503 modifying the Dahir of creation of the National Agency for Electricity and Water (ONEE) allowed the development of independent electricity generation above 10 megawatts (MW) under contract with the National Electricity Agency (ONE), fostering the emergence of the country's first wind farms.

In 2008, Law 16-08 increased the self-production threshold from 10 MW to 50 MW; it also granted access to the transmission network to facilities generating power from renewable sources and allowed the signing of private concession agreements for electricity generation from domestic energy resources. Law 16-08 also allows operators to sell to ONEE the occasional surpluses of electric power generated from domestic energy resources.

In 2009, the creation of the Moroccan Agency for Solar Energy (MASEN) and the transformation of the Centre for Renewable Energy Development into the National Agency for Renewable Energies and Energy Efficiency (ADEREE), as well as the creation of other institutions outlined below, provided renewed impetus. In parallel, Law 13-09, which removed the power ceiling for renewable energy facilities –previously limited to 50 MW – outlined the government’s commitments and in particular, set the objectives of (i) promoting energy production from renewable sources, as well its marketing and export by public or private entities; (ii) subjecting energy production facilities from renewable sources to an authorisation or declaration regime; iii) granting an operator the right to produce electricity from renewable sources on behalf of a consumer or group of consumers connected to the medium-voltage (MV), high-voltage (HV) or very high-voltage (VHV) grids within the framework of an agreement whereby they commit to consuming the electricity thus produced exclusively for their own use.

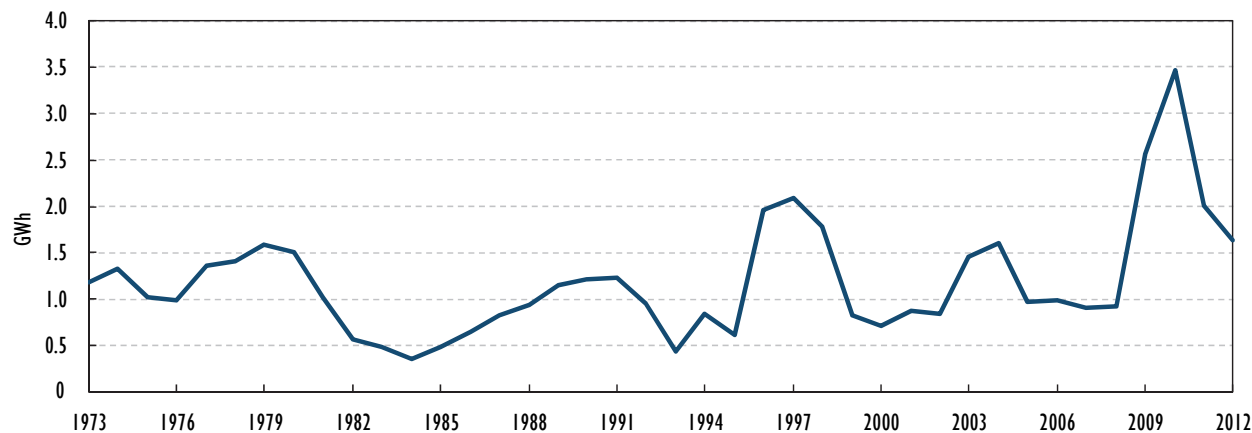
In 2012, the current renewable energy generation fleet mainly comprised 27 hydropower plants with a total capacity of 1 306 MW, a number of wind farms with a total capacity of 291 MW and the 20 MW Ain Beni Mathar solar power plant. According to government estimates, electricity production from renewable energy sources should grow strongly in the coming years. In fact, many hydraulic, wind and solar projects have recently been launched.

The development of ambitious wind and solar programmes would ensure an annual production of electricity of 4 500 GWh for solar, 6 600 GWh for wind and 1 500 GWh for an average hydraulic year (e.g. between 2003 and 2008), i.e. around 25% of the total electricity production expected in 2020 and 60% of power demand.

### Hydro power

The surface water resources of the territory overall are estimated at between 20 bcm and 30 bcm in an average year, but they can range from 5 bcm to almost 50 bcm. Half of these resources are concentrated in the hydraulic basins in the north, which cover less than 8% of the country’s total area. Hydro-electricity is only one aspect of Morocco’s hydrological management, whose main aim is to provide drinking water, irrigation and protection against floods, thanks to 135 major dams with a total storage capacity of 17 bcm, a dozen others in construction, and about 30 smaller dams. Even so, production of hydropower varies considerably from year to year (Figure 6.5).

**Figure 6.5** Variability of hydropower generation in Morocco, 1973-2012



Source: IEA (2013b), *Energy Statistics of Non-OECD Countries 2013*, OECD/IEA, Paris.

With 27 hydropower plants totalling 1 306 MW in pure energy, hydraulic energy today remains the main source of renewable energy in Morocco. However, the potential of this resource is far from fully tapped; 520 MW will be installed on the major dams under construction by 2020. Moreover, under Law 13-09, seven hydraulic micro-plants with a total capacity of 54 MW are now under development by the private sector. Finally, retention basins have been built, and drip irrigation developed, with a view to separating irrigation needs from energy needs to better satisfy demand. Decided in 2011 (Law 40-09) and effective in April 2012, the merger of the former National Energy Agency (ONE) and the National Drinking Water Agency (ONEP) aims to “harmonise national strategies in these two synergistic key sectors [water and electricity]”.

The increase in the share of variable renewable energies – such as wind and solar power – renders even more essential the use of Morocco’s flexible hydropower resources.

Managing this variability will be made easier thanks to pumped storage plants already existing (Afourer, 464 MW, since 2004) or in development (Abdelmoumen, 350 MWh, around 7 hours of storage at full power).

### Wind power

The first wind farms were commissioned in the 2000s on behalf of ONE (now the National Agency for Electricity and Water [ONEE]) – the sole buyer – or by industrial consumers. They currently have a total capacity of 291 MW. Under Law 13-09, additional capacities of 300 MW for ONEE, and 420 MW for industrial customers, are being developed. The installed base for renewables production features a wind farm in Tetouan (54 MW, commissioned in 2000), Lafarge’s wind farm at Tetouan (32 MW, commissioned in 2005, 2008 and 2009), Amogdoul’s wind farm at Essaouira (60 MW, commissioned in 2007), the Tangiers wind farm (140 MW, commissioned in 2009-10) and the cement plant at Laâyoune (5 MW, commissioned in 2011).

Projects under construction or at an advanced stage of development include the Tarfaya wind farm (300 MW), belonging to an independent producer (Nareva, in partnership with GDF Suez) under an energy purchase agreement with ONEE, and projects belonging to Nareva and other independent producers intended for industrial clients and totalling 410 MW (Akhfennir, 200 MW; Foug El Oued, 40 MW; El Haouma, 50 MW; Jbel Khalladi, 120 MW).

In addition, ONEE has launched an integrated wind programme which will total 1 000 MW upon completion; the first 150 MW capacity is currently under development at Taza. The five wind farms planned in this integrated programme are:

- Tanger II (Tangiers), 100 MW
- Midelt (Midelt), 150 MW
- Jbel Lahdid (Essaouira), 200 MW
- Tiskrad (Laâyoune), 300 MW
- Boujdour (Boujdour), 100 MW.

These wind farms will be developed in the context of public-private partnerships in which ONEE, the Energy Investment Company (SIE) and the Hassan II Fund for Economic and Social Development will join with one or several strategic partners of reference in the fields of electricity production and wind power, with a view to creating a project company under Moroccan law and taking equity stakes on a case by case basis in each of the five wind farms.

The ONEE will purchase all the net electricity produced by these wind farms for a period of 20 years from their initial commercial operation, based on power purchase and supply agreements.

In addition to producing wind power, this wind programme aims to promote Morocco's wind industry, to constitute a high-level expertise base and to strengthen research and development (R&D) at the national level in order to master this technological sector which offers strong potential for furthering Morocco's economic development.

Moreover, ONEE intends to increase the power of the Tetouan (Koudia El Baïda) wind farm to 130 MW or 150 MW.

By 2020, the expected 2 000 MW capacity should generate around 6 600 GWh per year thanks to the exceptional quality of the wind resources on the Moroccan coasts, expected to save annually 1.5 Mtoe and prevent the emission into the atmosphere of 5.6 million tonnes of carbon dioxide per year. Thanks to the quality of its wind resource, Morocco – whose economically exploitable potential is estimated at over 25 gigawatts (GW) – is very well placed to export to the European electricity market.

### **Solar energy**

Since 1995, Morocco has undertaken an ambitious Global Rural Electrification Programme (PERG), entrusted to ONEE. In the space of 15 years, 3 660 villages have thus been equipped with electricity, i.e. 1.9 million households; of these, 51 000 were equipped with individual (isolated) solar kits with a capacity of 70 kilowatts (kW) or 200 kW – totalling around 10 MW of photovoltaic (PV).

A solar power plant with a 20 MW (electricity equivalent) capacity, commissioned in 2011 with the support of the World Bank's Global Environment Facility, was incorporated in the combined cycle gas power plant of Ain Beni Mathar.

The 2010 Moroccan Solar Programme will be developed by MASEN – created for this purpose – and will be located on several sites. Five sites were initially selected: Ain Beni Mathar, Ouarzazate, Fom al Oued, Sebkhah Tah and Boujdour. The programme was conceived without a stated technological preference, but it demonstrated keen interest in concentrated solar power (CSP) systems.

The development of the Ouarzazate site began with a call for tender for a 160 MW parabolic trough CSP plant (NOOR 1), which should become operational by 2015 and will feature three hours of storage at full power. A consortium led by the Saudi group Acwa Power and featuring the Spanish group Acciona was retained to build and operate this plant for 25 years.

For this iconic project, MASEN was able to collect many concessional loans from multilateral development institutions, including the European Investment Bank, Kreditanstalt für Wiederaufbau, French Agency for Development, World Bank and African Development Bank. The Clean Technology Fund also donated to the project.

The launch of the construction of the first NOOR 1 power plant took place at a ceremony hosted by King Mohammed VI on 10 May 2013. MASEN has already taken the early steps necessary to ramp up the site's capabilities, with consultations for the supply of an additional 200 MW in parabolic troughs and 100 MW in tower form. While the desired storage volumes are not known with certainty, they are assumed to be about five hours' worth of solar power.



In addition to Ouarzazate, which could also accommodate a 50 MW PV plant, the solar programme renamed “NOOR solar plan” will most likely continue to be developed at two newly identified sites, Tata and Midelt.

There are today very few solar projects created by independent producers or for purposes of self-consumption (see the “Assessment” section). One exception is the Airlight Energy Ait Baha Plant project, which will provide thermodynamic solar electricity to the Italcementi cement plant near Agadir. This is an original parabolic trough plan, which uses air as a transfer fluid and stone pebbles as a storage medium (for 12 hours), in order to supply partially (3 megawatts thermal) an existing 12 MW Rankine turbine.

To further develop the strong domestic solar energy potential, ONEE launched a programme to develop end-of-line, mid-sized (20 MW to 30 MW) solar PV plants, which will help strengthen security of electricity supply in the selected zones.

This programme, which aims for a total installed power of around 400 MW, is seen as a network management tool, since it is mainly intended to improve the quality of the customer service provided in faraway regions, particularly during daytime hours. This programme features the following projects:

- The NOOR ATLAS project is intended to meet the needs of the southern and eastern regions through the deployment of eight solar PV plants with a 200 MW capacity at Guemim, Tata, Tahla, Guenfouda, Ain Beni Mathar, Boudnib and Boulmane.
- The NOOR Tafilalt project is intended to strengthen the Zagora Arfoud and Misour networks thanks to three solar PV plants with a 75 MW capacity.
- The addition of 100 MW is intended to strengthen the network in other Moroccan regions.

In order to improve agricultural yield and productivity while saving on water and energy, the national programme promoting solar pumping in irrigation water saving projects has been developed. This programme has a budget of 400 million MAD and foresees the development of 3 000 PV pumping systems with a total peak installed capacity of 15 MW. It would allow, among other things, saving on the butane gas subsidy by the Compensation Fund. These savings would cover the subsidy amount, which would be recovered at the end of three to five years. The subsidy granted for the solar pumping component will cover 50% of the installation cost, with a 7 000 EUR cap, providing the farmer installs drip irrigation.

### **Biomass power**

Biomass power offers a relatively modest potential in Morocco compared with its hydro, wind and solar potential. Biogas recovery projects at the Agadir, Fes and Marrakech water treatment plants for heat and power co-generation have been presented to the Clean Development Mechanism (CDM) under the United Nations Framework Convention on Climate Change (UNFCCC).

For the recovery of solid waste from landfills, the amount of waste conveyed to the solid waste treatment and recovery centre in the city of Oujda, located in the country’s eastern region, is around 110 000 tonnes per year (t/year). The quantity of gas extracted is estimated at 12 million cubic metres per year (mcm/year), producing the equivalent of 2.3 MW of electricity, i.e. an energy potential of 0.02 terawatt hours per year (TWh/year).

According to the ECOMED Group, the landfill of the city of Fez receives 310 250 t/year of waste and produces 17.52 mcm/year of biogas, equivalent to 5 MW of electricity; i.e. an energy potential of 0.044 TWh/year.

## HEAT

### Solar heat

PROMASOL, the Development programme of the Moroccan market for solar water heaters, has helped install 48 000 square metres (m<sup>2</sup>) in 2010 (to a total of 300 000 m<sup>2</sup>), resulting in an increase in penetration from 0.28 m<sup>2</sup> per 1 000 capita (m<sup>2</sup>/1 000 capita) in 2000 to 1.1 m<sup>2</sup>/1 000 capita in 2010 – still well below that of countries such as Tunisia (38 m<sup>2</sup>/1 000 capita) (ADEREE, 2013). This is a comprehensive, certified system integrating the technical installation and financing of the solar water heater in the residential sector (which will then be extended to other sectors and PV), combined with an investment subsidy and bank loan repayable through the electricity bill. The goal is to reach 1.7 million m<sup>2</sup> of installed capacity by 2020, capable of delivering around 1.2 gigawatt hour thermal capacity. The goal by 2030 is a capacity of 3 million m<sup>2</sup>.

To meet this goal, Morocco is finalising the financial model which consists in granting (i) a variable public subsidy according to equipment productivity and (ii) a standardised consumer credit, repayable over five years.

There is also great potential – still to be determined precisely – for using solar heat in agriculture, industry and services – all the more so as Morocco has excellent direct sunlight and can, depending on the degree of concentration used, obtain good yields of solar heat at all the commonly used temperature levels (see “Assessment” below).

A few projects of this nature are actually under development in Morocco. One such project, submitted to the CDM of the UNFCCC, is a central steam plant for the fishmeal industry at Laâyoune Plage. This project aims to achieve fuel savings by using alternative supply options. To this end, 24 decentralised fossil fuel-fired water heaters will be replaced with steam plants. A solar power plant using Fresnel technology will supply basic energy, while an oil burner will supply steam for peak demand and night-time operations. The envisaged solar power plant will be one of the largest applications worldwide of solar heat for industrial processes. The plant will supply power to eight food processing plants for fish products, all connected to the same steam network.

### Thermal biomass

Several projects that replace gas or oil with biomass in order to generate thermal power have been recently developed or are under development in Morocco. The main projects pertain to:

- using oil waste at the Renault plant in Tangiers (a “zero carbon” automobile plant)
- using excess bagasse from the Surac sugarcane processing plant at Belksiri to help fuel the neighbouring Sunabel beetroot processing plant
- replacing oil with wood biomass at the paper pulp plant Cellulose du Maroc or at the Bati Chaouia brickyard in Berrechide.

## INSTITUTIONS

**MEMEE:** The Ministry of Mines, Energy, Water and Environment (MEMEE) is in charge of designing and implementing government policy in the areas of energy, mines and geology, as well as supervising other sectors under its authority. It oversees the companies and public institutions that fall under its jurisdiction.

