



# NOTA DI LAVORO

30.2015

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**The Future of Renewable  
Energy in the Mediterranean.  
*Translating Potential into  
Reality***

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## Energy: Resources and Markets Interim Series Editor: Matteo Manera

### The Future of Renewable Energy in the Mediterranean. *Translating Potential into Reality*

By Simone Tagliapietra, Fondazione Eni Enrico Mattei

#### Summary

This study seeks to provide a clear and comprehensive overview on the various aspects related to the current status and the future prospects of renewable energy (namely solar and wind) in Southern and Eastern Mediterranean countries (SEMCs). In order to do so, the study will first provide a comprehensive analysis of the regional energy market, particularly focusing on the booming energy -and electricity- demand. This key trend is likely to further accelerate in the future, at a level that might create additional risks to the economic sustainability of the region, considering the extensive use of universal fossil-fuel consumption subsidies. Meanwhile, solar and wind energy continue to cover less than 1% of the region's electricity generation mix: a figure that strongly collides with the region's abundant solar and wind resources. In fact, SEMCs are endowed with a huge solar and wind energy potential. The exploitation of this potential could bring various benefits to the region, such as meeting the rising energy/electricity demand at a lower cost, freeing up additional export volumes of oil and gas in energy exporting countries, reducing energy bills in energy importing countries, creating new jobs, alleviating energy poverty, enhancing the quality of the environment and enhancing cooperation both among SEMCs and between SEMCs and the EU. Notwithstanding all the efforts to promote renewable energy carried out over the last decade both at the regional level and at the European level (e.g. Desertec, Mediterranean Solar Plan, etc.), SEMCs continue to lag far behind most other regions in the world in terms of solar and wind energy deployment. This study will try to explore the reasons of this paradox, particularly focusing on the key barriers to the development of renewable energy in the region: the extensive use of energy subsidies and the lack of adequate electricity infrastructures, energy regulatory frameworks and financing mechanisms. On the basis of this in-depth analysis, the study will propose an innovative approach to tackle these barriers, involving a joint action of MedTSO, MEDREG and key financial institutions under the umbrella of a newly-established "Euro-Med Renewable Energy Platform" designed to become -on the basis of an inclusive, pragmatic and bottom-up approach- the new catalyst for the development of renewable energy in SEMCs.

**Keywords:** Mediterranean Energy Markets, Renewable Energy, CSP, Solar Energy, Wind Energy

**JEL Classification:** Q40, Q42, Q48

*This paper represents the seventh outcome of the FEEM research project "The rise of Turkey and the new Mediterranean. Challenges and opportunities for energy cooperation in a region in transition". This project analyses how energy could represent a major tool to strengthen the economic, political and social integration in the enlarged Euro-Mediterranean region. The project focuses particularly on Turkey, a country considered as crucial for both the EU energy security and for the regional balance of power in the aftermath of the so-called "Arab Spring".*

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## Introduction

This study seeks to provide a clear and comprehensive overview on the various aspects related to the current status and the future prospects of renewable energy in the Southern and Eastern Mediterranean region (Morocco, Algeria, Tunisia, Libya, Egypt, Israel, Palestinian Territories, Jordan, Lebanon, Syria and Turkey).

For the sake of simplicity and given the region's natural endowment, this study exclusively focuses on solar energy (i.e. concentrating solar power and photovoltaic) and wind energy.

In order to pursue its aim, the study will first provide a detailed snapshot of the regional energy landscape, analysing the past, current and future trends of the region in terms of energy demand and supply, energy consumption, energy efficiency, energy production and electricity demand and supply.

This analysis will reveal that the Southern and Eastern Mediterranean is among the most rapidly growing regions in the world in terms of energy demand. This trend particularly concerns the electricity market, which has grown dramatically over the last few decades mainly due to the economic and demographic expansion of the region, but also to other dynamics such as urbanization, growth in living standards and progressive economic transformation towards the tertiary sector. This trend is likely to further accelerate in the future, at a level that might generate a number of risks for the economic sustainability of the region.

In fact, the regional electricity generation mix is still predominated by fossil fuels (55% gas, 16% coal, 16% oil) and due to the implementation of universal fossil-fuel consumption subsidies, this situation generates an unsustainable burden on the public finances of both energy importing and energy exporting countries in the region. Meanwhile, solar and wind energy continue to cover less than 1% of the region's electricity generation mix: a figure that strongly collides with the region's abundant solar and wind resources.

As a matter of fact, Southern and Eastern Mediterranean countries (SEMCs) are endowed with a huge solar and wind energy potential. Various scientific analyses, also widely discussed in this study, have demonstrated that the regional economic potential for CSP, photovoltaic and wind power is among the highest in the world. Such an abundant solar and wind energy endowment could bring various benefits to the region, such as meeting the rising energy/electricity demand at a lower cost, freeing up additional export volumes of oil and gas in energy exporting countries, considerably reducing energy bills in energy importing countries, creating new jobs, alleviating energy poverty, enhancing the quality of the environment and enhancing cooperation both among SEMCs and between SEMCs and the EU.

Over the last decade, this important renewable energy potential -with all its related potential benefits- has progressively paved the way for the launch of various large-scale renewable energy projects in the region: Desertec, the Mediterranean Solar Plan, MedGrid and Res4Med. The basic idea on which all these projects have been

developed is to export solar and wind electricity produced in SEMCs to the EU via electricity interconnections to be built between the two shores of the Mediterranean. However, the economic and financial crisis on the one hand, and the Arab uprisings on the other hand, have considerably diminished that initial enthusiasm, also leading the promoters of these projects to reconsider their initial concept. Furthermore, SEMCs' abundant solar and wind energy resources did not only paved the way for the conceptualization of European-based, large-scale renewable energy projects but also for the development of national plans within SEMCs themselves, involving a series of targets for the development of solar and wind energy, typically by 2020 and/or 2030. These national plans have been often accompanied by the establishment of national renewable energy agencies aimed at supporting the deployment of renewable energy by complementing the activities of the energy ministries and of the energy regulatory authorities.

Notwithstanding all these efforts, SEMCs continue to lag far behind most other regions in the world in terms of solar and wind energy deployment.

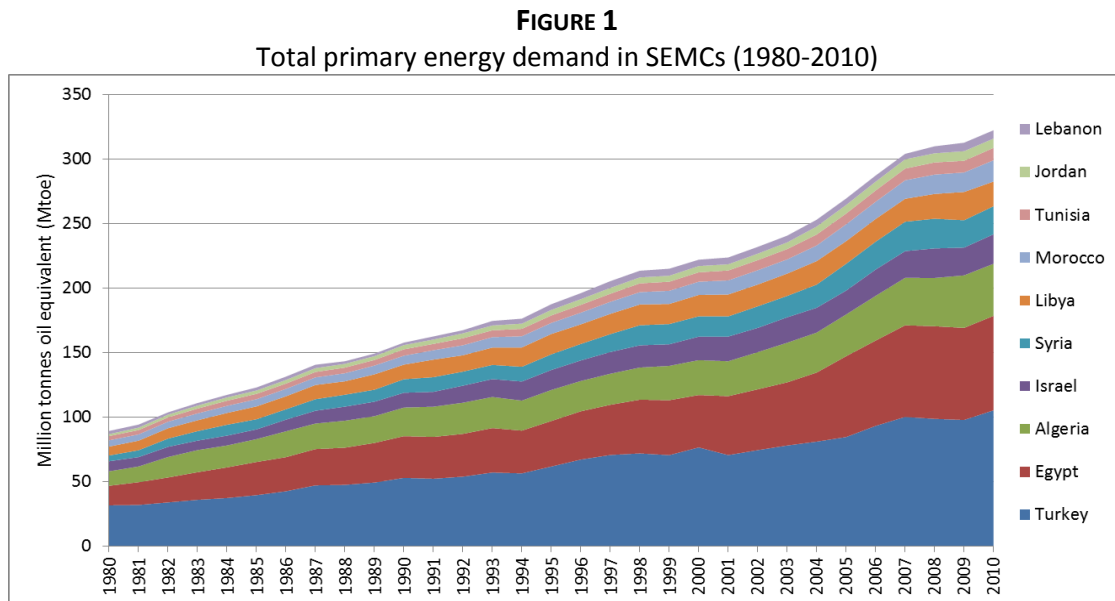
This study will try to explore the reasons of this paradox, particularly focusing on the key barriers to the development of renewable energy in the region: a) The extensive use of universal energy subsidies; b) The lack of an adequate electricity infrastructure; c) The lack of a stable and harmonized energy regulatory framework; d) The lack of adequate financing mechanisms for the support of renewable energy.

On the basis of this analysis, the study will propose an innovative approach to tackle these barriers, involving a joint action of MedTSO (Association of the Mediterranean Transmission System Operators), MEDREG (Association of the Mediterranean Energy Regulators), key European financial institutions (i.e. EIB, EBRD) and selected institutional investors (i.e. sovereign wealth funds, pension funds, etc.) under the umbrella of a newly-established "Euro-Med Renewable Energy Platform" designed to become -on the basis of an inclusive, pragmatic and bottom-up approach- the new catalyst for the development of renewable energy in the Southern and Eastern Mediterranean region.

## 1. The Southern and Eastern Mediterranean Energy Landscape

### 1.1 Energy Demand and Supply

The primary energy demand of SEMCs<sup>1</sup> has progressively increased over the last few decades, and most notably after the early 2000s, due to various factors such as rapid population growth, urbanisation, economic growth and low energy efficiency (Fig. 1).



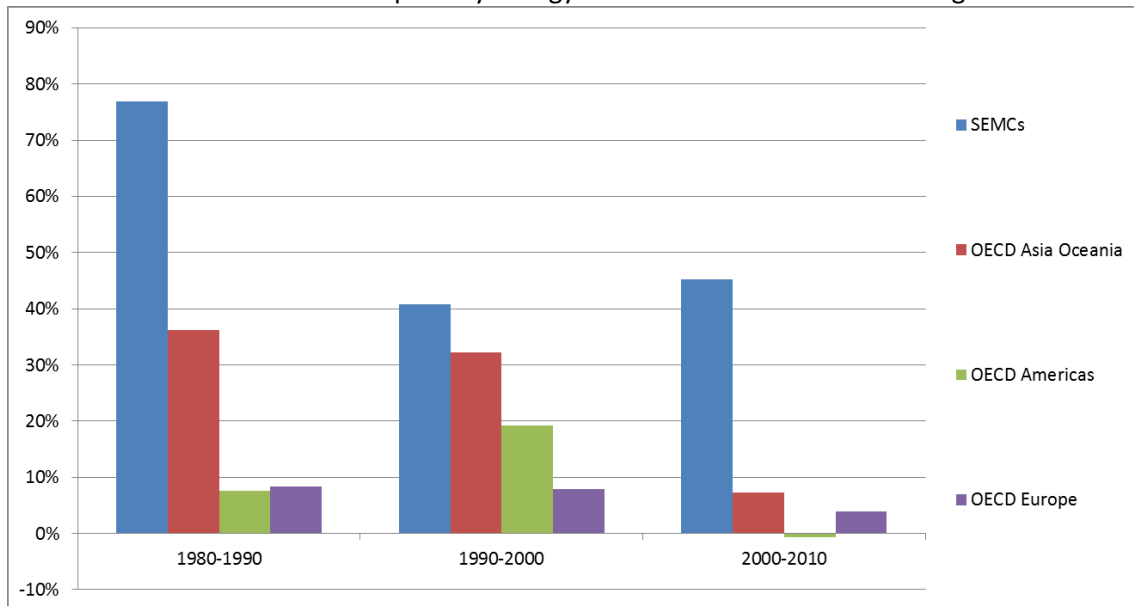
Source: own elaboration on International Energy Agency, Extended World Energy Balances Database, accessed in May 2014.

In absolute numbers, the primary energy demand in SEMCs grew from 89 million tonnes oil equivalent (Mtoe) in 1980 to 157 Mtoe in 1990, to 221 Mtoe in 2000 and to 322 Mtoe in 2010. Presented in this way, these figures might not be very expressive. However, they can become more useful if translated into growth rates. Such a perspective reveals that the primary energy demand in SEMCs rose by 77% between 1980 and 1990, by 41% between 1990 and 2000 and by 45% between 2000 and 2010. These growth rates are even more interesting if compared with other regions in the world.

In fact, over the last few decades the growth rates of primary energy demand in SEMCs well surpassed -in comparative terms- the ones of OECD Asia Oceania, OECD Americas and OECD Europe: the world's three key economic areas (Fig. 2).

<sup>1</sup> Calculated by the International Energy Agency (IEA) as total primary energy supply (TPES): production of fuels + inputs from other sources + imports - exports - international marine bunkers + stock changes.

**FIGURE 2**  
Growth rates of total primary energy demand in SEMCs and other regions

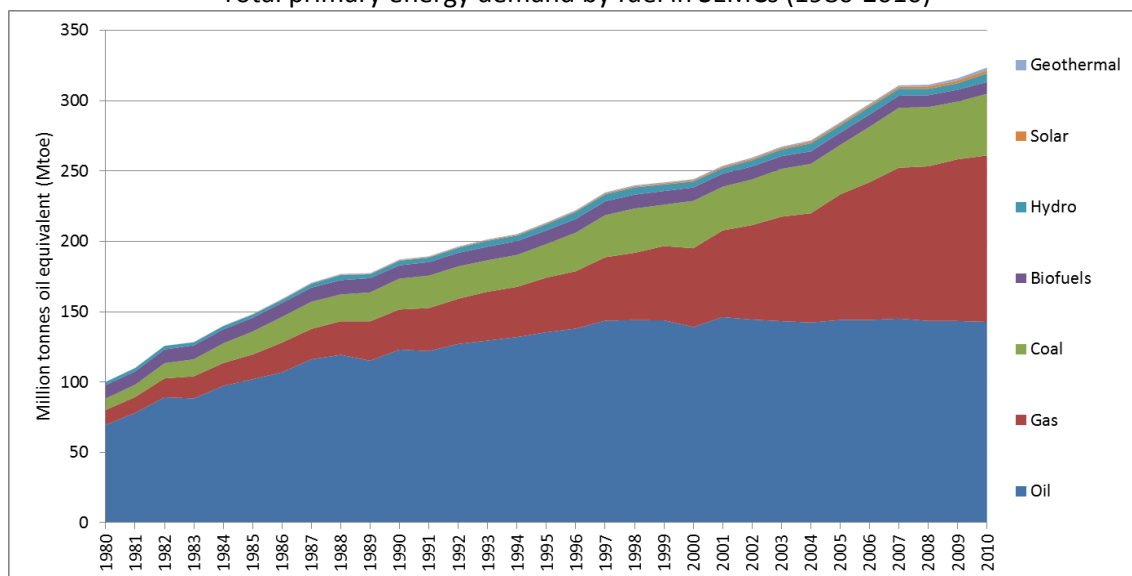


Source: own elaboration on International Energy Agency, Extended World Energy Balances Database, accessed in May 2014.

This trend, before significantly accentuated in the 1980s and then less pronounced in the 1990s, is particularly interesting in relation to the first decade of the 2000s. In fact, in this period of time the growth rate of primary energy demand in SEMCs strongly exceeded the one of OECD Asia Oceania, an area generally considered as the key driver of energy demand worldwide. This figure clearly exemplifies how rapid and consistent the evolution of primary energy demand in SEMCs currently is.

But how is the primary energy demand in SEMCs actually composed? Today the fuel mix of SEMCs is composed as follow: 44% oil, 36% natural gas, 13% coal, 2% hydro, 5% other renewable energy sources (biofuels, geothermal, solar, wind). The composition of this fuel mix considerably changed over the last few decades, in particular as far as the shares of oil and natural gas are concerned (Fig. 3).

**FIGURE 3**  
 Total primary energy demand by fuel in SEMCs (1980-2010)



Source: own elaboration on International Energy Agency, World Energy Balances Database, accessed in May 2014.

Oil has been the dominant component of the region’s fuel mix for a long time and, mainly due to the transport sector, it continues to maintain its major share. In absolute terms, its demand increased from 70 Mtoe in 1980 to 140 Mtoe in 2000, a plateau level that later characterized all the first decade of the 2000s. However, in relative terms its share in the region’s fuel mix dramatically fallen from a level of 70% in 1980 to a level of 44% in 2010.

This major change was due to the increased use of natural gas in electricity generation, also allowed by the attractive prices and easy availability due to the newly discovered natural gas resources in the region. As a result of this trend, the share of natural gas in the region’s fuel mix boomed from a level of 10% in 1980 to a level of 36% in 2010.

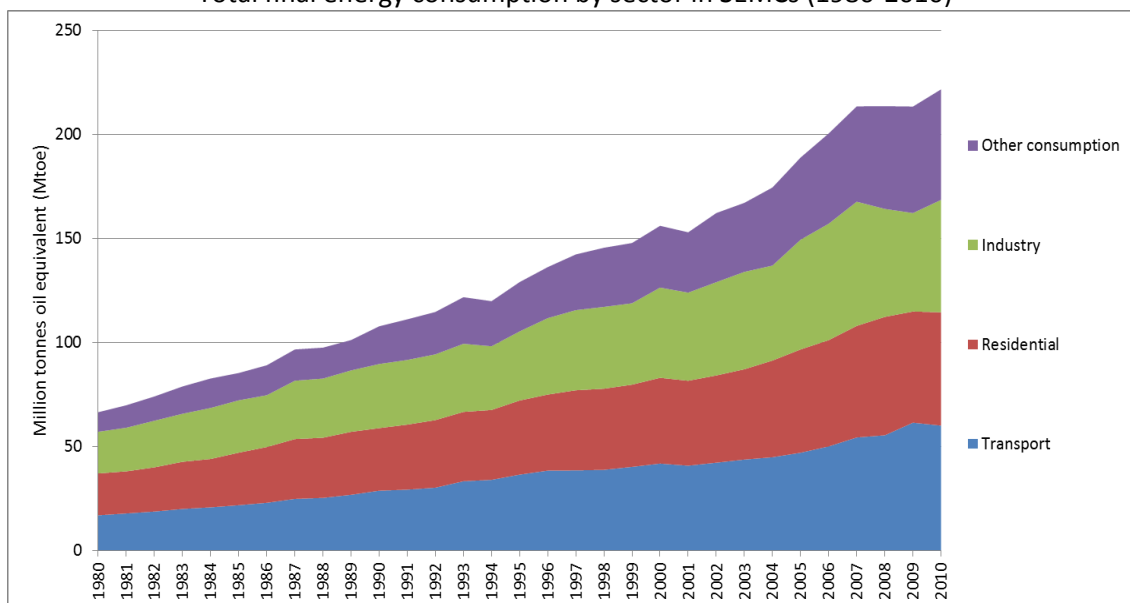
Finally, over the last few decades coal, biofuels and hydro have substantially maintained their shares in the region’s fuel mix.

## 1.2 Energy Consumption and Efficiency

In parallel to the growing primary energy demand, over the last few decades the total final energy consumption (TFC) of SEMCs also experienced a considerable growth. In fact, in absolute terms TFC in SEMCs grew from 66 Mtoe in 1980 to 107 Mtoe in 1990, to 156 Mtoe in 2000 and to 222 Mtoe in 2010 (Fig. 4). Transport remained a predominant energy consuming sector throughout the period of reference, followed by the residential sector, industry and other consumption sectors (a category that combines segments of the economy such as agriculture, tourism, commercial and public sector).



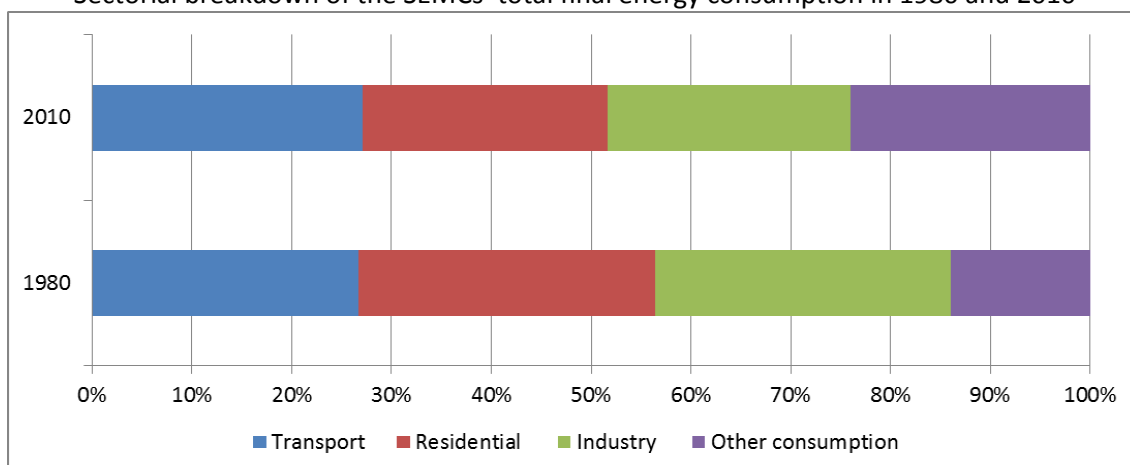
**FIGURE 4**  
 Total final energy consumption by sector in SEMCs (1980-2010)



Source: own elaboration on International Energy Agency, Extended World Energy Balances Database, accessed in May 2014.

In relative terms, from 1980 to 2010 the transport sector maintained its share of 27% in the region’s TFC, while the residential sector declined from 30% to 25% and the industry also fallen from 29% to 24%. Only the category of other consumption sectors actually increased its share, from 14% to 24% (Fig. 5). This significant expansion was due to an increased use of energy in agriculture (+5%) and commercial and public sector (+5%) between 1980 and 2010.

**FIGURE 5**  
 Sectorial breakdown of the SEMCs’ total final energy consumption in 1980 and 2010



Source: own elaboration on International Energy Agency, Extended World Energy Balances Database, accessed in May 2014.

When discussing energy consumption trends it is necessary to take into consideration how efficiently energy is actually consumed. It is thus necessary to analyse energy efficiency, which is -by the way- the most cost effective way to enhance security of energy supply, to reduce emissions of greenhouse gases and to enhance economic competitiveness at one fell swoop. For decades, the significance of energy efficiency was undervalued and its potential role in the energy mix discussed, sometimes dismissively so, all over the world. This was due to the fact that, in contrast to supply-side options, energy efficiency options are often obscured as efficiency is rarely traded or priced. Furthermore, improving efficiency involves a wide range of actions affecting a variety of energy services across different sectors -including buildings, industry and transport- so the overall achievement is often difficult to quantify. But today, as Yergin correctly points out, «energy efficiency has moved from contention to consensus. Environmental groups and energy companies agree that it should be at the top of the agenda of what needs to be done. Indeed, efficiency could well be called the "first fuel"»<sup>2</sup>.

Energy intensity, defined as the amount of energy used to produce a unit of GDP<sup>3</sup>, is the indicator generally used to measure the energy efficiency of a nation's economy. As an overall trend, the world's energy intensity has fallen over the last decades, primarily as a result of efficiency improvements in the power and end-use sectors and a transition away from energy-intensive industries. However, the rate of decline in energy intensity has widely differed from country to country. For instance, the best performers in terms of energy intensity reduction have been the United States and Japan, which started to lower their energy intensity already in the second half of the 1970s, when the oil crises of 1973 and 1979 seriously impacted their economies.

On the contrary, SEMCs (albeit starting from a structural lower level of energy intensity) have not considerably improved their energy efficiency performances over the last few decades and for this reason the energy intensity in SEMCs remains today up to two times higher than in the EU (Tab. 1). This signifies that up to two times more energy is consumed in some SEMCs per unit of GDP PPP, relative to the best performers in the EU.

Without additional efforts for energy efficiency, the TFC in SEMCs will thus continue to grow substantially in the future, putting pressure on existing infrastructure and creating an urgent need of large investments in electricity, oil and natural gas.

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<sup>2</sup> Yergin (2011).

<sup>3</sup> As Suehiro (2007) points out, it is impossible to accurately evaluate how advanced a country's energy conservation is and measure it against that of other countries, which are different not only in terms of their economies and welfare but also in natural and social conditions. However, energy intensity of GDP is often used to see a country's energy conservation level as the approximate index. The problem is that this index largely differs depending on the currency conversion rate. Conversion based on market exchange rates (MERs) tends to overestimate the GDP of countries that have higher prices, while conversion based on purchasing power parity (PPP) tends to overestimate the GDP of countries with lower prices. This means energy intensity based on MERs is advantageous to advanced countries with higher prices and that based on PPP is advantageous to developing countries with lower prices.

**TABLE 1**  
Final energy intensity 1980-2008 in thousand tonnes oil equivalent per \$ GDP (PPP) 2005

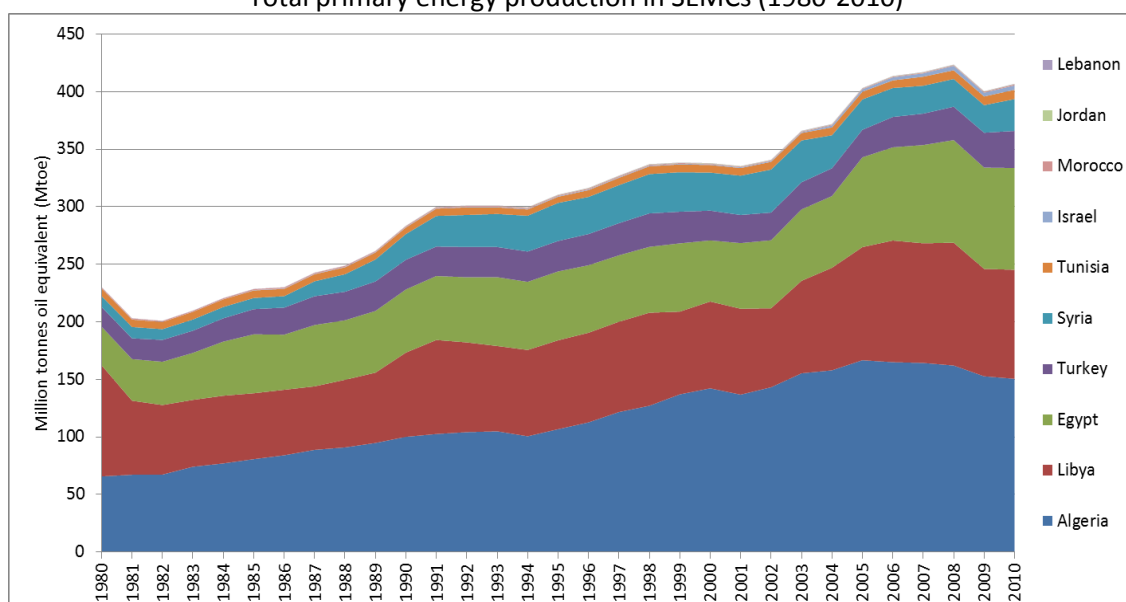
	1980	1990	2000	2008	2000-8 change (%)
Algeria	0.055	0.080	0.081	0.100	2.7
Egypt	0.112	0.115	0.105	0.112	0.8
Israel	0.080	0.082	0.078	0.069	-1.5
Jordan	0.121	0.207	0.195	0.154	-2.9
Lebanon	0.094	0.090	0.110	0.060	-7.3
Libya	0.134	0.274	0.121	0.106	-1.6
Morocco	0.083	0.072	0.085	0.086	0.2
Syria	0.134	0.215	0.165	0.121	-3.8
Tunisia	0.101	0.113	0.104	0.085	-2.5
Turkey	0.132	0.118	0.119	0.109	-1.1
EU-27	0.135	0.109	0.091	0.080	-1.6

Source: Blanc (2012, p.4) based on WEC, Enerdata - Global Energy & CO<sub>2</sub> Data.

