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Morocco's Power Sector Transition: Achievements and Potential

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Abstract

As the only North African country with no own oil resources, Morocco is the largest energy importer in the region. The country is faced with the challenging task of meeting rising local demand while keeping its import bill under control. Against this backdrop, Morocco is pursuing an ambitious, cost-effective energy transition aimed at endowing the country with a sustainable, competitive and secure energy sector. This paper assesses the achievements and constraints facing the Moroccan energy system with a focus on the power sector, which is responsible for the transformation or production of more than half of the country's primary energy. It also dwells on existing policies aimed at integrating the Moroccan energy market into the regional and Euro-Mediterranean energy systems by exploiting its strategic position at the crossroads between the Atlantic Ocean and the Mediterranean Sea.

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Introduction

As the only North African country with no natural oil resources, Morocco is the largest energy importer in the region. The country is faced with the challenging task of meeting rising local demand while keeping its import bill under control. This has proven to be a major problem as consumption figures and global commodity prices have increased, putting particular pressure on the country's finances. As a result, energy independence, reform and continued liberalisation of the sector and its price-setting mechanisms are at the top of the government's agenda.

More than half of the country's primary energy is transformed or produced by the power sector. The importance of this sector in Morocco's overall energy landscape is illustrated when comparing the world average energy and electricity consumption per capita to the Moroccan consumption figures. While the country's energy consumption per capita is 540 kilograms of oil equivalent (kgoe) or three times less than the 1840 kgoe world average, the Moroccan electricity consumption at 864 kWh per capita is almost three times higher than the world average of 313 kWh.[1] The role of the power sector was further emphasised in 2009 when the Moroccan government developed a national energy strategy geared towards more reforms and investments in the electricity sector.

This review presents an overview of the Moroccan energy system, with a focus on the power sector, in order to identify the achievements and the long-term opportunities and challenges ahead. More specifically the paper will: (i) provide a picture of the energy sector, describing the organisation and the impact of reforms carried out over the last two decades; (ii) summarise the emerging trends (liberalisation, renewable energy); (iii) identify some of the main challenges facing efforts to make the most of the recent transformations in the power industry; (iv) outline some potential areas where future developments will facilitate a cost-effective energy transition, while taking into account security and environmental considerations.

1. Current energy context in Morocco

Morocco depends on imports for most of its energy needs. Morocco's domestic supply of oil, gas and coal is either negligible or suffers from high per-unit costs of production, with the result being an acute imbalance between domestic production and consumption of energy. The country's dependence on imported fossil fuels, predominantly oil, puts a heavy burden on government finances and budgets. The high oil prices recorded in 2011 and 2012 were particularly damaging to public finances and led to a widening of the Moroccan budget deficit to reach 7.3 percent in 2012 of which 6.6 percent is directly related to the cost of energy subsidies.[2] Morocco is the largest energy importer in North Africa and is 96 percent dependent on imports to satisfy its energy demand.[3] In addition to oil and petroleum products, Morocco imports coal, used for power and industry, and gas for power from Algeria.

Rapid economic growth prior to the global economic crisis triggered a rapid increase in energy demand and hence a sustained growth of primary energy supply in Morocco, which reached 17760 ktoe in 2012 (equivalent to 206.55 TWh).[4] The share of the various sources of the total primary energy supply in 2012 can be seen in figure 1.

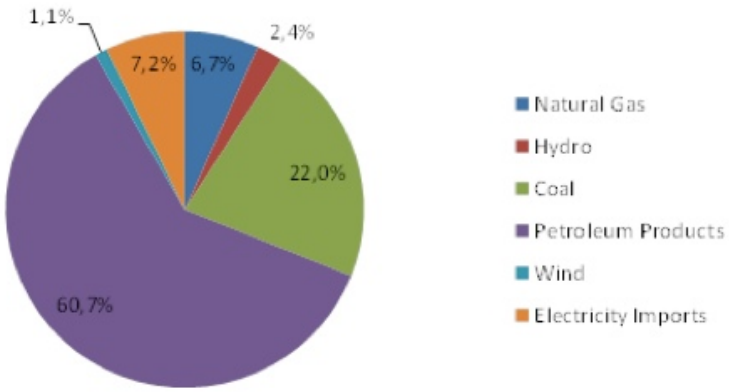
[1] 2012 data from the International Energy Agency (IEA).

[2] Haut-Commissariat au Plan du Maroc, *Simulation de l'impact de l'indexation des prix de certains produits pétroliers sur l'économie nationale*, Septembre 2013, http://xfru.it/Jcje6i.

[3] Ministry of Energy, Mining, Water and Environment (MEMEE), *Secteur de l'énergie, Chiffres clés pour l'année 2012*, November 2013, http://www.mem.gov.ma/SitePages/ChiffresCles1/ChCleEnAnnuels.aspx.

[4] Idem.

