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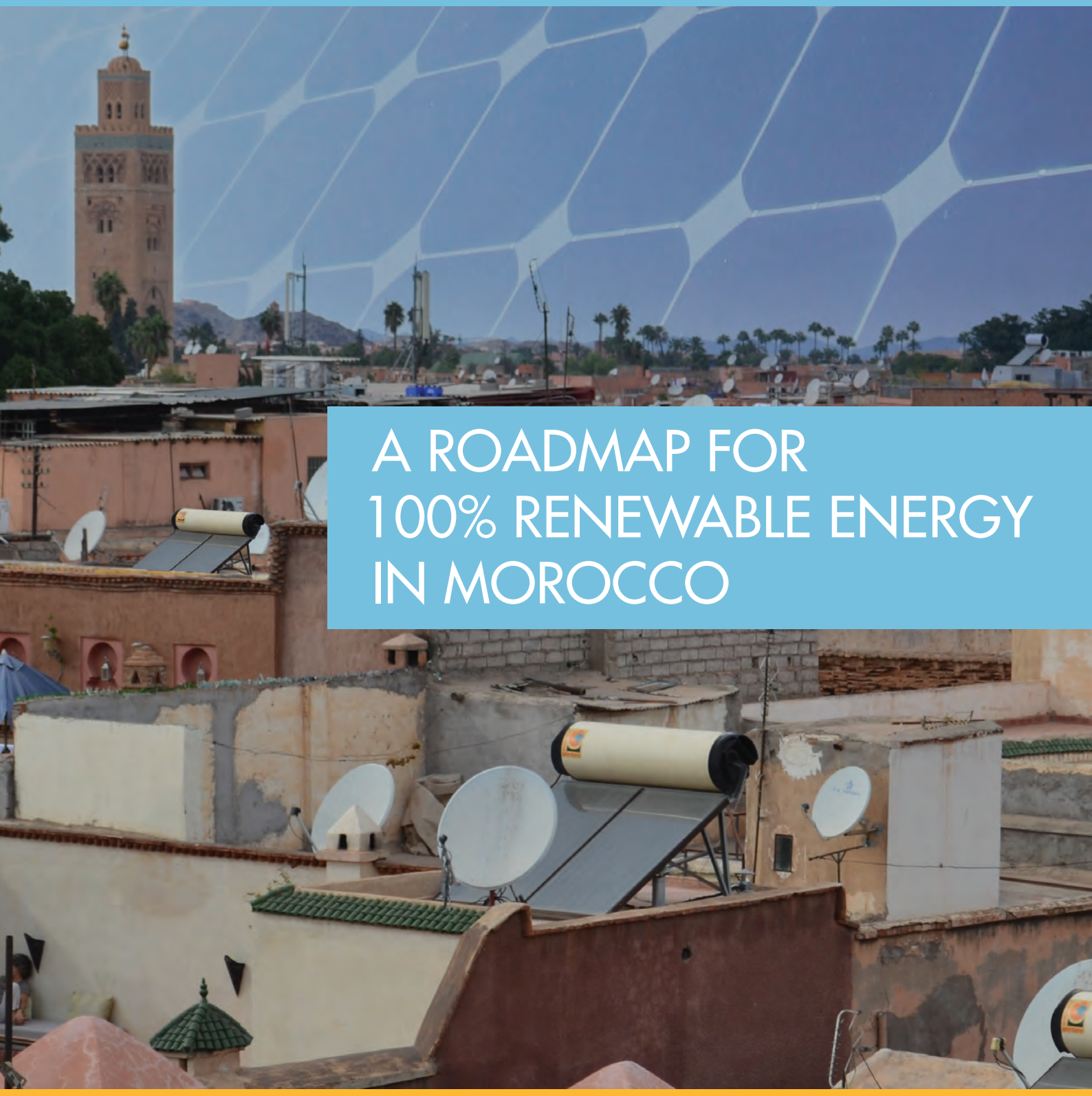

A ROADMAP FOR 100% RENEWABLE ENERGY IN MOROCCO

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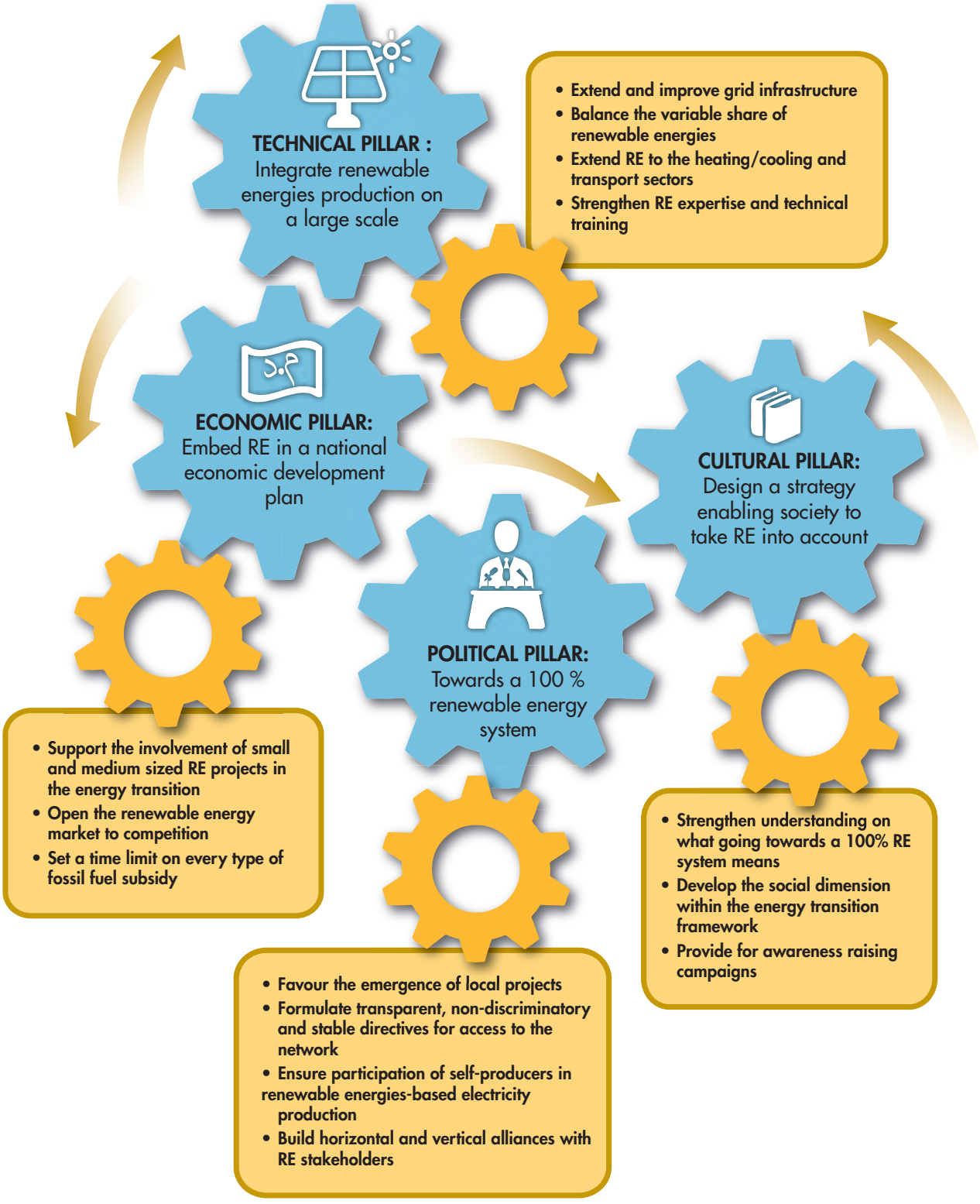


INTRODUCTION

A growing number of governments worldwide have set renewable energy goals (REs) to provide to all access to sustainable energy while at the same time combating poverty and climate change caused by human activities. In only 10 years, the number of countries pursuing RE projects has quadrupled, from 43 in 2005 to 164 in 2016, according to the International Renewable Energy Agency's report «Renewable Energy *Target Setting* »

Indeed the world today admits the growing need to reconcile economic development, environmental protection and social commitment. It is within this perspective that during the COP21 states committed to limit global warming to « well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C »

More than ever, climate change caused by a growth model characterised by pressure on natural resources, energy market volatility and erratic price swings, have confirmed that an in-depth change in economic growth models and energy pathways is inevitable.

COP 22 taking place in Marrakesh in November 2016 must be the occasion to reaffirm the positive spirit of Paris and transform these objectives into concrete results. Fortunately it is already widely recognised – to start with by Morocco the host country – that this goal will only be achieved if accompanied by ambitious renewable energy objectives and actions.

As emphasised by Said Mouline « Morocco has not waited for COP 22. Since 2009 we have prioritised renewable energies and energy efficiency ». Aware of the nature of the opportunities and stakes confronting Morocco, the nation has mobilized to share the message about the urgency and advisability of changing the energy pathway.

In 2008, His Majesty King Mohammed VI during the anniversary of the accession to the throne recognised the need for the country to adapt to the profound changes affecting the energy sector at world level and to « resolutely pursue efforts to making alternative and renewable energies the keystone of national energy policy[1]».

Morocco currently imports 95 % of domestic consumption and depends on imports for 90 % of its electricity needs[2]. These energy imports comprise 50 % of the trade deficit, affecting its trade balance and weigh heavily on the national budget (accounting for 10-12 % of GDP[3]).

To this are added a growing electricity demand increasing at an annual 6.6 % in the last ten years as well as the huge increase in greenhouse gas emissions. Indeed, energy accounts for about 78 % of Morocco's CO2 emissions and over half of its global GHG emissions[4].

Forecasts for Morocco see an increase in temperatures of 0.5 to 1°C by 2020 and 1 to 1.5°C by 2050 and 2080. Rainfall could decline by 30 % between now and the end of the century. Moreover, the forecast issued by the government in 2015 emphasised that whatever the scenario envisaged, Morocco would suffer a water shortage as from 2020-2030[5].

From a sustainable development perspective, progress towards a 100 % renewable energy system is presented as the most efficient solution to combat climate change as well as the multiple existential crises caused by the current fossil fuels based energy system.

Thus the development and promotion of renewable energies have become central topics for the nation. In 2009, Morocco announced its goal to raise the share of renewable energies to 42 % of its total installed capacity by 2020. During the COP 21, the government increased this to 52 % by 2030. Currently, renewable energies are the subject of a diversified portfolio for solar, wind and hydro anchored in a legislative framework, notably Law nº 13-09 on renewable energies.

In this development, advantages are beginning to be shared by society as a whole. For example in NOOR Ouarzazate, the first project launched by the Moroccan solar energy agency (MASEN), covering 3,000 hectares with a total capacity of 580MW by 2018, Moroccan companies contributed « almost one-third of the value of the plant, supplying metallurgical, cabling, construction and public works components or services ». This generated 2,000 jobs of which 40 % in the region[6].

Nevertheless, Morocco can go further and faster. There remain a good number of political, economic, technical and cultural obstacles which stand in the way or slow down the transition towards a renewable energy system. Moreover, the majority of actions are concentrated on the electricity sector, neglecting the heating and cooling as well as the transport sector.

To ensure the energy transition towards a nation supplied by 100 % renewable energies, Morocco must radically modify its energy sector and take the right steps. The challenge is not so much a lack of energy resources but to fundamentally transform the way in which the energy system is structured.

Our dependence on fossil energies has engendered a complex centralised system which lacks diversity and security and is

characterised by a vertical supply system in which benefits are shared between a small number of actors.

To move towards a 100 % renewable energy system offers the opportunity to change this reality. By their nature, renewable energies are based on decentralised production, have a horizontal supply chain and need an infrastructure and market completely different to the current energy market, which will permit the emergence and participation of new actors, including citizens.

The question is then posed to know in what terms this transition will take place so as to profit present and future generations. This is why it is imperative to allow political decision makers at national, regional and local level and the various stakeholders to meet and exchange views on the roadmap to go towards a 100 % renewable energy system.

In order to address the complexity, challenges and opportunities of the energy challenge, the World Future Council organised a process of reflection for Moroccan actors playing a leading role in this transition: parliamentarians, political actors, academics and civil society.

In this spirit, round tables and conversations were organized between 2014 and 2016 guided by the following questions:

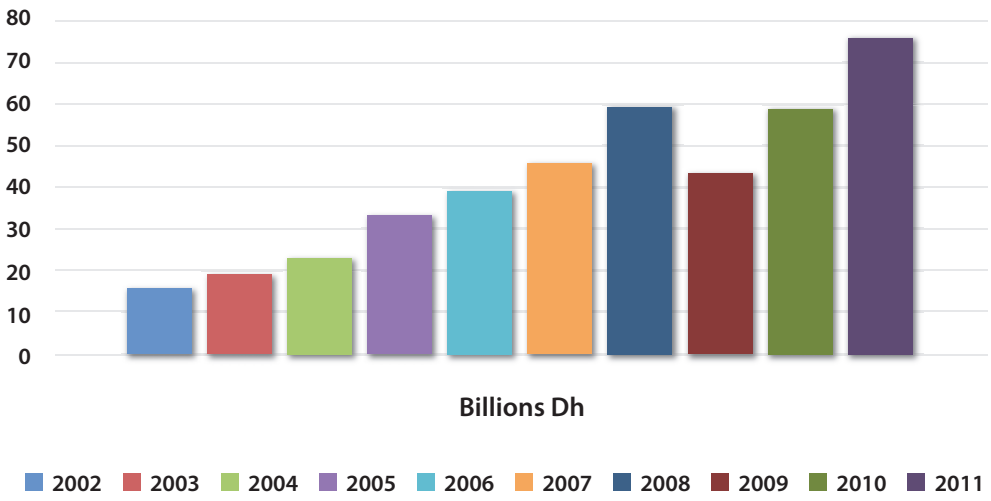
- Morocco's current energy context : challenges, renewable energies potential and energy strategy
- Morocco's leading renewable energy projects: main features, total installed power, production capacity, estimated cost, financing and entry into service dates.
- Socio-economic benefits of renewable energies in Morocco: challenges being addressed up by renewable energy projects.
- Guidelines for energy transitions: legislative, institutional and economic reforms.
- Principal challenges for deployment of renewable energies in Morocco: political, economic, technical and cultural.
- Recommendations to guarantee a successful energy transition for Morocco.

This report reflects discussions held as well principal points debated, and aims to identify the solutions for putting into place a coherent political framework which allows the materialisation of a 100 % renewable energy Morocco.

1. Energy context

Morocco's energy structure is undergoing total transformation. The nation depends almost completely on foreign sources for its energy supply, importing over 95 % of its energy needs in 2014. Oil purchases account for 24 % of total imports and nearly 50 % of the trade deficit[7]. And these figures only represent the electricity sector.

Figure 1: Morocco's oil bill 2002-2011



Source: Ministry of Energy, Mines, Water and Environment of Morocco (2013)[8]

High energy dependence

Highly sensitive to exogenous shocks, this dependence has grown and weighs heavily on the economic and financial equilibria of the country. In 2014 the energy bill reached nearly Dh 92 billion[9], as against Dh 17.15 billion in 2000[10], accounting for 10.1% of GDP. This was up from 3.1% of GDP during 1995-1999, 6.3% during 2000-2007 and 10.5% during 2008-2014[11]. Moreover, in order to safeguard purchasing power and the economy's competitiveness, the government subsidised the prices of oil-based products. This support became an ever heavier burden on the government's budget, going from Dh 0.7billion in 2003 to Dh 43 billion in 2011[12].

Figure 2: Impact of the subsidy on the public retail prices of petroleum products in 2011

	Super Dh / Litre	Gasoil Dh / litre	Fuel N°2 Dh / tonne	Fuel ONE Dh / tonne	Special Fuel Dh / tonne	12 kg Bottled butane gas Dh
Maximum Official price	10.18	7.15	3,678.00	2,384.83	2,600.92	40
Ex-subsidy Price	12.88	11.05	6,049.83	5,848.28	7,126.51	123.72
Compensating charge	2.7	3.9	2,371.83	3,463.45	4,525.59	83.72
Subsidy %	20.9%	35.3%	39.2%	59.2%	63.5%	67.6%

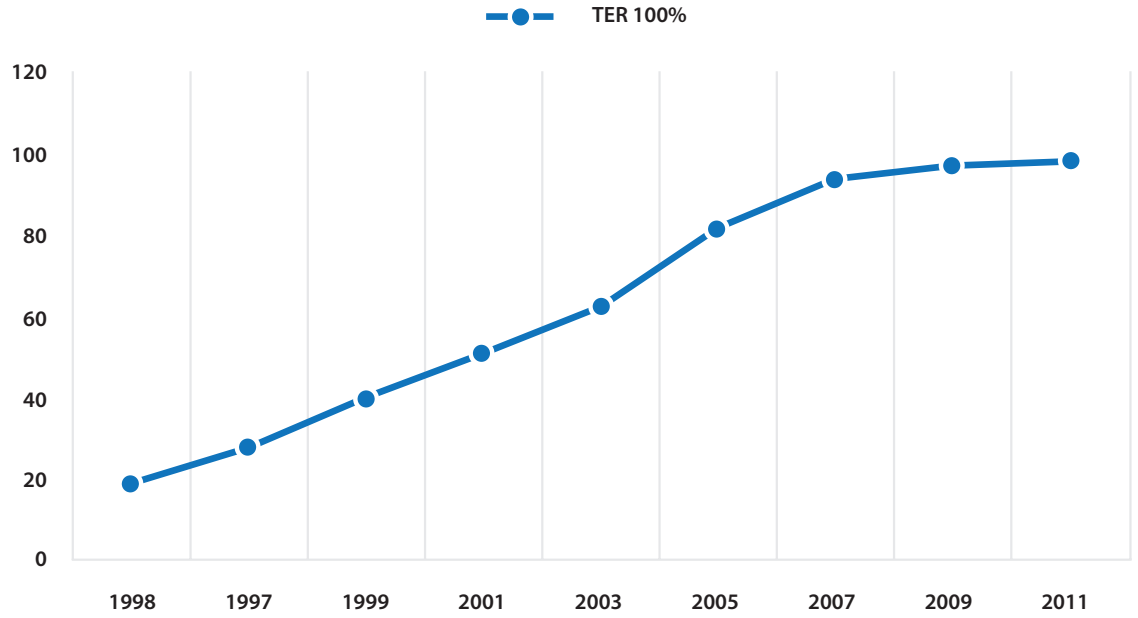
Source: World Bank (2013)[13]

Although Morocco ended all subsidies on liquid petroleum products at the end of 2014, those for butane amounted to nearly Dh 16 billion in 2015[14].

