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FEMIP

Study on the Financing of Renewable Energy Investment in the Southern and Eastern Mediterranean Region

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Glossary

AC	Alternate Current
ADEREE	Agency for the development of Renewable Energy and Energy Efficiency (Morocco)
AEC	Algerian Energy Company
AFD	Agence Française de Développement (French Development Agency)
ALI	Association of Lebanese Industrialists
ALIS	Lebanese Association of Solar Industrials
ALMEE	The Lebanese Association for Energy Saving & for Environment
ANME	The National Agency for Energy Conservation (Tunisia)
BOO	Build Own and Operate
CDER	Renewable Energy Development Centre (Morocco)
CO_2	Carbon Dioxide
CPV	Concentrated Photovoltaic
CREG	Regulatory Commission of Electricity and Gas Regulation (Algeria)
CSP	Concentrating Solar Power
CTF	Clean Technology Fund
DC	Direct Current
DNI	Direct Normal Irradiation
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EDC	Electricity Distribution Companies
EDL	Electricity of Lebanon
EE	Energy Efficiency
EEHC	Egyptian Electricity Holding Company
EIA	Environmental Impact Assessment
EIB	European Investment Bank
ELB	Lebanese Electricity Holding Company (Electricité du Liban)
ELJIST	Egypt, Lebanon, Jordan, Israel, Syria and Turkey Interconnection
ENTSO-E	European Network of Transmission System Operators for Electricity

EPC	Engineering, Procurement and Construction
ERA	Electricity Regulatory Agency (Egypt)
ERC	Electricity Regulatory Commission (Jordan)
EU	European Union
FEMIP	Facility for Euro-Mediterranean Investment and Partnership
GEDCO	Gaza Electricity Distribution Co. limited
GHG	Greenhouse Gases
IAER	Algerian Institute of Renewable Energy
IEA	International Energy Agency
IEC	Israel Electricity Corporation
IFI	International Financial Institutions
IPP	Independent Power Producer
ISCC	Integrated Solar and Combined Cycle
JICA	Japan International Cooperation Agency
KfW	Kreditanstalt für Wiederaufbau (Reconstruction Credit Institute)
LEC	Levelised Energy Cost
MASEN	Moroccan Agency for Solar Energy
MEE	Ministry of Electricity and Energy
MEM	The Ministry of Energy and Mining (Algeria)
MEMEE	Ministère de l'Énergie, des Mines, de l’Eau et de l’Environnement (Morocco)
MEMR	Ministry of Energy and Mineral Resources (Jordan)
MENA	Middle East and North Africa
MENR	Ministry of Energy and Natural Resources (Israel)
MEW	Ministry of Energy and Water (MEW)
MIT	Ministry of Industry and Technology (Tunisia)
MNI	Ministry of National Infrastructures (Israel)
MoE	Ministry of Electricity (Syria)
MoF	Ministry of Finance (Israel)
MPC	Mediterranean Partner Countries
MSP	Mediterranean Solar Plan

N/A	Not Available
NEAL	New Energy Algeria
NEPCO	National Electric Power Company (Jordan)
NERC	National Energy Research Centre (Jordan and Syria)
NREA	New & Renewable Energy Authority (Egypt)
OECD	Organisation for Economic Co-operation and Development
ONE	The National Office for Electricity (Morocco)
ONEP	The National Office for Potable Water (Morocco)
PEA	Palestinian Energy Authority
PEC	Palestinian Energy & Environment Research Centre
PEED	Public Establishment for Electricity Distribution (Syria)
PEEGT	Public Establishment of Electricity Generation (Syria)
PENRA	Palestinian Energy and Natural Resources Authority
PNDERRE	National Programme for Development of Renewable Energy and Energy Efficiency
PPA	Power Purchasing Agreement
PR	Performance Ratio
PUA	Public Utility Authority (Israel)
PV	Photovoltaic
RE	Renewable Energy
R&D	Research and Development
RFP	Request for Proposal
RES	Renewable Energy Source
SAR	System Average Rate
SME	Small and Medium Enterprises
SONATRACH	National Society for the research, production, transportation, processing and marketing of hydrocarbons (Algeria)
SONELGAZ	National Society for Electricity and Gas (Algeria)
STEG	Tunisian Company for Electricity and Gas
TPA	Third Party Access
TSP	Tunisian Solar Plan

TSO	Transmission System Operator
UAPTDE	Arab Union of Producers, Transporters and Distributors of Electricity
UNDP	United Nations Development Programme

EXECUTIVE SUMMARY

THE CONTEXT

The Mediterranean Solar Plan (MSP) is one of the priority projects of the Union for the Mediterranean and aims at coping with the challenges posed by energy demand increases, security of supply and environmental sustainability in the Euro-Mediterranean region. It promotes the implementation of sustainable energy solutions concerning renewable energy and energy efficiency. Its objective is to develop an additional RE capacity in the region of 20 GW by 2020 along with the necessary electricity transmission capacity, including international interconnections.

At the Nice Ministerial Conference on Industry (November 2008), the Euro-Mediterranean Ministers requested the EIB to propose a road map for renewable energy (RE) in the Mediterranean region under the umbrella of the MSP.

OBJECTIVES AND APPROACH

This study contributes to this objective. It was carried out by MWH, working in close cooperation with EIB own specialists. The main aim of the study was to assess the level of maturity of the existing or planned RE projects in the different Mediterranean Partner Countries[1] (MPC), the economic impacts of developing these projects, as well as the main obstacles that may affect their implementation.

The study has focused on the following objectives:

- Identification of projects in the RE sector that the different countries foresee to implement during the period to 2020, which could be part of the MSP.
- Analysis of the main economic impacts of the development of the projects identified (in particular investment needs, gaps between RE costs and economic cost of the energy displaced and CO_2 emission reductions).
- Identification of the main obstacles to successful implementation of the projects, namely financial, organizational and technical.

The study was performed on the basis of a desk review of relevant public documents and studies (notably those carried out by the international and bilateral financial institutions and the European Commission), information available at the EIB regarding the current cost of the different technologies and assessment of cost developments over time, and field research visits to five countries (Egypt, Jordan, Morocco, Syria and Tunisia) as well as direct contacts with officials in the remaining Mediterranean Partner Countries.