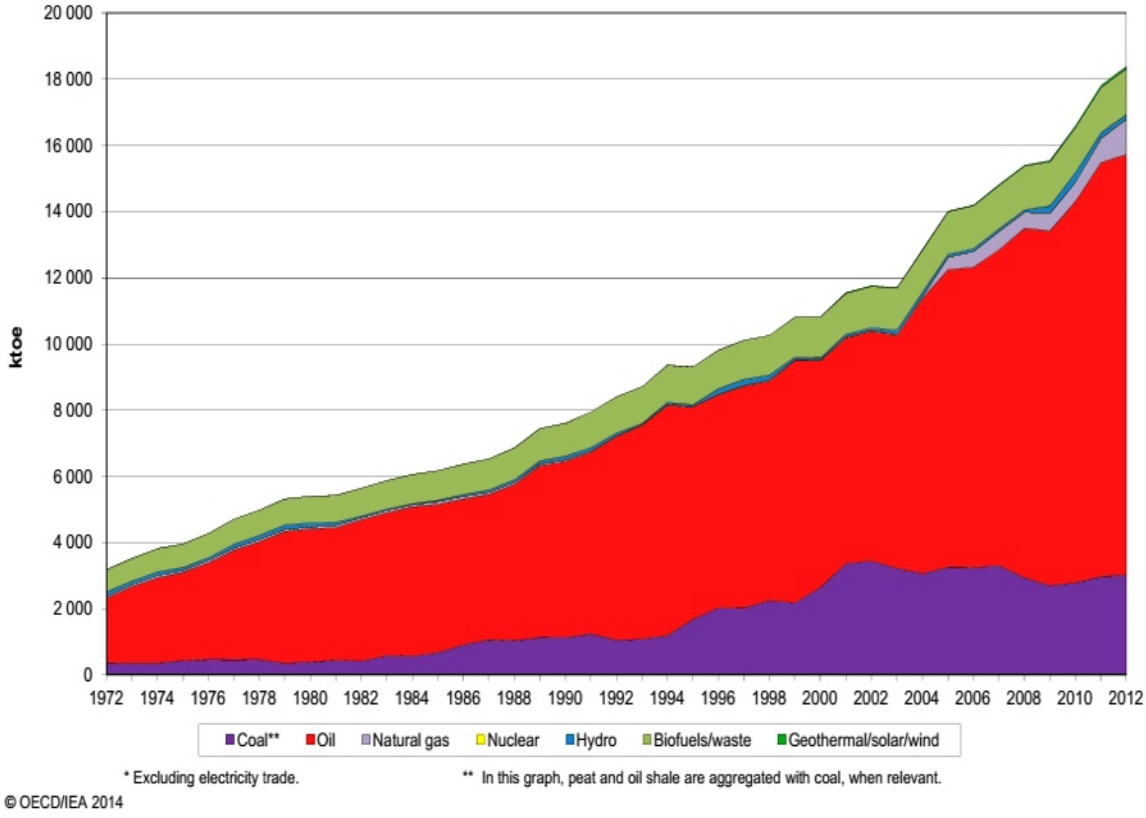
Figure 1 | Total primary energy supply, 2012



Source: Ministry of Energy MEMEE

Figure 2 illustrates the increase of primary energy supply by type of fuel over 40 years, between 1972 and 2012 (excluding electricity imports). It presents how Morocco has diversified its energy mix over the last twenty years, first by increasing coal use mid-nineties and, more recently in 2005, with the introduction of natural gas.[5] The chart clearly shows the country's dependence on fossil fuels with oil still covering 60.7 percent of the country's energy needs, compared to 76 percent in 1990. It is expected that fossil fuels will remain dominant for at least the next three decades in the Moroccan energy supply.

Figure 2 | Total primary energy supply Morocco, 1972-2012



Source: IEA.

[5] World Bank, *Morocco. Office National de l'Electricite (ONE) Support Project*, May 2008, p. 22, http://documents.worldbank.org/curated/en/2008/05/9463432/morocco-office-national-de-l-electricite-one-support-project.

Morocco's proven oil deposits are small, but there is reasonable evidence that there could still be important undiscovered oil (and gas) reserves. Recent drilling activity and studies indicated that there are vast onshore and offshore sedimentary basins, still largely unexplored, that are suitable for oil reserves.[6] High hopes for Morocco's potential is based on the similarity of the off shore geology to eastern Canada's first oil-producing reservoir, Cohasset-Panuke, and the recently developed Deep Panuke gas field.

Despite increased drilling activity and some recent discoveries, Morocco's proven natural gas reserves are small. Morocco plays an important role in the transportation of gas from Algeria to Spain and Portugal. The Maghreb-Europe gas pipeline links the Hassi R'mel field in Algeria via Morocco and the Strait of Gibraltar with Spain where it feeds into the European gas grid.

Regarding shale oil, Morocco has the seventh-largest proven reserves in the world. The total reserves are estimated to be around 50 billion barrels.[7] The Moroccan national oil and gas company ONHYM (Office National des Hydrocarbures et des Mines) has been studying oil shale and shale gas potential in the country since the end of seventies. In 1985, a demonstration unit plant was constructed and operated to extract crude oil from oil shale. More recently, ONHYM signed up partnerships with several private companies to start a shale gas exploration programme focused on the central-eastern zones of the country.

Oil and gas exploration and surveys are partially carried out by ONHYM in cooperation with international partners where ONHYM's share is capped at 25 percent. Morocco has recently attracted many foreign companies through the application of liberal and investor-friendly regulations, including tax exemptions and investment incentives.