Growing energy needs

The trend of an increasing energy bill is intensified by a constant growth in demand. Since the 1990s Morocco has insisted on the key role of energy in national socio-economic development and in 1995 the government launched an ambitious rural electrification programme so as to extend energy access to the entire population by 2010. In 1990, rural electrification was only 18 % compared to 70 % in Tunisia and 84 % in Algeria. In 2009 the grid reached 98 % of the population, 35,086 villages having been connected, representing 1,897,100 households (of which, 51,500 with solar electricity)[15].

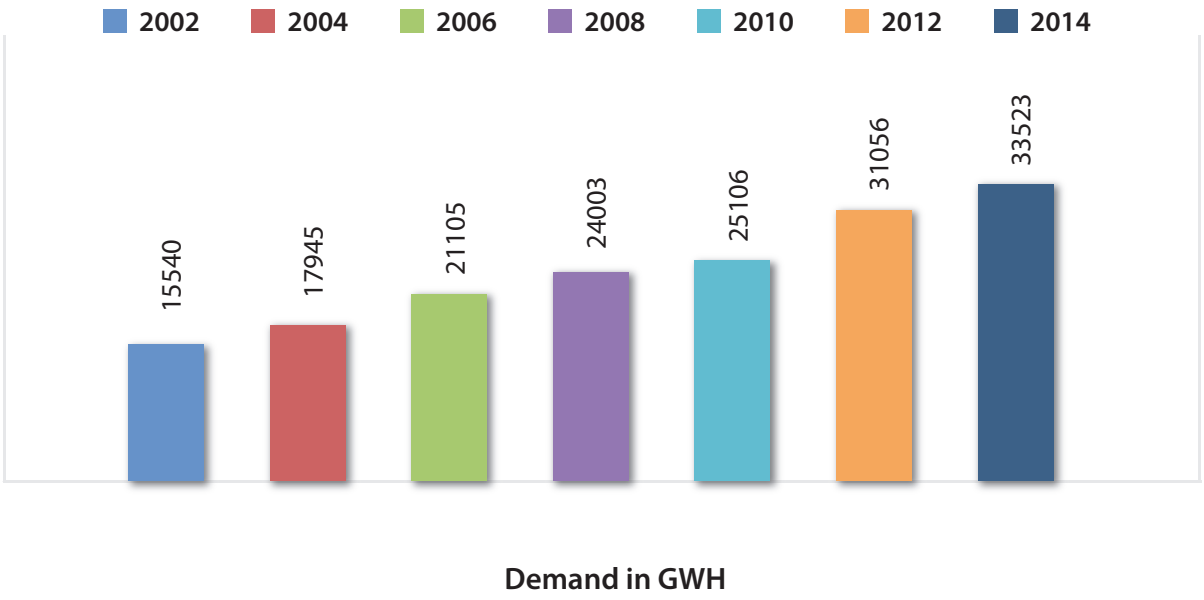
Figure 3: Development of rural electrification rates (%) in Morocco since 1995



Source: Ministry of Energy, Mines, Water and Environment of Morocco (2013)

This development contributed to a steady growth rate of 4 to 5 % a year, although it also led to a strong boost to electricity demand[16]. In fact during the last ten years, and driven by the generalisation of electricity access, improved living standards and demographic growth, electricity demand in Morocco grew at 6.6 % a year with a structure increasingly resembling that of developed countries. It thus went from 15,540GWh in 2002 to 33,523GWh in 2014. A further 70 % increase is foreseen up to 2025. Within this framework, industry accounts for 40 % of consumption, followed by domestic (32%) and services (17 %)[17].

Figure 4: Growth of electricity demand in Morocco at 6 % a year (2002-2014)



Source: Ettaik, Z. (2015)

Trends in the electricity mix

Detailed information on the development of the electricity mix shows that the use of oil must visibly drop from its current level of 24 % to reach 11 % of the electricity mix in 2020, then fall to 5 % in 2025 and 3 % at the end of the next decade. The role of coal will remain preponderant in Moroccan energy production. It currently accounts for 32 % of the electricity mix and this share should increase to 40 % by 2020 and then return to 32 % in 2025 and fall to 20 % in 2030. The share of natural gas must increase by 5 % by 2020, 16 % in 2025 and climb to 25 % in 2030. The share of hydro will trend downwards going from 22 % in 2015 to 14 % in 2020 and then 12 % in 2030. The share of wind which accounted for 10 % in 2015 will increase to 15 % in 2020, 18 % in 2025, and will represent 20% in 2030. Finally, solar currently accounts for 2 % but should increase to 14 % in 2020, 16 % in 2025 and 20 % in 2030[18].

Figure 5: Development of renewable energy installed capacity in Morocco (2015-2030

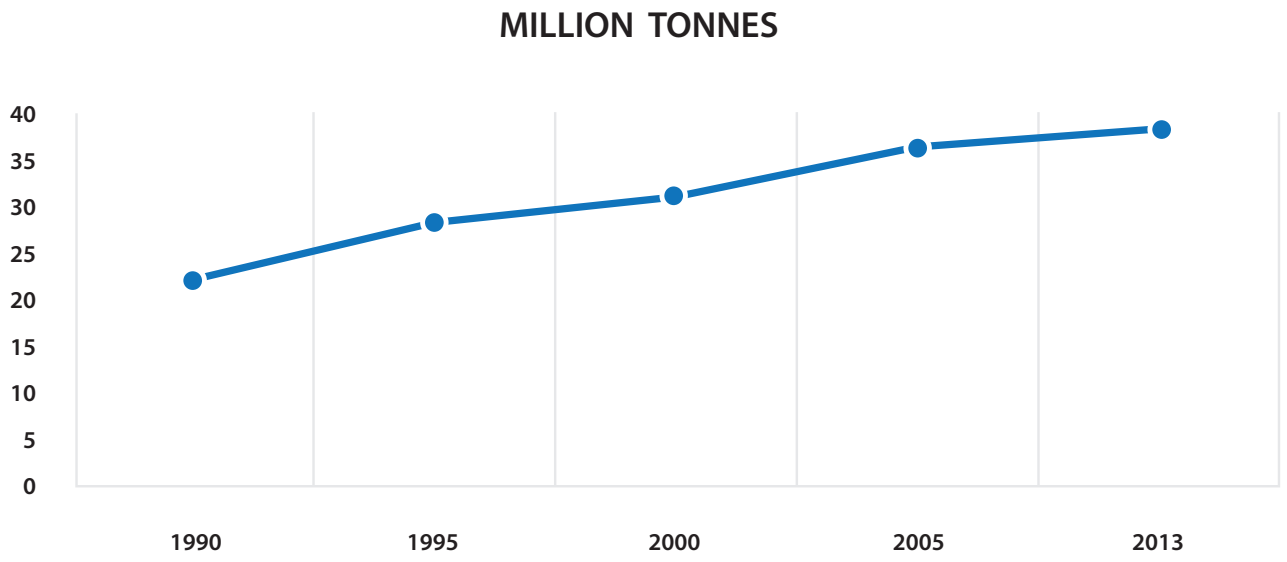
Type of energy	2015	2020	2025	2030
Oil	24%	11%	5%	3%
Coal	32%	40%	32%	20%
Natural gas	4%	5%	16%	25%
Hydro	22%	14%	16%	20%
Wind	10%	15%	18%	20%
Solar	2%	14%	16%	20%

Source: WFC compilation on the basis of data by M. Hayoun (2016)

Increasing greenhouse gas emissions

In Morocco as in the world over, strong dependence on coal, oil and gas generates a relatively high level of greenhouse gas emissions. During recent decades, its CO2 emissions increased from 22 million tonnes in 1990 to 38 million tonnes in 2013[19].

Figure 6: Carbon dioxide emissions due to energy consumption in Morocco



Source: WFC compilation from data by I.Kolesnikov (2015)

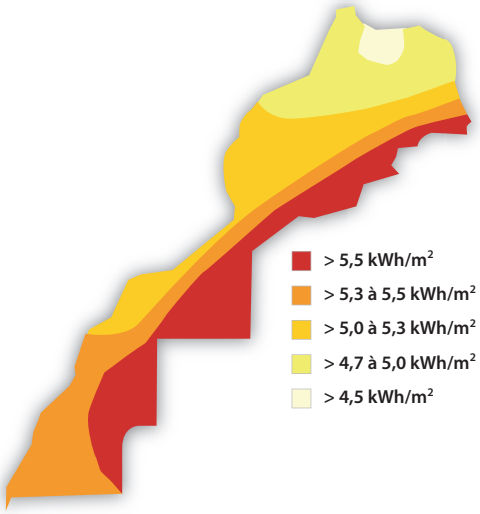
Due to its geographical location, Morocco is strongly affected by climate change (desertification, flooding, decreasing water resources) and its vulnerability will increase in the future. For this reason between 2005 and 2010 the government devoted 64 % of its climate-related expenditures to adaptation[20]. This demonstrates the measure of the climate change challenge to the country which, as its Ministry of Energy, Mines, Water and Energy emphasises, is accentuated by various factors such as the level of awareness of the population, the legal framework, the absence of an approach adapted by territory and economic structure, with its high dependence on water resources, agriculture and the coastal areas[21]. According to estimates, during the 21st century agricultural production could decline by 15 to 40 %. This entails the risk of rising food prices, an aggravation of social inequality and the destabilisation of the entire socio-economic equilibrium of the country[22]. Added to the increase in population and forecast industrial needs, these vulnerabilities will progressively increase, impacting not only the agriculture sector, but the entire economy and stability of the nation[23].

1.1. Renewable energies potential

Morocco's strong dependence on fossil fuel imports seriously endangers its present and future energy security, weighs heavily on its economic and financial equilibria and on its development possibilities. Indeed, Morocco is scantily endowed with conventional energy resources. However it benefits from a topography and climate which are extremely well suited to the development of renewable energies, in particular solar and wind.

Solar

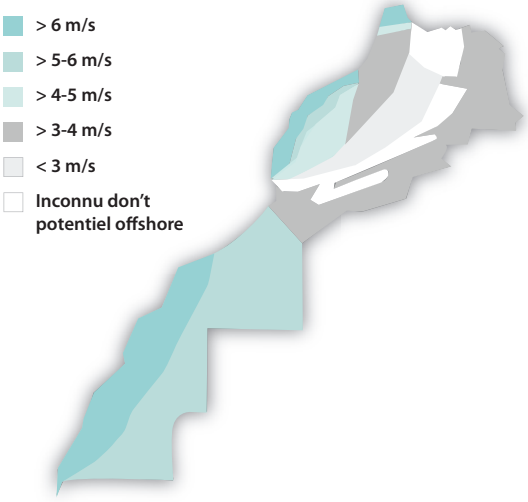
Solar is certainly the leading source of renewable energy in Morocco since its solar resources are equivalent to 20,000MW, with more than 3000 hours a year of sunshine and irradiation of 5 kWh/m2/day[24].



Source : Société d'Investissements Énergétiques (2015) : « Gisement solaire du Maroc »

Wind

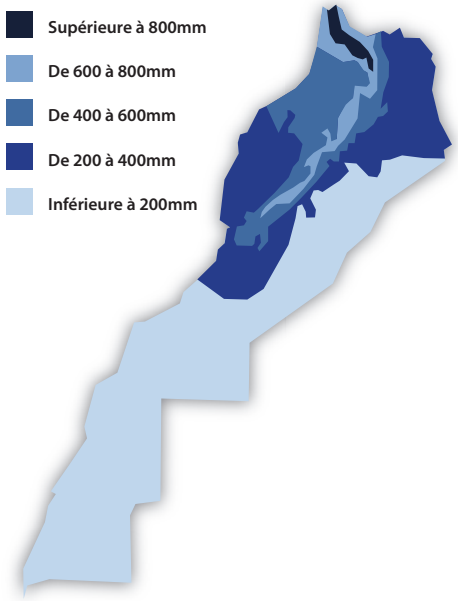
Morocco has major wind potential, officially estimated at 25,000MW since there are several regions with wind resources, especially along the coasts, with wind speeds of over 6.5m/s up to 10m/s[25].



Source : Société d'Investissements Énergétiques (2015) : « Gisement éolien du Maroc »

Hydraulic

The nation already has a hydroelectric structure which covers basic energy needs. In 2015 installed capacity reached 1,770 MW and its hydroelectric potential is estimated at 3,800MW[26].



Source : ONEE (2013) « Gisement hydraulique du Maroc »

Morocco is in fact the world's 14th most attractive country for renewable energies. It is ranked first in the MENA region and second in Africa behind South Africa according to the renewable energies barometer « *Renewable Energy Country Attractiveness Index* » issued by Ernst & Young[27] in 2016. The quality of resources is such that the price of wind and solar energy is already competitive with the price of fossil fuel based energies: prices of wind projects vary between Dh 0.31 (US$ 0.03 cents/Kwh) for the Integrated Wind Project; Dh 0.57 (US0.05 cents/Kwh) at Taza and Dh 0.72 (US$0.07 cents/Kwh) at Tarfaya. The price of thermo-solar projects at Ouarzazate vary between Dh 1,5 (US$ 0.15 cents/KWh) at NOOR O CSP I with 160 MW and 3 hours storage and Dh 1.4 (US$ 0.14 / KWh) at NOOR O CSP II and NOOR O CSP III with 350 MW with 8 hours storage. In comparison the fuel fossils import price during the last ten years has been 0.97 Dh (US$ 0.09 / Kwh).

Figure 7: Kwh price of renewable energy projects in Morocco

Renewable Energy projects	Installed capacity	Per KWH price in electricity purchase contract	Developer
Taza wind park	150 MW	0,57 Dh (0,05 US$) / KWh)	EDF/MITSUI
Tarfaya wind park	301 MW	0,72 Dh (0,07 US$ / KWh)	Nareva-Engie
Integrated wind project	850 MW	0,31 Dh (0,03 US$ / KWh)	Nareva-Siemens Enel Green Power
Noor O I csp	160 MW	1,5 Dh (0,15 US$ / KWh)	Acwa Power
Noor O II csp	200 MW	1,4 Dh (0,14 US$ / KWh)	Acwa Power
Noor O III csp	150 MW	1,4 Dh (0,14 US$ / KWh)	Acwa Power

Source: WFC compilation on the basis of Greenpeace data(2015)[28] & Massolia (2016)[29]

1.2. Morocco's renewable energy targets

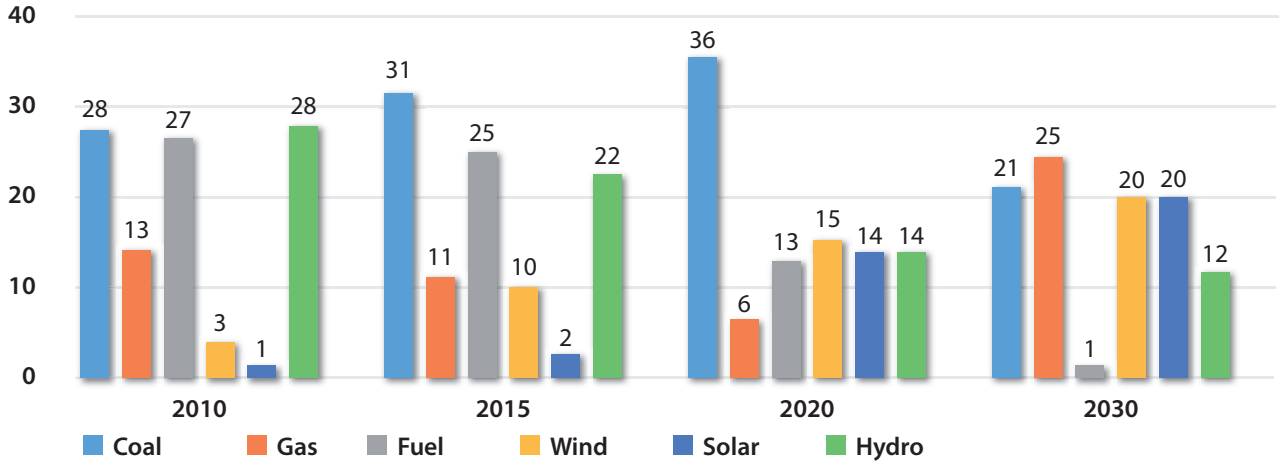
Aware of the nation's energy stakes and the promising future of green energy sources, in 2009 Morocco presented a new National Energy Strategy to 2030 to take up these challenges. The Strategy aims to « strengthen security of supply energy availability as well as its generalised access at reasonable cost ». The strategy also sets the acceleration of renewable energies development so as to « cover a substantial share of its energy needs; reduce energy dependence; and decrease greenhouse gas emissions ».