MAIN RESULTS OF THE STUDY

1.1.1. RE PROJECTS FOR THE PERIOD UP TO 2020

Mediterranean Partner Countries have set ambitious RE targets. Were planned targets met, the region could reach 26.1 GW of additional RE capacity by 2020, fulfilling the MSP objective of

[1] Algeria, Egypt, Gaza/West Bank, Israel, Jordan, Lebanon, Morocco, Syria, Tunisia.

20 GW by 2020. However at present, actual projects identified in the national pipelines represent a total capacity of 10.3 GW only for approximately 90 RE projects (see Table 1). The difference between the national targets and the current pipeline underlines the fact that Mediterranean Partner Countries are fully aware of the region's huge potential with regards to RE deployment, although the means to achieve national objectives are not yet in place. By providing a detailed analysis on the project pipeline, this study aims to encourage the implementation of the current projects and accelerate the identification of new ones,

Out of the identified 10.3 GW project pipeline, about 2.2 GW corresponds to projects which are at an advanced stage of development, of which, however, only 0.6 GW have a financial plan. The other 8.1 GW are at different degrees of maturity. Pre -feasibility studies have been carried out for 3.2 GW, while the 4.9 GW are at the identification stage. It should be noted that projects identified represent only a small part of the wind and solar potential of the region. Therefore, more RE capacity could be developed in the period up to 2020.

Maturity of projects is also linked to the maturity of the underlying technologies. Most of the mature projects concern wind energy (1.7 GW out of 2.2 GW), while most of the less mature ones are solar energy projects (87%). Out of the total new capacity identified (10.3 GW), solar projects (both PV and CSP) account for 56%[2], whereas on-shore wind accounts for 38%, the balance (6%) covered by hydropower projects.

Two scenarios ("low" and "high") have been established, on the assumption of a progressive implementation of the RE capacity identified over the period 2010-2020 and taking account of the maturity of the different projects (Figure 1).

Under the "low" scenario, only the more mature projects are implemented and a capacity of 3.9 GW is reached by 2020. Under the "high" scenario, all the projects identified are implemented in the period 2010-2020. The two scenarios correspond to 19% to 52% of the MSP target for 2020 respectively. It should be noted that in the same period, the potential new RE capacity in Turkey (also included in the MSP) for the period 2010-20 has been estimated by the EIB at about 20 GW[3] (see Appendix 1). Renewable power generation in Turkey has, in fact, grown very rapidly in recent years, and the RE deployment model which they used could potentially be followed as a reference for the MPC.

In order for the MPC to play a significant role in meeting the RE objective of the MSP, it is necessary to accelerate the implementation of their programmes, with particular emphasis on the development of the less mature projects identified in the study. If only the low scenario is realized, the region will continue to play a very marginal role in the RE sector.

The implementation of the projects identified will increase significantly the RE electricity capacity in the MPC region (excluding hydropower): from 0.5% in 2008 to 3.3% and 8.9% of the projected

[2] Depending on the technology mix chosen by Morocco for its 2,000MW solar plan, CSP could represent between 59% and 93%, respectively, of the total solar capacity identified.

[3] Assessment based on figures found in TEIAS (2009) *Turkish Electrical Energy 10 year capacity projection 2009-2018*, June 2009.

2020 capacity, under the two scenarios considered. Although this is a substantial increase, these percentages are significantly lower that the expected EU average by 2020 (around 25%[4]).

1.1.2. INVESTMENT NEEDS FOR NEW RE CAPACITY IDENTIFIED

The evaluation of the investment needs depends on assumptions concerning expected cost development for the different technologies. The estimates of current investment cost used in the study are based on the EIB's experience in the region or elsewhere, notably in the EU Member States. The study assumes that cost will gradually decrease (slowly in the case of on-shore wind and faster for solar technologies[5]). Under the low scenario investments needs amount to EUR 7 billion by 2020 in 2010 prices and in the high scenario over EUR 21 billion (Figure 2). A large share of investment needs relates to solar projects, in particular under the high scenario (36% in the low scenario and 69% in the high scenario). These investments are a small share of the total investments in electricity generation in the region (between EUR 120 and 140 billion for the same period[6]) in the low scenario, but may represent up to 18% of the total in the high scenario.

The investment cost of the projects in an advanced stage of preparation (2.2 GW) is about EUR 1.5 billion, but only three wind farms included in this group (about 600 MW) have a tentative financing plan in place.

1.1.3. COST OF RE PROJECTS IDENTIFIED BY COMPARISON TO CONVENTIONAL GENERATION

The study compares the cost of electricity generation in the projects identified with the cost of the alternative fossil fuel generation that will be replaced. Cost estimates have been based on assumptions regarding cost development for the various RE technologies and on alternative fossil fuel generation costs[7]. Concerning alternative fossil fuel generation, the main assumption was related to energy price scenarios, particularly natural gas and imported coal, based on the latest baseline energy price scenarios published by the International Energy Agency. Lower gas prices have been considered in the gas exporting countries than for the gas importing countries, to reflect the difference in gas transportation costs. In addition, the cost of displaced energy is based on base-load generation costs for wind projects, whereas it uses mid-merit generation costs for solar projects.

[4] Estimated from the Commission staff working document SEC(2008) 2871 Volume I 13 11.2008. European Commission, Brussels. http://ec.europa.eu/energy/strategies/2008/doc/2008_11_ser2/strategic_energy_review_wd_future_position2.pdf [Accessed 06 May 2010].

[5] Based mainly on EU studies carried out in the context of the different EU technological platforms.

[6] Based on World Energy Outlook 2009, IEA and Mediterranean Energy Perspectives 2008, OME.

[7] Calculation based on feasibility studies when available or using regional averages.

On this basis, the cost of electricity in the wind energy projects identified is similar to or slightly lower than the cost of the alternatives at present (Figure 3). Wind energy becomes very competitive in relation to the alternatives in 2020 (average wind costs around 39% less than base-load electricity for the region in 2020). In the case of solar technologies, the cost is currently substantially higher than the alternatives at present (68% more for PV and 108% more for CSP), but it is close to the alternatives in 2020 (18% lower in the case of PV and still 3% higher in the case of CSP).

