



## Solar energy development in Morocco

**SUMMARY** *The Middle East and North Africa (MENA) region has experienced a steep increase in energy demand in the past decade, prompted by economic and population growth, and improved living standards. However, the trend is not sustainable in the long term, in particular for net energy-importing countries such as Morocco. In order to ensure the security of energy supply and an energy mix less dependent on hydrocarbons they have focused on renewable energy sources (RES) – solar, wind, hydropower, biomass, etc.*

*Morocco is a pioneer among MENA countries in establishing a policy and regulatory framework for promoting RES and energy efficiency. Morocco benefits from great solar and wind energy potential, as well as from a key geographical location. Two major RES initiatives – the Moroccan wind and solar projects – have been launched in order to reach the national target of increasing the share of RES in the energy mix to 42% by 2020.*

*EU-Morocco cooperation on RES (solar energy, in particular) would bring benefits to both sides, as well as challenges. Initiatives already exist, with the Mediterranean Solar Plan as the most significant.*

*Solar energy technologies can also contribute to local job creation and development of small and medium-sized enterprises (SMEs).*

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### Glossary

**Primary energy:** Energy in the form in which it is first accounted for in a statistical energy balance, before any transformation to secondary or tertiary forms of energy.

**Installed capacity:** The maximum capacity at which a system is designed to run.

### Issue definition

As the largest energy importer in the MENA, Morocco has tried to diversify its energy mix and ensure its energy security through increasing the share of RES in this mix. Major RES projects (wind and solar energy) were started as a means to reach the RES targets. EU-Morocco cooperation in the RES field – in solar energy, in particular – provides both partners with advantages and constitutes a potentially unifying project for the Euro-Med area. Solar energy projects also have an impact on local SMEs and industry.

### Overview of Morocco's energy sector

#### Regional energy trends

According to a [recent OECD study](#), the MENA region witnessed a rapid increase in energy and electricity demand. Primary energy consumption has risen on average by 5.2% a year since 2002, while demand for electricity registered an average increase of 6.16% a year from 1998 to 2010. Among the



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determining factors are: rapid economic growth, energy-intensive industries, population growth, as well as higher living standards and urbanisation. The situation is a particular burden for MENA countries that are net importers of hydrocarbons (e.g. Morocco, Jordan).

Another study [deems](#) these conditions unsustainable in the long run, although the entire MENA region [accounts for](#) 50% of the world's crude oil and 40% of its gas. Some [scenarios](#) predict energy and electricity demand in MENA will double and triple, respectively, between 2009 and 2030. Already, the volatility of global energy commodity prices, with a heavy impact on finances, and [energy poverty](#) (i.e. lack of access to modern energy services) are harming socio-economic development in the region, particularly in rural areas.<sup>1</sup> Most MENA countries are also very energy intensive (requiring high levels of energy to produce one unit of economic output).

### The energy sector in Morocco

Morocco is the [largest energy importer](#) in North Africa, with a high dependence rate on these imports (95.6% in 2011). Energy consumption has risen at an [average annual rate](#) of 5.7% from 2002 to 2011. However, [per capita energy consumption](#), at 0.52 tonnes oil equivalent (Toe) in 2011, is less than one third the world average (1.7 Toe). Morocco's focus on energy-intensive sectors (chemicals, construction, etc.), on building infrastructure, on tourism and industry will increase its long-term energy needs.<sup>2</sup>

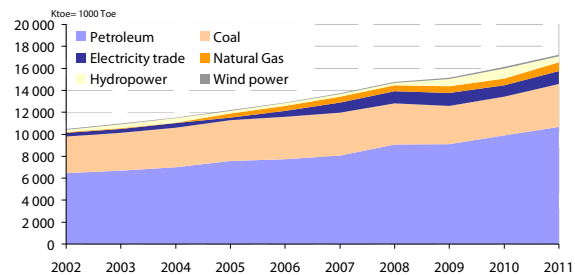
[Statistics](#) from the Moroccan Ministry for Energy, Mines, Water and Environment (MEMWE) offer an overview of the energy sector in Morocco.

#### Primary energy

Morocco's gross energy bill for 2011 was 85.9 billion dirhams (MAD), approximately €7.7 billion. Of this, 75.9 billion MAD (€6.8 billion) was spent on crude oil and petroleum products.

Morocco consumed 17 262 kToe of energy in 2011, with petroleum products accounting for 61.9%. Coal is second (22.5%), followed by electricity trade<sup>3</sup> (7.2%), natural gas (4.6%) and RES, namely hydropower (3.0%) and wind power (1.0%).