Accordingly Morocco has set as its principal goal to increase the share of renewables to 42 % (6,000 MW) of total installed capacity by 2020. The three leading renewable energy sources (solar, wind and hydro) are forecast to each contribute 2,000MW or 12 % of national electricity production. In other words, the contribution of renewable energies to primary energy consumption will increase from 5 % in 2009 and 8 % in 2012 to reach 10 to 12 % in 2020[30].

Moreover, within the framework of COP 21, King Mohammed VI raised Morocco's ambitions and the Kingdom announced its commitment to reach a rate of renewable energies penetration of 52 % of total installed capacity by 2030: 20 % using solar energy, 20 % wind and 12 % hydro. « To reach this goal, the Kingdom of Morocco will develop additional electricity production capacity between 2016 and 2030 of around 10,000MW in renewable energies of which 4,560MW solar, 4,200MW wind and 1,330MW hydro. Total investment expected for renewable energy electricity projects will amount to US$ 32 billion presenting real investment opportunities for the private sector » as explained by the Minister of Mines, Water and Environment, Abdelkader Amara at the Germany pavilion at COP 21.

Already at the end of 2014 energy consumed totalled 33,523 GWh, of which 11.6 % renewable, marking a turning point in the energy transition process. As regards installed capacity, renewable energies represented 32 % of the 7,992 MW, will reach 15,946 MW in 2020, 20,070MW in 2025 and 24,800MW by 2030. To reach the targets set for 2020 and 2030 Morocco will have to develop between 2016 and 2030 additional renewable energies electricity production capacity amounting to about 10,100MW of which 4,560 solar, 4,200 wind and 1,330 MW hydro[31].

Figure 8: Prospects of Renewable Energies development in Morocco - Evolution of energy mix 2010-2030 in %



Source: ONEE (2015)[32]

2. Renewable energy projects in Morocco

This is summary of solar, wind and hydro projects launched by Morocco to facilitate the implementation of the national energy strategy to 2020. However, the projects enabling Morocco to raise the share of renewable energies from 42 to 52 % of total installed capacity between 2020 and 2030 have not yet been revealed.

2.1. The integrated solar programme

This integrated project, named NOOR (light in Arabic) aims at the installation of 2,000MW by 2020. This goal will be achieved through major solar projects located at five sites: NOOR Ouarzazate, NOOR Tafilalt and Atlas, NOOR Midelt, NOOR Laâyoune and Boujdour, NOOR Tata, and by solar power stations in low-cost areas (150MW in PV)[33].

Figure 9: Main characteristics of Morocco's solar programme to 2020

Main characteristics	
Installed capacity	2,000 MW (38% of installed capacity)
Production capacity	About 4,500 GWh per year
Estimated cost	Dh 70 billion (US$ 9 billion)
Date of entry into service	First units in 2015 Whole project at end 2019

Source: MASEN (2015)[34]

NOOR Ouarzazate

The NOOR Ouarzazate complex is the first solar mega-project launched by the Moroccan solar energy agency (MASEN). Covering 3000 ha, its total capacity will reach 580MW by 2018.

NOOR Ouarzazate I is the first stage of the NOOR Ouarzazate complex. This project whose capacity could reach 160MW uses the Concentrating Solar Power technology with cylindrical-parabolic captors with a thermal storage capacity estimated at 3 hours at full power. NOORo I extends over a surface of about 450 ha. Construction work for the project's first solar park was officially launched on 10th May 2013 and it was inaugurated in February 2016. Project NOORo I is managed by the Saudi promoter and operator ACWA Power at a level of 95 %. The price offered by this consortium reached a record low at that moment, with a tariff of Dh 1.6187 per Kwh. NOORo I required an investment of €1 billion.

Financing of the next phase – NOORo II (200MW) and NOORo III (150 MW) – , with an estimated cost of US$ 2 billion, was also assumed by ACWA Power. Construction work on the site officially started in February 2016. Only the financing of the last phase, NOORo IV (70MW) is still pending. The construction starting date for NOORo IV is foreseen for 2016/2017, with entry into service in 2017/2018.

Figure 10 : NOOR Ouarzazate technical data

	NOOR O I	NOOR O II	NOOR O III	NOOR O IV
SPONSOR	MASEN	MASEN	MASEN	MASEN
PURCHASER	MASEN /ONEE	MASEN /ONEE	MASEN /ONEE	MASEN/ONEE
DEVELOPER	Acwa Power	Acwa Power	Acwa Power	Being selected
TECHNOLOGY	CSP – Cylindro-Parabolique	CSP – Cylindro-Parabolique	CSP – Tower	PV
GROSS CAPACITY	160 MW	200 MW	150 MW	70 MW
THERMAL STORAGE	3 hr	8h	8h	
SURFACE	~480 ha	~680 ha	~750 ha	210 ha
CONSTRUCTORS	Acciona, Sener, TSK	Sener, Power China, Sepco	Sener, Power China, Sepco	
FINANCE MOBILISED	~730 millions €	~810 millions €	~645 millions €	
FUNDERS	French Development Agency, African Development Bank, European Bank for Reconstruction and Development, World Bank, Clean Technology Fund, KfWBankengruppe, EU	African Development Bank, European Bank for Reconstruction and Development, World Bank, Clean Technology Fund, KfWBankengruppe, EU	French Development Agency, African Development Bank, European Bank for Reconstruction and Development, World Bank, Clean Technology Fund, KfWBankengruppe, EU	
DATE OF ENTRY INTO SERVICE	2015	2017	2017	2017/2018

Source: MASEN (2016)[35]

NOOR Tafilalt and Atlas

The plants comprising the Atlas project are medium-sized and will have a production capacity of between 10MW and 30MW for an overall investment of around US$ 800 million. This programme has two phases the first being the Tafilalet plant with a production capacity of 100MW which aims to achieve in a final stage an output of 300MW photovoltaics-based electricity. The NOOR Atlas project should be operational in 2017 and will comprise eight EPC *(Engineering Procurement Construction)* plants with a total capacity of 200MW[36]. The Tafilet project, estimated at Euros 150 million is almost entirely financed by the World Bank (Euros 148.95 million). As regards the Atlas project, financing will be extended by the German Bank KfW (Kreditanstalt für Wiederaufbau), the European Investment Bank as well as the European Commission[37].

NOOR Midelt

The NOOR Midelt project comprises the construction of new solar installations near Midelt, a town in the centre of the country 150 km south of Fes. Covering a surface of about 2,400 hectares, the site will be developed in several phases using two technologies. First the CSP phase (thermodynamic solar power station) representing 80 to 85 % of NOOR Midelt's total capacity. Then a photovoltaic phase accounting for the remaining 15 to 20 %. The Moroccan solar energy agency has revised upwards the potential capacity of the site, from 470MW to 600MW. The financial engineering of the project should be concluded during 2017, construction work will be launched towards the end of the same year and entry into service will start in 2019[38].

NOOR Laâyoune and Boujdour

The NOOR Laâyoune project with a maximum capacity of 80MW is the largest photovoltaic plant of the solar plan. Once completed it will also be one of the largest photovoltaic sites in Africa. The NOOR Boujdour project will have a capacity of about 20MW. The reception date for the NOOR project is 2018 but related financing remains to be confirmed. The two sites will generate 230 GWh a year[39].

NOOR Tata

Potential generating capacity of the NOOR Tata plant has also been revised upwards by MASEN, from 400MW to 600MW (300MW from CSP and 300MW from PV). The pre-selection process of developers should be launched in the second half of 2016. As in the case of NOOR Midelt, the site's commercial entry into service will be from 2019[40].

2.2. The wind programme

Morocco's wind energy project aims to install a capacity of 2,000MW by 2020, with an annual production of 6,600GWh, corresponding to 26% of current national electricity production in Morocco.

Main characteristics	
Installed capacity	2000 MW
Production capacity	About 6,000 GWh a year
Estimated cost	Dh 34 billion (US$ 3,5 billion)
Dates of entry into service	First units in 2013. Whole project terminated in 2020

Figure 11: Main features of Morocco's wind energy programme to 2020

Source: Ministry of Energy, Mines, Water and the Environment of Morocco[41] (2013)

This objective will be achieved by means of the following installations:

Figure 12: Achievement of Morocco's wind energy programme to 2010

Already built	Under construction Entry into service foreseen for 2016	To be developed Entry into service between 2017 and 2020
Total : 780 MW	**Total : 220 MW**	**Total : 1000 MW**
Abdelkhalek Torrés (50 MW)	Akhfennir (100 MW)	Taza (150 MW)
Amogdoul (60 MW)	JbelKhalladi (120 MW)	Tanger II (100 MW)
Tanger 1 (140 MW)		Boujdour (100 MW)
Lafarget (30 MW)		Tiskrad (300 MW)
Haouma (50 MW)		Midelt (150 MW)
Laâyoune (50 MW)		JbelLahdid (200 MW)
Akhefennir (100 MW)		
Tarfaya (300 MW)		

Source: WFC analysis

780 MW already installed by mid-2016

AbdelkhalekTorrés

Further to the discovery of the Koudia El Baida site (between Ksar Sghir and Tetouan) where average wind speeds reach 11m/sec (nearly 40km/h) the National Electricity Office (ONE) launched an international call for tenders in 1994 for a 50MW wind park according to the (*Build Transfer Operate and Transfer*) formula where ONE remains owner of the park and the operator produces and sells electricity for 20 years to ONE. A French group was in charge of the park's entry into service in August 2000. It produces 226GWh a year, equivalent to the annual consumption of a city such as Tetouan and comprises 84 wind turbines. The related investment amounted to US$ 52 million. The order of magnitude of the Kwh price is around Dh 0.70 (US$0.07)[42]. A planned extension will increase the park's total capacity to 300MW in the medium term.

Amogdoul

This park, 15km south of Essaouira, produces an annual average of 200GWh with 71 turbines (60MW total power). The park was built in 18 months by the Spanish company GAMESA, selected after an international call for tender. The site was inaugurated in 2007[43]. The related investment amounted to Dh 800 million (US $ 52 million) and was financed by the German BANK KfW BankenGruppe and ONE[44]. Object of an EPC (Engineering Procurement Commissioning) on behalf of ONE, a maintenance contract was concluded with GAMESA.

Tangiers 1

Spanish company GAMESA was also entrusted with the construction and signed a maintenance contract for the Tangiers wind park. With a length of 42kms, the park will comprise 165 wind turbines of 850kW each. Total capacity will reach 140MW with an annual production of 526.5 GWh. This installation has been constructed under a Build-Own-Operate-Transfer with a 20-year electricity purchase guarantee from ONE[45]. Costing Dh 2,750 million (US$ 282 million) this project was financed by Spain's ICO (Euros 100 million) as well as by the European Investment Bank (Euros 80 million), KfWBankenGruppe (Euros 50 million) and ONE[46].

Lafarge

The Lafarge wind park started up in 2005 with a first park of 10MW and 12 GAMESA 850 KW wind turbines supplying more than 50 % of the energy needs of the Tetouan cement works. This is the first cement works to be directly connected to a wind park. After two extensions in 2008 and 2009, total capacity was increased to 32MW with an additional eleven 2W wind turbines. A supply contract between Lafarge Maroc and Nareva has also enabled the supply of the Bouskoura plant as from 2013 and the one in Meknes as from summer 2014. The total project cost was Dh 496 million (US$ 49.8 million)[47].

Haouma, Akhefennir and Laâyoune

Since January 2013, Nareva Holding manages three parks representing an investment of Dh3 billion (US$307 million) with 105 installed turbines, 200MWh electricity production and another 100MWh under installation. Overall, the project will provide 770GWH/year, equal to the consumption of the city of Agadir. Financing consists of own funds advanced by shareholders in the project company (Dh 800 million or US$ 82 million) and bank loans obtained[48].

Haouma is a mid-sized park with 22x260 tonne Siemens wind turbines and a total capacity of 50 MW. It is situated a few kilometres from Ksar Sghir, some 30 km from Tangiers. Energy produced at Haouma is reserved for supplying the cement works in Lafarge, Casablanca and Meknes[49].

A 50.6MW park at Foum El Oued, 70km from Laâyoune entered into service in 2013. It comprises 22x 80 metre high 2.3 MW Siemens turbines with an annual output of 202.7GWh. The Foum El Oued site will enable the direct supply of partner factories in the project: PhosBoucraa, the ONEE (National Bureau of Electricity and Drinking Water)seawater desalination plant as well as ONDA[50].

The third site is at Akhefennir. The first phase entered into service in 2013 with 61 Alstom turbines and a capacity of 100MW. Today a good share of Tan-Tan's consumption is covered by this park.

Tarfaya

Construction works for the 300MW Tarfaya wind park project started on 24 December 2012 and entry into service took place sequentially at the rate of 50MW a month, between June and December 2014[51]. Tarfaya comprises 131 Siemens wind turbines with a production potential of 1,084GWh/year and it supplies 1.5 million households with energy which is 100 % renewable. Total project cost was Dh 5 billion (US$ 510 million) of which Dh 1 billion were paid in by the operators of the project, Nareva (50%) and Engie (50%) and the rest by bank loans obtained[52].

220 MW under development

Akhefennir (2nd phase)

The second phase of the Akhefennir park will comprise 56 General Electric turbines doubling its capacity to 200MW. Entry into service is foreseen during 2016. At this park as in the case of Haouma and Laâyoune, the special feature is that the electricity output is sold under private contracts ("*Power purchase agreement*") with companies such as Lafarge, Samir, Managem, OCP or Sonasid. The national electricity company ONE only undertakes the electricity transport[53].

JbelKhalladi

Launched by ACWA Power, this project should enter into service at the end of 2016. The future Khalladi park at JbelSoundouk near Tangiers will comprise a park with 40 Vestas turbines totalling 120 MW. A total investment of Dh 1.5 billion is foreseen. The Banque Marocaine du Commerce Extérieur (BMCE) and the European Bank for Reconstruction and Development (EBRD) announced in November 2015 an investment of Dh 1.34 billion (US$140 million) in the project with equal participation. 85% of the energy produced will be sold either under short-term electricity sales contracts or to the ONE[54].

Integrated Wind energy project (1000 MW) to be developed

The project is developed in two phases:

- 1st phase: Taza wind park project (150MW) with entry into service foreseen during 2017;
- 2nd phase: comprising five wind parks (860MW) spread over the northern and southern regions of the country with high potential: Tanger II (100MW), Boujdour (100 MW) Tiskrad (300MW) Midelt (150MW) and JbelLahdid (200MW). Entry into service between 2017 and 2020[55].

Taza

Constituting the first phase of the 1,000MW wind programme, this project located some 12km from Taza, east of Fes will have a total capacity of 150MW and comprise 50x3MW Alstom turbines. The project will be managed by France's EDF Energies Nouvelles, with the Japanese trading house Mitsui & Co. requiring an investment of Dh 2.8 billion (US$ 290 million)[56].

Integrated 850MW Wind project

In a consortium with Enel Green power and Siemens Wind Power, Nareva was the successful bidder for the integrated wind project, with a tariff of Dh 0.30/Kwh. This group is thus responsible for developing, designing, financing, building, managing and ensuring the maintenance of the project's five wind parks with a total capacity of 850MW: Tanger II (100MW), Boujdour (100MW), Tiskrad (300MW) Midelt (150MW) and JbelLahdid (200MW). The project requires an investment of about Dh 12 billion (US$1.2 billion). Energy produced will be sold to ONE under an electricity supply sales contract for a 20-year period. Forecast electricity output will be equivalent to the consumption of Casablanca[57].

2.3. The hydroelectric programme

Hydro also plays a role in the national energy mix and is planned to cover 14 % of electrical capacity by 2020. Installed capacity in 2015 was 1,771MW. The implementation of additional features of the programme provides for the building by 2020 of the Storage Power Pumping station (STEP) at Abdelmmoumen with a capacity of 350MW and the 125 MW hydroelectrical complex at M'Dez-El Menzel. However in June 2016, ONE, responsible for launching the project, revised its options for the M'Dez-El Menzel complex. Instead ONE plans to develop Storage Power Pumping Station (STEP) there. Details of the resizing have not yet been revealed[58]. Moreover, micro-hydro installations totalling a capacity of about 100MW are under development by private companies within the framework of Law nº 13-09 on renewable energies and about 300MW are under review. The total investment would be Dh 4.5 billion[59].

3. Socio-economic benefits of renewable energies in Morocco

In Morocco energy is not only a very important factor in the production of goods and services, but a development vector. Despite socio-economic progress achieved in recent years, many challenges remain. As indicated in the report by Schinke et al.[60] (2016), these challenges comprise:

- **Demographic growth**. Currently at 34 million, population is expected to increase to 40 million between now and 2040.

- **High unemployment rates**. Although the country benefits from stable economic growth, the national unemployment rate remains high, at 9.7 % in 2016. A more detailed analysis shows that unemployment particular affects the urban population (80.9%), youth (20.1 %) and university graduates, whose rate of unemployment is double the national average (22.5%).

- **Lack of competitiveness and absorptive capacity of the secondary and tertiary sectors**. The economy remains very concentrated on non-exportable services which require considerable labour. Innovation resources are limited, there are skills imbalances on the labour market and a high level of informal activities amongst the small and medium enterprises which undermine the productivity and competitiveness of the active population. For this reason, the lack of human capital and weak technical progress are two important factors limiting Morocco's capacity to benefit from knowledge transfer and slowing down its progress towards becoming a high value added economy.

- **Trade deficit**. The government makes major efforts to strengthen macro-economic stability by means of structural reforms and by encouraging direct foreign investment. However, the trade deficit was equivalent to 6 % of GDP in 2015. This can be explained by the economic value of main imports such as fossil fuels, machinery, electrical equipment and vehicles.