The implementation of the solar projects identified will need subsidies to cover the difference between their cost and the cost of the fossil fuel alternatives for as long as they are more expensive than the alternatives. These subsidies are calculated, in net present value terms[8], at EUR 328 million in the low scenario and EUR 1.2 billion in the high scenario. Part of these costs can be covered by carbon credits, around 20% in the low and 34% in the high scenarios, based on conservative assumptions on the price of these credits[9]. The rest of the subsidies will need to be covered from other sources, either national or international.

1.1.4. CO_2 EMISSION REDUCTIONS FROM THE IMPLEMENTATION OF IDENTIFIED RE PROJECTS

On the basis of the CO_2 emissions of the alternative fossil fuel generation that the projects replace, the identified projects are expected to yield significant reduction in CO_2 emissions. This reduction will reach 36-65 million tCO_2 by 2020 and 100-250 million tCO_2 by 2040, respectively in the low and high scenarios.

1.1.5. MAIN OBSTACLES TO THE IMPLEMENTATION OF RE PROJECTS

Three key barriers have been identified for the implementation of RE projects: financial, regulatory and capacity of the electricity grids.

The main obstacle seems to be financial. This is related to the subsidies necessary to cover the financial gap between the cost of generation from solar plants and the cost of their fossil fuel alternatives. As indicated before, carbon credits can only cover a small fraction of the gap; the rest has to be covered by subsidies from other sources, including in particular exports of RE energy to the EU, on the basis of the Article 9 of the new EU directive on RE (2009/28/EC). The latter would also imply the need to develop the electricity transmission capacity with EU countries, as the existing capacity is limited.

In view of the expected private sector involvement in the development of the RE sector, a key issue is the existence of a regulatory framework that takes due account of project risks and ensures an acceptable financial viability of the investments. Current regulations are weak in most of the countries, constituting a major obstacle to the development of projects. Experience from certain EU Member States demonstrates the importance of such a regulatory framework for the development of RE technologies but also shows that, in the case of RE technologies which are cost competitive with alternatives (such as on-shore wind in most of the countries), the regulation is not dependent on public budget availability. There is anecdotal evidence in some countries of obstacles to developing RE, even if they are competitive. This is often related to limited policy

[8] At a 5% discount rate.

[9] An indicative conservative price of 10 EUR/tCO_2 was used in this calculation.

support and limited experience with RE, notably concerns regarding their impact on the stability of electricity networks.

The public authorities interviewed by MWH noted that the development of the planned RE energy projects will require a reinforcement of the countries' electricity grids. In addition, the reinforcement of the interconnections among the countries of the region can also contribute to a certain extent to the integration of more RE capacity in the national systems.

Finally, the need was also noted in some cases to develop the background information for the development of RE energy projects, for example wind and solar resource measurements or potential locations. However, these issues were not specifically covered by this study. In addition, support for the development of specific projects and regulations (general studies, feasibility studies, etc.) seems to be needed for many projects, considering the limited experience in developing such projects, notably solar projects.

MAIN CONCLUSIONS AND RECOMMENDATIONS

- Were all identified RE project implemented in the MPC, the Mediterranean region including Turkey could achieve the MSP target by 2020. However renewable power generation is growing very rapidly in Turkey and potential new RE capacity in the country for the period 2010-20 has been estimated at about 20 GW. Therefore there is a clear need to accelerate the development of RE projects in the Mediterranean Partner Countries, if they are to play a significant role in achieving the objectives of the MSP.
- Most of the mature projects identified in the MPC correspond to onshore wind. However, on the basis of the projects identified, wind alone will not be able to make a major contribution to the MSP target. It is thus necessary to significantly develop the solar projects identified (nearly 6 GW), which are generally at a very early stage of development. The development of such projects will require Technical Assistance (TA) for project preparation as well as support for the adoption of appropriate regulatory frameworks. Such regulatory frameworks are indispensable also for attracting investments in the RE sector in the region.
- The investments needed to implement the projects identified are significant, with the lion share for solar projects. However, these investments represent only a modest part of the investment needs in power generation that the region will require in the coming years.
- Most of the more mature project proposals are onshore wind (1.7 GW), which have an electricity generation cost generally similar to or lower than base-load electricity. Additionally, up to 2.3 GW of onshore wind projects have been identified up to 2020. On the contrary, the cost of electricity in solar projects is substantially higher today than the fossil fuel alternatives (88 % higher on average), but their cost is expected to decrease considerably and be close to the alternatives by 2020.
- Therefore, for solar projects (CSP and PV) the main obstacle to their implementation is financial and relates to the need for subsidies to cover the additional cost in relation to the fossil fuel alternatives. If a significant part of the subsidies comes through electricity exports to the EU, this will imply a need to expand the international electricity transmission capacity with the EU.
- Mediterranean Partner Countries will need to reinforce their electricity transmission networks as well as adapting their grid codes, in order to increase the maximum RE capacity acceptable in their systems.

Table 1: Identified new RE capacity by 2020 classified by level of maturity and technology

Source: MWH calculation

Level of maturity	Wind on-shore (MW)	Solar (MW)	Hydro (MW)
Feasibility study	1,671	231	332
Pre-feasibility study	1,862	1,378	-
Identification stage	350	4,210	300
TOTAL	2,233	3,240	4,860

