SOUTH-SOUTH IDEAS

RENEWABLE ENERGY IN THE MIDDLE EAST AND NORTH AFRICA REGION:
POTENTIAL AND LIMITS

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ABBREVIATIONS AND ACRONYMS

ADEREE	National Agency for the Promotion of Renewable Energy and Energy Conservation
ARDL	Autoregressive-Distributed Lag
BRICS	Brazil, Russia, India, China and South Africa
CCGT	Combined Cycle Gas Turbines
CDER	Center for the Development of Renewable Energy
CIPS	Cross-sectional augmented IPS
CSP	Concentrated Solar Power
DOLS	Dynamic Ordinary Least Squares
EIA	U.S Energy Information Administration
EWA	Bahrain's Electricity and Water Authority
FD	Financial Development
FMOLS	Fully Modified Least Squares
GCC	Gulf Countries Council
GCF	Green Climate Fund
GDP	Gross domestic product
GHG	Greenhouse Gases
INDC	Intended National Committed Contribution
IRENA	International Renewable Energy Agency
kWh	Kilowatt Hour
MASE	Moroccan Agency of Sustainable Energy
MASEN	Moroccan Renewable Energy Agency
MENA	Middle East and North Africa
NDCs	National Domestic Contributions
NES	Moroccan's National Energy Strategy
NREAP	Bahrain's National Renewable Energy Action Plan
OCGT	Open Cycle Gas Turbine
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
PNAP	Moroccan's National Priority Action Plan
PPP	Public–Private Partnerships
PROSOL	Tunisian Solar Programme
PV	Photovoltaic
R&D	Research and Development
RE	Renewable Energy
RERT	Renewable energy re-purchase tariff
ROP	Real Oil Prices
RTE	Tunisian Energy Transition Fund

SEU	Bahrain's Sustainable Energy unit
ST	Steam Turbine
STEG	Tunisian Company of Electricity and Gas
TFP	Total Factor Productivity
TSP	Tunisia's Solar Plan
TO	Trade Openness
UNEP	United Nations Environment Programme
UTICA	Tunisian Union of Industry, Trade and Crafts
WDI	World Bank Development Indicators
WTI	West Texas Intermediate

EXECUTIVE SUMMARY

Over the last years, there has been a commitment to spur unprecedented deployment of renewables across Middle East and North African (MENA) countries. According to the last International Renewable Energy Agency report (IRENA, 2017), the amount of renewable investment will reach US$35 billion per year by 2020 in the region. In 2008, the amount of investment in renewable energy in the Arab region was US$ 1.2 billion. In 2016, it had reached the value of US$ 11 billion, which is a good indicator of the evolution of investment in renewables. Total renewable energy installed capacity increased by 150 per cent, during the period 2012-2015, exceeding 3.0 GW compared to 1.2 gigawatt in 2012 (Irena, 2017).

This study contributes to the knowledge on what determines renewable energy demand by analyzing the contribution of financial development, international trade, oil price, CO2 emissions to renewable energy demand, with a focus on the MENA countries. A deeper understanding of the determinants of renewable energy consumption in MENA countries is of great importance. In fact, increased concern over the issues related to energy security, climate change, and global warming suggest that there will be a greater reliance on the demand of renewable energy in the near future.

Our methodology is to proceed in two stages. During the first stage, we develop an econometric model in order to examine the macro-level determinants of renewable energy demand in MENA countries. The empirical model that we develop in this study is consistent with the broader literature on the determinants of renewable energy consumption and takes the following form:

$$RE = f\left(CO_2, ROP, \mathrm{Y}, \mathrm{TO}, \mathrm{FD}\right)$$

where *RE* represents the renewable energy consumption and it is a function of four variables including CO_2 emissions (CO_2), real Oil prices *(ROP)*, per capita gross domistic product (GDP) (*Y*), trade openness (*TO*), and financial development (FD). During the second stage, we develop four cases studies (Algeria, Bahrain, Morocco and Tunisia) based on interviews and questionnaires in order to deepen our understanding of the current trend of adoption of RE in MENA Countries. We stress the barriers to adoption of RE and the main lesson learnt from these experiences that may benefit the rest of the MENA Countries and the Southern countries in general. Possible fields of South-South cooperation are also stressed.

Our main findings are: Taking the entire panel of countries, our results show that in the case of carbon emissions, a 1 per cent increase in CO2 emissions raises per capital renewable energy consumption between 0.149 per cent and 0.221 per cent (according to whether the estimation technique is used). The oil prices elasticities are positive, statistically significant and very similar in value across the two estimation techniques (0.275 and 0.184). For trade openness, the panel results show positive and statistically significant coefficients and very similar values across the two estimations (0.310 and 0.410). However, the panel estimated that elasticity for financial development is positive and statistically significant according to one technique and statistically non-significant according to the other technique.

For the different determinants for each country, first we can notice that the effect of the carbon emissions on renewable energy consumption, except Egypt and Algeria, is statistically significant and positive, at the 1 per cent and 5 per cent levels, for all the countries considered. The coefficients' magnitude is ranging from 0. 0.114 to 0.414, which imply that a 1 per cent increase in the per capita CO2 emissions increases the per capita renewable energy consumption of MENA countries from 0. 0.114 per cent to 0.414 per cent, respectively. Concerning the oil prices variable, the findings indicate that oil prices have positive and statistically significant effects on renewable energy consumption at the 1 per cent and 5 per cent level. The per capita GDP has a significant positive impact on renewable energy consumption in MENA countries. This suggests that economic growth is an important determinant of renewable energy consumption in MENA countries. Finally, our findings show that financial development has a significant and positive effect on renewable energy consumption in MENA countries. This finding suggests that financial development significantly promotes renewable energy in MENA region in the long run.

The second part of the study presented four cases studies based on semi-structured interviews and questionnaires with selected stakeholders (especially policy makers, researchers and development agencies) in the Renewable Energy Market from four Arab Countries (Morocco, Algeria, Tunisia, and Bahrain).

Morocco has one of the most ambitious renewable energy targets. The plan expects to provide more than 42 per cent of the Moroccan's energy demand from renewable sources (Solar, hydroelectric and wind) by 2020 and 52 of electric energy demand by 2030. The Moroccan experience needs to be shared, especially in regard to building a critical mass of skills in all the renewable energy segments. The experience is also very instructive regarding how the regulation was divided between wind and solar energies. Tunisia is also an interesting case where lessons need to be learnt from changes in the institutional and legal framework for the renewable energy market. Trial and error in regard to institutional design is unlocking renewable energy potential. Revision of the regulations and changes introduced in the tendering process are helping the country to reach its targets. Algeria is another interesting case where public policy is shifting toward renewable energies, despite the important endowment in gas and oil.

Finally, Bahrain has to increase the share of renewables in the generation mix, not only to boost hydrocarbon export revenues but also to enhance the security of supply and diversify the energy mix in order to attract private capital to the country. Bahrain's economy still relies on oil and gas exports, as it represents 50 per cent of all exports in 2016. However, in 2017 the crude oil and natural gas sector shrank by 1.4 per cent, while the economy as a whole grew by 3.6 per cent (Oxford Business Group, 2018). In the long term, renewables can contribute to economic diversification, which is one of the main targets in Bahrain's economic vision. We should take into account the fact that Bahrain has the highest CO_2 emissions from electricity and heat production compared to other countries in the region (Rizk et al. 2017). Therefore, the country should pay attention to maintaining the same growth of economy with lower consumption of energy to mitigate the impact of rising domestic oil and gas demand and reduce the country's carbon footprint. The challenge facing Bahrain with RE is how to design a reform model that can attract investment and improve efficiency, while at the same time integrate new technologies into its power system.

Policymakers in the MENA region face several choices to increase levels of renewable energy production when faced with several risks and obstacles, including technological and financial severe constraints. Firstly, it is necessary to prioritize technologies that can supply renewable energy at a low cost. Secondly, there is a need to design and implement appropriate policies to attract private investment in renewable energy.

1. INTRODUCTION

This report seeks to provide an updated analysis of the MENA (Middle East and North Africa) countries strategies with regard to renewable energies and characterize the needs and potential cooperation between MENA countries, specifically with regard to interconnection, innovation and research and development (R&D) in the field. Indeed, the Arab region Renewable Energy (RE) landscape is changing rapidly and important developments have taken place in recent years. Since 2014, an impressive increase in renewable installed capacity has been observed in many Arab countries. The total installed capacity of all renewable energies (including hydropower) reached about 3 GW in 2015 (while it was only about 1.2 GW in 2012).

Shifting to RE in MENA countries can have several positive impacts on human and sustainable development, especially the Sustainable Development Goal 7 (SDG 7 on affordable and clean energy). On the one hand, renewable energies sources have diverse *supply* sources and are not limited. This diversity of sources implies a flexible and distributed system instead of a rigid and centralized system with the classical sources of energy. Their pricing models have shown great stability instead of volatility, as in the case of oil and gas markets. Moreover, the urgent need for MENA Countries to move to carbon neutral economy will necessitate huge investment in RE. Renewable energies avoid significant emissions of Greenhouse Gases (GHG) and have an impact with regard to health. Finally, the shift to renewable energies is a better option with regard to security. A centralized delivery system shows important vulnerability, while the renewable energies sources are more secure and resilient. Renewable energies can provide energy for all at a competitive price and can improve health conditions in MENA Countries. In fact, renewable energy deployment may play an important role in improving environmental quality and reducing human health risks associated with traditional fossil fuels, including cardiovascular and respiratory diseases.

Renewable energy wide-scale development potential in MENA countries is huge. The current intensive trend of energy consumption in the region, mainly due to the urgent needs for economic development and highly demographic growth, call for substantial and stable energy resources that can meet increasing demand and in the meantime improve environmental quality.

It is worth noting, that despite the considerable potential of RE, in 2015 only 6 per cent from the total installed power generation capacity was dedicated to green power in the MENA Region (IRENA, 2017). In addition, only four countries of the 22-member countries account for almost 80 per cent of non-hydro renewables growth. Several barriers need to be removed in order to foster the adoption of renewable energies in MENA Countries, mainly legal, political and technological barriers. In fact, the competitive renewable energy market needs clear policies and legal procedures to attract the interest of private investors, mainly foreign investors. Innovative legal procedures may create a stable and predictable investment environment, thereby reducing the risk of project failure by insuring predictable cash-flows.

Moreover, technological barriers include lack of technologies and infrastructures to support technologies. Therefore, to facilitate the development of renewable energy in MENA countries, policy-makers should improve the development of the distribution networks and physical facilities for transmission, as well as necessary services and equipment for energy companies. In addition, it is crucial to facilitate connectivity of renewable energy to the grid. In fact, inadequate connectivity to the grid has been identified as a significant technical barrier to renewable energy expansion, mainly in the wind power sector.

In recent years, there has been an increasing commitment to spur renewables across MENA countries. According to the last IRENA report (2017), the amount of renewable investment will reach $35 billion per year by 2020 in the region. In 2008, the amount of investment in renewable energy in the Arab region was US$ 1.2 billion. In 2016, it had reached the value of US$ 11 billion, which is a good indicator of the evolution of investment in renewables. Total renewable energy installed capacity increased by 150 per cent, during the period 2012-2015, exceeding 3.0 GW compared to 1.2 gigawatt in 2012 (IRENA, 2017).

Table 1 shows that most of the MENA countries have already achieved their Solar and Wind Atlas targets, except Iraq and Mauritania. Wind and Solar Atlas coverage help decision-makers to estimate the potential of Renewable energies in their countries and the potential location of the Wind farms and Solar energy infrastructures.

Table 1: Wind and solar atlas coverage in Arab countries

	Solar Atlas	**Wind Atlas**
Algeria	Yes	Yes
Bahrain	Resource assessment completed in 2012	Resource assessment completed in 2012
Egypt	Yes	Yes
Iraq	No	Measurement on going
Jordan	Yes	Yes
Kuwait	Yes	Yes
Lebanon	No	Yes
Libya	Preliminary data, 2004-2010	Preliminary data, 2006-2007
Mauritiana	No	No
Morocco	Yes	Yes

Oman	No	Yes
Qatar	Resource mapping ongoing	Resource mapping ongoing
Saudi Arabia	Yes	Yes
State Of Palestine	Yes	Yes
Sudan	Yes	Yes
Syrian Arab Republic	Unverified	Unverified
Tunisia	Yes	Yes
United Arab Emirates	Yes	Yes
Yemen	Unverified	No

Table 2 shows the installed capacity in Arab countries in 2015 while table 3 shows the targets for the period 2020 and 2030. The average installed renewable energy capacity in Arab countries was 6 per cent with huge differences prevailing between the countries. For instance, Bahrain has only 0.27 per cent of its electricity generated by renewable energies while Egypt has 11.48 per cent. Most of MENA countries have very ambitious targets nowadays. For example, Djibouti is targeting to have 100 per cent of its electricity from RE by 2025, making it the most remarkable case for the entire region and in the world. With the exception of Djibouti, one needs to mention the ambitious programme in place in Morocco to reach 50 per cent of its electricity generated by renewable energies by 2030.

Table 2: Renewable power: Installed capacity in Arab countries (2015)

	Wind	PV (Photovoltaic)	CSP (Concentred Solar Power)	Hydro	Other	Renewables excluding hydro (2015)		Total Renewables including hydro (2015)	
	[MW]	[MW]	[MW]	[MW]	[MW]	[MW]	[%]	[MW]	[%]
Algeria	10	270	25	228	-	305	2.2	533	4.1
Bahrain	0.5	10	-	-	-	10.5	0.27	10.5	0.27
Egypt	745	90	20	2,874	-	855	2.63	3,729	11.48
Iraq	-	3.5	-	2,513	-	3.5	0.01	2516.5	9.83
Jordan	197	15	-	12	3.5 [2]	215.5	4.39	227.5	4.66
Kuwait	-	1.8	-	-	-	1.8	0.01	1.8	0.01
Lebanon	-	20	-	280	-	20	0.74	300	11.07
Libya	-	5	-	-	-	5	0.05	5	0.05
Mauritania	34.4	18	-	30	-	52.4	12.38	82.4	19.46
Morocco	790.5	15	183	1,770	-	988.5	12.05	2,758.5	33.63
Oman	-	-	7	-	-	7	0.08	7	0.08
State of Palestine	0.7	4	-	-	0.2 [1]	4.7	3.38	4.9	3.38
Qatar	-	1.2	-	-	40 [2]	1.2	0.4	35.6	0.4
Saudi Arabia	-	23.2	-	-	-	23.2	0.05	23.2	0.05
Sudan	-	12	-	1,593	-	12	0.38	1,605	50.89
Tunisia	245	20	-	66	-	265	5.82	331	7.37
UAE	0	33	100	-	1 [2]	133	0.46	135	0.46
Yemen	-	3	-	-	-	3	0.2	3	0.2
Arab Region	**2,023.1**	**544.7**	**335**	**11,000**	**44.7**	**2,947.5**	**1.27%**	**13,948**	**6%**

1 Including hydro

2 Electricity generation

Table 3: Renewable energy targets in the Arab region

	Renewable Energy Targets							
	Wind	PV	CSP	Biomass	Geothermal	Total		Target Date
	MW	MW	MW	MW	MW	MW	%	
Algeria	1,010	3,000	-	360	5	4,375	15	2020
	5,010	13,575	2,000	1,000	15	21,600	37[3] /27[2]	2030
Bahrain	-	-	-	-	-	250	5[3]	2030
Djibouti	300	200		-	500	1,000	100[2]	2025
Egypt	7,200	2,300 +	-	-	-	9,500	20[2]	2022
Iraq	-	300	-	-	-	300	1[2]	2020
Jordan	800	800	100	50	-	1,750	10[4]	2020
Kuwait	700	4,600	5,700	-	-	11,000	15[2]	2030
Lebanon	400	150-100		-	-		12[2]	2020
Libya	600	344	125	-	-	1,069	7[2]	2020
	1,000	844	375	-	-	2,219	10[2]	2025
Mauritania	30	30	-	-	-	60	20[2]	2020
Morocco	2,000	2,000		-	-	6,000[6]	42[3]	2020
	4,200	4,560		-	-	10,090	52[3]	2030
State of Palestine	44	45	20	21	-	130	10[2]	2020
Qatar	-	-	-	-	-	1,800	20[3]	2030
Saudi Arabia	9,000	16,000	25,000	3,000[7]	1,000	54,000	30[3]	2040
Sudan	680	667	50	68	54	1,582[8]	11[3]	2020
	1,000	1,000	100	-	-	~2,100	20[2]	2030
Syrian Arab Republic	1,000	2,000	1,300	250	-	4,550	30	2030
Tunisia	1,755	1,510	460	-	-	3,725	30[3]	2030
UAE – Abu Dhab	-	-	-	-	-	-	7[3]	2020
UAE – Dubai	-	5,000	-	-	-	5,000	25[2]	2030
Yemen	400	8.25	100	6	200	714.25	15[3]	2025

1 Including hydro 2 Electricity generation 3 Installed capacity 4 Primary energy 5 Including 400 MW hydro
6 Including 2,000 MW hydro 7 Waste to energy 8 Including additional 63 MW hydro

Between 2010 and 2016, the average cost of the electricity produced from RE has fallen on average by 60 per cent for solar energy, 20 per cent for wind energy and 19 per cent for the thermodynamic solar. These advances are induced globally by new strategies implemented by several countries, including southern countries such as China, and by the need to challenge climate change issues following the Paris Agreement in 2015. The decreasing costs have been driven by continuous innovation and technological improvement, including larger wind turbines and more efficient solar PV modules.

MENA Countries adoption of RE is timely since they are benefitting from these scientific advances and important R&D investments. R&D spillovers are benefitting the region and a local capacity in matter of innovation in RE is already operational in some countries. Most of MENA Countries are acquiring the most efficient available technologies nowadays at a low price compared to previous technologies. At the same time, we need to mention that innovation and R&D in this sector is increasing very fast.

MENA Countries are urged also to reduce their CO2 emissions in the context of global warming and the Paris Agreement. The 2015 United Nations Climate Change Conference, known as the Paris COP 21 agreement, reinforces the importance of renewable energy and energy efficiency as the prime vehicles to tackle the enormous challenge of climate change. There is a consensus that shifting to renewable energy supply achieves various benefits regardless of location. Investment in renewable energy is one of the most viable options in reducing the carbon footprint. Promoting renewable energy should be the nucleus of any energy policy that aims at mitigating the carbon footprint and tackling the economic growth and environmental sustainability paradox. In this context, MENA countries have been urged to reduce their carbon emissions.

This research seeks to provide an updated analysis of the MENA Countries strategies with regard to renewable energies and characterize needs and potential cooperation between MENA countries, specifically with regards to innovation and R&D in the field. This study contributes to the knowledge of what determines renewable energy demand by analyzing the contribution of financial development, international trade, oil price, CO2 emissions to renewable energy demand, with a focus on the MENA countries. A deeper understanding of the determinants of renewable energy consumption in MENA countries is of great importance. In fact, increased concern over the issues related to energy security, climate change, and global warming suggest that there will be a more considerable reliance on the demand of renewable energy in the near future. According to the International Energy Agency (IEA) (2006) report, renewable energy is projected to be the fastest-growing energy source between now and 2030.

Our methodology is to proceed in two stages. During the first stage, we develop an econometric model in order to examine the macro-level determinants of renewable energy demand in MENA countries. The empirical model that we develop in this study is consistent with the broader literature on the determinants of renewable energy consumption and takes the following form:

$$RE = f\left(CO_2, ROP, \mathrm{Y}, \mathrm{TO}, \mathrm{FD}\right)$$

where *RE* represents the renewable energy consumption and is a function of four variables including CO_2 emissions (*CO_2*), real oil prices *(ROP)*, per capita GDP (*Y*), trade openness (*TO*), and financial development (FD).

During the second stage, we develop four case studies (Algeria, Bahrain, Morocco and Tunisia) based on interviews and questionnaires in order to deepen our understanding of current trend of adoption of RE in MENA Countries. We stress the barriers of adoption of RE and the main lesson learnt from these experiences that may benefit the rest of the MENA Countries and the Southern countries in general. Possible fields of South-South cooperation are also stressed.

A special focus is made on the "technological absorptive capacity" of MENA Countries with regard to renewable energies by examining whether Science, Technology and Innovation policies frameworks and strategies take into account renewable energies.