- **Regional disparity**. The poverty rate has considerably decreased over the last ten years. In spite of progress achieved, the majority of rural areas show a higher poverty rate than the country as a whole. Regional disparity also emerges in terms of access to services such as safe water (98 % in urban areas, 62.7 % in rural areas).

Indeed the spread of renewable energies is attacking these obstacles. The integrated solar energy policy will enable coverage of 18 % of current electrical production, represent a saving of 1 million toe or nearly US$ 500 million, and will avoid emissions of 3.7 million tonnes a year. The integrated wind energy policy will cover 26 % of current electricity production, enabling a saving of 1.5 million toe, or US $ 750 million and will reduce CO2 emissions by 5.6 million tonnes. Moreover, a study undertaken in 2013 by the Ministry of Energy, Mines, Environment and Water generated the following scenario for job creation in the renewable energies sector by 2020[61]:

Figure 13: Employment needs in the renewable energies sector in Morocco up to 2020

Sectors	Jobs to be created by 2020	%
Renewable Energies	**13.300**	**↑26.55%**
CSP	6,100	↑45.86%
PV	4,700	↑35.34%
Biomass	1,300	↑9.77%
Wind	1,100	↑8.27%
Micro-hydro	100	↑8.27%
Energy Efficiency	**36,800**	**↑73.45%**

Source: Ministry of Energy, Mines, Environment and Water of Morocco (2013)

Another study by MASEN in 2011 about the value chain of CSPs (see Figure 14) emphasised that there is a great potential for Moroccan companies to respond to the needs of the RE market ; especially as regards activities related to project development, installation, management and maintenance of renewable energy capacities. More specifically, on the basis of a 50MW CSP, and a total investment of US$ 364 million, MASEN estimated that the added value at local level would be between US $ 101.11 million and US$ 139.99 million[62].

Figure 14: CSP value chain in Morocco

Value chain	Project development	Materials	Components	Equipment engineering and construction	Management	Distribution
Key elements in the value chain	Engineering design, geographical perimeter, identification of overall requirements	Concrete, steel, sand, glass, silver, copper, salt and other chemical products	Mirrors, supporting structure, receptor, thermal transfer fluids, connecting pipework, structure, steam generator/heat exchangers, pumps, storage system, connection to the grid	Detailed engineering, supplies, construction	Running and maintenance of power stations	Supply, transport and distribution of electricity
Essential partners	Financing & Ownership					
	Research & Development					
	Political institutions					

Source: MASEN (2011)

Currently the construction of the NOOR I station, the world's biggest monoturbine installation with a production capacity presently at 160MW, has attained a rate of more than 30 % industrial integration by means of resort to Moroccan companies, especially in the construction and public works sectors and of metallurgy and cabling[63]. Overall, NOOR I mobilized over 2,000 workers, of which 85 % were Moroccan. About 250 men and women will be working directly in its management over the next 25 years. For NOOR Ouarzazate II and NOOR Ouarzazate III, MASEN aims at a local integration rate of about 35 % and the end to the isolation of several neighbouring villages, the emergence of new tourism products and the international profile of Ouarzazate as a model of socio-economic development powered by renewable energies[64]. According to the African Development Bank with NOOR II between 2,000 and 2,500 direct jobs will be created during the construction phase, 500 jobs during the operational phase, in addition to thousands of additional indirect jobs[65].

The wind energy programme is also set in the industrial integration of regional and national actors and the revitalization of the economic structure, with job and knowledge creation and the emergence of local industry. For example, the Tarfaya wind park has contributed to the creation of new road installations and equipment. Moreover, it has become a source of additional income for local communities by means of the business tax, apart from the development of local skills and capacities relating to wind energy[66]. The Jbel Khalladi site will lead to the creation of 300 jobs at peak periods according to data supplied by the group responsible for the project, ACWA Power[67]. In addition the integrated 850MW wind energy project foresees doubling the industrial integration of renewable energy projects to reach 70 %, as compared to 35 % to 40 % of the preceding ones. It was possible to propose this rate because a good part of wind turbine components will be manufactured locally, with the installation of the first wind turbine blade factory in Morocco, creating over 700 jobs[68].

In a country like Morocco the decentralised character of renewable energies can especially benefit poor rural areas. Indeed, today renewable energy technologies are giving certain and reliable access to electricty, enabling an improvement in the lives of the least developed communities. For example, as Mohammadi Benhmida (University Chouaïb Doukkali) explains, in the rural community of Haouiza, 12 km. From El Jadida, the installation of solar panels has enabled the powering of a water pump in a rural school. Before that the school was not connected either to water or to the grid and there were no sanitary infrastructures. The impact of water availability in the school and of sanitary infrastructure had the effect in particular of prolonging girls' enrolment up to age 14 and thus increasing their numbers, from 25 % of total enrolments in 2010 to 48 % in 2015.

Another example of stimulated development in rural villages thanks to renewable energies has been the construction of the combined cycle integrated thermo-solar station at Aïn Beni Mathar, near the Algerian frontier, with a maximum capacity of 472MW of which 20MW solar. For construction of the site, 500 workers were hired for the project of which 250 were inhabitants of Aïn Beni Mathar. Installations were put in place to supply accommodation and meals to workers, enabling the local economic stimulus and creation of indirect jobs in catering, transport and accommodation. Moreover, the income generated in the region by the sale of plots for the construction of station enabled the building of three country roads and four schools. Before that no route was accessible during the rainy season. The project thus facilitated access of inhabitants of these rural villages to social services and to schools by linking them to the region where the plant was installed. Also, the use of this system enabled a saving of 12,000 tonnes of fuel a year while avoiding annual emissions of 1,000 tonnes of CO2 as compared to a gas-powered power plant[69].

Between 2016 and 2030, total investment for renewable energy electricity projects should reach some US$ 40 billion, which according to the Minister of Energy, Mines, Water and the Envrionment of Morocco, Abdelkader Amara, will represent major new opportunities for the private sector and enable a 32 % reduction in greenhouse gas emissions by 2030[70].

4. Axes for renewable energies deployment in Morocco

Since 2009 Morocco has progressively issued its National Energy Strategy, one of whose major priorities was the establishment of an energy policy favouring the development of renewable energies. This political will was manifested by:

- The establishment of a new legislative framework, notably Law n°13-09 relating to renewable energies which favours the development and expansion of renewable energies for electricity production ; and
- Creation of institutions with the capacity to manage, supervise and promote RE projects in particular Law n°16-09 relating to the creation of a national agency for the development of renewable energies and energy efficiency (ADEREE).

4.1 Legislative Reforms

The Moroccan government has implemented a number of substantial reforms to remodel the institutional and legislative framework so that it becomes appropriate to the development of RE. Political action is particularly concentrated on electricity production, especially as regards competition and exports in the renewable energy sector, demand management and the improvement of energy efficiency mechanisms. A list of various regulations in force, introduced over the last few years, is presented below with emphasis on the major principles.

Law n° 13-09 relating to renewable energies[i]

In February 2010, Law nº 13-09 relating to renewable energies was promulgated so as to liberalise and develop the renewable energy sector in Morocco. This law certainly represents one of the essential steps for RE development and introduces major innovations concerning:

- **Opening of production to competition**

This law permits any public or private moral or physical person justifying appropriate technical and financial capacities to produce electricity from renewable energy sources.

The building of renewable energy-based electricity production installations is subject to a provisional authorisation issued by the administration, following the technical opinion of the manager of the national electricity transmission network. This authorisation can vary from a simple prior notice (generally called a « prior declaration ») to a veritable authorisation process according to the scale and nature of its production (eg. electrical or thermal).

Basic installations will only be permitted if electricity generated exceeds 20kW. More exactly, the prior declaration must define whether electricity produced is between 20kW and 2MW. Above 2 MW, necessary authorisations for setting up the electricity generation project must be delivered by ADREE. Finally, renewable energy-based electricity production installations are freely established, managed and modified while the maximum accumulated power per site or group of sites belonging to the same enterprise is below 20 kilowatts[71].

- **Access to the electricity network**

For the commercialisation of electric energy produced from renewable energy sources, the administrator benefits from the right of access to the national medium, high and very high voltage electricity grid within the limits of related available technical capacity. The law does not set tariffs but demands that all modalities of access to the medium, high and very voltage networks be fixed under a convention concluded between the administrator and the manager of the national electricity transport network, which is in fact run by the centralised distributor, ONE – the national electricity office.

- **Export of electricity produced from renewable energies**

By virtue of this law and after the technical opinion of the manager of the national transmission network, energy produced by the administrator of an installation connected to the national medium, high and very high voltage grid can export electricity produced from renewable energy sources.

- **Construction of direct export line**

Export of electricity produced from renewable energy sources is made through the national electricity transmission network including interconnections. However, when the capacity of the national electricity transmission network and of the interconnections is insufficient, the administrator is authorised to build and use for its own use direct transport lines. This will be agreed within the framework of a concessionary convention to be concluded with the manager

i For more information, refer to: « Loi 13-09 relative aux énergies renouvelables » *http://www.finances.gov.ma/Docs/2013/depp/loi%20Energies%20renouvelables.pdf*

of the national electricity transmission network, which notably provides for:

- The nature and consistency of works to be carried out and time period for their completion ;
- Particular charges and obligations of the concessionary transit royalty to be paid by the concessionary;
- Duration of the concession which cannot exceed the validity duration of the operation's authorisation;
- Measures to be taken by the concessionary for the protection of the environment, in particular the carrying out of an impact study ;
- Conditions for withdrawal or deprivation of the concession, as well as the handing over of the installations at the end of the concession.

In 2015 the progressive liberalisation of the electricity sector took on renewed dynamism with the launch of new initiatives to reform the law on renewable energies.

Decree 2-15-772[ii]

In application of article 5 of Law nº 13-09 relating to renewable energies, the entry into force in November 9, 2015 of Decree n° 2-15-772 relating to access to the national medium voltage grid was aimed at:

- Setting access conditions and modalities to renewable energies-based electricity production installations to this medium voltage grid;
- Facilitate progressive and harmonious opening of the said grid;
- Put in place a transparent, non-discriminatory and stable framework for investors.

Law n° 58-15[iii]

Law n° 58-15 modifying and completing Law nº 13-09 relating to renewable energies was adopted by the Moroccan Parliament in December 2015. The main new elements in this law are:

- **Access to the low voltage grid**

Article 5 of Law nº 13-09 provided that renewable energies-based electricity production installations could only be connected to the national medium, high and very voltage grids. Access to the low voltage grid was not foreseen in this provision. Law nº 58-15 guarantees to renewable energies-based electrical energy production installations the opening of access to the low voltage grid. This measure will permit the development of the industrial branch relating to small and medium-sized installations, notably for photovoltaics as well as the creation of jobs in the renewable energies sector.

- **Possibility to sell surplus renewable energy produced**

Article 23 of Law nº 13-09 stated that for marketing of renewable energies-based electrical energy the administrator benefits from right of access to the medium, high and very high voltage grids, within the limits of the technical capacity available in the said grid. Law nº 58-15 renders possible access to the low voltage grid. However, the law also provides for the sale of surplus of electricity produced from renewable energy sources:

- To the national electricity office ONE for installations connected to the high and very high voltage national grid;
- To the administrator of the electricity distribution network concerned for installations connected to the medium and low voltage national grid.

However, the administrator cannot sell more than 20 % as surplus of annual production of electricity produced from renewable energy sources.

Law n° 48-15[iv]

In June 2016, the government published Law nº 48-15 relating to the regulation of the electricity sector, which from now on, will dispose of a new regulatory framework in which the attributions and responsibilities of different stakeholders in electricity transmission and distribution are clarified and

ii For more information, see : « Accès au réseau électrique de moyenne tension » *http://www.mem.gov.ma/SitePages/TestesReglementaires/Decret%20MT%202015.pdf*

iii For more information, see : Ministère de l'Énergie, des Mines, de l'Eau et de l'Environnement du Royaume du Maroc (2015) "Loi 58-15 amendement et complétant de la loi n° 13-09 Relative aux énergies renouvelables » *http://www.mem.gov.ma/SitePages/TestesReglementaires/loi%20n13-09ver23dec15.pdf*

iv For more information see: Ministère de l'Énergie, des Mines, de l'Eau et de l'Environnement du Royaume du Maroc (2015) « Note de présentation du projet de loi relative à la régulation du secteur de l'électricité » *http://www.mem.gov.ma/SitePages/TestesReglementaires/Avploi48-15Fr.pdf*

institutionalised around a new independent regulatory entity, the National Authority for Electricity Regulation ANRE.

ANRE's principal missions are to set the tariffs for use of the national electricity transmission network and of usage tariffs for the medium voltage grids. ANRE also approves the code of the national electricity transmission network, including interconnections as well as rules concerning use of the said network. Besides the creation of a regulatory authority, the law sets out rules to be respected as regards electricity transport and management of medium voltage electricity grids.

With this law Morocco aims for the positive functioning of the electricity market and at giving a strong signal of independence in relation to electricity sector operators. Until now, regulation was based on ONE, under ministerial control. However, by virtue of this law, ANRE is free from all control. This institutionalisation should also increase the attractiveness of the renewable sector to donors, sector industrialists and private investors.

Regulations relating to renewable energies

In parallel to these developments, the government has issued other laws and regulations during the last ten years to facilitate the development of renewable energies:

- **In 2006, Law n° 54-05[v] on the delegated management of public works and services** was promulgated. This law authorizes the State or local authorities to cede administration of public services to a private entity. In general, the delegated administration essentially focuses on the following sectors: motorways, urban transport, distribution of water and electricity, sanitation and household waste collection as well as electricity production. An example is the delegated administration for the treatment and energy use of waste in Oujda granted by the Oujda municipality to the CSD-CRB company.

- **Law nº 16-08[vi] relating to self-production** was introduced in October 2008 to enable industrial installations to produce their own electricity from renewable energies on condition that this production did not exceed 50KW; that it be destined for the exclusive use of the producer; that it would not upset plans for energy supply in the area concerned; that the surplus production not used by the producer should be exclusively sold to ONE. The modalities of connection to the national grid are established by a connection convention.

- **In September 2011, Law nº 40-09[vii] brought together the activities of ONE and the national office for potable water (ONEP), setting up the National Office for Electricity and Potable Water**. This decision aimed to optimise quality standards, costs and performance in supply of electricity and drinking water (ONEE).

- **In order to ensure the better use of energy in all areas of economic and social activity, Lawº 47-09[viii] was introduced in 2011**. Its implementation rests mainly on the principles of energy performance, energy efficiency needs, energy impact studies, obligatory energy audits and technical control. More specifically the law comprises measures relating to : energy efficiency in public administrations ; promotion of energy efficiency in public lighting; campaign for promoting low-energy bulbs ; system of incentive tariffs ; regulations foreseen for heating/air conditioning standards in buildings ; setting up of energy service companies and communication, education and awareness raising. Morocco's strategic objective is to save 12 % of its overall energy consumption by 2020 and 15 % between now and 2030[72].

- **In June 2015, the new Law nº 86-12[73] on Public Private Partnerships entered into force** under which private partners are authorised to design, construct, finance, rehabilitate and maintain certain infrastructure needed by the public sector.

v For more information see: "Dahir n° 1-06-15 du 15 moharrem 1427 (14 février 2006) portant promulgation de la loi n° 54-05 relative à la gestion déléguée des services publics » *http://www.finances.gov.ma/Docs/2013/depp/Loi%20n%C2%B0%20 54-05%20relative%20%C3%A0%20la%20gestion%20 d%C3%A9l%C3%A9gu%C3%A9e%20des%20services%20publics.pdf*

vi For more information see : « Dahir n° 1-63-226 du 5 août 1963 portant création de l'Office national de l'électricité » *http://uir.fh-bingen.de/fileadmin/user_upload/Marokko/Energie/gesetzestexte/Dahir1-63-226_portant_creation_de_l-ONE_consolide.pdf*

vii For more information see : Ministère de l'Énergie, des Mines, de l'Eau et de l'Environnement du Royaume du Maroc (2011) «Loi n°40-09 relative à l'Office National de l'Electricité et de l'Eau potable (ONEE) » *http://www.mem.gov.ma/SitePages/TestesReglementaires/Loi%2040-09%20ONEE.pdf*

viii For more information see : Ministère de l'Énergie, des Mines, de l'Eau et de l'Environnement du Royaume du Maroc (2011) «Loi 47-09 relative à l'efficacité énergétique » *http://www.mem.gov.ma/SitePages/TestesReglementaires/Loi47-09.pdf*

The PPP can offer an economic solution for the promotion and development of infrastructures needed for renewable energies.

- **In accordance with Law nº 54-14[ix] promulgated in August 2015, Morocco gives the possibility to national self-producers of electricity (with an accumulated installed capacity of over 300MW) to accede to the transmission network to carry energy from the production sites to consumption sites**. These operators will undertake to sell exclusively to the Office the surplus production which they have not used for their own needs. The goal is to promote private production to lighten the national electric load.

4.2 Institutional Reforms

The progressive liberalization of the energy sector has been accompanied by the establishment of institutions to take up the challenges of the energy transition, amongst which:

MASEN

Law nº 57-09[x] promulgated in February 2010 created the Morocco Agency for Solar Energy, a private company endowed with public capital. It was made responsible for accompanying the implementation of the large-scale national integrated solar energy project which aims to establish by 2020 renewable energies-based electricity production with a total capacity of 2,000MW. Masen's activities rest on three pillars:

- Support to the development of a strong and competitive industrial branch ;
- Development of strong partnerships to promote the formation of qualified resources ;
- Support to research and development to contribute to improving the performance of solar technologies in general.