As for renewable energy, Morocco possesses extensive wind and solar resources, which have the potential to cover a significant share of the increasing domestic energy demand.[8] The wind energy potential is excellent in vast parts in the northern and southern regions, with the annual average wind speed exceeding 9 m/s at 40 meters elevation. The solar resource is abundant and the annual sunshine averages 3000 hours per year or 5.3 kWh/m²/day.

2. Background and evolution of Morocco's electricity market

The electricity sector in Morocco is dominated by the state-owned operator ONEE (Office National de l'Electricité et de l'Eau Potable).[9] ONEE owns the complete transmission network and much of the distribution network and is the main retail supplier. With the exception of renewable energy produced under the framework of Law 13/09, ONEE acts as the single buyer in the sector and owns and operates an important share of the generation capacity; however, ONEE can give concessions to private operators with purchase guarantees.[10]

Responsibility for the subsector is divided at the Government level between the Ministry of Energy, Mines, Water and Environment (MEMEE), which has oversight over ONEE, and the Ministry of Interior (MI), which supervises the overall performance of the public enterprises responsible for the distribution of water and electricity in large urban areas. Morocco's power distribution subsector includes about seven local municipal utilities, also known as "Régies" (utilities for distribution of electricity and water owned by a municipality, commune, or group of neighbouring communes) as well as four private distribution utilities, also known as "gestionnaires délégués".

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[6] David E. Brown, *Africa's Booming Oil and Natural Gas Exploration and Production. National Security Implications for the United States and China*, Carlisle, US Strategic Studies Institute, December 2013, http://www.strategicstudiesinstitute.army.mil/pubs/display.cfm?pubID=1186.

[7] R. Bouchta, O. Zemmouri, "Etude géologique et réserves du gisement de schistes bitumineux de Timahdit (Moyen Atlas)", in *Mines, géologie et énergie*, No. 50 (2nd semestre 1981), p. 55-69.

[8] Source: Agence de développement des énergies renouvelables et de l'efficacité énergétique (ADEREE).

[9] ONEE is the state-owned company resulting from the recent merger between the country's water (ONEP) and electric (ONE) utilities.

[10] This law liberalises the renewable energy production and sets a legal framework for production and commercialisation of clean energy.

2.1 1994-2014: two decades of reform

Starting from 1990, the Moroccan power sector confronted serious power supply shortages, which can be seen as a legacy of the difficult economic and financial problems faced by the country in the eighties. This was mainly due to a sharp fall in hydropower resources, a prolonged drought, and the poor performance of the recently commissioned Mohammedia coal-fired power plant.[11]

Faced with these recurring problems and the inability of the state and of ONE (Office National de l'Electricite) to maintain a financially sustainable power system while delivering the necessary investments to meet increasing demand, the Moroccan government decided to overhaul the existing legal framework, introducing an ambitious strategy to reform the sector. A new amendment to the sector legislation to allow private investment and the introduction of the IPPs (Independent Power Productions) model in the electricity generation sector has been the spearhead of this strategy. At the same time, the decision was made to reduce the share of oil and hydro in power generation and to diversify fuel options with the increase of the share of coal and the introduction of natural gas. The restructuring and financial recovery of the power state monopoly was a major part of this strategy and involved concrete steps to improve its operational performances. This goal was also to be achieved with the introduction of new power generation technologies and energy conservation measures.[12]

Encouraged by the World Bank, in 1994 the government of Morocco adopted a decree which allowed the national power monopoly ONE to enter into power purchase agreements with IPPs or privately owned power producers.[13] This partial liberalisation forms part of an attempt to improve the performance of power generation facilities and offer electricity to consumers at competitive prices. Subsequently, in 1996, ONE awarded CMS Energy and ABB Energy a 30-year concession agreement under a competitive bid tender. The project consisted of two stages. The first was to manage two operating 348-MW coal-fired/steam-based generation units under a 30-year concession arrangement. The second consisted of a power plant expansion by building two similar specification generators under a build-transfer-operation (BTO) arrangement. The total capacity for all four units is 1,356 MW and the project cost was 1.48bn dollars. The Jorf Lasfar project was Morocco is earliest IPP and was considered a successful experience, which prompted the country to replicate the model and significantly increase the share of the private sector in power generation.[14]

To diversify sources of energy supply, ONE launched an ambitious programme to develop utility scale renewable projects and harness the huge wind resources available in the extreme north of the country. The privately owned 50-MW Koudia wind farm started production in 2000, which resulted in a major change of attitude towards renewables and encouraged ONE to pursue development of more wind power projects.

The inauguration in December 1996 of the Maghreb-Europe gas pipeline provided Morocco with the opportunity to introduce the use of natural gas in power generation. The first combined cycle power plant, a joint venture between ONE, Siemens and Endesa, was commissioned in 2006 and resulted in the increase of the natural gas share in Morocco's primary energy demand from less than 1 percent in 2004 to 3.5 percent in 2006 and subsequently to 6.7 percent in 2012 after completion of the first integrated solar combined-cycle plant in Ain Beni Mathar.[15]

In 2008, the Moroccan government decided to further open the power generation market to private investors. Private power producers were allowed to own and operate plants with capacities not exceeding 50MW, and sell

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[11] World Bank, *Morocco. Repowering of Power Plant Project*, GEF Project Document, July 1994, p. 1, http://documents.worldbank.org/curated/en/1994/07/698185/morocco-repowering-power-plant-project .