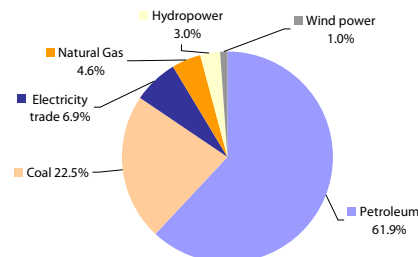
**Fig. 1. Evolution of energy consumption**



Source: [Ministry for Energy, Mines, Water and Environment](#), 2011

[Traditional](#) biomass (wood, plant waste) is used extensively, in rural areas, but is not included in the national energy balance. One of its negative impacts is deforestation.

**Fig. 2. Distribution of energy consumption, 2011**



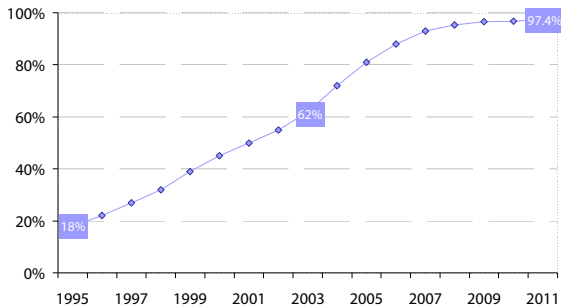
Source: [Ministry for Energy, Mines, Water and Environment](#)

#### Electricity

Electricity demand has also been growing, at an average of 7% in the past decade, according to the Moroccan state-owned electricity utility (Office National d'Electricité, ONE). In 2011, [electricity consumption](#) was 28.8 TWh, 8.4% more than the previous year. Morocco generates its electricity mainly from coal and oil power plants and marginally from natural gas. One natural gas combined-cycle power plant (Ain Beni Mathar) runs using the fee in kind Morocco receives from the Maghreb-Europe gas pipeline that links Algeria to Spain through Morocco. Electricity imports accounted for some 16% of consumption in 2011.

A [rural electrification programme](#) (PERG) put in place in 1996 increased the rural electrification rate from 18% in 1995 to 97.4% at the end of 2011.

**Fig 3. Rural electrification rate 1995-2011**



Source: [Ministry for Energy, Mines, Water and Environment](#), 2011

### Energy price subsidy in Morocco

MENA countries account for almost half of global energy subsidies. Total energy subsidies in Morocco amount to approximately 5% of GDP and almost 20% of state revenue. As there are many [arguments against energy subsidies](#), including that they may divert investment from energy-efficient measures or RES, Morocco is considering [reforming its subsidy system](#). A possibility is to replace the [universal consumption subsidy](#) with cash allowances for households most in need.

## Morocco's commitment to RES

### The case for RES in MENA

MENA countries have the [highest solar energy potential](#) in the world, and good wind energy potential. The International Energy Agency (IEA) estimates that solar power could generate 100 times the combined electricity consumption of Europe and MENA. By including RES in their energy mix, MENA countries could benefit from more reliable energy supplies. Also, RES could be a [solution](#) for rural communities not connected to the electricity grid.

However, in MENA, RES accounted for only 4% of electricity generation in 2009. Without hydropower, this figure drops to 1%. Some MENA countries have started to focus on RES, by adjusting their legal frameworks and by setting [national targets](#).

### Morocco's commitment to RES

According to the [International Renewable Energy Agency](#) (IRENA), Morocco has a key geographical position and the potential to be a regional hub with network interconnections with Spain and Algeria.<sup>4</sup> Renewable energy [potential](#) in Morocco is immense. Solar radiance registers an average of 2 300 kWh/m<sup>2</sup>/year, while great potential for wind power exists in particular in the north and south, according to [measurements](#) conducted by the National Agency for the Development of Renewable Energy and Energy Efficiency (ADEREE).

### Policy and regulatory framework

Morocco has one of the most ambitious RES programmes in the region. The country recently deregulated its electricity sector and facilitated the development of RES.

#### National Energy Strategy

The [National Energy Strategy](#) adopted in 2008 sets out the fundamental objectives and the strategic directions for the energy sector. The strategy identifies RES and energy efficiency as priorities and sets the [targets](#) to be achieved by 2020: 42% of total installed capacity for electricity production from RES; 12% of energy saving; and 1.7 million m<sup>2</sup> of solar water heaters (SWH).

Specific targets are also set for each RES: solar, wind and hydropower should each reach 14% of electricity production by 2020.