During 2016, in accordance with the spirit of the reform introduced by the bill n° 37-16[xi], adopted by the cabinet on 24 June 2016 and modifying and complementing law n° 57-09, MASEN will officially become «The Moroccan Agency for Sustainable Energy» (AMED). In accordance with this bill, the agency will become an associated company endowed with a Board of Directors, responsible for the development of renewable energy power stations while ensuring guidance of studies, planning, financing, achievement, management and maintenance.

The cabinet meeting of 24 June 2016 also adopted the bill modifying and completing Law nº 38-16[xii] modifying and completing the national electricity office ONE. This bill stipulates the transfer to the Agency of all means of production using renewable energies except for energy transfer pumping stations, infrastructures producing electricity to meet peak hour demand and to stabilising the national electricity system and renewable energies- based electricity production structures governed by Law nº 13-09[74].

ADEREE

Law nº 16-09[xiii] published in March 2010 places the National Agency for the Development of Renewable Energies and Energy Efficiency (ADEREE) on the front line for implementing the new energy efficiency component of the national energy strategy. This law permits the agency to draw up sectoral development programmes for renewable energies and energy efficiency, valorise within the framework of regional deployment the natural resource potentials of each region, and to make proposals relating to regions in a position to host electricity production projects based on wind and solar energies.

The cabinet meeting of 24 June 2016 adopted bill nº 39-16 modifying law nº 16-09 relating to ADEREE. Under this bill, this agency's missions will not concern renewable energies but will remain focused on energy efficiency. Consequently, the Agency will be called the Moroccan Agency for Energy Efficiency (AMEE)[75].

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ix For more information see: Ministère de l'Énergie, des Mines, de l'Eau et de l'Environnement du Royaume du Maroc (2015) «Loi nº54-14 » *http://www.mem.gov.ma/SitePages/TestesReglementaires/LoiN54-14.aspx*

x For more information, see: Ministère de l'Énergie, des Mines, de l'Eau et de l'Environnement du Royaume du Maroc (2015) «La loi n°57-09 relative à la création de la Moroccan Agency for Solar Energy » *http://www.mem.gov.ma/SiteAssets/PdfDocumentation/LoiMASEN.pdf*

xi For more information, see : Ministère de l'Énergie, des Mines, de l'Eau et de l'Environnement du Royaume du Maroc (2016) « Projet de loi nº 37-16 » *http://www.sgg.gov.ma/Portals/0/lois/Projet-loi-37-16%20NV.Fr.pdf?ver=2016-06-29-134105-190*

xii For more information, see: Ministère de l'Énergie, des Mines, de l'Eau et de l'Environnement du Royaume du Maroc (2016) « Projet de loi nº 38-16 » *http://www.sgg.gov.ma/Portals/0/lois/Projet-Loi-38-16.Fr.pdf?ver=2016-06-29-134350-990*

xiii For more information, see: Ministère de l'Énergie, des Mines, de l'Eau et de l'Environnement du Royaume du Maroc (2010) «Loi n°16-09 relative l'Agence nationale pour le développement des énergies renouvelables et de l'efficacité énergétique» *http://www.mem.gov.ma/SitePages/TestesReglementaires/loiN16-09.aspx*

SIE

The energy investments company, La Société d'Investissements Energétiques (SIE[xiv]) was set up in 2010 and represents the financial arm of the State to accompany the national development plan for renewable energies. SIE has been endowed with a capital of Dh 1billion[76] and participates in the development of energy projects by means of partial State financing. This participation is a direct participation in the capital or by means of an investment made by a financial partner in the capital of the project company. Thus SIE has been entrusted with the development of the medium voltage sector mainly via PV, or with energy efficiency relating to public lighting.

IRESEN

The Institute for Solar Energy and Renewable Energies Research (L'Institut de Recherche en Énergie Solaire et Énergies Nouvelles (IRESEN[xv]) was set up in 2011 in order to translate the national strategy into research and development projects in the field of renewable energies and to ensure the implementation, financing as well as steering of research projects. Since 2012 it has launched 7 calls for projects in the fields of thermal solar, photovoltaics, wind and biomass, mobilising a budgetary allocation of Dh 125 million and selecting 31 innovative projects carried out by consortia of universities and of national and foreign companies. The number of projects submitted for calls to projects has increased each year involving a growing number of researchers and Moroccan and foreign companies in various specialisations in the field of renewable energy[77].

For example, one of the projects on « Lithium-ion batteries » coordinated by Cadi Ayyad University seeks to develop performing batteries from the energy point of view by insisting on the « materials » aspect. Electrode materials based on Moroccan mineral resources will be targeted. Another project « CHAMS1 » launched in 2013 was aimed at developing the first concentrating solar field of the innovative Fresnel type, low cost and 100 % Moroccan. These projects are within the framework of the INNOTHERM I call for projects, whose aim is to encourage researchers and industrialists in the design and realisation of innovative, 100 % Moroccan technical solutions using thermodynamic solar[78].

xiv For more information, see: SIE (2016) *http://www.siem.ma/la-sie*

xv For more information see: IRESEN *http://www.iresen.org/fr/index.html*

xvi REUNET (2015) «REUNET - un nouveau Concept pour le Développement des Energies Renouvelables au Maroc » *http://www.reunet.ma/*

REUNET

REUNET[xvi] is a university network for promoting renewable energies and energy efficiency, a not-for-profit Moroccan association set up in 2013 in Rabat on the initiative of researchers, teacher-instructors and engineers from public sector establishments involved in the renewable energies and energy efficiency sectors. REUNET's main mission is the promotion of renewable energies and energy efficiency in the short, medium and long term by training, scientific research and technological innovation.

4.3 Reform of energy subsidies

The fossil fuels subsidy system set up in 2000 is mainly concentrated on diesel, fuel and butane. In 2011 it cost Morocco 5.1 % of its GDP or Dh 41.4 billion (Euros 3.7 billion) as against nearly nothing in 2003. This ratio is considered eventually untenable for public finances. Thus in 2011, the public deficit amounted to 6.8 % or nearly the equivalent of the cost of the subsidies. This system, as underlined by a study undertaken by the International Monetary Fund in 2013 on the reform of state subsidies to fuels in Morocco[79], is not efficient in sustaining the living standards of the poorest. Quite the contrary, it benefits the largest consumers[80].

Accordingly in 2013 the government announced the reform of fossil fuel subsidies so as to master the situation and progressively align its fuel prices on those prevailing in international markets. So much so that the Ministry of General Affairs and the Governance of the Kingdom of Morocco recognised « this compensation burden weighs ever more heavily on public finances at the expense of other investments which could stimulate the economy and develop the nation ».

Thus in September 2013 Morocco applied a partial indexation to gasoil, petrol and fuel oil n°2 with a level of subsidy aligned with credits provided for under the Finance Law. In February 2014, the government adopted the total indexation of petrol and fuel and abolished the related subsidies. However, the gasoil subsidy was gradually reduced until its removal at the end of 2014. In June 2014 the subsidy on fuel n°2 was abolished as well as that on the special fuel used for electricity production within the framework of the ONE-Government contract.

This operation was accompanied by a set of palliative measures in order to reduce the impact on consumers, amongst which notably the introduction of a support device for the transport sector (taxis and buses) within a convention framework.

From 1st January 2015 the prices of liquid fuels (petrol and gasoil) as well as fuels were subjected to an approval system. And since 1st December 2015, the prices of fuels obey the free play of supply and demand[81].

However, since 1st January 2015 electricity tariffs have been increased, after being maintained at their 2009 level despite the significant rise in fuel costs. The increase mainly concerns the highest tranche of consumption by low voltage consumers (+3.4%), industrial clients using medium voltage (+13 % on average) and high voltage and very high voltage clients (+6.7%)[82].

However, the government continues to subsidise the price of butane. The State assumes about two-thirds of the price of a 12kg flask. Currently the reform of the compensation system is being studied and aims to target budgetary support for needy households. These subsidies will be replaced by direct aid to the 8.5 million Moroccans living below the poverty threshold. However, the Minister of General Affairs, Mohamed el Ouafa, stated in June 2016 that the conditions for ending the butane subsidy had not yet been fulfilled[83].

5. Principal challenges for deploying renewable energies in Morocco

It is widely recognised that all the political actions, legislative reforms and investments by the government are signs of a true commitment by Morocco to promote the deployment of renewable energies. Indeed, Morocco is one of the first countries in Africa to bet on renewable energies, allying economic development with respect of the environment. Today it has one of the most ambitious programmes in the region.

However, major obstacles remain in the way of faster progress for renewable energies and on a larger scale.

5.1 Political, institutional and regulatory challenges

Despite this avant-garde energy policy, there remain a number of political, institutional and regulatory challenges in the way of better exploiting Morocco's renewable energy potential. During round tables and dialogues facilitated by the World Future Council with energy sector stakeholders, the main obstacles identified were the following:

Regulatory framework exclusively favouring large-scale renewable energy production installations

In Morocco, the development of renewable energies is mainly through calls for tender from ONE or MASEN. It is a matter of BOOT (build, own operate and transfer) in which a private investor as « Independent Power Producer » obtains a concession for a fixed period for a production infrastructure which it builds. Within the framework of these contracts, ONE or MASEN buy from the consortium the electricity produced at fixed price. This model was notably used in the case of the integrated solar and wind energy programme.

These projects already constitute an example on an international scale of renewable energy deployment. « Now we have wind projects cheaper than coal-based ones » the secretary-general of the Ministry of Energy, Abderrahim El Hafidi stated at a round table during the international renewable energies conference in Abu Dhabi[84]. Similarly optimistic observations were also made by Badr Ikken, Director-General of IRESEN, regarding solar energy « the NOOR plant is probably the cheapest CSP in the world [85] ».

These projects are in the context of a will to increase the share of renewable energies in the nation's energy mix and are already manifested in benefits at both local and national level. However, legislative and regulatory texts have been criticised for favouring large-scale projects without proportional support to small and medium scale producers. « Most of financing goes to large projects » was a comment made several times by participants in round tables faclitated by the World Future Council. The result being the lack of continuity and capacity to spread projects and initiatives on a large scale.

This is the case for photovoltaics in which some operations have been carried out. One of the most important is at the Mohammed V airport in Casablanca, where a 150kWc generator has been installed on the roof and linked to the airport's internal network. At the National School for the Mining Industry a 2KW system has been installed and will serve for the training of photovoltaic engineers, trainers, technicians and installers.

Similarly, the Casablanca Technopark has a 50KW photovoltaic unit and a training centre. Power produced will be injected into the park's power supply. The purpose of this project is the initiation of Moroccan experts in photovoltaic system techniques on three training modules which will be connected to 18 public and private multipliers. Subsequently these multipliers will disseminate techniques amongst technicians, engineers, consultancies and solar energy students to promote the use of photovoltaics and inform them about their advantages.

« However we still have difficulty in getting beyond demonstration projects » Zohra Abib, managing director of EnRafrique emphasised. « When we tell companies or prosumers that we can offer neither subsidies nor financial tools, they don't want to take that step ». For Mohammadi Benhmida there are also the needs of availability. « Administrative obstacles lengthen the time needed to install renewable technologies and a lot of time is needed to start a project. If formalities were easier, we could do much better ».

Absence of clear directives for access to the low voltage grid

« Large scale installations will certainly enable the country to go towards a 100 % electricity supply system but they don't create many jobs (less than 100 permanent jobs for 150MW wind or solar units). The country must be inspired by what is being done abroad for a development of renewable energies

which will create jobs, by opening the low voltage electricity market and promoting RE applications to transport and industry », according to Mustapha Ayaita, general coordinator of Renewable Energy University Network (REUNET).

« The reform of Law nº 13-09, especially by the adoption of Law nº 58-15 has been one of the measures in this direction, guaranteeing to electric energy production installations based on renewable energies the opening of access to the low voltage grid. However, we still lack the implementing decrees », indicates Mustapha Ayaita.

As stated by Abdelmourhit Lahbabi, President of ADS Maroc, « the injection of renewable energy into the low voltage network is very important for the stabilisation of the electricity distribution network. The German network is stable because it is largely fed by decentralised systems which play a very important role in the supply and stabilisation of the network ».

However, access conditions to the network and conditions for the valorisation of the quantity injected are not yet fixed by law: which represents one of the principal challenges for moving renewable energies deployment to the next scale. « Law nº 13-09 as it is now is very vague, especially as concerns low voltage. The question relating to low voltage is thus the following: how does the government wish to successfully steer the energy transition and with what mechanisms », says Philippe Lemp of GIZ.

This vagueness holds back the development of PV in Morocco. According to Zohra Ettaik, head of the Renewable Energies division in the Ministry of Energy, Environment, Water and Mines of Morocco, with the legal and regulatory bases in place for linking residential PV systems into the low voltage network, installed capacity by 2030 could reach 4.5GW[86].

Law nº 58-15 also provides for the possibility of selling 20 % of the surplus renewable energy produced by installations connected to the low, medium, high and very high voltage grid. The inclusion of the low and medium voltage grid should be welcomed since this was not foreseen in the bill. However, as it has been emphasised by stakeholders in Morocco's energy sector, it is important to increase the rate of sales of surpluses and ensure that priority is given to renewable energies.

Lack of legal and fiscal status of the residential and tertiary self-producers

By virtue of the provision of Law nº 16-08 modifying and completing dahir n° 1-63-226, the possibility is foreseen for production of electricity by public or private persons on condition that this does not exceed 50MW, does not disturb plans for electricity supply in the areas concerned, that this energy is mainly destined for own use and that the surplus is exclusively sold to the ONE; without however a regulatory text specifying the purchase price.

Moreover, the text foresees that « on the expiry of the concessionary agreement, the owner of the installations as well as the rights relating to the site are transferred without charge to the ONE according to modalities established in the convention ». This prior condition of free cession is surprising. This mechanism could be understood were it a case of concessionaires of a public service where the site and assets could have been considered as being part of the public domain, justifying their cost-free cession to the ONE at the end of the concession. However, production by self-producers is not for the benefit of the public at large[87].

Moreover, it should be pointed out that this system does not distinguish between renewable and fossil fuel energies. Thus the text directs that ONE is « enabled to conclude, by mutual agreement, on request of interested parties, conventions with concessionaires of electric energy production from national renewable or fossil energies and in particular wind energy, with producers or groups or producers established to this end ».

In 2015 in response to requests from leading industrialists, Law nº 54-14a was passed recognising that « moral persons under public or private law, can upon their request, be authorised by the administration to produce, with their own means, electrical energy with power production above 50MW with right of access to the national grid, on condition that power production is above 300MW ».

However, the technical modalities of connecting to the national electricity network, the commercial conditions for purchase of surplus energy produced by the said producer, as well as commercial conditions relating to the transport of energy are determined under a convention with ONE. Although ONE tends to repeat the terms already used in previous contracts under the same system, these conventions are not made public.

The final challenge, and not the least, is residential and tertiary self-production which is not contemplated in the current legislative framework. For Dieter Uh, a GIZ consultant in Morocco « it must be said that the law in its current form is confusing. Law nº 58-15 does not mention self-production at all ».

According to the President of ADS Maroc, Abdelmourhit Lahbabi « the large-scale development of residential and

tertiary self-production would complete the strategy of structuring programmes for renewable energies-based industrial generation ». Thus, small projects can represent important power outputs when they are grouped together. « If 100,000 farmers each have a 5KW solar pump, this would add up to 500MW which would not be consumed on the grid », the managing director of ADEREE, Said Mouline, emphasised[88].

Uncertain, incoherent and non-inclusive government practices

Morocco has accomplished progress in the coordination of the renewable energies effort. The country now has laws on renewable energies and energy efficiency which seek and favour a convergence of policies, and of the legislative framework. The putting in place of institutions focused on the issue should allow them to play a key role in advancing renewable energies deployment. However, certain factors undermine the nation's renewable energies development:

Contradictory signals from policymakers

The success of this energy transition demands strong political will. And this political will as Mr. Lahbabi pointed out, must be clear and unequivocal in favour of the development of renewable energies. "We currently see in the press contradictory signals about Morocco's commitment to the development of renewable energies: while royal instructions have been given to activate and raise Morocco's renewable energy ambitions, the nuclear energy option continues to be evoked, knowing that countries such as Germany are disengaging from nuclear and we have the assets to aim for a 100 % renewable energies scenario". « The launch of shale gas exploitation is also the subject of much debate in Morocco, especially within civil society working on the environment and sustainable development », according to the Morocco Working Group (Groupe de Travail Maroc).

This uncertainty about forthcoming political decisions weakens investor confidence in renewable energies.

Leaders' short-term vision

In 2009 Morocco adopted an energy strategy aimed to promote the deployment of renewable energies. Today these energies already represent nearly 35 % of current national electricity production. And during COP 21, the Moroccan Minister of Energy, Abdelkader Amara raised the target to 52 % by 2030. But Morocco can go further and faster by launching a project for the country which goes beyond short-term stakes and offers a long-term vision, beyond 2030, with ambitious goals. This approach will enable support to changing socio-economic structures and show proof of a real, unequivocal political commitment.

Lack of transparency

The lack of transparency and clarity in relation to the management of the energy sector has been highlighted. The manner in which decisions are taken is not always clear, nor who the actors are and which interests are pushing these decisions. Moreover, parliamentarians are not involved in the drafting of laws.

Lack of support, inter-party cooperation and communication

Change is catalysed by a mandate of official action. However, if Morocco aims to achieve a global energy strategy for national development, participants have emphasised the importance of obtaining a high level of support from stakeholders. As emphasised by Dieter Uh, GIZ consultant in Morocco: « there is so much will...but everyone goes their own way. There is an absence of management at government level so as to form a common political vision for the promotion of renewable energies. Actors and consultation need to be organised with a sufficiently open discourse enabling participation by all actors ».