**ONEE:** The National Agency for Electricity and Water (ONEE) is the result of the merger of ONE (electricity) and ONEP (drinking water), which became effective in April 2012 (Law 40-09). It is the (quasi) sole buyer of electricity in Morocco. As a public industrial and commercial establishment possessing legal personality and financial autonomy, it was invested with exclusive rights to production and transport. It also ensures the distribution of electricity to several Moroccan provinces, especially in rural areas. The main missions of the ONEE are to respond to the country's electrical energy needs, manage and develop the distribution grid, ensure the extension of rural electrification, promote the development of renewable energies and manage overall electrical energy demand.

**ADEREE:** The National Agency for Renewable Energies and Energy Efficiency (ADEREE) replaced the Centre for the Development of Renewable Energies in March 2010 (Law 16-09). Its mission is to develop and promote renewable energies and energy efficiency to help implement the national energy policy for reducing energy dependence and protecting the environment.

**MASEN:** The Moroccan Agency for Solar Energy (MASEN) is a limited liability company with a board of directors and a supervisory board (Law 57-09). Its mission is to carry out a programme for developing integrated solar power generation projects with a minimum 2 000 MW in total capacity.

**SIE:** The Energy Investment Company (SIE) was created in June 2009 to finance Moroccan renewables projects (Finance Law 40-08). The national interest company has a capital of MAD 1 billion (around EUR 89 million) and should eventually be vested with over EUR 700 million. The SIE "is intended to invest in projects aiming to increase energy generation capacities, develop and commercialise renewable energy resources and increase energy efficiency".

**IRESEN:** The Institute for Research into Solar and Renewable Energies was created in 2011 to consolidate the needs of the various industry stakeholders and ensure that the different research projects on energy efficiency and renewables are developed and implemented to best effect.

IRESEN represents Morocco within the SolarPACES programme of the IEA.

## RENEWABLES FINANCING

The Energy Development Fund (EDF) was created to support the National Energy Strategy. With a USD 1 billion budget, this fund aims to strengthen and preserve production capacities from local energy sources, particularly renewable energy sources, provide financial support to energy efficiency projects and support energy service companies.

Within the framework of this fund, the Energy Investment Company (SIE) was created in June 2009 (Decree No. 2-09-410 of 30 June 2009 authorising the creation of the limited liability company named "Energy Investment Company") to finance Moroccan renewable energy projects. This national interest agency, endowed with a 1 billion MAD budget, is intended to invest in projects aiming to "increase energy production capacities, develop renewable energy resources and strengthen energy efficiency".

Several missions were entrusted to SIE to accompany the industrialisation of key energy sectors, such as taking strategic stakes in companies "undertaking concrete and profitable projects with proven industrial feasibility" or targeting clean and innovative projects (solar energy, biomass, wind energy and hydro).

## OPPORTUNITIES FOR INDUSTRIAL INTEGRATION

To promote the establishment on its soil of renewables components industries, Morocco has devised the Morocco Renewable Energies Plan, focusing on three areas: infrastructure, human capital and incentives. Within this context, an important land bank (about 2 000 hectares) reserved for industrial activities has been mobilised, with attractive rental prices for the developed plots. Established businesses in these areas will be exempt from value-added tax and customs duties, as well as from the patent for the first 15 years and corporation tax for the first five fiscal years (after which a fixed rate of 8.75% will apply for 20 years). The established industrial projects will also have the benefit of measures to support investment and the free repatriation of their profits and capital.

Under this plan, the Energy Development Fund finances investment grants of up to 10% of the acquisition cost of new capital goods, capped at MAD 20 million (about EUR 2 million). Finally, assistance in staff development, at induction and for long-term training, is also provided to these new enterprises, depending on the profiles of the human resources hired, for a period of three years.

## LEGISLATIVE AND REGULATORY FRAMEWORK

### Law 13-09 on renewable energies

Among the main objectives of Law 13-09 on renewable energies are the right for an operator to generate electricity from renewable energy sources on behalf of an individual consumer or group of consumers connected to the national MV, HV or VHV grid, under an agreement committing them to consume the electricity generated exclusively for their own use. Specific procedures for opening the MV grid shall be set by a decree currently being prepared.

#### Box 6.1 Power generation schemes under Law 13-09

**Authorisation system:** implementation, operation, capacity expansion or modification of power generation facilities from renewable sources with an installed capacity above or equal to 2 MW. These authorisations are given for previously determined zones and take into account the possibilities of connecting to the national grid and the protection of the environment, historical monuments and listed sites, in accordance with the legislation in force.

**Declaration system:** implementation, operation, capacity expansion or modification of power generation facilities from renewable sources with an installed capacity below 2 MW and above or equal to 20 kW; this also applies to thermal power generation facilities with a capacity above or equal to 8 MW (thermal power).

**Free system:** free establishment, operation and modification of power generation facilities from renewable sources with an installed capacity under 20 kW; this also applies to thermal power generation facilities with a capacity below 8 MW (thermal power).

### Law 16-08 on self-production

Law 16-08 raised the self-production threshold from 10 MW to 50 MW. It also granted access to the transmission network to power generation plants, particularly from renewable sources, and allowed direct awards of concession agreements for electricity generation from domestic energy resources. ONEE transmits the energy generated to the consumption centres and buys the energy surplus.

## RESEARCH AND DEVELOPMENT (R&D)

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As a major player in the field of renewable energies in Morocco, IRESEN has the task of co-ordinating and combining R&D activities. Under the aegis of MEMEE, IRESEN co-ordinates the energy players in particular – its founding members. IRESEN also works closely with other ministries, including the Ministry of Higher Education, Training and Scientific Research and the Ministry of Industry, Trade and New Technologies. Universities, research centres and industry are at the heart of a circle of co-operation and co-ordination designed to achieve the operational implementation of scientific R&D.

In February 2012 and with the support of MEMEE, IRESEN launched two calls for proposals, InnoTherm I and InnoTherm II, under two different but complementary themes – thermal solar and solar support technologies. More than 72 universities, research centres and Moroccan and foreign industrial companies bid under consortia; 8 projects were selected for funding and allocated research budgets between MAD 1 million and MAD 5 million per project. The projects involved both the public and private sectors and included over 50 researchers and PhD students.

Several countries inject more than 4% of their gross domestic product (GDP) into R&D. The funds put into play by the Kingdom of Morocco in this regard remain limited and do not exceed 0.8% of GDP. However, the creation of IRESEN has helped to focus financial resources within the field of renewable energy research. MEMEE allocated MAD 250 million from the Energy Development Fund to support and encourage applied and technological research in the field of renewable energies.

IRESEN has set up a training process for evaluating the impact of financing programmes, as well as obtaining feedback on experiences and establishing better practices in this field. IRESEN has a Scientific Council comprising internationally renowned researchers and experts in the field. The Council's mission is to review and evaluate the programme and management process for R&D carried out by the Institute to ensure the quality and relevance of the projects, as well as their relevance to the mission of IRESEN.

Thanks to its position in the field of renewable energies, IRESEN has entered into partnerships with a number of institutions, notably: Mines ParisTech, the solar research centre of the German Aerospace Centre (DLR), the University of Seville - Andalusian Association for Research and Industrial Cooperation (AICIA), Helmholtz PVcomB and Fraunhofer Gesellschaft.

IRESEN is in the process of establishing scientific platforms dedicated to the various renewable energies. The concept of the platform is to group technologies and host the private and public operators according to their field of competence and the distribution of the Kingdom's industrial fabric and academic competences.

## ASSESSMENT

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The IEA can only congratulate Morocco on adopting these objectives and policies, which have aroused great interest within the international community – as witness the support of numerous bilateral and multilateral development institutions and/or institutions that support clean technology. The National Energy Strategy adopted by Morocco has been translated into an action plan setting clear and precise objectives. Its implementation, which is occurring according to the initial timeline, would benefit today from taking full account of recent technological evolutions, particularly the strong drop in the cost of solar PV systems.

Moreover, the emergence of thermodynamic technologies with a point-focus receptor (central receptor systems or “towers”) allows the development of thermal mass storage at a significantly reduced cost, thanks to a much higher temperature difference between “cold” and “hot” salts.

In keeping with these evolutions, tasks should be more clearly divided than during the first phase of the Ouarzazate solar power plant: assign daytime electricity generation to PV; assign electricity generation during peak demand – the five hours after sunset – in priority to CSP. Even today, or in the very near future, these technologies – and they alone – will not need financial support to compete with the marginal kWh cost provided on the grid at those hours: PV will compete with the cost at regular hours – dictated by the cost of gas – and CSP will compete with cost at peak hours – dictated by the cost of oil products.

Until the middle of 2014, the price of oil fuels used for electricity generation (ONEE oil and special fuel oil) was lowered artificially through a regulatory framework and the deficit (about MAD 1 per kWh ex-fuel) supported by the Compensation Fund.<sup>1</sup> The recent elimination of this subsidy will make the relevant operators more aware of the economic benefit for Morocco of replacing imported oil products with a local renewable resource.

## PV

Since PV is highly variable, there is no particular reason to favour major solar power plants. However, since floor space is available in all the regions, there is no particular reason either to favour the more costly PV roofing systems and small-scale systems. The economically optimal size, factoring in the issue of injecting the power into grids, probably ranges between 1 MW and 20 MW.

It is therefore necessary to promote without delay the development of PV, by establishing priority access to the (low tension and medium tension) network by amending Law 13-09 for low tension and using the Law’s implementation decree for medium tension. While it is certainly necessary to develop self-consumption as much as possible, given the optimal facility size – and except for special cases in the commercial and service sectors – the degree of self-consumption conceivable in the absence of economic storage technologies is too low to allow spontaneous development of PV if production surpluses cannot be sold at decent prices.

Priority network access seems necessary for new PV markets to take off as the local competitiveness of PV is not yet firmly established. By lowering the risk to developers, priority access will lower the cost of capital – an important factor in the discounted cost of electricity because of the capital intensive nature of renewable energy projects. It is only later, when the local market is sufficiently mature and the number of experienced fitters is large enough, that it will become possible to gradually expose new PV projects to competitive risk.

Foreign experience suggests that calls for tender should be reserved for the largest power plants, e.g. over 10 MW.<sup>2</sup> For smaller domestic systems, e.g. up to 12 kW, net

1. See in particular *Étude sur les produits subventionnés dans le cadre du système de compensation (Study of subsidised products in the framework of the compensation system)* by the Competition Council, Rabat, June 2012 (Competition Council of the Kingdom of Morocco [2012]); and *Rapport sur le système de compensation au Maroc – Diagnostic et propositions de réforme (Report on the compensation system in Morocco – diagnosis and proposals for reform)* by the Court of Auditors, Rabat, January 2014 (Court of Auditors of the Kingdom of Morocco [2014]).

2. PV power plants with several tens of MW are therefore not to be excluded, and Morocco numbers numerous favourable locations. It would be useful to reserve for CSP those sites – like Ouarzazate – that have both abundant water resources and

energy metering should be considered. This option consists in setting a purchase price above the retail sale price, so that a single meter would suffice to measure the balance of consumption and production. However, even if the retail purchase and sale prices can initially be similar, different purchase and sale prices may be preferable to facilitate their necessary evolution (probably in opposite directions).

For larger systems, e.g. between 12 kW and 1 MW (or more), one option is to set a guaranteed purchase price for 20 or 25 years at a sufficiently high level to guarantee developers a fair income. For higher capacities, it might be preferable to proceed through calls for tender to benefit from increased competition, while maintaining the principle of long-term purchase agreements. Local utilities could also be authorised to produce PV power in this context. While the necessary rate could quickly become inferior to the marginal cost of electricity at regular hours, the rate proposed should still be sufficiently attractive and factor in the market immaturity and resulting over-expenditure.

A rapid deployment of several hundred MW, or even several GW, is likely to occur in the space of only a few years. A GIZ study evaluated the PV potential on buildings at 2.7 GW. For ground PV, the limit is naturally due to the variable nature of the capacity provided and the volume of electricity storage capacities or demand shift towards solar production hours.

Nevertheless, a gradual approach is advisable in order to check the network's capacity to absorb growing quantities of variable renewable energies as solar PV is being developed. Frequent reviews of purchase prices – which are also useful to limit excessive earnings – could help manage this development, but they must be programmed in advance and known to all. The changing value of PV energy as its capacity value – i.e. its ability to render unnecessary the construction of new thermal power plants – declines should also be taken into account. To control the rate of PV deployment, annual financial commitments (rather than new installed capacity, which would penalise efforts to gradually lower costs) could also be capped.

The question of local technological content is an issue in Morocco as elsewhere, for which pragmatism is advisable. Due to the significant decrease in the cost of PV screens, they represent today barely one-third of the value of PV systems; the rest – tangible or intangible – must or can be very largely local. Where the screens themselves are concerned, only the existence of an adequate local market can draw investment in plants specialising in cell encapsulation, which is a very important step to guarantee the operational life of the system. The current global overcapacity in cells, however, should prompt the greatest caution regarding possible investment in cell manufacturing – which is about to become a global commodity.

## CSP PLANTS

The development of large solar thermodynamic power plants should be re-oriented towards priority coverage of consumption peaks after sunset.<sup>3</sup> This is a profound change: until now, the strategy was to produce mainly during sunlight hours, while extending electricity

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excellent direct sunlight, since they are rare both in Morocco and around the world. The three coastal sites that were initially retained can naturally benefit from sea water cooling, but it remains to be verified through on-the-ground measures whether they have the direct sunlight required for CSP technologies.

**3.** Except, however, for possible solar “boosters” to be inserted into thermal power plants (especially coal-fired), currently in use or under development, the only formula today allowing concentration technologies to compete in terms of cost with PV for daytime production when the sun shines. The revitalisation project of the Jerada coal plant in the eastern province, a few kilometres away from the Ain Beni Mathar site, is in this respect an opportunity that should be considered.

generation to also cover part of the evening peak demand thanks to a modest storage capacity for electricity hours (even more modest in terms of the thermal power collected by the solar power plant). The idea was to accept over-expenditure while participating in the global effort to implement CSP technology so as to lower its cost. This over-expenditure is borne by the state budget.

However, it appears today that this over-expenditure can be significantly reduced. PV electricity is approximately at cost parity with the marginal cost of electricity at regular hours, which will soon be that of gas-fired plants. Similarly, the cost of CSP energy is close to the marginal cost of electricity during peak demand hours, i.e. that of oil-powered generation. It is therefore necessary to build new plants, not so much to lower the cost of the kWh “in general”, but to lower the cost during peak hours, taking into account the firm capacities thus made available. This cost could be higher than that of phase 1 of Ouarzazate,<sup>4</sup> and yet the extra cost for the network is drastically reduced or even nil.

Of course, when a solar power plant is rendered profitable by its production at peak hours, the question of extending its production to half-peak hours can be viewed in other terms – especially when these hours coincide with maximum sunlight. In fact, such an extension only requires extending the solar power plant itself, since the costs of alternative turbines and the connection to the network are already underwritten. A solar power plant designed to cover total supply at peak hours during the least sunny months will in any case supply large amounts of electricity in the spring and summer.

## OTHER APPLICATIONS OF SOLAR ENERGY

Numerous other applications for solar energy are very underdeveloped in Morocco due to the considerable fossil fuel (particularly butane) subsidies. Conversely, it could be said that developing these applications today offers very important leverage to reduce the considerable weight of these subsidies in the Moroccan state budget. In this respect, solar water heaters in the residential and commercial sectors, and PV pumping in agriculture – within or outside the network – bear mentioning.

Judging from international comparisons, the level of provision of solar water heaters is still low in Morocco, due to the very high levels of butane subsidies. The government has acted to promote solar energy. This programme requires the establishment of a local industry, professional training and certification, and equipment certification. Soon, however, the profitability of domestic water heating should be ensured through the gradual elimination of butane subsidies. Solar water heaters could eventually become compulsory in new constructions, as is the case today in Spain.