**Fig. 4. Targets of the National Energy Strategy**

in %	2009	2015	2020
Coal	29%	35%	27%
Oil	27%	19%	10%
Gas	11%	8%	21%
Hydropower	29%	21%	14%
Solar	0%	5%	14%
Wind power	4%	12%	14%

Source: [Ministry for Energy, Mines, Water and Environment](#)

#### Legal provisions for national targets

Morocco's adaptation of its [legislative framework](#) to achieve the national targets on RES and energy efficiency appears to have been fundamentally implemented:

- [Law No 13-09 on Renewable Energies](#) provides a framework for investors in RES projects, and for green energy exports;

- [Law 57-09 on the creation of MASEN](#) (Moroccan Agency for Solar Energy) – responsible for the implementation of the Moroccan Solar Plan;
- [Law 16-09 on ADEREE](#) extends the mandate of the previous Centre for the Development of RE (CDER);
- [Law 47-09 on Energy Efficiency](#).

### *Funding and other agencies<sup>5</sup>*

An [Energy Development Fund](#) (FDE) has been put in place, with contributions of up to US\$1 billion from Saudi Arabia, the United Arab Emirates and the Hassan II Fund. The Energy Investment Corporation (SIE), with a capital of 1 billion MAD, finances RES and energy-efficiency projects. International donors such as the European Investment Bank, the World Bank, and the AFD (French Development Agency) have also been involved. In 2011, an [institute](#) for research in solar energy and new energies was set up.

### *Incentive schemes*

Before the adoption of the National Energy Strategy, the national electricity company ONE created two incentive programmes. The first focused on a public-private partnership set up to provide rural households with solar photovoltaic (PV) systems to produce off-grid electricity. The second programme (EnergiPro) encouraged energy intensive industrial groups to produce their own renewable electricity up to 10 MW. Current [incentive schemes](#) for private sector contribution to RES include:

- The EnergiPro programme was extended by Law 13-09 to allow up to 50 MW of installed capacity. ONE guarantees the purchase of all energy produced in excess of the company's needs at an incentive tariff for a period of 20-25 years.
- Competitive bidding contracts: private investors may produce electricity through concessions from ONE. They build the plants and may obtain contributions towards operating expenses, staff training costs or investment costs, as well as access to the electricity grid, to land, etc.

Power Purchase Agreements may be available (ONE buys the electricity from the investor at a fixed tariff for a period of 20-25 years; plant ownership is then transferred to ONE).

- As part of PERG, PV home solar systems were deployed in areas remote from the electrical grid. A private operator ([TEMASOL](#)) implemented the project, while ONE covered more than 60% of the equipment costs and administration.

In addition, the Moroccan government has put in place an investor credit for R&D/job training.

### *Major RES programmes*

The Moroccan government launched two major RE projects in 2009 and 2010: the Moroccan Integrated Solar Energy Project (described below) and the Integrated Wind Energy Project.

The **Wind Energy Programme** [aims](#) at installing a capacity of 2 000 MW with annual production of 6 600 GWh (26% of current national production) by 2020. Five sites have been identified.<sup>6</sup> The first wind farm will be operational in 2014. Investment costs are estimated at US\$3.5 billion. This project is expected to produce annual savings of 1.5 Toe and of 5.6 million tonnes of CO<sub>2</sub>. Already, 1 000 MW is [completed](#) (286 MW) or being developed (714 MW).

Also, two large [hydropower projects](#) are in development, while 200 sites have been identified as suitable for "[micro hydropower](#)" (producing off-grid electricity).

## Solar energy in Morocco

### **The Moroccan Integrated Solar Project**

The Moroccan **Solar Energy Project** [aims at](#) achieving an installed capacity of 2 000 MW by 2019 on [five sites](#), and annual production of 4 500 GWh (18% of current national production). The investment costs for the project amount to US\$9 billion, however the project would lead to savings of 1 million Toe and 3.7 million tonnes of CO<sub>2</sub> emissions per year.

The first solar plant, the Ouarzazate CSP plant, is planned to be in service in 2015. In 2012, MASEN announced the [group selected](#) to implement the first phase with an initial capacity of 160 MW (parabolic trough facility) of a total planned capacity of 500 MW. Photovoltaic modules and CSP towers are to be used in later stages. The [complex](#) will be among the largest CSP plants in the world. The group is led by the Saudi International Company for Water and Power (Acwa), with 95% ownership. The [value](#) of the contract is \$1 billion. [Financing](#) will be found through loans from the World Bank, the African Development Bank, the European Investment Bank, the EU, the German KfW Bank, and others. In January 2013, bids were invited for the [second phase](#), consisting of two CSP plants with total capacity of 300 MW.<sup>7</sup>

### Completed solar projects in Morocco

By 2008, 3 163 douars (villages) with 44 719 homes were equipped with individual solar PV kits not [connected](#) to the grid, within PERG. For grid-connected solar PV, two PV systems of 200 KW had been installed. Through the programme [PROMASOL](#), about 240 000 m<sup>2</sup> of SWHs were installed at the end of 2008, with the target of reaching 1.7 million m<sup>2</sup> by 2020. Finally, the [Ain Beni Mathar thermo-solar combined cycle power plant](#) (472 MW) came into service in 2010. It uses the natural gas from the Maghreb-Europe pipeline and CSP technology with a capacity of 20 MW.