2. LITERATURE REVIEW

Based on the existing energy economics literature, determinants of renewable energy demand can be grouped under five major headings: economic growth, environmental degradation, oil prices, international trade, and financial development (see e.g., Sadorsky, 2009a,b, Brunnschweiler, 2010; Salim and Shafiq, 2012; Omri et al. 2015a ; and Kim and Park, 2016). This section reviews the existing studies that discuss the relationship between these five variables and renewable energy demand.

Economic growth and renewable energy consumption

There exists a considerable interest in literature about the relationship between renewable energy consumption and economic growth. For instance, using ordinary least squares (OLS), fully modified least squares (FMOLS), dynamic ordinary least squares (DOLS), and Granger-causality techniques, Sadorsky (2009a) examines the growth-renewable energy use nexus for 18 selected emerging countries. He finds that there exists a causality impact running from economic growth to renewable energy consumption in the short-run. Using panel co-integration technique, Sadorsky (2009b) also examines the determinants of renewable energy consumption for the G7 countries using annual data from 1980 to 2005; their empirical findings reveal that economic growth is a major driver behind the consumption of renewable energy. They also find that an increase in economic growth by 1 per cent over the long-run increases renewable energy consumption in emerging economies by around 3.5 per cent. Similarly, using annual data from 1992 to 2007 for 13 Eurasian countries, Apergis and Payne (2010) find a feedback relationship between economic growth and renewable energy demand. The same result was found by Apergis and Payne (2011) for 6 Central American countries during the period 1980-2006. Moreover, Salim and Rafiq (2012) also investigated the determinants of renewable energy consumption in a set of six major emerging economies and found that renewable energy consumption is significantly determined by income, in the long-term. Al-Mulali et al., (2013) examine the long-term relationship between economic growth and renewable energy consumption for low-, middle-, and high-income countries. Their findings reveal that 79 percent of the countries have a positive long-run bidirectional relationship between economic growth and renewable energy consumption, while 19 percent of the countries have no relationship between variables. Using data for 11 African economies and the panel Granger causality test, Ben Aissa et al. (2014) investigated the relationship between economic growth, renewable energy consumption and trade openness. Their findings show that economic growth causes the consumption of renewable energy. Using annual data over the period 1990-2010 for 31 Organization for Economic Co-operation and Development (OECD) countries and 49 non-OECD countries, Cho et al. (2015) examine the association between economic growth and renewable energy consumption by applying a multivariate panel vector error correction model. Their findings reveal that there exists, in the long-run, a unidirectional causal relationship from economic growth to renewable energy consumption for OECD countries, and a feedback relationship between them for non-OECD countries. Moreover, Omri et al. (2015a) examine the drivers of renewable energy consumption for a panel of 64 countries, and find that per capita GDP is one of the major drivers behind renewable energy consumption.

However, some other studies also examined the relationship between economic growth and renewable energy and found no significant relationship. For instance, Chiou-Wei et al. (2008) examine the causality between both variables using linear and non-linear Granger causality tests over the period 1954-2006. They found no causality between energy consumption and economic growth for the Republic of Korea, Thailand, and the United States of America Similarly, using Total Factor Productivity (TFP) as a measure of economic activity, Tugcu and Tiwari (2016) investigated the relationship between economic growth and renewable energy for Brazil, Russia, India, China and South Africa (BRICS) countries over the period 1992-2012. They found a causal relationship between TFP growth and renewable energy consumption.

In accordance with the above discussion, we can see that most of the existing studies show that economic growth is a significant determinant of renewable energy consumption, Accordingly, we expect that a high level of economic growth leads to a high level of renewable energy demand. Hence, a positive impact of economic growth on renewable energy consumption in Arab countries is expected.

CO_2 emissions and renewable energy

Several empirical studies have investigated the effect of environmental pollution on the demand of renewable energy[1]. These researchers are unanimous in their finding that environmental pollution positively contributes to the demand of renewable energy. A potential explanation is that an increase in environmental degradation leads to an increase in the demand for environmental protection and encourages the development and use of alternative renewable energies, which are carbon emission free (Omri and Nguyen, 2014). For instance, using data for G7 countries over the period 1980-2005, Sadorsky (2009b) examines the drivers behind renewable energy consumption using the panel cointegration

1 (see e.g. Sadorsky, 2009b; Menegaki, 2011; Salim and Rafiq, 2012, Omri et al., 2015 a & b).

approach. The empirical findings show that an increase in per capita CO_2 emissions leads to increase in the demand for renewable energy. This empirical finding is similar to that of Menyah and Wolde-Rufael (2010) for the United States of America over the period 1960-2007, and that examined the causal relationship between CO2 emissions, renewable and nuclear energy consumption, and GDP, using a modified version of the Granger causality test. Sebri and Ben Salha (2014) investigated the causal relationships among economic growth, renewable energy consumption, CO_2 emissions, and trade in the BRICS countries over the period 1971-2010.

They concluded that an increase in CO_2 emissions, which is the main cause of global warming, causes policy-makers to try to reduce this greenhouse gas by taking some measures of scaling down fossil energy consumption and relying more on energy from renewable sources. Using data for 64 high-, middle-, and low-income countries over the period 1990-2011, Omri and Nguyen (2014) examined the determinants of renewable energy consumption. They also confirm the impact of CO2 emissions on the consumption of renewable energy. Using data for 17 developed and developing countries, Omri et al. (2015b) investigated the interrelationships among economic growth, renewable energy, and nuclear energy, using dynamic simultaneous-equation panel data models over the period 1990-2011. They found that CO2 emissions contribute to the demand for renewable energy in 9 out of 17 countries. However, Paweenawat and Plyngam (2017), who use data from 1986 to 2012 in order to investigate the causal relationship among renewable energy consumption, CO2 emissions, and economic growth that exists in Thailand. Their findings reveal no causal relationship between renewable energy consumption and CO2 emissions.

In light of the above discussion, we can expect an impact of CO2 emissions on renewable energy consumption in Arab countries.

Oil prices and renewable energy

In the energy-economics literature, little attention is given to the relationship between oil prices and the demand for renewable energy. Most of the fewer existing studies on the relationship between oil prices and renewable energy consumption, such as Sadrosky (2009b), Salim and Rafiq (2012); and Omri et al. (2015 a,b), among others, show that oil prices increases have a smaller although negative impact on the demand of renewable energy. According to these authors, this negative relationship may be due to the relative short sample period being studied or due to peculiarities regarding how these variables interact with short-term movements in renewable energy demand in the countries considered. However, Brini et al. (2017) examined the empirical association between oil prices, renewable energy consumption, trade, and economic growth using a bounds testing approach to co-integration and the Autoregressive-Distributed Lag (ARDL) methodology for Tunisia over the period 1980–2011. Their finding reveals that an increase in oil prices leads to an increase in the consumption of renewable energy. Similarly, using dynamic simultaneous-equation panel data models for 17 developed and developing countries, Omri et al. (2015b) find that oil prices contribute to renewable energy consumption only for eight out of 17 countries, while the effect on oil consumption is negative. So, growing oil prices should encourage households and businesses to decrease oil consumption, purchase more efficient products and switch to renewable energy sources (Economic Report of the President, 2006). Therefore, higher oil prices should reduce consumption and increase the demand for renewable energy. This theoretical prediction indicates a positive relationship between oil prices and renewable energy demand and oil prices.

As a consequence, an impact of oil prices on the demand for renewable energy is expected in the Arab countries.

Trade and renewable energy

Foreign trade can play an important role in promoting the renewable energy sector, in particular, by facilitating the technology transfer for renewable energy and by responding to demand for sustainable energy sources. This demand leads to several trade opportunities, including exports of raw materials and components for renewable energy supply products and finished products, exports of energy from renewable sources, and exports of renewable natural resources to produce energy (UNEP, 2011). So, international trade can increase the availability of goods and services that are more energy-efficient. Therefore, a higher international trade could be a good policy for combating global warming as it encourages the use of renewable energy.

Despite its importance, little attention in the existing energy economics literature has been paid to the link between international trade and renewable energy. For instance, Ben Aissa et al. (2014) examined the empirical association between renewable energy consumption, and economic growth in a sample of 11 African countries over the period 1980-2008. They concluded that African governments should boost international trade because of its positive effect on technology transfer and on output. Using both static (Pooled OLS, Panel Fixed and Random Effects) and dynamic (difference and system GMM) panel data estimation approaches, Omri et al. (2015a) also investigated the contribution of international trade to renewable energy consumption for a panel of 64 countries over the period 1990-2011. Their findings show a positive contribution of international trade to the demand of renewable energy. They also conclude that an increase in per capita GDP through a high degree of international trade could provide the countries concerned with greater financial means to develop renewable energy. Similarly, Sebri and Ben-Salha (2016) examine the empirical association between economic growth, renewable energy consumption, CO2 emissions and international trade in the BRICS countries over the period 1971–2010. Their findings reveal that international trade impacts positively on the demand for renewable energy only in cases of Brazil and India, which indicates that these two countries have benefitted from the technological transfer through international trade in order to promote the renewable energy sector. Recently, Tiba and Omri (2017) examined four-way interrelationships among renewable energy, environmental quality, international trade, and economic growth, using simultaneous-equation panel data models for 24 middle- and high-income countries over the period 1990–2011. They also confirmed the positive contribution of international trade to renewable energy consumption.

In light of this discussion, a positive impact of international trade on the demand for renewable energy in the Arab countries is expected.

Financial development and renewable energy

Therefore, it is commonplace to suppose that financial development –characterized by availability of capital for investors through financial markets and an efficient banking system– can have major impacts on the acceleration of such energy transition and sustainability of MENA Economies. The financial sector may play an important role in shaping the energy transition and enhancing sustainability in the MENA Countries.

Analyzing the role of the financial development in achieving economic performance has generated a vast literature over the past few decades. However, in this study, we focus on another important topic: the link between financial development and renewable energy demand. This missing relationship has been pointed out by several practitioners, who see the absence of a well-developed financial sector and the consequent financing difficulties as one of the most important obstacles in promoting the renewable energy projects in developing countries (e.g., Painuly and Wohlgemuth, 2006). For this reason, since the late 1990s, the United Nations Environment Programme (UNEP) has worked with the financial sector to develop innovative mechanisms for promoting sustainable energy technologies in developing countries. As part of this effort, UNEP has developed the Solar Program (PROSOL), a programme to finance the public energy bill for solar thermal systems in Tunisia. Since 2005, the PROSOL programme has been helping homes and businesses to finance more than 35,000 solar water heater systems, with five-year electricity bill payments. Public financing covers the cost of the technical evaluation and a reduced interest rate for loans. Through this programme, the market penetration of solar water heating technologies in Tunisia has reached that of Portugal, Spain, and France.

Over the past few years, many scholars have stated their concern about the specific contribution of financial development to the development of the renewable energy sector. For instance, Wohlgemuth, Painuly (2006), and Sonntag-O'Brien and Usher (2004) empirically examined the factors affecting the implementation of renewable energy technologies in developing and transitional countries and stated that the implementation process of these technologies will face serious financing issues, particularly private financing. In the same context, Kim and Park (2016) examined the impact of financial development on renewable energy technologies in the case of 30 countries over the period 2000-2013 and found that the improvement in financial sectors is a key determinant of the deployment of renewable energy. They also stated that policy-makers should design institutional mechanisms with easier access to financing projects in the renewable energy sector.

Despite the great importance of the financial sector on the development of the renewable energy sector, as evidenced by a large number of studies and reports, academic research on this topic is still lacking, in particular empirical research regarding the effect of financial development on renewable energy deployment. This study contributes to knowledge regarding what determines renewable energy demand by analyzing the contribution of financial development to renewable energy demand, with a focus on the Arab region countries. In view of the above discussion, a high level of financial development should lead to a high level of renewable energy demand. Hence, a positive impact of financial development on renewable energy consumption in the Arab region is expected.

3. METHODOLOGY

To estimate this model, we propose an empirical methodology in four steps. We first analyze the cross-sectional dependence and check the stationarity of the series. Then, we perform a co-integration test to examine the long-run dynamics of cross-sectional dependence across countries. As third step, we estimate the long-term relationships among the variables using appropriate panel long-run estimates (FMOLS and DOLS). Finally, the fourth step consists of estimating a panel VECM in order to study relationships. The data used covers a panel of 10 Arab Countries with data from the World Bank Development Indicators (WDI), BP Statistical Review of World Energy, and the U.S. Energy Information Administration (EIA) over the transition years from 1990 to 2015. Consistent with the existing literature, the dependent variable is renewable energy measured by the net geothermal, solar, wind and wood and waste electric power consumption. Explanatory variables include per capita GDP as an indicator of economic growth, CO_2 emissions in metric tons per capita, trade openness measured by total exports plus imports as a per cent of GDP, financial development measured by domestic credit provided by financial sector as a per cent of GDP, and oil prices measured, using the spot price on West Texas Intermediate (WTI) crude oil.

In light of the above discussion, we formulate the following hypotheses:

H1. The financial development and financial markets performance promote renewable energies

H2. Global financial crisis impedes the growth of renewable energies.

H3. The financial performance and renewable energy nexus is sensitive to the degree of carbon intensity.

H4. Ex-post higher growth in innovations drives the financial performance FMD and cleaner energy nexus.

H5. The link between financial development and renewable energy is weaker in countries with a higher natural resource (oil and gas) dependence.

In addition to the hypothesis formulated above, this research can also provide valuable ideas and information to answer the following questions:

- What is the role of renewable energy deployment in reducing carbon emissions in the MENA countries?
- Is there a possibility of substitution of green for non-green energy without altering the economic growth process?
- How can green energy contribute to reducing pollutant emissions and sustaining long-term economic growth?
- What is the impact of the increasing energy demand on the environmental quality in the Region?

In order to test our hypotheses, we used the data covering a panel of 10 Arab economies with data from the World Bank Development Indicators (WDI), BP Statistical Review of World Energy, and the U.S. Energy Information Administration (EIA) over the period from 1990 to 2015. Consistent with the existing literature, the dependent variable is renewable energy measured by net geothermal, solar, wind and wood and waste electric power consumption. Explanatory variables include per capita GDP as measure of economic growth, CO_2 emissions in metric tons per capita, trade openness measured by total exports plus imports as a per cent of GDP, financial development measured by domestic credit provided by financial sector as a per cent of GDP, and oil prices measured using the oil price on West Texas Intermediate (WTI) crude oil (spot price). Details on the list of variables, their definitions and sources can be found in Table 4.

Table 4: Definition of the variables used in the analysis

Variable name	Signs	Description	Source
Renewable energy consumption	RE	Is total renewable electricity consumption defined in millions of kilowatt hours (kwh) as the net geothermal, solar, wind and wood and waste electric power consumption.	Energy Information Administration (EIA)
Economic growth	Y	Per capita GDP (Constant 2005, US$)	World Bank (WDI)
Oil prices	ROP	Measured using the spot price on WTI crude oil	BP Statistical Review of World Energy
CO_2 emissions per capita	CO_2	CO_2 emissions (metric tons per capita)	World Bank (WDI)
Trade openness	TO	Total of exports and imports (% of GDP)	World Bank (WDI)
Financial development	FD	Domestic credit provided by financial sector (% of GDP)	World Bank (WDI)

Notes: WDI: World Development Indicators.

4. ANALYSIS: ECONOMETRICS

Before examining the stationarity of the six variables, we will test the presence of cross-sectional dependence using the Pesaran test (2004) where the CD statistic is based on the average of the correlation coefficients between the different countries taken two by two for each period. The results provided by Table 5 clearly indicate that there is a strong presence of cross-sectional dependence for the countries in the sample considered. Accordingly, the first-generation panel unit root tests could produce biased results (Apergis and Payne, 2014) and it follows that there is a preference for implementing second-generation panel unit root tests, such as Pesaran (2007), Chudik et al. (2011).

In our study, we apply the cross-sectional augmented IPS (CIPS) test proposed by Pesaran (2007) in order to address the existence of cross-sectional dependence. As presented in Table 5, we find that all the considered variables are integrated at one order (I(1)). In this case, we may use Pedroni's (1999, 2004) panel co-integration test to test the long-term equilibrium relationships among variables. The results of this test are presented in Table 6. As can be seen in the overall sample, the seven tests allow us to conclude the existence of a co-integration relationship between the demand for renewable energies and the variables of CO_2 emissions, GDP, trade, and financial development. After confirming the existence of co-integration among the variables under consideration, we estimate the long-term coefficients in the following step using Fully Modified Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) techniques. The results of these techniques are reported in Table 7.

Table 5: Results of the panel unit root and cross-sectional dependence tests

Variables	**Pesaran CD test**		**CIPS test**			
			Level		Δ	
	CD-test	p-value	T-stat	p-value	T-stat	p-value
LnRE	6.014*	(0.000)	0.295	(0.616)	-11.668*	(0.000)
LnCO2	7.416*	(0.000)	-1.629	(0.052)	-12.732*	(0.000)
LnROP	34.205*	(0.000)	14.142	(1.000)	-14.247*	(0.000)
LnY	9.876*	(0.000)	-3.881	(0.000)	-9.003*	(0.000)
LnTO	16.152*	(0.000)	0.165	(0.566)	-7.597*	(0.000)
Ln FD	8.009*	(0.000)	3.142	(0.999)	-4.923**	(0.000)

*Notes: All panel unit root tests were performed with restricted intercept and trend for all the variables. * indicates statistical significance at the 1 per cent level.*

Table 6: Pedroni (1999, 2004) panel cointegration results

I– Pedroni (1999, 2004) panel cointegration results.

Within-dimension	t-statistics	Probability
Panel v-stat	2.329**	*(0.037)*
Panel rho-stat	–1.309*	*(0.000)*
Panel ADF-stat	–1.653*	*(0.009)*
Panel PP-stat	–0.928**	*(0.021)*
Between-dimension		
Group rho-stat	3.169*	*(0.002)*
Group ADF-stat	–5.349*	*(0.000)*
Group PP-stat	–2.791*	(0.000)

*Notes: The null hypothesis is that the variables are not co-integrated. Lag length selected based on SIC automatically with a maximum lag of 2. Lag selection: Automatic 2 lag by SIC with a maximum lag of 4. p–values are reported in brackets. The superscript * and ** denote statistical significance at the 1 per cent and 5 per cent levels, respectively.*

The parameter estimates in Table 7 of these models can be interpreted as long-term elasticities coefficients of the determinants of renewable energy consumption for the MENA countries considered in this study.

One of the first things to notice about the estimates in Table 7 is that, for each variable, the panel estimated elasticity is remarkably similar in sign and magnitude across the two estimation techniques. In the case of carbon emissions for example, a 1 per cent increase in CO2 emissions raises per capita renewable energy consumption by 0.149 per cent or 0.221 per cent according to whether the estimation technique is FMOLS or DOLS respectively. For the panel model results, the oil prices elasticities are positive, statistically significant and very similar in value across the two estimation techniques (0.275 for FMOLS estimation, 0.184 for DOLS estimation). Real oil prices seem to have a significant impact on renewable energy consumption in MENA countries. Concerning, the trade openness, the panel results show a positive and statistically significant coefficients and very similar value across the two estimations (0.310 for FMOLS estimation, 0.410 for DOLS estimation). However, the panel estimated elasticity for financial development is positive and statistically significant with the FMOLS technique and statistically non-significant using the DOLS technique.

Looking for the different determinants for each county, firstly we can notice that the effect of the carbon emissions on renewable energy consumption, except in Egypt and Algeria, is statistically significant and positive, at the 1 per cent and 5 per cent levels, for all the countries considered. The coefficients' magnitude ranges from 0. 0.114 to 0.414, which implies that a 1 per cent increase in the per capita CO2 emissions increases the per capita renewable energy consumption of MENA countries from 0. 0.114 per cent to 0.414 per cent, respectively. This result is in line with the findings of Omri and Nguyen (2014). This long-term finding coincides with the conclusions in Omri and Nguyen (2014) that for some selected low-income countries, the level of carbon emissions contributes to renewable energy consumption. In addition, based on an empirical study for the G7 countries, Sadorsky (2009) highlighted mixed elasticities of per capita carbon emissions. The numerical values range from a low of 3.430 (Canada) to a high of 27.540 (United Kingdom). Increases in per capita CO2 increase renewable energy consumption in France and the United Kingdom but reduce renewable energy consumption in Japan.