Other heating needs at various temperature levels in industry and services could be met through solar technologies, without concentration for low temperatures (washing, etc.) or with different levels of concentration depending on the temperature levels (or steam pressure) required. The textile, agri-food, pharmaceutical and chemical industries in particular are likely to offer interesting market niches for solar technologies – all of which are affordable by local manufacturers – thereby reducing their consumption of oil, diesel, natural gas or coal, as well as the generous subsidies granted to oil and diesel. There are today many solar technologies that can supply all the desired temperature

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4. This increase would result from a higher MW/kWh ratio. The transition to melted-salt tower technologies (both as transfer fluids and storage media) should, however, reduce the storage cost strictly speaking by a factor of three and facilitate the complete coverage of peak hours. It should also lower the investment cost for the power plant and receptor as a whole.



levels when the solar resource – and more precisely direct sunlight – makes it possible to concentrate sunlight. Some sectors with seasonal energy requirements (e.g. sugar refineries) could use their CSP plants both to generate high-temperature steam to meet their own needs in the spring (when the solar resource is at its highest, but electricity consumption is lowest) and inject electricity into the network during most of the year – a kind of deferred co-generation.

In the longer term, Morocco could produce various energy vectors derived from the sun's radiant energy both for its own consumption and for export. Sustained R&D efforts are recommended to enable the country to participate fully in these new developments.

## RECOMMENDATIONS

*In the field of solar energy, the government of Morocco should:*

- *In the framework of initiatives to open up the medium voltage market and to encourage the supply of renewable energy at low voltage, unlock the potential for PV production in the low and medium voltage electric grids belonging to ONEE and the distributors, e.g. by granting priority access and one or several purchase rates for a period of 20 to 25 years at similar levels to those of the marginal cost of electricity generation at regular hours and which are sufficiently attractive but reviewable, while capping the annual amounts of financial commitments for this purpose.*
- *Orient more clearly the development of large CSP plants to priority production during peak hours after sunset.*
- *Accelerate the implementation of the programme for installing residential and commercial solar water heaters, as well as the programme for developing PV pumping for irrigation purposes, thus helping reduce both the value and volume of butane subsidies awarded through the Compensation Fund.*
- *Identify the heating needs of the agricultural, industrial and service sectors by temperature levels and periodisation.*
- *Identify and develop specific technologies to meet these needs economically through solar energy.*

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## 7. OIL

**Key data (2012)****Crude oil production:** 6.5 kt (negligible)**Imports of crude oil:** 5.4 Mt**Net imports of oil products (including petroleum coke):** 6.1 Mtoe**Consumption of oil products by sector:** transport 37.4%, industry 20%, commercial/agriculture 13.6%, electricity generation 12.3%, residential 11.9%, other transformations 4.7%**Share of oil:** 67.6% of TPES and 25.3% of electricity generation\***National demand for oil products:** 10.5 Mtoe (including 1 Mt of petroleum coke)

\* All the energy statistics in this document were produced according to international standards (International Energy Agency [IEA], United Nations and EUROSTAT databases). Nevertheless, the IEA has always counted petroleum coke as an oil product and not as a kind of coal, even if 100% of the petroleum coke in Morocco is consumed in coal plants. Thus, the percentage of oil in the energy mix appears higher in IEA statistics.

## OVERVIEW

Oil is the main source of energy in Morocco representing 67.6% of TPES in 2012. Since 2002, the supply of oil products in Morocco has increased by 83.1%, in line with the strong growth in oil product imports.

Since indigenous production is negligible, Morocco is very dependent on imports of both crude oil and oil products.

A system of indexing product prices was put in place in 1995, based on international prices. However, in September 2000 certain key products were de-linked from international markets to limit the rise in domestic prices. With the rise in international product markets over the last decade, domestic retail prices moved further and further away from international prices. This had an impact on both the balance of payments and the government budget.

The government decided therefore to bring prices for motor fuels (super and diesel) and for fuel oil progressively into line with international markets. Being guided by the ceiling on hydrocarbon subsidies stipulated in the 2013 budget (at MAD 35 billion), the government put in place a system of partial indexation for motor fuels and industrial fuel oil.

This partial indexation, which came into effect on 16 September 2013, recognised the needs of both sustainability and social solidarity. It fixed a level of subsidy for certain products based on the budget law, with consumer prices reflecting, partially, both the rise and fall in international markets. The government could thereby cap the subsidy bill within the limits set by the budget and avoid overspending.

A second revision of the indexation system was adopted in January 2014. The government decided to fully decompensate gasoline and industrial fuel oil from 1 February 2014, and fuel oil for electricity generation from 1 June, leaving butane and diesel oil as the only fuels still subsidised.

For diesel oil a decree of the Ministries of Finance, Energy and General Affairs set a fixed rate subsidy that would decrease by MAD 0.45/litre every three months to the end of 2014. The retail price is then set on the 16th of each month against refinery gate prices recorded over the preceding two months and international prices on the Rotterdam market, as used in the existing indexation system.

This helps to cushion the price from fluctuations in international markets. Retail prices are adjusted whenever the index moves (up or down) by more than 2.5%. The process is transparent, while the decision whether to adjust prices will depend on both the international product market and on the MAD/USD exchange rate.

The last reduction of MAD 0.45/litre for 2014 will come into effect on 16 October. From then onwards, the subsidy will remain at MAD 0.80/litre.

The IEA congratulates Morocco on these decisions and the success with which this important initiative has been addressed.

## EXPLORATION AND PRODUCTION

In the framework of its plan of action and in keeping with its National Energy Strategy, Morocco is pursuing its momentum and consolidation of oil exploration by attracting as many investors as possible and intensifying research. Currently, 34 international oil companies, including major companies, super- independents and independents, operate in different regions of Morocco, both offshore and onshore.

Today, exploration wells are being drilled in the most advanced exploration areas and Morocco is sparing no effort to promote and intensify oil exploration of its sedimentary basins by its own means or in partnership with international companies. At the end of 2013, hydrocarbon research covered an area of 394 000 square kilometres (km<sup>2</sup>), with 142 exploration permits (including 90 offshore), 6 survey authorisations (including two offshore), 12 development concessions and four memoranda of understanding on oil shale.

Morocco evaluated the potential for oil shale in the 1980s and 1990s. The resources are estimated at 50 billion barrels, with Morocco ranking sixth globally in terms of oil shale resources. The characteristics of oil shale, and its complexity in terms of valuation, mean that Morocco has still not reached the stage of industrial exploitation to date.

Since 2005, the government of Morocco has implemented a complete strategy for developing oil shale, focused mainly on partnerships with oil companies and/or process-owning companies. It bears noting that tests were conducted and pilot sites established between 2006 and 2007, which have however not matured from an industrial standpoint. Today, tests continue to take place in the Tarfaya and Timahdite regions, including pilot tests. However, the production stage has not been reached yet.

National hydrocarbon production is concentrated in the Essaouira and Gharb regions, mainly covering natural gas and condensate for use by local industries. In 2013, sales totalled 45.16 million cubic metres (mcm) of natural gas and 5 936 tonnes of condensate, a 4% increase over 2012.

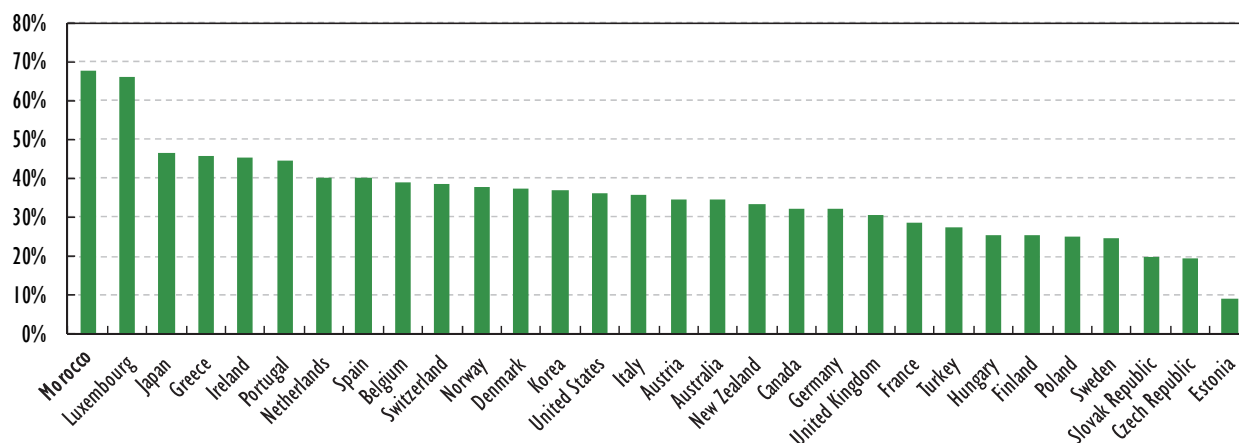
The number of interested companies and the pace of drilling in Morocco are on the increase. This is the result of the attractiveness of the hydrocarbon legislation, the prospectivity of Morocco's sedimentary basins and the partnership and promotion strategy undertaken by Morocco.

However, Moroccan basins are not sufficiently explored by international standards and Morocco and its partners are determined to further and step up exploration efforts to better develop the subterranean oil potential.

## SUPPLY AND DEMAND

Oil products are the primary source of energy in Morocco, accounting for 67.6% of total primary energy supply (TPES) in 2012 (see Figure 7.1). Since 2002, Moroccan oil supply has increased by 83.1%, thanks mainly to growing demand for oil products.

**Figure 7.1** Share of oil in Morocco's TPES compared with IEA member countries, 2012



Sources: IEA (2013b), *Energy Statistics of Non-OECD Countries 2013*, OECD/IEA, Paris; IEA (2013a), *Energy Balances of OECD Countries 2013*, OECD/IEA, Paris.

## SUPPLY

Given its negligible national production, Morocco is dependent on imports of crude oil and oil products.

Fuel oil and gasoil account for the lion's share of production by the Moroccan Refining Industry Limited Liability Company (SAMIR) refinery, with fuel oil representing 30% and gasoil representing 36% of its total 2012 production. Other products included jet fuel (13%), naphtha (7%) and gasoline (6%).

Morocco also imports oil products in order to meet its growing demand. In 2012, total imports of oil products amounted to 7.2 million tonnes (Mt), including 1 Mt of petroleum coke. Unlike crude oil, oil product imports have experienced phenomenal growth over the last decade, posting a 264% increase since 2002. The largest increase occurred in 2003, with imports almost doubling in one year in the wake of a major fire at the Mohammedia refinery (in November 2002) which led to its temporary shutdown. Since 2003, imports have increased at an annualised rate of 7.4%. In 2012, gas oil and diesel oil accounted for 33.3% of total oil product imports and liquefied petroleum gas (LPG) for 32.3%.

Exports of oil products are modest and relatively stable: 1.04 Mt in 2012. Kerosene-type jet fuel and naphtha are the country's main exports.

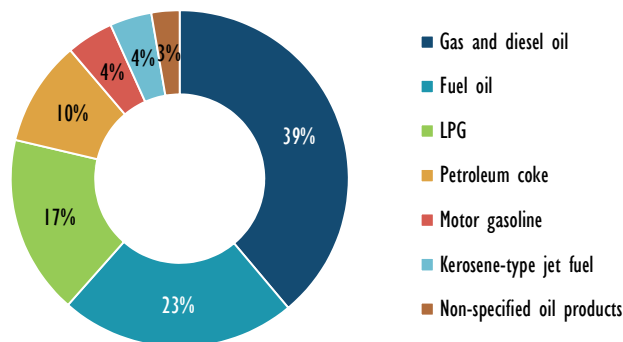
When compared with IEA member countries, Morocco has the highest share of oil in its TPES, followed by Luxembourg, Japan and Greece.

## DEMAND

Morocco's oil product demand totalled 10.78 Mt (including 1 Mt of petroleum coke) in 2012 (220 thousand barrels per day (kb/d) in 2012) – a 1% increase compared with 2011. Even so, spurred by economic and demographic growth, annual demand growth has remained strong since 2002, with an annualised rate of 6% over 2002-12.

Gas oil and diesel oil account for 39% of total demand (Figure 7.2). Thanks to the considerable subsidies provided for diesel, this fuel is much less expensive than gasoline and the vast majority of the vehicle fleet in Morocco features diesel engines. Diesel is also used in the agricultural sector.

**Figure 7.2** Oil demand by product, 2012



Source: IEA (2013c), *Oil Information*, OECD/IEA, Paris.

Fuel oil accounts for around one-quarter of total demand. LPG accounted for 17.2% of oil demand in Morocco in 2012, compared with only 6% in 1980. Butane has traditionally been used locally as a cooking fuel, but consumption has risen rapidly in recent years as its use has expanded to other sectors, such as agriculture, where it serves to power the engines of irrigation water pumps. The commercial and industrial sectors also use small volumes of LPG. Butane is heavily subsidised. Propane, on the other hand, is sold at international prices. Hence, LPG sales are very largely centred on butane (93.6%).

Demand for gasoline is quite weak, as the number of gasoline-powered vehicles is relatively low compared to diesel-powered vehicles. Gasoline prices are much closer to international prices. Consequently, gasoline prices are much higher than those of diesel as a motor fuel, which explains the low level of gasoline demand in Morocco.

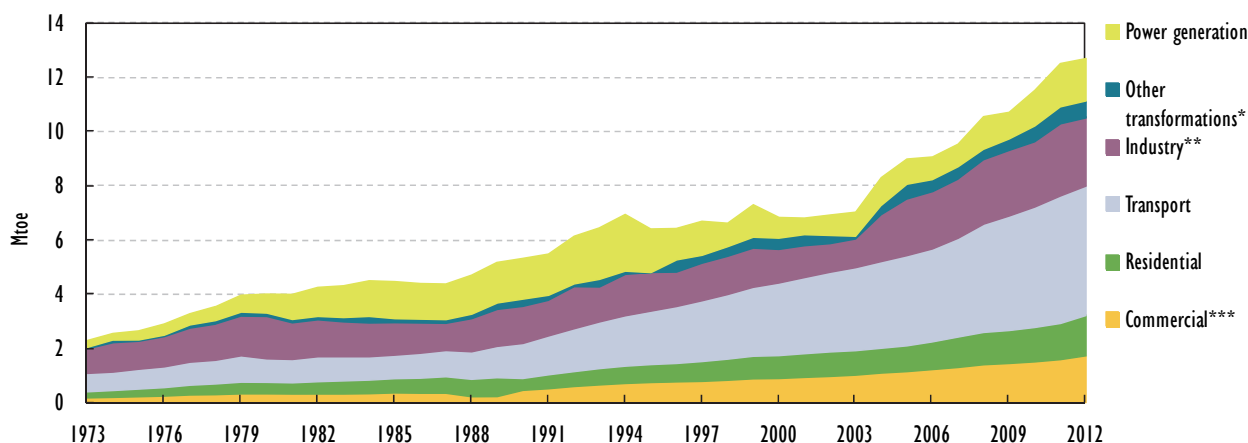
## DEMAND BY SECTOR

Oil is the main source of energy in all sectors in Morocco, except electricity production. Over 99% of all modes of transport are powered by oil products, while 68.2% of the energy consumed by the industrial sector derives from oil products. Oil products account for 55.5% of the energy needs of the commercial, agricultural and residential sectors. With 25.3% of electricity production powered by oil products, the rate of oil use is lower than in other sectors; however, it remains very high in the electricity production sector, especially as regards the costs incurred.

Accounting for 37.4% of total consumption in 2012, the transport sector is the largest consumer of oil products (Figure 7.3). Diesel for road vehicles is the main fuel used for transport. Indeed, the already high level of “dieselisation” of the vehicle fleet grew by around 6% per year between 2000 and 2012. Diesel cars, including over two-thirds of non-commercial

vehicles, now account for over 75% of the vehicle fleet. The industrial sector is another major consumer of oil products (20% of total consumption in 2012), followed by agriculture (13.1%) and other commercial (0.5%), electricity production (12.3%), residential (11.9%) and other transformations including refining and energy own-use (4.7%) (Figure 7.3).