[12] Ibid, p. 2.

[13] World Bank, "The World Bank's Role in the Electric Power Sector: Policies for Effective Institutional, Regulatory, and Financial Reform", in *World Bank Policy Papers*, January 1993, http://documents.worldbank.org/curated/en/1993/01/440599/world-banks-role-electric-power-sector-policies-effective-institutional-regulatory-financial-reform. See also Bernhard Brand and Jonas Zingerle, "The renewable energy targets of the Maghreb countries: Impact on electricity supply and conventional power markets", in *EWI Working Papers*, No. 10/02, p. 4 (May 2010), http://www.ewi.uni-koeln.de/fileadmin/user_upload/Publikationen/Working_Paper/EWI_WP_10-02_Renewable-Energy-Maghreb.pdf.

[14] Deloitte Touche Tohmatsu, *Sustainable Power Sector Reform in Emerging Markets. Financial Issues and Options*, Joint World Bank/USAID Policy Paper, July 2004, p. 35, http://pdf.usaid.gov/pdf_docs/PNADB308.pdf.

[15] World Bank, *Morocco. Integrated Solar Combined Cycle Power Project*, February 2007, p. 32, http://documents.worldbank.org/curated/en/2007/02/7517679/morocco-integrated-solar-combined-cycle-power-project.

their electricity directly to large industrial consumers. With the 2010 Renewable Energy Law, Morocco set out a legislative framework for the promotion of renewable investments, establishing a procedure for the authorisation of renewable energy installations as well as production, distribution and trade; thereby opening a new market segment in which certain industrial customers are allowed to freely choose their electricity suppliers.

Faced with the risks of the increasing cost of fossil-fuel imports and the subsequent high burden on public finances, in 2009 Morocco announced ambitious renewable energy targets for 2020. To achieve these objectives, the government decided to create two dedicated governmental agencies: the Moroccan Agency for Solar Energy (MASEN), in charge of implementing the Moroccan Solar Plan and the National Agency for the Development of Renewable Energy and Energy Efficiency (ADEREE).[16]

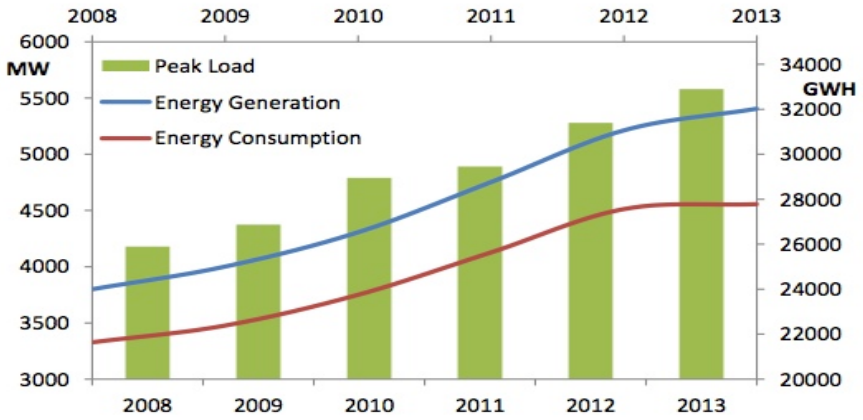
To improve performance and quality of service at all levels of the electricity sector, the reforms were quickly extended to the power distribution subsector. The privatisation of electricity distribution utilities initiated in Morocco in the 1990s will take the legal form of transferred management or 'gestion déléguée'. In 1997, the French Lyonnaise des Eaux (LYDEC) took control of the municipality owned distribution utility in Casablanca. By signing this 30-year concession agreement, the local authority assigns to the private sector the task of investment, construction and operation of the necessary infrastructure to deliver the public services of supply of electricity, water and sewerage to the urban area of Casablanca.[17] The respective roles of the public and private parties were clearly stated:[18]

- the public authority acts as a decision maker and a regulator. It sets the investment programme and performance objectives for public services, and protects the interest of consumers and the environment;
- the private partner has a dual obligation regarding resources and results. It must (i) achieve an efficient and financially sustainable management of the public service, (ii) adopt a commercially-minded approach, and (iii) provide the technical expertise and accordingly make the appropriate investment and operational decisions.

2.2 Electricity demand and generation capacity

Electricity demand has grown fast, at an average annual rate of around 6.7 percent, between 2003 and 2013 to reach 32,024 GWh. Growth in peak demand exceeded 8 percent many times during the same period, reflecting the impact of recent efforts to expand access to electricity. On the supply side, the country relied on thermal power plants for almost 70 percent of the total generated power while importing 18 percent from Spain.

Figure 3 | Peak power, energy production and demand in Morocco, 2007-2012



Source: ONEE.

[16] Climate Investment Funds, *Clean Technology Fund Investment Plan for Morocco. Update Note*, January 2014, p. 6, https://www.climateinvestmentfunds.org/cif/sites/climateinvestmentfunds.org/files/CTF%20Morocco%20IP%20update_Jan%202014.pdf.