### 1.3 Energy Production

The total primary energy production in the Southern and Eastern Mediterranean region grew from 230 Mtoe in 1980 to 283 Mtoe in 1990, to 338 Mtoe in 2000 and to 407 Mtoe in 2010. Three countries cover about 80% of the region's energy production: Algeria, Libya and Egypt (Fig. 6).

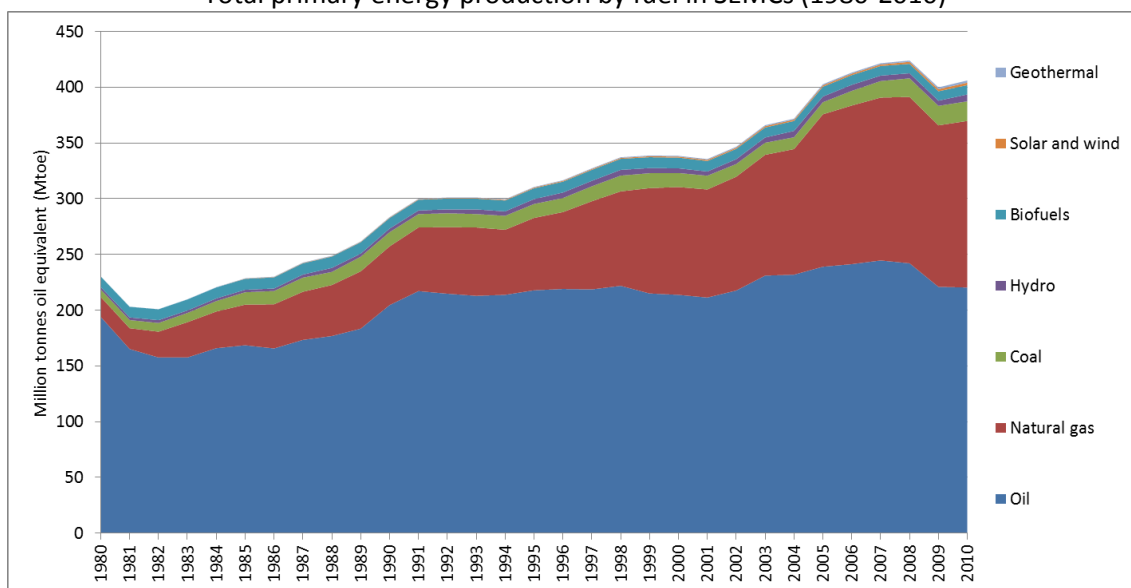
**FIGURE 6**  
Total primary energy production in SEMCs (1980-2010)



Source: own elaboration on International Energy Agency, Extended World Energy Balances Database, accessed in May 2014.

Oil has always been -and continues to remain- the first fuel produced in SEMCs. The SEMCs' oil production remained practically constant over time, ranging from 194 Mtoe in 1980 to 200 Mtoe in 2010. Over the last few decades natural gas has been the real game changer of SEMCs' primary energy production. In fact, natural gas production boomed from a level of 17 Mtoe in 1980 to a level of 149 Mtoe in 2010. The production trend of other fuels basically followed a flat dynamic over the period of reference<sup>4</sup> (Fig. 7).

**FIGURE 7**  
 Total primary energy production by fuel in SEMCs (1980-2010)



Source: own elaboration on International Energy Agency, Extended World Energy Balances Database, accessed in May 2014.

The oil production of SEMCs is mainly concentrated in Libya and Algeria (Fig. 8). Libya owns 48 billion barrels (bbl) of proven oil reserves<sup>5</sup>, the largest of the entire African continent. This level of reserves might even grow in the future, considering that the U.S. Geological Survey (USGS) estimated in 2011 that there might be almost 4 bbl of undiscovered oil across the Libyan Sirte Basin, the Tunisian Pelagian Basin and western Libya<sup>6</sup>. Despite such a huge bonanza, Libya's oil production did not increase substantially over the last few decades, remaining at a level far below its potential<sup>7</sup>.

With 12 bbl of proven oil reserves<sup>8</sup>, Algeria significantly increased its oil production over the last few decades and in particular after 2003, when substantial oil discoveries took place in the Ourhoud field. Egypt and Syria are also considerable oil producing

<sup>4</sup> For a detailed discussion of SEMCs' oil and gas markets, please refer to: Hafner, M., Tagliapietra, S. and El Andaloussi, E. (2012b).

<sup>5</sup> British Petroleum (2013).

<sup>6</sup> U.S. Geological Survey (2011).

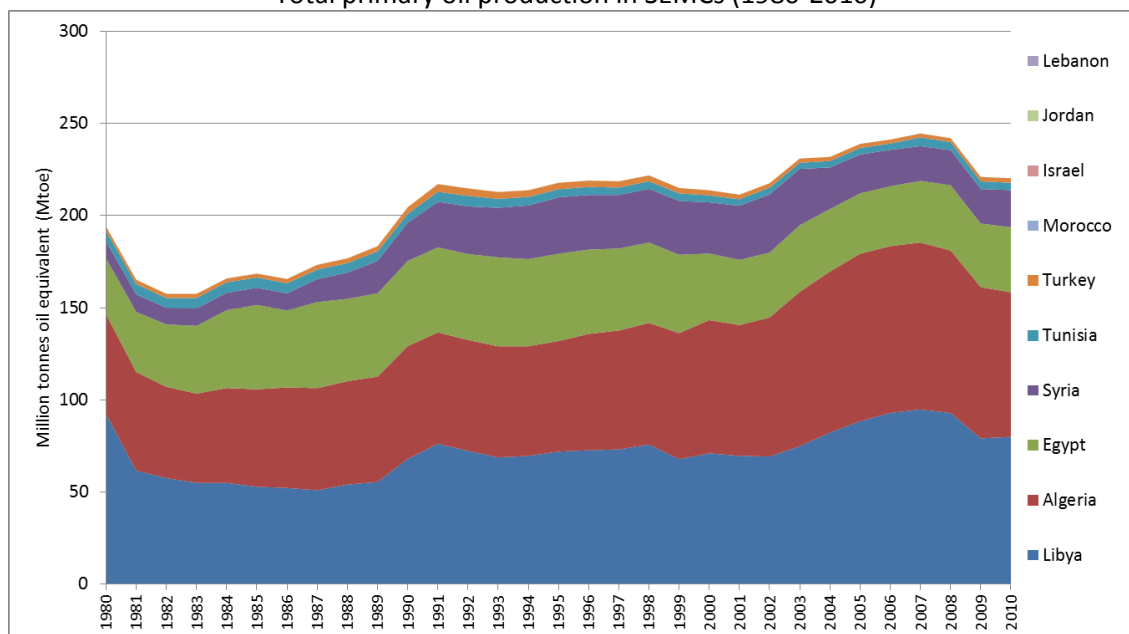
<sup>7</sup> For an updated analysis of Libya's oil production trend see: El Katiri, L., Fattouh, B. and Mallinson, R. (2014).

<sup>8</sup> British Petroleum (2013).

countries. In particular, Egypt is estimated to have a significant untapped potential, as the country remains relatively underexplored<sup>9</sup>.

**FIGURE 8**

Total primary oil production in SEMCs (1980-2010)



Source: own elaboration on International Energy Agency, Extended World Energy Balances Database, accessed in May 2014.

The natural gas production of SEMCs has traditionally been concentrated in Algeria, the frontrunner of the regional natural gas markets (Fig. 9). In 2012 Algeria's proven natural gas reserves were estimated at about 4.5 trillion cubic meters (tcm)<sup>10</sup>, around 30% of the estimated proven natural gas reserves of the entire African continent. This massive bonanza has represented the base of Algeria's rising natural gas production (from 11 Mtoe in 1980 to 72 Mtoe in 2010), a trend likely to grow in the future as the country better assesses its shale gas reserves, considered as the most extensive in North Africa.

But Algeria is not the only important natural gas producing country in the region. In fact, since the early 2000s the region's traditional natural gas production landscape has rapidly evolved, with the rapid and consistent entering of Egypt and Libya into the scene.

Egypt's proven gas reserves were estimated at 2 tcm in 2012<sup>11</sup>, representing the third-largest reserves in Africa (after Nigeria and Algeria). Moreover, in 2010 the USGS released the assessment of the Nile Delta Basin Province, estimating that 6 tcm (mean estimate) of undiscovered, technically recoverable natural gas would be located in the

<sup>9</sup> U.S. Geological Survey (2010).

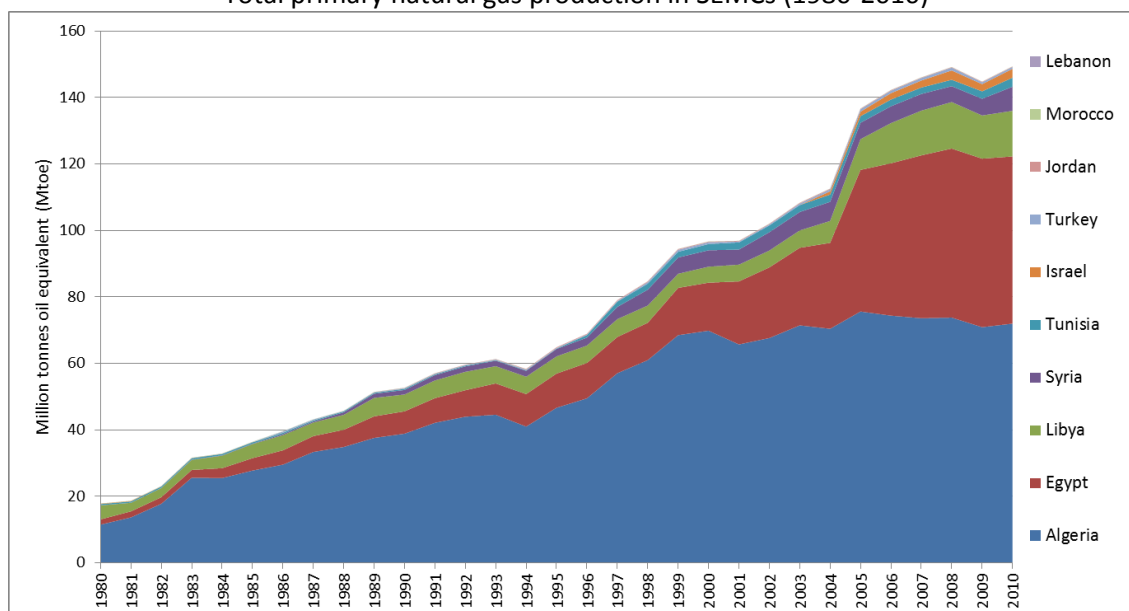
<sup>10</sup> British Petroleum (2013).

<sup>11</sup> Ibidem.

Basin<sup>12</sup>. If confirmed, these figures would provide Egypt a major natural gas production potential, to be added at the already distinguished production trend (from 1 Mtoe in 1980 to 50 Mtoe in 2010).

Libya's proven natural gas reserves were estimated at 1.5 tcm in 2012<sup>13</sup>, but recent new discoveries are expected to raise these estimates in the near term. The country's natural gas production has progressively grown over the last few decades (from a level of 4 Mtoe in 1980 to a level of 13 Mtoe in 2010) and is expected to expand in the future. Natural gas production represents a high priority for Libya, in order to increase its exports -mainly to Europe- and to use natural gas instead of oil for domestic power generation (freeing up more crude oil for export).

**FIGURE 9**  
Total primary natural gas production in SEMCs (1980-2010)



Source: own elaboration on International Energy Agency, Extended World Energy Balances Database, accessed in May 2014.

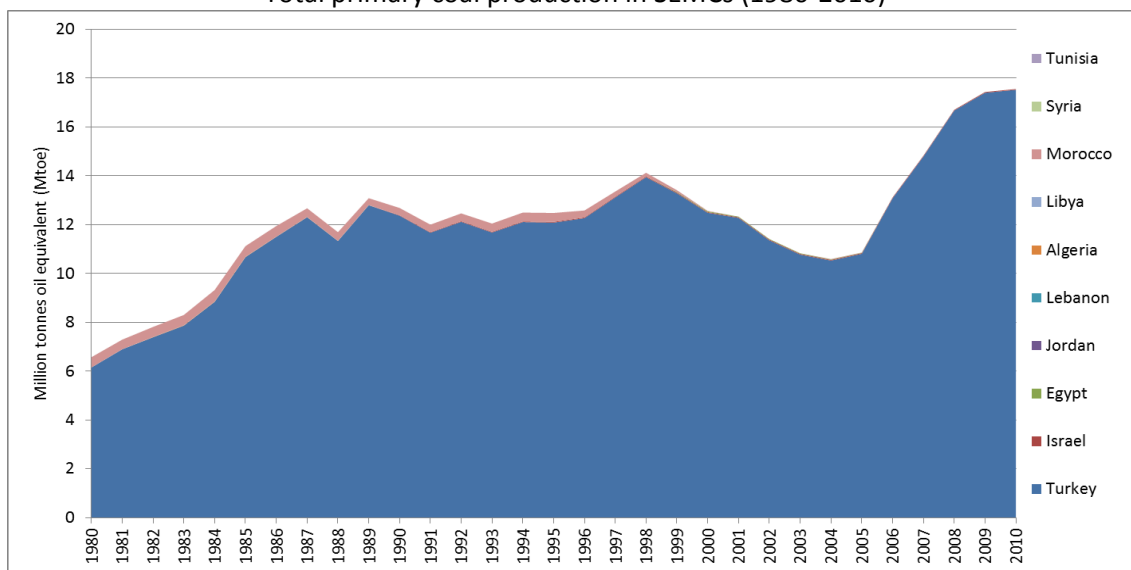
Among SEMCs, coal is basically produced only in Turkey (Fig. 10). The country's coal production is low (2 Mt in 2010), but the production of lignite rose from 45 Mt in 1990 to 65 Mt in 1999. After a sharp drop between 1999 and 2004 (46 Mt in 2004), it has recovered since then (77 Mt in 2010). In Turkey about 70% of coal is used in electricity production, 15% is consumed by the industry and the remaining by the residential and tertiary sector<sup>14</sup>. Coal production in Turkey is likely to further expand in the future, as it is often considered as a key tool to lower the country's huge energy dependency on imported fuels.

<sup>12</sup> British Petroleum (2013).

<sup>13</sup> Ibidem.

<sup>14</sup> Enerdata (2013).

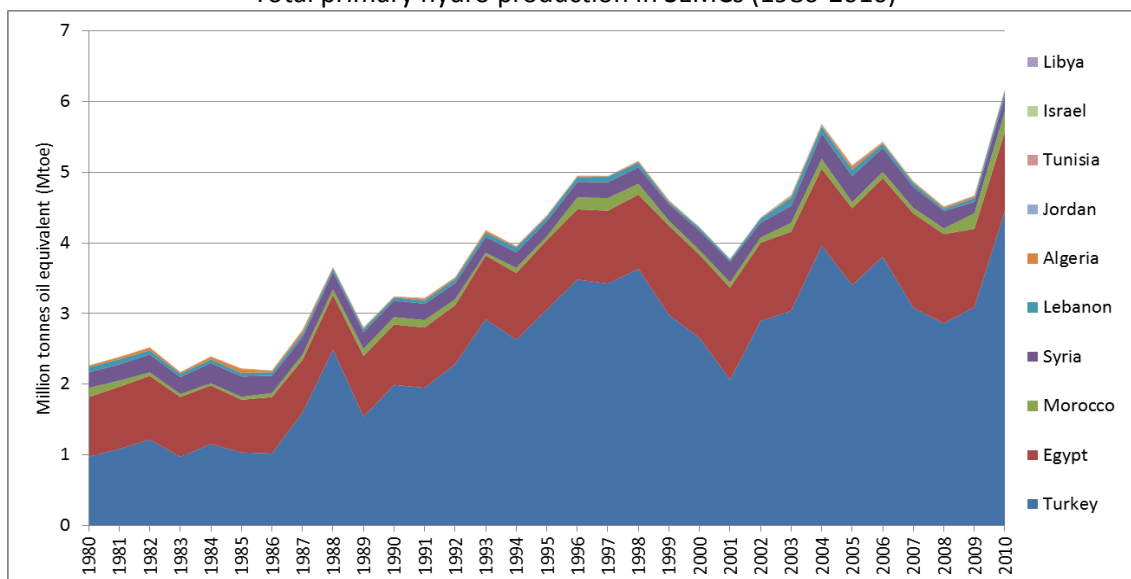
**FIGURE 10**  
 Total primary coal production in SEMCs (1980-2010)



Source: own elaboration on International Energy Agency, Extended World Energy Balances Database, accessed in May 2014.

Turkey also plays a major role in the region’s hydropower production (Fig. 11). In fact, hydropower production in the country increased from 1 Mtoe in 1980 to 4 Mtoe in 2010. As in the case of coal, also this increase is mainly due to the country’s willingness of maximising its own energy resources, in face of a heavy dependence of imported oil and natural gas. Egypt also has a well-developed hydropower sector, which has tapped most of the Nile River’s hydroelectric potential.

**FIGURE 11**  
 Total primary hydro production in SEMCs (1980-2010)

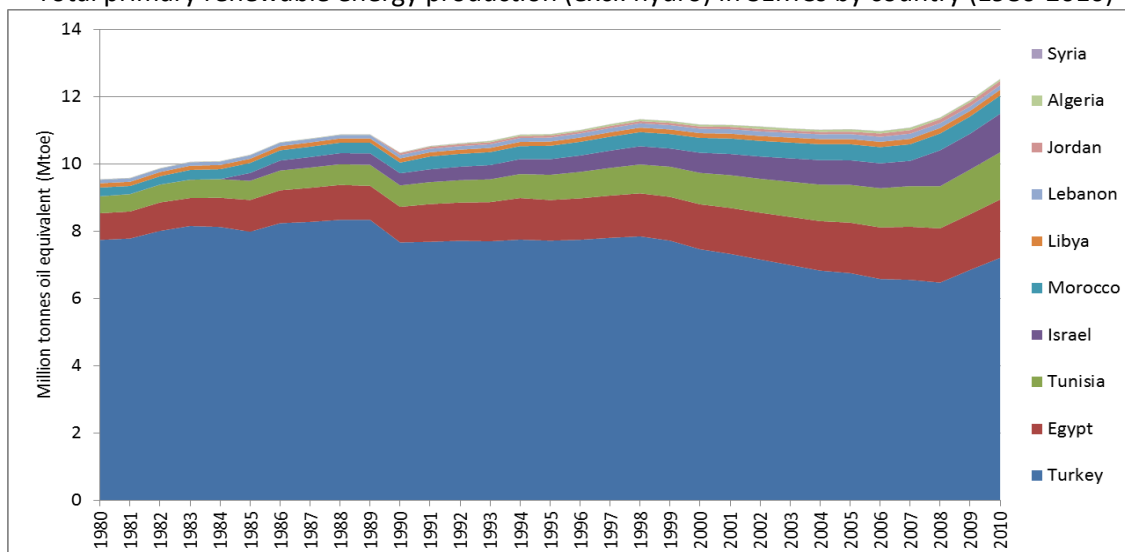


Source: own elaboration on International Energy Agency, Extended World Energy Balances Database, accessed in May 2014.

As far as the production of other renewable energy sources is concerned, Turkey is leading the trend (Fig. 12) mainly because of the substantial use of biomass and geothermal (Fig. 13). In 2010, about 60% of the region’s biomass production took place in Turkey, while in the same year the country also counted for 100% of the region’s geothermal production. Solar and wind thus count for a very minor share of renewable energy production, totalling only 2 Mtoe in 2010: 0.5% of SEMCs’ total primary energy production. But this trend will be better explored in the second section of the paper.

**FIGURE 12**

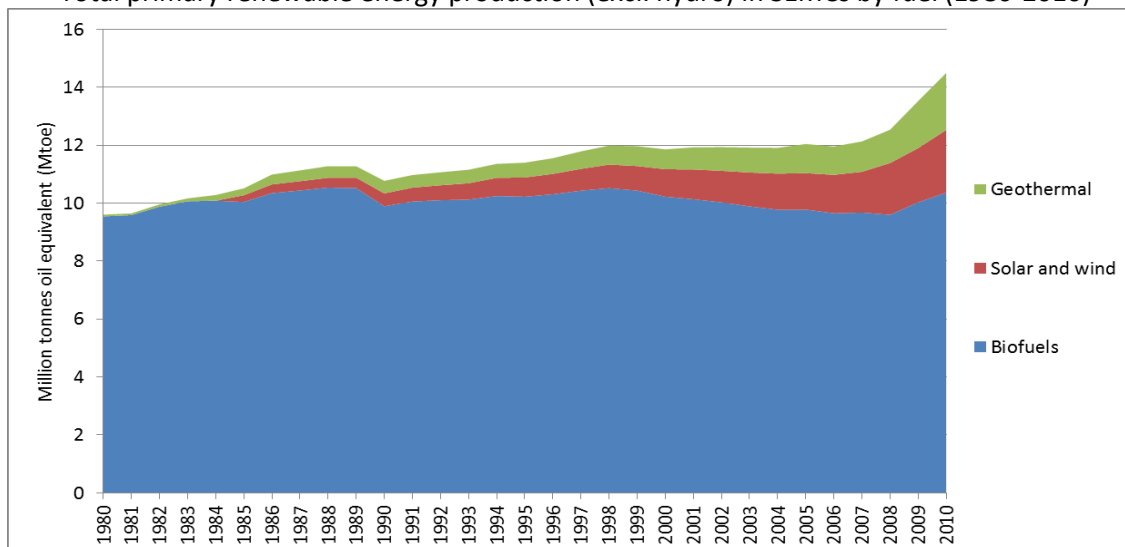
Total primary renewable energy production (excl. hydro) in SEMCs by country (1980-2010)



Source: own elaboration on International Energy Agency, Extended World Energy Balances Database, accessed in May 2014.

**FIGURE 13**

Total primary renewable energy production (excl. hydro) in SEMCs by fuel (1980-2010)



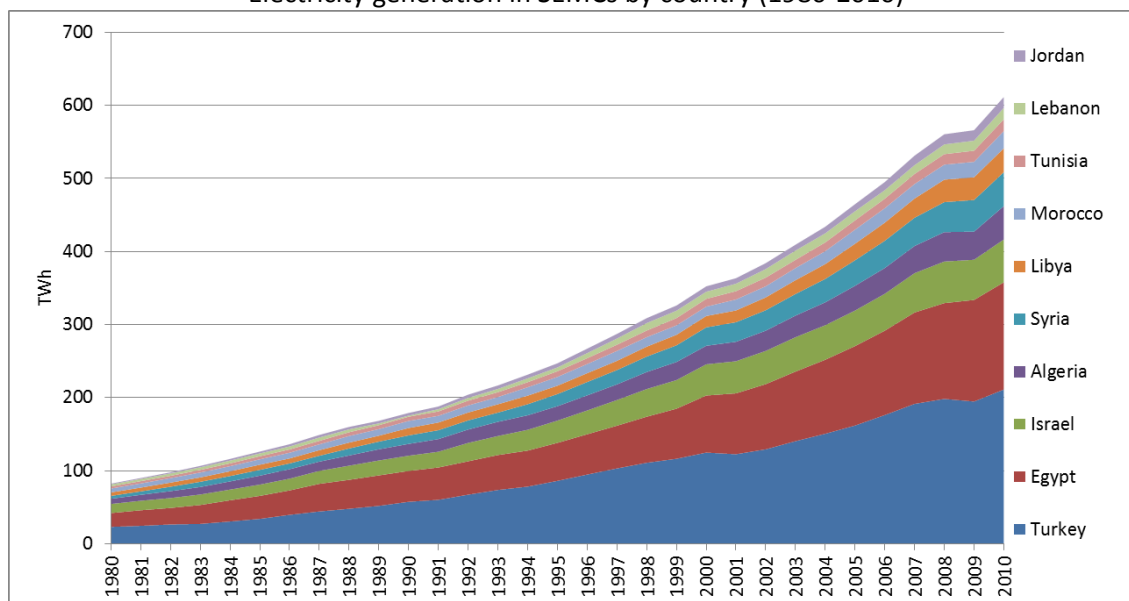
Source: own elaboration on International Energy Agency, Extended World Energy Balances Database, accessed in May 2014.



## 1.4 The Crucial Role of Electricity

Electricity plays a crucial role in the Southern and Eastern Mediterranean energy systems. Between 1990 and 2010 electricity consumption in SEMCs grew by an annual growth rate of about 6%. Just to provide a quick comparison, in the same period of time electricity consumption in North Mediterranean countries grew by an annual growth rate of 1.8%<sup>15</sup>. Electricity generation in SEMCs grew from 82 TWh in 1980 to 611 TWh in 2010 (Fig. 14).

**FIGURE 14**  
 Electricity generation in SEMCs by country (1980-2010)



Source: own elaboration on International Energy Agency, World Energy Balances Database, accessed in May 2014.

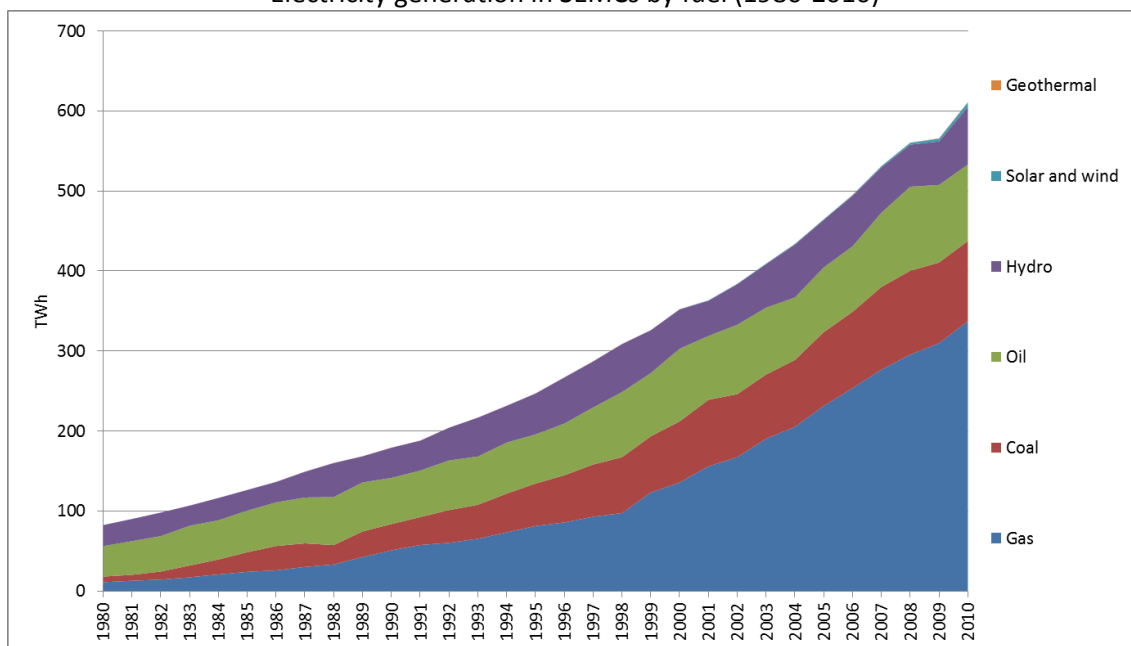
Higher level of economic growth and population will push up demand for electricity in the future. For instance, the Observatoire Méditerranéen de l'Energie (OME, 2011a) forecasts electricity generation in SEMCs to reach 1,534 TWh in 2030, implying an average annual growth rate of about 5%<sup>16</sup>. Such a rapid and consistent growth will put additional pressure on the existing electricity infrastructure, requiring major investments on the construction of new electricity generation facilities, transmission lines and distribution networks.

In the Southern and Eastern Mediterranean the electricity generation mix is mainly based on fossil-fuels and hydro. In 2010 natural gas covered 55% of the region's electricity generation mix, followed by coal (16%), oil (16%) and hydro (12%). Other renewable energy sources (solar, wind, geothermal) only covered 1% of the region's electricity generation mix (Fig. 15): a number that collides with the region's huge renewable energy potential, as the second section of the paper will outline.