Concerning the oil prices variable, the findings indicate that oil prices have positive and statistically significant effects on renewable energy consumption at the 1 per cent and 5 per cent level. The results suggest that oil prices are a significant determinant of the renewable energy consumption in the MENA countries. This confirms the previous claim that crude oil as the major source of energy is a substitute for renewable energy, and therefore a volatile international oil price may influence the economic incentive for making technological progress towards a green energy since the industries that use fossil fuels as their source of energy benefit from a stable energy price. Sadorsky (2009) argued that the oil price elasticities for the G7 countries are mixed, with positive and significant values observed for France, Germany, and Italy but negative and significant values observed for the United Kingdom and the United States of America.

Table 7 also shows that the per capita GDP has a significant positive impact on renewable energy consumption in the MENA countries. This suggests that economic growth is an important determinant of renewable energy consumption in the MENA countries. This finding suggests that rising incomes lead to more disposable income, which can be used to develop environmental-friendly technology and energies. The trade openness is found to have a statistically significant and positive effect on the renewable energy consumption in the MENA countries, except for Iraq and Saudi Arabia. It is largely admitted in the literature that greater trade openness could be a good policy for combating global warming as it permits the rapid spread and exchange of green goods, services and renewable technologies around the world (Omri and Nguyen, 2014).

Finally, our findings show that financial development has a significant and positive effect on renewable energy consumption in the MENA countries**.** This finding suggests that financial development significantly promote renewable energy in the MENA region in the long-term. This finding is in line with the results of the previous research. These long-term findings coincide with the proposition of Doytch and Narayan (2016), Hsu et al. (2014) and Frankel and Romer (1999) who document the positive role of financial development in promoting innovations. These results also reciprocate the findings of Fangmin and Zhou (2011). The finding of a positive and significant coefficient for the financial market development also supports a recent policy argument of EIA (2015), which asserts that the elimination of financial barriers to the flow of funds is a prerequisite for spurring the growth of renewable energy.

Table 7: FMOLS and DOLS long-run estimates

	Dependent variable: Renewable energy demand					
	Constant	CO2	ROP	Y	TO	FD
FMOLS results						
Algeria	0.414**	0.088	0.107	0.234*	0.217*	0.087
Egypt	0.188	-0.114	0.233**	0.103**	0.278*	0.164***
Iraq	--11.233*	0.149	-0.127	0.061	-0.104	0.115
Jordan	-1.449	0.208***	0.211*	0.257*	0.139***	0.092**
Lebanon	-5.222*	0.414*	0.179*	0.139***	0.177**	0.071
Mauritania	0.077	0.059	0.097***	0.079**	-0.118	0.042
Morocco	-0.998**	0.326*	0.276*	0.195*	0.191**	0.173**
SaudiArabia	-7.069*	0.149**	0.124***	0.181**	0.102	0.101
Tunisia	0.481	0.193**	0.233*	0.187***	0.155***	0.073
United ArabEmirates	1.099	0.224*	0.093***	0.163**	0.295**	0.174*
Panel	**-5.219***	**0.149****	**0.275***	**0.097**	**0.310***	**0.107*****
DOLS results						
Algeria	-0.119	0.154**	-0.036	0.205*	0.092***	0.103
Egypt	5.177**	0.179	0.266*	0.088	0.119	0.099
Iraq	-0.995*	0.094	0.101	0.172**	0.152	0.142
Jordan	-1.507***	0.155**	0.192*	0.147***	0.138	0.177**
Lebanon	-0.301	0.114***	0.117**	0.107	0.131***	0.094
Mauritania	-4.312*	0.109	0.181**	0.061	0.129	0.072
Morocco	-17.327*	0.139**	0.319*	0.299**	0.193*	0.196**
SaudiArabia	-8.181*	0.291*	0.124	0.159*	0.153	0.069
Tunisia	-2.319*	0.119**	0.171*	0.269*	0.182**	0.090
United ArabEmirates	0.789**	0189*	0.092	0.132*	0.116***	0.112***
Panel	**-8.011***	**0.221***	**0.184****	**0.112**	**0.410***	**-0.078**

*Notes: All variables in natural logs. Significance levels: * (1%), **(5%), and*** (10%).*

In order to deepen our investigation, we propose to focus on five countries and examine their specific situation in order to stress how the main determinants have been working and also to discuss the best practices.

5. CASE STUDIES

This section provides an examination of the Renewable Energies adoption and evolution in four Arab Countries in order to deepen our understanding and to stress the diversity of the situations facing the countries in the MENA region. We will focus on two countries facing scarcity in matter of oil and gas (Morocco and Tunisia) and two countries with more abundant resources of standard source of energies (Bahrain and Algeria). All the mentioned countries are engaged in an important change of their electricity markets and by virtue of adopting renewable energies. However, they are following different paths and using different political and regulatory frameworks.

As table 8 shows, the MENA Countries are using a diversity of mechanisms and policies in their energy transition and adoption of renewable energies. There are at least four policies (instruments) used for the implementation of renewable energy markets in the MENA countries namely: Competitive Bidding[2], Direct Proposal Submission[3], Feed-in-Tariff (FiT)[4] and Netmetering[5]. As the Table shows, while some countries such as Jordan and Egypt are using all these instruments and policies, in Algeria only Fit is used nowadays.

Table 8: Policies promoting renewable energy in the Arab region

	Competitive Bidding	Direct Proposal Submission	FiT	Net Metering
Algeria			✓	
Egypt	✓	✓	✓	✓
Jordan	✓	✓	✓	✓

2 Competitive bidding is a process of issuing a public bid with the intent that companies will put together their best proposals and compete for a specific project.

3 Direct proposal scheme: Under this scheme, developers are responsible for acquiring the development assets by themselves and guaranteed a tariff for the power they produce.

4 Feed-in tariff (FiT) scheme provides a guaranteed premium price to the green electricity producer and places an obligation on the grid operators to purchase the generated electricity output

5 Net metering is an electricity policy which allows utility customers to offset some or all of their electricity use with self-produced electricity from the RES-E system.

Kuwait	✓			
Lebanon	✓			✓
Morocco	✓			✓
Oman	✓			
State of Palestine	✓		✓	✓
Syrian Arabic Republic	✓		✓	✓
Tunisia				✓
United Arab Emirates	✓			✓
Yemen				

5.1 The Case of Tunisia

In this paragraph, we will discuss the prospect of Renewable Energies in Tunisia. We will restrict our analysis to Wind and Solar energies. While opportunities exist already in bio-energy resources, hydro-electrical resources, biomass and geothermal, their actual share is close to 1 per cent. We will start by discussing the context; then we will present the drivers of adoption of RE in Tunisia, before analyzing the strategies and the institutional design adopted, challenges, and the main lessons for the other southern countries.

5.1.1 The context

Tunisia was among the earlier adopters of Renewable energies in the early 1970s. Several pilot projects were implemented, and technological centers devoted to clean and renewable energies were put in place. The Solar Program (PROSOL), launched in 2005, is a joint programme between the Tunisian National Agency for Energy conservation, State-Utility STEG (Tunisian Company of Electricity and Gas) and the Italian Ministry for Environment, Land and Sea. The programme aims to finance the public energy bill for solar thermal systems in Tunisia and has been helping homes and businesses to finance more than 50,000 solar water heater systems for Tunisian families, with five-year electricity bill payments. Public financing covers the cost of the technical evaluation and a reduced interest rate for loans. Through this programme, the market penetration of solar water heating technologies in Tunisia has reached that of Portugal, Spain, and France.

Despite the fact that Tunisia was an earlier adopter of Renewable Energies and has set in place agencies for the RE and energy efficiency, the total share of RE on the total electricity supply is still very low. In 2018, only 4.9 per cent of the total electricity came from RE (UNDP, 2018). Three main explanations can be provided for this low penetration rate. Firstly, until the year 2000, Tunisia was with a positive energy balance and covered most of its needs. Since then there has been no urgency to change the situation. Secondly, Tunisia has strongly invested in Energy Efficiency programmes, making it less necessary to show initiative in the variation of the energy mix and adoption of renewable energy low. Thirdly, the Renewable energies were not high on the agenda of the previous regime (before the 2011 civilian uprising) and the regulatory framework was unclear for investors.

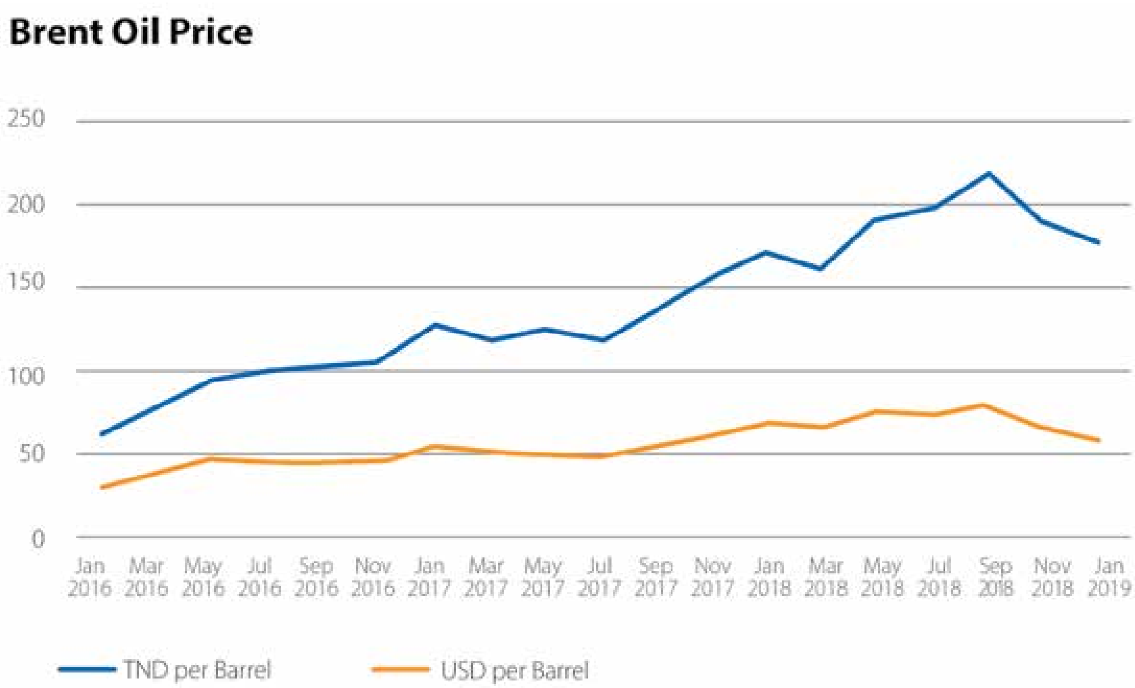
In 2011, Tunisia has changed its political regime and institutions after the civil uprising. Sustainable development became one of the main objectives of the new constitution of 2014 and new regulations for renewable energies were adopted (adoption of Energy Transition fund in 2014, the Renewable Energy Act in 2015…). Solar and Wind energies were considered as an intrinsic part of national wealth that needed to be well managed (like oil, gas and mining). At the same time, since 2000 the volatility of oil price has become very high, implying a change at the policy level. Wind and Solar PV provide the opportunity to improve Tunisia's energy security, to address growing demand, and ultimately to become a future power-export industry.

Extensive institutional and regulatory changes have been adopted in Tunisia since 2011 in order to foster investment in the renewable energy sector. In 2014, Tunisia adopted an Energy Transition Fund (RTE). The aim of this fund is to promote the decarbonization of the economy and to promote renewable energies. At the same time in 2015, a new law was adopted regarding renewable energy production for the electricity market. This law is among the most important decisions of the mandate of the national constitutional assembly (the first assembly after the 2011 revolution) states D. MANAI (Deputy between 2011-2014).

5.1.2 The determinants of adoption of RE in Tunisia

In the case of Tunisia, oil price is one of the main determinants in the decision to invest in renewable energies. Tunisia is characterized by a situation where we observe an increasing energy deficit. In 2017, the deficit was equal to 49 per cent of its needs. Securing the provision of energy and lowering the external deficit balance were at the heart of the new energy sector strategy. The electricity capacity at the end of 2015 was 5695 MW and is expected to sharply increase to 7500 MW by 2021 in order to meet the rising power demands of the industrial and domestic sectors. Provision of electricity in Tunisia mostly depends on gas importation from Algeria and there is the urgent need to diversify its sources of energy. Since the energy sector is intensively subsidized, local consumption does not depend on prices. Consumers do not pay the effective price.

Figure 1: Evolution of the oil price in Tunisia



The second important factor is the climate change agreements and the signing of the Paris Agreement in 2015. Tunisia has undertaken a commitment to decrease its CO2 emissions by 41 per cent in 2030**.** In order to meet this target, Tunisia needs to increase the share of Renewable energies in its electricity market to 30 per cent by 2030. While Tunisia will decrease its level of emissions by 13 per cent by its own means, the country needs international funding in order to decrease the remaining 28 per cent. This is expected to be financed by the Green Climate Funds (GCF) and other International donors. Since the signature of the Paris Agreement, Tunisia has accelerated its plans with regard to renewable energy.

The third important factor is the fact that the electricity sector is highly concentrated in Tunisia and there is a need to deconcentrate it. The power sector in Tunisia is characterized by the dominance of the only power state utility (STEG). Even for Renewable Energies, mainly STEG-owned projects account for 4.9 per cent of total electricity generation in 2018. The company is the main producer (91 per cent of electricity supply), the main distributor and is in charge of the Grid. The main source for the generation of electricity is gas (mainly imported from Algeria). The power sector is characterized by substantial subsidies in form of non-cost reflective tariffs and subsidized gad input prices.

5.1.3 National Strategies and Institutional Design

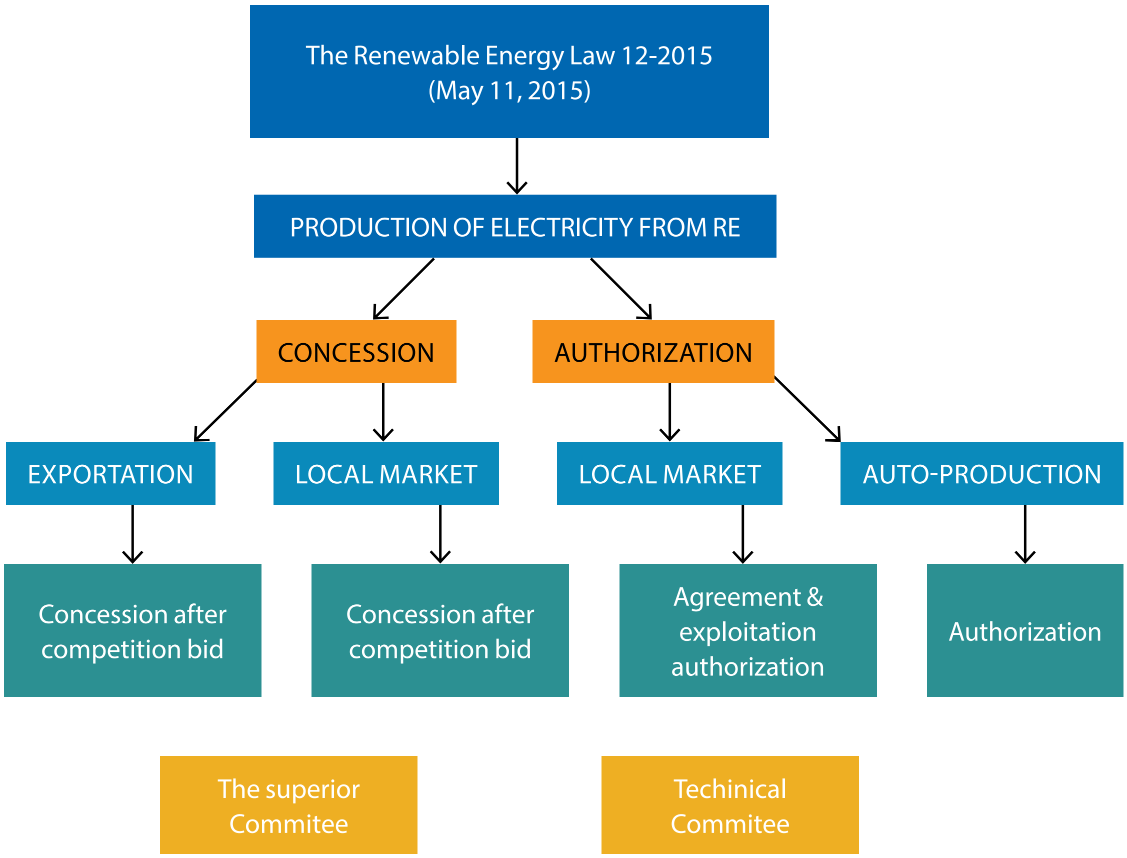
Tunisia's Solar Plan (TSP) was adopted in order to operationalize the 2015 Act. The solar plan objective is to reach 12 per cent of RE in the share of electricity sources by 2020 and 30 per cent in 2030. In order to reach the objective of 12 per cent in 2020, in December 2016, the Tunisian government adopted a plan for the period 2017-2022 that aimed to install a capacity of 1800 MW of RE. The plan is composed of four pillars: 1000 MW under the concession regime, 210 MW under the authorization regime, 210 MW under the auto-production regime and 380 MW by the national company (STEG).

The new law has defined the scenario and how the future electricity market from RE can work. While the new institutional design seems theoretically well organized, it will be challenged in practice. On the one hand, several actors with opposite or different interests are involved in the RE electricity market and one need to observe how they will behave (the public utility STEG, the Unions, Private Firms, NGOs and Public administrations like the ANME). On the other hand, one needs to examine how the administration and public authorities will manage this complex market design.

A first call for proposals and tenders was launched in 2016**.** Based on the results of this first call for proposals, the actors agreed that there is a need for deep change in mechanisms and market design. Several inconsistencies and problems emerged.

The results and the outcomes of the Tunisia's Solar Plan (TSP) were unsatisfactory**.** Several problems were pointed to by all the actors in the market, including the regulatory framework, administrative procedures, and financial and technical problems. The most important problem was the re-purchase tariff (PPA). A new plan was adopted entitled "accelerating the renewable energies projects in Tunisia" during March 2018 in order to solve the problems and accelerate the adoption of RE in Tunisia. A new action plan seeks to unlock the forces behind weak progress. The new action plan contains six domains: concession regime, authorization regime, auto production, financing the Solar plan, the structure of the governance of the Solar plan and land property. This plan was adopted by the Council of Ministers on 28 February 2018.

Figure 2: The structure of the RE electricity market in Tunisia

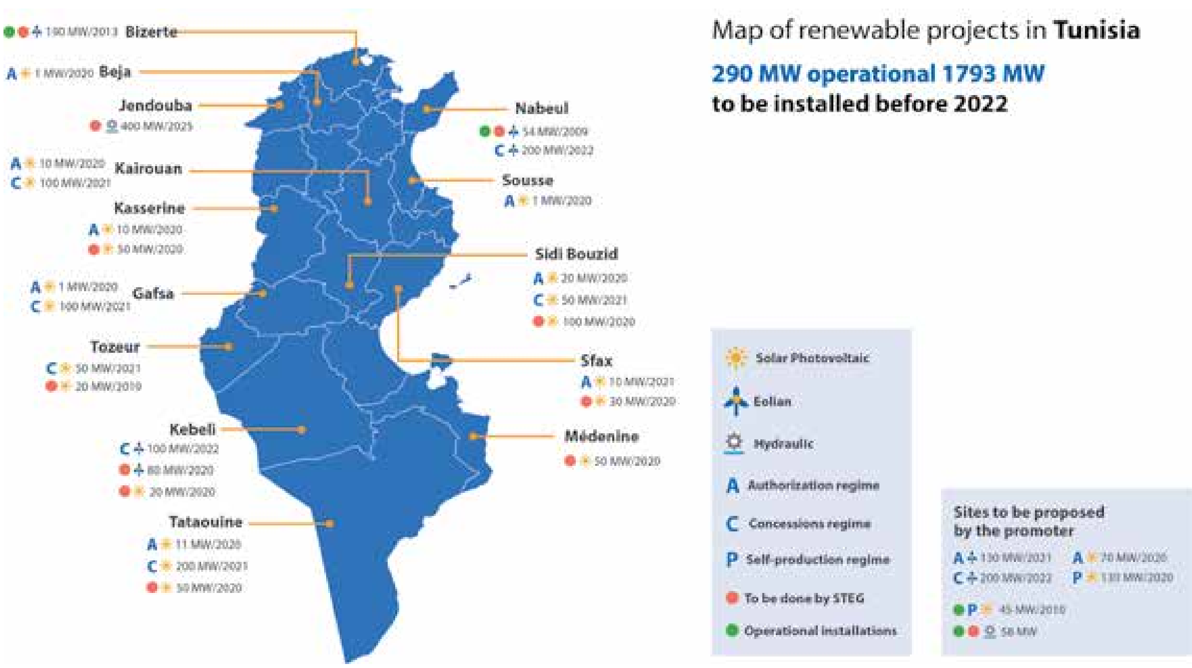


The concession model was upgraded and instead of realizing 200 MW the government seeks to realize 1000 MW by 2020. Several concession projects are expected to be launched in Wind and PV. Some projects previously planned during the period 2021-2025 will be launched (500 MW instead of 100 MW for PV and 300 MW instead of 200 MW for Wind). Currently, 16 bidders are prequalified. The increase of the capacity for the concessions was highly recommended in order to decrease transaction costs and ultimately the price of the kWh proposed by the concessionaires. The main problem faced in this area was securing the needed land and launching the tenders. Moreover, a simplification of the administrative procedures in order to accelerate the execution of the programme is needed. The technical committees are already in place nowadays.