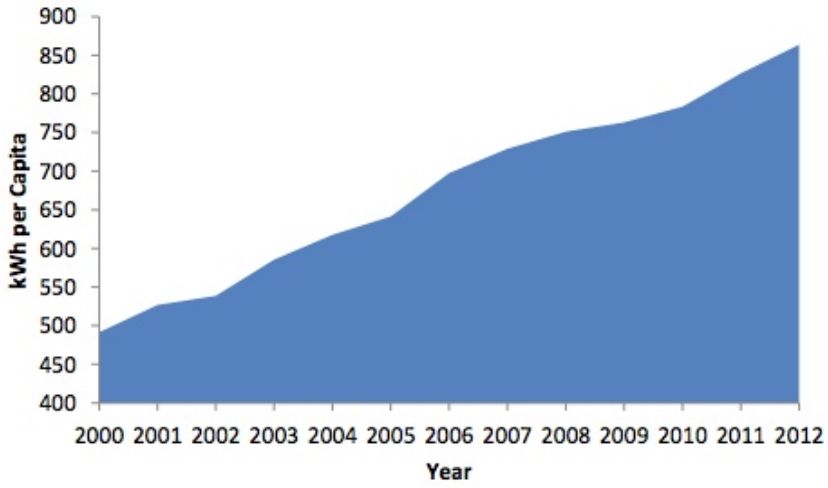
[17] Tarek Hatem, "LYDEC: Providing Electricity, Water & Sanitation to Casablanca's Shanty Towns", in *GIM Case Studies*, No. A027 (September 2007), p. 9, http://cases.growinginclusivemarkets.org/documents/58.

[18] LYDEC, *Note d'information: Emission d'un emprunt obligataire coté et non coté*, 25 June 2010, p. 78, http://www.casablanca-bourse.com/Documents/LYD/fr/Lydec_NI_obl_fr.pdf.

As of 2013, Morocco's total installed power generation capacity was 7,342 MW. This consists of 5,077 MW (70 percent) of thermal power stations, 1,770 MW (24 percent) of hydropower including 464 MW of hydro pumped storage. Wind generation plants provide the remaining 495 MW (6 percent). An additional 350 MW of coal-fired units are due to be commissioned in 2014, hence substantially increasing the share of generation from privately owned power plants.

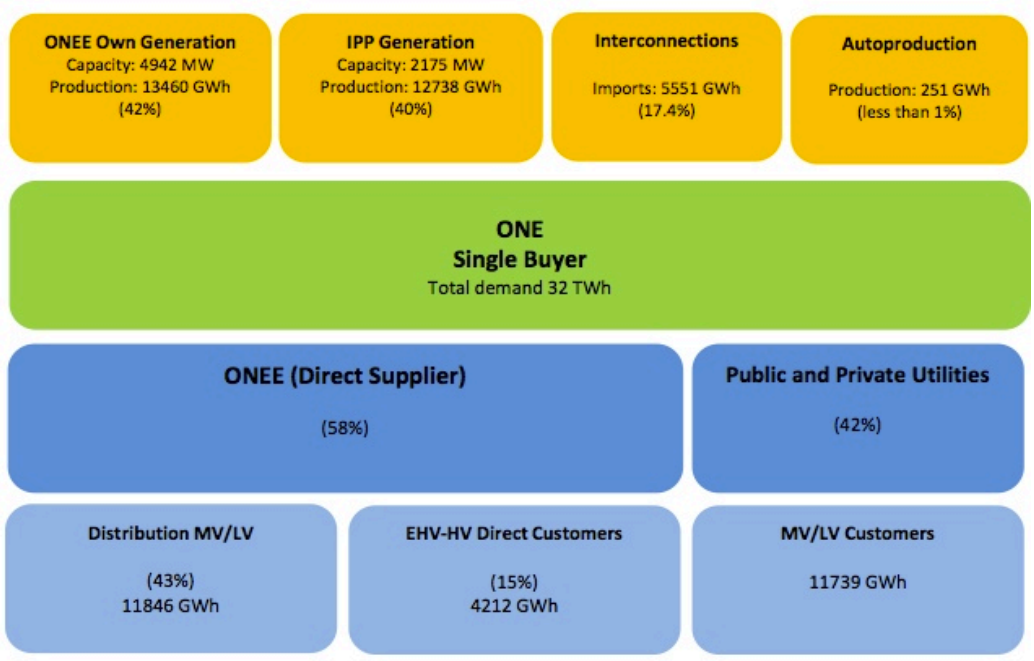
Figure 4 presents the rapid increase of the electric power consumption per capita. In 2000 the per capita consumption was 491 kWh before reaching in 2012 864 kWh.

Figure 4 | Per capita electricity consumption in Morocco, 2000-2012



The electricity generation balance consists predominantly of thermal generation (see Figure 5), which comes from IPPs (42 percent) and imports from Spain (16 percent).

Figure 5 | Balance of supply-demand, 2012



Source: ONEE and World Bank, *Morocco: Clean and Efficient Energy Project* …, cit., p. 15.