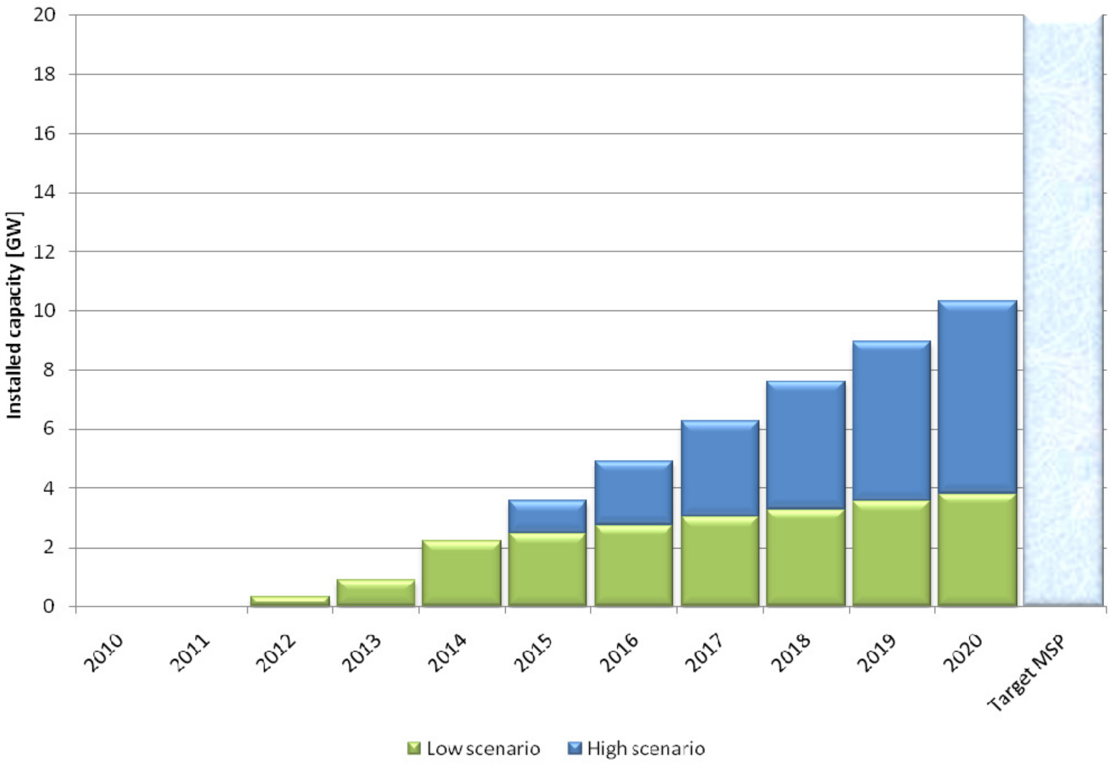

Figure 1: Cumulative RE capacity installed in time for the low and high scenarios

Source: MWH modelling results

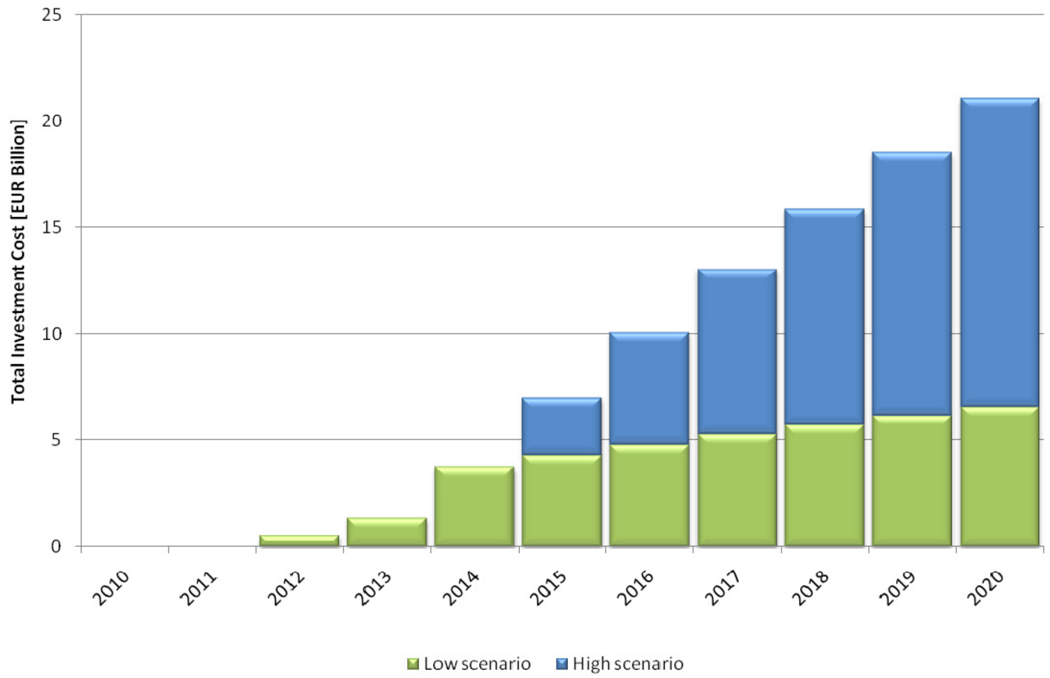

Figure 2: Cumulative investment needed for new overall RE capacity for the low and high scenarios

Source: MWH modelling results

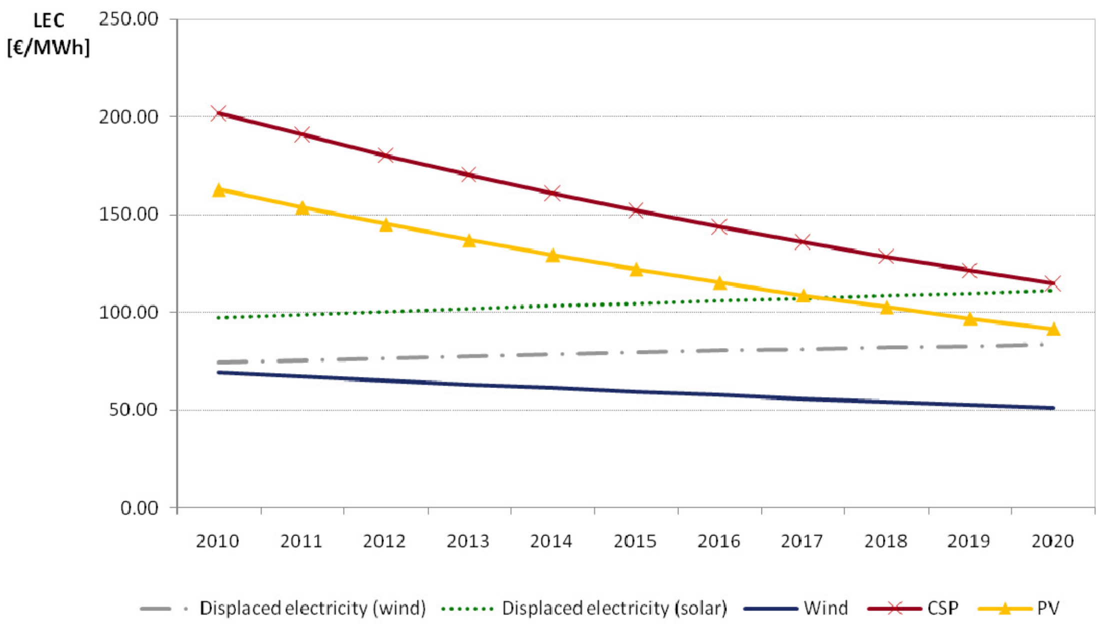

Figure 3: Evolution of levelised electricity costs by technology 2010-2020[10]

Source: MWH modelling results

[10] Averaged for the countries covered in the study.