The authorization model was subject to the revision of the law and the decree of February 9, 2017. The renewable energy re-purchase tariff (PPA) and the modalities of the authorization need to be changed. The experience has evidenced that for the authorization regime the administrative procedures were complex, thereby increasing costs and delaying activities for the investors. Consequently, there is a need to simplify the criteria, standardize the required documents, change the manual of procedures and have in place special procedures for small projects. With the current prices (PPAs), most of the investors cannot guarantee the return on investment and their investments are not profitable. Their business model is based on a re-purchase tariff (PPA) higher than that proposed by the national authorities.

For production for self-consumption, five main actions were taken in order to foster its adoption: simplification of the procedures and elaboration of a guide of procedure for auto-producers, revision of the repurchase tariff, revision of the system of accounting and pricing, possible associations between auto-producers and the private sector (especially in the case of producers of cement), conception a specific PV social programme for households with low revenues. Initially, the regime of auto-production consists of offering the possibility for every client to produce their own electricity needs from renewable energies. This regime exists pursuant to the 2009 act and was extended by the 2015 act to municipalities and public establishments. The producer can use the grid to transport its electricity produced from the production site to the consumption sites. The 2015 law added a disposition by which every households can produce for its own consumption. RE and the National Utility (STEG) can also purchase up to 30 per cent of the self-production if there is a surplus in the production of the electricity by the household. Such a step was introduced in order to incentivize more and more people to invest in RE for self-consumption.

Figure 3: RE projects in TUNISIA



Finally, the financing of the Tunisia's Solar Plan has been revised. Four actions were taken. Firstly, a capacity-building programme for the financial sector is needed in Tunisia in order to better understand the needs for this specific market. Secondly, there is a need to restructure the Energy transition fund. Thirdly, the publication of a manual for the access to RE and their advantages for investors is called for. Fourthly, preparing a pipeline of project for the Green Climate Fund (GCF) is necessary.

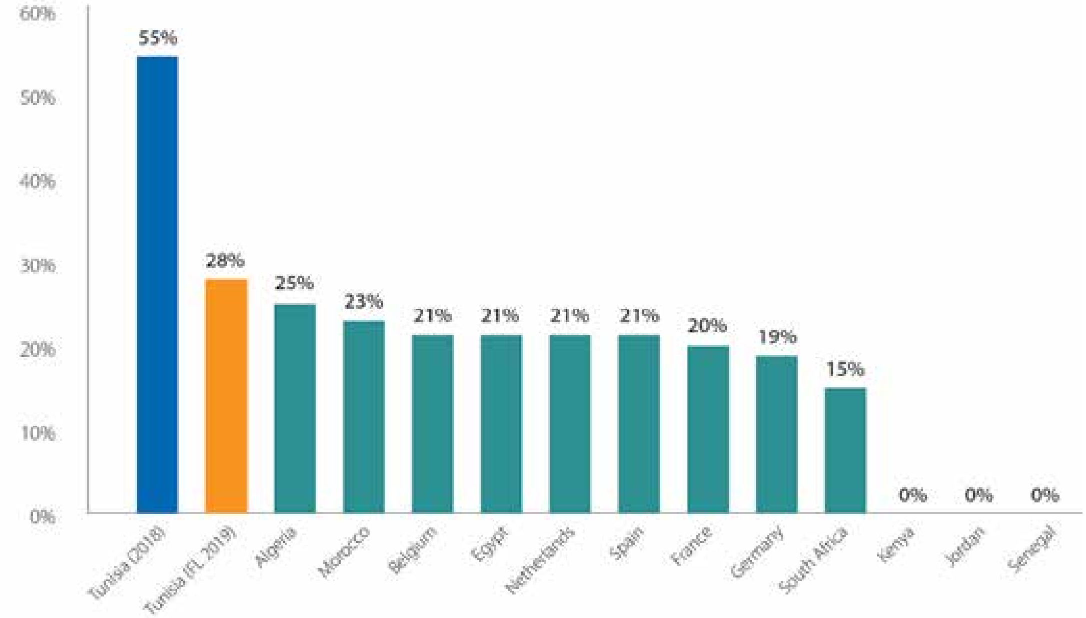
5.1.4. The challenges of the Tunisian RE sector

The interconnexion with Italy can foster investment in renewable energies in Tunisia. Given the proximity of Tunisia to Europe (Italy), connecting the Tunisian Grid with the European one can increase investment in renewable energies. The interconnexion can increase the capacity to manage the "surplus" and to import/export. The project of interconnexion is not a new project. It was mentioned several times in the discussions between the European Union and Tunisia. The total cost of the investment needed is estimated at 600 million euros. The project is technically feasible, but Tunisia is facing important problems with regard to funding it. Without a grant from the European Union, the project may not materialize. Cost benefits were sent to the European Commission and the project needs the support of at least three members countries in order to be eligible to "The Connecting European Facility", which may invest 50 per cent of the amount necessary. While feasibility studies started, it seems the project has not yet been approved by the European Commission.

While Tunisia has built a new institutional setting in favor of renewable energies, the risk associated with renewable market investment is still very considerable. Financing costs are still high in Tunisia. A recent study shows that the cost of equity in Large-scale Wind energy and solar PV in Tunisia is 17 per cent, compared with 7 per cent in Germany. The political risk accounts for 1.9 per cent and the transmission risk is 1.5 per cent. A strategy for de-risking the renewable energy investment is needed in order to meet the objective. "Tunisia market risk, transmission risk, counterparty risk and political risk contribute most to higher financing costs (UNDP, 2018)".

Most of the solar panels needed for the renewable energy market are imported from abroad (especially from China). Previously, the external tariff imposed by Tunisia on solar panels was very high at around 55 per cent of the total cost. This tariff was prohibitive and increases the total cost for any project (especially for the households). This was an important barrier for RE sector expansion and for faster adoption by households. Recently the government has cut this tariff by nearly half (from 55 per cent to 28 per cent) and it is now comparable to the average of most southern countries tariffs as figure 4 shows.

Figure 4: Tax imposed on solar panels



5.1.5 Lessons learnt from the Tunisian RE sector

Tunisia is an interesting case study for renewable energies diffusion. In the MENA Countries, Tunisia is an exception with poor endowment in matter of oil and gas. The recent progress was possible thanks to a change in the institutional and legal frameworks. The adoption of a new law dedicated to renewable energies has promoted investment. At the same time, Tunisia is a case in point of the real need for an institutional learning-by-doing. A revision of the law, decrees and strategic plans is needed in order to resolve problems. With regard to Renewable Energies, several unexpected problems may arise and there is a need for constant change in order to meet targets. For instance, one lesson learnt is that regulators need a deep understanding of the business model of investors in order to sustain their activities. Given the initial announcement of tenders and projects, a revision of the repurchase tariff (PPAs), deep change in the procedures and the need to deal seriously with the raising risk in this sector, a de-risking strategy is needed.

Tunisia has built a critical mass of skills for Renewable Energies over the last years. More than 10 Universities and Engineering Schools are delivering degrees on Renewable energies. Tunisia is building its own skills vis-a-vis Renewable energies. However, due to a narrow market, most of these educational skills are not employed in the Renewable Energy sector or are used abroad. The list include the following institutes and faculties: Higher Institute of Sciences and Environmental Technologies of Borj Cédria (BA in Energy and Master in Renewable Energies), National School of Engineers of Tunis (Master in Electric Systems "Solar PV, Solar Thermal, Wind, Hydraulic"), Higher Institute of Sciences and Energy Technologies of Gafsa (Applied Licence in Energy Systems/ Maintenance of Energy Systems / Renewable Energies and Environment), National School of Engineers of Sfax (Master of research in electrical conversion and renewable energies),Higher Institute of Biotechnologies of Sfax (Master in Renewable Energies), National School of Engineers of Monastir (National diploma of Genie of energy: option renewable energies and environment), Higher Institute of Technological Studies (Master of Electrotechnics applied to renewable energies systems, Higher Institute of Technology of Hammam Sousse (Applied BA in Renewable Energies), Higher Institute of Applied Mathematics and Computer Sciences of Kairouan (in cooperation with Germany), Higher Institute of Polytechnics in Tunis (Private) (Professional Master in Renewable energies and Energy Efficiency).

From the perspective of South-south cooperation in the renewable energy market, the case of Tunisia is instructive in three ways. Firstly, Tunisia will need to develop better interconnection with Libya and Algeria. This is key for the future steps of its Solar Plan. Without these interconnections, the efficacy and efficiency of the system will be very weak. As the Renewable energies share increases, the randomness of the system increases. Having an inter-connection with neighboring countries gives flexibility and ensures that the country can provide the other countries with its surplus of electricity production and can import when needed. Secondly, Tunisia has built a critical mass of skills in this field. These skills are fully operational and can be used in other countries. Several competencies from Tunisia are in deployed nowadays in Djibouti, Morocco or Algeria. Tunisia has more skills than its own needs with regard to Renewable energies. South-South cooperation is essential by establishing bilateral and multilateral agreement for free mobility for those skilled workers. Thirdly, there is also a room for south-south cooperation vis-a-vis private sector involvement. Southern firms and investors are expected to play a key role in the next stages of the tenders launched by the Tunisian authorities. Weaknesses of the Tunisian financial market may be compensated by bilateral funding from renewable energies plans. Saudi Arabia through its Saudi Development Bank is playing a key role in the financing of the classical plants of electricity generation in Tunisia and other southern countries may become key players in the Tunisian renewable energy market. Several power plants were funded by the Saudi Development Bank and Saudi Arabia may also be interested in funding the Energy Transition in Tunisia.

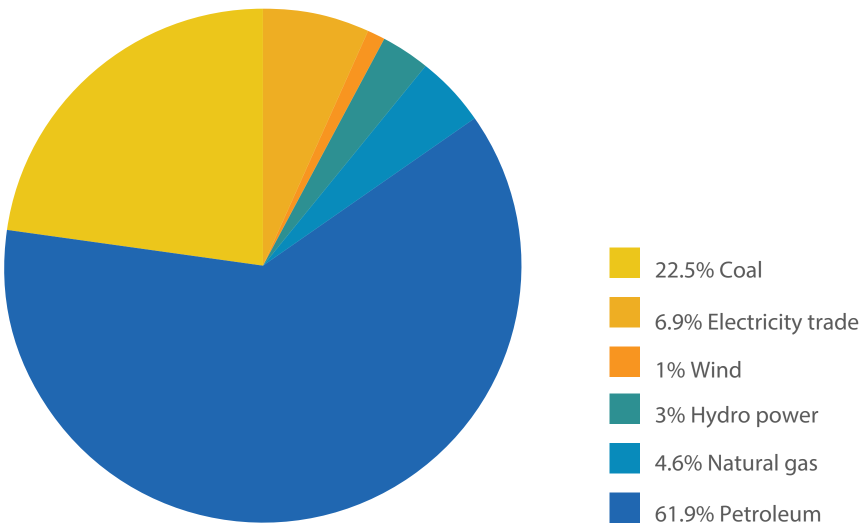
5.2 The Case of Morocco

Morocco lights the way for North African countries in the field of renewable energy. Like many other MENA countries, Morocco has pronounced ambitious renewable energy targets, defining future shares of "green" energy in their national generation mix. Up to now, Morocco represents one of the largest potential markets for renewable energy across the MENA region.

5.2.1 The determinants of adoption of RE in Morocco

The main reason behind Morocco's pushing for renewable energy sources is its dependence on energy imports, representing about 96 per cent of its total energy needs. It is worth noting, that fossil fuel reserves in Morocco are rather limited and that the country is almost entirely reliant on imports. As we can see from Fig. 5, petroleum represents about 62 per cent of the global national energy consumption in Morocco.

Figure 5: Energy consumption distribution in Morocco (source: Brand and Zingerle, 2011)



The second driver is related to the additional steady increase of electricity consumption (8 per cent per year), rising fossil fuels prices, and growing population, which seriously aggravates the country's trade deficit. This context has provided the Kingdom with the impetus to harness renewable energy on a large scale and emerge as a stable leader for renewable project investment in the region.

The energy demand in Morocco has risen on average by about 5 per cent per year over the past five years and is expected to increase by 7–8.5 per cent per year in the next decade. This increasing demand needs to be satisfied.

5.2.2 National Strategies and Institutional Design

A national energy strategy was launched in 2009 based upon two main pillars: renewable energy and energy efficiency improvement. The main purpose of this plan is to spur renewable energy production to reach 20 per cent of the Morocco's domestic energy demand and improve energy efficiency level to reduce energy demand by 12 per cent in 2020 and 15 per cent in 2030. This strategy was spearheaded by the Moroccan Renewable Energy Agency (MASEN), which later became the Moroccan Agency of Sustainable Energy (MASE).

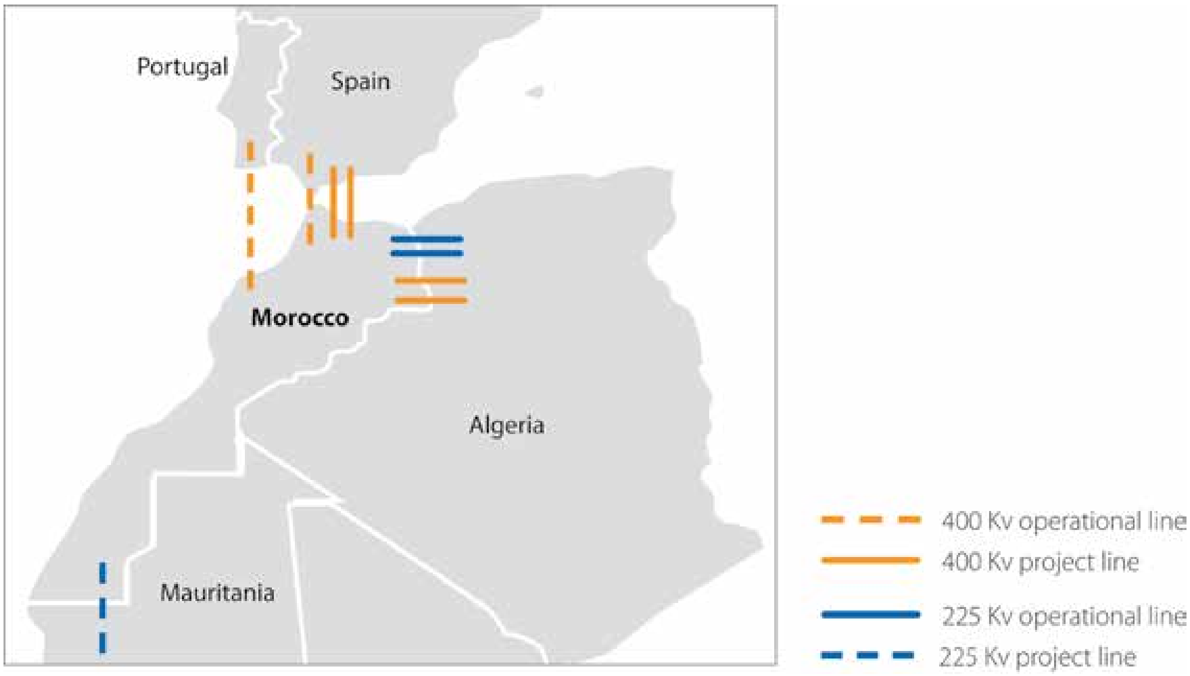
Among MENA countries, Morocco has one of the most ambitious renewable energy targets. The plan expects to provide more than 42 per cent of the Moroccan's energy demand from renewable sources (Solar, hydroelectric and wind) by 2020 and 52 per cent of electric energy demand by 2030, equivalent to about 4560 MW from solar, 4200 MW from wind, and 3100 MW from hydropower. The Moroccan's National Energy Strategy (NES) goals, linked to the National Priority Action Plan (PNAP, 2009/2015), are described in the table 9 below. This ambitious target seems feasible, because Morocco counts on a huge solar and wind power potential, thanks to its strategic geographical position in the heart of the Euro-Mediterranean energy hub.

Table 9: Morocco's National Energy Strategy (NES) goals

	Components	Objectives
1	**ELECTRICITY SUPPLY**	Increase the total installed capacity of RE in the electricity sector to 42% and to 52% by 2050 (up from 34%)
2	**ENERGY DEMAND**	Provide 10-12% of the primary energy demand by 2020 and 15-20% by 2030 with renewable energy sources.
3	**ENERGY EFFICIENCY**	Achieve 12% energy reduction by 2020 and 15% by 2030, and reduce CO2 emissions in the transport sector by 35%.

One of the main strengths of the Morocco renewable energy programme is the available interconnections with neighboring countries, providing security and reliability of the supply, and which contribute to the stability of the system. Figure 6 displays the existing and the ongoing interconnections projects with neighboring countries.

Figure 6: Existing and ongoing energy interconnection projects with neighboring countries



Source: Azeroual et al., 2018

The Center for the Development of Renewable Energy (CDER) created in 1982, renamed as ADEREE in 2011 (Agence Nationale pour le Développement des Energies Renouvelables et de l'Efficacité Energétique) made major efforts to characterize and identify the country renewable energy sources. Data collected by the agency during this period affirms that Morocco is endowed with a huge potential of solar resources and excellent wind energy potential in several regions (See Fig. 6).

Morocco's National Plan of Priority Actions focuses on four strategic priorities:

- Security of supply with diversification of fuel origin and types.
- Access to energy for all segments of society at competitive prices.
- The promotion of renewable energy and energy efficiency.
- Regional energy integration in the Euro-Mediterranean markets.

The main objective of the National energy strategy of Morocco is fourfold:

- Securing an energy supply, mainly by reducing the dependence on fossil fuels imports by improving renewable energy production, from 96 per cent in 2015 to 82 per cent by 2030, and increasing the exploration of conventional energy sources.
- Monitoring energy demand, especially by improving energy efficiency levels.
- Expanding access to energy for all the population at competitive and affordable prices
- Improving the quality of the environment.