<sup>15</sup> OME (2011a), p. 58.

<sup>16</sup> Ibidem.

**FIGURE 15**  
Electricity generation in SEMCs by fuel (1980-2010)



Source: own elaboration on International Energy Agency,  
World Energy Balances Database, accessed in May 2014.

## 2. The Regional Renewable Energy Potential and the Rise of Large-Scale Projects

### 2.1 The Renewable Energy Potential of the Region

The Southern and Eastern Mediterranean region is generally considered to be endowed with massive renewable energy resources, most notably solar and wind. This observation is correct, but it is habitually supported by basic intuition rather than precise empirical evidences. In order to provide an accurate discussion of the topic, this section will present and discuss the key results of the few scientific studies carried out in the recent past with the aim to accurately assess the region's renewable energy resources. For the sake of simplicity and given the region's natural endowment, the section will exclusively focus on solar resources, both for concentrating solar power (CSP) and photovoltaic, and wind resources<sup>17</sup>.

#### - Resources for concentrating solar power (CSP)

Solar energy is generally considered as the potentially most important renewable energy resource in the Southern and Eastern Mediterranean region. A particular attention is generally paid to the potential for solar thermal electricity generated with CSP systems, but notwithstanding this relevance only one scientific study has been carried out in the past with the aim to assess the resources for CSP in the region.

This study, called "MED-CSP - Concentrating Solar Power for the Mediterranean Region"<sup>18</sup> was commissioned by the German Federal Ministry for Environment, Nature Conservation and Nuclear Safety, and published in 2005 by the German Aerospace Center (DLR) in cooperation with the National Energy Research Center of Jordan, the Centre National pur la Recherche Scientifique et Technique of Morocco, the NOKRASCHY Engineering of Germany, the New and Renewable Energy Authority of Egypt, the New Energy Agency of Algeria, the Internationales Forschungszentrum für Erneuerbare Energien of Germany and the Hamburg Institute of International Economics of Germany<sup>19</sup>.

In this study, DLR calculated the region's direct normal irradiance (DNI) on the ground with a high resolution method, able to model in detail «the optical transparency of the atmosphere, by quantifying those atmospheric components that absorb or reflect the sunlight, like clouds, aerosols, water vapour, ozone, gases and other»<sup>20</sup>. Most of this

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<sup>17</sup> An overview of the related technologies is presented in Annex I.

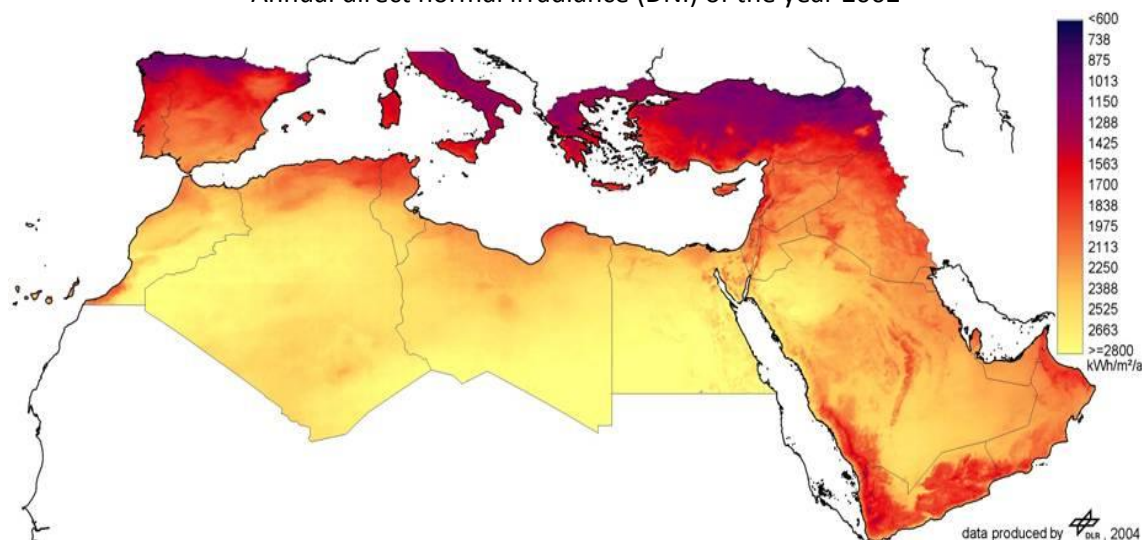
<sup>18</sup> DLR (2005), "MED-CSP - Concentrating Solar Power for the Mediterranean Region", Deutsches Zentrum für Luft- und Raumfahrt, Stuttgart.

<sup>19</sup> This consortium also carried out two additional studies: the "TRANS-CSP" study, focused on the interconnection of the electricity grids of Europe, the Middle East and North Africa, and the "AQUA-CSP" study, focused on the potential of concentrating solar thermal power technology for large-scale seawater desalination for the urban centres in the Middle East and North Africa.

<sup>20</sup> DLR (2005), p. 58.

information was derived from satellite remote sensing (SOLEMI 2004), considered as «much more accurate with respect to the information previously provided by the NOAA satellite of NASA»<sup>21</sup>. The analysis, performed for SEMCs for the year 2002, revealed that in SEMCs the sunshine duration ranges between 2,650 and 3,600 hours/year, while the DNI ranges between 1,300 kWh/m<sup>2</sup>/year on the coast and 3,200 kWh/m<sup>2</sup>/year in the Saharan desert<sup>22</sup> (Fig. 16).

**FIGURE 16**  
Annual direct normal irradiance (DNI) of the year 2002



Source: DLR (2005, p. 59).

In 2005 DLR limited its analysis to a single year, albeit it outlined that «a one-year basis is not sufficient for the development of large CSP projects, as the annual climatic fluctuations can be in the range of +/- 15%. For the project development purposes, at least 5-15 years of data should be processed.»<sup>23</sup> At the time DLR considered a one-year basis analysis as sufficient for the assessment of SEMCs' national solar electricity potentials, particularly because «in most [SEMCs] countries the total solar energy potential is some orders of magnitude higher than the demand»<sup>24</sup>. Successively, in the framework of the "Solar Atlas for the Mediterranean" project<sup>25</sup>, DLR processed 20 years of data (1991-2010), reaching a result not too different from the previous one (Fig. 17).

<sup>21</sup> DLR (2005), p. 58.

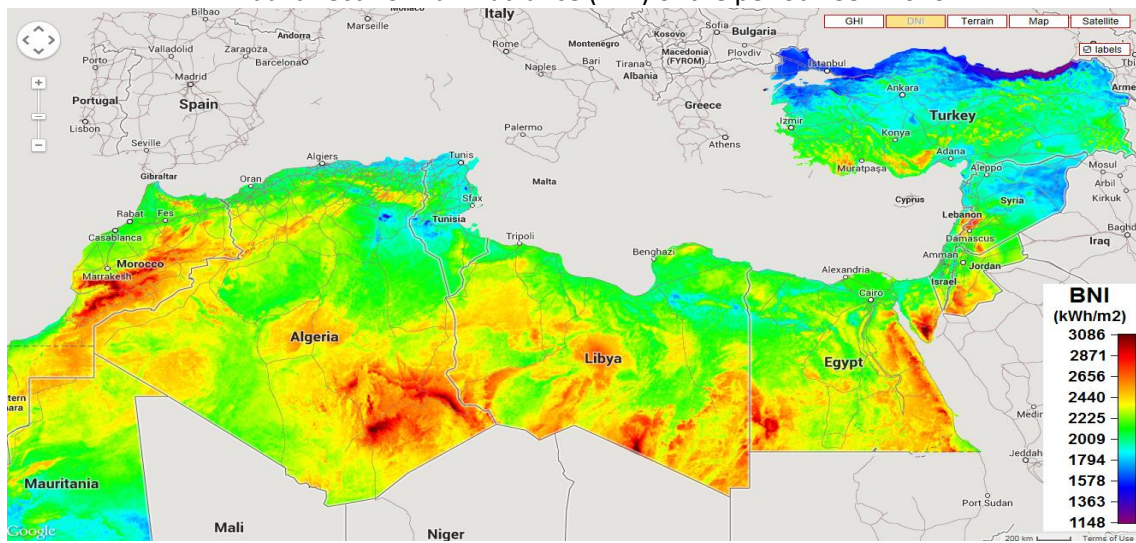
<sup>22</sup> Ibidem, p. 59.

<sup>23</sup> Ibidem, p. 59.

<sup>24</sup> Ibidem, p. 59.

<sup>25</sup> The "Solar Atlas for the Mediterranean" is a portal for global horizontal and direct normal irradiance data for the southern and eastern Mediterranean region. The project is supported by the German Ministry of Environment, Nature Conservation and Nuclear Safety. The Project Consortium is composed by the German Aerospace Center (DLR), Mines-ParisTech, Transvalor, GeoModel Solar, United Nations Environmental Programme, Observatoire Méditerranéen de l'Énergie and RCREEE Regional Center for Renewable Energy and Energy Efficiency. For further information refer to: [www.solar-med-atlas.org](http://www.solar-med-atlas.org)

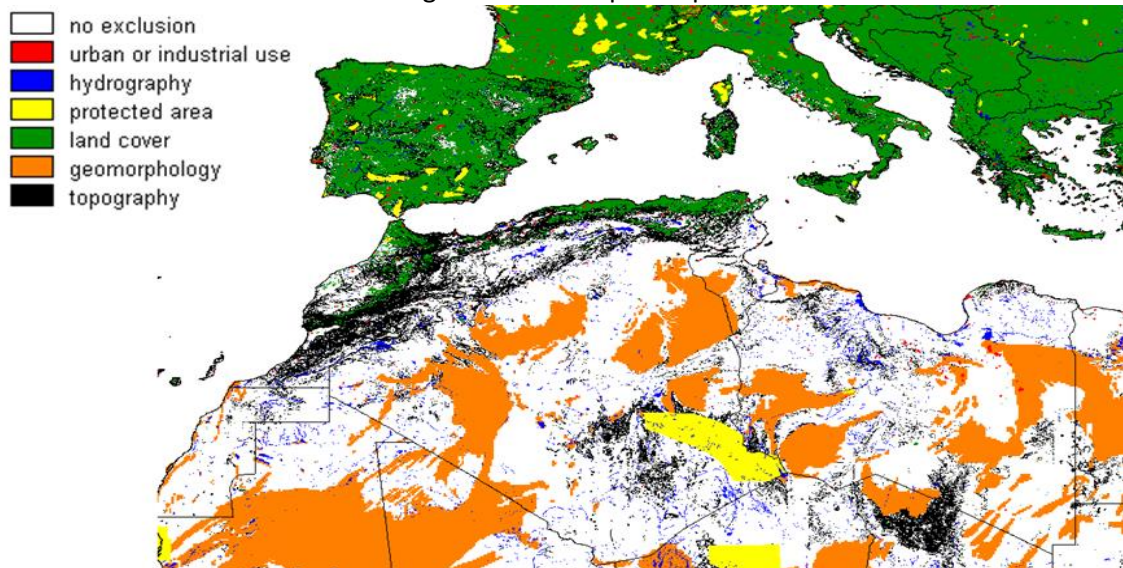
**FIGURE 17**  
 Annual direct normal irradiance (DNI) of the period 1991-2010



Source: Solar Atlas for the Mediterranean (2012).

However, the calculation of the DNI is not sufficient to fully understand the regional potential in terms of CSP. In fact, concentrating solar collector fields can only be placed in land areas with particular characteristics. For this reason, DLR detected the SEMCs' land resources suitable to the development of CSP technologies by excluding all unsuitable areas due to «population density, ground structure, water bodies, slope, dunes, protected or restricted areas, forests, agriculture etc.»<sup>26</sup>, with the result presented in Fig. 18 and Fig. 19 (in white the areas suitable to the deployment of CSP).

**FIGURE 18**  
 Exclusion areas for concentrating solar thermal power plants – Western Mediterranean

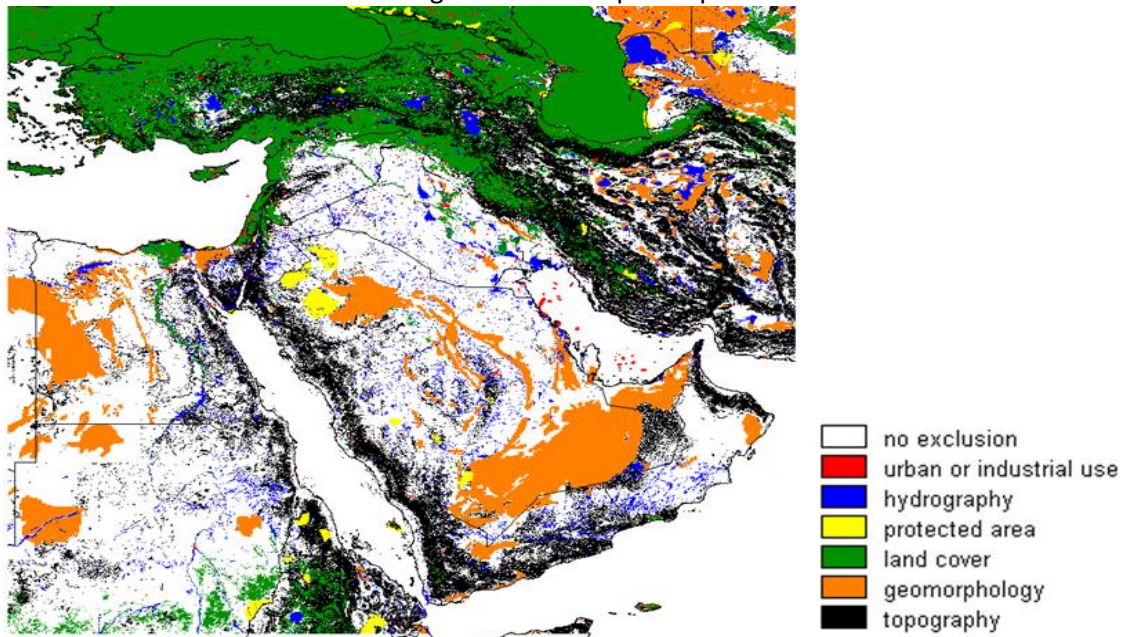


Source: DLR (2005, p. 60).

<sup>26</sup> DLR (2005), p. 59.

**FIGURE 19**

Exclusion areas for concentrating solar thermal power plants – Eastern Mediterranean



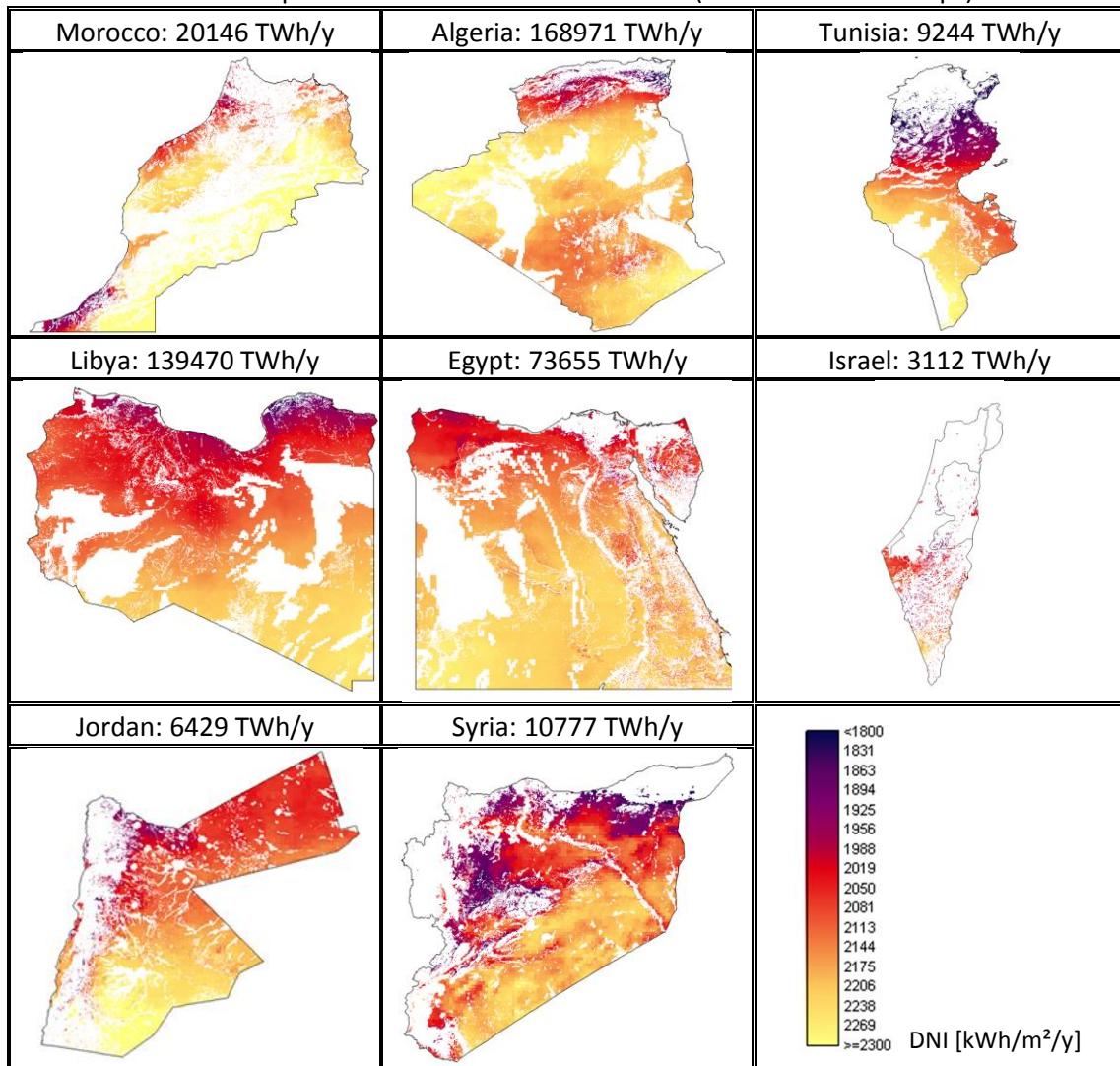
Source: DLR (2005, p. 60).

These two analyses were then combined by DLR to generate maps of DNI at the remaining sites for each country, an exercise that ultimately defined the technical potential of CSP of each country<sup>27</sup> and the related economic potential (defined by all non-excluded areas with a DNI higher than 2,000 kWh/m<sup>2</sup>/y)<sup>28</sup>, as shown in Tab. 2.

<sup>27</sup> As outlined in DLR (2005, p. 60): «solar electricity potentials were calculated from the annual DNI with a conversion factor of 0.045, which takes into account an average annual efficiency of 15% and a land use factor of 30% for CSP technology. This is state of art for parabolic troughs and thus a very conservative assumption.»

<sup>28</sup> As underlined in DLR (2005, p. 61): «this is an adequate threshold to achieve in the medium term solar electricity costs competitive with conventional and other renewable energy sources for power generation.»

**TABLE 2**  
 Economic potential of CSP in selected SEMCs (with related DNI maps)



Source: own elaboration on DLR (2005).

On the basis of this analysis carried out by DLR, the economic potential of CSP in the overall Southern and Eastern Mediterranean region could be estimated at 431,382 TWh/y.

To fully understand this figure, it might be useful to remind that, in the same study, DLR estimates the economic potential of CSP in the Northern Mediterranean region (i.e. Portugal, Spain, Italy, Malta, Greece and Cyprus) at 1,450 TWh/y: a level almost 300 times lower than the one of the Southern and Eastern Mediterranean region<sup>29</sup>.

<sup>29</sup> These calculations are based on the MED-CSP Databank available online at the official website of DLR: [http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422\\_read-6575/](http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6575/)

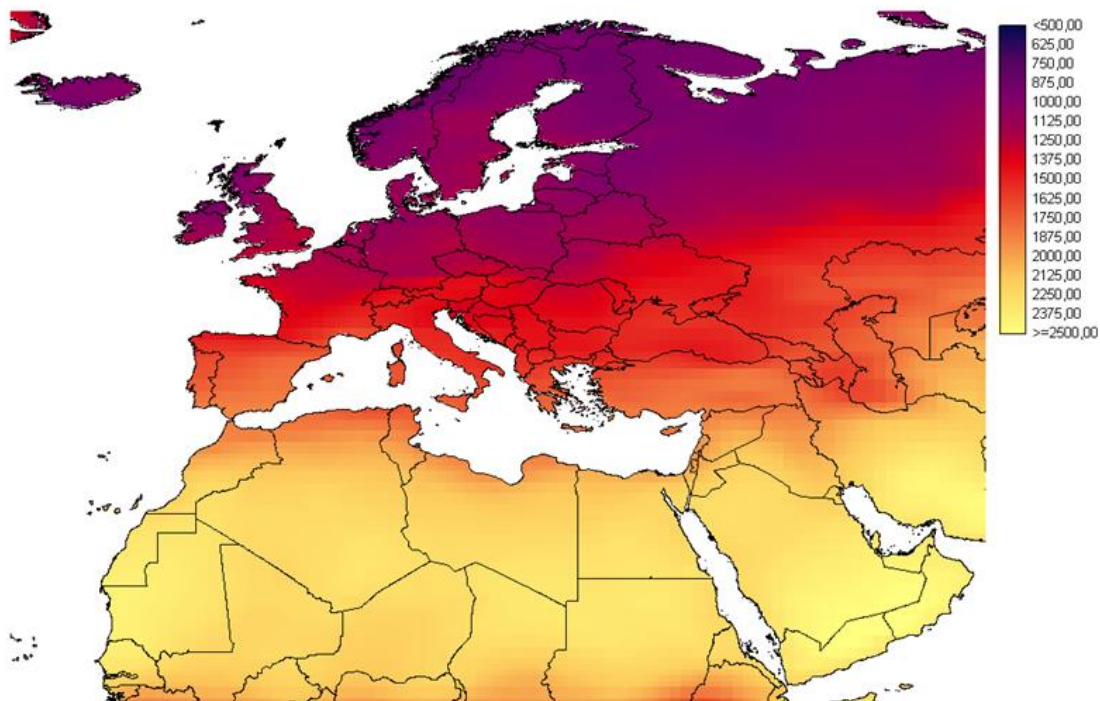
- Resources for photovoltaic

But solar energy is not just all about solar thermal electricity. In fact, in addition to CSP another technology that could be used to convert solar resources into electricity is, of course, photovoltaic (PV).

In order to assess the regional resources for PV, in the “MED-CSP” study DLR calculated the annual global irradiation in the overall region, with the result presented in Fig. 20.

**FIGURE 20**

Annual global irradiation on surfaces tilted south with latitude angle in kWh/m<sup>2</sup>/year

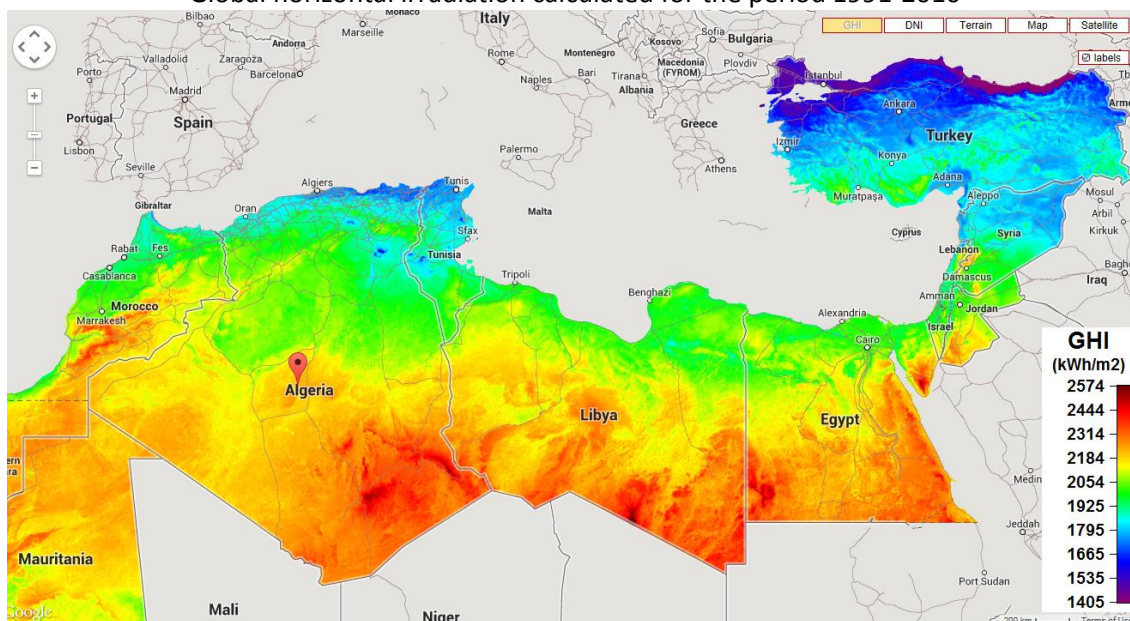


Source: DLR (2005, p. 69).

As occurred for DNI, also in this case DLR limited its analysis to a single year (2002). For this reason, in the “Solar Atlas for the Mediterranean” project, DLR also processed 20 years of data (1991-2010) for global horizontal irradiation, reaching a result compatible with the previous analysis (Fig. 21).



**FIGURE 21**  
Global horizontal irradiation calculated for the period 1991-2010



Source: Solar Atlas for the Mediterranean (2012).

In the case of PV there are no criteria for site exclusion, as these systems can be installed almost everywhere. PV systems can be either grid-connected or decentralized with small scale applications in remote regions off-grid. On this basis, DLR estimates the economic potential of PV in the overall Southern and Eastern Mediterranean region at 122 TWh/y.

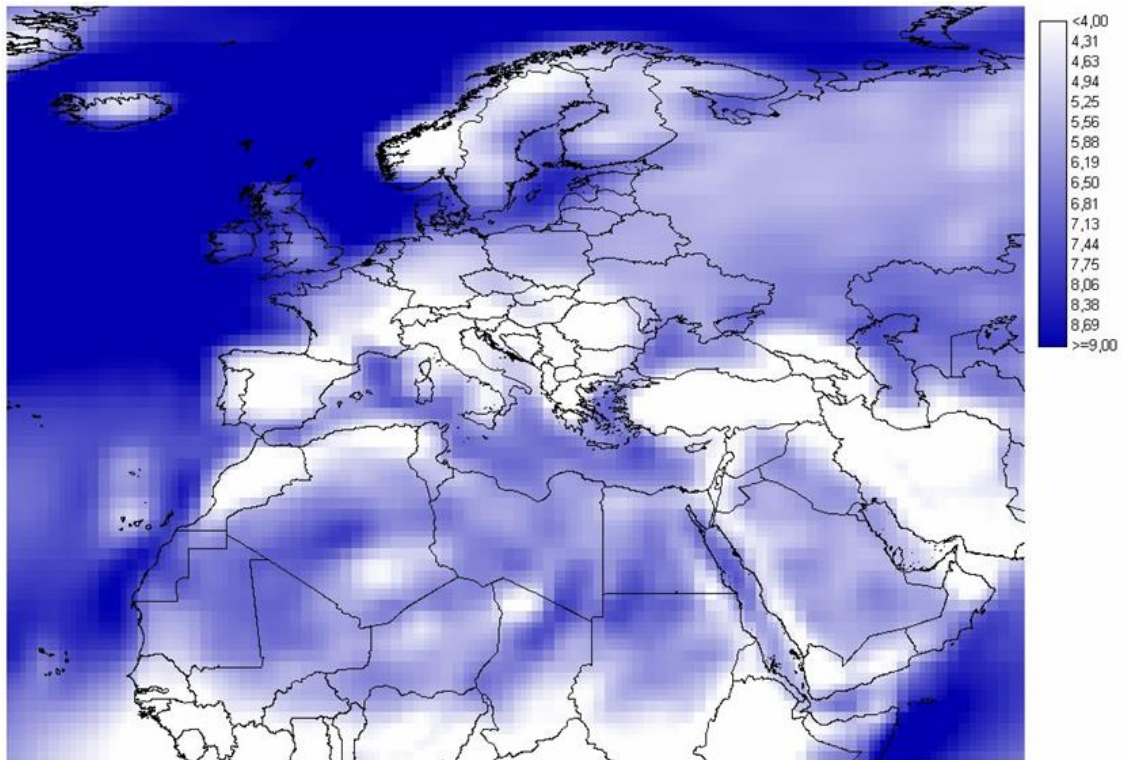
To fully understand this figure, it might be useful to remind that, in the same study, DLR estimates the economic potential of PV in the Northern Mediterranean region (i.e. Portugal, Spain, Italy, Malta, Greece and Cyprus) at 22 TWh/y: a level almost 5 times lower than the one of the Southern and Eastern Mediterranean region<sup>30</sup>.