Incoherent legislative framework lacking a decentralised approach

The current political framework excludes small and medium producers, prevents cities from creating their own private distribution network (which can only be created when the electricity is for export and must always be the subject of negotiation with ONE) and hinders local authorities and citizens from investing in local renewable energy production.

Certainly decree n° 2-15-772 authorises producers of electricity from renewable energy sources to be connected to the medium voltage grid for sales to private consumers. This is the case of the Oujda municipality which since 2012 produces and feeds into the ONE medium voltage grid RE electricity derived from the treatment and energy valorisation of waste.

However, the decree provides under Article 15 that « these provisions must in no way undermine the balance of delegated management distribution contracts ». Moreover, annual allocations for integration of renewables-based electricity are provided for, but these allocations cannot be higher than 10 % of the energy supplied to clients connected to the medium voltage grid[89].

This lack of coordinated inter-sectoral communication and the absence of a platform for discussion do not facilitate the development of innovative shared practices. Moreover, in the absence of a common, clear political vision, diverging interests prevent the formation of a cohesive environment related to renewable energies.

5.2 Economic and financial challenges

Through its integrated projects, Morocco seeks to deploy promising technologies for the valorisation of renewable energy resources, while promoting the economic development of the nation and supporting the development of its industrial structure. The government is already reaping the fruits: currently, industrial integration of Moroccan operations in renewable energy projects is at 30 % and should reach 50 % in 2020. This rate was 7 % when the first wind energy projects were launched. Notwithstanding there remain determining financial barriers to be overcome in order that the nation as a whole can benefit from efforts on renewable energies deployed by the government.

A silo economic strategy for renewable energies

The Moroccan government recognises the vital role of renewable energies in the stimulation of economic and social development of the country as well as the need to mobilize investments indispensable to the renewable energies sector. The legislative and institutional framework set up over recent years is proof of this, in particular the liberalisation of the medium voltage grid by decree n°2-15-772, the opening of access to the low voltage grid to renewable energies installations and the recent expanded role of MASEN; now the Moroccan agency for sustainable energy. However, there lacks a clearly designed strategy to integrate the development of renewable energies into a national economic development plan, which follows an integrated approach and serves the economic development of the nation's territories.

Absence of financial support in favour of small and medium-sized renewable energy projects

« Financing for renewable energies projects is certainly absolutely necessary ». As indicated by Meryem Lakhssassi, in charge of sustainable development at MASEN, « MASEN projects, with an integrated approach and the goal of creating a solar ecosystem in Morocco, relied on the support and strong involvement of the State in the guarantee of concessionary loans granted by international financial institutions ».

However, this support is lacking for small and medium-sized projects which do not have available a line of credit specific to renewable energies, nor an appropriate framework for the successful financing despite the excellent opportunities and a sizeable renewable energies market in the country. The accessibility and capacity to pay for renewable energy technologies remains a major obstacle for the majority of households and commercial enterprises in Morocco.

The potential market for domestic photovoltaic solar systems in Morocco is estimated at US$500 million by 2025. To make such potential a reality, apart from reforms in access to the network, financing instruments are needed for private individuals as well as for small and medium-sized enterprises, such as lines of credit with preferential conditions in favour of renewable energies.

Currently the government is studying formulas such as a loan so that households can install photovoltaics and reimburse the amount received with the savings they will make with solar electricity. It should be noted in addition that Moroccan micro-credit associations have adopted a goal to increase the loan portfolio by US$1.6 billion over the next ten years. However, this will require a profound reform of the regulatory statute of micro-finance to increase the legal limit of current loans (Dh 50 000) and permit micro-credit associations to extend their activities beyond income generating activities[90].

In the same way, credits for financing renewable energy related community activities are also unfavourable. Until now, a low number of community projects to develop renewable energies have been supported. Credits extended are not very favourable to multiplying the launch of renewable energy projects. For example, The Community Equipment Fund offers credits to municipalities at very high rates (7 to 8%) for the deployment of renewable energies.

Finally, it is important to indicate the very modest participation of the private sector in renewable energy deployment. In Morocco renewable energies are principally financed by the government and international funds rather than by local private investors or regional banks. The Moroccan private sector has an unavoidable role to play in the successful conduct of an energy transition and the establishment of renewable energy production on a large scale.

Low profitability threshold

The economic viability of renewable energy projects is also endangered by the fact that the initial costs are higher

than those of conventional system, the payback period is considered lengthy (currently 7 years for a 120KWh/month photovoltaic system) and the perception of risks relating to renewable energies is biased. Moreover, all renewable energies seem to be more risky, so higher returns on investment are expected in compensation.

A project called « Clean energy and energy efficiency » launched in Morocco 2015 and co-financed by two loans, one from the World Bank (US $ 125 million) and the other by the Clean Technology Fund (US$ 23.95 million). This is to assist the ONE in building the first of its three solar photovoltaic plants with a total capacity of 75MW. This project will finance the installation of hourly meters, thus enabling some 300,000 persons to benefit from advantageous tariffs at low consumption hours[91].

However, there is no generalised mechanism where in the case of RE-based energy production, the surplus is injected into the grid at a guaranteed price. And where, in the contrary case, the consumer can momentarily derive electricity from the network.

Market limits and imperfections

Costs decline and competitiveness increases if market penetration is sizeable. However, renewable energies still do not penetrate well as compared to fossil fuel-based energies. Large swathes of the energy sector tend to be monopolised by procedures based on fossil energies and a high return on investment.

With decree n°2-15-772 producers of RE-based electricity can be connected to the medium voltage electricity grid for sales to private consumers, which are, first of all, medium-sized industries. In cities covered by concessionary contracts for electricity distribution, private operators are thus directly in competition with the concessionaires. This will be the case of Tangiers, Tetouan, Rabat, Salé and Casablanca.

However, in its article 15 the decree mandates that « its provisions must not in any case undermine the balance of delegated distribution management contracts ». Moreover, the decree provides for annual allocations of electricity integration which cannot exceed 10 % of the energy supplied to clients connected to the medium voltage grid for each distribution network[92].

The low market penetration of renewable energies is also explained by the lack of promoters, qualified workers and enterprises which can explain the implications of renewable energies. « If in Morocco we had private enterprises enabled to carry out integrated projects with a 45 % participation of local value, that could be profitable from the point of view of employment creation », Mohammadi emphasises. « At NOOR there is an industrial integration rate of 30 %. However 70 % of jobs created are in construction. This is not durable employment».

Heavy fossil fuel subsidies

Fossil fuel subsidies endanger the competitiveness of renewable energies. Since 2013, the Moroccan government has undertaken a programme of progressive elimination of fossil fuel subsidies. However, butane gas, used mainly for domestic heating and cooking, remains heavily subsidised for social reasons.

For a long time butane consumption has been growing at an average annual rate of 5 %[93]. In order to ensure massive access to this product, the State assumes about two-thirds of the cost of a 12kg flask, whose price has remained a Dh 40 since 1990. This currently costs the government Dh 15 billion a year accounting for about 30 % of the government's budget deficit[94]. Moreover, the butane subsidy considerably affects the competitiveness of renewable energy technologies, in particular solar water heaters in the domestic and tertiary sector, as well as PV pumping in agriculture[95]. Despite several initiatives and programmes introduced by ADEREE to overcome the development constraints of solar water heaters, their competitiveness remains weak for households since butane is largely used to heat water[96].

Finally, externalities such as environmental pollution or climate change, health costs, the impact on energy security, etc. are not taken into account by the market and are not evaluated in cost analysis. This results in a distortion in the comparison of costs of renewable energies and fossil options.

5.3 Technical challenges

One of the principal renewable energy challenges is their intermittent character. A policy aimed at encouraging the deployment of renewable energies should be endowed with technical competences to implement such a project.

Lack of qualified personnel and sufficient maintenance staff

In order to carry forward innovative actions in its energy transition, Morocco must invest more in strengthening research capacity by greater involvement of doctoral students, young researchers and teacher-researchers in accompanying this strategy. The university network for promoting renewable energies and energy efficiency (REUNET) has certainly

been able to train more than 200 teacher-researchers in this field and facilitate their networking with European research institutions.

However, the government has extended financial support to universities, notably for projects with the industrial sector through the launch of calls for projects targeted at promoting renewable energies and employment creation in the sector. Projects such as Innotherm, InnoPV and InnoWind will support renewable energies research and enable closer cooperation between researchers and industrialists.

This is a very positive development as compared to ten years ago. Conventions have now been signed between IRESEN and Moroccan universities for the creation of a renewable energies industrial developing « competitive and performing Lithium-Ion batteries: a choice solution for solar energy, storage », the « thermal solar energy storage by fusion of phase change materials within a hybrid system of Dwelling-solar captor MCP: application to passive domestic heating in Morocco » or « Evaluation of performance of thermos-solar sites».

However, financial means mobilised by the government remain limited. As the Director-General of IRESEN, Badr Ikken stated « Morocco remains far behind developed nations above all in terms of the budget allocated to research and development[97].

Training in renewable energy skills is not considered as a priority either. For example, as explained by Adnane El Ghazi, Head of the Planning, Environment and Sustainable Development Service of the Oujda Municipality « in Morocco only three training institutes for renewable energy and energy efficiency (IFMEREE) have been programmed for Oujda, Tangiers and Ouarzazate ». The first institute built and operating is in Oujda, and the first promotion of specialised renewable energy technicians selected for 2015-2016 involved only sixty people. The institute in Tangiers is under construction and that for Ouarzazate has not yet started to be built.

However, under the requalification programme for 25,000 graduates launched by the government in 2016, each beneficiary will be entitled to Dh 1,000 a month during the entire training period, set at a maximum of twelve months. “Nonetheless, a specific training activity for renewable energies has not been foreseen”, according to Mohammadi Benhmida.

Finally in addition to training and research on technologies, Moroccan universities could intervene in the evaluation of the renewable energies potential, design, financial engineering, etc.

Technical constraints of the transmission and distribution networks

In order to accompany projects for RE-based electricity production, ONE as responsible for electricity transmission and distribution is undertaking a programme for the extension and strengthening of the grid. A total of Dh 12 billion will be spent between now and 2017 on this programme. Moreover, the operator is determining the capacity of the grid to receive renewable energies up to 2025.

Despite this, energy distributors continue to wonder whether the grid is stable enough to absorb the injection of new energy sources. According to stakeholders in the Moroccan energy sector, one of the reasons explaining this perception is the lack of a clear and holistic vision on the part of the authorities on the transmission and distribution networks. These stakeholders also wondered about the capacity of the current infrastructure to transport energy from the north of the country to the south. For this, investments in the grid not foreseen by ONE would be required.

In addition, the financial situation of ONE remains a growing source of concern for the sector as a whole. Indeed, ONE is confronted on the one hand by the increase in fuel prices and significant investment needs and on the other by relatively low administered sale prices. In this precarious situation, the deficits engendered by electricity supply activities impact the group as a whole[98].

In this context, Khalid Benhamou, Director-General of the Sahara Wind project emphasised the need to improve Morocco’s grid infrastructure in order to ensure a greater penetration of wind energy in the energy mix. For economic reasons, wind systems are situated in sites with higher productivity. These sites are remote, with weak electric infrastructures which limit the level of penetration of wind energy. In this regard, the energy investment company SIE recognising that « the technical capacity of wind energy certainly exceeds 10,000MW installed capacity », admits that « this potential is limited principally by the integration capacity of the grid, at least in the medium term, or from now to 2020»[99].

While the capacity of the national electricity transmission grid and interconnections is insufficient, Law n° 13-09 only envisages the authorisation of ONE so that the administrator can build direct transmission lines for own use.

In addition to investment in the construction and management of extensive electricity grids, reflection should be broadened from the grid to the overall electricity system. Technical problems arise if the supply of large areas is only by

means of intermittent energies which are not connected to each other. Flexibility must also come from measures on the side of consumers so as to optimise decentralised production and distribution and develop better links between supply and demand.

ONE, which at the beginning of 2016 had more than 5 million clients across the country is advancing in this direction. At Oujda its grid is digitalised, which enables the long distance solution of different types of breakdowns and to feed the grid in an optimal manner. However, this technique is only used for medium voltage and is not generalised through the country whether by ONE or other private operators exercising delegated management in the major urban centres of Morocco.

Need to extend renewable energies to the transport and heating and cooling sectors

Until now, renewable energies have only been incorporated into the electricity sector. One notes a lack of inter-sectoral approaches which take heating and cooling into account as well as the transport sector. « The electricity sector only represents 20 % of total national consumption. More than 80 % of energy consumption will remain by 2030 based on imported fossil fuels, used to a great extent in transport and industry », says Ayaita. « Morocco must therefore, parallel to the electricity sector, redouble its efforts to develop renewable energies for these two sectors, profiting from the considerable wind, solar, hydraulic and biomass resources and the high-level scientific and technological skills in this field, while adapting training to the needs of enterprises ».

In particular, the transport sector represents more than 40 % of final energy consumption in Morocco. Numerous urban transport projects have been implemented, such as the trams in Rabat and Casablanca or the bus corridors in Agadir, Oujda and Marrakesh, which moreover plans to introduce 15 electric buses into its public transport fleet during COP 22.

As regards motor cars, the government has prohibited the import of vehicles more than five years old, has introduced a licence for high cylinder vehicles and reduced customs duties to 2.5 % for hybrid vehicle[100]. The government has also adopted measures aimed at renewing the transport pool; especially taxis. Morocco's taxi fleet is estimated at 70,000 vehicles, of which two-thirds are large taxis. All taxis are powered by diesel and about 70 % of the vehicles used by the large taxis in circulation are over 30 years old. The government recognises the problem these vehicles represent. A Dh 3.6 billion budget has been allocated to the reconversion of taxis. Drivers replacing their taxis with new ones will receive a subsidy of between Dh 50,000 and 80,000[101], with Dh 30,000 for the small taxis. However, these measures do not impose any energy consumption or carbon emissions obligations. At present there is no support programme for electric vehicles.

As regards heating, just the replacement of the traditional hammam boilers by modern and efficient biomass boilers could enable the 6,000 hammams existing in Morocco to reduce their energy consumption by some 60 %. Within the framework of the new energy strategy, the government decided to increase the installed capacity of solar water heaters to 1.7 million m_2 by 2020. Over the last ten years, the installed SWH capacity has increased from 40,000 m_2 to 260,000 m_2. However, its development potential is greatly affected by government subsidies to butane gas[102].

5.4 Cultural or educational challenges

Awareness raising and encouragement of various actors in the nation is key to the deployment of renewable energies. It is a matter of encouraging these actors to systematically favour and adopt the use of renewable energies within the framework of their activities. In Morocco, cultural obstacles hold back solutions to ensure an energy system fed by renewable energies, especially due to:

Policy-makers' lack of knowledge of renewable energies' potential

One of the difficulties indicated by persons trying to implement RE projects lays in the lack of knowledge among policy-makers and technical personnel. They are not well familiarised with the technology, its challenges and advantages. Although, for example, accompanying local authorities is needed for the validation of projects, this is not always possible due to the lack of understanding of the potential of renewable energies.

Certain stakeholders mention resort to directives of the Ministry of Interior. « If the Ministry of the Interior issues statements to encourage local authorities to collaborate with associations proposing renewable energies, this could represent a first step in the right direction », Benhmida adds.

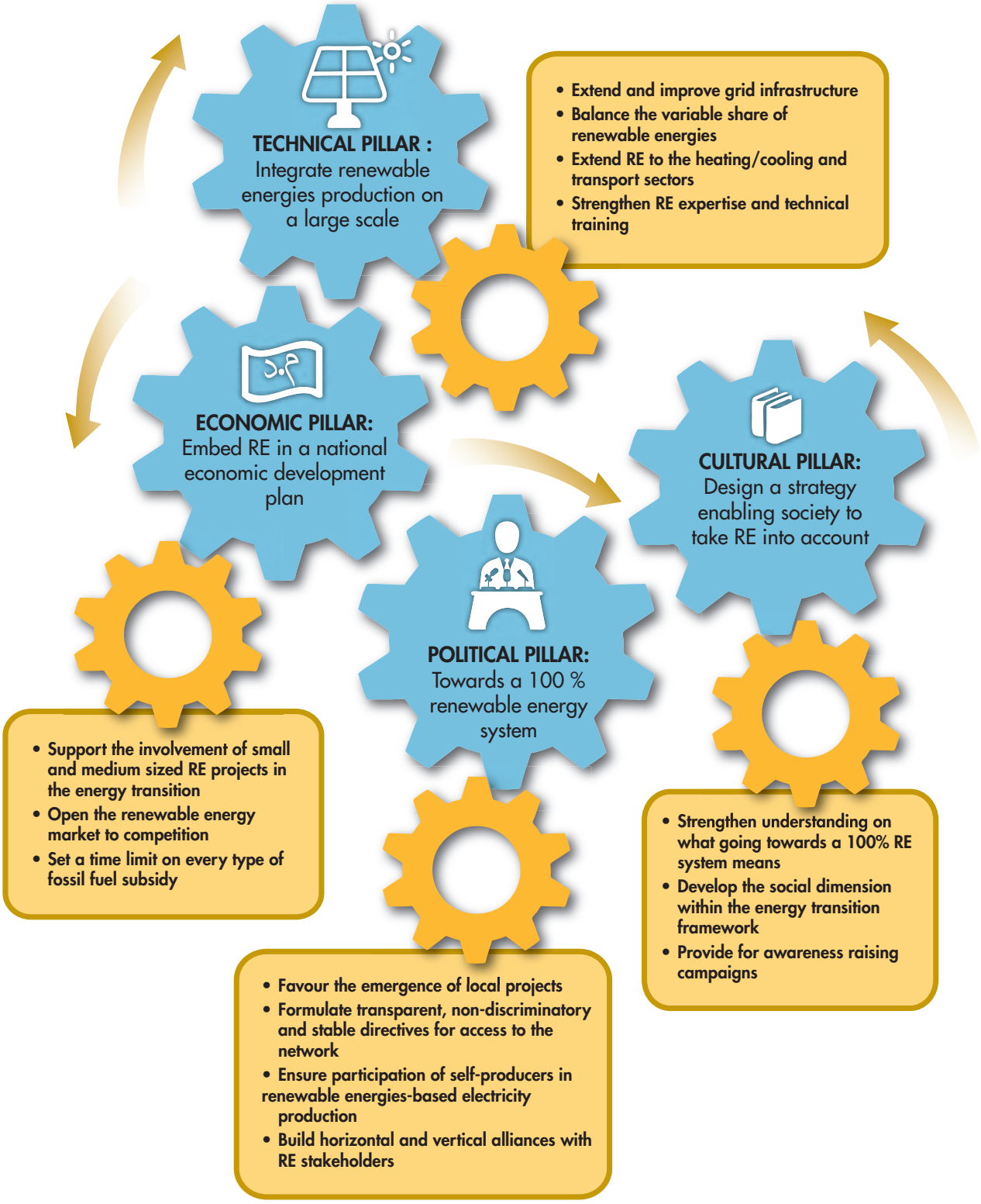
Others insist on the need to share information and exchange experiences amongst policy-makers so that they are familiar with the benefits which renewable energies offer.