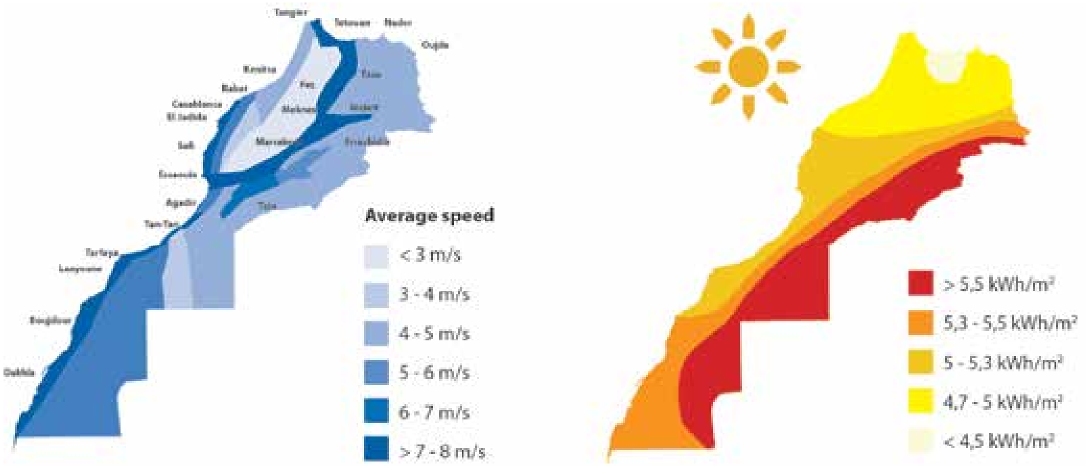
With its national adoption of a renewable energy plan, the Moroccan Government has made a huge effort to achieve its renewable energy goals. Up to now, Morocco has achieved significant progress and has taken important steps to reform the policy and regulatory framework. The main laws related to the Morocco's renewable energy strategy are summarized in the table below.

Table 10: Morocco's laws relating to the national energy strategy (Kousksou et al., 2018)[6]

Law	Objectives
Law no. 13-09 promulgated on 11 February 2010 relating to renewable energy	This law allows: (i) the opening of the generation to competition, (ii) the access to the electricity grid, (iii) the export of green electricity and (iv) the construction of a direct line for export
Law no. 57-09 creating the Moroccan Agency for Solar Energy (MASEN) setting out a specific framework for solar projects (January 14, 2010)	MASEN is considered as the most important actor for the Moroccan solar energy sector. The joint stock company, with a Board of Trustees and a Supervisory Board, is independent from the MEMEE
Law no. 47-09 relating to energy efficiency dated 29 September 2011	This law aims to increase the efficiency of energy resource consumption, to reduce energy costs on the national economy and to contribute to sustainable development
Law no. 16-09 creating the National Agency for the Promotion of Renewable Energy and Energy Conservation (ADEREE) (January 13, 2010)	This law defined the reorganization and renaming of the existing Center for the Development of Renewable Energy (CDER) [26]. The ADEREE is primarily active in the Corporate Energy Efficiency Program
Draft law on Public–Private Partnerships (PPPs)	This draft is strongly inspired by the French Ordinance of 17 June 2004 on PPPs, but also follows the approach used by the UK Private Finance Initiative experience

6 Kousksou, T., Allouhi, A., Belattar, M., Jamil, A., El Rhafiki, T., Arid, A., & Zeraouli, Y. (2015). Renewable energy potential and national policy directions for sustainable development in Morocco. Renewable and Sustainable Energy Reviews, 47, 46-57.

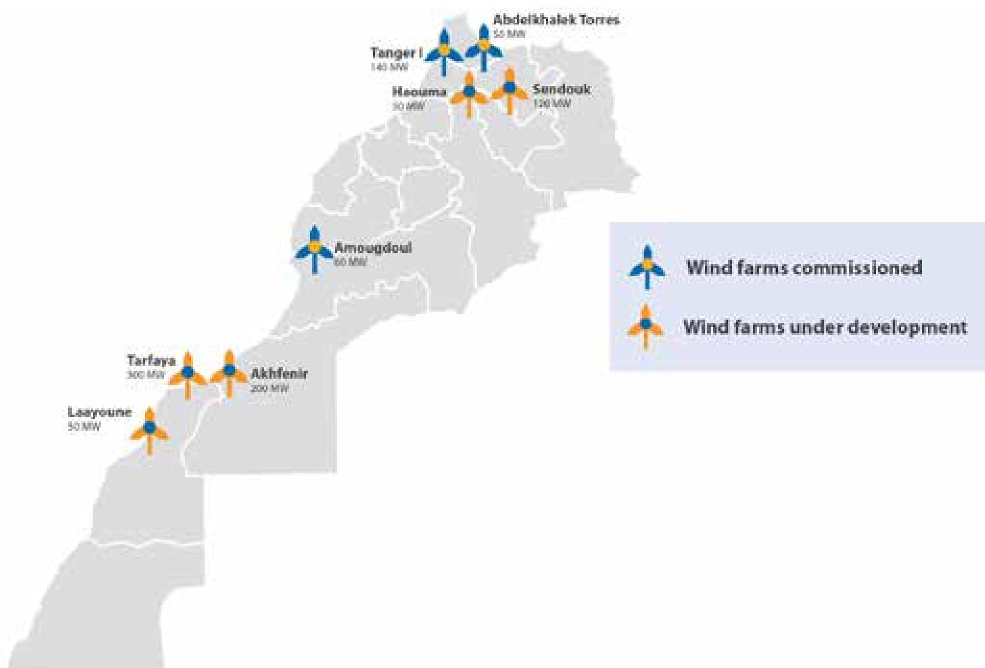
Figure 7: Wind energy and Solar energy map of Morocco



Source: Azeroual et al., 2018 and Kousksou et al. 2015

The discussed ambitious renewable energy strategy has led Morocco stakeholders to the realization of significant solar stations and wind farms. Figure 8 displays the main wind farms under development.

Figure 8: Wind farms under development in Morocco



Source: Azeroual et al., 2018

Morocco has launched an ambitious plan for the development of Solar energy projects as we can see from the figure 9 below.

Figure 9: Morocco's solar programme

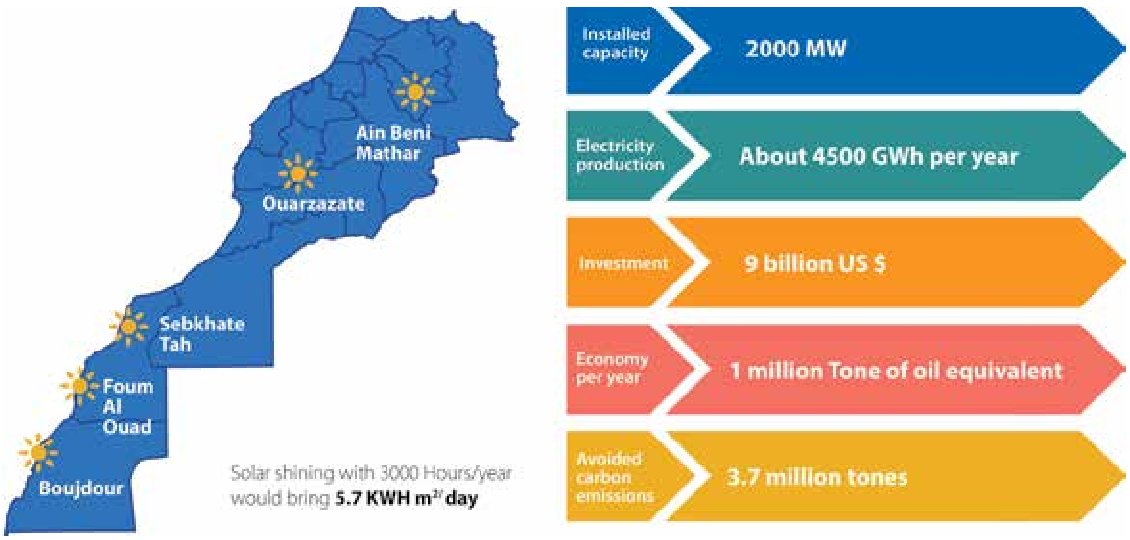


Table 11 gives a description of the executed solar stations under development in Morocco.

Table 11: The realized solar stations under development in Morocco

Site/power plant	Power in MW	Technology	State of the project
NOORo I Ouarzazate	160	CSP	Under service
NOORo II Ouarzazate	200	CSP	Under development
NOORo III Ouarzazate	150	CSP	Under development
NOORo IV Ouarzazate	70	PV	Under development
Midelt	400	CSP and PV	Under development
Tata	400	CSP and PV	Under development
Ain Beni Mathar	20	CSP and Gas	Under service
Noor B Boujdour	80	PV	Under development
Noor L Laayoune	20	PV	Under development
Noor Tafilalt	75-100	PV	Under development
Noor Atlas	200	PV	Under development
Noor Argana	100	PV	Under development

Source: Azeroual et al., 2018

5.2.3. Challenges and barriers to the development of renewable energy in Morocco

The power grid in Morocco is facing four main challenges**.** Firstly, increasing of carbon emissions: despite the country's efforts to base its electricity system on high shares of renewable in the energy mix, Morocco's energy demand is still dominated by fossil fuels. Therefore, total carbon emissions are expected to follow the rising energy demand. Secondly, the stability electricity system: With the steady increase of electricity demand, Morocco is in critical need of new infrastructure, which requires a significant investment in additional power generation capacity, distribution, transmission, and storage infrastructure. Thirdly, electricity prices: The prices of electricity prices are not uniform in Morocco. In fact, the prices of electricity are differentiated by voltage and consumer type. However, the current electricity pricing strategy does not consider the user's socioeconomic attributes.

Dependence on energy imports: As mentioned above, Morocco is highly dependent on imported fossil fuels. More than 96 per cent of Moroccan's energy supplies come from outside: from Saudi Arabia for the oil, gas from Algeria, and coal from South Africa and Russia.

5.3 The Case of Bahrain

The kingdom of Bahrain was the first Arabian Gulf country to discover oil in commercial quantities in 1932. It was also the first country to exploit oil revenues to establish and build its necessary infrastructure. Since then, oil has become the keystone of the country's economic development, which is reflected in all sectors, particularly power generation. This accentuates the challenge of shifting from a well-established energy source to renewable energies. Nevertheless, Bahrain has set a roadmap for diversifying its energy mix and incorporating renewables.

Bahrain is at a stage of development where economic growth, robust population growth, rapid urbanisation, and economic prosperity have led to soaring domestic electricity demand, with increasing amounts of liquid fuels and natural gas diverted to the power sector at prices below international levels. Therefore, Bahrain's government has had to increase the share of renewables in the generation mix not only to boost hydrocarbon export revenues but also to enhance the security of supply and restructure the power sector. It is worth presenting the existing power generation in the country to show the need to integrate the renewable in the country's energy mix, before discussing the most promising renewable energies for Bahrain.

5.3.1 Bahrain's Power Generation

Bahrain's Electricity and Water Authority (EWA), which is a governmental entity, is responsible for operating Bahrain's national power grid. However, only two power stations out of five are owned by EWA, while the rest are owned by "independent power & water producer", which represents the private sectors. Riffa and Sitra power stations are the governmental ones, and their contribution is only 11 per cent of total power generation. The rest of generation is supplied by the private power stations, Aluminium factory known as

"Alba" and the Gulf Countries Council (GCC) interconnection. Table 12 shows the installed capacity for all points of supply into Bahrain's national grid and the type of technologies, which are either open or close cycle of the gas turbine, steam turbine and exchange between other grids.

Table 12: Power Stations and Installed Capacity

Station	Installed Capacity (MW)
Riffa	700
Sitra	125
Hidd	929
Al-Ezzal	942
Al-Dur	1224
GCC Grid	600
ALBA	300

As depicted in the table, the private companies; namely: Hidd, Al-Ezzal and Al-Dur, have the most substantial portion of the total generation with a total cumlative installed capacity of 3,095 MW. Besides, Bahrain's grid is connected to the GCC link which presently serves as a backup for supporting the network during emergencies and blackouts, but this link could be one of the pillars for promoting renewables, as it can tackle the surplus power, this constituting the problem usually associated to renewable energies.

The next section will elucidate Bahrain's most promising renewable energies and the main targets elicited from the National Renewable Energy Action Plan (NREAP).

5.3.2 The Opportunities from Renewable Energies

Recently, Bahrain's government has taken several steps to diversify energy sources. A significant milestone was achieved in January 2017, when the Sustainable Energy unit (SEU) launched the National Renewable Energy Action Plan (NREAP). This plan has become the roadmap for identifying the most appropriate renewable resources and their best technologies, which can be reconciled with Bahrain's particular requirements. The action plan laid down a target of 255 MW of renewable power by 2025, with a production of 480 GWh per year. Also, it sets another goal for 2035, which is to produce 700 MW with 1460 GWh per year (Table13).

Table 13: Renewable energy targets for Bahrain

Renewable Energy Targets	2025 Targets		2035 Targets	
	MW	GWh	MW	GWh
Wind	50	125	300	750
Solar	200	340	400	680
Biogas	5	13	10	26
Total	255	478	710	1456

To achieve these targets consistently, three approaches were proposed as follows:

1. Decentralised Urban Generation.
In this approach, the renewable energy is generated from the demand side. In other words, the customer assumes the responsibility for installing renewable generation sources in order to meet fully or partially demand and on some occasions feeding the national grid.

2. Large-scale Generation on Available Land.
It means building renewable energy plants on Bahrain soil, which can be easily connected to the national grid.

3. Offshore Generation.
This aims to build renewable energy power plants in bodies of water. The offshore wind farm is a popular example of this application.

In order to ensure achieving the target of 5 per cent by 2025, three complementary policies were proposed to attract the private sector and consumers for investing in renewables. The policies are as follows: Net metering, Tender-based and Renewable energy mandate for new buildings. Table 14 presents these policies and their objective as well as associated targets and incentives. The first policy, which is the net metering, was accomplished in February 2018 based on the Minister of Electricity and Water Affairs announcement. Regarding tender-based policy, in April 2018 the Electricity and Water Authority (EWA) issued a tender for project concepts proposals for the onshore solar plant at the landfill site. For the third policy, it is thus far at the planning stage, and hopefully, it will be implemented in 2019.

Table 14: Bahrain's policies for promoting renewable energies

	Policy 1	Policy 2	Policy 3
	Net metering	**Tender-based feed-in tariff**	**Renewable energy mandate for new buildings**
Objective	Enable consumers to generate their own power from renewable energy sources for self-consumption.	Attract private investors to develop renewable energy projects through a competitive procurement process.	Require new buildings and real estate developers to integrate renewable energy technologies in the building design.
Target Group	Residential, commercial and industrial electricity customers.	Renewable energy developers and large electricity customers.	New building and real estate developers.
Incentive	Reduced electricity bill through on-site power generation and the ability to credit the excess electricity fed back to the grid.	Long-term standardized power purchase agreement.	Reducing energy demand of the building (reduced electricity bill).

According to the national renewable energy action plan, there are three main renewable resources, which suits Bahrain's condition:

SOLAR ENERGY

Bahrain enjoys relatively high solar global horizontal irradiance, at around 2,600 kWh/m2/year. According to Alnaser, the maximum power that can be generated by currently installed solar-based technology is approximately 6.8 KWh/m2/day in the summer months (June to September), and approximately 5 KWh/m2/day in winter months (December to February).

Two solar technologies have been considered in Bahrain's action plan, and they can fall under the large-scale generation category. The technologies are photovoltaic (PV) and concentrated solar power (CSP). Table 15 presents the main pros and cons of these technologies in the light of Bahrain privacy for the onshore application.

Table 15: Advantages and disadvantages of PV and CSR

Technology	Advantages	Disadvantages
PV	• Strong resource potential. • Cost-competitive technology • Can be deployed in modules. • Can shave the day peak.	• Requires large land areas. • Overcoming dust challenge might entail additional costs. • Generates power only during the day.
CSR	• Strong resource potential. • Ability to store heat that can be used to generate power after sunset.	• Requires large land areas. • Requires water for cooling and for cleaning mirrors. • Significant upfront investment costs.

WIND ENERGY

In 2018, the sustainable energy unit published a national wind atlas, which shows that Bahrain has sufficient wind presence in specific areas. The strongest wind speeds reached up to 7 m/s in summer months, compared to 3.8 m/s during winter. Additionally, the atlas provides a preliminary indication that wind energy could be feasible for shore and offshore applications but, as mentioned earlier, the focus will be more on the land application in this research.

For a large wind project, the horizontal wind turbine is the most powerful technology for producing electricity. Table 16 shows the main advantages and disadvantages of onshore wind turbines in Bahrain.

Table 16: Advantages and disadvantages of onshore wind turbines

Technology	Advantages	Disadvantages
Onshore wind	• Estimated good resource potential. • Cost-competitive technology.	• Power generation is less predictable • Requires unobstructed land parcels • Resource potential is not identified, need to compile a detailed wind atlas

WASTE TO ENERGY

Bahrain's action plan has addressed two technologies for the waste to energy option, and they are biogas and landfill gas recovery. The NREAP also emphasises that these technologies have the highest deployment potential for Bahrain. As for other methods, such as pyrolysis, biodiesel and waste incineration, the plan mentioned that these applications need to establishing a waste management strategy first before pursuing them, and this has not existed until now in the country.

Regarding biogas, it can be produced from organic waste, which represents approximately 60 per cent of total municipal solid waste in Bahrain, taking into account that the country produces more than 1.8 million tons of solid waste per year, and that currently is just being landfilled. This application will be beneficial for generating electricity, as well as reducing greenhouse gas emissions.

Similarly, landfill gas recovery has both environmental and energy advantages, because it is based on collecting available methane gas in the landfill, which is a natural byproduct of decomposition of organic material in the solid municipal waste. This gas has a global warming potential 21 times greater than carbon dioxide; therefore, preventing it from being released into the atmosphere is extremely crucial. The recovered landfill gas can be used to produce medium-Btu gas and pipeline quality gas, thereby producing electricity and reducing consumption of the gas resource.

Table 17 presents an overview of the main pros and cons of biogas and landfill gas recovery applications in Bahrain's context.

Table 17: Advantages and disadvantages of Biogas and landfill gas recovery

Technology	Advantages	Disadvantages
Biogas	• Avoid greenhouse gas emissions from landfilling the waste. • Reduce the volume of waste to be landfilled, saving landfill capacity. • Stabilization, sanitation and odor reduction. • Generate useful energy that can be used for multiple applications. • Biogas can be used to generate electricity that can be dispatched, predictable and available at night.	• Energy recovery is limited to the quantity of organic waste produced. • Food and other organic waste need to be collected and sorted out.
landfill gas recovery	• Reduction in greenhouse gas emissions from landfill. • Reduction in odor emissions. • Reduction in emissions of hazardous organic air pollutants to the atmosphere. • Recovery of a low-cost, useful energy that can be used to generate electricity that is able to be dispatched, predictable and available at night.	• Energy recovery is limited to the quantity of landfill gas available • Risk of methane leakage.

5.3.3 Bahrain's RE challenges:

Bahrain has to increase the share of renewables in the generation mix not only to boost hydrocarbon export revenues but also to enhance the security of supply and diversify the energy mix in order to attract private capital to the country. Bahrain's economy still relies on oil and gas exports, as it represents 50 per cent of all exports in 2016. However, in 2017 the crude oil and natural gas sector shrank by 1.4 per cent, while the economy as a whole grew by 3.6 per cent (Oxford Business Group, 2018). In the long-term, renewables can contribute to economic diversification, which is one of the main targets in Bahrain's economic vision.

Another key driver for adopting the RE in Bahrain is related to its environmental obligation. Bahrain has signed the Paris Agreement on Climate Change and committed to reducing its GHG emission by the submission of its "Intended National Committed Contribution" (INDC) in 2015 (Albuflasa, 2018). It should be taken into account that Bahrain has the highest CO_2 emissions from electricity and heat production compared to other countries in the region (Rizk et al. 2017). Therefore, the country should pay attention to maintaining the same growth of economy with lower consumption of energy to mitigate the impact of rising domestic oil and gas demand and reduce the country's carbon footprint.

One of the main challenges facing Bahrain with RE is how to design a reform model that can attract investment and improve efficiency, while at the same time integrating new technologies in its power system. Due to the nature of renewable energy structures, there is a lack of policies and regulations favouring their deployment in the country, and thereby it is difficult to increase the interest of investors. Enabling policies can create a stable and predictable investment environment, which in return will ensure predictable project revenue streams.