#### - Resources for wind power

Less generally recognized, but no less important, the Southern and Eastern Mediterranean region also has favourable wind conditions. In the “MED-CSP” study, DLR estimates that some areas in the region belong to the world’s top sites in terms of wind potential, with several sites exceeding mean wind velocity of 7 m/s and, in some cases, even 11 m/s (Fig. 22).

<sup>30</sup> These calculations are based on the MED-CSP Databank available online at the official website of DLR: [http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422\\_read-6575/](http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6575/)

**FIGURE 22**  
 Annual average wind speed at 80 m above ground level in m/s



Source: DLR (2005, p. 68).

This favorable wind conditions are particularly exceptional on Morocco’s Atlantic coast and the Red Sea but attractive sites for wind power generation might also be found in Turkey, Algeria, Libya and Syria, as indicated in Tab. 3.

**TABLE 3**  
 Economic potential of wind power in selected SEMCs

Country	Technical potential (TWh/y)	Economic potential (TWh/y)
Egypt	7650	90
Algeria	7278	35
Morocco	1188	25
Turkey	200	55
Jordan	109	2
Syria	98	12
Tunisia	50	8

Source: DLR (2005).

According to the analysis of DLR, the technical potential of wind power in SEMCs amounts to 21,967 TWh/y. Following our usual comparison, the technical potential of wind power in Northern Mediterranean countries (NMCs) amounts to 648 TWh/y, a figure 34 times lower than the one of SEMCs.

The wind power potential of SEMCs is considerably lower if translated into economic potential. On its model, DLR assumes a maximum installed capacity of 10 MW per square kilometer of land area and considers economically potential «the areas with annual full load hours over 1,400 h/y equivalent to a capacity factor of 16%.»<sup>31</sup>

However, the technical potential seems to represent here the real key to understand the region's wind power landscape, as the economic potential needs to be progressively adapted to the new economics and technology realities of wind power, which are rapidly evolving towards toward better performances, largely unexpected in the past.

## 2.2 The Potential Benefits of Renewable Energy in the Region

Having described the huge solar and wind energy potential of the Southern and Eastern Mediterranean region, let's now try to provide a comprehensive answer to the following question: what kind of benefits could renewable energy bring to the region?

*- Macro-economic benefits: meeting the rising energy demand at a lower price*

First of all, solar and wind energy could generate various economic benefits in SEMCs. In fact, these renewable energy sources could be primarily devoted to diversifying the region's energy mix, which still remains today largely dominated by fossil fuels (see § 1.1). This could contribute to satisfying the region's rapidly increasing energy demand at a lower cost, both in net-energy exporting countries (NECs) and in net-energy importing countries (NICs).

In the case of NECs, a consistent deployment of solar and wind energy sources might free up consistent volumes of oil and natural gas, alternatively used in the domestic power generation sector, for additional exports to Europe. Considering that an important natural gas infrastructure connecting North Africa with Europe is already in place, this choice would involve an immediate, significant economic return for region's natural gas exporting countries just because of the growth in the export value of natural gas stocks. The same dynamic could be applied to oil export, which even has a higher netback value than natural gas.

In the case of NICs, the potential economic benefit of renewable energy is even more obvious. In these countries the energy bill due to the import of oil and natural gas represents a dramatic burden to public finances, particularly because of the universal fossil fuel consumption subsidies regime currently in place. As correctly outlined by El-Katiri (2014), «at an import price for crude oil verging on \$110/bl, even the more cost-intensive options for PV and CSP may reduce overall energy import costs, and hence the fiscal burden faced by governments. Jordan, for instance, which imports 96 per cent of its primary energy needs, had incurred an import cost for fossil fuels

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<sup>31</sup> DLR (2005), p. 68.

representing 20 per cent of its GDP by 2010, and only a little of this is recovered via final consumer prices for energy.»<sup>32</sup>

*- Socio-economic benefits: creating new jobs and alleviating energy poverty*

In addition to these macro-economic benefits, the exploitation of solar and wind energy could also generate wider socio-economic benefits in SEMCs, such as job creation and alleviation of energy poverty.

Job creation is generally considered as one of key benefits of renewable energy. In fact, various quantitative analyses have demonstrated that renewable energy has a significantly higher labour intensity than fossil fuels. For instance, the United Nations Environment Programme (UNEP) and the International Labour Organization (ILO) estimate that for the production of the same quantity of MW/h, PV plants would use on average seven times more labour than coal-fired plants, and wind power would use on average 1.8 times more labour than natural gas<sup>33</sup> (Tab. 4).

**TABLE 4**  
Estimated employment per MW: renewable energy and fossil fuel power plants

	Average employment over life of facility (jobs per MW of average capacity)		
	Manufacturing, construction, installation	Operation and maintenance / fuel processing	Total
Solar PV	5.76-6.21	1.20-4.80	6.96-11.01
Wind power	0.43-2.51	0.27	0.70-2.78
Biomass	0.40	0.38-2.44	0.78-2.84
Coal-fired	0.27	0.74	1.01
Natural gas-fired	0.25	0.70	0.95

Source: UNEP/ILO (2008), p. 102.

Of course, these data must be carefully interpreted and adopted to the realities of SEMCs. In particular, it must be recognized that SEMCs generally do not have, at the moment, the technological know-how to directly manufacture high-tech renewable energy devices such as, for instance, receivers for CSP or PV cells.

However, many other components, such as mounting structures, could well be manufactured locally. For instance, the World Bank (2011b) estimates that «over 48,700 new local jobs for manufacturing components could be created by 2025 with high development of factories for CSP components in Algeria, Egypt, Jordan, Morocco and Tunisia. This assessment is based on a conservative calculation and assumes that the manufacturers use the same number of employees as comparable factories in Europe.»<sup>34</sup>

<sup>32</sup> El-Katiri (2014), p. 6.

<sup>33</sup> ILO (2008), p. 102.

<sup>34</sup> OECD (2013), p. 38.

In addition to these direct job opportunities, a consistent number of jobs could also derive from indirect job opportunities such as installing, operating and maintaining renewable energy generation facilities<sup>35</sup>. Renewable energy projects could thus contribute to the development of significant new industry and service sectors in SEMCs, leading to local job creation and manufacturing developments particularly at the level of small and medium enterprises (SMEs): a crucially important segment of SEMCs' economies<sup>36</sup>.

The second socio-economic benefit that the exploitation of solar and wind energy could potentially generate in SEMCs is the alleviation of energy poverty. Energy poverty is defined by the IEA as «a lack of access to modern energy services. These services are defined as household access to electricity and clean cooking facilities (e.g. fuels and stoves that do not cause air pollution in houses).»<sup>37</sup> Situations of energy poverty still persist in many SEMCs and renewable energy could well play a role to alleviate them.

In fact, as the OECD (2013) outlines, «the development of small scale renewable energy units in rural areas has the potential to stimulate economic development through provision of electricity and heating/cooling to areas previously without access to electricity. Energy poverty constrains local economic development and prevents female empowerment. The lack of energy sources mainly affects women, since they are usually responsible for providing heating and cooking for the family (through the collection of firewood or manure for burning) which is highly time-consuming. This workload can act as an incentive to take girls out of school and thus limit their ability to find skilled jobs in the future. Access to energy acts as a trigger for local economic activities enabling local entrepreneurs to start up small businesses such as electronic devices and repair shops. It also improves the prospects of future generations by freeing up time for children and women that can be used for education and to increase their overall standard of living.»<sup>38</sup>

#### *- Environmental benefits: lowering the energy intensity of SEMCs*

In parallel to the macro-economic and socio-economic benefits just described, renewable energy could generate important environmental benefits in SEMCs. This element is crucially important, particularly considering the regional reliance on fossil fuels already described in § 1.1.

Albeit starting from a structural low level in comparison to many other countries in the world (Fig. 23), the SEMCs' carbon footprint has grown dramatically over the last few

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<sup>35</sup> For an assessment of the local manufacturing potential for CSP in the MENA region please refer to: World Bank (2011b).

<sup>36</sup> For a comprehensive overview of the SEMC's economic structure, please refer to: Dabrowski and De Wulf (2013).

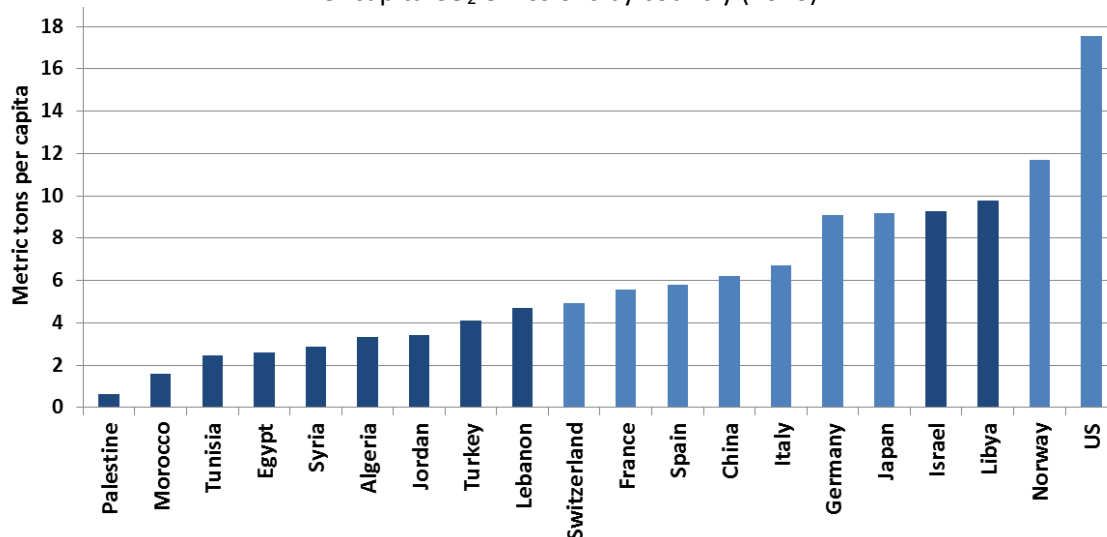
<sup>37</sup> IEA (2011a), p. 13.

<sup>38</sup> OECD (2013), pp.38-39.

decades, mainly because of rapid urbanization, rising living standards and rapid energy-intensive industrialization (Fig. 24).

**FIGURE 23**

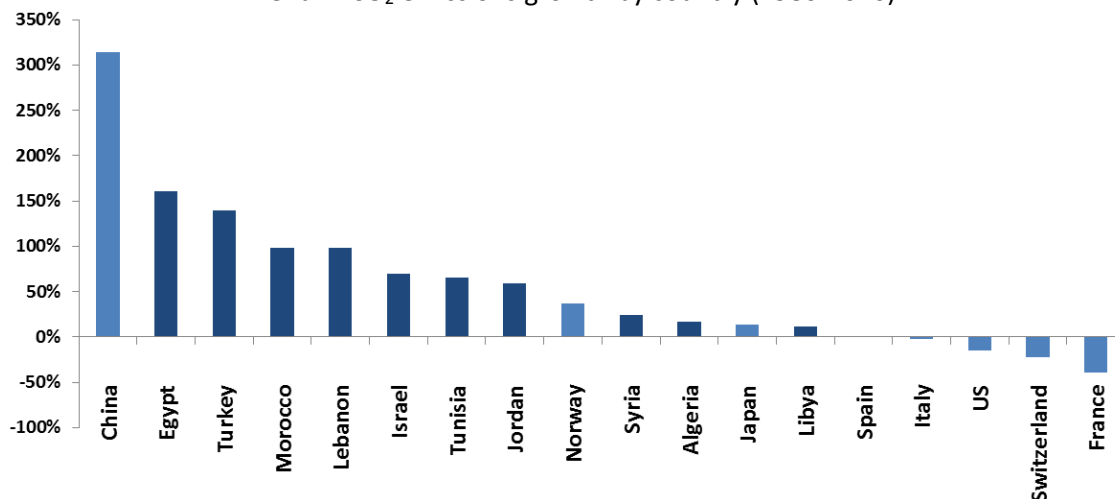
Per capita CO<sub>2</sub> emissions by country (2010)



Source: own elaboration on World Bank, World Development Indicators, accessed in May 2014.

**FIGURE 24**

Trend in CO<sub>2</sub> emissions growth by country (1980-2010)



Source: own elaboration on World Bank, World Development Indicators, accessed in May 2014.

Albeit often under-evaluated by the region’s governments, climate change represents a serious threat to SEMCs. In fact, as Osberghaus and Baccianti (2013) outline, «according to reports by the Intergovernmental Panel on Climate Change (IPCC) and other international and national studies, SEMCs are particularly vulnerable to global warming because of their geographical position and their dependence on climate-

sensitive economic sectors. Sea level rise endangers the living conditions of millions of people living on the Mediterranean coast. Important economic sectors like tourism and agriculture depend heavily on weather conditions, and the increase in temperature and the frequency of extreme events calls for comprehensive preventive measures to avoid future economic costs. Furthermore, water scarcity -already affecting the eastern Mediterranean region- is likely to become more severe in the future and a major cause of regional conflicts.»<sup>39</sup>

In this overall situation the deployment of solar and wind energy would clearly represent an important contribution to the much-needed sustainability path of SEMCs.

*- Cooperation benefits: enhancing both the intra-SEMCs and the EU-SEMCs cooperation*

To conclude, it might be interesting to outline the potential positive spillovers eventually generated by the deployment of solar and wind energy in the region, both in terms of intra-SEMCs cooperation and EU-SEMCs cooperation.

An extensive deployment of renewable energy in SEMCs would require the development of a regional electricity market able to permit the exchange of electricity in substantial volumes.

In particular, the basic requirement for an efficient large-scale deployment of renewable energy sources in SEMCs would be the development of a regional system of electricity interconnections, able to physically link SEMCs into a unique network.

Furthermore, as mentioned before, an extensive deployment of renewable energy in the region might represent a unique opportunity for the development of significant new industry and service sectors in SEMCs. This represents a crucially important point, as by sharing manufacturing facilities and therefore exploiting larger economies of scale, intra-SEMCs cooperation could also be promoted.

These two potential cooperation-spillovers are particularly important in the Southern and Eastern Mediterranean region. In fact, despite geographical proximity and common heritage, trade links between SEMCs remain at a very low level. As Escribano and Jordan (1998) point out, «this low level of intra-regional trade is usually justified by the political unwillingness to attain sub-regional cooperation, the protectionist commercial policies implemented by most SEMCs, the ineffectiveness of bilateral trade agreements within the region and inappropriate infrastructure. It has often been said that by removing these obstacles intra-regional would have grown at a fairly rapid pace. However, over the last few decades nothing has substantially changed, and the high potential for increased intra-regional trade in the region still remains untapped.»<sup>40</sup>

In conclusion, a large-scale deployment of renewable energy sources in SEMCs is often expected to enclose a relevant potential for cooperation between the two shores of

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<sup>39</sup> Osberghaus and Baccianti (2013), p. 1.

<sup>40</sup> Escribano and Jordan (1998), p. 7.

the Mediterranean. In fact, over the last decade various organizations have claimed that part of the electricity potentially produced via solar and wind energy sources in SEMCs might eventually be exported to Europe via HVDC (high voltage direct current) electricity interconnections. This idea has represented the foundation of several large-scale renewable energy projects, aimed at enhancing the Euro-Mediterranean cooperation through renewable energy. These projects, the best known of which is certainly Desertec, will be described in the following section.

### 2.3 The Evolution of Desertec and Other Large Scale Renewable Energy Projects

«Within 6 hours deserts receive more energy from the sun than humankind consumes within a year.»<sup>41</sup> On the basis of this concept, the German particle physicist Dr. Gerhard Knies elaborated in the early 2000s the idea of creating a network aimed at encouraging countries to work together to harness the power of the sun to bring clean energy to the world. This idea was translated into a concrete project in 2003, with the launch of the Trans-Mediterranean Renewable Energy Cooperation (TREC), an international network of scientists, experts and politicians actively involved in the field of renewable energy founded by the German Association for the Club of Rome and of the Hamburg Climate Protection Foundation.

The double aim of TREC was «to raise awareness with political and economic decision makers of the necessity, opportunities and advantages of renewable energies for peaceful co-operation for climate, energy and water supply security in the joint regions of Europe, the Middle East and North Africa (EUMENA) and to unlock the enormous unused potentials of renewable energy in the EUMENA region through co-operation as if there were no borders, for pursuing the common goals of: global climate stability, long term energy and water supply security, economic development in the MENA countries and sustainability as vision uniting the regions of EUMENA.»<sup>42</sup>

To concretize this view (see also Fig. 25), the TREC project proposed a theoretical win-win solution on which energy-hungry North Mediterranean countries would buy substantial volumes of solar and wind electricity produced in MENA countries and transported via HVDC interconnections to be built under the Mediterranean sea.

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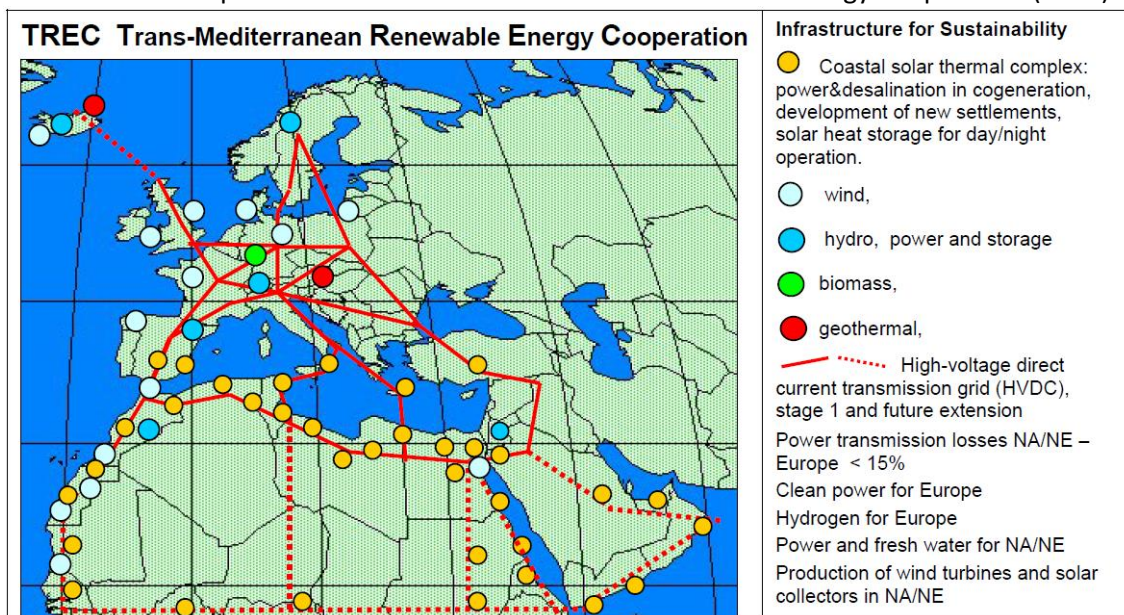
<sup>41</sup> See: <http://www.desertec.org/concept/>

<sup>42</sup> UNEP (2007), p 76.



**FIGURE 25**

The basic concept behind the Trans-Mediterranean Renewable Energy Cooperation (TREC)



Source: TREC (2003), p. 1.

This concept, which in the meantime assumed the name of Desertec, was presented in November 28, 2007 to the European Parliament by His Royal Highness Prince Hassan bin Talal of Jordan, former President of The Club of Rome and one of the strongest supporters of TREC and its Desertec concept. In particular, the document presented to the European Parliament was a White Paper entitled “Clean Power from Deserts - The Desertec Concept for Energy, Water and Climate Security”<sup>43</sup> based on the studies carried out by the German Aerospace Center (DLR) on the potential of deserts to supply clean power to Europe, the Middle East and North Africa (studies here already presented in § 2.1). The White Paper particularly focused on the MENA potential for electricity generation from CSP and the related potential for electricity export to Europe via HVDC<sup>44</sup>.

In 2009 TREC emerged to a newly established non-profit organization, the Desertec Foundation, established with the aim to promote the implementation of the Desertec concept<sup>45</sup>. In the same year the Desertec Foundation and a group of 12 European companies and banks (such as Munich Re, Deutsche Bank, E.ON, RWE and others) founded the Desertec Industrial Initiative (Dii) with the aim of accelerating the implementation of the Desertec concept in the regions of EUMENA (Fig. 26).

<sup>43</sup> For an updated edition of the White Paper see: Desertec Foundation (2009).

<sup>44</sup> TREC (2007).

<sup>45</sup> Founding members of the Desertec Foundation were the German Association of the Club of Rome, members of the TREC network as well as committed private supporters. A detail description of the Foundation’s mission is available at: <http://www.desertec.org/global-mission/>

**FIGURE 26**  
The Desertec concept



Source: Desertec Foundation (2013).

In particular, the mission of Dii is «to pave the way for a market for solar and wind power from the deserts for local consumption in the MENA region and, eventually, for export to Europe. The aim is to reach an energy mix of highest security of delivery, mainly based on lowest cost renewable electricity throughout the interconnected markets in EUMENA. Dii acts as a market and project enabler that builds partnerships throughout this region. As an expert, facilitator and catalyst, the industrial initiative gives guidance on the integration of desert power into the common market e.g. by highlighting the required political, regulatory, financial, (socio-)economic and technological conditions. Dii is not an investor itself, nor will it develop projects itself. Rather it helps the market to recognize and develop feasible projects.»<sup>46</sup>

Dii published in 2012 a study entitled “Desert Power 2050”<sup>47</sup>. The study argues that the regions EUMENA could better face their future energy challenges by working together as a single region. According to the study, «an integrated EUMENA power system allows Europe to meet its CO<sub>2</sub> reduction targets of 95% in the power sector more effectively and more economically by importing up to 20% of its electricity demand from MENA. Europe thereby saves a total of EUR 33 billion annually, or EUR 30 per MWh of power imported from MENA. Meanwhile, desert power enables MENA countries to supply their own energy needs reliably from the abundant solar and wind

<sup>46</sup> See: <http://www.dii-eumena.com/about-us/mission-vision.html>

<sup>47</sup> Dii (2012).

resources in the region. MENA can thereby contribute to a 50% CO<sub>2</sub> reduction in its power sector despite a massive increase in demand. At the same time, MENA benefits from an export industry worth up to EUR 63 billion. per year. Furthermore, Europe as well as MENA profit from a 40% drop in the marginal cost of CO<sub>2</sub> emission reductions in the power sector.»<sup>48</sup>

Notwithstanding the continuous primary focus on the overall EUMENA region, the Desertec organization (i.e. TREC and then Desertec Foundation and Dii) has progressively diverted its initial key focus on the potential export of solar and wind electricity produced in MENA countries to Europe via HVDC, toward a broader activity of market and project enabler that builds general renewable energy partnerships not only in the EUMENA region but also in Asia, Africa, Americas and Australia<sup>49</sup>.

In 2013 Paul van Son, CEO of Dii, declared that «If we talk about renewable energy from North Africa, only a small fraction will ultimately supply the European market. (...) Frankly, four years ago Desertec was all about bringing energy from North Africa. We abandoned that one-dimensional thinking. It's now more about creating integrated markets in which renewable energy will bring its advantages...That's the main objective.»<sup>50</sup>

Such a development was widely expected by the critics of Desertec, whom often questioned over the last years the viability of the concept. For instance, in 2013 Peter Droege, President of Eurosolar, declared that «Desertec is not viable in its original form because it is too expensive and utopian»<sup>51</sup>.

Among others, this position was better elaborated by Susanne Nies, Head of Unit for Energy Policy and Generation at Eurelectric: «Desertec's initial business model was set to work on the basis of exports. This would have allowed it to cover its power generation costs. However, this initial export approach might need to be reconsidered, for two main reasons. Firstly, at a very basic level, we are still missing lines and capacities for export. Building these is technically difficult because of the deep waters in the Mediterranean. Moreover, it is not just the link between North Africa and Europe that is the problem. Rather, the question arises what happens with the extra capacity once it reaches the Iberian Peninsula. Spain is already struggling with its own excess renewables production and additional imports from third countries would certainly compound that problem. (...) Secondly, it is difficult to argue that the EU needs the additional renewable energy capacity. Europe is currently witnessing a situation in which renewable energy capacity is competing to replace existing conventional plants. This shift requires solving plenty of system issues, including the resynchronisation of the system consecutive to the development of renewable energy, in particular variable wind and photovoltaic. Although variability is not a problem in

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<sup>48</sup> Dii (2012), p.6.

<sup>49</sup> For instance, a year after the nuclear disaster in Fukushima, the Desertec Foundation and the Japan Renewable Energy Foundation (JREF) started a cooperation aimed at promoting an Asian Super Grid necessary for the expansion of renewable energy in Asia. See: Desertec Foundation (2012).

<sup>50</sup> Euractive (2013).

<sup>51</sup> Ibidem.

itself, it obliges the system to change its way of functioning, which also means giving time to the technical, economic, and regulatory framework to adjust. Adding even more renewable energy from Desertec in the meantime would probably not support this move. One final reason for being perhaps a bit more sceptical about the export dimension than initially expected: concerns about Africa's own consumption. It would be a big mistake for Africa to neglect its own, indigenous power generation and risk its own security of supply for the sake of satisfying the demand of Europe.»<sup>52</sup>

Notwithstanding all its weaknesses, it should be recognized that Desertec played an important role, over the last decade, in enhancing the public awareness about the abundant renewable energy resources of the Southern and Eastern Mediterranean region. Desertec, together with the DLR studies on which the initial concept was based, certainly stimulated also the policy makers from both the shores of the Mediterranean to take an action in order to translate the region's renewable energy potential into reality but also to translate this potential renewable energy cooperation into a wider economic, political and social cooperation scheme for the benefit of the overall Mediterranean region. In fact, after the launch of the Desertec concept other large-scale renewable energy projects have gradually been conceptualized in the region: the Mediterranean Solar Plan (MSP), MEDGRID and RES4MED.

#### *- Mediterranean Solar Plan (MSP)*

The MSP has been launched in 2008 within the framework of the Union for the Mediterranean<sup>53</sup> as one of the strategic processes aimed at creating a path of sustainable development in the overall Mediterranean region. The primary objective of the MSP is to provide 20 GW of installed capacity from renewable energy (mainly solar and wind) by 2020 and to develop electricity networks among SEMCs and interconnections between the two shores of the Mediterranean. Furthermore, the MSP include energy efficiency and technology transfer as accompanying measures.

The objectives of the MSP are in line with the goals of the EuroMed Partnership<sup>54</sup> initiated in 1995 with the Barcelona Declaration<sup>55</sup>, which aims at promoting regional trade integration, infrastructure networks and improved environmental protection.