2.3 The quest to expand the grid and access to greener power

ONEE is responsible for operating and expanding the Moroccan power transmission grid. Aside from a small isolated network in the extreme south of the country, the transmission grid covers the entire country and is interconnected with the European and Algerian power networks. The transmission grid consists of 1,693 km of 400-kV transmission lines, 8,389 km of 225-kV transmission lines, 147 km of 115-kV transmission lines, 11,625 km of 60-kV transmission lines and 37 substations.[19]

Regional power interconnections are developed rather well, but actual electricity exchanges are limited. Transmission lines to connect power among Algeria, Tunisia and Morocco were constructed in the 1990s and 2000s. The main interconnection is through the Morocco-Spain network, which consists of two lines: a 400-kV line commissioned in August 1997; and another 400-kV line commissioned in June 2006.

Morocco's rural electrification programme, also known as PERG or *Programme d'Électrification Rurale Généralisé*, started in 1996 with the aim of replacing and energising existing limited initiatives to extend access to electricity. Over the last eighteen years, more than 39,000 villages were connected to the grid providing more than two million rural households with access to electricity and thereby pushing the rural electrification rate to 98 percent. Driven by economic considerations, ONE introduced off-grid renewable energy systems to bring electricity to some remote rural communities. Notably, more than 3,600 villages, including more than 51,000 rural households were offered photovoltaic systems.[20]

Although Morocco's average rate of GHG emissions (2.8 tonnes of CO_2 per year per capita) is considered low by global standards, it is projected to rapidly grow in the future, driven largely by increases in electricity generation, which currently accounts for approximately 26 percent of the country's total emissions.[21] Hence, in 2009 Morocco adopted an ambitious new energy strategy which puts renewable energy and energy conservation at the centre of the national energy policy. Against this backdrop, it was announced that the share of renewable energy generation will increase to 42 percent of the total installed capacity by 2020. Morocco plans to meet this target by increasing the installed hydro capacity to reach 2,000 MW, developing 2,000 MW of solar capacity, under the Moroccan Solar Plan (MSP), and 2,000 MW of wind capacity to take advantage of the country's excellent domestic solar and wind resources.

In 2010, MASEN started the development of the 500-MW Ouarzazate solar complex project structured as a public-private partnership (PPP). This project is being developed in two phases based on two technological variants. The first phase, under construction, will use parabolic trough CSP technology, while the next phase implements the tower receiver CSP technology. The Ouarzazate solar complex, dubbed Noor Power Plant, will also include three- to five-hour thermal storage capacity to meet the evening peak demand.

The Moroccan Integrated Wind Energy Programme aims to increase the wind-installed capacity from 830 MW to 2000 MW by 2020.[22] Five new potential sites have been selected for the construction of wind farms with a total nominal capacity of 1000 MW. The tendering process is underway and the construction of the farms is scheduled to start in 2016. The main goals of the wind energy programme are to raise the share of wind power to 14 percent of the total generation installed capacity by 2020 and support the emergence of a local wind power manufacturing capability.

3. Electricity market restructuring: challenges and possible ways forward

The current achievements of the energy transition in Morocco, while important, are not sufficient to further economic development of the country and to unlock the full socioeconomic potential of an efficient and sustainable energy system. The impediments to continuing the transition relate not to technology or cost, but to

[19] 2012 figures as shown in the annual ONEE's activity reports.

[20] ONEE-Branche Electricité, *Rapport d'activités 2012*, 2013.

[21] World Bank and African Development Bank (ADB), *Morocco: Noor 2&3 Concentrated Solar Power Project*, May 2014, p. 6, https://www.climateinvestmentfunds.org/cif/node/15673.

[22] Of which 550 MW is either under construction or commissioning.

the inflexibility of the existing power system structure, its legacy business models, and the resulting resistance to change.

3.1 Major challenges ahead

Despite the fact that the reforms implemented by the government during the last twenty years have improved the conditions of access to energy and considerably reduced the risk of acute power shortages, the electricity sector continues to face recurring severe financial challenges, while experiencing significant delays in key investments. These structural problems have been amplified with an ever more complex institutional environment, thanks in part to the multiplication of agencies, stakeholders and the absence of a clear framework defining the responsibilities of each and others in decision-making and development of energy policies. Financial difficulties are mainly due to (i) a tariff structure that does not reflect the sector's operating costs; (ii) the low collection (payments) rate and difficulties to recover debts from certain distributors and the public sector; (iii) the excessive use of expensive heavy fuel oil and diesel in energy production as a consequence of delays in investments in large cost-effective generation facilities; and (iv) the growing burden of ONEE's debt service, the result of an often non economically viable rapid deployment of the rural electrification programme. The main consequences of organisational problems are (i) the inability of the state monopoly to convey real costs of production to consumers and the lack of clear rules for the establishment and revision of tariffs; and (ii) the difficulties to implement a number of urgent decisions because of the number of stakeholders and their often non-convergent interests.

The current institutional setting of the sector has not been conductive to rational planning, investment or operation. Coordination is particularly essential in the areas of investment planning and load forecasting, standardisation of equipment and network management. Lack of coordination results in substantial inefficiencies in the overall management of the sector.

The practice of subsidised or cross-subsidisation of electricity is becoming a major problem. The current electricity tariff structure is set by a central governmental department and is designed with the dual objective of keeping the cost of energy low for a large spectrum of consumers (social tariffs), and ensure financial targets to distributors regardless of their size, region or type of clients. The government should extend recent efforts to reform petroleum products subsidies to the power sector and adopt a cost-based approach to set electricity tariffs.[23] This is all the more important as ONEE is facing a delicate financial situation and energy efficiency initiatives are struggling to take off.