In order to address the challenge mentioned above, three complementary policies were proposed to attract the private sector and consumers for investing in renewables [4]. The policies are as follows: Net metering, Tender-based and Renewable energy mandate for new buildings**.** Table 18 (Sustainable Energy Unit, 2017) presents these policies and their objective as well as associated targets and incentives. The first policy, which is net metering, was accomplished in February 2018 based on the Minister of Electricity and Water Affairs' announcement (Albuflasa, 2018). Regarding tender-based policy, in April 2018 the Electricity and Water Authority (EWA) issued a tender for project concepts proposals for the onshore solar plant at the landfill site. As for the third policy, it is until now in the planning stage, and hopefully it will be implemented in 2019.[7]

Table 18: Bahrain's policies for promoting renewable energies

	Policy 1	**Policy 2**	**Policy 3**
	Net metering	**Tender-based feed-in tariff**	**Renewable energy mandate for new buildings**
Objective	Enable consumers to generate their own power from renewable energy sources for self-consumption.	Attract private investorsto develop renewable energy projects through a competitive procurement process.	Require new buildingsand real estate developers to integrate renewable energy technologies in the building design.
Target Group	Residential, commercial and industrial electricity customers.	Renewable energy developers and large electricity customers.	New building and real estate developers.
Incentive	Reduced electricity bill through on-site power generation and the ability to credit the excess electricity fed back to the grid.	Long-term standardized power purchase agreement.	Reducing energy demand of the building (reduced electricity bill).

Finally, Bahrain has to bridge the gap between "environmental harm" and "economic good," which is called "economic decoupling'. The country should pay attention to maintaining the same growth of economy with lower consumption of energy in order to mitigate the impact of rising domestic oil and gas demand, and reduce the country's carbon footprint and environmental impact. Furthermore, the government should enhance the formal cooperation between the regional power sectors and the research institutions to address the challenges and opportunities for introducing renewable energy into Bahrain's national

7 "Tender Board - Kingdom of Bahrain." [Online]. Available: http://www.tenderboard.gov.bh/TenderDetails.aspx?id=RFI-PQ/201829257197314. [Accessed: 11-Dec-2018].

grid, as sharing experience and science between the developing countries could help to promote these technologies in the region. Besides, Bahrain's grid is connected to the GCC link which presently serves as a backup for supporting the network during emergencies and blackouts, but this link could be one of the pillars for cooperation and also for promoting renewables, as it can tackle surplus power, a problem usually associated with renewables.

5.4 The Case of Algeria

The energy sector is the backbone of the Algerian economy. Algeria is considered to be the third-largest oil producer in Africa, after Nigeria and Angola, and the leading natural gas producer in Africa. Furthermore, Algeria has one of the greatest reserves of natural gas and oil in the world, estimated at 4.51 trillion cubic meters of natural gas and 12.2 billion oil barrels. In addition, Algeria is estimated to hold the third-largest amount of shale gas resources in the world. According to the EIA (U.S. Energy Information Administration) Algeria holds about 707 trillion cubic feet (Tcf) and 5.7 billion barrels of technically recoverable shale gas and oil resources, respectively. Nevertheless, fossil fuel production in Algeria has been on a downward spiral since 2005 due to insufficient investment in upgrading existing fields and exploiting new discoveries and repeated project delays resulting from slow government approval, technical problems and infrastructure gaps.

Algeria has been struggling with a halving since 2014 of vital oil and gas revenues, which make up 60 percent of the budget and 95 percent of exports. Global energy consumption in Algeria has increased sharply in recent decades, driven by the steady increase in domestic energy demand, which can be explained by the rapid demographic growth and sustained economic welfare in the recent decades.

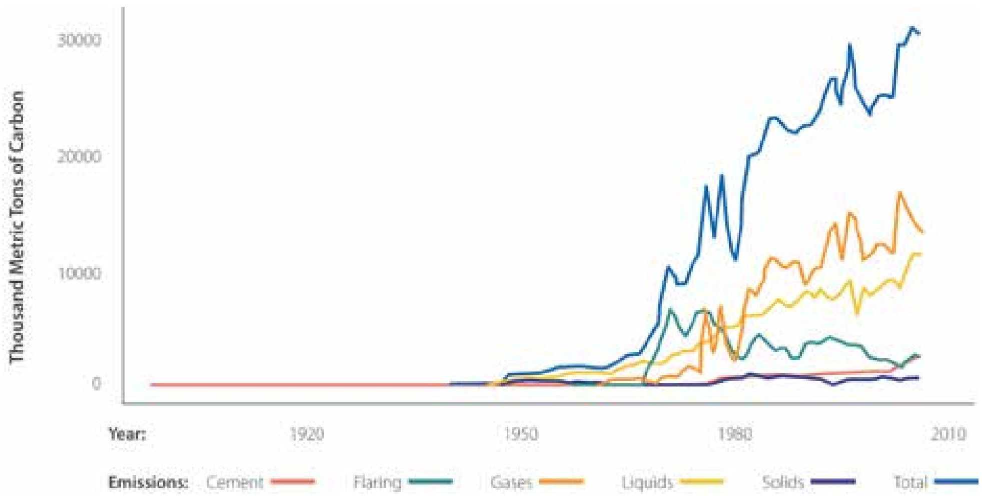
Electricity demand in Algeria is expected to increase at an average annual growth rate of 6 per cent. In 2013, electricity demand reached 40.9 TWh, and is expected to attain 75–80 TWh in 2020 and 130–150 TWh in 2030.

Despite the huge potential of renewable energy in Algeria, which can be harnessed by commercially available technologies, Algeria's energy mix is for the most part dominated by fossil fuels. More precisely, about 93 per cent of electricity generation is derived from natural gas and 6.5 per cent from oil (Bélaïd and Youssef, 2017). Up to now, renewable energy production is insignificant when considering Algeria's enormous potential.

The intensive electricity demand and gas over-use in electricity production are the major sources of carbon emissions in Algeria. Fig. 10 shows that since 1970 greenhouse gas emissions in Algeria increased sharply, mainly due to extensive use of fossil fuels.

In order to diversify the economy, create new jobs and meet the highly increasing energy demand, one of Algeria's main challenges for energy policy is the ability to launch a new energy model aiming to mainstream renewable energies into the national energy mix and developing new renewable energy projects.

Figure 10: CO2 emissions in Algeria



5.4.1 Renewable energy potential in Algeria

As we can see in Table 19, Algeria counts on the highest solar potential in the MENA region and one of the largest in the world**.** This huge potential could enable Algeria to be a leader of renewable energy production in the MENA region.

Table 19: Solar potential in Algeria

Regions	Coastal areas	Highlands	Sahara
Area	4	10	68
Average duration of sunshine (hours per year)	2650	3000	3500
Average energy received (kWh / m^2 / year)	1700	1900	2650

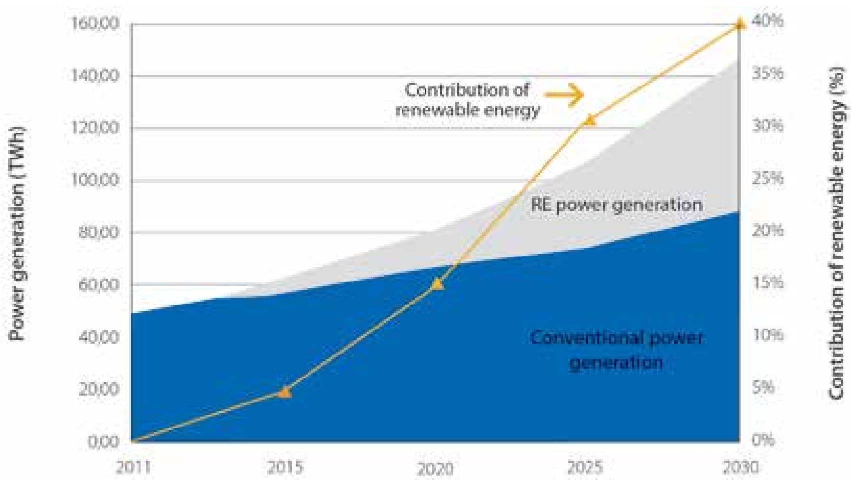
Overview of renewable energy program in Algeria

Renewable energy development gained interest in Algeria since the mid-80s. The first programme of renewable energy development was initiated during 1985-2000. This first programme was called "the solar energy great south programme". The main purpose of this project is the deployment of solar PV plants for various uses in rural areas for water pumping, household lighting, and highway lighting in the Algerian Sahara.

Recent efforts to reduce energy demand, diversifying the economy, and creating added value and jobs, have renewed interest by Algerian policy-makers in spurring renewable energy deployment. The main purpose of Algeria's renewable energy programme is to achieve a high industrial integration for raw materials, equipment, and production.

A new and updated renewable energy programme has been launched by the Algerian authorities. This ambitious programme aims to provide 22.000 MW during the period 2015-2030 and achieve a share of 40 per cent renewable in the energy mix. 4.500 MW of this programme are scheduled for 2020. More detail about this programme has been displayed in figure 11.

Figure 11: The Algerian program goals: Contribution of renewable energies for electricity generation by 2030



Source: Nacer et al., 2016

This renewable energy programme is based on various dimensions, including large-scale photovoltaic deployment, wind development, strengthening the biomass, cogeneration and geothermal sectors. The share of this target installed capacity of 22.000 MW per technology is displayed in table 20.

Table 20: Algerian National Program for the Development of Renewable Energy targets

Source	First phase 2015-2020	Second phase 2021-2030	Total (MW)
Solar PV	3000	10 575	13 575
Wind	1010	4000	5010
Concentrated Solar Power		2000	2000
Cogeneration	150	250	400
Biomass	360	640	1000
Geothermal	5	10	15
Total	4525	17 475	22000

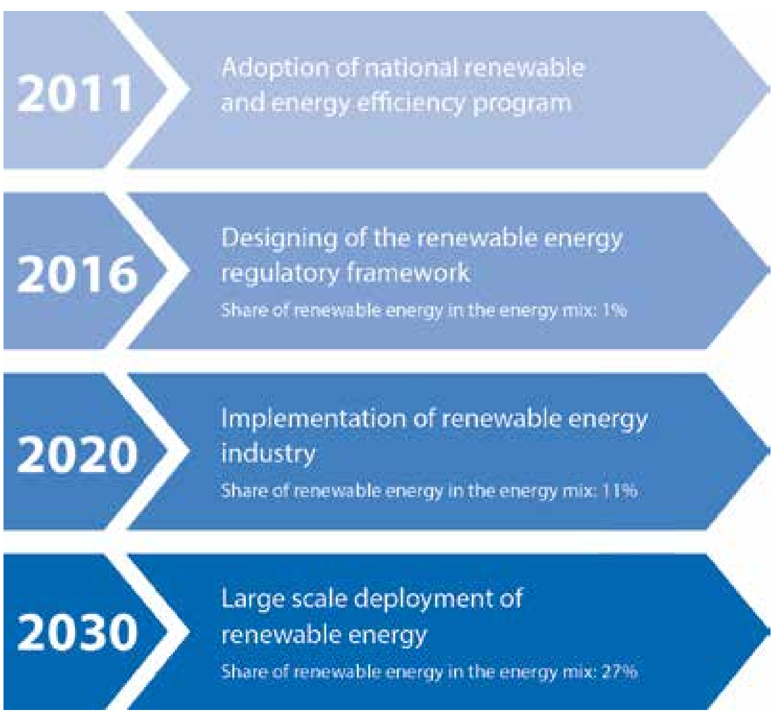
Achieving this programme will provide about 37 per cent of total installed capacity for the country, and 27 per cent of total electricity production which will be generated using renewable sources by 2030. The volume of natural gas that will be saved by the 22.000 MW of renewable electricity is equivalent to eight times the national consumption in 2014.

STEPS OF IMPLEMENTATION OF THE ALGERIAN RENEWABLE ENERGY PROGRAM

The main stages of the Algerian's renewable energy deployment during the period 2015-2030 are displayed in the Fig.12. The deployment of this current scheme is expected to have several impacts on economic diversification and environmental quality improvement including:

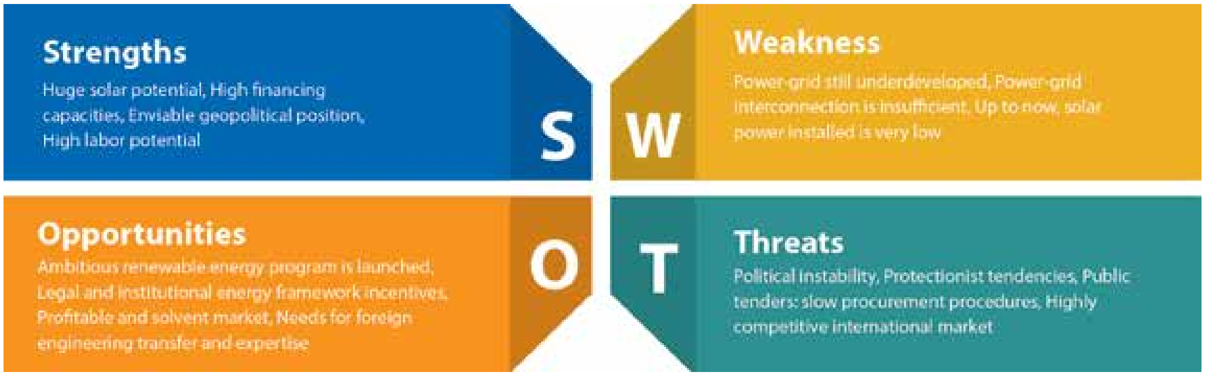
- Creation of more than 200,000 direct and indirect green jobs
- Promoting of the small-scale industries through the creation of small and medium sized enterprises.
- Promoting innovation and supporting technology and knowledge transfer.
- Achieving significant reduction of greenhouse gas emissions.
- Savings of several hundred billion cubic meters of natural gas.

Figure 12: main stages of Algeria's renewable energy deployment during the period 2011-2030



Solar technologies in Algeria are characterized by relatively high attractive economic parameters. The figure 13 highlights business opportunities associated with the solar energy market in Algeria. More precisely, it provides a summary of the strengths, weaknesses, opportunities, and threats for solar power development in Algeria. Despite the huge potential of solar energy potential and high financing capacities, the current renewable generation capacity from solar remains low. In fact, the Algerian technological environment suffers from a shortage of infrastructure capable of supporting renewable energy market growth. In addition, the administrative environment lacks the expertise and qualified workforce necessary to keep track of the diffusion of new renewable energy technologies, and their features, including their costs and benefits.

Figure 13: SWOT of the Algerian solar market



5.4.2 Renewable energy realized, planned or under construction

To achieve Algerian renewable energy targets, various ambitious projects have been realized. In this section, we summarize the main projects realized, planned or under construction vis-a-vis renewable energy projects in Algeria.

Acquisition and installation of wind measuring stations: 10 measuring stations were acquired and installed in the first half of 2015 in different regions, including El Bayadh, Khenchela, Tiaret, Naama, Timimoun, El Goléa, Labreg, M'sila, In Salah and Batna.

Pilot plants to test available technologies: two pilot projects have been in operation since 2014. The first aims to build 10MW from wind at Kabertene (Adrar), and the second relies on the construction of 1.1 MW photovoltaic plant in Ghardaia. Up to now, 24 power plants have been installed (23 PV and 01 wind plant). The equivalent installed power is about354.3 MW (344.1 MW PV and 10.2 MW Wind).

Table 21 and figure 14 display the detail of different installed ENR projects in Algeria.

Table 21: Installed ENR projects in Algeria

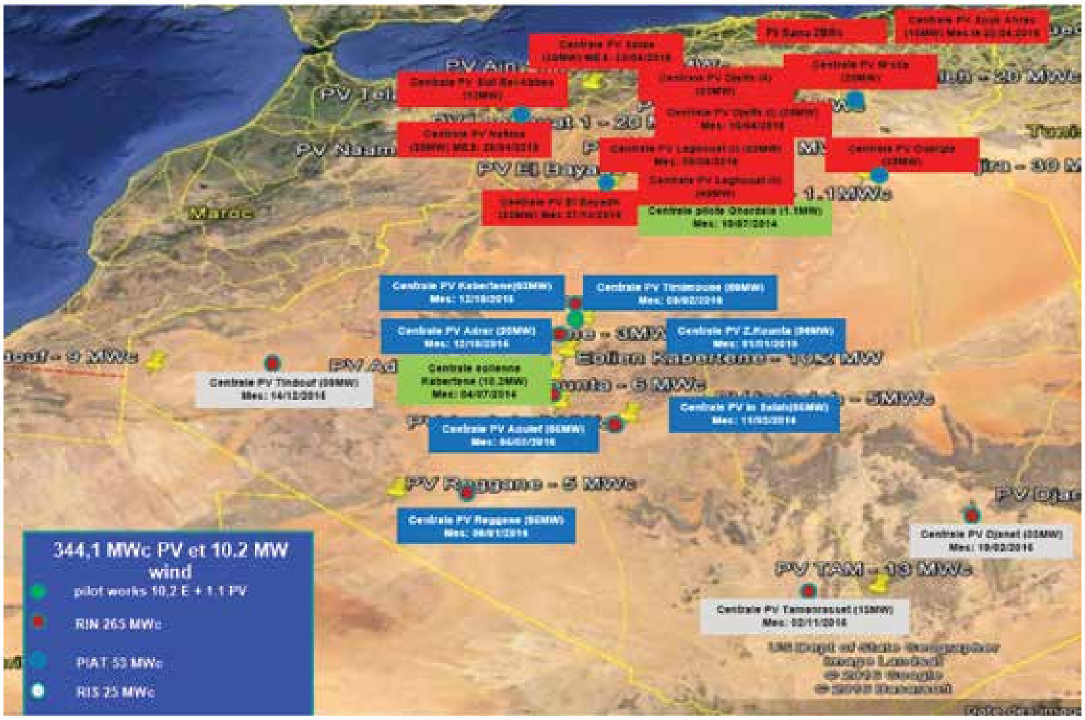
Power stations	Installed power (MW)
1- PIAT network	
Kabertene wind turbine	10
Adrar	20
Kabertène	3
In Salah	5
Timimoune	9
Regguen	5
ZaouiatKounta	6
Aoulef	5
2- RIS Network	
Tamanrasset	13
Djanet	3
Tindouf	9
3- Network RIN	
Oued Nechou PV (Ghardaia)	1.1
SedretLeghzel (Naâma)	20
Oued El kebrit (Souk Ahras)	15
Ain Skhouna (Saida)	30
Ain El Bel (Djelfa) 1 et 2	53
Lekhneg (Laghouat) 1 et 2	60
Telagh (Sidi-Bel-Abbes)	12
Labiodh Sidi Chikh (El-Bayadh)	23
El Hdjira (Ouargla)	30
Ain-El-Melh (M'Sila)	20
Oued El Ma (Batna)	2
Total SKTM (EnR)	**354**

The main achieved goals of the Algerian's EnR programme are summarized in the table 22.

Table 22: Achieved ENR results in Algeria

Production	**800 GWh (60 MWh wind plant)**
Gain in Gasoil	3000 m3
Gain in GAS	300 Million m3
CO2 emissions reduction	670 Million Tons
Jobs creation	411 agents

Figure 14: Photovoltaic plant of Laghouat 60 MWc



5.4.3 Key challenges of renewable energy development in Algeria

In Algeria, a substantial energy policy objective should be the "decoupling" of economic growth from convectional fossil fuel energy consumption growth. Along with this effort to promote renewable energy, promoting energy efficiency and conservation will be necessary.

Acknowledging the important role that renewable energy sources could play in the diversification of the economy and carbon emission reduction, the Algerian government has approved an ambitious strategy to increase the share of renewable sources in the energy mix and reduce the dependency on fossil fuels. To achieve these ambitious goals, the Algerian authorities plan to invest massively in renewable energy sources and to galvanize the deployment of solar and wind energy across the country over the next decades. The main goal of the Algerian renewable energy programme is to achieve 40 per cent of the energy mix from renewable sources. According to this objective, 22 GW should be installed by 2030 while 10 GW are reserved for exportation. In the short-term, an objective of 4.5 GW is the target set for installation by 2020. More recently, the Algerian Minister of Energy announced that the Council of Ministers have approved 200 MW solar power tenders.

Up to now, although Algeria has been able to count on one of the most promising renewable energy resources potential in the world, the current installed renewable generation capacity remains immature compared to other countries in the region. This shortfall is due to various barriers, including an unstable political and judicial environment, lack of transparency, and difficulties involved in attracting FDI.

Given this context, several measures and actions should be taken to enhance renewable energy deployment in Algeria, including: (1) designing a national programme for the development of renewable energy equipment manufacturing, (2) development of an extensive and regulatory framework for renewable power implementation, (3) Simplifying procedures to attract private and international investment, (4) enhancing financial incentives and exemptions to increase industrial investment in the rural area, and (5) improving research and development in renewable technologies to ensure local and regional competitiveness, and (5) supporting education and training of a high-skilled workforce.