PART I – REGIONAL OVERVIEW AND ANALYSIS

1. INTRODUCTION AND BACKGROUND

The overriding objective of this study is to assess the prospects for the implementation of renewable energies in the Southern and Eastern Mediterranean region. The development of renewable energies is at the cornerstone of Mediterranean Partner Countries' efforts to improve security of supply and reduce CO_2 emissions.

A critical initiative to support these efforts is the Mediterranean Solar Plan (MSP). The MSP outlines actions to address the challenges posed by energy demand increases, energy efficiency, security of supply, and environmental sustainability in the Euro-Mediterranean region. It aims at developing an additional renewable energy (RE) capacity in the region of 20 GW by 2020, including all renewable energy sources. The initiative also supports the strengthening of the region's electricity transmission capacity in order to reinforce the national power grids as well as its interconnections within the Mediterranean and with European countries.

The MSP was adopted as one of the priority projects of the Union for the Mediterranean, as recognised in the Joint Declaration of the Paris Summit for the Mediterranean held on 13th July 2008. Following this, at the Nice Ministerial Conference on Industry (November 2008), the Euro-Mediterranean Ministers requested the EIB to propose a road map for renewable energy (RE) in the Mediterranean region under the umbrella of the MSP.

1.1. OBJECTIVES

The study's objective is threefold:

- To assess the foreseen investments related to renewable energy in the Mediterranean partner countries (MPC)[11] over the period 2010-2020;
- Based on MPC identified RE projects, to analyse the main economic impacts of the development of the projects identified (in particular investment needs, gaps between RE costs and economic cost of the energy displaced and CO_2 emission reductions);
- To identify potential constraints for the implementation of RE projects as well as different measures to address implementation gaps.

1.2. APPROACH

The assessment of renewable energies in Mediterranean countries was conducted in three main phases.

During the first phase, projects promoting RE in MPC were identified. The identification of projects was conducted through desk reviews of relevant public documents and sector specific studies. Based on this preliminary screening, questionnaires were sent to incumbent stakeholders requesting additional information on RE projects and the countries' institutional set-up.

[11] The countries covered by this study are Algeria, Egypt, Gaza/West Bank, Israel, Jordan , Lebanon, Morocco, Syria, and Tunisia.

During the second phase, field missions to Egypt, Jordan, Morocco, Syria, and Tunisia were arranged. Throughout these missions, public sector officials holding different responsibilities in the energy sector (namely national renewable energy agencies, regulators, and utilities) were interviewed. For Gaza/West Bank, Israel, and Lebanon, information was gathered from publicly available documents and through telephone interviews with government officials. For Algeria, the assessment was only based on a desk review. Appendix 2 lists the institutions that provided information for the completion of the report.

In the third phase, data was systematically analysed. RE projects were identified in each country and classified into three categories related to their level of preparation (feasibility, pre-feasibility, and identification stages). A modelling calculation was performed to determine the Levelised Energy Cost (LEC) for each technology and the economic costs of their implementation (given by the need, or not, of subsidies). RE investment projections in the region were assessed taking into consideration two scenarios; high scenario, which included projects at a more advanced level of execution and low scenario, which included projects at an earlier stage of implementation). The modelling also took into account some of the expected environmental benefits of the projects, which was estimated by the reduction of CO_2 emissions.

1.3. STRUCTURE OF THE REPORT

The report is structured in two parts.

- Part I – General Overview, where:
  - Chapter 1 introduces the study and its background;
  - Chapter 2 provides a regional outlook describing the energy supply and RE penetration in Mediterranean Partner Countries. It also analyzes the configuration of the RE sector and the main stakeholders involved. The chapter finalizes with an overview of RE projects in the region;
  - Chapter 3 describes the selected methodology and presents the modelling, highlighting the main economic impacts of the projects;
  - Chapter 4 addresses the main constraints for the development of RE projects and the measures to overcome them;
  - Chapter 5 presents the main conclusions of the study;
- Part II – Country Analysis, where MPC efforts are assessed based on the following structure:
  - The first section presents an overall outlook of the energy sector in the country. It focuses on the main patterns of energy supply, the share of RE, and the relevant stakeholders operating in the country;
  - The second section addresses the different scenarios for the implementation of RE projects in each country. It also identifies the main constraints for RE projects in MPC.

2. REGIONAL OUTLOOK AND PROJECTS' ASSESSMENT

2.1. SUMMARY

The MPC region has about 61.8 GW of installed electrical capacity. Electricity from renewable energies sources account for 12% of the total installed capacity in the region. Hydro power represents the largest share of RE in the region (90%). It is followed by wind (9.6%) and solar (0.4%). Among the MPC, Egypt has the largest percentage of RE in the region. It owns 68% of the total installed wind capacity and 43% of the total hydro capacity.

Countries have set different RE targets. Were agreed targets met, the region could reach 26.1 GW of additional RE capacity by 2020. It means that the region would be fulfilling by itself whole of the MSP objective of 20 GW by 2020. However, the RE projects identified at present represent a total capacity of 10.3 GW, which is expected to be deployed in the next ten years.

Institutional setups differ from country to country. Even though different MPC have passed RE legislation, measures aimed at promoting the development of RE are rather limited. Two countries (Algeria and Israel) have feed in tariffs. Third party access is allowed in Algeria, Israel, and Morocco. Other countries (especially Egypt, Jordan, Morocco, and Tunisia) have implemented simplified authorisation procedures and/or tax exemptions.

The total electricity capacity of the projects identified amounts to 10.3 GW. About 2.2 GW corresponds to projects which are at an advanced stage of development, of which, however, only 0.6 GW have a financial plan. The other 8.1 GW are at different degrees of maturity. Pre -feasibility studies have been carried out for 3.2 GW, while the 4.9 GW are at the identification stage. It should be noted that projects identified represent only a small part of the wind and solar potential of the region. Therefore, more RE capacity could be developed in the period up to 2020.