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<sup>52</sup> Euractive (2013).

<sup>53</sup> The Union for the Mediterranean (UfM) is a multilateral partnership that encompasses 44 countries from Europe and the Mediterranean Basin: 28 member states of the EU and 16 Mediterranean partner countries from the MENA region and the Balkans. It was created in July 2008 as a re-launched Barcelona Process. The UfM, which represents the southern regional cooperation branch of the European Neighborhood Policy, has the aim of promoting stability and prosperity throughout the Mediterranean region. For detailed information refer to the website: <http://www.ufmsecretariat.org/en/>

<sup>54</sup> For an overview on the initiative refer to: EuroMed (2007).

<sup>55</sup> The Barcelona declaration (adopted at the Euro-Mediterranean Conference on November 28, 1995) intended to establish a comprehensive Euro-Mediterranean partnership in order to turn the Mediterranean into a common area of peace, stability and prosperity through the reinforcement of political dialogue and security, an economic and financial partnership and a social, cultural and human partnership.

In addition, the EuroMed Energy Priority Action Plan<sup>56</sup> established at the Limassol Conference for the period 2008-2013 featured the promotion of renewable and sustainable energy, as well as improvements to the institutional, legislative and political framework that governs the development and dissemination of renewable energy technologies.

The priority areas of action of the MSP are: «(a) Setting up of an adequate legal, regulatory, institutional and organizational framework to enable the development and massive deployment of solar energy and other renewable energy technologies; (b) Limiting the growth of energy demand and improve energy efficiency and energy savings; (c) Promote the development of electricity interconnections to establish a viable grid system for “Euro-Mediterranean green electricity” trade; (d) Facilitate co-operation on technology aspects.»<sup>57</sup>

The total cost of the MSP is estimated at EUR 45 billion: EUR 40 billion for electricity production and EUR 5 billion for electricity transportation<sup>58</sup>. The financial framework is composed by: «(a) Local contracts: state and local companies as buyers; (b) Export contracts: European companies as buyers; (c) Equity from investors: SWFs, banks, energy companies; (d) Debt or risk guarantee: multilateral organizations; (e) Country risk or special projects: National or European funds.»<sup>59</sup>

The MSP has the support of the European Commission, which is accompanying this initiative through capacity building projects such as “Paving the Way for the Mediterranean Solar Plan”, aimed at contributing to the establishment of harmonized legislative and regulatory frameworks for renewable energy, improving knowledge transfer and enhancing capacity building<sup>60</sup>.

In February 2013 the UfM Secretariat presented to the Joint Committee of National Experts for the MSP the draft of a new MSP Master Plan<sup>61</sup>, a strategy document developed in cooperation with the main stakeholders of both sides of the Mediterranean, with the aim «to provide clear guidance on what needs to be done to develop dynamic, regionally integrated and self-sustained markets for renewable energy and energy efficiency technologies, strengthen the inter-connections between the electricity systems of the member states and thereby facilitate the roll-out of safe, secure, clean, non-exhaustible, and non-polluting energies, thus paving the way to a

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<sup>56</sup> The Action Plan was endorsed by the European Energy Commissioner Andris Piebalgs and by Ministers from the EU Member States and from the Mediterranean partner countries at the 5th Euro-Mediterranean Energy Ministerial Conference. The Action Plan focused on three main areas: (a) To ensure the improved harmonization of energy markets and legislations and to pursue the integration of energy markets in the Euro-Mediterranean region; (b) To promote sustainable development in the energy sector; (c) To develop initiatives of common interest in key areas, such as infrastructure extension, investment financing and research and development.

<sup>57</sup> European Commission (2010).

<sup>58</sup> ENPI (2010).

<sup>59</sup> European Commission (2010).

<sup>60</sup> All studies prepared in the context of this project are available at: <http://www.pavingtheway-msp.eu/>

<sup>61</sup> See: <http://ufmsecretariat.org/mediterranean-solar-plan-joint-committee-of-national-experts-discusses-draft-of-the-master-plan/>

larger exchange of green electricity around and across the Mediterranean.»<sup>62</sup> The MSP Master Plan now needs to receive an official political endorsement by the EU Mediterranean Energy Ministerial Meeting.

#### - MEDGRID

In 2009 the French government launched, under the umbrella of the MSP, an initiative to study the feasibility of a HVDC transmission project between the two shores of the Mediterranean. The industrial stage of this project is represented by MEDGRID, an industrial consortium created in 2010 by a group of utilities, grid operators and equipment makers, with the target of carrying out a feasibility study of the development of a grid aimed at connecting Europe to North African solar electricity producers<sup>63</sup>.

Accordingly to its stakeholders, MEDGRID can bring two main advantages to the Euro-Mediterranean renewable energy cooperation: «a) Profitability for the solar plants in the southern and eastern countries, as a part of the electricity produced by solar power plants can be sold to Europe at higher prices for feed-in tariffs; b) Security of supply, with the import and export of electricity to respond to peak demand and intermittent renewable production.»<sup>64</sup>

MEDGRID has five main commitments: «a) Design the Mediterranean grid master plan for 2020, leading to concrete investment projects; b) Promote a regulatory and institutional framework for the exchanges of green electricity; c) Assess the benefits of investment in grid infrastructures; d) Develop technical and technological cooperation with southern and eastern countries in the area of power grids; e) Promote advanced HVDC technologies for power transmission.»<sup>65</sup>

In November 2011 MEDGRID and Dii signed a Memorandum of Understanding (MoU) to cooperate in terms of information exchange, update on progress, joint evaluation of potential synergies, and joint efforts on the EU and MENA level to obtain a more favourable regulatory framework for renewable energy markets<sup>66</sup>.

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<sup>62</sup> See: <http://ufmsecretariat.org/mediterranean-solar-plan-master-plan-meeting-with-the-minister-of-energy-and-mineral-resources-of-jordan/>

<sup>63</sup> Medgrid founding members are: Abengoa, Alstom grid, Areva Renouvelables, Atos WorldGrid, CDC Infrastructure, EDF, Ineo, Nemo, Nexans, Nur Energie, ONE, Pan Med Trading and Investment, Prysmian, Red Eléctrica, RTE, Siemens, Soitec Concentrix Solar, Taqa Arabia, Terna and Walid Elias Establishment. The French development agency (AFD) also concluded a strategic and financial partnership with MEDGRID.

<sup>64</sup> See: <http://www.medgrid-psm.com/en/project/our-mission/>

<sup>65</sup> See: <http://www.medgrid-psm.com/en/project/how-will-we-do-it/>

<sup>66</sup> European Commission (2011).

- RES4MED

RES4MED is a non-profit association set up in 2012 by CESI, Edison, Enel Green Power, Gestore Servizi Energetici (GSE), PricewaterhouseCoopers (PwC) and Politecnico di Milano<sup>67</sup>.

According to its stakeholders, RES4MED «intends to be a catalyst for the ongoing Mediterranean initiatives, while involving key players from North Africa, the Middle East and the Balkans. With its members' expertise and knowledge, RES4MED wants to present itself as an additional reference point for Mediterranean stakeholders committed to renewable energy promotion. In a low-carbon future, RES4MED believes that new RES generation in the Mediterranean will be gradually deployed, starting from mid-size up to large-scale power plants. As a complement, RES4MED focuses on research related to distributed generation, village power, energy from waste and smart cities. In developing these projects particular attention is paid to the demand side's needs in the Southern and Western shores of the Mediterranean.

RES4MED intends to be an additional reference point for southern Mediterranean and Balkan stakeholders and expects to play the role of "network of networks" for the ongoing Mediterranean initiatives by: a) Contributing to a faster deployment of renewable energy plants and systems in order to satisfy southern and eastern countries' needs – both large-scale power and distributed energy; b) Supporting the planning and design facets of additional national electric grids to supply an efficient distribution of clean energy towards local consumption centres; c) Fostering medium-term regional interconnections between the southern EU, northern Africa and the Balkans in order to facilitate the import of part of the energy produced, also to increase the bankability of such projects; d) Considering the social and economic benefits for host countries.

RES4MED aims to carry out the following activities: a) Analysis of regulatory, technical and financial aspects; b) Feasibility studies for the development of renewable energy and energy efficiency projects; c) Organisation of seminars, conferences and events, and the release of publications; d) Collaboration within the main associations active in the energy field to develop technical and economic research synergies; e) Training workshops to improve knowledge and technology transfers in renewable energy and energy efficiency sectors; f) Experience exchange on existing projects by creating a dialogue platform.»<sup>68</sup>

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<sup>67</sup> Asja Ambiente, Fondazione Ugo Bordoni and Terna Plus have joined as partners, while Althesys, AssoRinnovabili and RSE-Ricerca di Sistema Elettrico are affiliated members. Università Bocconi has honorary member status.

<sup>68</sup> See: <http://www.res4med.org/>

## 2.4 The Emergence of National Renewable Energy Plans

The abundant renewable energy resources of SEMCs did not only paved the way for the conceptualization and implementation of European-based, large-scale renewable energy projects such as the ones just described, but also generated a considerable awareness on the huge potential for renewable energy within SEMCs themselves. In fact, over the last years almost all SEMCs' governments adopted their own national renewable energy plans, with the aim to enhance their domestic exploitation of renewable energy resources. As an overall trend, SEMCs' national renewable energy plans mainly target solar energy, most notably PV and CSP, and wind. These plans generally include targets for shares of electricity generation from renewable energy, typically 10-20%, shares of total final energy supply from renewable energy, total amount of energy production from renewable energy, or installed electric capacities of specific technologies. The timeframe of these plans is generally 2020-2030 (Tab. 5).

**TABLE 5**  
 Overall renewable energy targets in SEMCs

Country	Targets
Morocco	○ 42% of electricity generation by 2020 of which 14% is solar, 14% is wind and 14% is hydro
Algeria	○ 6% of electricity generation by 2015; 15% by 2020; 40% by 2030
Tunisia	○ 11% of electricity generation by 2016; 25% by 2030 ○ 16% of installed power capacity by 2016; 40% by 2030
Libya	○ 7% of electricity generation by 2020 and 10% by 2025
Egypt	○ 20% of electricity generation by 2020
Israel	○ 10% of electricity generation by 2020
Palestinian Territories	○ 25% of primary energy by 2020 ○ 10% of electricity generation by 2020
Jordan	○ 7% of primary energy by 2015; 10% by 2020
Lebanon	○ 12% of electrical and thermal energy by 2020
Syria	○ Specific capacity targets for PV, solar heat and wind by 2030
Turkey	○ 30% of electricity generation by 2023

Source: own elaboration on UAE/IRENA/REN21 (2013) and national renewable energy plans.



The targets presented in Tab. 5 are generally enclosed in dedicated national renewable energy plans such as, for instance, Morocco's "National Renewable Energy and Efficiency Plan" launched in 2008, Algeria's "Renewable Energy and Energy Efficiency Program" launched in 2011 and Tunisia's "Solar Plan" launched in 2009. These plans do not just provide overall target such as the ones just presented, but also specific renewable energy capacity targets by technology, as shown in Tab. 6.

**TABLE 6**  
Solar and wind energy capacity targets by technology in SEMCs

Country	Installed capacity targets by technology
Morocco	<ul style="list-style-type: none"> <li>○ PV: 2,000 MW by 2020;</li> <li>○ Wind: 2,000 MW by 2020.</li> </ul>
	<b>Total: 4,000 MW by 2020</b>
Algeria	<ul style="list-style-type: none"> <li>○ PV: 830 MW by 2020; 2,800 MW by 2030;</li> <li>○ CSP: 1,500 MW by 2020; 7,200 MW by 2030;</li> <li>○ Wind: 270 MW by 2020; 2,000 MW by 2030.</li> </ul>
	<b>Total: 12,000 MW by 2030 (+10,000 MW for export)</b>
Tunisia	<ul style="list-style-type: none"> <li>○ PV: 1,500 MW by 2030;</li> <li>○ CSP: 500 MW by 2030;</li> <li>○ Wind: 1,700 MW by 2030.</li> </ul>
	<b>Total: 3,700 MW by 2030</b>
Libya	<ul style="list-style-type: none"> <li>○ PV: 344 MW by 2020; 844 MW by 2025;</li> <li>○ CSP: 125 MW by 2020; 375 MW by 2025;</li> <li>○ Wind: 600 MW by 2020; 1,000 MW by 2025.</li> </ul>
	<b>Total: 2,219 MW by 2025</b>
Egypt	<ul style="list-style-type: none"> <li>○ PV: 220 MW by 2020; 700 MW by 2027;</li> <li>○ CSP: 1,100 MW by 2020; 2,800 MW by 2027;</li> <li>○ Wind: 7,200 MW by 2020.</li> </ul>
	<b>Total: 10,700 MW by 2027</b>
Israel	<ul style="list-style-type: none"> <li>○ PV: 1,750 MW by 2020;</li> <li>○ Wind: 800 MW by 2020.</li> </ul>
	<b>Total: 2,550 MW by 2020</b>
Palestinian Territories	<ul style="list-style-type: none"> <li>○ PV: 45 MW by 2020;</li> <li>○ CSP: 20 MW by 2020;</li> <li>○ Wind: 44 MW by 2020.</li> </ul>
	<b>Total: 109 MW by 2020</b>
Jordan	<ul style="list-style-type: none"> <li>○ PV: 300 MW by 2020;</li> <li>○ CSP: 300 MW by 2020;</li> <li>○ Wind: 1,200 MW by 2020.</li> </ul>
	<b>Total: 1,800 MW by 2020</b>

<b>Lebanon</b>	○ Wind: 400-500 MW by 2020
	<b>Total: 400-500 MW by 2020</b>
<b>Syria</b>	○ PV: 380 MW by 2020; 1,750 MW by 2030; ○ CSP: 50 MW by 2030; ○ Wind: 1,000 MW by 2020; 2,000 MW by 2030.
	<b>Total: 3,800 MW by 2030</b>
<b>Turkey</b>	○ PV: 3,000 MW by 2023; ○ Wind: 20,000 MW by 2023.
	<b>Total: 23,000 MW by 2023</b>
<b>SEMCs</b>	<b>Total: 75,000 MW by 2030</b>

Source: own elaboration on UAE/IRENA/REN21 (2013, p. 20),  
 IRENA (2013) and Invest in Turkey (2014).

As illustrated in Tab. 6, if all targets were met, the installed solar and wind energy capacity of SEMCs could -approximately- reach 75,000 MW by 2030. An impressive figure, almost 40 times higher than the one of 1,700 MW estimated for 2010<sup>69</sup>. However, these targets should be handled very carefully, as they are generally not legally binding. Furthermore, it might also be considered that these targets often represent a means used by governments to show their country' commitment to renewable energy, particularly to international investors.

Having said that, the targets just presented at least demonstrate how policymakers in SEMCs are increasingly aware of their countries' abundant solar and wind energy resources and of the potential benefits of their exploitation. This growing awareness is also demonstrated by the fact that many SEMCs have put in place dedicated agencies to support their renewable energy plans. These agencies complement the activities of the ministries responsible for the energy sector and of the energy regulatory authorities in the promotion of renewable energy (Tab. 7).

<sup>69</sup> Hafner, Tagliapietra and El Andaloussi (2012a).

**TABLE 7**  
Renewable energy agencies in SEMCs

Country	Agency	Year	Functions
Morocco	Moroccan Agency for Solar Energy (MASEN)	2010	Public-private agency created for the implementation of the Moroccan Solar plan and the promotion of solar resources in every aspect.
Algeria	New Energy Algeria (NEAL)	2003	Agency established by the Algerian government and Algeria's national energy companies to encourage domestic production, use, and export of renewable energy.
Tunisia	National Agency for the Promotion of Renewable Energy (ANME)	2009	Agency established by the Tunisian government to encourage domestic production, use, and export of renewable energy.
Libya	Renewable Energy Authority (REAOL)	2007	Governmental institution created to implement renewable energy projects, increase the contribution of renewable energy in the mix and propose legislation to support renewable energy.
Egypt	New & Renewable Energy Authority (NREA)	1986	Agency established to act as the national focal point for expanding efforts to develop and introduce renewable energy technologies on a commercial scale.
Jordan	National Energy Research Centre (NERC)	1998	Centre dedicated to research, development and training in the fields of new and renewable energy.
Syria	National Energy Research Centre (NERC)	2003	Centre established by the Ministry of Electricity to conduct studies on renewable energy and implement experimental pilot projects.

Source: own elaboration on MASEN, NEAL, ANME, REAOL, NREA, NERC, NERC official websites.

The role of these agencies is to implement the policy of the government on the ground. To be effective, this function cannot be properly conducted either by those responsible for the design of renewable energy policies (ministries) or by those in charge of the distribution of electricity services (utilities). The former are typically characterised by lengthy and heavy procedures, which prevent a smooth and flexible implementation of renewable energy policies. The latter may face a conflict of interest as they are more concerned with the reduction of costs and the generation of profits than with the promotion of public goods. For all these reasons, dedicated renewable energy agencies that are separated from both policy formulation authorities and service providers are considered as the best guarantee for the implementation of renewable energy policies.

To conclude, this section has outlined three key points:

- a) The rich endowment of renewable energy sources, notably solar and wind, of the Southern and Eastern Mediterranean region;
- b) The wide range of benefits that might potentially be generated by a consistent deployment of solar and wind energy in the region, both in economic, social, environmental and political terms;
- c) The rise of large-scale renewable energy projects in the region over the last decade;

- d) The emergence of a wider awareness among SEMCs' policymakers about the regional renewable energy potential, with the related development of national renewable energy targets and plans.

Considering these elements, it might be natural to think that the situation of renewable energy in the region is well on track. However, as indicated in § 1.2, solar and wind energy continue to represent less than 1% of the regional electricity generation mix.

This paradox represents a clear signal that the efforts made so far to promote renewable energy in the region have not been completely efficient and successful. It is thus essential to investigate the reasons of this paradox, in order to understand how the regional deployment of solar and wind energy might be better promote in the future.

For this reason, the next section will provide an analysis of the barriers to the development of renewable energy in the region, with the aim to elaborate a new approach able to translate the regional renewable energy potential into reality.

### 3. Rethinking Renewable Energy in the Region: The Need for a New Approach to Translate Potential Into Reality

#### 3.1 Barriers to the Development of Renewable Energy in the Region

Generally speaking, the grade of success of the deployment of a new technology is mainly dependent to its comparative cost-advantage in relation to existing technologies. This overall concept is useful to understand part of the difficulties encountered by solar and wind technologies in the past, not only in the Southern and Eastern Mediterranean, but all around the world.

In fact, the typical structure of a solar or wind energy business plan often makes such projects less competitive than the conventional ones. This is due to the fact that solar and wind energy projects are characterized by high upfront costs, which implies a long payback period, given the marginal profit derived from each unit of electricity sold. To use an example provided by the OECD (2013), «the instalment costs of renewable energy power plant correspond broadly to the costs of building a gas power plant and the gas supply needed for the entire operation period of the power plant. Unlike the case for the gas supply investment, it is not possible to space out investments in renewable energy in order to split the risks related to the project: the costs are front-loaded.»<sup>70</sup>

Notwithstanding the fact that, due to its abundant renewable energy resources, lifecycle costs for solar and wind energy in the Southern and Eastern Mediterranean region could lie well below those in most other regions in the world, SEMCs lag far behind most other countries in Europe, North America and Asia in terms of solar and wind energy deployment. This is due to the fact that the development of renewable energy in SEMCs faces additional barriers, related to some specific features of the regional market.

In particular, these additional regional barriers could be categorized into four areas: a) commercial; b) infrastructural; c) regulatory; d) financial. Each one of these barriers will be discussed hereafter, with the underlying conviction that only by fully addressing them the region will be finally able to translate its renewable energy potential into reality.

#### 3.2 The Commercial Barrier: Reforming Energy Subsidies

Energy subsidies represent the cornerstone of the political economy of energy in the Southern and Eastern Mediterranean region and -among many other things- they represent a key barrier to the development of renewable energy in the region.

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<sup>70</sup> OECD (2013), p. 45.

The IEA defines an energy subsidy as «any government action directed primarily at the energy sector that lowers the cost of energy production, raises the price received by energy producers or lowers the price paid by energy consumers.»<sup>71</sup>

Energy subsidies have long been used by governments all over the world to reach specific political, economic, social or environmental targets. The most common justifications for the introduction of energy subsidies are: a) Alleviating energy poverty (via fossil-fuel subsidies); b) Boosting domestic supply (via indigenous fuel production subsidies); c) Redistributing national resource wealth (via subsidies in the form of artificially low energy prices); d) Protecting employment (via subsidies in the form of tariffs or trade restrictions); e) Protecting the environment (via subsidies supporting the electricity production from renewable energy sources)<sup>72</sup>.

Energy subsidies can assume different forms and modalities with a direct or indirect outcome on energy production costs and/or final prices. A typical example of direct energy subsidy is the arrangement that makes fuels available to consumers at prices below international levels, while an example of indirect subsidy is the feed-in-tariffs system, aimed at ensuring a premium to power producers for electricity generated, for instance, from solar panels. An overview on the main types of energy subsidies is provided in Tab. 8.

**TABLE 8**  
Main types of energy subsidies

Government intervention	Example	How the subsidy usually works		
		Lowers cost of production	Raises price of producer	Lowers price to consumer
Direct financial transfer	Grants to producers	X		
	Grants to consumers			X
	Low-interest or preferential loans	X		
Preferential tax treatment	Rebates or exemptions on royalties, sales, taxes	X		
	Tax credit	X		X
	Accelerated depreciation allowances on energy-supply equipment	X		
Trade restrictions	Quotas, technical restrictions and trade embargoes		X	
Energy-related services provided directly by government	Direct investment in energy infrastructure	X		
	Public research and development	X		
	Liability insurance and facility decommissioning costs	X		
Regulation of the energy sector	Demand guarantees and mandated deployment rates	X	X	
	Price controls		X	X
	Market-access restrictions		X	

Source: United Nations Environment Programme (2008, p.25).

<sup>71</sup> IEA (2011a), p. 509.

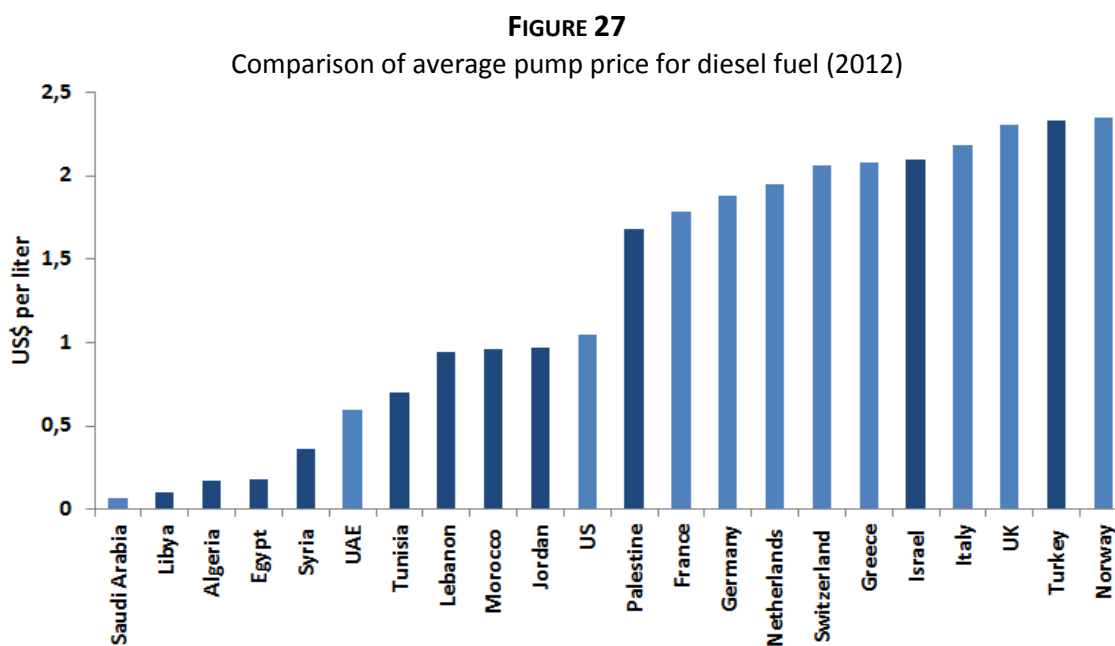
<sup>72</sup> IEA (2010), pp. 571-572.

As outlined by Bergasse and Paczynski (2013), «[in SEMCs energy subsidies] mostly consist of universal direct energy price reductions focused on LPG (used for cooking and heating), diesel (local transport and agriculture) and electricity (general and agriculture). Subsidies to fuels (LPG, diesel) account for the largest share, followed by electricity and natural gas.»<sup>73</sup>

As an overall trend, these universal energy subsidies (i.e. fossil-fuel consumption subsidies) have been employed by SEMCs with the official target of alleviating energy poverty. However, the situation slightly differs from country to country, and particularly from energy producing countries and non-energy producing countries.

Two key indicators of the overall SEMCs' policy of providing low-cost energy supplies are represented by pump price for diesel fuel and electricity prices.

As indicated in Fig. 27, pump price for diesel fuel in Libya, Algeria, Egypt, Syria, Tunisia, Lebanon, Morocco and Jordan are among the lowest in the world. Only the Palestinian Territories, Israel and Turkey match European levels.

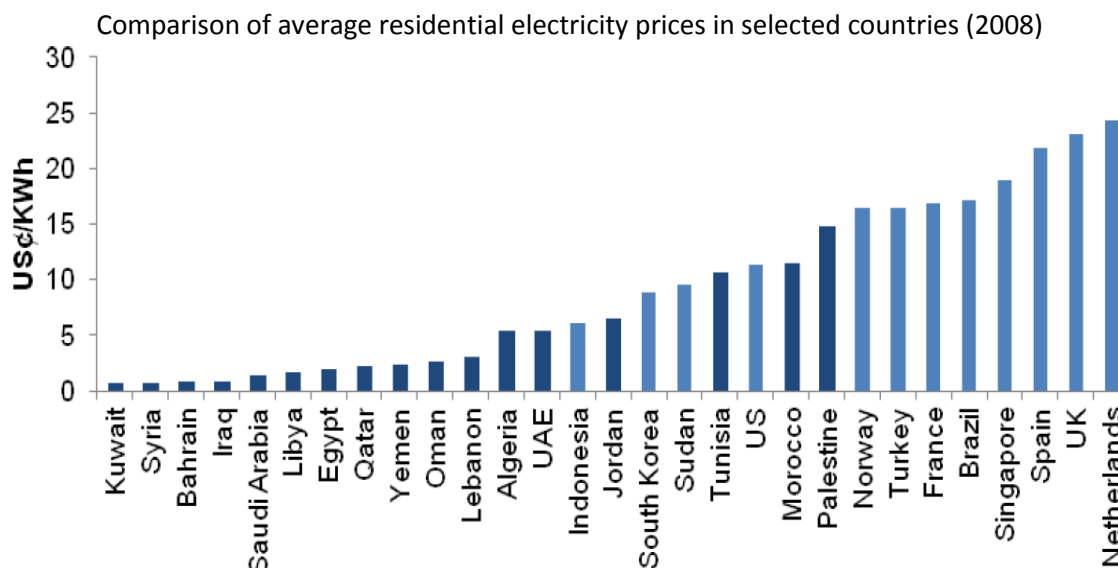


Source: own elaboration on World Bank, World Development Indicators, accessed in May 2014.

Furthermore, as indicated in Fig. 28, electricity prices in Syria, Libya, Egypt, Lebanon, Algeria and Jordan also are among the lowest in the world.

<sup>73</sup> Bergasse and Paczynski (2013), p. 16.

**FIGURE 28**



Source: El-Katiri (2014, p.9).