6. SOUTH-SOUTH COOPERATION

Adoption of Renewable Energies in the MENA Countries can benefit from the experience and expertise of Southern Countries. In fact, there are various areas of possible cooperation between Southern countries related to development of renewable energies in the MENA Region.

We list here four possible areas of cooperation. Firstly, RE deployment needs that MENA Countries strengthen their interconnection (among themselves and with neighboring countries). Secondly, there is a need to adapt existing technologies to the local needs and local context. Given the similarities between the MENA countries, joint research and development and scientific monitoring can avoid duplication of efforts and money. South-South cooperation is key for these activities (technical exchange, capacity-building, resource-sharing…). Thirdly, the MENA Countries need to learn from other southern countries in regard to regulation and governance of this specific sector. There is no one best way of regulating the RE markets. Best practices can be duplicated from one country to another. Increasing the knowledge and sharing best practices through think tanks is key for the deployment of renewable energy markets in the MENA Countries. Fourthly, opportunities in regard to cooperation in the area of investment are available. South-South cooperation is also key in reference to investment and private sector involvement.

South-South cooperation with regard to Interconnection is fundamental. One of the main pre-requisites for the development of renewable energies in the MENA Countries is to have better interconnection with their neighbours. The urgent need to strengthen this interconnection opens the door for cooperation between them and with the countries at their borders. It is worth noting that most MENA Countries need to improve their interconnection in order to foster the development of renewable energies, for example Bahrain is an active member in the GCC interconnection authority which links all GCC countries together. While countries such as Tunisia, Morocco and Algeria are seeking to implement interconnection with Europe, little is done in South-south cooperation in matter of common infrastructure (grid). The main existing barriers are political barriers. For example, the cooperation between Algeria and Morocco with regard to setting common infrastructure is weak and reflects the political divergence between the two countries. The situation is similar between Libya and Egypt. After the Arab Spring, the situation becomes more complex with the political instability in Libya, Syria and Yemen. Political stability and political cooperation can allow neighboring countries to develop common infrastructure. Unfortunately, this is not the case.

Building synergies with regard to innovation, R&D and technology watch. Renewable energies has been one of the most dynamic research area during the last decade. Several technologies are competing, and innovation and technological change are fast-evolving in this sector. One of the key dimensions of RE is storing energy and setting batteries. For this specific field, there is no unique technology available and several competing technologies are under development. In fact, all the MENA Countries are developing research centers and building capacity with regard to RE innovation. Sharing experiences, building transnational research teams, and increasing mobility between southern researchers are key for the next decades. Pooling resources and avoiding duplication in this area can increase the efficiency and the efficacy of the research and development in southern countries research centers and increase their competitiveness vis-a-vis innovation.

It is worth noting that reinforcing regional cooperation would facilitate the penetration of a higher share of renewable energy in the power grid, foster technology transfer and promote business and market opportunities for trade. Therefore, policy-makers in the MENA region should support the Clean Energy initiative, which aims at supporting the MENA countries and creating synergies among them in the integration of larger shares of renewable energy on their energy mix. The final goal is to reach an integrated power grid covering the whole region, enabling cleaner-based energy exchanges. Regional cooperation could help alleviate issues and create an effective coordination mechanism for stockholders. Complementary energy resources, added value to national economies, and economies of scale would benefit the whole region.

Most of the MENA Countries are transforming their Electricity Market by setting new regulation and legislation. There is no one best way of regulating the RE markets and experience is showing worldwide that several solutions can provide high satisfaction and efficacy. Southern countries need to learn from other southern countries with regard to regulation and governance of this specific sector. Best practices can be duplicated from one country to another. Increasing the knowledge and sharing of best practices through think tanks is key for the deployment of renewable energy markets in the MENA Countries.

Transition to RE will call for important financial resources and South-South cooperation can help to direct the financial flows to the Energy transition. Opportunities with regard to cooperation in investment exist. South-South cooperation is already working in this area. Several investments have already been made by Saudi Arabia and Kuwait in Tunisia in the Energy Sector. More can be done for the Energy transition by Southern Sovereign Wealth Funds. Moreover, private firms and investors from southern countries can collaborate more effectively. Renewable energies in the MENA countries can help networking and setting joint-ventures. South-South cooperation is also key with regard to investment and private sector involvement.

7. CONCLUSION

This study tried to contribute to the knowledge on what determines renewable energy demand by analyzing the contribution of financial development, international trade, oil prices, and CO2 emissions to renewable energy demand, with a focus on the MENA countries. In order to do so, we proceeded in two steps. During the first step, we developed an econometric model in order to examine the macro-level determinants of renewable energy demand in the MENA countries. The empirical model that we develop in this study is consistent with the broader literature on the determinants of renewable energy consumption. In the second step, we have presented four case studies based on semi-structured interviews and questionnaires with selected stakeholders (especially policy-makers) in the Renewable Energy Market (Algeria, Bahrain, Morocco and Tunisia).

Taking the entire sample (all the countries together), our results show that the oil prices elasticities are positive, and statistically significant. For trade openness, the panel results show a positive and statistically significant coefficient. However, the panel estimated elasticity for financial development is positive and statistically significant according to one technique and statistically non-significant according to the other technique.

For the different determinants for each country, firstly we can notice that the effect of the carbon emissions on renewable energy consumption, except Egypt and Algeria, is statistically significant and positive, at the 1 per cent and 5 per cent levels, for all the countries considered. Starting from this premise, we have tried to better highlight the Egypt and Algeria cases.

Concerning the oil prices variable, our findings indicate that oil prices have positive and statistically significant effects on renewable energy consumption at the 1 per cent and 5 per cent levels. The per capita GDP has a significant positive impact on renewable energy consumption in the MENA countries. This suggests that economic growth is an important determinant of renewable energy consumption in the MENA countries.

Finally, our findings show that financial development has a significant and positive effect on renewable energy consumption in the MENA countries. This finding suggests that financial development and promoting specific financial mechanisms for Renewable energies Projects can foster the deployment of renewable energy in the MENA region in the long run.

The huge potential of renewable energy sources in the region might benefit all the countries in the region in terms of energy security, replacing carbon-intensive energy sources, providing affordable electricity, stabilizing energy prices, promoting economic growth, creating new jobs, opening new business and market opportunities. Our findings suggest that increasing the supply of renewable energy would allow for the replacement of carbon-intensive energy sources and significantly reduce global warming emissions in the region. It is of the essence to promote deeper regional energy cooperation and to develop strategies to exploit the strong complementarities and interdependence between the various countries by considering the unique characteristics of each country in the region.

Renewable energy is a nascent industry with high potential for growth and exportation for many MENA countries. The value chain of renewable energies can be described by the following chart:

The value chain of renewable energies is composed of several segments starting with Studies and Development, production of equipment, installation, maintenance and *recycling*. Each segment offers several opportunities for the MENA Countries domestic firms to invest and to develop their activities. In Egypt, Jordan, Tunisia and Morocco an entire industry appeared in renewable energy and projections show a high potential growth in this sector.

Given the ambitious programmes adopted by the MENA Countries with regard to RE in order to reach the targets of their National Domestic Contributions (NDCs), there will be an important market for electricity production in the next decade. In fact, an emergent market exists for the provision of electricity for producers since the private sector is expected to produce an important share of electricity from renewable energies. In the case of Tunisia, the private sector will be in charge of two-thirds of renewable energies projects.

For North African Countries (Egypt, Tunisia and Morocco) there are many opportunities for exportations in Sub-Saharan Countries. According to the President of the P.V Installer Chamber of Commerce in Tunisia (UTICA) ((Tunisian Union of Industry, Trade and Crafts)) the market is a high growth market in SSA and there are many opportunities for exportations in these countries. The electrification of Africa is still very low and

Renewable Energies are proposed as the best solution to provide millions of people with electricity. Most of the people in Africa will adopt off-grid solutions for electricity provision based on renewable energies. Expertise in all the segments of the value chain domains is needed.

Since water is the main input for agriculture and the MENA Countries are under water stress, renewable energies are key for the development of agriculture sector. The nexus between energy, water and agriculture (food) is well established in scientific literature. Renewable energies can lower the price of energy which makes it possible to increase the availability of water (by desalinization or by extraction). Several farmers all over the MENA region are using off-grid solutions in order to have access to water and to improve their crops and plants. This is particularly true in Mauritania, Tunisia, Egypt, Jordan, Kuwait and Morocco.

Several industrial sectors are energy-intensive sectors; investing in RE can enhance their competitiveness. The cost of electricity represents an important share of the total cost. For the cement industry, the energy cost is more than half of the total cost. Investing in renewable energies can increase the competitiveness of the industrial sector in the Arab region and increase the efficiency of the entire economy. Policy-makers are urged to identify key industrial sectors where they can invest, particularly for a country such as Bahrain which has been pursuing the policies of sustainable and diversified economic growth.

The development and adoption of renewable energy technologies in the MENA region may be hindered by various factors, including market-related barriers, technical, socio-cultural, economic and financial barriers. Overcoming these multiple barriers calls for the implementation of multiple strategies and smart policies that improve renewable energy development in this region, including: (i) regulations reforms (e.g., energy pricing reforms, renewable energy targets by sources, enforcement mechanisms development, etc.), (ii) data and information collection (e.g., database on energy consumption, information and case study database, etc.); (iii) incentives and financial measures (e.g., public sector renewable energy financing, facilitate household credit access, etc.); (iv) technical capacity improvement (e.g., enhancing grid connection and energy storage capacity, development of energy management systems, etc.); and (v) institutional reforms (e.g., dedicated entity with renewable energy mandate; clear institutional roles/accountability; authority to formulate, implement, evaluate and report on renewable energy programmes; etc.).

POLICY RECOMMENDATIONS

Policy-makers in the MENA region face several choices in increasing levels of renewable energy production, faced with several risks and obstacles, including technological and financial severe constraints.

Firstly, it is urgent to prioritize technologies that can supply renewable energy at a low cost. Secondly, there is a need to design and implement appropriate policies to attract private investment in the renewable energy sector. Thirdly, it is important to improve South-South intra-regional investments in the renewable sector. An essential challenge for the development of renewable energy in the MENA region was the "Pan-Arab Strategy for the Development of Renewable Energy 2010–2030", which was adopted in 2013 at the Arab Economic and Social Development Summit. Implementation of the strategy regarding long-term targets for renewable electricity production requires concerted efforts from multiple stakeholders at the technical, financial, and regulatory levels.

To achieve the above-mentioned objectives and encourage renewable energy development energy policy -makers in the MENA region should encourage and improve region-wide MENA co-operation, e.g. developing mutually R&D research centers, unified standards, and free trade zones across the Region. Lack of technologies and infrastructures to support technologies are a major obstacle in the development of renewable energy.

Therefore, to facilitate the development of renewable energy in the MENA countries, policy-makers should improve the development of the distribution networks and physical facilities for transmission, as well necessary services and equipment for energy companies. In addition, it is crucial to facilitate connectivity of renewable energy to the grid. In fact, Inadequate connectivity to the grid has been identified as a significant technical barrier to renewable energy expansion, mainly in the wind power sector. This is an ambitious vision that will require solutions to complex technical problems, including high-voltage interconnection, renewable energy integration, smart grids and storage. Additionally, all of the MENA countries partners will need to cooperate to establish the institutions and procedures to allow for an equitable partnership.

PHASE OUT EXTENSIVE AND REGULATORY FRAMEWORK FOR THE IMPLEMENTATION OF A LARGE-SCALE RENEWABLE ENERGY PROJECT.

Energy policy-makers in the MENA countries should phase out an extensive regulatory framework and strategy for a large-scale clean energy implementation. There is a large consensus that competitive renewable energy market needs clear policies and legal procedures to attract the interest of private investors, mainly foreign investors. Innovative legal procedures may create a stable and predictable investment environment, thereby reducing the risk of project failure by ensuring predictable cash-flows.

GOVERNMENTS OF THE MENA REGION NEED TO WORK WITH THE FINANCIAL SECTOR TO IMPROVE THE ECONOMIC AND ECOLOGICAL SITUATION.

Environmental conditionality on loans, warranties offered by the government for entrepreneurs in counterpart of pro-environment projects, specific interest rates for responsible environmental and social investments are some examples of policies that the government should implement with the help of financial sector in order to build more sustainable economies. The financial sector can play a key role in educating investors to invest in the Renewable Energy Sector. Entrepreneurs in the MENA region do not observe the several opportunities offered by climate change and the increasing environmental awareness of consumers. The financial sector together with the government can help firms to exploit these sectors and share the risk with the start-up firms. Policy-makers need to consider the financial sector as part of the solution in MENA countries and involve them in the process of defining the environmental policies, their targets and strategies. Therefore, smoothing the availability of finances and using public funds to leverage and encourage firms to invest in R&D and large deployment of cost-efficient renewable energy technologies may play an important role in developing renewable energy technologies in the MENA region. More precisely, energy authorities should improve the subsidies availability, enhance incentives, and credit facilities with a low-interest rate.

RECONSIDER THE CONVENTIONAL FUELS SUBSIDIES TO IMPROVE MARKETS CONDITIONS IN WHICH CLEANER ENERGIES WILL BE COMPETITIVE.

Reforming fossil subsidies may play an important role in shaping renewable energy development in the MENA region, owing to the fact that high subsidies on conventional fuels may lead to unfair competition in the renewable energy sector, which makes renewable energy technologies uncompetitive compared to the conventional energy market.

ENHANCING AWARENESS ABOUT BENEFITS OF RENEWABLE ENERGY AMONG THE POPULATION MAY ALSO HAVE A POSITIVE IMPACT ON RENEWABLE ENERGY ADOPTION, MAINLY IN RURAL COMMUNITIES.

It is worth noting that lack of awareness and knowledge of renewable energy solutions and technologies across the population is a key barrier to the deployment of renewable energy. Therefore, increasing awareness of renewable energy benefits and sources across the population will be an additional prerequisite in galvanizing the development of renewable energy in MENA countries. This can be achieved by extensive information campaigns about renewable energy sources, technologies, and benefits, taking into account the population's socio-cultural attributes and practices.

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ANNEXES

ANNEX 1: ECONOMETRIC METHODOLOGY

EMPIRICAL MODEL

In this second part, we investigate whether economic growth, CO_2 emissions, oil prices, trade openness, and financial development are the main drivers of renewable energy consumption in 10 Arabian countries, namely Algeria, Egypt, Iraq, Jordan, Lebanon, Mauritania, Morocco, Tunisia, Saudi Arabia, and the United Arab Emirates. Following the works of Sadorsky (2009a) and Omri et al. (2015), the variables used in this research are selected on the basis of economic theory and data availability. These include renewable energy consumption, per capita CO2 emissions, oil prices, GDP per capita, trade openness, and financial development.

The empirical model that we develop in this study is consistent with the broader literature on the determinants of renewable energy consumption and takes the following form:

$$RE = f\left(CO_2, ROP, \mathrm{Y}, \mathrm{TO}, \mathrm{FD}\right) \quad (1)$$

where *RE* represents the renewable energy consumption and it is a function of four variables including CO_2 emissions (CO_2), real oil prices *(ROP)*, per capita GDP (*Y*), trade openness (*TO*), and financial development (FD). Since our empirical analysis involves a panel of countries, Eq. (1) can be linearized and written in a panel data form as

$$\ln RE_{i,t} = \alpha_0 + \alpha_1 \ln CO_{2i,t} + \alpha_2 \ln ROP_{i,t} + \alpha_3 \ln \mathrm{Y}_{i,t} + \alpha_4 \ln TO_{i,t} + \alpha_5 \ln FD_{i,t} + \varepsilon_{i,t} \quad (2)$$

where the subscript *i* (*i* =1,.., *N*) denotes the country *i* in our sample, with N being equal to 10. *t* (*t* =1,…, *T*) indicates the time period.

ESTIMATION PROCEDURES

To examine the macro-level determinants of the demand of renewable energy in Arab region, we propose an empirical methodology in 3 steps. Firstly, we analyze the cross-sectional dependence and check the stationarity of the series. Secondly, we perform a cointegration test to examine the long-run dynamics of cross-sectional dependence across countries. Thirdly, we estimate the long-run relationships among variables using appropriate panel long-run estimates (FMOLS and DOLS).

TESTING FOR CROSS-SECTIONAL DEPENDENCE AND PANEL UNIT ROOT

To test the presence of cross-sectional dependence of each variable, we use the Pesaran (2004) CD-test, which is an important step before applying panel unit root tests. The cross-sectional dependence test employs the correlation coefficients among the time-series for each panel member. For this test, the null hypothesis assumes cross-sectional independence against the alternative hypothesis of cross-sectional dependence. The rejection of the null hypothesis confirmed the existence of cross-sectional dependence across the countries. This statistic is asymptotically distributed as standard normal and efficient for the case of large samples and short time intervals.

The formula of the CD statistic is defined as

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}\right) \qquad (3)$$

Where $\hat{\rho}_{ij}$ is the estimate of

$$\rho_{ij} = \rho_{ji} = \frac{\sum_{t=1}^{T}\varepsilon_{it}\varepsilon_{jt}}{\left(\sum_{t=1}^{T}\varepsilon_{it}^{2}\right)^{1/2}\left(\sum_{t=1}^{T}\varepsilon_{jt}^{2}\right)^{1/2}}$$

The null hypothesis to be tested as: $\rho_{ij} = \rho_{ji} = corr(\varepsilon_{it}, \varepsilon_{jt}) = 0$ for i ≠ j and the alternative hypothesis to be tested is $\rho_{ij} = \rho_{ji} \neq 0$ for some i ≠ j. This statistic, therefore, involves the sum of the different correlations between the residues of each section. The term before the summation of correlations is simply a term of standardization. This statistic follows asymptotically in N a standard normal distribution (N (0; 1)). Therefore, the null hypothesis of independence is rejected when the absolute value of the CD is too great (with a 95 per cent confidence level, it is rejected for absolute values higher than 1.96).

Considering potential cross-sectional dependence, the first generation unit root tests tend to over-reject the null hypothesis, and stationary of the series has been analyzed with one of the second generation unit root test that is the cross-sectionally augmented IPS (CIPS) unit root test. This test is an extension of the CIPS test of Im et al. (2003), which is based on the average of individual Augmented Dickey-Fuller (CADF) test. Pesaran's test considers both heterogeneity and cross-sectional dependence across panels, and is considered a popular second-generation panel unit root test.

$$CIPS = \frac{1}{N}\sum_{i=1}^{N}CADF_i \qquad (4)$$

The CIPS test is specified as such:

In addition to taking into account cross-sectional dependence, the Pesaran test (2007) also assumes the heterogeneity of the parameters. For this test, the null hypothesis H0 is that each individual time series contains a unit root. The alternative hypothesis is that some of the series are stationary.

PANEL COINTEGRATION TESTS

The cointegration analysis leads to identify one or more long-term relationships between at least two variables. Any deviation from these long-term relationships initiates an adjustment process commonly referred to as the error correction process. If two or more series are non-stationary, but at least one linear combination of these series is stationary, then these series are considered cointegrated. The concept of cointegration stipulates that at least two variables are involved in a long-run equilibrium relationship. Accordingly, this study considers whether a possible long-run equilibrium relationship exists among renewable energy, economic growth, CO_2 emissions, oil prices, trade openness, and financial development.

After checking the non-stationarity of the variables for a panel data as a whole, it is natural to test the presence of a long-run equilibrium relationship between the selected variables. Pedroni's (2004) approach for panel data will be used in this study. This approach is based on seven non-cointegration tests that are based on the residue estimate of the following regression:

$$Y_{i,t} = \alpha_i + \rho_i t + \beta_i x_{i,t} + \mu_{it}; i = 1,2...,N, t = 1,2,...,T \qquad (5)$$

where x is a vector of regressors and ß are the estimated coefficients. As previously mentioned, the tests are based on the properties of the residues. Pedroni's approach makes it possible to identify one or more cointegration relationships in the presence of heterogeneous panels. The presence of heterogeneous coefficients, fixed effects and deterministic trend are allowed in the model. Pedroni (1999, 2004) panel cointegration test proposes seven different statistics to test for cointegration relationship in the heterogeneous panel, which are classified into within dimension and between dimensions statistics. The former group are referred to as panel cointegration statistics, while the latter statistics are called group mean panel cointegration statistics.