2.2. METHODOLOGY FOR PROJECTS' ASSESSMENT AND DATA GATHERING

The assessment only included RE projects to be implemented from 2011 onwards. Projects already under construction or commissioned before the end of 2010 were not taken into account either in the assessment or in the modelling exercise.[12] In addition, only projects identified by interviewed stakeholders at the time of the study were included in the assessment.[13]

The assessment was completed with information provided by the relevant stakeholders through personal interviews, phone conversations, and e-mail exchanges. For none of the listed projects was the relevant technical documentation (i.e. feasibility studies, land property documentations, equipment quotations, etc.) reviewed in detail.

Based on their level of maturity, projects were classified into three categories:

- **Projects at Feasibility Study stage (FS)**: those at an advanced level of preparation, since a feasibility study has been completed and\or the bidding process is in place;

[12] The exclusion from the modelling of RE projects under construction or commissioned before the end of 2010 was based on the need to estimate additional RE capacity in the three categories of maturity proposed.

[13] It is possible that in between the time of data collection and the final publication of this study, additional projects proposals have taken shape. These projects have been included at best (and clearly identified) in the countries' chapters of Part II. For practical reasons, however, they have not been considered in the assessment and modeling.

- **Projects at Pre-Feasibility Study stage (PFS)**: those under preparation, since a pre–feasibility study has been completed and\or further studies are to be developed;
- **Projects at Identification stage (IS)**: those at a conceptual level of preparation, since preliminary calculations have been performed and\or studies are at an early stage of preparation.

2.3. Outlook of Energy Supply and Share of RE

2.3.1. Installed electrical capacity in the region and share of renewable energy

Figure 2-1 shows installed electricity capacity by country and identifies RE contribution. Egypt has the largest stake of electrical power in the region (33.6%), followed by Israel (18.3%), and Algeria (13.7%). The majority of the countries still rely on fossil sources for electricity generation. RE capacity accounts for 12% of the region's total electricity generation. Egypt, Morocco, and Syria are the three MPC with the most significant share of RE in their mix (between 15% and 35%)[14]. To a lesser extent, Tunisia, Algeria, and Lebanon have also non negligible shares of RE in their power mix (less than 10%).

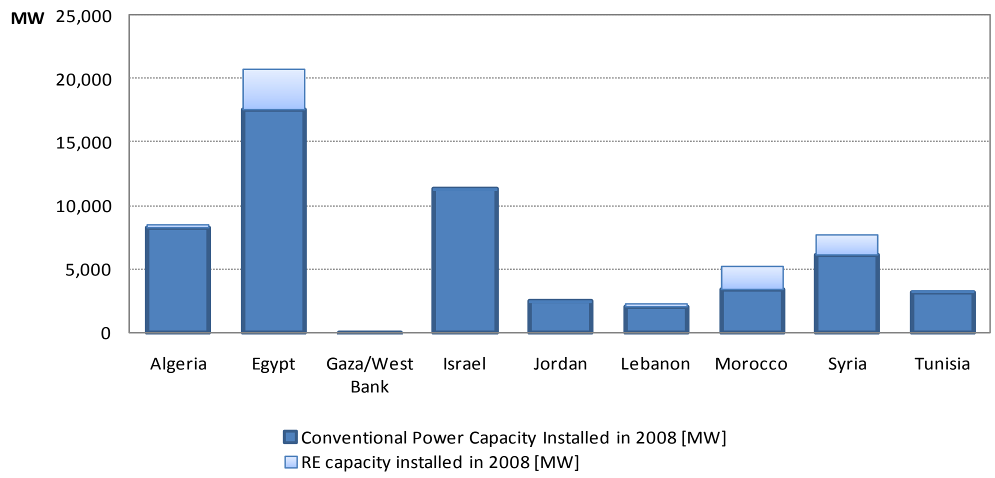

Figure 2-1: Installed electrical capacity in MPC (2008)

Source: [1]

Figure 2-2 shows total RE installed capacity by country and technology [1]. Except for hydropower, the penetration of RE in total installed capacity is still very marginal. The spread of RE in region started during the ninety decade with the development of solar photovoltaic for rural electrification purposes. Wind energy projects were implemented at the beginning of 2000. Since then, Morocco and Egypt, and to a lesser extent Tunisia, have led the region's efforts in deploying wind energy.

[14] It is important to note that hydro power currently represents the largest share in RE energy: 90% for Egypt, 93% for Morocco and 100% for Syria. For more information, please refer to the individual country chapters in Part 2.

Most recently, CSP projects (integrated with combined cycles) have been developed in some countries of the region. Integrated Solar Combined Cycle (ISCC) plants are being envisaged or are already under construction in Algeria (Hassi R'Mel), Egypt (El-Kureimat), and Morocco (Ain Beni-Mathar).

According to 2008 data, hydro power covers about 90% of the total RE installed capacity in the region. Solar and biomass sources represent, respectively, 9.6% and less than 0.2% of total electricity generation.

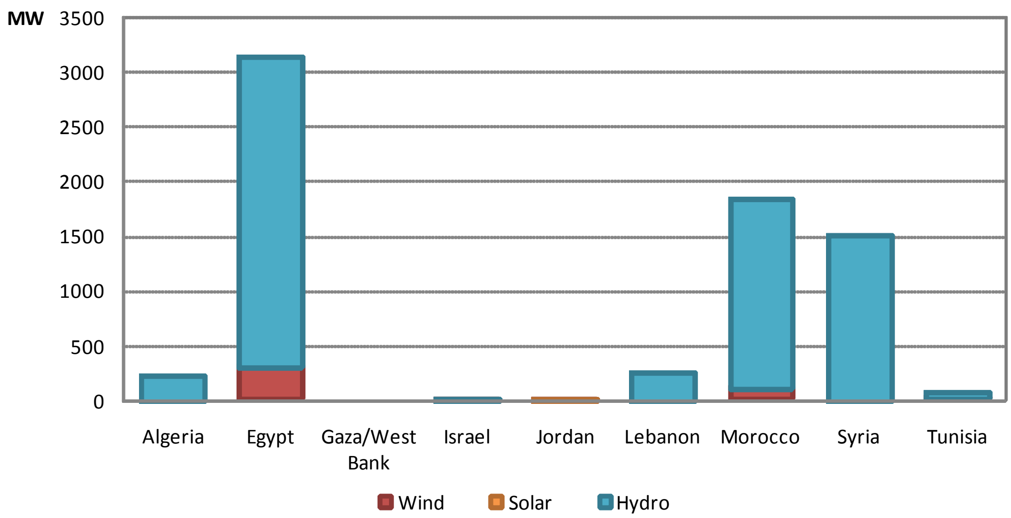

Figure 2-2: RE installed capacity in the region by country (2008)[15]

Source: [1]

Among the three biggest electric systems in the region, Egypt stands out with the largest share of RE. In terms of smaller electric systems, Morocco and Syria contribute with significant shares of RE.