### Perspectives

The authorities will continue the installation of SWHs for producing household hot water.

Also, they will set up pilot projects of household PV microplants.

### EU-Morocco cooperation in solar RE

The European Union constitutes a [potential market](#) for MENA countries' RES, as the EU's energy needs are set to rise in the future. The neighbouring MENA region is ideally situated to supply European countries with energy from RES, also contributing to the EU's energy security and to its greenhouse gas emissions targets. The EU set itself the [target](#) to raise the share of RES to 20% of the EU's overall energy consumption by 2020.

The Renewable Energy Directive ([2009/28/EC](#)) establishes mandatory targets and opens up the possibility for EU Member States to cooperate with third countries in RES projects and to import 'green' electricity from these countries (Art. 9).

Therefore, [an EU-North Africa solar partnership](#) would benefit both sides: cooperation can remedy the electricity shortages in MENA, while supplying the EU with solar electricity from the desert; energy projects could also reinforce the [Euro-Mediterranean partnership](#). Divergent interests may nonetheless arise, as some EU Member States look to increase their export opportunities and may be reticent to transfer

technology and know-how to MENA partners. EU-MENA cooperation in the RES field has been advancing, with a number of interlinked projects in development.

### The Mediterranean Solar Plan (MSP)

The [MSP](#) is one of the six priority projects of the Union for the Mediterranean (UfM) initiative, launched in July 2008 to reinforce

#### Capturing solar energy

[Photovoltaic](#) (PV) systems convert light directly into electricity through photovoltaic cells. [Concentrated solar thermal power](#) (CSP) technologies use mirrors to concentrate solar radiation to heat water or another fluid, then this heat is used to generate electricity. CSP is said to provide a significant advantage compared to PV or wind energy. While the latter generate electricity directly, which cannot be stored or produced at night, CSP generates heat that is relatively easy to store. Thus, CSP has the capacity to provide electricity at any time of the day. It may also be combined with other fuels (gas or biomass) or may be used for seawater desalination. Four [CSP technologies](#) are available, the most common being the parabolic trough plant. Finally, solar thermal installations capture solar energy for heating (SWH), not for electricity.

Euro-Mediterranean cooperation. The MSP has two targets: to develop 20 GW of new renewable energy production capacities and to achieve significant energy savings around the Mediterranean by 2020.

A draft [MSP Master Plan](#) is being debated among all stakeholders, with a view to having it endorsed politically at the UfM Energy Ministerial meeting in December 2013. An EU-funded project ([Paving the Way for the Mediterranean Solar Plan](#)) provides analyses on regulatory frameworks affecting RES in MENA. The Neighbourhood Investment Initiative (NIF) and the EIB's Facility for Euro-Mediterranean Investment and Partnership (FEMIP) serve as financing mechanisms. The MSP also aims to complement other [regional energy programmes](#) funded under the European Neighbourhood and Partnership Instrument (ENPI).

The Moroccan Solar Plan, in particular the development of the first Ouarzazate CSP plant, is viewed as a key project in developing the MSP.<sup>8</sup>

### Desertec

The [Desertec Industrial Initiative](#) (Dii GmbH), founded by the Desertec Foundation (non-profit) and private-sector companies from North Africa and Europe, supports the development of solar and wind RES in MENA that could supply Europe with green energy (15% of Europe's energy needs), through investment and financing guidance, studies and pilot projects. [It was hoped](#) that, by 2050, 125 GW of RES electricity capacity could be installed in North Africa. The investment proposed by Dii amounted to €400 billion.

In 2011, Dii and MASEN signed a memorandum of understanding concerning the [development of a solar project in Morocco](#) to test export possibilities of RES generated energy from Morocco to Spain. MASEN is the project developer and Dii offers feasibility advice.

### MedGrid

The [MedGrid initiative](#) is also a private industry initiative focused on setting up a trans-Mediterranean super-grid of high-voltage direct current (HVDC) cables, able to export 5 GW of energy from MENA to Europe by 2020. It is considered part of the framework of the MSP. MedGrid focuses on three [possible corridors](#), including the existing Morocco-Spain submarine cable. The signature of a memorandum of understanding in 2011 [recognises](#) the complementarity of the two initiatives (one focused on energy generation, the other on energy transmission) and provides for collaboration.