The public's lack of interest and awareness

Raising awareness of society of energy issues is also very important for the rapid evolution of renewable energies.

It would seem that Morocco lacks the general culture sustaining renewable energies and their added value. If the public is made aware of energy issues, citizens tend to better accept renewable energy technologies. For example, one of the participants in the round tables facilitated by the World Future Council indicated the difficulty of involving local populations in RE projects, especially after the pilot phase, because of their lack of knowledge of the RE's potential.

A ROADMAP FOR 100% RENEWABLE ENERGY IN MOROCCO



6. Recommendations

Policies and regulations adopted by the country for renewable energies are vital for energy security, economic development and environmental protection of the nation, in direct contact with the territories hosting energy policies. Few subjects imply such a cross-cutting approach. However, Morocco must assume certain challenges to accelerate the change of direction in favour of renewable energy sources. Given the nature of the challenges and the collection of obstacles encountered by renewable energies in the country, there is no single institution or action which can resolve them all. On the contrary, the recommendations emanating from dialogues in Morocco facilitated by the World Future Council propose holistic solutions, coordinated and underpinned by four pillars : political, economic, technical and cultural. Each pillar is composed of specific actions. Overall they constitute the principal elements to integrate so as to draw up the political roadmap suitable to expanding renewable energies in Morocco.

6.1. Political Pillar: Towards a 100 % renewable energy system

The Moroccan government has already made a very important step in RE promotion by announcing the objective of raising the RE share to 42 % of installed electric power by 2020 and 52 % by 2030. However, setting a ceiling on the RE share can have a negative effect and limit their potential. Thus, there is a risk that deployment of renewable energies can be held back as the objective is progressively achieved.

The transition towards an economy powered by renewable energies requires the development of an ambitious national strategy, integrated into all economic and social sectors, where investments in domains favouring RE production and energy efficiency are accorded primary importance.

Taking into account the breadth of change to be managed, it is imperative to set an ambitious long-term goal. If Morocco has the ambition to transform its energy system, one of the pillars of its strategy must be the construction of an energy mix which is 100 % RE. Such a goal reflects a political vision, manifests the commitment of government and plays a central role in the implementation of policies and mechanisms favouring the deployment of renewable energies.

Indeed the fact of communicating the 100 % RE objective helps to clearly define the path to follow in order to replace fossil fuels by renewable energies, to build a veritable political project around this objective and identify means needed for different investment actions and operations.

This can help political decision makers to commit themselves, to ensure a more efficient deployment of technical and administrative resources and reduce the risk of duplication and of policy goals competing with each other. This objective can also help decision makers win the confidence needed for major investments, for example in the transmission and distribution networks. Finally, the objective to go towards a 100 % renewable energy system is also necessary in order to build the public's awareness and obtain its support.

Finally, it is important to highlight that setting a 100 % RE objective is certainly the first stage in ensuring the efficient transformation of the energy system, but not the last. It is a process being continually enriched and evolving to ensure a solid political and regulatory framework. In this sense, key challenges must be addressed today to progress towards a 100 % RE system. Below are the essential actions for the country to be able to fully exploit its RE potential.

Favour the emergence of local projects

The point of departure must be the principle that energy is consumed locally and that the local public can thus get involved in its production. In order to favour small and medium-scale projects and so that these can get past the pilot phase, it is important to clearly define the roles of different actions and institutions as well as to achieve legislative coherence. Contradictory or vague policies and roles penalise people wishing to get involved in renewable energy projects.

Within this framework it would be necessary to:

- **Favour a more territorialised and decentralised approach to energy policies**. It is very important to involve the cities so that they can propose solutions to the challenges which hinder RE deployment and territorial economic growth. The future Local Authority Action Plans (PAC), Provincial Action Plans (PDP) and Regional Development Plans (PDR) offer an opportunity in this direction and can help align national energy strategy with future local and regional strategies.
- **Reaffirm the role which stakeholders must play** at local level – citizens, enterprises, local authorities and endow them with the means enabling them to better support and seize the opportunities available at local level for the energy transition.
- **Develop simple and efficient administrative procedures**. This approach could be translated by the establishment of a single entry point for small and medium-sized projects. This point would

define institutional responsibilities, facilitate administrative steps, help coordinate multiple procedures, improve submissions presented and make services more efficient by building the capacities of the programme's administrators. It is hardly advantageous that small and medium sized projects should be subjected to the same administrative procedures.

Formulate transparent, non-discriminatory and stable directives for access to the network

Inequitable grid access hinders the pursuit of the development of renewable energies-based electricity production projects. Moreover, the lack of transparency and clarity concerning rules for access to the low voltage grid involve a loss of profitability of small and medium-sized RE projects. In this context, Morocco would benefit from putting in place a transparent, non-discriminatory and stable framework for investors. Only if the profitability of RE projects is similar to that of fossil fuel or nuclear projects will there be a strong incentive to invest in renewable energy production installations. For this there must be:

- **Grid priority access for renewables**. Grid priority access for RE guarantees producers' return on investment. When the grid administrator is also responsible for electricity production, as is the case with ONE, this measure avoids the administrator giving priority to its own production units. This is an important determinant of cost in view of the capital-intensive nature of renewable projects. According to the International Energy Agency « it is only later on, when the local market is sufficiently mature and the number of experienced installers sufficiently high, that it will be possible to progressively expose new projects to competitive risks »[103].

- **Set conditions and modalities for access to the low voltage grid**. As it was the case with the medium voltage grid, the regulation of the low voltage grid should be transferred to the national electricity regulatory authority ANRE.

- **Put in place a mechanism for the equitable sharing of costs between the electricity producer and operator**, envisaging the strict separation between infrastructure investments and those in production capacity: a scheme where the producer pays the entire costs downstream from the connection point or where the operator assumes the strengthening of the grid upstream from the connection point. These investments can also be shared between operator and producer in order to encourage the producer to use the available network infrastructure and choose the most optimal location from the energy resources point of view. On the other hand, if producers are obliged to assume all the costs involved in access and connection to the network, this can only encourage renewable energies-based electricity production exclusively in regions provided with a good network. This would be advisable in the case of coal and gas-powered electricity plants. However, it is more logical for example, to build wind power installations in the most windy places and not only in regions where the electricity network is adapted[104].

- **Define tariff conditions for electricity injected into the network**. The parameters to calculate the tariff must include capital, consumption and maintenance costs. The goal is to fix a tariff which can guarantee a return on investments (between 5 and 10%). However, the duration of the tariff must also be defined. If it is for a long period remuneration can be reduced.

- **Fix purchase obligations**. Apart from tariff conditions, it is very important that the closest grid operator should be obliged to purchase and distribute electricity produced from renewable energy sources. This measure is especially pertinent to wind and PV solar, since the producer cannot exactly foresee the moment of electricity production. In the current context of rising demand, it is important to allow the operator to sell surpluses. In addition this would enable financial support to RE development.

Ensure participation of self-producers in renewable energies-based electricity production

Definition of the self-production framework offers the possibility to improve the conditions for renewable energies integration into the grid. Moreover, it encourages the development of RE on sites where consumption absorbs production to best effect, thus contributing to reducing losses, withdrawal peaks and minimising costs for integration into the distribution network. However, in order for the self-production levers to be activated, Morocco must recognise

the specific stakes relating to self-production and improve the current framework, which exclusively recognises industrial self-production and does not distinguish between renewable energies and fossil fuels. In consequence it is necessary to:

- **Endow the self-producer with a specific regulatory and insurance framework**. The regulatory framework currently governing industrial self-production does not distinguish between renewable energies and fossil energies. The regulatory framework should recognise self-producers' right of access to the low voltage grid and establish the obligation on the distribution organisation to accept current derived from renewable energies injected by the self-producer.

- **Extend the self-producer status to the residential, tertiary, local authorities and public enterprise sectors**, with the possibility to sell on their surpluses. If the strategy is to favour a more sustainable and territorial approach to energy issues, the benefits must be recognised by increasing their role in the production and distribution of energy.

- **Define the fiscal regime for self-produced electricity and modalities to valorise quantity injected**. This regime must enable self-producers to develop and make the necessary investments.

Build horizontal and vertical alliances with RE stakeholders

The change needed to successfully implement Morocco's energy transformation and proceed towards a 100 % renewable energy system requires cooperation and synergy between parties and between different levels of society. Morocco is currently confronted with two fundamental challenges: the lack of transparency in decision making and the lack of cooperation and support from stakeholders. In order to confront these challenges Morocco must:

- **Favour dialogue and coordination at international and regional levels.** During the discussions facilitated by the World Future Council, it was suggested that Morocco would profit from active participation in the International Renewable Energy Agency (IRENA), taking into account its recent entry as a member. At regional level, Morocco would benefit from deepening links with the Arab Parliament, putting in place discussion platforms about the 100 % RE potential and synergies required to attain this objective. In the same way, the Union for the Maghreb can propose a discussion forum for possibilities of setting up a political framework for support to renewable energies. Interregional collaboration can have major technical advantages in relation to the intermittence of renewable energies.

- **Promote cooperation between various officials responsible for the energy sector**. Cooperation and mobilisation of actors of the energy transition are indispensable for a better understanding of the stakes, for establishing coherent policies and guaranteeing their implementation and monitoring. In this spirit, it has been suggested to set up a scientific committee comprising researchers, experts, jurists in order to improve the dialogue between such groups and set up a knowledge pole. It is essential that cooperation takes place between the various ministries and government departments which do not have the habit of working together. This includes the need to involve members of parliament from the outset, keys to the design of legal frameworks for the promotion and financing of renewable energies[105].

INTERNATIONAL REFERENCE CASES	
100% RE	Denmark: The country aims to entirely eliminate the use of fossil fuels in all energy sectors by 2050. The implementation of the goal to achieve a 100 % renewable energy system will be endowed with staged goals: between now and 2020, half of consumption of traditional electricity will be covered by wind energy. In 2030, coal will be eliminated from power stations. Fuel burners will be abolished. In 2035, electricity and heating supplies will be covered by renewable energies. In 2050 all energy supply – electricity, transport, heating and cooling – will be fed by renewable energies[106] . This will imply amongst other aspects the conversion into thermal form of the abundant wind resources (for example by channelling more wind energy into the heating system, and into water heating sites), as well as energy storage batteries for the transport system. Enlarging energy transport lines with neighbouring countries is also foreseen in order to increase renewable energy imports and exports.
FEED-IN TARIFFS	Germany: The Renewable Energies Law (EEG) entered into force in 2000 with a view to encouraging the use of renewable energies. The law was modified in 2004, 2009, 2012 and 2014 in order to adapt it to the positive development renewable energy markets in all sectors and support self-consumption. The essential characteristics of the law are: priority access for renewable energies to the electricity network. Fixed tariffs (or feed-in-tariffs) for energy producers for each kilowatt hour produced from renewable energies for a set period (normally 20 years). Tariffs set are sufficiently high to guarantee the return on investment. However, the government lowered them in order to reflect market conditions and establish a downward pressure on production prices. All renewable energy sources are addressed and tariffs are differentiated as a function of size, source, first year of operation. The supplementary cost is shared by all users through the EEG surcharge. This means that final energy consumers will expect to pay part of the sum per kWh used[107]. In 2015 renewable energies accounted for about 35 % of total national electricity production, as compared to 6.25 % in 2000[108]. In 2016, according to IRENA estimates, 355,000 persons were employed in renewable energies, making Germany the EU leader as regards job creation in the sector[109].
SELF-PRODUCTION	Tunisia[110]: on 11th May 2015 Tunisia adopted its third law on electricity production from renewable energy sources. The first two laws (2004 and 2009) introduced RE into the Tunisian energy mix. The 2015 text promulgated on 21 May brings three novelties: (i) the definition of a national plan to produce electricity from RE (ii) expansion of the status of self-producers to local authorities, public enterprises and private companies with the possibility of selling surpluses to the Tunisian Electricity and Gas Company (STEG) (resale price fixed by ministerial directive) and (iii) authorisation of RE for export on condition of benefiting the State with part of the output.

6.2 Economic Pillar: Embed RE in a national economic development plan

The energy transition can become a factor of national economic development and the lever for local development. To ensure sustainable prosperity over the long term, Morocco must embed the 100 % RE strategy into a national economic development plan.

Developments in the energy sector, notably the increased share of RE in the energy mix, opens new opportunities for innovation and value creation at local level. One of the principal reasons is that investments are made in the country and enable fructification of national funds instead of their being spent on fuel imports. Moreover, renewable energies create more jobs per unit of energy produced than fossil fuels and in 2015 the sector already employed 8.1 million people worldwide, 5 % above the 2014 level and in contrast with the crisis of the fossil energies market[111].

The socio-economic fallout from renewable energies can be measured all along the value chain. One of the key questions for numerous governments, including political decision makers is to know where in the RE value chain (Figure 15) job creation is the most fruitful.

It is certain that in an initial phase most technologies are imported from countries offering advanced and competitive technologies,

such as China. Thus the first jobs, such as Noor Ouarzazate show, will not be created in production but in international trade, project management, installation and construction, entry into service and maintenance. A range of indirect employment is already arising out of this sector in research and development, logistics, transport, consulting and administrative and regulatory work. And in the long-term Morocco will also benefit from the development of local industries linked to production[112].

Figure 15: Socio-economic benefits of solar and wind energy

Potential for domestic value creation	Stage of development		
	Beginning of wind & solar energy development	First projects realised, local industries suitable for participating	Many projects realised, national wind/solar industry developing
LIFECYCLE PHASE			
Project planning	Weak	Medium	High
Manufacturing	Weak	Medium	Medium / High
Installation	Weak	Medium	High
Grid connection	High	High	High
Operation & Maintenance	Medium	High	High
SUPPORTING PROCESSES			
Policy-making	High	High	High
Financial services	Weak / Medium	Medium	High
Education and Training	Weak / Medium	Medium	Medium / High
Research & Development	Weak	High / Medium	Medium
Consulting	Weak	Weak	Medium

Source : IRENA[113] (2014)

Morocco is currently at a crossroads and must decide whether it wishes to become a producer of RE technologies (encouraging the production of certain RE components), a knowledge pole in the RE field or whether it prefers to develop RE research and development. It is up to Morocco to foment and accompany these dynamics enabling them to let loose all their economic potential and stimulate growth. These are the actions to incorporate in order to realise these ambitions:

Support the involvement of small and medium sized RE projects in the energy transition

Logically, for the large-scale dissemination of RE technologies the Moroccan government should not only mobilise funds to help private operators realise major infrastructures, but also to provide economic and fiscal incentives to small and medium-sized RE projects. To accompany the sector during the investment process Morocco should:

- **Offer financial support suited to small and medium-sized RE projects**: The technology costs of renewable energies have considerably declined in recent years. As a matter of fact, the costs of solar energy have dropped by 80 % since 2009. However, investors in renewable energies in the domestic and private sectors still must face high financing costs which penalise the deployment of renewable energies to the detriment of fossil fuel-based energies. For example, in a country with higher financing costs, the production cost for wind energy can be 40 % higher. This is due to the high initial capital intensity required by renewable energies. Loans specifically dedicated to RE, at preferential terms as regards interest rates and reimbursement duration would favour the accessibility to RE projects. Such a loan system must be accessible to the majority of households and SMEs. At the city level, it is important to lighten the terms of loans given by the Local Authority Equipment Fund.

- **Support the development of Power Purchase Agreements**. Energy sector actors are currently mobilising leading Moroccan companies for the launching of solar PPA self-consumption projects. However, the lack of knowledge of this new distribution market as well as the lack of financial and legal structures are slowing the realisation of these projects. For stakeholders in the energy sector, the involvement of the General Confederation of Moroccan Enterprises (CGEM) could be a locomotive for the development of priority projects, as they represent the private sector to the government authorities and institutions.

- **Put in place measures inciting investments in RE**. Within the framework of measures to encourage RE investments, Morocco would benefit from reducing the high customs duties impacting products used in the production of renewable energy. An equally crucial measure is the reduction (or suppression) of the added value tax on RE technologies. If financial incentives are not granted to invest in PVs, its economic potential will remain insignificant in the short term. The establishment of companies specialised in RE development at local and regional level should be encouraged, in particular in the Technopoles. This could be done by placing at their disposal sites at very attractive or symbolic prices.