RE in Egypt is largely explained by its hydro capacity. Egypt owns about 68% of wind and 43% of hydro power capacity presently deployed in the region. It is followed by Morocco and Syria, whose share of RE in the region is also explained by their hydro resources. Morocco owns 26% of both hydro and wind power currently deployed in the region. Syria follows, with 23% of the total regional installed hydro capacity. The rest of the countries have a minor participation in total RE generation.

[15] Data on Israel is from 2007.

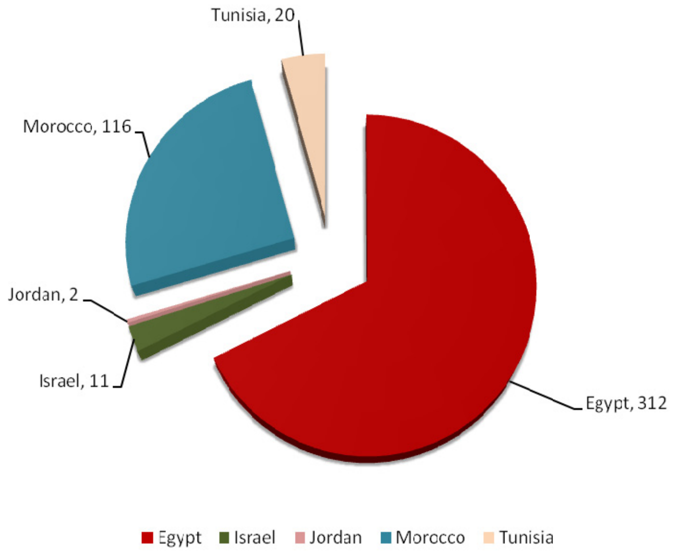

Figure 2-3: Wind capacity installed [MW] in the MPC (2008)

Source: [1]

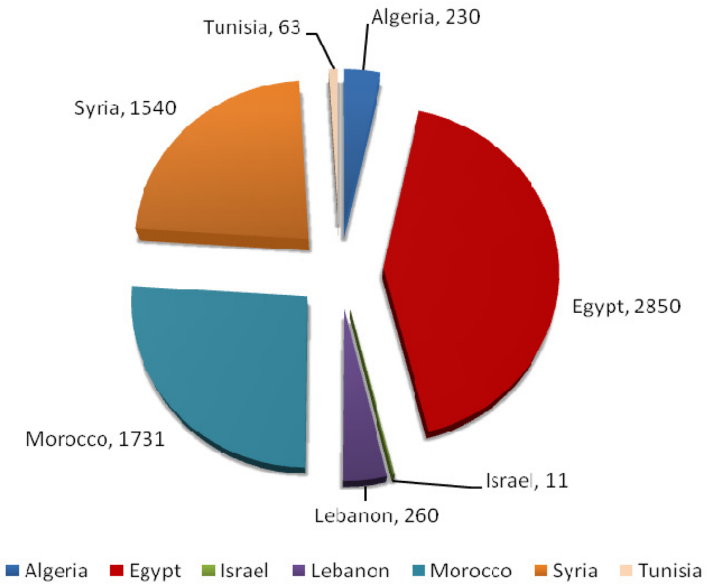

Figure 2-4: Hydro capacity [MW] installed in the MPC (2008)

Source: [1]

2.3.2. ESTIMATED ADDITIONAL RE CAPACITY BY 2020

In recent years, most of the MPC have set targets for the development of RE. Table 2-1 summarizes the RE targets for each of the countries.

Table 2-1: Targets of additional RE capacity

Sources: Various, as indicated in the table

Country	National target	Source
Algeria	5% RE installed capacity by 2017 (750 MW) and 20% by 2030, with the following breakdown: 70% CSP, 20% PV and 10% wind.	[2]
Egypt	20% of total electricity generation through RE sources by 2020. 12% belongs to wind energy (7,200 MW) and the remaining to hydro, solar and biomass. NREA expects solar contribution to be 120 MW (100 MW CSP and 20 MW PV) by 2020.	[3] [4]
Gaza/West Bank	No targets identified.	N/A
Israel	10% of RE by 2020.	[5]
Jordan	Target of 7% share of RE in primary energy by 2015 and 10% by 2020. In order to achieve this target, MEMR expects to develop by 2020 600 MW wind power, 600 MW solar power, and 30 - 50 MW waste.	[6]
Lebanon	12% of RE by 2020.	[7]
Morocco	42% share of RE installed capacity by 2020. It is expected to install 2,000 MW wind, 2,000 MW solar and 2,000 MW hydro.	[8]
Syria	6,000 MW of renewable energy installed capacity by 2030(50% solar and 50% wind).	[9]
Tunisia	10% of RE in total energy consumption by 2020.	[10]

Based on identified RE targets, it is estimated that the region could install about 26.1 GW of RE capacity by 2020 (see Figure 2-5 and Figure 2-6), reaching a total of approximately 33.3 GW. Were MPC to deploy agreed RE targets, the region would experience a remarkable increase of its RE capacity. Compared to the last available data of 2008, the implementation of identified RE projects would increase RE in the region by 365 %. Under these assumptions, the region would be also fulfilling by itself whole of the MSP objective of 20 GW by 2020.