### Challenges and state of play<sup>9</sup>

An important aspect of EU-Morocco/MENA RES cooperation is the transmission of electricity from one side to the other. Europe and MENA are connected only through the Morocco-Spain transmission line (1400 MW), therefore additional HVDC lines interconnecting the two Mediterranean shores are needed, to realise the ambitions of the MSP. The issue of grid interconnection is a related challenge, as both the interregional (EU-MENA) and intraregional interconnections must be improved, not only in MENA, but on the [EU side](#) as well. The development of natural gas infrastructure, to provide back up capacity to RES, is also of importance to Morocco.

Training and technical cooperation are needed so that local workers benefit from the RES sectors where most jobs are available.

Financing has become a problem, in the context of the financial crisis. High initial investment [costs](#) may act as structural barriers to solar projects, as they are initially uncompetitive on the market. Public support schemes and political support are therefore needed for their promotion, until profits are made.

Finally, [Western Sahara's](#) status is a sensitive issue, as some [fear](#) that EU-Morocco projects would help preserve the status quo.

As for the [state of play](#), the Moroccan solar plan continues to attract investment, even if the Desertec initiative has experienced some setbacks: in 2012, the Spanish government failed to support the Desertec project in Morocco and two important partners – Bosch and Siemens – announced their withdrawal from Dii.

### Solar energy, local SMEs and industry

An International Labour Organisation (ILO) [study](#) shows that growing interest in solar energy will lead to soaring employment in this sector (projections of 6.3 million jobs in solar PV alone by 2030 worldwide). The local impact consists mainly of the creation of jobs in the installation, operation and maintenance of the systems. Concerning only CSP, [estimates](#) from industry state that every 100 MW of CSP plant installed will provide 400 person-year equivalent manufacturing jobs, 600 in contracting and installation, and 60 in operation and maintenance. [Another study](#) (World Bank, 2011) presents the impact of CSP for local SMEs and specific industry sectors in MENA. It also draws lessons for future CSP projects from the example of the Ain Beni Mathar plant in Morocco: low participation of local industry in the project may lead to little technology transfer and know-how; also, cost advantages for local components and services were not identified.

SMEs (and households) in Morocco have been targeted by projects (such as [FreemE](#))

promoting RE and energy efficiency through microfinance.

#### The European Parliament

In the framework of its [Delegation to the Parliamentary Assembly of the Union for the Mediterranean](#) (PA-UfM), the EP is following [developments](#) regarding the Mediterranean Solar Plan and may propose side projects. In a [report](#) recently adopted by the Industry, Research and Energy (ITRE) Committee, MEPs highlight the importance of cooperating in the field of RES with Mediterranean countries and stress their support for RES projects.

### Main references

[European Energy Policy: an environmental approach](#)/Ed. F. Morata, I. Solorio Sandoval, 2012.

[La nouvelle Stratégie Énergétique Nationale - Bilan d'étape](#)/ Ministry of Energy, Mines, Water and Environment, Kingdom of Morocco, 2013.

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<http://www.library.ep.ec>

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### Endnotes

- <sup>1</sup> The IEA elaborated an [Energy Development Index](#) (EDI), to measure energy poverty in developing countries. The EDI for each country is expressed as a value between 0 and 1. The values closer to 1 indicate a good performance.
- <sup>2</sup> Morocco, the European energy policy and the Mediterranean Solar Plan/ G. Escribano-Frances, E. San Martin Gonzalez, in [European Energy Policy: an environmental approach](#), ed. F. Morata, I. Solorio Sandoval, 2012, pp. 193-210.
- <sup>3</sup> Imports minus exports of electricity.
- <sup>4</sup> Morocco's relations with Algeria have been problematic, also due to the issue of [Western Sahara](#). Algeria maintains its border with Morocco closed since 1994.
- <sup>5</sup> [La nouvelle Stratégie Énergétique Nationale - Bilan d'étape](#)/ Ministry of Energy, Mines, Water and Environment, Morocco, 2013.
- <sup>6</sup> Taza (Taza), Sendouk (Tanger), Koudia Baida II (Tetouan), Tiskrad (Laâyoune) and Boujdour.
- <sup>7</sup> A 100 MW CSP tower plant and a 200 MW parabolic trough plant.
- <sup>8</sup> See endnote 2, p. 198.
- <sup>9</sup> Ibid., pp. 199-207.