Only Tunisia, Morocco, the Palestinian Territories, Turkey and Israel match European levels in terms of electricity prices, albeit if, as El-Katiri (2014) outlines, «both Moroccan government and the Palestinian authorities subsidize electricity prices, suggesting that actual generation costs may well exceed these already high price levels.»<sup>74</sup>

In short, energy prices are subsidized in all SEMCs, with the only exception of Turkey and Israel, which are in line with the European levels of energy prices.

In theory, the employment of energy subsidies might appear beneficial for the socio-economic development of a region -such as the Southern and Eastern Mediterranean- where an important share of the population still lacks access to modern energy services. However, the concrete implementation of this principle turns out to be rather controversial. In fact, as the IEA points out, «energy subsidies have proven to be an inefficient means of fulfilling the objectives of promoting economic development or alleviate energy poverty, instead creating market distortion that encourage wasteful consumption and can lead to unintended negative consequences.»<sup>75</sup> In particular, these negative consequences can be summarized as follows:

- a) Energy subsidies lead to an inefficient allocation of resources and market distortions by encouraging a rent-seeking behavior and thus an excessive production or consumption;
- b) Energy subsidies generate an unsustainable financial burden in energy importing countries that purchase energy at world prices and sell it domestically at lower;

<sup>74</sup> El-Katiri (2014), p.10.

<sup>75</sup> IEA (2011), p. 508.



- c) Energy subsidies generate huge economic losses in net-energy exporting countries, as an important share of their resources is sold domestically at a fraction of its international market value. This is particularly true after the international oil price surge occurred in the first decade of the 2000s;
- d) Energy subsidies «limit financial resources available for investment in the energy sector, discourage efficient energy use, encourage fuel adulteration and smuggling and lead to increased environmental degradation»<sup>76</sup>;
- e) Energy subsidies also appear inefficient in addressing their social targets, as on average only 8% of fossil-fuel subsidies go to the poorest income group and in some cases they may not even reach the poor at all<sup>77</sup>;
- f) Energy subsidies distort the economics of energy and the price signals of energy resources -particularly in SEMCs oil and gas producers-, also limiting the competitiveness of renewable energy sources<sup>78</sup>.

The long list of negative consequences generated by universal energy subsidies just presented (see also Fig. 29) might raise the question on why such economically-detrimental and socially-inefficient schemes continue to be adopted throughout the Southern and Eastern Mediterranean region. The answer to this question must be sought in the political sphere rather than in the economic one.

In fact, energy subsidies represent a key element of the “social contract” in many SEMCs, notably the energy-producing ones. In other words, energy subsidies -along with food subsidies- «are generally considered as a major component of the social safety net for the poor, guaranteeing the availability of affordable goods.»<sup>79</sup>

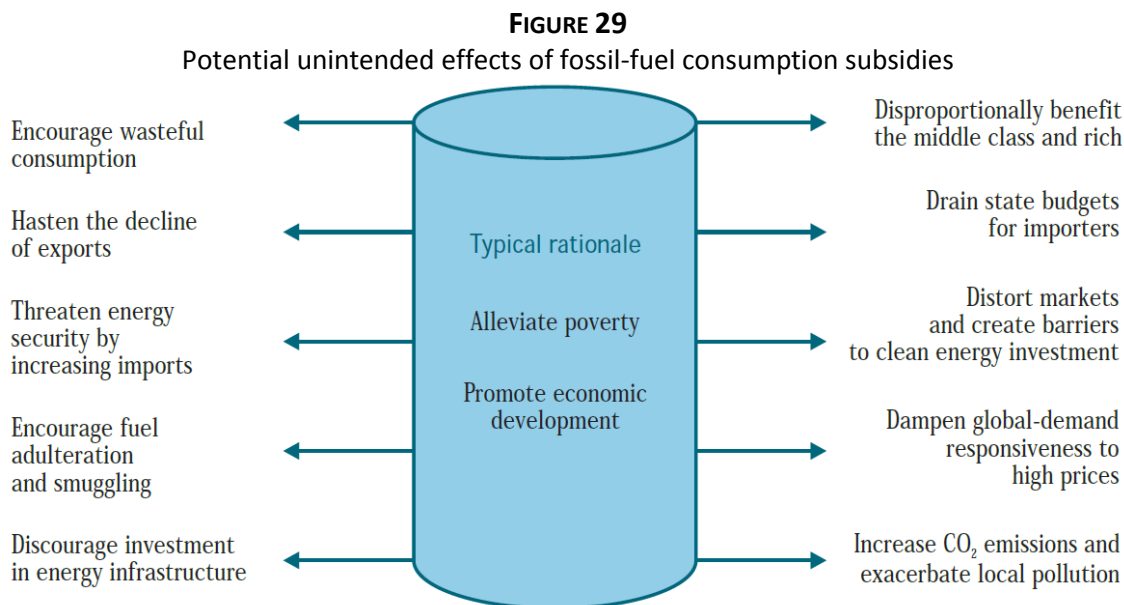
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<sup>76</sup> IEA (2011), p. 511.

<sup>77</sup> IEA (2011), p. 519. As Bergasse and Paczynski (2013, p. 13) point out: «The main reasons for this low efficiency are as follows: a) The poorest households may be unable to afford to pay even for subsidised energy but above all for the high connection fees and appliance costs. Also, they may have no physical access to the energy system, for instance, in isolated rural areas or urban slums (no electricity grid connection) or when they are not considered as viable customers by energy companies; b) When poor households are able to purchase energy at subsidised prices, their consumption is generally modest and sometimes capped (e.g. electricity lifeline or block tariff, which can nevertheless provide a more effective support to poor and limit distortions towards richer customers). Thus, the share of the subsidy remains low in their revenues and does not significantly reduce poverty. In addition, those who generally benefit from the universal consumption subsidies are the wealthiest customers, especially in urban areas, whose energy consumption is much higher.»

<sup>78</sup> As El-Katiri (2014, p. 11) correctly outlines: «Unwilling to consider the *opportunity cost* (the cost associated with value lost for fossil fuel sources priced domestically below their economic value on international markets) as being a ‘subsidy’, many MENA [oil and gas] producers refer to the long-run marginal cost of production per unit of energy as the relevant benchmark framework for evaluating the cost of domestically produced fossil fuels vis-à-vis renewable and other alternative sources of energy. The subsequent paper-based cost comparison between both renewables and nuclear on the one hand, and regionally produced fossil fuels on the other is hence absurdly asymmetric, particularly in the case of crude oil and oil products. The value lost to NECs is in the form of: wasted energy, a more rapid depletion of these countries’ hydrocarbon resources, and consumer subsidies that benefit primarily large users of energy, and while not quantifiable in the conventional sense, it can only be thought of as being excessive.»

<sup>79</sup> Bergasse and Paczynski (2013), p. 15.



Source: International Energy Agency (2010, p. 573).

The elimination of universal energy subsidies would provide a number of economic and environmental gains such as energy savings, lower levels of emissions and reduced fiscal burdens. Furthermore, as the IEA emphasizes, «curbing the growth in energy demand via subsidy reform also has several important energy security implications. In net-importing countries, lower energy demand would reduce import dependence and thereby spending on imports. For net-exporting countries, removing subsidies would boost export availability and earnings. For all countries, it would also improve the competitiveness of renewable energy in relation to conventional fuels and technologies, further diversifying the energy mix. Lower energy demand would also alleviate upward pressure on international energy prices, yet the elimination of subsidies would make consumers more responsive to price changes, which should contribute to less volatility in international energy markets.»<sup>80</sup>

However, economic and commercial rationalities do not always match with political requirements. Governments face difficult challenges in reforming energy subsidies also because, as the IEA points out, «subsidies create entrenched interests among domestic industries advantaged by cheap energy inputs and those income groups that are accustomed to receiving this form of economic support. Such stakeholders can be expected to resist subsidy phase-out, particularly in the absence of clear plans to compensate losers or make the transition gradual. Resistance to fossil-fuel subsidy reform can be particularly strong in major fossil-fuel-exporting countries, where people may feel entitled to benefit directly from their nation's resource wealth.»<sup>81</sup>

A reform of energy subsidies, for instance aimed at phasing out universal fossil-fuel consumption subsidies to replace them by individualised/targeted subsidies, would be

<sup>80</sup> IEA (2011), p. 521.

<sup>81</sup> IEA (2011), p. 523.

essential to improve the energy, economic and social sustainability of the overall Southern and Eastern Mediterranean region. Such a move would also favour the deployment of solar and wind energy, by removing a key market-distortion.

In the aftermath of the Arab uprising, such a reform process seems to be even more difficult, even if in the case of Egypt a recent reform has effectively reduced for the first time the country's unsustainable energy subsidy system<sup>82</sup>. In the medium-term all SEMCs should advance an energy-subsidy reform process, phasing out universal fossil-fuel consumption subsidies in favour of targeted subsidies aimed at effectively address the problem of energy poverty.

### 3.3 The Infrastructural Barrier: The Key Role of MED-TSO

Another key barrier to the deployment of solar and wind energy in SEMCs is represented by the lack of an adequate electricity infrastructure in the region.

This fact is strictly connected to the issue of energy subsidies, as in fact the development of a regional electricity transmission system has been limited by the lack of a regional market, largely due to energy subsidies themselves. The rigidities that this situation imposes mean that existing infrastructure is not used optimally, investment in new infrastructure is distorted and probably hindered, and the development of renewable energy is ultimately delayed.

In particular, the regional electricity transmission systems need to be enhanced at three levels: a) The national level (within SEMCs); b) The sub-regional level (between SEMCs); c) The overall regional level (between SEMCs and EU).

#### *- The national level*

First of all, electricity transmission lines within the respective SEMCs need to be reinforced. These lines are often weak and characterized by considerable technical distribution losses. Non-technical (commercial) distribution losses also remain at very high levels (up to 40% in Lebanon and 20% in Algeria) at the expense of paying customers and distributors. This situation is not sustainable, particularly if considering the growing electricity demand of SEMCs highlighted in § 1.4 (average annual growth rate of about 5% up to 2030).

The weakness of the existing electricity transmission lines, combined with the rapid and consistent growth of electricity demand in SEMCs, will generate a serious pressure on the existing infrastructure, requiring major investments in the future not only on the construction of new electricity generation facilities, but also of new electricity transmission lines and distribution networks<sup>83</sup>.

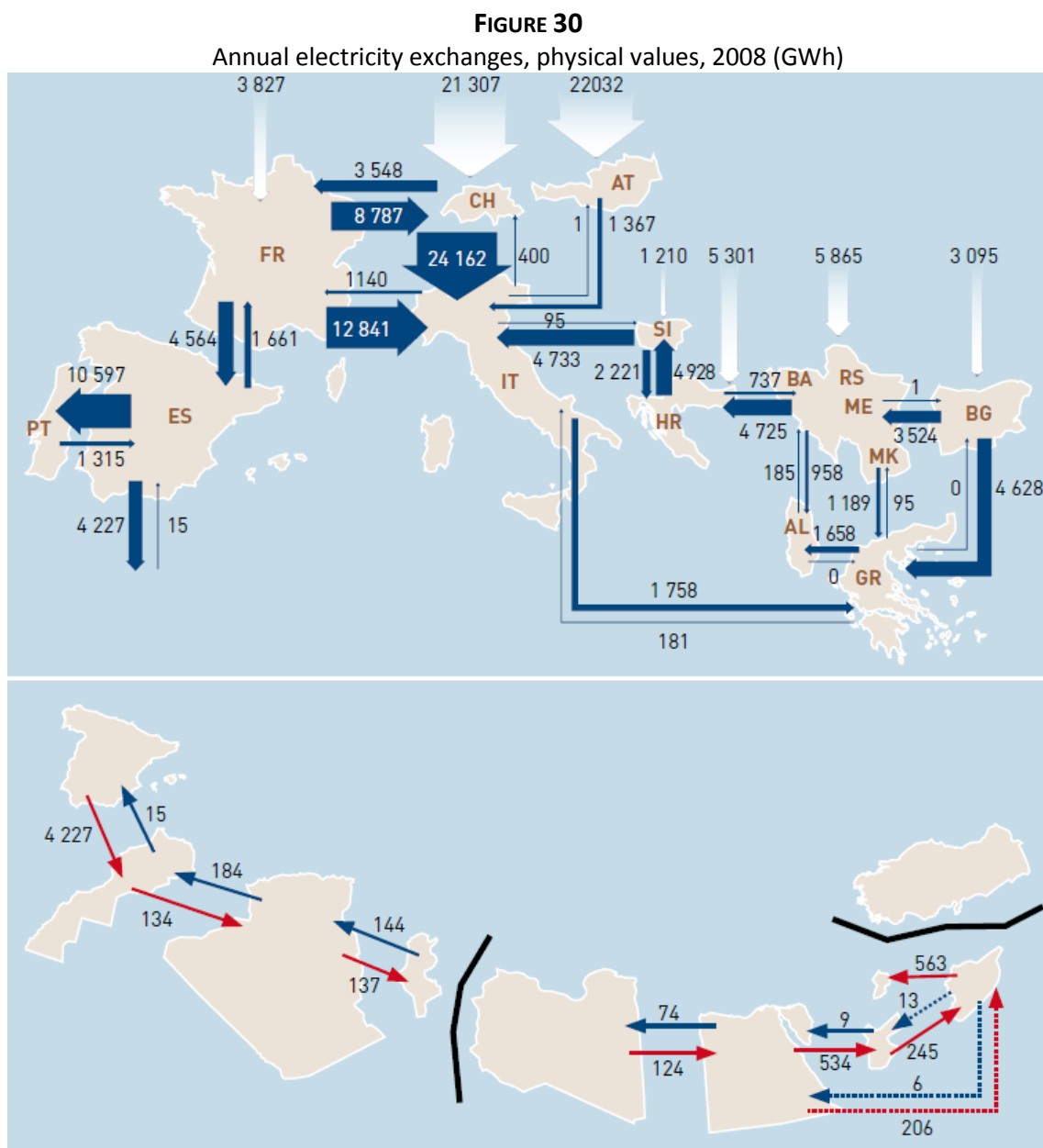
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<sup>82</sup> For a comprehensive analysis of the implication of Arab uprisings on MENA oil and gas markets refer to: El-Katiri, L., Fattouh, B. and Mallinson, R. (2014).

<sup>83</sup> A detailed analysis of the respective SEMCs' electricity networks is provided in PWMSP (2012a).

- The sub-regional level

Secondly, electricity transmission lines between SEMCs need to be constructed and, in certain cases, reinforced. Over the last decade SEMCs have pledged to connect their electricity networks but up to date the Southern and Eastern Mediterranean region is not fully interconnected (Fig. 30).



Source: elaboration of OME (2011b, p. 139), on MEDRING (2010).

Electricity interconnections do exist between Morocco, Algeria and Tunisia, as well as between Libya, Egypt, Israel, Palestinian Territories, Lebanon, Jordan and Syria.

However, connections currently do not exist between Algeria/Tunisia and Libya<sup>84</sup> or between Syria and Turkey<sup>85</sup>. Such a fragmented situation has actually resulted in the creation of three not-as-yet interconnected blocks: the western block (from Morocco to Tunisia), the eastern block (from Libya to Syria) and Turkey (Fig. 32).

Furthermore, the sub-regional exchange of electricity respectively within the western block and the eastern block continues to be very limited. As indicated in Fig. 32, minor quantities of electricity are exchanged between SEMCs in comparison to what happens among NMCs. This situation is due to the limited capacity of the existing electrical interconnections among SEMCs, and to the lack of synchronisation among the interconnected systems. In fact, the electricity networks of Morocco, Algeria and Tunisia are synchronised with continental Europe's UCTE network, while neither the Libyan nor the Egyptian networks are synchronised with their neighbours or continental Europe<sup>86</sup>.

Many electricity interconnection projects are on the table since many years. These projects involve the connection of the three blocks to one another also in view of connecting the overall Southern and Eastern Mediterranean region with Europe, as described here below.

#### *- The regional level*

The two shores of the Mediterranean have been connected since 1997 through an interconnector linking Morocco and Spain across the Strait of Gibraltar (Fig. 31). This line, doubled in 2006, is set to be tripled in the near future to reach 2,100 MW.

In addition to this, many SEMCs-EU electricity interconnection projects are under evaluation since many years already, the most advanced of which is the Tunisia-Italy HVDC cable. This line is set to be developed in two stages (500 MW in the first stage and an additional 500 MW in the second stage). For the second stage to become operational, the reinforcement of the Sicilian grid will be required. The realisation of the project is linked to the construction of a new power plant in Tunisia (coal or gas

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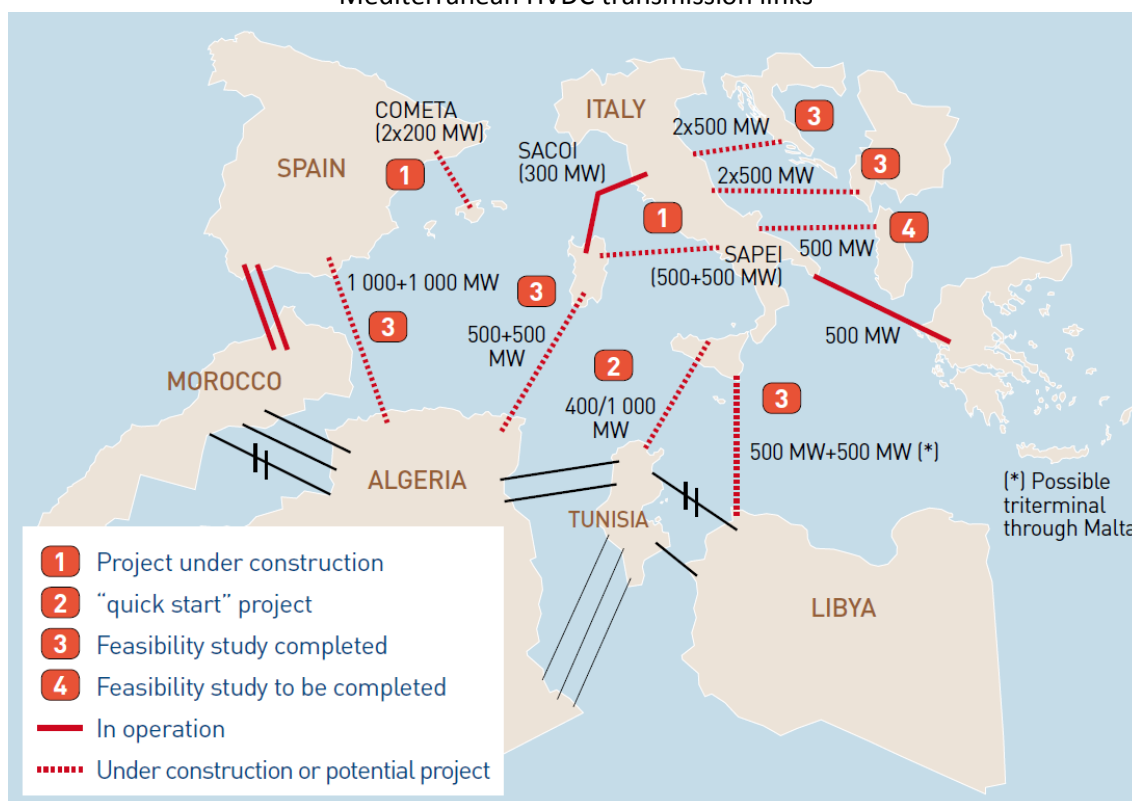
<sup>84</sup> Tunisia and Libya are physically interconnected through two overhead lines. A double circuit 225 kV line (380 km in length) exists between Medine S/S (Tunisia) and Abou Kammash S/S (Libya). A single 225 kV circuit connects Tataouine (Tunisia) to El Rowis (Libya). The construction of the lines was completed in 2003, but they are still not in operation. In 2005, a failed synchronisation attempt was made between Libya and Tunisia. In fact, a first attempt at synchronisation between Tunisia and Libya was tried on 21 November 2005. This trial, which would have synchronised the European Network of Transmission System Operators for Electricity/Synchronous Continental Region (ENTSO-E/SCR) with Libya and all of the Mashreq countries up to Syria, experienced an emergency interruption triggered by a defence plan in the Maghreb grid. Ex-post analyses revealed some deficiencies, such as an insufficient capacity of transmission lines at cross-border cut-sets, and faulty performance in SEMCs. A 400 kV link between Rowis in Libya and Mornaguia in Tunisia is envisaged for around 2015. If synchronisation with the Tunisian network is successful, it will finally achieve interconnection between the western and the eastern blocks.

<sup>85</sup> Syria and Turkey are physically connected through a 124-km long 400 kV single circuit line connecting Birecik and Aleppo. The line is presently in operation for local power exchanges from Turkey to Syria in "islanded" mode. The two networks are thus not synchronized.

<sup>86</sup> For a detailed discussion of this issue please refer to: Hafner, Tagliapietra, El Andaloussi (2012a).

fired with a capacity of 1,200 MW). The Tunisian-Italian joint venture (ELMED) was set up in April 2009 and will manage the process of tendering and contract awarding for the construction of the new power plant. According to the stakeholders, «the interconnector will be operated in the form of a “merchant” interconnection with 80% of capacity exempted from third-party access and reserved for the investor in the new power plant. Access to the remaining capacity is open. This capacity may eventually be used for trading “green energy” between the Maghreb and Italy. The interconnector is expected to enter into operation in 2016.»<sup>87</sup>

**FIGURE 31**  
 Mediterranean HVDC transmission links



Source: elaboration of OME (2011b, p. 143), on CESI/MEDELEC (2010).

Other, far less advanced, projects involve the construction of HVDC cables connecting respectively Algeria and Spain, Algeria and Sardinia, Libya and Sicily.

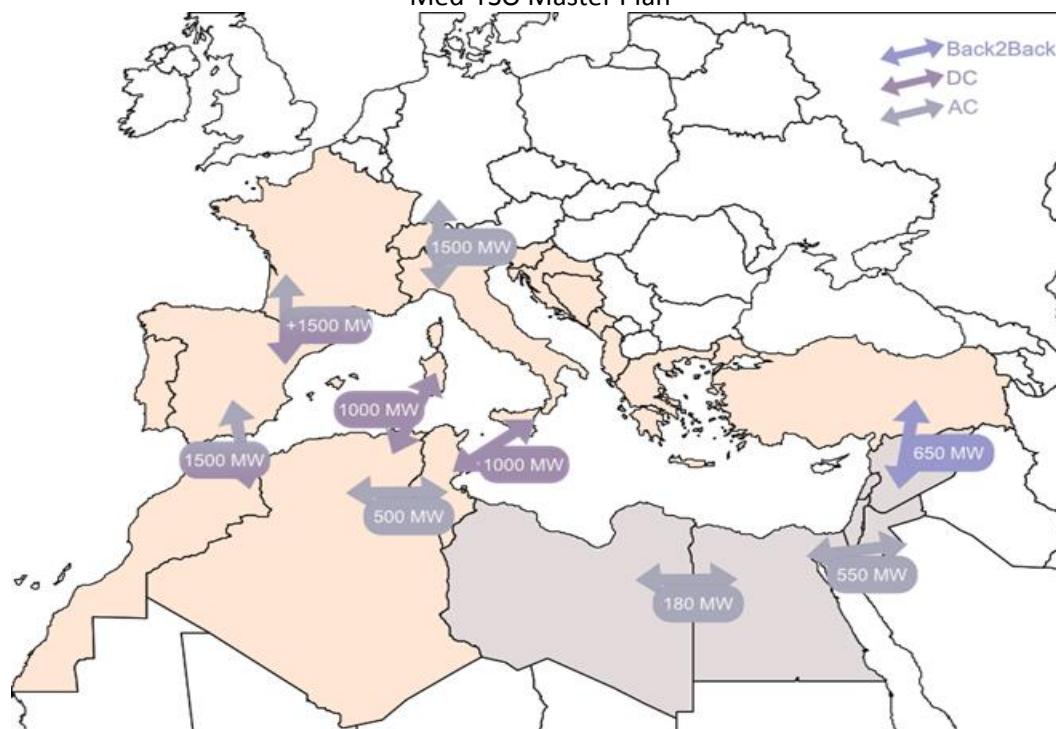
These South-North interconnections have always been considered as crucial not only for the deployment of renewable energy sources in SEMCs, but also for the overall Euro-Mediterranean energy cooperation. This is the reason why the EU launched already in 2000 the Euro-Mediterranean Energy Market Integration Project (MED-EMIP) with the aim to develop MEDRING (Mediterranean Electric Ring), a study meant at analysing the technical feasibility of interconnecting the electricity grids of the two shores of the Mediterranean, also evaluating the related economic benefits for both the EU and

<sup>87</sup> See: <http://www.terna.it/>

SEMCs. The European Commission presented in 2010 an updated version of the study, on which the market potential for renewable energy, and particularly solar energy, was also analysed. Among other things, the study also outlined that «merely closing the Ring requires significant modifications in the power systems in SEMCs.»<sup>88</sup> These modifications might be better pursued by a joint effort of the EU and SEMCs. In particular, an organization that could well contribute to abate the infrastructural barrier to the deployment of renewable energy in SEMCs is Med-TSO, the association of the Mediterranean transmission system operators.

The aim of Med-TSO, created in April 2012 in order to promote cooperation between the Mediterranean TSOs<sup>89</sup>, is to encourage the implementation of a regulatory framework aiming at the integration of Mediterranean electricity systems, through the development of the necessary transmission infrastructures. Med-TSO elaborated in 2013 the 1st Master Plan of the Mediterranean electricity interconnections. According to this document, over the next 10 year about 150 GW of new electricity generation capacity will be needed in the overall Mediterranean region (15% of which from renewable energy sources) and 33,000 km of new lines (both AC, VHV and DC) will thus be needed to support such a rapidly growing electricity market (Fig. 32).

**FIGURE 32**  
 Med-TSO Master Plan



Source: Med-TSO (2013).

<sup>88</sup> Euro-Mediterranean Energy Market Integration Project (2010), p. 6.

<sup>89</sup> The Funding Members and Future Associates of Med-TSO are: OST (Albania), SONELGAZ, GRTE, OS (Algeria), Cyprus Transmission System Operator (Cyprus), EETC (Egypt), RTE (France), ADMIE (Greece), IEC (Israel), TERNA (Italy), NEPCO (Jordan), GECOL (Libya), CGES (Montenegro), ONE (Morocco), REN (Portugal), ELEKTRO-SLOVENIJA (Slovenia), REE (Spain), STEG (Tunisia), TEIAS (Turkey).

Med-TSO also adopted in 2013 an Action plan for the period 2014-2016, consisting on the following points: «a) Rules: an international transport code in the Mediterranean; b) Infrastructure: operational tools for the coordinated planning process of the interconnections and the international exchanges; c) Reference Projects: feasibility demonstration of the interconnections through specific projects; d) Database Med-TSO: sharing information among TSOs for planning new infrastructures and developing power exchanges; e) Knowledge networking: a network for knowledge transfer, involving experts, students, middle managers and managers of the concerned companies and institutions.»<sup>90</sup>

To conclude, it is important to underline that, as the OME (2011b) correctly points out, «to promote market interdependence, the involvement of both transmission operators and regulators needs to be officially encouraged and the relevant associations need to contribute. This can foster development of appropriate regulations (competition, transparency, unbundling) in SEMCs that will facilitate the convergence of norms and pricing»<sup>91</sup>, in order to achieve a unique South-East Mediterranean network which can be integrated into the European network.

### 3.4 The Regulatory Barrier: The Key Role of MEDREG

As an overall trend, a stable regulatory framework represents a fundamental prerequisite for the large-scale deployment of solar and wind energy. This is particularly due to the fact that, as mentioned before, solar and wind energy projects are characterized by high upfront costs, which implies a long payback period. In this period of time the “rules of the game” should not change, as any regulatory alteration might represent a major threat to the long-term business plan on which any solar or wind energy project is developed.