**Figure 7.3** Oil supply by sector, 1973-2012



Note: TPES by consumption sector.

\* *Other transformations* include any other transformation and energy consumption in the sector.

\*\* *Industry* includes non-energy-related use.

\*\*\* *Commercial* includes consumption by the commercial sector, public services, agriculture/forestry, fishing and other sectors.

Sources: IEA (2013b), *Energy Statistics of Non-OECD Countries 2013*, OECD/IEA, Paris; IEA (2013a), *Energy Balances of OECD Countries 2013*, OECD/IEA, Paris.

## REFINING

### INFRASTRUCTURE

The current operational refining capacity is concentrated in a single refinery with a 200 kb/d capacity, the Mohammedia refinery located near Casablanca.

Morocco previously had two refineries. However, the smaller (30 kb/d) refinery of Sidi Kacem, northeast of Rabat, was closed permanently in 2009 as it was not able to meet the more stringent specifications for diesel sulphur content. It was converted into a storage site. SAMIR acquired the two refineries at Mohammedia and Sidi Kacem in 1997, following their privatisation.

Beginning in 2005, the Mohammedia refinery undertook a project to upgrade and expand its facilities, which it completed in 2012. The goal was to improve the profit and refining margins by increasing the refinery's complexity, and particularly improving the production of middle distillates and fuel quality.

After the first phase was completed in 2009, the refinery was able to meet the more stringent « EURO IV » (50 parts per million [ppm] standards for automotive diesel).

The second (more costly) phase of the project, which included the installation (in 2010) of a new 36 kb/d hydrocracking unit, has increased production of middle distillates to about 50% of oil product production, as well as produced motor fuels with a sulphur content lower than or equal to 50 ppm (see Table 7.1).

In parallel, a bitumen production unit with a capacity of 280 000 tonnes per year was also built in 2011 to meet the needs of the internal market for this product. The final phase of the

refinery upgrading project was the addition of a crude oil distillation unit with a capacity of 4 Mt per year (i.e. 36% additional capacity). This last phase was completed at the end of 2012.

**Table 7.1** Key characteristics of the Mohammedia refinery, 2012

Atmospheric distillation	10 Mt/year (200 kb/d)
Vacuum distillation	2.7 Mt/year (60 kb/d)
Hydrocracking	1.8 Mt/year (36 kb/d)
Storage capacity	1.7 Mt (2 million cubic metres [mcm]: 1 mcm crude oil and 1 mcm oil product)
Nelson complexity index	12.8

Source: information provided by the Moroccan government.

Given the level of complexity attained by the refinery after installation of the hydrocracking unit, it is now operating today on a relatively reduced range of crude oil sources, due in great part to supply contracts with suppliers from the Middle East, and particularly Saudi Arabia. In 2012, the refinery's crude oil supply comprised Arabian Light (around 47%), Basrah Light (12%), Kirkuk (15%) and an assortment of other kinds of crude oil.

## SUPPLY AND DEMAND BALANCE

Total imports of oil products (excluding petroleum coke) amounted to around 6 Mt in 2012, LPG and gasoil comprising over 80 %.

The modernisation and expansion of the SAMIR refinery at Mohammedia greatly enhanced its capacity to meet internal demand for oil products, thanks in great part to the increase in production of middle distillates (gasoil and jet fuel) and the decrease in fuel oil production. Before construction of the hydrocracker, gasoil production averaged 36 %. It now accounts for over 50% of total oil product production.

This refinery's modernisation should help harmonise its production of oil products in relation to the demand structure for such products in Morocco. In theory, the refinery, if it was running at a high rate of return, would be able to produce over three-quarters of Morocco's current demand in diesel and gasoline. The construction of the hydrocracker was specifically intended to reduce the production of heavy products (known as "barrel bottoms") and increase production of middle distillates (particularly diesel).

But despite the diesel deficit in Morocco, the refinery is not able to sell its total diesel production to distribution companies, due to more sizeable (and less costly) product imports. Nevertheless, the refinery continues to be the main source of supply for the country's considerable demand in fuel oil.

The refinery's production of jet fuel is much higher than demand (195%), while its production of LPG meets just over 5% of national demand.

## LOGISTICS AND DISTRIBUTION

### OIL PIPELINES

Morocco has two 200 km-long oil pipelines connecting the Mohammedia refinery to the Sidi Kacem deposit: an oil products pipeline with a 14-inch diameter and a crude oil pipeline with an 8-inch diameter. The crude oil pipeline was abandoned following the



shutdown of the Sidi Kacem refinery. The oil product pipeline, on the other hand, is still operational. It has a capacity of 2 Mt per year, making Sidi Kacem a distribution centre.

In 2009, a 16-inch oil pipeline was built at the Mohammedia refinery, connecting it to an oil import terminal at the port of Mohammedia and allowing the refinery to receive crude oil imports from large oil tankers.

The absence of oil product pipelines means that refined products are transported by road, rail and sea to the country's largest demand centres. The refinery, which is located near Casablanca and Morocco's industrial heartland, is well positioned from a purely logistical point of view to distribute oil products.

## PORTS

The port of Mohammedia is the country's main point of entry for oil products and accounts for around 80% of all product imports. The port features four dedicated platforms for refined products and LPG, each of which is capable of accommodating simultaneously two tankers with a 150 000 tonne dead weight (dwt) capacity.

Morocco is working to increase its port activity dramatically thanks to the construction of the Tanger Med port terminal, which it hopes to turn into the largest port in the Maghreb and a major transshipment hub in the Mediterranean region. Thanks to a favourable tax regime and ideal geographic location (near the Strait of Gibraltar), Tanger Med has also developed a large industry in international marine bunkers.

## STORAGE

### Liquid fuel products

Distribution companies' storage capacity for liquid fuel products (excluding LPG) amounted to 1.2 million cubic metres in 2014.

The Mohammedia refinery has a capacity of 1 Mt for liquid fuel products and 1 Mt for crude oil. Morocco's storage capacity continues to increase in a bid to meet the challenges presented by economic development, national ambitions and growing demand in oil products. Morocco is working on developing additional points of entry for oil import products, with a view especially to meeting the challenges of security of supply. The completion of the Tanger Med port terminal alone increased the country's total storage capacity by 25%, thanks to the construction of new storage facilities with a capacity of 508 000 cubic metres.

Other storage infrastructures have been built at Dakhla, Jorf Lasfar and Laâyoune. And yet, the bulk of the country's storage capacity is located close to its major cities and to the industrial and economic demand centres in the northwest region.

Given the considerable internal demand for diesel, most storage infrastructures are used to store this product.

### LPG

LPG plays a major role in Morocco, since it accounted for 17% of total demand for oil products in 2012. It has high degree of penetration and consumption in Moroccan households.

SAMIR produces just under 100 000 tonnes of LPG per year only – which amounts to around 5% of the country's annual demand. As a result, efforts to develop import and storage infrastructures should be pursued in order to meet the country's demand for LPG.

The country's overall butane (domestic LPG) storage capacity is over 260 000 tonnes over the network of terminals and filling centres. Morocco has 37 filling centres, 75% of which are directly connected to a port facility.

The Moroccan Storing Company (SOMAS) owns the largest butane storage capacity (200 000 tonnes) in the country.

## POLITICAL FRAMEWORK

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Due to its strong dependence on imported energy, Morocco is especially vulnerable to market disruptions and price volatility – all the more so in this dawning era of expensive energy and the uncertain global context.

The Ministry of Energy, Mines, Water and the Environment, which is responsible for the country's energy development, has integrated the international and national dimensions of these data and developed, in accordance with the High Royal Instructions, a new national strategy to meet these challenges. The strategy's main goals are to ensure the security of supply and availability of energy, generalised access to reasonably priced energy, demand restraint and environmental protection. To meet these goals, the strategic directions as set out in the short, medium and long-term action plans have defined the guidelines to be followed to satisfy growing energy demand.

With regard to oil products, the security of energy supply must be ensured by establishing strong and stable access to oil resources, integrating into regional and international markets and developing the potential of local energy sources.

Morocco's dependence on imports must be further reduced by encouraging upstream exploration, developing national sources of renewable energy and curbing its growing energy demand.

The energy infrastructure is crucial and the government is focusing on building and expanding port terminals, particularly import facilities for energy resources. The government has also expressed interest in designing a strategic storage programme for refined oil products.

Energy demand is growing at a rapid annual rate, which is proving costly from the point of view of subsidies. The government is currently analysing how to reduce growth in energy demand by refocusing subsidies where they are most needed (e.g. the lower socio-economic strata of society).

The last pillar of the government's energy plan is environmental conservation, for which it is taking important measures. The properties required of fuels derived from oil products have gradually become more stringent, with the gradual phasing out of lead kerosene in 2006 followed by leaded gasoline in 2009 and the gradual reduction of the sulphur content of motor fuels to 50 ppm in 2009. Notable efforts have also been made to modernise the vehicle fleet and the industrial base, including a ban on imports of used vehicles more than five years old.

## COMPETITIVE ENVIRONMENT

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### THE RETAIL MARKET

Morocco's distribution sector was privatised in 1995, when the national oil product company SNPP was privatised and international oil companies – Total, Shell and ExxonMobil – acquired local subsidiaries.

Today, 18 distribution companies operate in Morocco's liquid petroleum products distribution sector and the retail network numbered 2 400 service stations at the end of 2012. The market is dominated by three companies, which together hold about two-thirds of the market.

Price competition is limited because retail prices and margins are fixed by the government according to price structures that factor in international prices (see the following section, "Prices"). Consequently, companies seek to stand out by offering additional services, such as small convenience stores and mechanical services, supported by marketing campaigns.

## IMPORTS

The two refineries, Mohammedia and Sidi Kacem, were privatised in 1997, and then sold to SAMIR, which maintained a monopoly on oil imports. Following a fire at the Mohammedia refinery in November 2002, the government lifted import duties on oil products, which had been designed to protect the refineries.

Distribution companies increasingly purchase their oil products directly from abroad.

## EMERGENCY RESPONSE POLICY

Distributors are required to hold the equivalent of two months (60 days) of oil product sales, and refiners must hold the equivalent of one month (30 days) of crude oil sales.

Morocco's total storage capacity is only 1 243 000 tonnes: 973 000 tonnes of liquid products, 260 000 tonnes of butane and 12 800 tonnes of propane. Hence, even if all the storage facilities had been filled to the maximum, Morocco would only have held the equivalent of 47 days of net imports at the end of 2012. Indeed, the government estimates that the country held 350 000 tonnes of stocks at the end of 2012, equivalent to about 20 days of consumption. The stock levels of oil products held by distribution companies are below the requirement set out in legislation (60 days of sales equivalent for distribution companies), but also below the requirement imposed by the IEA on its member countries (see Box 7.1).

The Moroccan government has indicated interest in developing the country's storage capacity, with an eye particularly to handling emergency situations affecting security of supply. However, the financing of the strategic storage programme is problematic, as it would require covering the costs associated both with building the infrastructure itself and the high costs of hydrocarbons.

### Box 7.1 IEA stockholding requirement for member countries

Each IEA member country is required to hold the equivalent of at least 90 days of net oil imports.

Currently, three IEA members who are net exporting countries (Canada, Denmark and Norway) are not subjected to this storage requirement in the framework of the International Energy Programme.

The minimum stockholding requirement set by the IEA is based on the net imports of oil products as a whole, including primary products, such as crude oil, and refined products. It does not cover naphtha and oil volumes used for international marine bunkers.

**Box 7.1** IEA stockholding requirement for member countries (continued)

The 90-day requirement imposed on each IEA member country is based on the average net daily imports of the previous calendar year. This requirement can be met by counting stocks maintained exclusively for security purposes and stocks maintained for commercial or operational purposes, including stocks maintained in refineries, port facilities and berthed oil tankers.

The requirement lists several types of stocks that cannot be counted towards fulfilling it, in particular military stocks, volumes contained in oil tankers at sea, oil pipelines or service stations, and quantities already purchased by final consumers (tertiary stocks). Crude oil volumes that have not yet been produced also do not meet this requirement.

IEA member countries can arrange to stock the oil outside their national borders and count these stocks towards the minimum requirement. This is particularly important for countries in which constraints related to storage capacities or supply logistics mean that domestic stockholding is insufficient.

To exercise this option and count the stocks held abroad towards this requirement, the governments concerned must have bilateral agreements ensuring unconditional access to the stocks in case of emergency. When evaluating a country's compliance with the 90-day stockholding requirement, the IEA applies a 10% decrease of the country's total stock, after deduction of the oil held under bilateral agreements. This includes technically unavailable volumes, such as tank ends. (For more on this subject, see the IEA methodology on the Agency's website.)

Source: IEA website.

**PRICES**

With the exception of a few niche and small markets (propane, jet fuel, lubricants, diesel for fishing vessels, premium gasoline, industrial fuel and fuel used for electricity production), prices of oil products (diesel and butane) remain subsidised and do not reflect the real market cost. Oil product prices are revised every 15 days (except for diesel and butane prices, which are revised monthly), based on international prices quoted in Rotterdam.

**Box 7.2** Oil product subsidies

The Compensation Fund directly subsidises several commodities, and especially sugar and energy products. Due to increasing energy demand and higher energy prices, energy product subsidies came to represent an ever-increasing proportion of the amount allocated to subsidies, and in 2012 accounted for approximately 84% of the Compensation Fund's total expenditure. The money is levied directly on the state budget. The amount of subsidies (in MAD billion) is as follows:

2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
0.7	3.7	7.4	7.7	10.7	24	8.2	22.9	43	47

The prices of all oil products have been liberalised and the old prices charged by the refinery were indexed to Rotterdam prices in 1995. However, this indexation was phased out in September 2000 for a number of key products in an attempt to limit increases in domestic prices. Due to rising commodity prices over the last decade, domestic retail prices in Morocco have gradually distanced themselves from international prices.

**Box 7.2** Oil product subsidies (continued)

The Compensation Fund covers three categories of oil products. The subsidy levels listed below cover the period between 1 and 15 April 2014:

- Diesel (50 ppm): This heavily used product is subsidised to the tune of MAD 1.90 per litre. In 2012, diesel alone accounted for MAD 21.6 billion of the Compensation Fund's expenditure.
- Fuels destined for electricity production:
  - fuel oil No. 2, subsidised at MAD 3 226.81 per tonne
  - special fuel oil, subsidised at MAD 4 426.18 per tonne.

In 2012, the subsidies for these two fuels totalled MAD 7.2 billion. The government considers this equivalent to a 15% subsidy on the price per kilowatt hour.

Butane is strongly subsidised for social reasons. The 12 kg cylinder of butane gas is currently subsidised to the tune of MAD 82.07. In 2012, the total gas butane subsidy amounted to MAD 15.8 million.

The government decided to fully decompensate premium gasoline and industrial fuel from 1 February 2014, and fuel oils used for electricity from 1 June; thus, only butane and diesel are still subsidised by the state.

Source: government of Morocco.

Wholesale and retail margins are set by the government, based on a price ceiling. The retail margin previously consisted of a percentage of the pump price (3%); the government now regulates distribution margins in absolute terms (i.e. MAD 0.28 per litre for diesel, MAD 0.38 per litre for premium fuel and MAD 90 per tonne for fuel oil).

**Box 7.3** A sustained effort to reduce subsidies

At the beginning of 2014, by the interministerial decree of 15 January, the government set a gradually diminishing scale for the 2014 per-unit subsidy on diesel, as follows:

- 16 January: MAD/L 2.15 (Moroccan dirhams per litre)
- 16 April: MAD/L 1.70
- 16 July: MAD/L 1.25
- 16 October: MAD/L 0.80

At the same time, the maximum resale price for 16 January, calculated on the basis of the average Rotterdam fob prices of the previous fortnight for premium fuel and diesel, have been set as follows:

- Premium fuel: MAD/L 12.02
- Diesel: MAD/L 8.54

The government opted to fully decompensate premium fuel and fuel oil for industrial use from 1 February 2014, and fuel oils for industrial use from 1 June 2014; thus, only butane and diesel are still subsidised by the state.