3.2 Transition toward a sustainable power system

The energy transition undertaken by Morocco can and must go beyond the objectives adopted in the 2009 strategy, in particular by further increasing the share of renewable energy. This can be achieved thanks to a systematic use of information and communication technologies for the deployment of a more flexible and efficient power system, strengthening regional interconnections, and above all a significant reform of the regulatory framework. The following sections discuss three particular areas with opportunities for electricity market reform to move beyond the prescriptive solutions of the past.

3.2.1 Transition toward low-carbon electricity production

Despite the abundance and the quality of wind and solar resources in Morocco, and the goodwill expressed by the authorities to achieve ambitious targets for renewable energy production, the existing legal and institutional environment does not allow for a sustained deployment of clean energy technologies. The lack of a transparent pricing policy and artificially low electricity tariffs are major obstacles to the development of an open and competitive energy market. The combination of ONEE's position as a sole buyer and a state owned entity in receipt of concessional public funding leads to non-well though-out investment decisions which further complicate a more sustainable energy transition.

Falling costs of a number of clean generation technologies should boost the growth of renewables in markets where grid parity is achieved. In Morocco, the average cost of new wind and solar PV projects has dropped to levels close to or below retails tariffs. Morocco has recently undertaken a policy for gradually lifting restrictions on access to the medium- and low-voltage grids with the objective of unlocking the huge potential of

[23] Paolo Verme, Khalid El-Massnaoui and Abdelkrim Araar, "Reforming Subsidies in Morocco", in *World Bank Economic Premises*, No. 134 (February 2014), http://documents.worldbank.org/curated/en/2014/02/18909331/reforming-subsidies-morocco.

distributed generation. However, this will not be enough since renewable energy is required to compensate for any economic losses of inefficient legacy utilities and at the same time compete with artificially low and subsidised energy costs. Morocco can garner fully the benefits of a major global shift, but for that to happen, policy makers must stop promoting non-coherent and non-interdependent blocks of an energy strategy, and should put in place an integrated energy policy that places great importance on energy conservation and renewable energy.

3.2.2 Fostering a more ambitious regional integration agenda

Morocco does not have the enormous oil income of some countries in the region, but it has a unique geographical position, having access to the Mediterranean and a very large coastline on the Atlantic. This geographical position provides Morocco with many opportunities, which it has been able to take advantage of to develop a relatively stable and successful market economy. Morocco could also play the role of an energy transit hub between the southern shore of the Mediterranean and African energy exporting countries, and Europe. The successful completion of projects such as the Maghreb-Europe natural gas pipeline and the power interconnection with the European power grid attest to Morocco's reputation as a reliable energy partner.

The Strait of Gibraltar is a major transit point for seaborne-traded oil, LNG and coal. Growing volumes of fossil fuels from Africa, the Middle East and Latin America are being transported by tankers and dry-bulk vessels via the Strait to Western and Mediterranean markets. By 2020, Morocco will import around 10 million tonnes of coal annually and more than 100 million boe of oil and petroleum products. A regionally centred energy supply strategy, where Morocco will play the role of a transit hub for customers in the region, including offering a wide variety of services, will directly help the government produce cheaper primary energy supply for the power sector and for the economy as a whole.

Strengthening power grid regional interconnections between the two shores of the Mediterranean region benefits from significant political support in Europe and North Africa, and was at the centre of several unsuccessful regional initiatives (The Mediterranean Solar Plan, Medgrid, Desertec, etc.). The rationale for further regional integration of power systems is mainly driven by the fact that a larger and further interconnected power system would help to unlock the important renewable energy resources available in many parts of the region. From the technical point of view, a larger and stable power system can accommodate a large share of renewables without impairing the power grid reliability or quality and continuity of service. From an economic point of view, interconnections offer access to markets with better business opportunities and hence more financial incentives for renewables.[24]

Integration of the energy systems of North Africa is considered an important component of such a regional integration strategy. However, a well-functioning regional market will require implementing necessary reforms in order to meet global market standards, pursuing policies that promote the harmonisation of national regulations and technical rules for operation of power systems, and removing subsidies or any other barriers that can impede competition and the smooth physical flow of power. The final goal is to have a market design that optimally combines economic logic and technical constraints.

The EU's energy reform programme has made the region an attractive market for energy exports. The programme was designed to create a single, integrated, competitive power market with numerous buyers, sellers, traders, and power exchanges participating. Morocco and the EU recently expressed – in the 2008 Advanced Status signed between the two parties – their interest to deepen bilateral energy cooperation and stated the ultimate Moroccan objective of integration into the European energy market. Morocco will need to view its geographic position and advanced relations with the EU as an opportunity to position itself to play a leading role towards creating a Mediterranean energy hub in the south of Europe, deemed crucial to energy security of Europe and the whole region.

The limited cooperation between North African countries in the energy field is considered the greatest obstacle to any serious regional energy policy. The EU should engage in intensified political and trade dialogue with North African and eastern Mediterranean countries, in particular, with a view to opening their respective markets and increasing regional energy exchanges.