Open the renewable energy market to competition

The opening of the electricity market offers the opportunity to local authorities to master their energy management. For example, the city of Agadir aims to achieve 100 % RE. One of the objectives is to reduce the municipal energy bill (about 10 % of its annual budget) but also to lessen its dependence on fossil fuel imports, improve air quality and attract foreign investors. In order to achieve the 100 % RE target, Agadir has called for a reform of regulations, in particular Law n° 13-09 so that independent energy producers, such as municipalities, can feed the national grid with low or medium voltage current derived from renewable energies. This reform should enable cities to develop mixed capital companies which produce and sell their electricity on a large scale. To ensure the opening of the market and the participation of independent producers it would be necessary to:

- **Ensure a transparent and non-discriminatory grid access for all their users**. This market opening should provide for the free choice of supplier by consumers, as well as for the right of producers to create distribution networks. To sum up, the Government must provide a framework favouring greater participation of economic actors. The decentralised nature of RE offers Morocco a unique opportunity to develop a small-scale energy system in which local authorities and SMEs can be at the heart of local development and of the consolidation of economic approaches based on renewable energies.

- **Separate production, transmission and distribution activities** at least at functional, organisational and accounting levels. This would enable increased transparency and ensure the financial viability of ONE[114].

- **Supply all information needed by users**. The contractual outline for access to networks must be transparent, published and accessible to all users. These model contracts should be drawn up in consultation with the stakeholders of the grid and be objectively founded and applied. In this way, grid managers must act independently of any particular interest.

Set a time limit on every type of fossil fuel subsidy

One of the key elements in advancing towards a 100 % renewable energy system is the progressive elimination of fossil fuel subsidies. In this context, since 2014 and 2015 the government has saved Dh 10.5 billion[115]. However, fossil fuel subsidies remain higher than those for RE. This reality distorts competition and prevents the in-depth penetration of renewable energies into the market. To lift these obstacles, the Government should:

- **Put in place mechanisms to compensate the elimination of fossil fuel energy subsidies**. Morocco should consider available measures to anticipate related impacts. In this context, the government should endow itself with concrete mechanisms to lessen the negative impact of measures in the short term, especially on the most deprived population groups (eg. a financial compensation programme).

- **Arrive at an inter-party and inter-sectoral consensus to eliminate subsidies** and ensure a strong and robust political framework. Strong coordination and collaboration is needed between parties to ensure the fairest possible calibration for redistributing subsidies. In particular, the consensus requires a careful choice of the adjustment rhythm (gradual or a « Big Bang » ?), as well as ensuring convergence between the timing of the disappearance of fossil fuel subsidies with the establishment of the new system.

- **Accelerate the implementation of a programme to equip housing and the tertiary sector with solar water heaters and of the PV irrigation pumping programme**. This will facilitate the reduction – in price and quantity – of subsidies granted to butane via the Caisse de Compensation[116].

- **Launch a public information campaign**. A gradual price increase process should be accompanied by a wide public information campaign. Education and information of the public and enterprises facilitate public support and acceptance.

INTERNATIONAL REFERENCE CASES	
FINANCIAL SUPPORT	In the light of Austria's goal to achieve independence from fossil fuels by 2050, the federal government has established the *Climate and Energy Model* Programme. The objective is to support regions engaged in becoming independent from fossil fuel energies. The programme has three phases 1) development of an implementation concept (generally a leading regional organisation assumes this task) 2) designation of a « responsible manager for the model region » to assist project implementation. This function is financially supported by the programme for 2 years ; 3) implementation of projects. The programme supports the « model region » by co-financing projects up to 30 %-40 %[117].
INCENTIVE MEASURES FOR RE	In the USA, policies of net metering have facilitated the expansion of renewable energies thanks to on the spot electricity production. Thanks to net measuring, clients of distributed production can sell their surplus electricity at a retail price and receive a credit on their electricity bill. This credit compensates a client's electricity consumption during periods of the day or year, thus reducing the quantity a client buys from the electricity companies. Since 2010, US solar capacity has increased 418 % and more than half of this increase has been in the form of solar panels on houses and businesses.
ELIMINATION OF SUBSIDIES	In Namibia, the national energy council has set up a national working group on deregulation to examine the deregulation of the fuel price through a consultation process involving all stakeholders. Similarly to Niger, where the authorities have set up the « Comité du Différé » (Deferment Committee) to examine the way to advance the reform of fossil fuel subsidies. The strategy followed in the two countries has been essential to guaranteeing consensus and acceptance by all stakeholders of the principal elements of reform [118].

6.3 Technical Pillar: Integrate renewable energies production on a large scale

The backbone of the electricity system, the electricity transmission network, is a central asset for the transition towards renewable energies. The vocation of the electricity transmission network has always been to adapt to means of production and to consumption needs. Today the major flows of RE-based electricity and solidarity between territories constitute the main vectors for the evolution of the network and present new challenges to it.

Growing power demand, especially at peak periods, variations in energy flows and other disturbances impose strong constraints on the transport and distribution networks. With the increasing penetration of RE, by definition intermittent, grid instability increases. One of the challenges to overcome is thus the reconciliation of heterogeneous regional balances, disparate production potentials and irregular consumption profiles[119].

In this context, one of the imperatives emphasised by Morocco's energy sector stakeholders is the large-scale integration of RE production. One of the ways to diminish the intermittence of RE is to connect several RE sources to each other so that current variations from intermittent sources are reduced[120].

To successfully carry forward this strategy, Morocco must facilitate and accompany technical and structural changes necessary to an energy system only fed by RE. More concretely, the following actions must be identified and promoted:

Extend and improve grid infrastructure

The energy transition will create a new geographical distribution of electricity production. Certain regions will be essentially importers and others strong exporters. The wide-reaching and density of the grid will be an essential point for guaranteeing RE-based electricity and security of supply. It is therefore recommended that:

- **Authorities present a clear and holistic vision of the transport and distribution network infrastructure**. The design of a more concrete vision of electricity production and demand can help to identify and develop specific RE technologies to meet these needs. For example, Morocco could reorient the development of large thermodynamic solar plants for priority coverage of consumption peaks after sunset and assign to PVs the daily production of electricity. This strategy would enable a reduction of the charge on the network. And as the International Energy

Agency has emphasised, PVs are able today or in the very short term to rival without financial support the marginal kWh cost supplied on the network at those hours: PV with the cost of full hours – dictated by the cost of gas, and CSP with the cost of peak hours – dictated by the cost of petroleum products[121].

- **Undertake an active investment policy in network infrastructure and its total capacity**. The shortcomings of current transmission installations must not be a pretext for justifying access restrictions and sales thresholds but must be considered more as an incentive. If the grid is connected to RE sources, electricity reliability is improved and storage needs for reserve energies is minimised. In simple terms, if the wind is not blowing in the north of Morocco, it could well be blowing strongly in the south.

Balance the variable share of renewable energies

The rapid variation of RE production necessitates the development of demand and supply management and technical tools guaranteeing grid safety. More specifically, there must be:

- **Increased generation flexibility and mix of resources**. A greater flexibility is guaranteed by the simultaneous use of various RE sources. For example combining wind power with tidal power is suggested to reduce by 37% the cost of extra reserve to balance for intermittency as compared to wind-only scenario[122]. The interconnection of resources is particularly relevant for large areas where supply is only from RE sources which are not connected with each other.

- **Improve forecasting and planning methods**. Current planning methods and those for operating the electricity market are essentially based on models of predictable energies. In order to integrate renewable energies, rebalancing systems will be needed during the short term. This will enable the minimisation of costs because it is possible to precisely predict intermittencies[123].

- **Embrace smart grids and smart metering systems**. Flexibility cannot only come from the supply side, it must also be present on the demand side. Smart grids can maintain a permanent equilibrium between electricity demand and supply, contribute to the integration of RE and optimise their use by stabilizing multiple entry flows. Smart metering systems make it possible to know consumption in real time and incite consumers to change behaviour if incentive schemes are in place.

- **Develop storage capacities**. Energy storage makes it possible to even out peaks and troughs in RE production and can better reconcile RE production intermittence. In order to arrive at a 100 % RE system, it is imperative to store excess energy, whether in the form of heated or refrigerated water, or by using it for desalination or energy transfer by pumping (STEP).

Extend RE to the heating/cooling and transport sectors

In Morocco the development of renewables-based heating and transport systems remains very modest. Despite the existence of many possible RE entry points in these two sectors, their potential is held back by the low cost of fossil fuels, subsidies benefiting them and competition with other possible investments such as improvements in energy efficiency and the development of other RE systems[124]. Consequently, it would be necessary to:

- **Electrify heat networks**. Heat networks have an essential role to play in RE development and the valorisation of recovery energies. This makes it possible to use biomass in all its forms, enabling concentration in a single point of the obligations for storage, fuel handling, automation of these operations and the improved handing of smoke emissions; geothermal energy; and household waste incineration[125].

- **Encourage the growing use of electric vehicles**. Given the impact of transport on fossil energies consumption and related greenhouse gas emissions, the introduction of a policy enabling electric mobility in Morocco would represent an important fraction of RE objectives.

- **Integrate the three sectors into the energy strategy**. Overall, the integration of the electricity, heating and transport sectors into national RE strategy would enable the storage of surplus energy, for example in the form of heating of individual residences or enterprises or by allocating it directly to electric vehicles or other types of storage. This means that to progress towards a 100 % RE system,

energy must be managed in a far more dynamic way than in the past, with greater co-ordination between various sectors and dispatched energy needs.

- **Increase energy efficiency**. Finally, since energy efficiency is an essential element of optimal RE deployment, Morocco must increase its efficiency. The adoption of a national energy efficiency plan would be major step ahead. More specifically, Morocco would set objectives for the reduction of energy consumption by sector, describing in detail actions to be implemented and financial incentives. The Moroccan government should also accelerate the entry into force of decrees and flanking measures (such as building codes) and provide procedures for verifying energy performances on the ground. The Morocco energy efficiency agency is well placed to achieve this aim[126].

Strengthen RE expertise and technical training

Morocco's research and development projects are highly important, representing a very positive evolution as compared to the previous decade. In order to assume remaining challenges, Morocco needs to:

- **Increase financial efforts**. The creation of IRESEN has yielded valuable financial efforts related to RE. However, only 0.8 % of GDP is devoted to research and development.
- **Strengthen coordination between higher education research establishments**.
- **Involve Moroccan universities** in the evaluation of potential energy sources, project design and financial engineering. Moreover, universities can contribute to defining the rules for decision and approval of RE materials and technologies, as well as the certification of installers.
- **Design a plan for the anticipation of future needs for RE skills, research and technological innovation**. For training to correspond to the exercise of skills in the RE field and that graduates can easily enter the labour market, Morocco must provide a specific RE training activity.
- **Favour university/enterprise collaboration**. In this regard, dialogue platforms between the government, industry and universities will facilitate the pursuit of the same objectives and result in profess of RE knowledge.
- **Establish and extend partnerships between the Moroccan Institute for Training in Renewable Energies and Energy Efficiency Skills (IFMEREE) and various stakeholders**. The creation of other IFEMEREEs should be encouraged so as to promote the setting up of a vocational training system close to RE development.

INTERNATIONAL REFERENCE CASES	
MIXING OF RE	In Denmark, most power stations are able to co-produce electricity and urban heating. The nation has made great efforts to establish heat and/ or cold distribution networks to collect waste heat from factories, incinerators, transport systems, combining them with heat produced by solar energy thermal power stations, wind turbines, conventional gas and coal-fired power stations so as to ensure low-cost and highly efficient heat production and reduce the use of fossil fuels. Moreover in the national waste strategy issued in 2013, the government mandated that the organic fraction of household and services sector waste should be increasingly used as raw material for agricultural biogas installations to improve energy production[127].
RE IN THE TRANSPORT SECTOR	Costa Rica has set the goal of attaining 100 % RE in the electricity sector by 2021 and to be « carbon neutral » at the same date. Since transport accounts for about 44 % of final energy consumption, pursuing its RE efforts in the transport sector is an essential element of the nation's long-term goals. The country encourages the use of electric vehicles and offers targeted incentives for their import and sale, as well as for the development of charging points[128].
TRAINING AND CAPACITY BUILDING	In 1997 the Bangladesh government set up the Infrastructure Development Company Limited aimed at filling the financing shortfall for the development of medium-sized and large RE projects. Apart from its creditor role and provision of technical assistance and quality control, IDCOL is also engaged in RE training and capacity building. Until now, the institution has trained 1,500 professionals in the installation of domestic solar systems, maintenance, repairs and market development. Moreover, companies installing green technology have set up green technology centres in the country to facilitate the use of RE and train members of the public, in particular women who work independently as technicians and entrepreneurs in the sector[129].

6.4 Cultural Pillar: Design a strategy enabling society to take RE into account

The energy transition is the passage from one production centralised model based on fossil fuels towards a new RE-based model which is decentralised and people-centred. There are many advantages, especially regarding energy supply, economic development and environmental protection. This transition towards RE is both desirable and inevitable. Long before fossil energies are economically exhausted, we will have turned away from them towards renewable sources of energy simply on the basis of cost. The question is then posed to know if this transition from fossil fuels towards renewable energies is made on our own terms, in a way as to maximise advantages for all citizens today and for future generations.For this reason, it is essential that everyone should become aware of the significance and assets of RE and assume their responsibilities at each level. Taking into account the stakes, Morocco should:

Strengthen understanding on what going towards a 100% RE system means

The energy transition can give rise to reticence or not have the necessary support since a new system is being faced, where new models of production and consumption emerge, new actors (including citizens and small enterprises) are entering the energy system and where there is need for a completely different infrastructure and market[130]. Stakeholders' knowledge to what it means to go towards a 100 % RE system is thus primordial for the success of the energy transition. In this context if would be advisable to:

- **Define the attributions and responsibilities of stakeholders in the energy transition**. Everyone can participate in the energy transition, collectively or individually (investing in RE projects, installing solar panels or buying energy from a supplier of RE-based electricity). For this, clear understanding is needed of the roles which various actors can play in this transition. Directives from the Ministry of the Interior inciting local authorities to collaborate with associations proposing renewable energies would constitute a step in this direction. The transversal integration of specific RE axes in the future municipal action plan (PAC), provincial development plan (PDP) and regional development plan.

- **Strengthen the RE capacities of local authorities**. Local governments play an important role in validating and accommodating RE projects. Improving their knowledge and understanding of RE technological solutions is fundamental to fully exploit the potential of the advantages the population can derive from RE.

- **Establish mechanisms for sharing information and exchanging RE experience amongst policy-makers**. The systematic monitoring of the development of RE projects amongst policy-makers is key so that they are aware of the benefits offered by RE and can learn from the experiences of other regions. In the same way, this can aid to create synergies between territories. In this sense, it would be beneficial to support and replicate the experience of the « Jiha Tinou » programme launched by ADEREE with a view to optimising the capacity of local actors to contribute at their level to Morocco's 2020 energy objectives.

Develop the social dimension within the energy transition framework

Renewable energies bring together the qualities needed to become a key lever of development and social cohesion in Morocco. For this it would be necessary to:

- **Seek the acceptability of population groups concerned in RE projects**. The local population can contribute to the development and success of RE projects, or on the contrary become a significant obstacle, in particular if projects compete with other natural resources (water, farmland, woods). It is thus important to provide for appropriate mechanisms for the selection of sites and structures for RE projects which allow the participation of the populations concerned.

- **Create opportunities for citizens in RE projects**. The Moroccan government must ensure that RE investments made respond to citizens' needs, taking into account in particular objectives relating to habitat, improved energy performance and employment.

Provide for awareness raising campaigns

On 1st July 2016, Morocco launched the construction of the sustainable development house in Tangiers, aimed to raise public awareness of environmental problems. The house will comprise a space for awareness raising, education and exhibitions, will organise thematic workshops of which one about RE. This type of structure can be replicated in other cities. In parallel there is need to:

- **Establish a communication and awareness raising strategy about RE**. Strengthen public information about the positive impacts of RE to obtain public support for the government's energy strategy. The Info-Energie cell set up by the Chefchaouen municipality within the « Jiha Tinou » programme constitutes a good example of this approach.

- **Integrate the energy** dimension into educational programmes. These programmes will be adapted to different educational levels and aim to influence behaviour and the public's future consumer patterns.

7. Conclusion

With the ambition to increase the share of RE in installed electricity capacity to 52 % by 2030, Morocco has become one of the major actors in the world's energy transition and more especially on the African continent.

This additional electricity capacity of about 10,100MW of which 4,560 MW solar, 4,200MW wind and 1,330MW hydro renders Morocco as a candidate for a 100 % RE electricity system by 2050.

Morocco's RE potential is largely sufficient to respond to all the nation's needs. The intelligent exploitation of this potential could enable Morocco to completely eliminate imported fossil fuels, and contribute to the environment while creating new sources of wealth.

However, this requires a deeper commitment, with the establishment of a coherent political and regulatory framework, which sets clear and essential post-2030 goals in order to ensure security of investments, mobilisation of stakeholders and allocation of resources towards a common vision.

In order the set up such a political and regulatory framework, four major pillars have been proposed to structure and take up current challenges:

1. Set the objective to become a 100 % RE nation
2. Embed renewable energies into a national economic development plan
3. Integrate RE production on a large scale
4. Develop a strategy for the taking into account of RE in society

Moreover, as Morocco's energy policy is inserted into a process enlarged to its neighbours, it must bet on regional integration of RE through electricity interconnections.

COP 22 offers Morocco a magnificent possibility to redouble its efforts and show the way. The World Future Council and its partners undertake to support policy-makers in this enterprise. As mentioned above, this report aims to raise and extend the debate to other decision-makers so as to stimulate development through a 100 % renewable energy Morocco. This is no longer a utopia and can become Morocco's reality. The country's roadmap will determine when.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