The government decided to fully decompensate premium gasoline and industrial fuel from 1 February 2014 and fuel oils used for electricity from 1 June; thus, only butane and diesel are still subsidised by the state.

The price of butane is particularly low due to the subsidies, as it is the main domestic fuel used for cooking and heating and is heavily used by low-income households. Consequently, the price of a 12 kilogramme cylinder of LPG has not changed since 1990 and is stuck today at MAD 40. The current subsidy for a butane gas cylinder (MAD 82.7) represents about two-thirds of the actual cost of the cylinder (MAD 122.07).

## ASSESSMENT

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### SUPPLY AND DEMAND

Oil is by far the largest energy resource in the Moroccan economy, accounting for two-thirds of energy consumption. Oil products are the basis of almost all of the transport system. They contribute significantly to the residential (mainly LPG), industrial and agricultural sectors (diesel and LPG) and also play an indirect role in electricity production. The consumption of oil products has risen sharply (by around 5% per year) since 2000 and demand is forecast to continue to grow around 3% per year until 2020, driven by both demographic and economic growth.

However, oil production is negligible and the country is heavily dependent on imports to meet its consumption needs. Upstream drilling is still limited at this stage, but international companies – encouraged by favourable conditions for the granting of exploration and production licenses – are showing heightened interest in offshore exploration in Morocco. In addition, Morocco has large oil shale reserves, which remain unexplored to date. The gradual development of new technologies in this area may one day ensure both economically viable and environmentally sustainable exploitation of these resources and Morocco may benefit from research partnerships – particularly with foreign institutions and universities – to maximise the region's yield potential.

Morocco's diesel demand has grown faster than gasoline demand. This common trend is observed in many OECD countries, but has been exacerbated in Morocco by the much lower retail diesel prices owing to government subsidies. Today, diesel accounts for almost 40% of oil product demand. This is reflected in the gradual "dieselisation" of the fleet, with three-quarters of all vehicles (and two thirds of private cars) in Morocco featuring diesel engines.

Morocco is aware of its growing deficit in oil products (and particularly in diesel and LPG, which together account for 80% of oil product imports). While recent investments in the SAMIR refinery at Mohammedia (installation of a hydrocracker in 2010 and 45 kb/d capacity increase in 2012) have resulted in increased production of middle distillates, these upgrades have had (and will continue to have) little effect on the country's growing deficit in net oil product imports over the long term.

Demand for butane (LPG) is particularly high – accounting for around 17% of total oil product demand in 2012 – and continues to rise quickly. Demand for standard 12 kg butane cylinders is extremely strong, given that two-thirds of their cost is covered by public subsidies. Two-thirds of butane consumption is still used for residential needs, but due to its very low price, butane is gradually being used by unexpected sectors, such as irrigation water pumping and greenhouse heating. However, the Mohammedia refinery

can only supply modest amounts to meet the needs of the internal market, resulting in a growing reliance on butane imports. While global butane production is relatively stable, demand continues to grow regularly in many developing countries. This could exert upward price pressure and amplify existing subsidies if the government does not take measures to gradually liberalise butane prices in its internal market.

Demand for fuel oil is also both strong and steadily growing, mainly because of the demands of electricity production and the industrial sector – yet the construction of the Mohammedia refinery’s hydrocracker resulted in a decrease in heavy fuel production. The construction of the Tanger Med oil terminal, however, has created a second strategic entry point that will help meet the country’s demand for heavy fuel.

## COMPETITIVE MARKET AND LOGISTICS

The downstream market was liberalised in 1995, and today 18 companies sell oil products in Morocco. The country’s refining industry was privatised in 1997 and acquired by SAMIR. However, after the temporary November 2002 shutdown of the Mohammedia refinery in the wake of a major fire, import duties on oil products were lifted, limiting the influence of SAMIR over the downstream oil product market. From a logistical standpoint, oil products are transported to the distribution centres by road or rail. The government continues to push for the gradual expansion of oil product storage sites and import capacities. The development of coastal infrastructure projects (e.g. Nador West Med) and of Tanger Med has helped enhance the country’s oil infrastructure.

Where security of energy supply is concerned, the government has imposed stockholding obligations equivalent to two months of sales for distribution companies and one month of sales (stored as crude oil) for refineries. Even if the country’s entire storage capacity were filled, operators would not be able to comply with new stock requirements.

## PRICING

The government has taken significant steps to liberalise the Moroccan oil sector, particularly by allowing the elimination of customs duties on oil imports and the emergence of a competitive downstream segment. Price subsidies for oil products, which are financed by the state budget, have gradually increased over the years due to rising commodity prices and growing internal demand. These subsidies amounted to MAD 47 billion in 2012 – 3% of the gross domestic product and close to 20% of the government’s annual revenue – an unsustainable cost to the government over the long term.

Hence, the government has decided to gradually align its prices on the international prices of motor fuel (both premium fuel and 50 ppm diesel) and fuel oil. In September 2013, the government decided to enforce the ceiling (MAD 35 billion) set for total annual hydrocarbon subsidies (as stipulated in the 2013 Finance Law) by establishing a partial price indexation system on automotive fuel prices and No. 2 fuel. The government subsequently decided to fully decompensate premium gasoline and industrial fuel from 1 February 2014, and fuel oils used for electricity from 1 June; thus, only butane and diesel are still subsidised by the state.

However, given its widespread use, butane gas poses a particularly sensitive issue from a social impact point of view. The decompensation of butane prices will have to be done with great care to distinguish the different consumer groups (e.g. residential use versus industrial and agricultural use).

## RECOMMENDATIONS

*The government of Morocco should:*

- Gradually replace butane subsidies with direct monetary subsidies to low-income households, taking into account the possible social repercussions of this subsidy's elimination.*
- Immediately regulate the butane market in order to limit its use in the agricultural and industrial sectors.*
- Ensure the long-term survival of the Mohammedia refinery (for reasons of security of supply) while maintaining a competitive environment.*
- Implement a security stock management mechanism/system in order to manage the risks of a supply disruption in oil products.*

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## References

IEA (2013a), *Energy Balances of OECD Countries 2013*, OECD/IEA, Paris.

IEA (2013b), *Energy Statistics of Non-OECD Countries 2013*, OECD/IEA, Paris.

IEA (2013c), *Oil Information*, OECD/IEA, Paris.



## 8. COAL

### Key data (2012)

**Production:** Nil

**Imports:** 4.6 Mt (3.1 Mtoe)

**Share of coal in energy mix:** 16.1% TPES and 43.4% power generation

**Demand by sector:** power generation 99.7%, industry 0.3%, other 0.1%

## OVERVIEW

Coal plays a major role in Morocco's energy sector – mainly as a fuel in the electricity sector, where it accounted for 25.8% of the power generation capacity and 37.5% of national electrical demand in 2013.

In the medium term, the Moroccan government plans to increase the coal-fired electricity generation capacity from 1 785 megawatts (MW) in 2012 to 4 191 MW in 2018, thus allowing coal to satisfy at least 50% of electricity demand. Given the relatively moderate prices of coal on the international market, this should help reduce the average cost of electricity and control the impact of energy imports on the balance of payments and annual budget.

In order to limit its emissions of greenhouse gases (GHG), especially of carbon dioxide (CO<sub>2</sub>), Morocco relies on thermal power plants using clean coal technologies.

## SUPPLY AND DEMAND

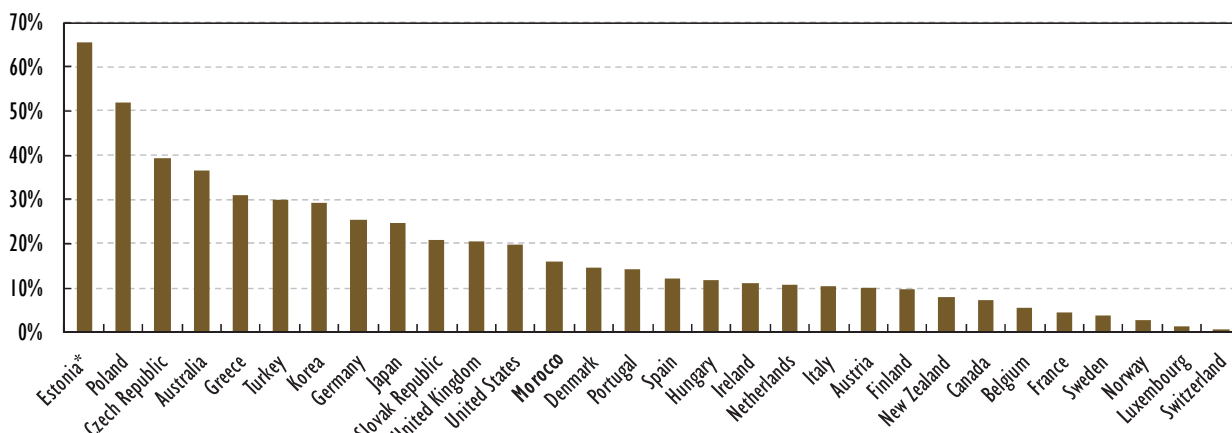
### SUPPLY

Coal accounts for around 16% of total primary energy supply (TPES) in Morocco, i.e. 3 million tonnes of oil-equivalent (Mtoe), or approximately 4.6 million tonnes (Mt) of coal in 2012. The share of coal in Morocco's energy mix has dropped by 13% since 2002, when it accounted for 29% of TPES. This decrease is due to the sustained increase in the consumption of oil products.

Coal production in Morocco ended in 2000, when it amounted to only 12 000 tonnes per year. The Jerada mine (in the eastern region of Morocco) was closed for technical and economic reasons. Production had been on a continuous decline since the 1980s, when it amounted to 775 000 tonnes per year.

Morocco, therefore, depends on imports – essentially from South Africa and Russia – to meet all of its coal needs. These imports increased regularly from 2002 to 2007, stabilising at around 4.1 Mt to 4.6 Mt per year between 2008 and 2012.

If Morocco were a member of the International Energy Agency (IEA), it would rank 13th with regard to the share of coal in the TPES, between Denmark and the United States (see Figure 8.1).

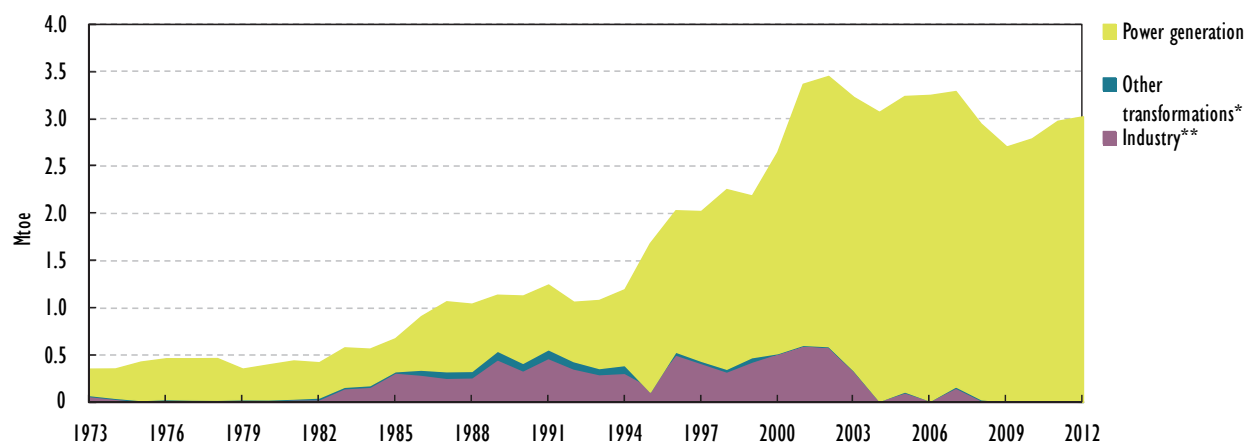
**Figure 8.1** Share of coal in the TPES in Morocco and IEA member countries, 2012

\* Represents mainly oil shale in Estonia.

Sources: IEA (2013b), *Energy Statistics of Non-OECD Countries 2013*, OECD/IEA, Paris; IEA (2013a), *Energy Balances of OECD Countries 2013*, OECD/IEA, Paris.

## DEMAND

The electricity sector accounts for nearly all coal consumption. In 2012, electricity accounted for 99.7% of coal consumption, while industry accounted for only 0.3% (Figure 8.2). Coal consumption was 12.4% lower in 2012 than in 2002, when industry made up 17.4% of coal demand.

**Figure 8.2** Coal by sector, 1973-2012

\* Other transformations include energy-own use.

\*\* Industry includes non-energy use.

Source: IEA (2013b), *Energy Statistics of Non-OECD Countries 2013*, OECD/IEA, Paris.

Beginning in the 1920s, coal from the Jerada mine was used for industry and electricity generation. Anthracite from Jerada, which is located 60 kilometres (km) to the south of Oujda in eastern Morocco, is known for its high quality. Yet during the 1990s, production costs had increased so much that coal extraction was no longer cost-effective in the energy sector. The mine closed in 2000. The small Jerada plant (3 x 55 megawatts [MW], commissioned in 1971) continued to operate with coal transported from the port of Nador by rail and road.

Nevertheless, the government of Morocco wished to keep the share of coal in the electrical energy mix and encouraged the establishment of a clean coal-fired electricity plant at Jorf Lasfar, 100 km southwest of Casablanca on the Atlantic coast. The construction of a port in the vicinity was meant to facilitate supplying coal from international markets.

### **Jorf Lasfar Energy Company (JLEC)**

JLEC signed a 30-year power purchase agreement with the National Agency for Electricity and Water (ONEE) in 1994. Established as a trading company in 1997, JLEC operates the Jorf Lasfar plant, which has a capacity of 1 320 MW and features four units – JLEC 1, 2, 3 and 4.

The company has 3 000 employees and a turnover of approximately MAD 5 billion (Moroccan dirhams). In 2009, the company was bought by TAQA, an investment firm specialised in the energy sector and operating under the aegis of the government of the United Arab Emirates. In December 2013, JLEC went public on the Casablanca Stock Exchange, giving it a market capitalisation of MAD 9 billion.

In 2013 the four Jorf Lasfar units accounted for around 25% of the national power generation capacity. They maintain a very strong availability rate (91%) and supply around 33% on average of daily demand. This contribution can reach up to 44% of daily demand over a period of a few days.

JLEC needs between 4 million tonnes (Mt) and 5 Mt of coal per year. The 4.6 Mt the company bought in 2012 cost it MAD 5.9 billion– a little less than 6% of the national import bill in the energy sector. Since 2009, prices have remained relatively stable. In the 1990s, they varied between USD 25 per tonne (United States dollar) (USD/t) and USD 35/t. In 2008, the prices quickly rose to over USD 200/t, then fell and stabilised at around USD 100/t. According to the JLEC accounts for fiscal year 2013, the average price of coal was USD 93/t, compared with USD 110/t the previous year.

To protect itself from coal market volatility, JLEC puts out every six months a tender for the supply of one-quarter of its coal requirements, to be delivered monthly over the course of one year. In so doing, it receives half of its monthly needs at a price that reflects the international market as it stood during the 12 preceding months. In parallel, it buys the other half of its monthly needs on the spot market (at a price that was formerly based on the European Coal Index and is now based on the API 2 price index). Any other “hedging” strategy would be the responsibility of ONEE, which is ultimately responsible for coal prices.

### **A medium-term strategy**

Since 2002, electricity demand in Morocco has grown steadily. This can be explained by the relatively sustained economic growth rate and the success of the Global Rural Electrification Programme, which helped raise the rate of access to the electricity grid to over 98%.

By 2020, the government of Morocco can anticipate a demographic growth rate of around 1% per year and an economic growth rate of between 5% and 6%, depending on the scenario. Energy demand will probably increase by 4.5% (“energy control” scenario) or 6% (“laissez-faire” scenario). Electricity demand will experience growth of 6% to 9% per year, which translates into an increase from 31 terawatt hours (TWh) in 2012 to between 44 TWh and 55 TWh in 2020.