It has been said that policymakers in SEMCs are increasingly aware of their countries’ abundant renewable energy resources and of the potential benefits of their exploitation. This growing awareness is also demonstrated by the fact that almost all SEMCs have progressively put in place dedicated regulatory policies aimed at promoting renewable energy.

As outlined by UAE, IRENA and REN21 (2013), «[in SEMCs] renewable energy power generation policies are more elaborated and better developed in net energy importing countries, since these countries have had strong incentives to develop alternative sources of energy for many years. However, also net energy exporting countries have also developed renewable energy power generation policies in recent years, and there are several indications that they are in fact catching up.»<sup>92</sup>

The regulatory measures commonly implemented in SEMCs are feed-in-tariffs (FIT) and net-metering (see Tab. 9).

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<sup>90</sup> Med-TSO (2013).

<sup>91</sup> OME (2011b), p. 137.

<sup>92</sup> UAE/IRENA/REN21 (2013), p. 21.



**TABLE 9**  
Renewable energy support policies in SEMCs

	Renewable energy targets	Renewable energy strategy/plan	Regulatory policies		Fiscal incentives				Public financing	
			Feed-in-tariffs	Net-metering	Capital subsidy, grants	Investment/production tax credits	Reduction in sales, energy, CO2, VAT, or other taxes	Energy production payment	Public investment, loans, or grants	Public competitive bidding
Morocco	Yes	Yes								
Algeria	Yes	Yes								
Tunisia	Yes	Yes								
Libya	Yes	No								
Egypt	Yes	Yes								
Israel	Yes	Yes								
Palestine	Yes	Yes								
Jordan	Yes	Yes								
Lebanon	Yes	Yes								
Syria	Yes	No								
Turkey	Yes	Yes								

Source: own elaboration on REN21 (2012) and Mondaq (2013).

As the EIA (2013) points out, «a FIT program typically guarantees that customers who own a FIT-eligible renewable electricity generation facility, such as a roof-top solar photovoltaic system, will receive a set price from their utility for all of the electricity they generate and provide to the grid.»<sup>93</sup>

In specific, as the OECD (2013) outlines, «FIT combines regulatory and financial incentives. In particular it guarantees to the producer grid access, long-term contracts for the electricity produced (typically 15-25 years) and fixed purchase prices based on the cost of renewable energy generation. The FIT sets up a long-term contract between the authorities and the renewable power generators; a fixed price is paid to renewable generators for each MWh produced and supplied to the grid. The FIT price is generally set by the government and aims to reward renewable-based electricity generators. It reflects the cost of the technology. Tariffs are based on the production costs of each technology, augmented by a premium which allows investors to obtain a reasonable return on their renewable energy investments. As a result, the price is set at a higher level than the spot price of electricity. The support given to renewable energy producers corresponds to the difference between the FIT and the market price for electricity. These costs are passed on to the consumer. The cost-based dimension

<sup>93</sup> EIA (2013).

of the tariff is a key efficiency factor which enables projects with differing levels of market-competitiveness (wind, solar, etc.) to be developed.»<sup>94</sup>

The FIT system, commonly used all over the world, is also widely deployed by SEMCs' governments to encourage the use of renewable energy technologies. In addition to FIT, also net-metering arrangements are widely deployed in SEMCs.

Generally less-known than FIT, net-metering is defined by the OECD (2013) as «a mechanism that encourages consumers to produce their own electricity from renewable energy sources and sell any surplus production for higher tariffs. Under this scheme, independent power producers, such as an energy-intensive industry, are allowed to produce renewable energy electricity to offset some or all of their energy use and transport it to the point of consumption through the national electricity grid. Furthermore, they are allowed to sell the surplus energy produced to the national electricity company at an incentive tariff. To this end, a device (a meter) is set up to measure the difference between the energy produced and the energy consumed by the industry, and determine the price difference. The benefit of this incentive for the government is a higher share of renewable energy in the national energy mix while subsidising only the excess energy produced.»<sup>95</sup>

Many types of fiscal incentives are also deployed among SEMCs, including capital subsidies and tax production credits or reductions. However, the most utilized renewable energy support policy in SEMCs is public competitive bidding for fixed quantities of renewable energy and public financing policies, including grants and subsidies. As UAE, IRENA and REN21 (2013) point out, «a number of countries have established special renewable energy funds to finance investments directly, provide low-interest loans, or facilitate markets in other ways, such as through research, education, and standards»<sup>96</sup>. For instance, Tunisia established in 2005 the Fond National pour la Maîtrise de l'Énergie, Algeria established in 2009 the National Renewable Energy Fund and Jordan established in 2013 the Renewable Energy and Energy Efficiency Fund<sup>97</sup>.

As this brief overview might have suggested, the current SEMCs' regulatory landscape in the field of renewable energy continues to be characterized by a high level of fragmentation. This feature represents a key barrier to the deployment of renewable energy in the region, as a fragmented (and unstable) regulatory framework does not

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<sup>94</sup> OECD (2013), p. 55.

<sup>95</sup> Ibidem, p. 59.

<sup>96</sup> UAE, IRENA and REN21 (2013), p. 21.

<sup>97</sup> Furthermore, as UAE, IRENA and REN21 (2013, p. 22) also outline, it might be interesting to remind that «from 2012 to early 2013, several countries started public competitive bidding processes. (...) Egypt moved ahead with a bidding process for the Kahramaa construction of a single wind farm to provide 1,000 MW of new capacity by 201. Algeria launched tenders for the development of two geothermal power plants, including a 5 MW plant in the region of Guelma, and Gas Natural Fenosa Engineering won a EUR 2.2 million competitive bid for engineering assistance in the construction of solar plants and wind farms. In Morocco, a consortium led by the Saudi Arabian project developer, investor, and operator ACWA Power International won the tender organised by the Moroccan Agency for Solar Energy (MASEN) to build and operate a 160 MW CSP plant in Ouarzazate.»

allow investors to be fully committed in developing projects in the region. A progressive harmonisation and stabilization of the regional regulatory framework would thus be crucial for the future development of solar and wind energy in SEMCs.

The removal of this regulatory barrier must pass through the national level and in particular through the institutions in charge of regulating the renewable energy market in each country of the region. Only such a bottom-up and inclusive approach has the potential to effectively pave the way for a harmonized and stable regulatory framework both at national and, consequently, regional level.

In order to pursue this path, the region's energy regulators established in 2006 MEDREG (Association of Mediterranean Energy Regulators) as a voluntary platform of cooperation aimed at promoting a clear, stable and harmonised regulatory energy framework in the Mediterranean. This platform became a permanent regional organisation in 2007, also thanks to the support of the European Commission.

The main objectives of MEDREG are to: «a) Promote a greater harmonization of the energy markets and legislations and seek progressive market integration in the Euro-Mediterranean region; b) Foster sustainable development in the energy sector through greater efficiency and integration of energy markets based on secure, safe, cost-effective and environmentally sustainable energy systems; c) Support initiatives of common interest in key areas such as infrastructure investment and development, innovative financing solutions for the Mediterranean area and research in the field of energy regulation; d) Provide capacity building activities through working groups, training sessions and seminars; e) Foster cooperation, information exchange and assistance among members, providing a permanent discussion framework and cooperation network.»<sup>98</sup>

As indicated by MEDREG (2013), integrating the regional electricity markets would require the following measures: «a) Progressive market opening to competition; b) Unbundling of energy generation, transmission, distribution and supply, public or private; c) Harmonization of technical rules; d) Implementation of clear and stable support schemes for renewable energy; e) Guidelines of Good Practice on transparency and third-party access to networks.»<sup>99</sup>

The targets and main achievements planned by MEDREG as concrete outcome of the Association's activities by 2020 are presented in Tab. 10.

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<sup>98</sup> MEDREG (2013a), p. 3.

<sup>99</sup> MEDREG (2013b).

**TABLE 10**  
**MEDREG Targets for 2015-2020**

Topic	Target	Timeframe		
		Short-term	Medium-term	Long-term
Institutional consolidation towards a stable legislative and regulatory framework	Harmonisation of the rules and principles governing the mission, organisation and resources of independent energy regulatory authorities		2015-2017	
	Harmonisation of the legal framework governing cross-border exchange of electricity among EuroMed countries -cooperation INS/ELE Working Groups		2015-2017	
	Harmonisation of the settlement of dispute mechanisms regarding non-discriminatory TPA to electricity and gas infrastructure		2015-2017	
	Support to the setting up of a Mediterranean Energy Community			2020
Electricity markets integration and interconnection	Contribution to the integration of electricity markets of Maghreb countries (IMME) –cooperation INS/ELE Working Groups	2015		
	Implementation of common guidelines for the development of Smart electricity grids in the Mediterranean region		2015-2017	
	Establishment of a Control Centre to monitor the activities of TSOs in different countries (reliability council)		2015-2017	
	Contribution to the integration of Mediterranean electricity markets, including completion of an operational MEDRING			2020
Gas markets integration and transparency	Setting up of an operational platform for the exchange of information and data on Mediterranean Gas markets	2015		
	Periodical assessment of the implementation of MEDREG Guidelines of Good Practice on TPA Transparency			
	Periodical assessment of the implementation of MEDREG Guidelines of Good Practice on Capacity allocation			2015-2020
	Contribution to the integration of gas markets of Mashreq countries			2015-2020
Environment, RES and Energy efficiency	Implementation of a common tool allowing the use of flexibility mechanisms according Directive 2009/28/EU	2015		
	Definition of frameworks to implement advanced distributed generation, grid parity and net metering in Mediterranean electricity systems		2015-2017	
Infrastructure investment	Definition of common regulatory positions on each electricity and gas infrastructure project in the Mediterranean (priorities, financing, tariffation, etc.)		2015-2017	
Customer issues	Establishment of an integrated Consumer protection framework in the Mediterranean energy sector		2015-2017	

Source: MEDREG (2013, p. 16).

As stated before, in order to promote the common development of the Mediterranean renewable energy market, a strong cooperation between MEDREG (as association of Mediterranean energy regulators) and MED-TSO (as association of Mediterranean TSOs) would be crucially important. In fact, if correctly pursued, such cooperation scheme might effectively have the potential to abate the infrastructural and regulatory barriers that still characterize the renewable energy market in the Southern and Eastern Mediterranean region, also paving the way for new investments in the area.

### 3.5 The Financial Barrier: The Key Role of Institutional Investors

The three barriers just described (e.g. commercial, infrastructural and regulatory) individually represent an obstacle to the deployment of renewable energy in SEMCs. However, when combined, they also generate -at one fell swoop- a fourth barrier to the deployment of renewable energy in the region: the financial barrier.

In fact, the combination of a distorted energy market (due to the use of universal fossil-fuels consumption subsidies), a lack of an adequate electricity infrastructure and a lack of a stable and harmonised regulatory framework, ultimately prevent private and institutional investors from financing renewable energy projects in the Southern and Eastern Mediterranean region.

As a result, government investment and finance from various European financial institutions continue to represent the cornerstone of the regional renewable energy financing scheme.

In particular, over the last decade the following European financing mechanisms have contributed to the financing of renewable energy projects in the Southern and Eastern Mediterranean region: the Facility for Euro-Mediterranean Investment and Partnership (FEMIP), the Neighbourhood Investment Facility (NIF) and the InfraMed Fund.

- *The Facility for Euro-Mediterranean Investment and Partnership (FEMIP)*

The European Investment Bank (EIB) has traditionally played an important role in supporting the deployment of renewable energy in SEMCs. In particular, this action has been carried out by the EIB through the Facility for Euro-Mediterranean Investment and Partnership (FEMIP).

As an overall trend, FEMIP represents the main financial instrument ever designed by the EU for the Southern and Eastern Mediterranean region<sup>100</sup>. FEMIP brings together the whole range of services provided by the EIB to assist the economic development and the integration of SEMCs, with the aim to accompany the region along a path of sustainable and socially-inclusive development. In line with the priorities of the Union for the Mediterranean (UfM) already illustrated in § 2.3, FEMIP does not focus only on renewable energy but also on pollution reduction in the Mediterranean Sea and development of maritime and land highways<sup>101</sup>.

Since its establishment in 2002, FEMIP invested EUR 13 billion in the region, 40% of which targeted the energy sector<sup>102</sup>. These investments have mainly targeted the exploitation of the renewable energy potential, including solar energy, wind energy and hydropower, the upgrading of national energy infrastructure and the strengthening of regional energy interconnections. For instance, FEMIP has contributed to the construction of new power plants (in Syria, Egypt and Tunisia), new gas pipelines (in Egypt, Tunisia, and Jordan), new LNG plants (Egypt), new hydropower plants (Morocco) and new wind farms (Morocco, Egypt)<sup>103</sup>.

FEMIP essentially offers three types of product<sup>104</sup>:

a) *Loans*. Most of FEMIP operations consist of long-term loans, extended in one of two forms: i) Individual loans: are made directly to private or public sector promoters of projects where the investment cost exceeds EUR 20-25 million. The financing terms (maturity and grace period) are tailored to the type of investment, and appropriate security is required; ii) Credit lines: cater for projects with an investment cost below EUR 20-25 million. They are advanced to local intermediary banks and leasing bodies, which on-lend the funds to finance investment undertaken by SMEs or local authorities. Credit lines can also be used to meet the needs of micro-enterprises, in partnership with specialized associations.

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<sup>100</sup> Specifically, FEMIP is devoted to the so-called "Mediterranean Partner Countries": Algeria, Egypt, Gaza/West Bank, Israel, Jordan, Lebanon, Morocco, Syria and Tunisia.

<sup>101</sup> These priorities have been identified in occasion of the Paris Summit of July 2008. For a brief overview of FEMIP operations on each priority-area refer to EIB (2010a).

<sup>102</sup> EIB (2012), p. 7.

<sup>103</sup> For more information about FEMIP activity on the energy sector please refer to EIB (2010b).

<sup>104</sup> List here reported as published online: <http://www.eib.org/>

b) *Private equity*. FEMIP finances private companies by providing equity or quasi-equity funding (participating or mezzanine loans) from its budgetary resources. In terms of potential beneficiaries, it targets mainly but not exclusively, small and medium-sized enterprises. As part of its support activity, FEMIP also deploys risk capital resources via participating loans to certain micro-credit associations. Private equity operations must present a number of features: i) Governance: the EIB's hands-on approach to individual investment leads to the application of best market practice (often EU standards) in the areas of financial discipline and governance; ii) Leverage: the Bank is always a minority investor, committing at a very early stage to the projects that it finances. Through its early involvement, the Bank often allows the company to attract other sources of funding; iii) Sustainability: Private equity operations are designed to support profitable ventures creating value added and jobs. The achievement of an expected return commensurate with the risk taken is a *sine qua non* for each investment decision by the EIB.

c) *Technical assistance*. Technical assistance is a key instrument for improving the quality of lending operations and enhancing their development impact. It is an integral part of the appraisal and implementation process for FEMIP loans, and provides the analytical data needed to understand the economic and financial development issues of the Mediterranean partner countries. The technical assistance offered by FEMIP is based on two funds: i) The FEMIP Support Package: supports existing projects that have already been identified. This assistance can be delivered at various stages of the project, from preparation through to completion; ii) The FEMIP Trust Fund: provides upstream technical assistance for loan operations, which is not necessarily linked to an EIB investment.

d) *Guarantees*. In order to stimulate the regional capital market, to mobilise additional resources to augment the volume of public capital, to reduce exchange rate risks and to support the development of sub-state entities, FEMIP also provides guarantees to SMEs, local banks, public sector promoters and sub-state entities.

- *The Neighbourhood Investment Facility (NIF)*

The Neighbourhood Investment Facility (NIF) is a financial facility created in 2008 in order to support capital-intensive infrastructure projects in partner countries covered by the European Neighbourhood Policy (ENP) as well as to support their private sector<sup>105</sup>. In particular, the NIF invests in energy and transport projects, and supports SMEs through risk capital operations. The NIF is implemented by the Development and Cooperation Directorate General of the European Commission<sup>106</sup>. In order to benefit from NIF interventions, a country must be included in the NEP and must have signed an Action Plan with the EU<sup>107</sup>.

The NIF brings together grants from the European Commission and the EU Member States with loans from European financial institutions, as well as own contributions

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<sup>105</sup> See: <http://ec.europa.eu/europeaid/>

<sup>106</sup> Ibidem.

<sup>107</sup> Ibidem.

from the partner countries. In doing so, the EU backs its neighbors' priorities and supports them in carrying out necessary investments for the future. For the 2007-2013 period, the European Commission has taken the commitment to contribute a minimum amount of EUR 745 million for the NIF. In 2012, EUR 172 million was made available by the EU budget, bringing the total EU budget contribution to the NIF to a total of EUR 567 million, of which EUR 109 million was earmarked for the Mediterranean Neighborhood<sup>108</sup>.

As an overall trend, a total of 66 projects have received final approval since the launch of the NIF in 2008. The total NIF grant contribution assigned to these projects comes to EUR 589 million and an overall potential investment cost of over EUR 18 billion (of which EUR 10 billion in the Mediterranean Neighborhood)<sup>109</sup>. Out of the 66 projects supported so far by the NIF, nearly two thirds (41) were low-carbon and climate resilience projects (Tab. 11) and received NIF contributions worth EUR 332 million (of which EUR 234 million in the Mediterranean Neighborhood)<sup>110</sup>.

**TABLE 11**  
 List of selected renewable energy projects co-financed by the NIF

Country	Year	Project	Total project cost (€ million)	NIF contribution (€ million)
Egypt	2008	200 MW Wind Farm in Gulf of El Zayt	340	10
Egypt	2010	Combined Renewable Energy Masterplan	500	3
Egypt	2010	Technical Assistance for the implementation of a 20 MW PV Grid Connected Power Plant	100	0.8
Egypt	2010	Egyptian Power Transmission	762	20
Morocco	2011	Ouarzazate Solar Plant	800	30

Source: European Commission (2012).

#### - The InfraMed Fund

InfraMed is a long-term infrastructure investment fund launched in May 2010 by five major institutional investors: Cassa Depositi e Prestiti (Italy), Caisse des Dépôts et de Consignations (France), Caisse de Dépôts et de Gestion (Morocco), EFG Hermes (Egypt) and the European Investment Bank<sup>111</sup>. InfraMed's objective is to promote, within a market environment, equity investments in urban, energy, and transport infrastructure projects in SEMCs. The five institutional investors provided an initial contribution of

<sup>108</sup> European Commission (2012).

<sup>109</sup> Ibidem, p. 27.

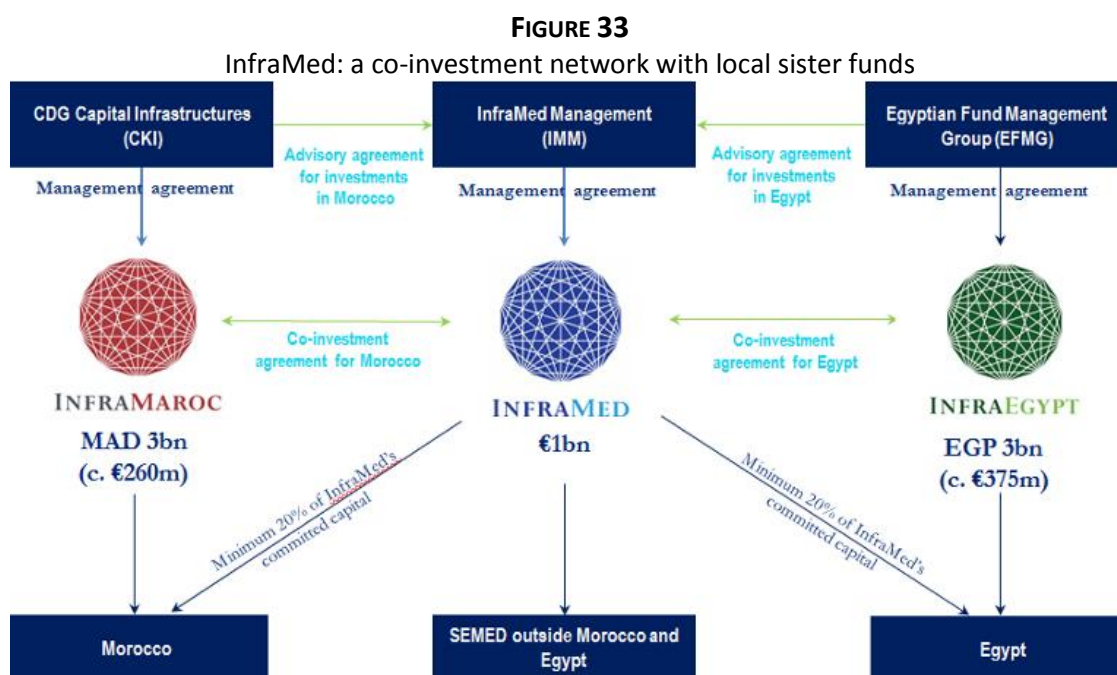
<sup>110</sup> Ibidem, p. 31.

<sup>111</sup> In their history, InfraMed sponsors have invested more than EUR 400 billion in MENA infrastructure assets and over EUR 35 billion in listed and private equity funds. These prominent investors give InfraMed a considerable market leverage and preferred investor status in deal sourcing, structuring, and mobilizing of additional capital from commercial and multilateral sources.

EUR 385 million to InfraMed<sup>112</sup>, which is now open to collect other capital from private investors to reach the target size of EUR 1 billion.

InfraMed seeks investments in a wide range of sectors keeping a maximum flexibility with a capped percentage of 65% of its total size for any single infrastructure sector. InfraMed primary methods of investment are equity, shareholder's loan and mezzanine finance.

Two local investment funds, InfraEgypt and InfraMaroc, have also been established to increase the global investment capacity of InfraMed (Fig. 33).



Source: InfraMed (2013).

In May 2012 EFG Hermes - a shareholder of InfraMed - and QInvest L.L.C. - a Qatari investment bank linked to the Qatar Investment Authority- announced an agreement to enter into a joint venture to be 60% owned by QInvest and 40% owned by EFG Hermes<sup>113</sup>: EFG Hermes Qatar LLC. The aim of the alliance is to create a leading investment bank with operations in the Arab world and beyond, comprehensively covering the Middle East, Africa, Turkey and South and South East Asia<sup>114</sup>. The presence of Qatar, Egypt and the EU within the InfraMed Fund could thus represent a first step towards a more close financial cooperation in the future between the three players.

To conclude, with regard to renewable energy the first investment made by InfraMed in the field targeted the Tafila greenfield wind farm project in Jordan. InfraMed is a

<sup>112</sup> See: <http://www.inframed.com/>

<sup>113</sup> See: <http://qinvest.com/>

<sup>114</sup> Reuters (2012).



50% shareholder in the company developing the wind farm project via a joint-venture agreement with Masdar, the renewable energy arm of Mubadala, and EP Global Energy Ltd. Once completed, Tafila will be the first and largest privately financed wind farm in Jordan, targeting a total installed capacity of 117MW at an initial stage, with the potential to reach 300 MW in the near to medium term<sup>115</sup>.

*- The need for a new financing scheme: the potential role of institutional investors*

The three financing mechanisms just described have surely provided a considerable contribution to the development of certain renewable energy projects that, as in the case of the Ouarzazate Solar Plant in Morocco, might also serve as pilot projects for the overall region. However, this financial framework does not appear sufficient to support a consistent development of renewable energy projects in the region. In fact, a large-scale deployment of solar and wind energy in the region would require a much more solid financing scheme that only capital markets can provide.

As outlined in § 3.1, solar and wind energy projects are characterized by high upfront costs, which implies a long payback period, give the marginal profit derived from each unit of electricity sold. In financial terms, this means that only investors with a long-term investment horizon can potentially find attractive to finance this segment of the energy sector. This is even truer in the aftermath of the economic and financial crisis, with the traditional sources of renewable energy investments -governments, commercial banks and utilities- facing significant constraints. For instance, commercial banks are drastically reducing infrastructure investments as their ability to provide long-term financing is being negatively affected by new banking regulations (e.g. Basel III), which generate a trend toward short-term allocation.

In this overall situation the only sustainable option for the financing of renewable energy projects in the Southern and Eastern Mediterranean region seems to be represented by institutional investors such as pension funds, insurance companies, mutual funds and sovereign wealth funds (SWFs). In fact, the long duration of their liabilities allows institutional investors to make buy-and-hold investments in long-dated productive assets, achieving higher yields to offset longer-term risks and lower liquidity inherent in many of these assets. In other words, their longer time horizons enable institutional investors to behave in a patient, counter-cyclical manner, also restraining “short-termism”<sup>116</sup>.

In OECD countries institutional investors held over USD 83 trillion in assets in 2012<sup>117</sup> and in non-OECD countries SWFs are key sources of capital, with USD 6 trillion in assets in 2012<sup>118</sup>. Nevertheless, according to the OECD (2013) institutional investors currently place only 2% of their resources in financial products connected to infrastructures. The economic downturn has certainly had an impact on long-term asset allocation strategies of institutional investors by promoting more conservative investment

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<sup>115</sup> See: <http://www.inframed.com/>

<sup>116</sup> European Commission (2013).

<sup>117</sup> Kaminker, et al. (2013).

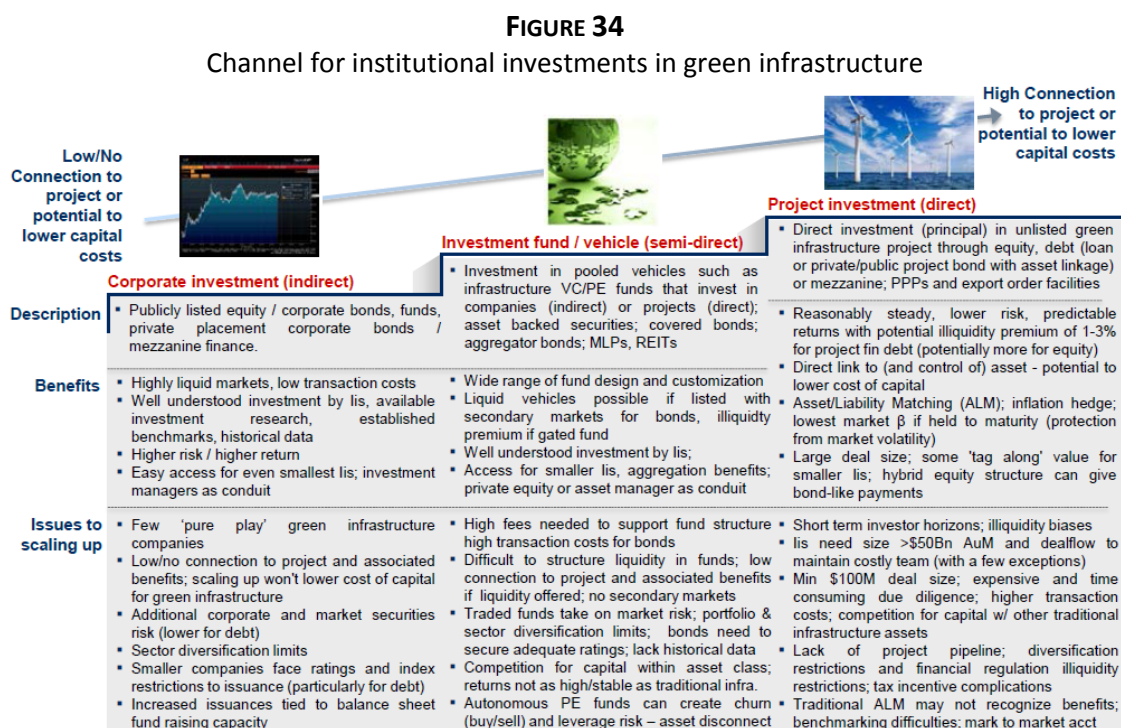
<sup>118</sup> Sovereign Wealth Fund Institute.

strategies. However, this trend is also due to the fact that, exactly as commercial banks, also institutional investors such as pension funds or insurance companies are obliged to meet a variety of prudential regulations. In particular, the new prudential rules for insurance undertakings (Solvency II) require them to hold assets to cover the nature and duration of their liabilities, affecting their ability to play a long-term financing role.