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[24] Emanuele Santi, Saoussen Ben Romdhane and William Shaw (eds.), *Unlocking North Africa Potential through Regional Integration. Challenges and Opportunities*, African Development Bank, 2012, p. 39, http://www.afdb.org/en/news-and-events/article/unlocking-north-africas-potential-through-regional-integration-new-afdb-report-9591.

3.2.3 Technological innovation as a driver of change

Given the urgency and the new challenges raised by the grid integration of renewable energy, it is crucially important to deploy new infrastructure required to provide a reliable supply of power, and press for continuously adapted grid operation practices. Until recently, energy policies were designed, at the level of central governments, with the sole purpose of ensuring the balance between supply and very often a non-decreasing demand, while attempting to minimise costs for the consumers. This model is increasingly deemed to be non-fit for a new world where issues ranging from protection of the environment and reduction of greenhouse gas emissions, sustainable growth and preservation of natural resources, future technological developments, energy conservation and the large deployment of clean technologies, are considered to be vital. The legacy grid model based on unidirectional flows of energy from centralised generation to transmission and distribution will likely move towards a more decentralised interconnected grid with customers acting at the same time as consumers and producers, and fitted with the intelligence required to smoothly manage challenges arising from operating this new network.[25]

Morocco was at the forefront in the region in developing a modern telecommunication infrastructure and embracing information technologies. A very similar attitude is required for an efficient and optimal energy transition. Smart metering and smart grid technologies can be introduced to reduce waste and inefficiencies in the power system, fully optimise demand-side resources, while making it possible to add more renewables. Accurate forecasting of wind speed and solar radiations plays a key role in reducing the operational challenges, often linked with intermittency, of renewable energy generation. Short term weather forecasts or now casting are used to maintain grid stability while maximising the share of clean energy production. Energy storage systems, either decentralised or centralised, will enable grid operators and individual consumers to store electrical energy or displace excess renewable production in order to better manage the supply-demand balance for electricity. Sizeable capacities of hydro pumped storage and thermal storage are already used or planned to be developed by ONEE and MASEN.

While some of these technologies are still not widely adopted or can present high costs compared to existing alternatives, international public financing can play an important role in catalysing renewable energy and new energy technologies deployment and diffusion in developing countries.[26] In the past, Morocco has funded a number of renewable projects and energy efficiency initiatives from multilateral development banks, bilateral aid agencies, the Global Environment Facility, and, more recently, the Clean Technology Fund for large solar and wind projects.

Conclusion

The power sector in Morocco is experiencing a phase of rapid changes and will probably witness important transformations in the near future as well. Faced with a sustained growing demand, caused by the recent widespread access to electricity and household equipment, the growth of several sectors of the economy and rapid urbanisation, the country will need to install large amounts of additional power generation capacity and continuously expand the power grid. However, the last decade has shown that the prevailing institutional organisation and legal framework in the power sector can impede implementation of much needed reforms. ONEE, the state power monopoly, encounters a number of difficulties to perform its tasks but at the same time embodies the widespread reluctance to change.

Although the government of Morocco has recently announced the decision to create a regulatory agency with the assignment to oversee the sector reform, it is very unlikely that its role will be effective in the next years or go beyond supervising some minor issues related to conditions of access to the grid for private producers of renewable energy.[27] The reform is further complicated by political considerations mainly related to territorial

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[25] Alexander Ochs and Christoph von Friedeburg, *Energy Transitions in Germany and the United States. Transatlantic Perspectives, Challenges, and the Way Forward*, Strategy paper, Washington, Worldwatch Institute, June 2014, p. 20-21, http://www.worldwatch.org/energy-transitions-ge-us.

[26] Deloitte Touche Tohmatsu, *Sustainable Power Sector Reform in Emerging Markets*, cit.

[27] See the Moroccan Minister's recent speech on solar PV development in Morocco: Morocco Ministry of Energy and Mines (MEMEE), *Abdelkader Amara dévoile sa feuille de route pour le développement de l'utilisation de l'énergie solaire photovoltaïque au Maroc à l'occasion de l'inauguration de la Première édition du Salon International sur le Photovoltaïque: Photovoltaica*, 4 November 2014, p. 5, http://www.mem.gov.ma/SitePages/Discours/Discours%20Mle%20Ministre3nov%202014.pdf.

planning and development. The Moroccan energy transition cannot do without a transformation of the current institutional set-up and deal with some established taboos, otherwise it will be incomplete and ineffective.

In the absence of a common regulatory framework, regional energy integration is limited to regular large energy imports from Spain to cover the shortfall in installed capacity. While regional integration must be compatible with its national interests, Morocco must take advantage of intraregional complementarities and its geostrategic position and take steps towards considering energy integration between countries as more than physically interconnecting national power grids, but also a political commitment to create a common energy market and a secure and reliable hub for energy transits from south to north and from the Atlantic basin to the Mediterranean region.

A viable energy transition will need to take into account economic objectives and the ever-growing aspirations of societies for a sustainable, inclusive growth, and will require the deployment of appropriate energy strategies and a gradual shift towards a more flexible energy system. Moroccan decision makers should aim at creating an open market that facilitates wider energy cooperation and promotes innovation, permanent and transparent dialogue between policy makers and everyone else involved in the energy sector with the aim of setting the main objectives and immediate actions towards a successful energy transition for the country.

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