To meet this challenge, the government plans to invest heavily in renewable energies (see Chapter 6) and to establish a gas distribution grid to industry and the electricity sector (see Chapter 9). At the same time, the government is keen to include coal in its electricity generation capacity for the following reasons:

- to maintain a diverse energy mix
- to take advantage of the profitability of coal-fired power generation to gradually decrease the share of (imported and costly) oil in the electricity sector, thus improving the financial situation of ONEE – international coal prices and market stability favour this approach.

The production capacity equipment programme involves the development of the following power plants:

- 1. JLEC: units 5 and 6: 700 MW
- 2. Safi Energy Company (Safiec): 1 386 MW
- 3. New Jerada plant: 320 MW.

### 1. JLEC units 5 and 6

Following its acquisition by TAQA in 2009, JLEC renegotiated its contract with ONEE. At the same time, it devised a project to expand the plant from 4 to 6 units, which will increase its capacity by 700 MW, from 1 320 MW to 2 020 MW. This project costs around USD 1.8 billion and features a desulphurisation and emission cleansing system costing USD 200 million.

Unit 5, which was completed at the end of 2013, is being integrated into the ONEE grid. Unit 6 should be completed in the course of 2014. When both are operational, JLEC will be able to supply nearly 50% of national electricity demand. Coal imports will also increase by 50%.

### 2. Safi Energy Company (Safiec)

Safi is also located on the Atlantic coast, 200 km southwest of Casablanca. The project consists in building a 1 386 MW plant (two 693 MW units). It will be managed through an independent generation project whose partners are the French company GdF Suez (35%), the Moroccan company Nareva (35%) and the Japanese company Mitsui (30%). Similarly to JLEC, they signed a PPA with ONEE for a period of 30 years.

Similarly to Jorf Lasfar as well, the project – which will cost around MAD 22 billion (USD 2.7 billion) – will include the construction of a port for discharging coal. The plant should be completed in 2017, leading in time to a 3.6 Mt increase in coal imports, to 11 Mt per year.

The project will be developed using “clean carbon” technologies, not only for combustion (the plant will use “supercritical” combustion technology), but also for treating emissions (desulphurisation) and waste (dust discharge).

### 3. Jerada

As indicated above, the little coal-fired plant at Jerada remained operational despite the shutdown of the Jerada mine. In July 2013, the Chinese company Sepco III launched an expansion project for this 165 MW plant which will include an additional unit with a 320 MW capacity. The cost is estimated at MAD 3 billion excluding tax. The work is expected to be completed at the beginning of 2016 – a development that will herald a major increase in coal transport from the port of Nador.

## ASSESSMENT

Since 2011, the price of coal has been seriously limited by a number of developments in the international market: production investments in Australia and Indonesia especially, a slowdown in Chinese demand, the production of unconventional gas in the United States and the consequent release of additional quantities of coal onto the international market. The gradual replacement of oil by coal should therefore have major benefits for the finances of ONEE.

In its forecasts of the international coal markets, the IEA estimates that global demand growth will be mostly dependent on China's economic growth rate and imported coal requirements (IEA, 2012). At the same time, the presence of exporters such as Australia, Indonesia, Colombia, Russia, South Africa, the United States and Mozambique seems to indicate that the Atlantic basin market will remain well supplied with coal until at least 2020.

It should be noted, however, that this increase in coal consumption in the electricity sector will result in an increase in CO<sub>2</sub> emissions. CO<sub>2</sub> emissions per capita have risen slightly since the beginning of the century. The new coal plants will exacerbate this trend, even if coal in the electricity sector displaces a certain amount of special oil. Moreover, CO<sub>2</sub> emissions per kilowatt hour (kWh) of electricity – which had fallen slightly – may reverse this trend, at least in the medium term.

One option to help cap, even modestly, the predicted increase in CO<sub>2</sub> emissions could be to integrate thermodynamic solar fields in these plants – and particularly in the projected plant at Jerada, which is located close to the Ain Beni Mathar site in eastern Morocco and therefore in principle enjoys good sunshine.

Coal plants generally have a higher gross electric capacity than their listed capacity. Normally, maximum efficiency is reached when the steam extractions from the turbine's high-pressure chamber allow pre-heating or even vaporising the feed water. At the request of the network operator when attempting to deal with an exceptional peak in demand, these extractions can be eliminated and the effective power of the plant increased, lowering the plant's energy efficiency. The establishment of a solar power plant makes it possible to supply the coal plant with heat at medium temperatures and to eliminate these extractions when the sun is shining, without lowering the plant's efficiency.

This also helps produce solar kWh at a significantly lower investment than for an independent thermal solar plant. The synergy between the solar power plant and coal combustion is ultimately more propitious than grafting a solar power plant onto the steam cycle of a combined cycle gas plant.

## RECOMMENDATIONS

*The government of Morocco should:*

- *Ensure that investments are in place to import coal not only for the electricity sector but also for Moroccan industry, taking into account the citizens who live near the planned projects.*
- *Closely follow technological developments for carbon gas capture and storage and assess Morocco's storage capacities to eventually lessen the impact of coal consumption on overall GHG emissions.*

- *Consider the possibility of including solar power plants in coal plants (e.g. Jerada) to reduce coal consumption and decrease GHG emissions, while also creating a surge in power and energy without degrading the plants' energy efficiency.*
- *Ensure that any new project in this sector is able to meet the most stringent standards for treating emissions of air pollutants.*
- *Reconsider the possibility of redeveloping local coal resources in the Jerada region by exploring on-site coal combustion technologies (through underground coal gasification). Explore alternative coal deposits in eastern Morocco that could be developed with new extraction technologies.*

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## References

IEA (2013a), *Energy Balances of OECD Countries 2013*, OECD/IEA, Paris.

IEA (2013b), *Energy Statistics of Non-OECD Countries 2013*, OECD/IEA, Paris.

IEA, *Medium-term Coal Market Report 2012*, OECD/IEA, Paris.

## 9. NATURAL GAS

### Key data (2012)

**Production:** 0.06 bcm, +57.5% since 2005

**Imports:** 1.1 bcm, +187% since 2005

**Share of natural gas:** 5.7% of TPES and 22.7% of electricity generation

**Internal demand:** 1.2 bcm, +181% since 2005

**Demand by sector:** electricity 94%, industry 6%

### OVERVIEW

Morocco is currently a small consumer of natural gas, with consumption amounting to 1.2 billion cubic metres (bcm) (2012). It currently produces relatively little gas (0.06 bcm). Demand – which was previously covered only by domestic production for industrial use – increased substantially in 2005 with the advent of the first combined cycle gas project. A second such plant has since been built. Gas demand is therefore very oriented towards the electricity sector. While royalty gas from the transit of Algerian gas through the Maghreb-Europe Gas Pipeline (GME) to the Iberian Peninsula was sufficient to power the first combined cycle, a specific contract with Algeria had to be signed for the second plant.

The electricity sector enjoys a legislative and regulatory framework which allows the use of gas in power generation; but to develop the use of gas in industry and in the commercial and residential sectors Morocco must also develop a legislative and regulatory framework appropriate for expanding the place of gas in the energy mix. Currently, the National Agency for Hydrocarbon and Mines (ONHYM) handles domestic production, Metragaz (a Spanish-Portuguese-Moroccan joint venture company based in Tangiers) manages the exploitation of the Moroccan segment of the transit pipeline and the National Agency for Electricity and Water (ONEE) is the main consumer of gas, interacting directly with Sonatrach, the Algerian national oil and gas company.

### SUPPLY AND DEMAND

Morocco's natural gas market is relatively small, with consumption of around 1.2 bcm in 2012, compared with estimated global consumption of 3 421 bcm (IEA, 2013). While Morocco has been a gas consumer for decades, until 2005 consumption did not exceed tens of millions of cubic metres (mcm) – only 0.3% of the national energy balance, dominated by oil (60%) and coal (30%). Consumption, however, grew significantly with the arrival of Algerian gas in 2005.

### DEMAND

Gas consumption remained modest until 2005, when the first combined cycle was built in Tahaddart (near Tangiers) and supplied through royalty gas from the transit through

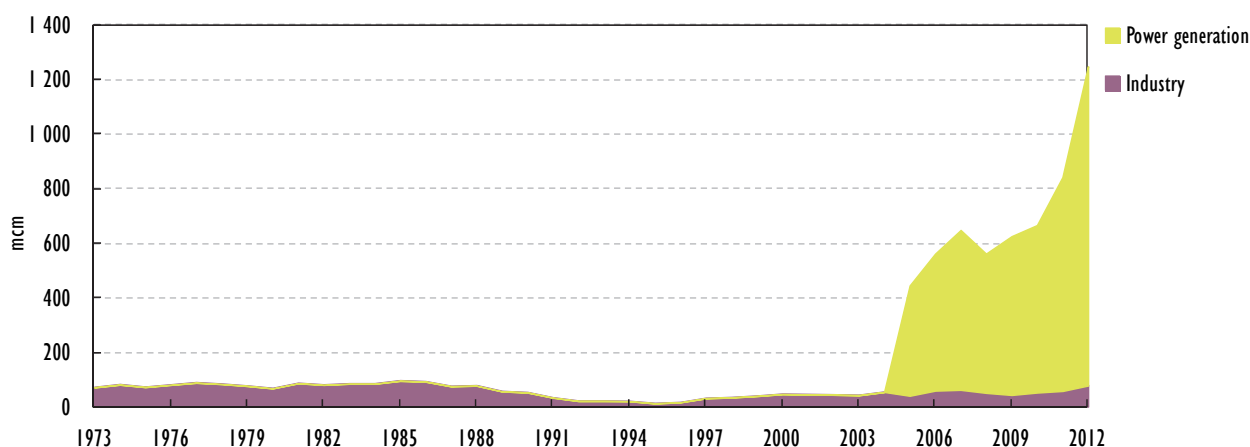
the territory of the GME transporting Algerian gas towards the Iberian Peninsula since 1996. Previously, demand was equal to the national production of tens of mcm. The bulk of demand comes from the electricity generation sector, with some marginal demand from the industrial sector (see Figure 9.1).

Local production of gas in the Gharb and Essaouira basins supplies local industries, such as the Sidi Kacem refinery, the Moroccan Cardboard and Paper Company and the Sharifian Phosphate Office (OCP).

In 2012, demand reached 1.2 bcm. Two gas-fired power stations are operational: Tahaddart (with a 384 MW capacity, put into service in 2005) and Ain Beni Mathar (452 MW, put into service in 2009). Tahaddart consumed 489 mcm and produced 2 830 GWh of electricity, while Ain Beni Mathar consumed 622 mcm and produced 3 370 GWh. The share of natural gas in the electrical energy supply was thus around 23%.

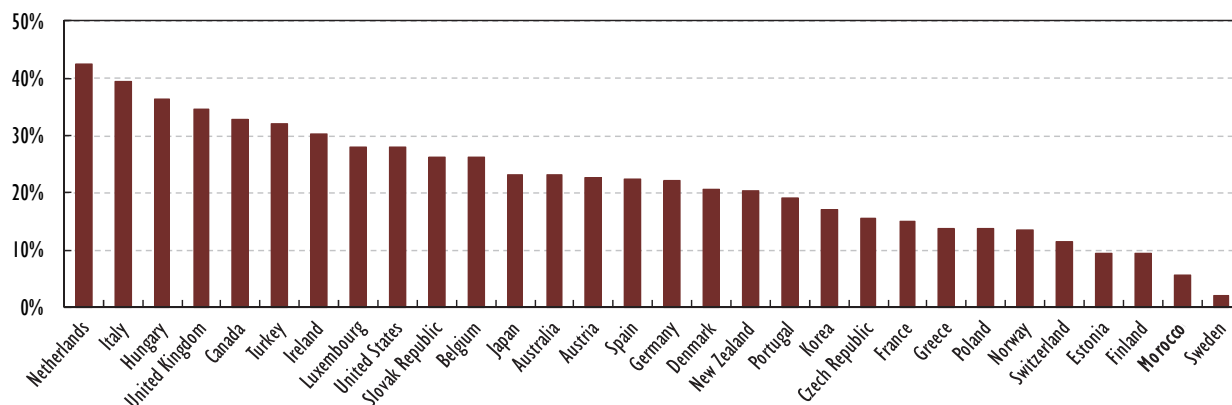
Compared with IEA member countries, natural gas consumption in Morocco remains low (Figure 9.2).

**Figure 9.1** Supply of natural gas by sector, 1973-2012



Source: IEA (2013), *Natural Gas Information 2013*, OECD/IEA, Paris.

**Figure 9.2** Share of natural gas in total primary energy supply (TPES) in Morocco and in IEA member countries, 2012



Source: IEA (2013), *Natural Gas Information 2013*, OECD/IEA, Paris.



In the medium and long term, Morocco expects to increase the share of gas in the energy mix in keeping with the National Energy Strategy to diversify energy sources and forms and to provide energy at least cost.

The decision in favour of the large-scale use of gas in the energy mix, and particularly in electricity generation, is essentially based on the need to introduce additional flexibility into the Moroccan power system which will be increasingly marked by a strong increase in generating capacity from renewable sources susceptible to variability.

Gas demand could reach 9 bcm in 2030. The sectors benefiting from gas would be the power generation sectors, industry (OCP, ceramics, etc.) and the refining industry. In the power generation sector, the plan is to convert some plants that are currently using oil products. Indeed, Morocco has considerable latent demand due to the current use of oil-powered units for both power generation and industry. Once consumers have access to gas, they are likely to gradually switch over to gas which would be cheaper.

Such an evolution of demand would require on the one hand, developing import infrastructures and on the other hand, developing a national transmission network.

## SUPPLY

A small quantity of the gas supply currently comes from national production, with the rest imported from Algeria. In 2012, this quantity amounted to 56 mcm. Gas exploration began in the early 20th century in Morocco, in the Gharb basin. The Sherifian Phosphate Office was created in 1929, but the first gas reserve was only discovered in 1957. In 1981, the National Agency for Oil Exploration and Production (ONAREP) was created and the Meskala field – the largest field in operation – was discovered the same year. Finally, the National Office of Hydrocarbons and Mines (ONHYM) was created in 2005 from the merger of ONAREP and the Bureau of Mining Exploration and Concessions (BRMP). Today, gas exploration and production are concentrated in two regions: the Essaouira basin and the Gharb basin near Rabat.

Given Morocco's geographic proximity with its gas- and oil-producing neighbours, it is possible that the country has yet-undiscovered resources. Several companies, such as Tangiers Petroleum and Longreach Oil and Gas, believe they have identified a geological potential, which drillings during the course of 2014 could translate into reserves. Giants such as Chevron and Total are also starting to show interest in this potential.

The interest of oil and gas companies is also due to the incentives included in the Hydrocarbon Code, which offers tax exemptions on the ten first years of activity, a 10% royalty rate on oil revenues and barely 5% royalty rate on gas revenues, and a total exemption on dividends and capital gains from the sale of company shares. Moreover, unlike many producer countries, Morocco's share via ONHYM is limited to 25% of the capital.

Exploration for unconventional hydrocarbons is also underway, essentially for shale gas. Four companies have partnered with ONHYM under three survey contracts for shale gas exploration. Trials are underway at the Timehdit deposit, but no shale gas is currently produced. According to the United States Energy Information Administration, Morocco has an estimated 12 trillion cubic feet (340 bcm) in technically recoverable shale gas resources in the Tindouf and Tadla basins.

At present, the main supply of natural gas comes from Algeria via the GME. While it was put into service in 1996, the supply of gas to the Moroccan market only began in 2005. The GME pipeline allows Morocco to enjoy a transit royalty of around 600 mcm per year

on average,<sup>1</sup> which initially covered demand. This pipeline now has a capacity of 12 bcm per year (bcm/year), compared with 8.6 bcm/year initially; it is mainly used to transport Algerian gas to the Iberian Peninsula.