In the framework of a broader research activity on institutional investors and long-term financing, the OECD has analysed the potential role of institutional investors in green infrastructure investments. In particular, a seminal study carried out by Kaminker et al. (2013) explores the current barriers and the future opportunities for institutional investors' investment in green infrastructure, such as renewable energy projects.

According to this study, institutional investors could well play a role in this investment area, particularly considering that «given the current low-interest rate environment and weak economic growth prospects in many OECD countries, institutional investors are increasingly looking for tangible asset classes that can deliver diversification benefits and steady, preferably inflation-linked, income streams with low correlations to the returns of other investments.»<sup>119</sup>

In practise, institutional investments in green infrastructure could be channelled in various ways, as indicated in Fig. 34.



Source: Kaminker, et al. (2013), p. 6

<sup>119</sup> Kaminker, et al. (2013), p. 6.

However, institutional investors should not be considered as the unconditional "saviours" of the renewable energy sector, as their primary concern is to have a proper risk-adjusted financial performance.

This is a crucial point to bear in mind, also considering that institutional investors «have to invest in accordance with the “prudent person principle”. Assets have to be invested in the best interest of member and beneficiaries and policyholders and in such a manner as to ensure their security, profitability, liquidity and quality.»<sup>120</sup>

In particular, Kaminker et al. identify three kind of barrier to institutional investors' investment in green infrastructure: the first is general and concerns infrastructure investments overall, the second is specific to green investments and the third relates to the lack of suitable investment vehicles (Tab. 12).

**TABLE 12**

**Barriers to institutional investment in green infrastructure**

<p><b>1</b> Issues with infrastructure investments</p>	<ul style="list-style-type: none"> <li>▪ <b>Direct investing challenges</b> <ul style="list-style-type: none"> <li>- Short term investment horizon and need for liquidity (illiquidity risk)</li> <li>- Difficulties with bidding process and timing; lack of investor best practice and expertise</li> <li>- Asset and liability matching (ALM) application issues; diversification and exposure limits</li> <li>- Need scale &gt;\$50Bn AuM and deafflow to maintain costly team</li> <li>- Min \$100M deal size; expensive and time consuming due diligence; higher transaction costs;</li> </ul> </li> <li>▪ <b>Regulatory and policy issues</b> <ul style="list-style-type: none"> <li>- Political uncertainty</li> <li>- Illiquidity and direct investment restrictions e.g. capital adequacy rules (Solvency II, IORP II)</li> <li>- Uncertain new policy application e.g. Solvency II for pension funds?</li> <li>- Accounting rules e.g. mark to market for illiquid assets</li> </ul> </li> <li>▪ <b>Lack of project pipeline and quality historical data</b> <ul style="list-style-type: none"> <li>- Compounded by exit of banks (Basel III/deleveraging)</li> <li>- Little historical pricing data or indices for investments such as private placement debt</li> </ul> </li> </ul>
<p><b>2</b> Issues particular to green investments</p>	<ul style="list-style-type: none"> <li>▪ <b>Risk/return imbalance</b> <ul style="list-style-type: none"> <li>- Market failures: insufficient carbon pricing and incentives; presence of fossil fuel subsidies</li> </ul> </li> <li>▪ <b>Unpredictable, fragmented, complex and short duration policy support</b> <ul style="list-style-type: none"> <li>- Retroactive support cuts, switching incentives (FIT to FiP) or start and stop (PTC)</li> <li>- Use of tax credits popular with insurers can discourage tax exempt pension funds</li> <li>- Unrelated policy objective discouragement e.g. EU unbundling preventing majority ownership of both transmission and generation/production</li> <li>- Fiduciary duty debate</li> </ul> </li> <li>▪ <b>Special species of risk</b>, e.g. technology and volumetric require expertise and resources</li> <li>▪ <b>Competition for capital</b> with other traditional infrastructure assets</li> </ul>
<p><b>3</b> Lack of suitable investment vehicles</p>	<ul style="list-style-type: none"> <li>▪ <b>Issues with fund and vehicle design</b> <ul style="list-style-type: none"> <li>- High fees to support fund structure</li> <li>- Liquidity trade-off with connection to underlying asset and associated benefits: difficult to offer liquidity without asset disconnect, churn and leverage in fund</li> </ul> </li> <li>▪ <b>Nascent green bond markets, no indices/funds, restricted access to liquid vehicles</b> (MLPs &amp; REITs) <ul style="list-style-type: none"> <li>- Small pipeline of projects, high transaction costs, minimum deal size and definition uncertainty</li> </ul> </li> <li>▪ <b>Challenges with securitisation</b></li> <li>▪ <b>Credit and ratings issues</b> <ul style="list-style-type: none"> <li>- Historical lack of ratings data, expensive process</li> <li>- Absence of monoline insurers since financial crisis</li> </ul> </li> </ul>

Source: Kaminker, et al. (2013, p. 11).

On the basis of a comprehensive analysis of recent policy and investment trends in the renewable energy sector, Kaminker et al. recommend seven actions necessary to address these barriers in order to facilitate institutional investments in renewable energy infrastructure projects<sup>121</sup>:

1) Ensure a stable and integrated policy environment, developed in co-ordination with asset allocators, which provides investors with clear and long-term visibility and incentives.

<sup>120</sup> Ibidem, p. 8.

<sup>121</sup> Recommendations here reported as in Kaminker et al. (2013), p. 13.

- 2) Address market failures which create risk-return investment profiles that favour polluting or environmentally damaging infrastructure projects over green infrastructure investments. Phasing-out inefficient energy subsidies and implementing regulations that impose a price on environmentally damaging activities (implicitly through standard setting, or explicitly through carbon taxation or emissions trading) is also an important element of shaping the risk-return profile of green investments.
- 3) Provide a national infrastructure road map which would give investors confidence in government commitments to the sector and demonstrate that a pipeline of investable projects will be forthcoming.
- 4) Facilitate the development of appropriate green financing vehicles. Governments can issue financing vehicles or support the development of markets for instruments or funds with appropriate risk-return profiles for institutional investors.
- 5) Reduce the transaction costs of green investment by fostering collaborative investment vehicles between investors, so helping to build scale and in-house expertise among institutional investors.
- 6) Promote public-private dialogue on green investments by creating or supporting existing platforms for dialogue between institutional investors, the financial industry and the public sector to understand the barriers and opportunities to investment in green infrastructure projects. Institutional investors require support and track records to invest in new asset areas. Learning from leading investors and the experience of peers could assist in building their confidence and the capabilities of other institutional investor service providers.
- 7) Promote market transparency and improve data on infrastructure investment by strengthening formal requirements to provide information on investments by institutional investors in infrastructure and green projects.

If transposed into the reality of SEMCs, some of these points clearly reflect what has previously been said with regard to the potentially crucial role of institutions such as Med-TSO and MEDREG in creating a stable and harmonized regulatory environment, in enhancing SEMCs' national renewable energy plans and in helping regional governments in addressing market distortions, notably universal fossil fuels consumption subsidies. However, such an action at the regulatory and policy level would not be sufficient to open the Southern and Eastern Mediterranean renewable energy sector to capital markets and particularly to institutional investors.

In fact, as the action plan delineated by Kaminker et al. outlines, an additional effort is needed to create appropriate, collaborative, financing vehicles and risk mitigating tools. Neither SEMCs' governments nor institutions such as Med-TSO or MEDREG can deliver such financing mechanisms. The only way to provide such a tool-kit seems to be represented by a new coordinated effort of the European Investment Bank (i.e. FEMIP) with a key financial player that has only recently extended its action to the region: the European Bank for Reconstruction and Development (EBRD).

- *The new role of the EBRD in the Southern and Eastern Mediterranean region*

The EBRD was established in 1991 in response to major changes in the political and economic climate in Central and Eastern Europe, with the aim to support the development of market economies in the region. Considering the Bank's experience in accompany countries in political and economic transition, in May 2012 the EBRD's shareholders gave unanimous backing to the expansion of the Bank's mandate, allowing future activities in the Southern and Eastern Mediterranean region.

In November 2012 Egypt, Jordan, Morocco and Tunisia were granted the status of potential recipient countries, enabling the Bank to conclude six investment transactions in the region already by the end of the year, for a total commitment of EUR 181 million.

Looking forward, the EBRD is estimated to have the capacity to invest up to EUR 2.5 billion in SEMCs by 2015<sup>122</sup>. The Bank's overall goal in SEMCs is to improve financing of the private sector via investments in loans and equities, while providing support and expertise through policy dialogue, capacity building and other forms of technical assistance.

More specifically, the Bank has identified a limited number of initial priorities for the region, among which there is the renewable energy sector. The EBRD will thus support renewable energy and energy efficiency investments in SEMCs and it will assist governments in unbundling and gradually liberalizing the sector while strengthening regulatory agencies<sup>123</sup>.

This effort would fit into the wider activity framework of the EBRD in the field of renewable energy: the Sustainable Energy Initiative (SEI). This initiative was launched in 2006 to address the twin challenges of energy efficiency and climate change in the EBRD region, which is among the most energy intensive areas in the world. SEI market segments include renewable energy, energy efficiency, sustainable energy financing facilities through financial intermediaries and carbon market support. From 2006 to 2012, the EBRD invested EUR 11 billion in 602 sustainable energy projects in 33 countries. In 2012, SEI investments accounted for 26% of the EBRD's activities<sup>124</sup>.

Considering the experience and the expertise of the EBRD, this *nouvelle vague* represents a unique opportunity for the Southern and Eastern Mediterranean region to tackle the financing barrier to the deployment of solar and wind energy at the regional level.

Considering the complex interdependence of the various issues on the table (e.g. commercial, regulatory, infrastructural and financial) the action of the EIB and the EBRD in the region might turn out to be more effective if framed into a cooperation framework with Med-TSO and MEDREG. This cooperation might be promoted with an innovative, dedicated, platform designed as proposed in the conclusions of this study.

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<sup>122</sup> EBRD (2013a), pp. 7-13.

<sup>123</sup> Ibidem, p. 13.

<sup>124</sup> EBRD (2013b).

## Conclusions: Towards a New “Euro-Med Renewable Energy Platform”

The study has outlined that -notwithstanding the huge renewable energy potential and the numerous benefits potentially related to its exploitation, and the various actions that have been undertaken at both national and international level to promote the deployment of such technologies over the last decade- SEMCs continue to lag far behind most other regions in the world in terms of solar and wind energy deployment.

The study has argued that this paradox is mainly due to the fact that the deployment of renewable energy in the region faces four key barriers: commercial, infrastructural, regulatory and financial. In order to effectively tackle these barriers, a “double-track” approach seems to be essential. In other words, these barriers are so resilient that they should be faced both singularly and globally, at a one fell swoop. Let’s see how this might be done, and what role might European institutions play in this chessboard.

As illustrated in the study, reforming universal energy subsidies is not an easy game. Subsidies represent the cornerstone of the “social contract” in many SEMCs, and particularly in oil and gas producing countries. Over the last decades, some governments tried to reform universal energy subsidies, but did not accomplish the target. In the aftermath of the Arab uprising, such a reform process seems to be even more difficult, particularly in the countries where the political situation is not fully stabilized. For this reason it is not possible to expect substantial changes on this crucial point across the region. However, in the medium-term all SEMCs should advance an energy-subsidy reform process, phasing out universal fossil-fuel consumption subsidies in favour of targeted subsidies aimed at effectively address the problem of energy poverty. In this field little support can be provided by European institutions. In fact, the regional governments are well aware of the major economic burden represented by universal energy subsidies; however, economic rationalities currently do not match with political requirements that only an overall process of political and economic stabilization in the region might eventually change.

As far as the development of an adequate regional electricity infrastructure is concerned, Med-TSO -in quality of association of the Mediterranean transmission system operators- might play a potentially crucial role in coordinating the various players in the field, in promoting a clear regional transport code and in developing operational tools for the coordinated planning process of the regional interconnection. Such an inclusive and bottom-up approach seems to represent the best way to promote the development of an adequate electricity infrastructure in SEMCs, among SEMCs and between SEMCs and the EU.

The same rationality could well be applied to energy regulation. In fact, as illustrated in the study, MEDREG -in quality of association of the Mediterranean energy regulators- might play a key role in promoting a clear, stable and harmonised regulatory energy framework in the Mediterranean region.

Concerning the financial dimension of renewable energy in the region, a “great leap forward” is urgently needed. As illustrated in the study, a strong cooperation between

the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD) seems to represent the best way to develop a set of proper financing mechanisms aimed at attracting institutional investors such as pension funds, mutual funds, insurance companies and sovereign wealth funds into the regional renewable energy market. On the basis of the principle that institutional investors will jump into this area only if a proper risk-adjusted return is considered as guaranteed, the EIB and the EBRD might develop a sort of “Mediterranean Renewable Energy Infrastructure Fund” aimed at channelling financial resources from institutional investors into renewable energy companies acting in the region, solar and wind energy projects, asset backed securities or bonds. Such a mechanism, already applied in the region -albeit in a smaller scale- by the InfraMed Fund, could have many important advantages: a) By making use of the multi-year experience of the EIB and the EBRD in financing renewable energy projects, such a mechanism might allow institutional investors to play a role in a sector with which they are often not familiar; b) Considering the financial capability of the EIB and the EBRD, risk mitigating and credit enhancing tools might also be included in the mechanism; c) Considering the high reputation of both the EIB and the EBRD, such a mechanism might progressively attract a number of institutional investors, thus allowing the exploitation of economies of scale in the determination of the projects to be financed.

Considering the complex interdependence of all these infrastructural, regulatory, and financial issues, a strong coordination between Med-TSO, MEDREG, the EIB-EBRD tandem and selected institutional investors seems to be essential. This would not require the creation of an additional institution, but only the constitution of a small and flexible platform in charge of coordinating all these efforts in order to avoid overlaps and promote a harmonised framework of action. Such kind of entity, which might assume the name of "Euro-Med Renewable Energy Platform" (EUREP) and might be created in the framework of the wider "Euro-Mediterranean Platform on Regional Electricity Markets" launched in November 2014 by the European Commission (Directorate General for Energy), MED-TSO and MEDREG<sup>125</sup>, could well have the potential to emerge as the focal point for the development of renewable energy in the Southern and Eastern Mediterranean region.

The Euro-Mediterranean region is currently characterized by the presence of countless large, medium and small scale organizations dealing with renewable energy. In such an intricate -and often redundant- situation, it is necessary “to put the house in order” and focus on the key players in the field to develop a new renewable energy mechanism able to break with conventions. Transmission system operators, energy regulators and the key financial institution in the region are the most important players to proceed in this direction. On the basis of an inclusive, pragmatic and bottom-up approach, they have the potential to boost the regional renewable energy market, reversing the trend of disillusion that has progressively characterized the Southern and Eastern Mediterranean renewable energy sector over the last years and ultimately translating the regional renewable energy potential into reality.

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<sup>125</sup> MEDREG (2014).

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## Annex - Renewable Energy Technologies Overview

### Concentrating Solar Power (Technical fiche by IRENA)

*Process and Technology Status* – In Concentrating Solar Power (CSP) plants, mirrors concentrate sunlight and produce heat and steam to generate electricity via a conventional thermodynamic cycle. Unlike solar photo-voltaics (PV), CSP uses only the direct component (DNI) of sunlight and provides heat and power only in regions with high DNI (i.e. Sun Belt regions like North Africa, the Middle East, the southwestern United States and southern Europe). CSP plants can be equipped with a heat storage system to generate electricity even under cloudy skies or after sunset. Thermal storage can significantly increase the capacity factor and dispatchability of CSP compared with PV and wind power. It can also facilitate grid integration and competitiveness. In sunny, arid regions, CSP can also be used for water desalination. In past years, the installed CSP capacity has been growing rapidly in keeping with policies to reduce CO<sub>2</sub> emissions. In 2012, the global installed CSP capacity was about 2 GW (compared to 1.2 GW in 2010) with an additional 20 GW under construction or development. While CSP still needs policy incentives to achieve commercial competitiveness, in the years to come technology advances and deployment of larger plants (i.e. 100-250 MW) are expected to significantly reduce the cost, meaning that CSP electricity could be competing with coal- and gas-fired power before 2020. The CSP technology includes four variants, namely Parabolic Trough (PT), Fresnel Reflector (FR), Solar Tower (ST) and Solar Dish (SD). While PT and FR plants concentrate the sun's rays on a focal line and reach maximum operating temperatures between 300-550°C, ST and SD plants focus the sunlight on a single focal point and can reach higher temperatures. PT is currently the most mature and dominant CSP technology. In PT plants, synthetic oil, steam or molten salt are used to transfer the solar heat to a steam generator, and molten salt is used for thermal storage.

*Performance and Costs* – Commercial PT plants in operation have capacities between 14-80 MW. They reach a maximum operating temperature of 390°C, which is limited by a thermal degradation of the synthetic oil used as the heat transfer fluid. The efficiency (i.e. the ratio of electricity generated to the solar energy input) is about 14-16% and the capacity factor is on the order of 25-30%, depending on the location. Some PT and ST plants have molten salt thermal storage systems with storage capacities of 6-15 hours, which increase the plant capacity factors to over 40% and 70%, respectively. Two plants (i.e. a 5-MW PT plant in Italy and a 20-MW ST plant in Spain) are currently testing the use of high-temperature (550°C) molten salt for heat transfer and storage purposes. This option is expected to significantly improve the CSP performance and storage capacity. The available operational experience suggests that PT plants have a lifetime of more than 30 years. In the ST plants, steam (direct steam generation) and compressed gasses can also be used as alternative heat transfer fluids, and significant potential exists to improve performance (i.e. temperature and efficiency). The cost of CSP plants is still high in comparison with conventional power plants and other renewable technologies. The International Energy Agency (IEA) estimates a current investment cost for CSP plants between USD 4,200-8,500 per kW, depending on local conditions, DNI, the presence of thermal storage and – last but not least – the maturity level of the project (i.e. pilot, demonstration or commercial). Recent (2012) estimates by the International Renewable Energy Agency (IRENA) suggest upfront investment costs of between USD 5,500-8,000 per kW for PT plants with no storage and costs between USD 7,500-8,500 per kW for PT plants with six hours of storage. ST plants are usually designed with high storage capacity. Estimates range from USD 6,300-7,700/kW for 6-9 hours of storage to USD 9,000-10,500/kW for 12-15 hours of storage. The current levelised cost of electricity (LCOE) for PT plants ranges from USD 200/MWh (i.e. typically, plants with six hours of storage and high DNI) to USD 330/MWh (i.e. with no storage and low DNI). ST plants range from USD 170-240/MWh (i.e. with 12-15 hours of storage) to USD 220-280/MWh (with 6-7 hours of storage). Typically, investment and

financing costs account for about 84% of the LCOE, the rest being operation and maintenance costs. Investment costs and LCOE are expected to decline by 10-20% by 2015 and by 30-50% by 2020 due to technology learning and economies of scale following the increasing deployment of CSP power. The benefits of carbon-free energy should also improve CSP's competitiveness.

*Potential and Barriers* – CSP offers considerable potential in terms of energy production. In principle, assuming a land use of two ha/MWe, the North African potential could meet several times the combined electricity demands of Europe, the Middle East and North Africa. Assuming significant capital cost reduction and the contribution of energy storage, the IEA suggests in its roadmap that CSP could become economically competitive for intermediate and peak loads within the current decade. The global installed capacity could reach 150 GW by 2020, with an average capacity factor of 32%. Between 2020 and 2030, CSP could become economically competitive with conventional base-load power due to reduced CSP costs and the increasing prices of fossil fuels and CO<sub>2</sub>. The global installed capacity could reach about 350 GW by 2030 (i.e. 3.8% of the global electricity demand, with an average capacity factor of 39%). The United States, North Africa and the Middle East would be major producers of CSP electricity while Europe would be the largest importer. At present, many countries around the world (e.g. Algeria, Australia, China, Egypt, India, Italy, Morocco, South Africa, Spain, United Arab Emirates, and the United States) have policies in place to support CSP deployment.

Source: IRENA (2013a, pp. 3-4).



## Photovoltaic

(Technical fiche by IRENA)

*Process and Technology Status* – Photovoltaic (PV) solar cells directly convert sunlight into electricity, using the photovoltaic effect. The process works even on cloudy or rainy days, though with reduced the production and conversion efficiency. PV cells are assembled into modules to build modular PV systems that are used to generate electricity in both grid-connected and off -grid applications, such as residential and commercial buildings, industrial facilities, remote and rural areas and power plants (i.e. utility PV systems). Over the past decades PV technology has been constantly improving performance and reducing costs. Most recently, rapid cost reductions are enabling PV plants to become economically competitive not only in niche markets such as off -grid installations, but also for on-grid applications. As a result, PV power is expanding rapidly in many countries, even though governmental support policies and incentives (feed-in tariffs) are being reduced. In countries with good solar resources and high electricity tariffs, residential solar PV systems have already reached parity with electricity retail prices, whilst in general PV is now fully competitive with power generated from diesel based on- and off -grid systems. The global cumulative installed PV capacity grew from 1.4 GW in 2000 to about 70 GW at the end of 2011, with around 30 GW added in 2011 alone. Global annual investment totalled some USD 93 billion in 2011. Italy, Germany, China, the United States, France and Japan are the leading countries in terms of cumulative capacity, annual installed capacity and/or production of PV modules and systems. European countries accounted for 70% of the newly installed capacity in 2011.

*Performance and Costs* – Crystalline silicon (c-Si) cells have reached a record efficiency of around 25%. The efficiency of the best current commercial modules is around 19-20% (with a target of 23% by 2020). The majority of commercial c-Si modules, however, have efficiencies in the range of 13-19% with more than a 25-

year lifetime. Commercial TF modules offer lower efficiency between 6-12% (with a target of 12-16% by 2020). In addition to the commercial options, a number of new PV technologies is under development (e.g. concentrating PV, organic PV cells, advanced thin films and novel concepts and materials) and hold out the promise of high performance and low costs in the medium-term. Today's PV systems are fully competitive for off-grid electricity generation and with diesel-based on-grid systems in countries with good solar resources. In an increasing number of countries with high cost of electricity and good solar resources, small PV systems are also achieving the so-called grid-parity between the PV electricity cost and the residential retail prices for householders. For instance, in 2011, electricity prices for householders in the EU-27 ranged between USD 83-291/MWh, excluding taxes (Eurostat), while the average cost of PV electricity for large ground-mounted systems ranged from USD 160- 270/MWh in southern and northern Europe, respectively. Furthermore, advantages of PV electricity are that it is usually produced close to the consumption site and can match peak demand profiles. Owing to their low capacity factors, PV systems are not yet cost competitive for base-load electric power generation. However, PV capital costs are declining very rapidly due to technology learning, increasing industrial production and improved efficiency. With a learning rate between of between 18-22% for each doubling of installed capacity, PV module prices have dramatically dropped over the past two decades. A 60% reduction has been achieved over the last two years and more than a 40% reduction is likely to occur by 2020. In September 2012, Chinese c-Si module prices had fallen to an average of USD 0.75/W, although the rate of decline has slowed. In Germany, the costs of installed rooftop PV system had fallen to USD 2.2/W by mid-2012. PV system costs have been declining so rapidly that past projections of cost reductions have become obsolete in a very short time. The latest industry projections suggest a slowdown in cost reductions of PV systems, with residential rooftop systems in the most competitive European markets falling to between USD 1.8-2.4/W by 2020. The recent cost reductions for c-Si modules have squeezed TF

technologies increasingly into niche markets while novel PV concepts are expected to reach the market in the medium- to long-term.

*Potential and Barriers* – PV power has a virtually unlimited energy potential with no environmental constraints to market expansion. A main issue is the limited capacity factors that translate into higher electricity costs than most base-load electricity generation technologies. To drive cost reductions through deployment, many governments offer financial incentives (such as feed-in tariffs and tax incentives). The variable nature of the solar source also means that appropriate grid management and technology (i.e. smart grids) and energy storage are required for high PV penetration. Where feed-in tariffs and incentives are in place, PV is attractive to investors and consumers and contributes significantly to energy production and the mitigation of greenhouse gas emissions. PV technology is perceived as a sustainable business with jobs creation opportunities, and is usually the least-cost solution when integrated with storage and/or backup generation to provide electricity to remote areas. Scenarios analysed by the European PV Industry Association project that PV power could reach between 4.9-9.1% of the global electricity generation by 2030 (depending on PV growth and electricity demand) and up to 17-21% of electricity share by 2050. The World Energy Outlook 2012 of the International Energy Agency presents a more conservative outlook that projects PV power to provide between 2-3.3% of the global electricity by 2030 assuming continued policy support and cost reductions. It is noteworthy that since 2001 the global PV market has grown faster than the most optimistic projections.

Source: IRENA (2013b, pp. 3-6).

## Wind

(Technical fiche by IEA)

The average grid connected turbine has a rated capacity of about 1.6 MW. It extracts energy from the wind by means of a horizontal rotor, upwind of the tower, with three blades that can be pitched to control the rotational speed of a shaft linked via a gearbox to a generator, all housed in the “nacelle” atop the tower. Other design variations being pursued include two-bladed rotors, and drive trains with large-diameter low-speed generators in place of the conventional gearbox and high-speed generator. Today’s offshore wind turbines are essentially marinised versions of land turbines with, for example, enhanced corrosion protection. Wind turbines generate electricity from wind speeds ranging from around 15 km/h, (4 metres per second [m/s], corresponding to force three on the Beaufort Scale or a “gentle breeze”) to 90 km/h (25 m/s, force nine, or “strong gale”). The availability of a wind turbine is the proportion of time that it is ready for use. Availability thus provides a useful indication of operation and maintenance (O&M) requirements, and the reliability of the technology in general. Onshore availabilities are more than 97%. Availability of offshore turbines ranges from around 80% to 95%, reflecting the youth of the technology. An important difference between wind power and conventional electricity generation is that wind power output varies as the wind rises and falls. Even when available for operation, wind plants will not operate at full power all of the time. This characteristic of variability will become increasingly significant as wind penetrations of energy rise above around 10%, at which level power system operation and, eventually, design, need to be modified to maintain reliability.

Onshore wind turbine development is now characterised by incremental reductions in the cost of energy, rather than by single, disruptive technology leaps. Deeper understanding of the conditions to which a wind power plant will be subjected over its lifetime will facilitate the development of improved turbine designs with the ability to extract more energy from the wind, more of the time, over a longer lifetime, and in specific operating environments (e.g., areas of higher typhoon

activity or extreme cold). Energy capture in the rotor holds the greatest potential for long-term reduction of the cost of wind energy. The larger the area through which the turbine can extract that energy (the swept area of the rotor), and the higher the rotor can be installed (to take advantage of more rapidly moving air), the more power that can be captured. However, a larger swept area typically means a heavier rotor, which is needed to cope with increased loading during high wind events, and increased costs. This factor has effectively set an economically optimum rotor size, based on cost-effective materials available today. Advanced materials with higher strength to mass ratios, such as carbon fibre and titanium, could enable larger area rotors to be cost-effective, but their usage has yet to be made commercially feasible. Additional cost reductions could be achieved through lighter generators and other drive train components, which would reduce tower head mass. New materials could also encourage a transition away from industry's current dependence on steel for taller towers. As rotors become larger with longer, more flexible blades, a fuller understanding of their behaviour during operation is required to inform new designs. Notable rotor-research areas include advanced computational fluid dynamics models; methods to reduce loads or suppress their transmission to other parts of the turbine, such as the gearbox or tower head; innovative aerofoil design; nanotechnology to reduce icing and dirt build-up; and lower aerodynamic noise emission.

Source: IEA (2009, p. 10, p. 22).

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