Panel v-Statistic:

$$Z_v \equiv T^2 N^{3/2} \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\kappa}_{11,i}^{-2} \hat{\mu}_{it-1}^{2} \right)^{-1} \qquad (6)$$

Panel ρ -statistic:

$$Z_p \equiv T\sqrt{N} \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\kappa}_{11,i}^{-2} \hat{\mu}_{it-1}^{2} \right)^{-1} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\kappa}_{11,i}^{-2} \left(\hat{\mu}_{it-1} \Delta \hat{\mu}_{it} - \hat{\lambda}_i \right) \qquad (7)$$

Panel t-statistic (non-parametric):

$$Z_t \equiv \left(\tilde{\sigma}^2 \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\kappa}_{11,i}^{-2} \hat{\mu}_{it-1}^{2} \right)^{-1/2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\kappa}_{11,i}^{-2} \left(\hat{\mu}_{it-1} \Delta \hat{\mu}_{it} - \hat{\lambda}_i \right) \qquad (8)$$

Panel t-statistic (parametric):

$$Z_t^* \equiv \left(\tilde{s}^{*2}_{N,T}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{\kappa}_{11,i}^{-2}\hat{\mu}_{it-1}^{2}\right)^{-1/2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{\kappa}_{11,i}^{-2}\hat{\mu}^{*}_{it-1}\Delta\hat{\mu}^{*}_{it} \qquad (9)$$

Group ρ-statistic:

$$Z_t^* \equiv \left(\tilde{s}^{*2}_{N,T}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{\kappa}_{11,i}^{-2}\hat{\mu}_{it-1}^{2}\right)^{-1/2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{\kappa}_{11,i}^{-2}\hat{\mu}^{*}_{it-1}\Delta\hat{\mu}^{*}_{it} \qquad (10)$$

Group t-statistic (non-parametric):

$$\tilde{Z}_t \equiv N^{-1/2}\sum_{i=1}^{N}\left(\hat{\sigma}_i^{2}\sum_{t=1}^{T}\hat{\mu}_{it-1}^{2}\right)^{-1/2}\sum_{t=1}^{T}\left(\hat{\mu}_{it-1}\Delta\hat{\mu}_{it}-\hat{\lambda}_i\right) \qquad (11)$$

Group t-statistic (parametric):

$$\tilde{Z}_t^* \equiv N^{-1/2}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\tilde{s}^{*2}\hat{\mu}_{it-1}^{2}\right)^{-1/2}\sum_{t=1}^{T}\hat{\mu}^{*}_{it-1}\Delta\hat{\mu}^{*}_{it} \qquad (12)$$

Where $\hat{\lambda}_i = \frac{1}{2}(\hat{\sigma}_i^2 - \hat{s}_i^2)$ and $\tilde{s}^{*2}_{N,T} = \frac{1}{N}\sum_{i=1}^{N}\hat{s}^{*2}$

Both categories of tests are based on the null hypothesis of absence of cointegration: H_0: *Y*=1; where *Y* denotes the autoregressive term of estimated residues under the alternative hypothesis.

FMOLS AND DOLS LONG-RUN ESTIMATES

After we find that all variables for sub-panels countries are cointegrated, we must found the long-run coefficient estimates of the independent variables. Various techniques exist, such as the Fully Modified Ordinary Least Squares (FMOLS) method initially proposed by Phillips and Hansen (1990), or the Dynamic Ordinary Least Squares (DOLS) method of Saikkonen (1991), Stock and Watson (1993). In the case of panel data, Kao and Chiang (2000) showed that these two techniques lead to estimators whose bias is asymptotically distributed according to a normal distribution. Similar results are obtained by Pedroni (1996), Phillips and Moon (1999) for the FMOLS method. The advantage of using these estimators is that they are also quite effective in eliminating the endogeneity issues in the regressors and serial correlations in the error terms and so the variables also have asymptotic properties. The FMOLS estimator help in resolving the problem of endogeneity among independent variables and the problem of correlation between estimators, while the DOLS estimator eliminates the problem of correlation among independents variables (Ramirez, 2006).

The panel FMOLS estimator for the coefficient β is defined as:

$$\hat{\beta} = N^{-1}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}(y_{it}-\bar{y})^2\right)^{-1}\left(\sum_{t=1}^{T}(y_{it}-\bar{y})\right)z_{it}^{*} - T\hat{\eta}_i \qquad (13)$$

W $z_{it}^{*} = (z_{it}-\bar{z}) - \frac{\hat{L}_{21i}}{\hat{L}_{22i}}\Delta y_{it}$, $\hat{\eta}_i \equiv \hat{\Gamma}_{21i} + \hat{\Omega}_{21i}^{0} - \frac{\hat{L}_{21i}}{\hat{L}_{22i}}(\hat{\Gamma}_{22i} + \hat{\Omega}_{22i}^{0})$

and $\hat{L}_i$ is a lower triangular decomposition of $\hat{\Omega}_i$

The associated t-statistics gives:

$$t_{\hat{\beta}^*} = N^{-1/2}\sum_{i=1}^{N} t_{\hat{\beta}^*,i} \quad \text{Where} \quad t_{\hat{\beta}^*,i} = \left(\hat{\beta}_i^* - \beta_0\right)\left[\hat{\Omega}_{11i}^{-1}\sum_{t=1}^{T}(y_{it}-\bar{y})^2\right]^{1/2} \qquad (14)$$

The panel DOLS estimator for the coefficient β is defined as:

$$\beta^{\wedge\cdot\cdot} = \frac{1}{N}\sum_{i=1}^{N} \square \left[\left(\sum_{t=1}^{T}(Z_{i,t}Z_{i,t})\right)^{-1}\left(\sum_{t=1}^{T} Z_{i,t}\, w_{i,t}\right)\right] \qquad (15)$$

Where

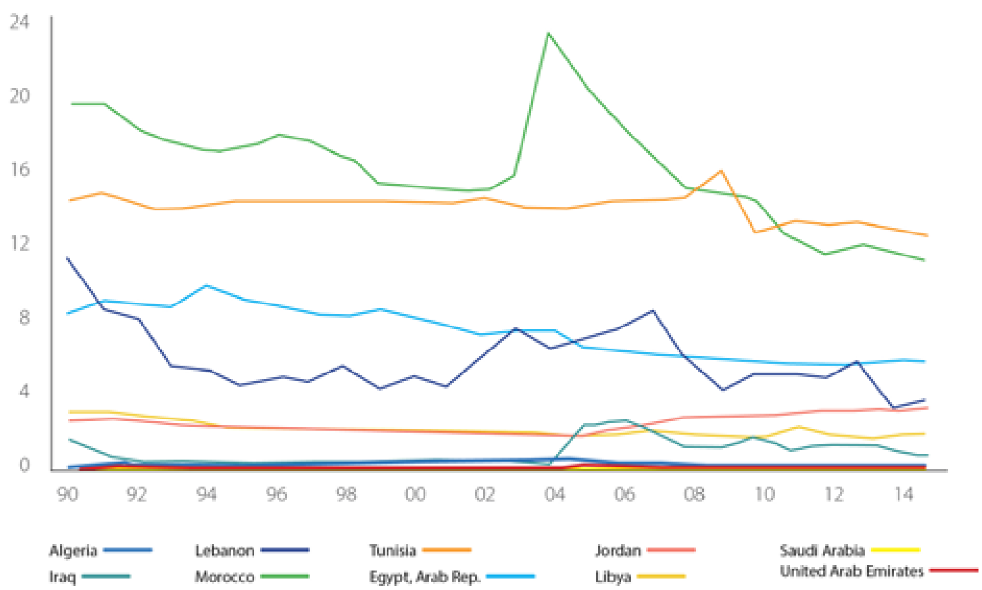
$Z_{i,t} = \left[X_{i,t} - \bar{x}_i, \Delta X_{i,t-K_i}, \dots, \Delta X_{i,t+K_i}\right]$ is vector of regressors, and $\tilde{w}_{i,t} = w_{i,t} - \overrightarrow{w_i}$

ANNEX 2: DESCRIPTIVE STATISTICS

The table below reports some descriptive statistics and correlations of the series of variables used in the study over the 1990–2015 period. Renewable energy ranges from 0.005 to 23.505 million kwh. The annual average of renewable energy consumption is 4.943 million kwh. Per capita gross domestic product ranges from US$1427.92 to US $ 67606.91. The annual average of renewable energy consumption is 10756.37 million kwh. With regard to real oil prices, the range is from US$14.385 to US$ 100.062. The annual average of renewable energy consumption is US$ 46.83. CO2 emissions variable ranges from 0.946 to 35.678 metric tons per capita. The annual average of CO2 emissions per capita is 6.846 metric tons per capita. According to the IEA (2014), the MENA region is positioned in the second place after North America in CO2 emissions, with 9 metric tons of CO2 per capita; which is higher than the average value for Africa (1.1), Asia (3.7), Europe (7.1), and even higher than the world average (4.6). In addition, international trade as per cent of GDP ranges from 0.020 to 175.221. The annual average of foreign trade as share of GDP is 81.3. Finally, financial development, defined as domestic credit provided by financial sector, ranges from -114.693 to 196.231. The annual average of domestic credit provided by financial sector as share of GDP is 62.052. **This table also shows that per capita GDP and per capita CO2 emissions have the highest correlation with renewable energy consumption, while the lowest correlation is found for the oil prices variable**. Trade openness also has the highest correlation with per capita GDP, indicating that trade plays an important role in fostering economic growth. Per capita GDP, financial development, and international trade have a positive correlation on renewable energy consumption, which means that an increase in these variables leads to more renewable energy demand. As shown in Fig.1, regarding the renewable energy variable, Morocco and Tunisia have the highest level of renewable energy consumption, while the United Arab Emirates and Saudi Arabia have the highest levels of per capita CO2 emissions and per capita GDP during the whole period 1990-2015.

	RE_{it}	Y_{it}	ROP_{it}	$CO2_{it}$	TO_{it}	FD_{it}
Mean	4.943	10756.37	46.829	6.846	81.300	62.052
Standard deviation	5.758	15518.56	30.063	7.461	33.015	52.456
Minimum	0.005	1427.921	14.385	0.946	0.020	-114.693
Maximum	23.505	67606.91	100.062	35.678	175.221	196.231
RE_{it}	1					
Y_{it}	0.362	1				
ROP_{it}	-0.105	0.255	1			
$CO2_{it}$	-0.442	0.493	0.121	1		
TO_{it}	0.193	0.558	0.393	0.303	1	
FD_{it}	0.291	0.167	-0.129	0.280	0.014	1

REC **CO_2**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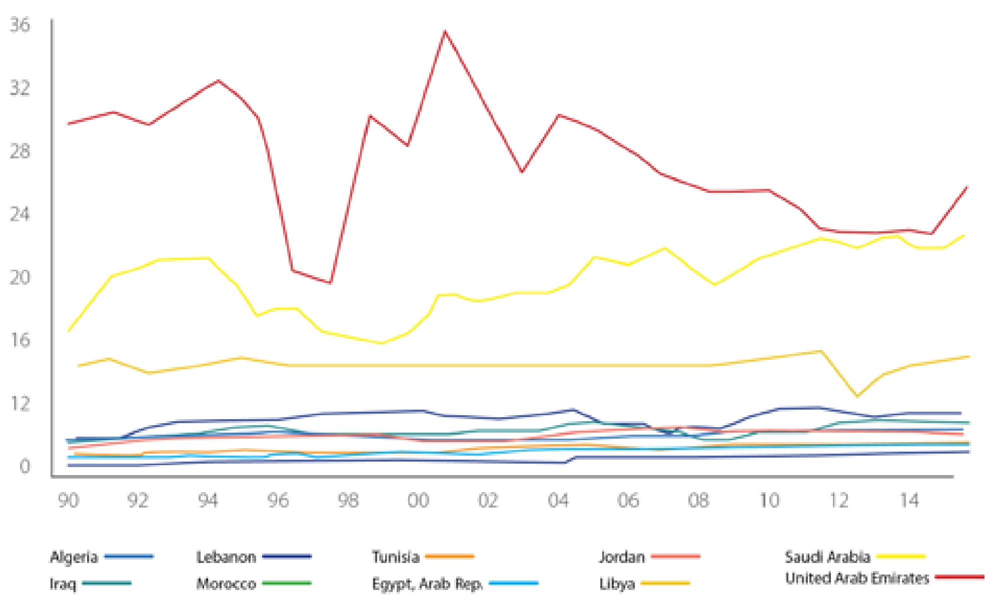
Libya
United Arab Emirates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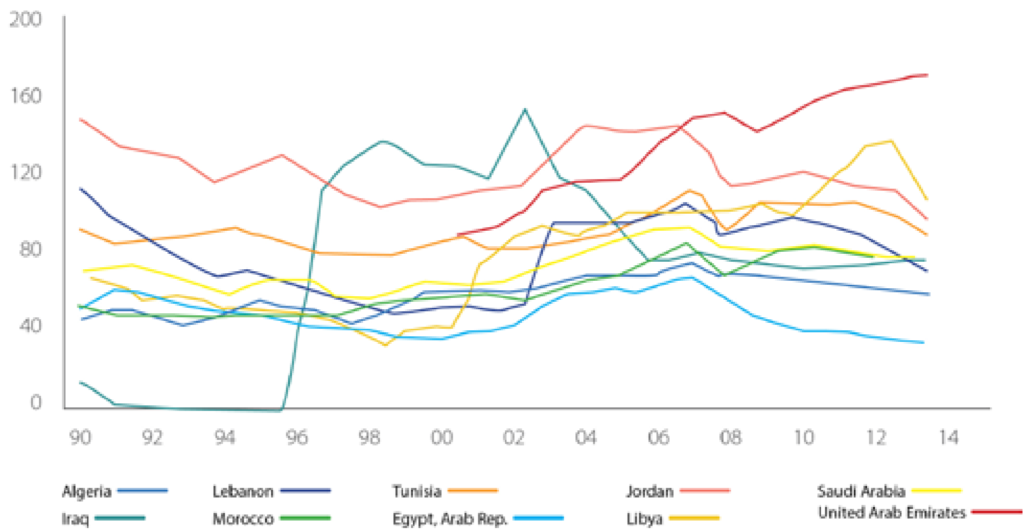
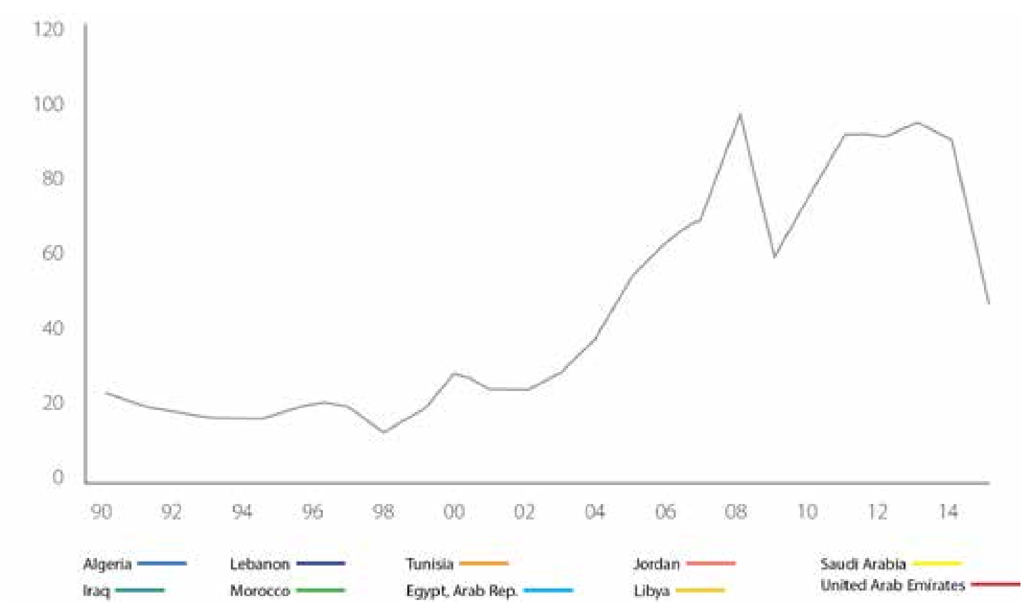
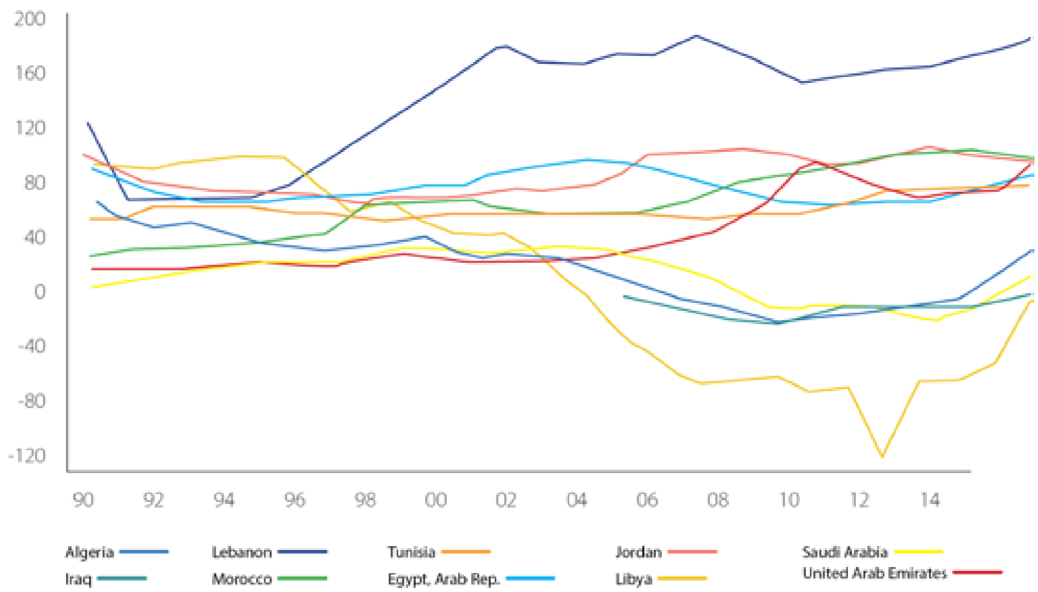
Trade **Oil prices**







Source: Compiled from World Bank Development Indicators (WDI), BP Statistical Review of World Energy, and the U.S. Energy Information Administration (EIA).

ANNEX 3: RENEWABLE ENERGY PROJECTS UNDER CONSTRUCTION OR PLANNED IN THE ARAB REGION

Algeria	MW
Khenchela	20
Distributed projects at different sites	73
Guelma	5
North and Upper Platheus	343
North and Upper Platheus	5010

Lebanon	MW
Systems under the National Energy Efficiency and Renewable Energy Action (NEEREA)	30
To be confirmed, under bidding process	60-100

Mauritania	MW
Nouakchott	30
Nouakchott	30

Oman	MW
Amal Oil Field	1021
Dhofar Wind Farm	50

Egypt	MW
Gabal El-Zayt	220
Gulf of El-Zayt	120
FiT windprojects	2000
FiT PV projects	2300

Libya	MW
Darnah	60
Al-Magron I	80
Al-Magron I	120
Al-Jofra	14
Houn	14
Sebha	40

State of Palestine	MW
Tubas	470
Jericho	700

Jordan	MW
Maan	75
Shamsuna Aqaba	10
Al Quaira / Al Aqaba	150
Al Mafraq	10
NEPCO/Masdar	200
Additionalprojects	400
Additionalprojects	230
Al Fagig / Al Shobk	90

Morocco	MW
Taza	150
Tanger II	100
JbelKhalladi	120
Boujdour	100
Tiskrad	300
Midelt	150
JbelLahdid	200
Noor II	200
Noor III	150

Qatar	MW
Duhail	10
Kahramaaproject	100

SaudiArabia	MW
Al Khafji	15
Mecca	100
Green Duba ISCC	50

Kuwait	MW
Shagaya RE Complex I	10
Shagaya RE Complex I	10
Shagaya RE Complex I	10

Djibouti	MW
Grand Bara	300

UAE	MW
Dubai MBR Solar Park Phase 2	470
Abu Dhabi Solar Park (including Noor 1 project)	700

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