In 2011, ONEE and Sonatrach signed a commercial gas supply contract for ten years, since the gas royalty could not cover the additional needs of another plant. In 2012, Algerian gas imports amounted to 1.1 bcm – 634 mcm delivered under this new contract until 2022, to be used exclusively for ONEE power generation, and 477 mcm from royalties. A new supply contract is being considered, within the limits of the available capacity of the GME; its terms could have a significant impact on the projected energy mix by 2021.

## LEGISLATIVE AND REGULATORY FRAMEWORK

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### INSTITUTIONS

The gas sector is the responsibility of the Ministry of Energy, Mines, Water and Environment (MEMEE), which is in charge of defining and supervising the implementation of the government's policy relating to the energy and mining sectors. MEMEE has a range of missions, from managing and developing energy and mining assets, developing access to energy and organising the operations of the energy markets, to ensuring the security of energy supply.

ONHYM oversees the exploration and development of Morocco's potential oil and gas resources. This organisation was created in 2005 through the merger of ONAREP and BRMP. ONAREP had previously been created to exploit Moroccan hydrocarbons through its own means and in partnership with foreign oil companies.

### LEGISLATIVE AND REGULATORY FRAMEWORK

Developing the gas sector requires establishing a comprehensive legislative framework. A "Draft Law on Natural Gas" is in preparation and MEMEE expects to submit it for the appropriate approval process before the end of 2014.

## INFRASTRUCTURE

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### TRANSMISSION AND DISTRIBUTION

The Moroccan gas grid is currently limited and focuses mainly on the GME. The pipeline supplies the two combined cycle plants of Tahaddart (12 kilometres [km] from the GME, near the city of Tangiers) and of Ain Beni Mathar (13 km from the GME, near the city of Oujda). It is mainly dedicated to transporting gas to the Iberian Peninsula.

Distribution is very limited, since gas is only consumed near the GME or the production basins of Gharb and Essaouira. The Circle Oil Company recently built a gas pipeline connecting its fields to the paper industry established in Kenitra.

### INTERNATIONAL GAS PIPELINES

Morocco is traversed by the GME, which supplies the Iberian Peninsula with Algerian gas. The 540 km gas pipeline, which cost USD 2.3 billion (United States dollars), was approved following an agreement between Spain, Algeria and Morocco in 1991. The

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1. When a country is crossed by a gas pipeline, it can choose from among several royalty options: in kind (gas) or cash.

convention signed in 1992 between Morocco, Spain and Portugal provides that the bare ownership of GME shall pass to Morocco in 2022. The financing of the gas pipeline was mainly ensured by banks, such as the European Investment Bank (45%), export credit agencies (19%), European funds (19%) and commercial banks, with the balance (15%) from equity investments. The ownership of gas is transferred to the buyer at the Algerian border, in other words, in Morocco.

Two companies have signed long-term agreements with Algeria: Enagas (Spain, now Gas Natural) and Transgas (Portugal, now called GALP GN): the contracts are valid until 2020. The Moroccan segment of the GME belongs to the state and is operated by the Metragaz company (Gas Natural, Transgas and National Oil Products Company [SNPP]) in the framework of a convention that expires in 2021. The operator of the GME provides weekly information on transit forecasts and hence the available volume of gas royalties. Electricity production is adjusted accordingly.

The Moroccan state receives a transit fee (477 mcm in 2012) either in cash or in kind. The state sells this gas to ONEE for electricity production.

## SECURITY OF SUPPLY

Given its dependence on a single supplier and supply source – except for the limited domestic resources – Morocco is at very high risk in case of a disruption of Algerian supply, which would entail a cut in supply to the two gas-fired power stations currently supplied by the gas pipeline.

## RETAIL SUPPLY AND MARKET

### MARKET STRUCTURE

Gas from domestic production is sold directly to a few industrial customers. Gas from Algeria, on the other hand, directly supplies power plants, either through in-kind gas supplies from transit royalties or through gas supplied under the contract (0.64 bcm/year) signed in 2011 with Sonatrach.

### RECOMMENDATIONS

*The government of Morocco should:*

- *Increase the security of the gas market by diversifying the sources and the means of supply, particularly through the development of LNG.*
- *Pursue and accelerate the development of the gas sector to diversify the energy mix and foster a progressive competitive market mentality.*
- *Establish as soon as possible a development plan for gas infrastructure, including the construction of an LNG terminal, and resulting in the creation of an integrated network for gas transmission.*
- *Accompany the increase in generating capacity from renewable sources with a large-scale introduction of more flexible technologies such as gas-fired power plants.*

- Quickly finalise the “Draft Law on Natural Gas” and its implementation texts, paying particular attention to the following aspects:
  - The development and management of the gas grid should be entrusted to one or several entities that are not involved in the gas trade, and whose activities should be supervised by the future National Energy Regulatory Authority.
  - The methodology for setting the rates charged for using the LNG terminal and the grid should be cost-based and take into account international best practice.
  - A market model should be defined to allow large consumers to import, acquire and resell natural gas on a competitive basis; to this aim, a national market platform could be gradually established as the market develops.

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## Reference

IEA (2013), *Natural Gas Information 2013*, OECD/IEA, Paris.

**PART III**  
**ENERGY TECHNOLOGY**



## 10. ENERGY TECHNOLOGY RESEARCH AND DEVELOPMENT

### Key data (2012)

**Government renewable energy R&D spending:** MAD 250 million

**Share of GDP:** 0.8%

Source: country submission.

### OVERVIEW

Morocco's ambitions in the field of renewable energies were prominently displayed during the launch of the integrated solar and wind programmes under the patronage and instructions of the King. Through these programmes, Morocco aims to ensure its energy independence, reduce its greenhouse gas emissions and diversify its energy mix. It is now increasingly necessary to create a research and development (R&D) pillar in order to ensure that these programmes are sustainable and position Morocco as a leader in the field of renewable energies and energy efficiency.

It is with this goal in mind that the Institute for Research into Solar Energy and Renewable Energies (IRESEN) was created in February 2011. The Institute, under the aegis of the Ministry of Energy, Mines, Water and the Environment (MEMEE), brings together the main national stakeholders in the energy field, namely the National Agency for Renewable Energies and Energy Efficiency (ADEREE), the National Centre for Energy Sciences and Nuclear Technologies (CNESTEN), the Moroccan Agency for Solar Energy (MASEN), the Sharifian Phosphate Office (OCP), the National Agency for Electricity and Water (ONEE), the National Agency for Hydrocarbons and Mines (ONHYM) and the Energy Investment Company (SIE) in order to promote R&D in the applied sciences and develop innovation and networking in the areas of solar energy and new energies. The mission of IRESEN is to define research areas and implement, finance and manage R&D projects in the sector.

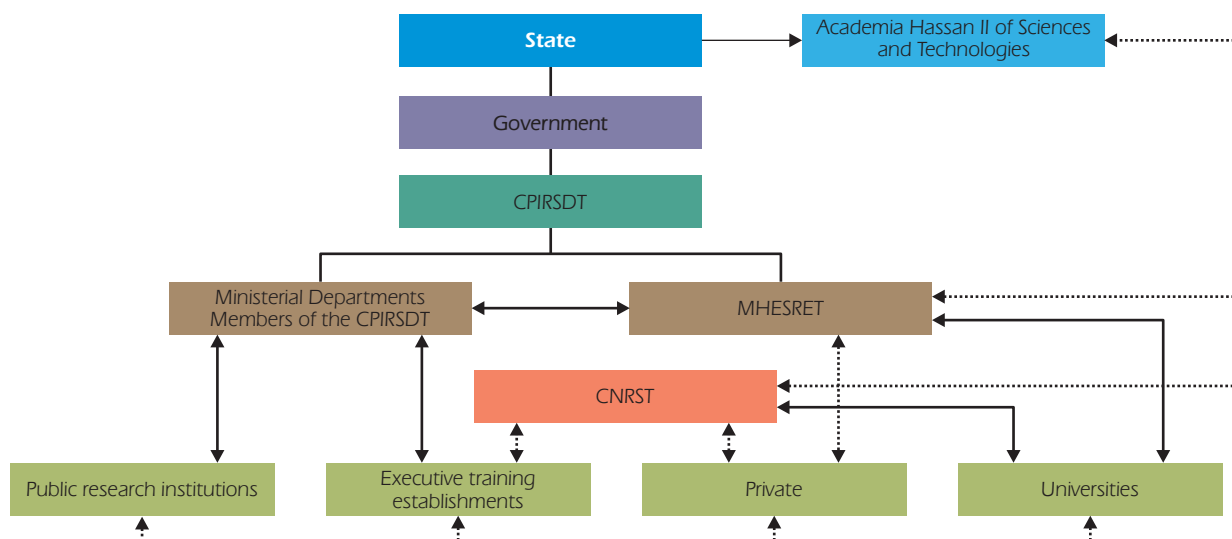
Morocco recognises that its national R&D expenditure (0.8% of the gross domestic product) remains relatively low. Nevertheless, the creation of IRESEN has helped to focus financial resources in the area of renewable energies. In 2012, MEMEE allocated MAD 250 million (Moroccan dirhams) to the Energy Development Fund to support and promote applied and technological research in the field of renewable energies.

In the current economic context, and particularly where energy is concerned, Morocco has the opportunity to reinforce its capacities in energy technology, accelerate the development of renewable energy technologies and expand its role as a regional leader in this field. Since the number of higher education students has risen strongly in recent years, it might be opportune at this time to consider expanding the national R&D budget and strengthening international co-operation, particularly in the field of energy technologies.

## INSTITUTIONAL FRAMEWORK

At the government level, R&D remains the responsibility of the Permanent Interministerial Committee on Scientific Research and Technological Development (CPIRSDT). The administration of the universities and research centres is the responsibility of the Ministry of Higher Education, Scientific Research and Executive Training.

**Figure 10.1** Distribution of R&D responsibilities in the Moroccan state



Source: government of Morocco.

To promote innovation, the Ministry of Higher Education, Scientific Research and Executive Training works closely with the Ministry of Industry, Trade and New Technologies, for example through the Morocco Innovation Initiative, launched in 2009 in the wake of the first Innovation Summit at Skhirate.

The National Centre for Scientific and Technical Research (CNRST), for its part, is in charge of co-ordinating research programmes among the 12 universities and scientific institutions. In 2012, it had around 200 employees, an administrative budget of MAD 15 million and a programme budget of MAD 8.3 million. Since 2011, it has managed 44 scientific programmes, 10% of which pertain to energy technologies. It is also working on 40 incubation and dissemination projects, in co-operation with Moroccan industry.

In the field of energy, the CNRST created the Unit for Renewable Energies and Energy-Saving Technologies, whose aim is to manage and co-ordinate research in energy, water and the environment – not only with regard to solar technologies, but also to wind, hydrogen and fuel cell technologies. Thus, it carried out one of the first studies on the long-term perspectives of wind energy, in collaboration with the National School of Mineral Industry and ONEE/Electricity Branch.

In the international context, the CNRST is responsible for establishing and maintaining connections and collaborative programmes with foreign countries, including over 300 such partnerships with French institutions, 44 with Spain and Portugal and 28 with Italy.



## IRESEN: STRUCTURE AND OPERATIONS

As a major stakeholder in renewable energies, IRESEN has the task of co-ordinating and consolidating R&D activities. Under the aegis of MEMEE, it co-ordinates the actions of the various stakeholders – and particularly of its founding members – in R&D and energy. IRESEN also works closely with other ministries, notably the Ministry of Higher Education, Scientific Research and Executive Training and the Ministry of Industry, Trade and New Technologies.<sup>1</sup> Universities, research centres and industry are also at the heart of a circle of co-operation and co-ordination designed to achieve the operational implementation of scientific R&D. Two agencies support IRESEN in its mandate:

- The IRESEN research centre has a project-based approach and operates according to the needs of the national stakeholders, while ensuring continuous interaction between researchers and industry.
- The IRESEN funding agency launches calls for proposals and manages financial resources to support applied R&D projects in the field of renewable technologies.

IRESEN has a Scientific Council comprising internationally renowned researchers and experts in the field. The Council's mission is to review and evaluate the R&D programme and management process 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.

One of the initial priorities of IRESEN was thermal solar. In February 2012 and with the support of MEMEE, IRESEN launched two calls for proposals, InnoTherm I and InnoTherm II, under two different but complementary themes – thermal solar and solar support technologies. More than 72 universities, research centres and Moroccan and foreign industrial companies bid under consortia; 8 relevant projects were selected for funding and allocated research budgets ranging from MAD 1 million to MAD 5 million per project. The projects involved both the public and the private sectors and included over 50 researchers and PhD students. They will have a combined total value of MAD 40 million.

In 2013, IRESEN launched three calls for proposals in the field of solar photovoltaic (PV), wind and thermal solar, with a total budget of MAD 45 million. The programme includes the InnoTherm III project (2013) in solar thermal (6 projects), with a total budget of MAD 15 million; Inno Wind (wind application projects), valued at MAD 15 million; and Inno PV (PV projects), for an additional MAD 15 million.

Combined with the launch of two calls for proposals in 2014, IRESEN will have spent over MAD 125 million on R&D project financing.

IRESEN has set up a training process for evaluating the impact of financing programmes, as well as obtaining feedback on experiences and establishing better practices in this field.

## INTERNATIONAL CO-OPERATION

Thanks to its positioning in the field of renewable energies, IRESEN has entered into partnerships with the following institutions:

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1. IRESEN works with: CNESTEN, SIE, ADEREE, MASEN, ONEE, OCP, and ONHYM; with the Energy Federation; with companies and industry, universities, engineering schools and research centres; and with MANAGEM (the Moroccan mining corporation).

## Resources

**Mines ParisTech:** One of the oldest engineering schools in France, the school trains high-level general engineers who will one day have positions of responsibility in multiple fields.

## Solar thermal

**DLR:** The solar research centre of DLR (the German Aerospace Centre) is the largest European research entity in the field of concentrated solar power.

**University of Seville:** Andalusian Association for Research and Industrial Cooperation (AICIA): The University of Seville is one of the oldest public higher education establishments in Spain. Thanks to its 4 200-strong teaching staff, the university has a very high research potential. AICIA is the research body associated with the technical and scientific engineering school of the University of Seville.

## Solar PV

**Helmholtz PVcomB:** PVcomB is a research centre specialising in thin film PV and nanotechnologies. It is part of the Helmholtz Institute in Berlin.

**Fraunhofer Gesellschaft:** Fraunhofer is a German organisation focusing on research in the applied sciences. It numbers 57 institutes over 40 sites throughout Germany, each specialising in applied science research, and has 13 000 employees, making it one of the largest international research institutions with a budget over EUR 1.5 billion. Fraunhofer CSP is the institute specialising in crystalline PV, under the aegis of the Fraunhofer Institute for Solar Energy Systems, Europe's largest PV research centre.

IRESEN is also a member of the Maghrenov (European Union/Maghreb) consortium, which brings together representatives from France, Spain, the Netherlands and Belgium with representatives from Morocco and Tunisia under the aegis of the 7th Framework Programme for Research and Technological Development (FP7) European research project. IRESEN expected to continue this co-operation under the aegis of the "Horizon 2020" programme.

Finally, IRESEN, the teacher training university École Normale Supérieure de Rabat and the African Network for Solar Energy have just officialised their partnership for scientific co-operation. The newly created "African Network for Solar Energy – ANSOLE" network could thus allow Morocco to strengthen its role in promoting renewable energy technologies at the regional level and expanding South-South co-operation in this field.

The international technology network supported by the International Energy Agency (IEA) currently numbers 41 Implementing Agreements. IRESEN represents Morocco in the agreement on the implementation of the SolarPACES project covering applied R&D in CSP. These groups of experts in the different energy technologies work closely together to share their knowledge. Morocco could expand its participation to include groups that are working on other renewable technologies (wind, solar PV or geothermal energy), as well as on energy efficiency, power grid management, and oil and gas generation.

## INDUSTRIAL CO-OPERATION

Through its financing system, IRESEN brings together both the public and private sectors. Several private sector stakeholders – including companies, industrial concerns and research centres – participated in the InnoTherm I and InnoTherm II proposals.

The planning of IRESEN's calls for proposals also involves the relevant Moroccan industrial federations. IRESEN is responsive to companies' R&D needs, thanks to individual and collective consultations aiming to establish public-private partnerships in R&D and innovation policy.

IRESEN is in the process of establishing scientific platforms dedicated to the various renewable energy technologies. The concept of the platform is to group technologies and host the private and public operators according to their field of competence and the distribution of the Kingdom's industrial fabric and academic competences.

The creation of R&D infrastructures is also evidenced by the establishment by IRESEN of the very first renewable energy testing, research and training platform in the city of Benguerir. The "Green Energy Park" centre of excellence, under the aegis of IRESEN and the OCP group, is under construction on an area spanning eight hectares. It will combine the infrastructures of several Moroccan research institutions, with the goal of creating a centre of excellence where Moroccan universities and industries share knowledge and know-how with the support of their foreign counterparts. The research park will feature equipment valued at MAD 90 million and will be operational at the end of 2014.

Given its responsibilities with regard to solar projects (in which it often also owns equity), MASEN is also pursuing an R&D programme. Accordingly, it plans to launch its first solar energy research platform at Ouarzazate – the site of the first CSP project – during the course of 2014. This technology centre is perfectly aligned with the vision by MASEN of developing Morocco's solar programme in an integrated manner. It aims to deploy R&D focusing on mastering and developing solar technologies. It also aims to create a competitive industrial fabric capable of maximising the rate of local industrial integration relative to the development of solar power plants.

This scientific platform will help companies, researchers and operators carry out trials or pilot projects, as well as test and evaluate small-scale concepts or equipment, particularly related to CSP. This centre is being developed in partnership with DLR, the German research institute specialising in aeronautics, aerospace and energy and is partially financed by the GIZ co-operation agency. The programme has the opportunity to create real value-added for Morocco at the international level.

With the launch of the other planned solar power sites, MASEN does not rule out developing other research centres in order to stay close to its industrial partners. It should be noted that in 2011, the two global specialists in electronics and energy, Soitec and Schneider Electric signed a memorandum of understanding with MASEN establishing an integrated partnership around CPV Concentrix technology (concentrated PV) in Morocco. The announcement of this agreement underlined that the partnership focuses particularly on CPV-related R&D that allows technology sharing and facilitates knowledge transfer between the partners.

Still in the area of industrial co-operation, it should be noted that the first "industrial cluster" – the "Solar Cluster" – was launched on 21 April 2014 in Casablanca. Initiated in partnership with the trade associations and the higher education establishments specialising in teaching and research, the creation of the solar cluster reinforces the actions undertaken in the context of the NOOR Solar Plan and aims to deepen the synergies among operators in the sector to promote the emergence of a competitive solar industry in Morocco. This cluster was designed with the participation of (among others) ONEE and the General Confederation of Moroccan Enterprises (CGEM).

Thus, the Moroccan effort to promote R&D is supported by CGEM, whose Intilak and Tatwir programmes subsidise research efforts by “start-ups” (up to MAD 1 million), as well as by small and medium-sized enterprises (up to MAD 4 million). Beginning in 2013, these programmes have benefitted from closer collaboration between CGEM and the CNRST.

With that goal in mind, OCP has also financed the construction of the Mohammed VI Polytechnic University at Benguerir, supported by major international universities (e.g. the Massachusetts Institute of Technology in the United States and Mines ParisTech in France), and around which it plans to build a “Green City” in partnership with IRESEN (see above). One of the goals of the university will be to attract the Moroccan diaspora, which is said to number 13 000 researchers around the world.

In the near and medium-term future, the government of Morocco will do well to work closely with Moroccan industry, as well as with the country’s university and research institutions, to promote the return to their homeland of Moroccan researchers currently working abroad. The Moroccan diaspora represents a very valuable human resource. Exploiting this resource could accelerate the development of the country’s technological capacity and strengthen its role as a regional “leader” in R&D, particularly in the field of renewable energies.

### NUCLEAR ENERGY

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CNESTEN, the national energy centre, was founded in 1986 under the aegis of MEMEE. It focuses on developing and promoting nuclear technologies and training human resources in the field. It also provides technical assistance to the state in the area of nuclear safety and radioactive waste management.

Beginning in 2003, CNESTEN developed the Centre for Nuclear Studies, a scientific and technological complex that includes a research reactor with a 2 MW capacity (commissioned in 2009) and a dozen laboratories specialising in sectoral applications of nuclear techniques.

Over the long term, Morocco does not rule out deploying nuclear energy, not only to help diversify the energy supply, but also to promote the creation of R&D-oriented industries. A favourable fiscal policy (e.g. a tax credit for R&D expenditure) would play a major role in furthering this goal.

### ASSESSMENT

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Given the government of Morocco’s desire to diversify energy supply sources, evidenced by the recent increase in budget allocations for R&D in energy technologies, the creation of organisations (IRESEN, MASEN) and programmes to implement these strategies, and the growing number of researchers and contributions from industrial stakeholders, Morocco is at a key stage in developing national value-added for a number of energy technologies.

Morocco can also be thankful that the interministerial co-ordination of national research programmes has been so transparently managed thanks to the creation of IRESEN in 2011. This has resulted in clear progress in terms of launching research programmes, e.g. allowing MASEN to carry out a research programme in partnership with solar energy industry operators.

At the industry level, major industrial companies, such as OCP, have made considerable progress in R&D. There are also encouraging instances of multinational companies establishing research centres on Moroccan soil at their own expense.

That said, Morocco could accelerate the diversification of its energy supply sources by expanding the breadth of energy technologies and the number of its international partners, and supporting these efforts with an additional influx of public R&D budgets.

For example, Morocco's exemplary participation in the international CSP programme of the IEA could also provide a platform for broader and more diverse participation in other programmes, such as wind energy, solar PV or grid management.

Moreover, Morocco could benefit from the participation of its diaspora, which is said to include nearly 13 000 researchers working abroad. Exploiting this human resource could help develop and enhance research in new technologies, particularly renewable energies.

It should be noted that despite the existence of a research centre focusing on nuclear energy, the government of Morocco currently has no plans to build nuclear power plants. Yet nuclear energy could play a significant role in the country's power capacity, thereby helping to increase the establishment on Moroccan territory of other industries dedicated to R&D, provided that a favourable fiscal policy is in place.

## RECOMMENDATIONS

*The government of Morocco should:*

- *Continue to increase R&D financing, with a focus on applied research in renewable energies and energy efficiency technologies.*
- *Encourage R&D in industry and the private sector thanks to a favourable fiscal policy, for example a tax credit for companies and R&D expenses.*
- *Promote international co-operation in the field of R&D with other regions and world players, for example through the IEA Implementing Agreements.*
- *Examine how it could better exploit its human resources in the field of R&D, including those presented by the Moroccan diaspora, to accelerate the development of its research programmes and reinforce its role as a regional leader in the field of renewable energy technologies.*



**PART IV**  
**ANNEXES**





## ANNEX A: ORGANISATION OF THE REVIEW

### REVIEW CRITERIA

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The Shared Goals, which were adopted by the IEA Ministers at their meeting of 4 June 1993 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

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The IDR team visited Rabat from 25 March to 1 April 2013 and held discussions with government officials, energy companies, non-governmental organisations and other stakeholders. The IEA Secretariat drafted this report based on those discussions and subsequent meetings during follow-up visits to Rabat in October 2013 and April 2014, as well as on the official response to the IEA policy questionnaire and other information provided by the government authorities of Morocco.

Data were provided by the IEA Energy Data Centre, based on Morocco's data submission for 2012, supplemented where necessary by some provisional data for 2013.

The team wishes to express its sincere appreciation to Mr Abderrahim El-Hafidi, Secretary General of the Ministry of Energy, and Mme Maya Aherdan, Head of the Directorate of Observation and Programming, for their consistent support and helpful advice. The IEA wishes also to thank the European Commission for the financial support which made this review possible, as well as the numerous stakeholders in Rabat and elsewhere who offered their time and shared their expertise.

Mr Richard Lavergne (Head of Mission), Advisor to the Director-General for Energy and Climate, Ministry of Ecology, Sustainable Development and Energy, France

Mr Beat Goldstein, Energy Policy Senior Advisor, Swiss Federal Office of Energy, Switzerland

Mr Olivier Silla, Deputy Head of Unit, Directorate-General for Energy, European Commission

Mr Ulrich Benterbusch, Director of Global Energy Policy, International Energy Agency

Mr Cédric Philibert, Senior analyst, International Energy Agency

Mme Yamina Saheb, Senior analyst, International Energy Agency

Mr Christopher Segar, Analyst/co-ordinator, International Energy Agency

Mr James Simpson, Analyst/co-ordinator, International Energy Agency

The review was co-ordinated by Christopher Segar, with the invaluable assistance of James Simpson. Cédric Philibert drafted the chapter on renewable energy, Yamina Saheb the chapter on energy efficiency and James Simpson the chapter on oil. The chapter on gas was drafted by Anne-Sophie Corbeau, the chapter on coal by Christopher Segar and the chapter on electricity by Steve Heinen. The chapter on climate change was drafted by Christopher Segar, with assistance from Simone Targetti-Ferri. The chapter on research and development was written by Christopher Segar, with support from Carrie Pottinger.

The Executive Summary and the chapter on General Energy Policy were prepared by Christopher Segar. The review has also received vital support from other colleagues at the IEA, including Sonja Lekovic and Wendy Wei, who prepared key graphs and handled the formatting, and Bertrand Sadin, who prepared the maps and the charts. Muriel Custodio, Therese Walsh, Angela Gosmann, Astrid Dumond and Rebecca Gaghen supervised and managed the production. Lastly, we are all greatly indebted to Romy de Courtay, who handled the complexities of English-French and French-English translation and editing with skill and patience.

## ORGANISATIONS VISITED

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Ministry of Energy, Mines, Water and the Environment (MEMEE)  
Ministry of General Affairs and Governance  
National Office of Hydrocarbons and Mines (ONHYM)  
National Agency for Renewable Energies and Energy Efficiency (ADEREE)  
National Agency for Electricity and Water (ONEE)  
Moroccan Agency for Solar Energy (MASEN)  
Institute for Research into Solar Energy and Renewable Energies (IRESEN)  
Moroccan Refining Industry Limited Liability Company (SAMIR)  
General Confederation of Moroccan Enterprises (CGEM)  
Moroccan Petroleum Industry Association  
Oilibya Maroc  
Akwa Group  
Total  
Sharifian Phosphate Office (OCP)  
Jorf Lasfar Energy Company (JLEC)  
EDF Maroc  
Redal Amendis  
Moroccan Association of Solar and Wind Industries (Amisole)  
National Federation of Electricity, Electronics and Renewable Energies (FENELEC)  
National Energy Federation  
Nareva  
Sahara Wind  
The World Bank  
United Nations Development Programme (UNDP)  
European Investment Bank  
Delegation of the European Union to the Kingdom of Morocco

Embassy of France in Rabat

Embassy of the Federal Republic of Germany in Rabat

French Development Agency

Kreditanstalt für Wiederaufbau (KfW)

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)



## ANNEX B: 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 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 hydro power, 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 held in Paris, France.)

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

## ANNEX C: 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.

ADEME	French Environment and Energy Management Agency
ADEREE	National Agency for Renewable Energies and Energy Efficiency
AICIA	Andalusian Association for Research and Industrial Cooperation
ANRE	National Energy Regulatory Authority
b/d	barrels per day
bcm	billion cubic metres
BEC	building energy code
BRPM	Bureau of Mining Exploration and Concessions
CDER	Renewable Energy Development Centre
CDM	Clean Development Mechanism
CFL	compact fluorescent lamp
CGEM	General Confederation of Moroccan Enterprises
CNESTEN	National Centre for Energy Sciences
CNRST	National Centre for Scientific and Technical Research
CO <sub>2</sub>	carbon dioxide
COMELEC	Maghreb Electricity Committee
CPV	concentrated photovoltaics
CSP	concentrating solar power
DLR	German Aerospace Centre
DOP	Directorate of Observation and Programming
EDF	Energy Development Fund
EUR	euro
FIRM	Facilitating Implementation and Readiness for Mitigation
GDP	gross domestic product
GHG	greenhouse gas
GIZ	<i>Deutsche Gesellschaft für Internationale Zusammenarbeit</i>
GME	Maghreb-Europe Gas Pipeline
GW	gigawatt
HV	high voltage

IEA	International Energy Agency
IMA	Morocco-Algeria Interconnection
IME	Morocco-Spain Interconnection
IMF	International Monetary Fund
IRESEN	Institute for Research into Solar Energy and Renewable Energies
JLEC	Jorf Lasfar Energy Company
KfW	<i>Kreditanstalt für Wiederaufbau</i>
km	kilometre
kV	kilovolt
kWh	kilowatt hour
LECB	Low Emission Capacity Building
LNG	liquefied natural gas
LPG	liquefied petroleum gas
MAD	Moroccan dirham
MASEN	Moroccan Agency for Solar Energy
mcm	million cubic metres
MEMEE	Ministry of Energy, Mines, Water and Environment
MENA	Middle East and North Africa
MII	Morocco Innovation initiative
MRV	monitoring, reporting and verification systems
Mt	million tonnes
Mtoe	million tonnes of oil-equivalent
MV	medium voltage
MW	megawatts
NAMA	Nationally Appropriate Mitigation Action
OCP	Sharifian Phosphate office ( <i>Office Chérifien des Phosphates</i> )
OECD	Organisation for Economic Co-operation and Development
ONAREP	National Agency for Oil Exploration and Production
ONE	National Electricity Agency
ONEE	National Agency for Electricity and Water
ONEP	National Drinking Water Agency
ONHYM	National Office for Hydrocarbons and Mines
PERG	Global Rural Electrification Programme
PGPE	Environment Management and Protection Programme
PMR	Partnership for Market Readiness
PPA	power purchase agreement
PPP	Purchasing power parity
PROMASOL	Development Programme of the Moroccan Market for Solar Water Heaters
PSPS	pumped storage power stations
PV	photovoltaics
R&D	research and development



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S&L	Standards and Labels
SAMIR	Société Anonyme Marocaine de l'Industrie du Raffinage
SIE	Energy Investment Company
SOMAS	Moroccan Storing Company
TAP	Technological Action Plans
TAQA	Abu Dhabi National Energy Company
TFC	total final consumption
TNA	Technology Needs Assessment
toe	tonne of oil-equivalent
TPES	total primary energy supply
TWh	terawatt hour
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States dollar
VAT	value-added tax
VHV	very high voltage
W	watt



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## Morocco 2014

The Kingdom of Morocco is over 90 % dependent on energy imports, so a major challenge is to develop indigenous resources. Topography and climate are favourable to wind, solar and additional hydropower. By 2020 Morocco aims to derive more than 40 % of its electrical capacity from these sources, strengthening both energy security and sustainability. At the same time, Rabat aims to retain its attractive investment conditions for oil and gas exploration.

To reduce the burden of energy subsidies, transport fuels have progressively been brought up towards full market prices, and electricity tariffs are also being adjusted upward. Energy efficiency has been elevated to a national priority, with a range of measures on lighting, building standards, appliances and vehicles.

Morocco's electricity grid now covers more than 98 % of households. The sector is being progressively liberalised, with foreign investment in both renewables and coal-fired power stations. The energy mix is diversified further by imports of gas from Algeria and electricity from Spain.

Morocco has established new national agencies to promote energy efficiency, renewable energy, and research and development. Co-operation on climate change within the United Nations framework is widely perceived as exemplary. Persevering in this direction could help Morocco emerge as a regional leader in energy sector reform, as well as in the renewable energy technologies in which it has a natural advantage.

This review analyses the energy-policy challenges facing Morocco and provides recommendations for further policy improvements. It is intended to help guide policy makers in the country towards a more secure and sustainable energy future.



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