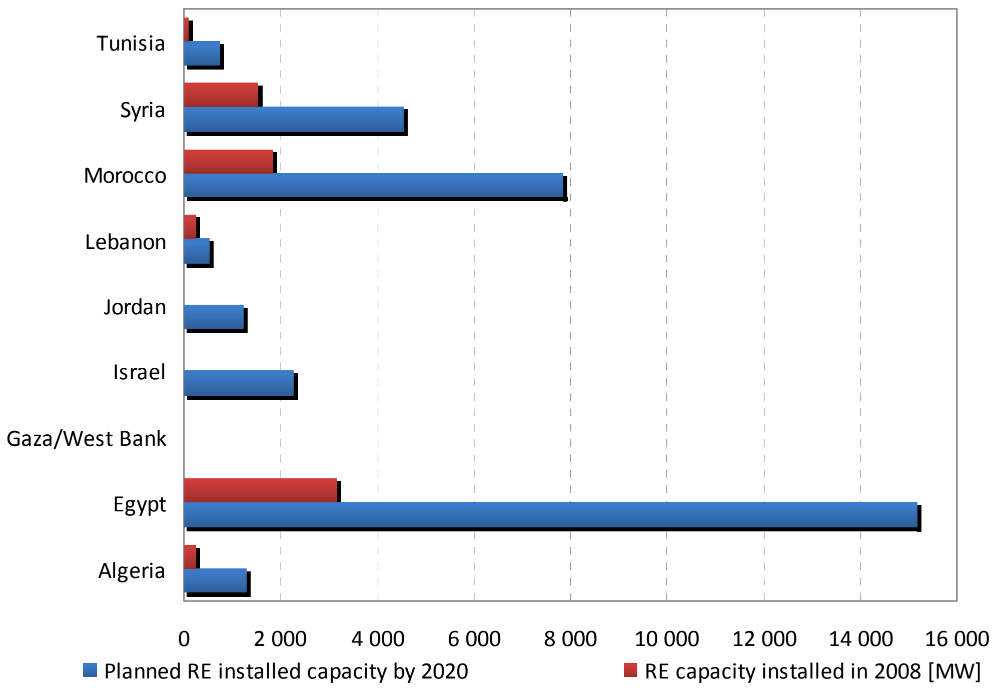

Figure 2-5: RE power installed in 2008 compared countries' RE targets for 2020. [16]

Sources: [1] and references in Table 2-1

In absolute terms, Egypt and Morocco are planning the largest increases of RE capacity. In particular, they are focusing on wind and solar energy by developing, respectively, an additional capacity of 12 GW and 6 GW. In relative terms, Israel shows the most ambitious increase of RE capacity in the region. Israel's goal of an additional 2.25 GW of RE capacity would represent a 100 fold increase, compared to the last available data of 2007. Syria has also committed to an important increase of its RE capacity; by 2020 it plans to triple its current installed RE capacity (2008 data).

[16] For those countries in which targets are not expressed in terms of installed capacity or refer to different years (Algeria, Israel, Syria, and Tunisia), data was considered as estimates.

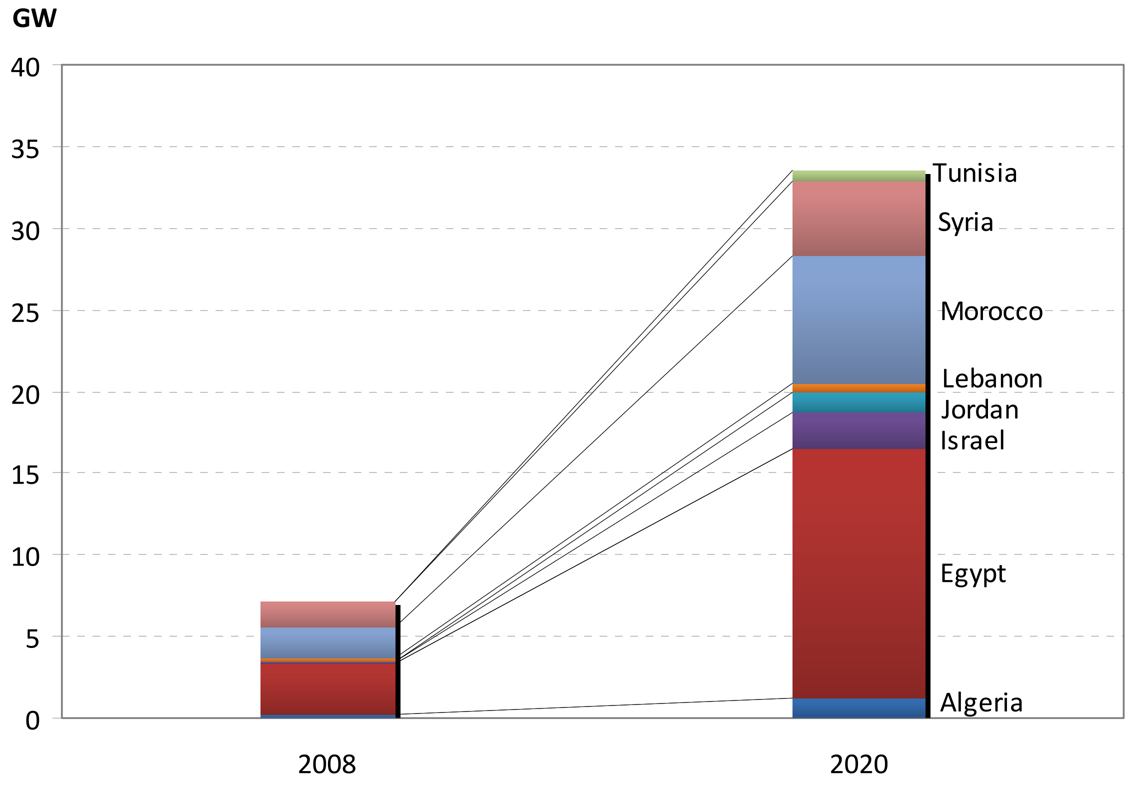

Figure 2-6: RE power installed in 2008 compared to projections for 2020

Source: MWH/EIB modelling results

2.4. OUTLOOK OF ELECTRIC INTERCONNECTIONS

Most of the MPC are connected to a regional electricity network. There are two electricity networks, one in the Maghreb region (Morocco-Algeria-Tunisia-Libya) and the other in the Mashreq region (Jordan, Syria, Egypt, Iraq, Lebanon, and Gaza/West Bank).

The electricity network is part of the Arab power system, which was started in 1988 by a five-country agreement including Jordan, Syria, Egypt, Turkey, and Iraq. The first step in these efforts was to reach a common regional standard which would allow member countries to connect to the network. Based on this commitment, each country undertook an upgrade of its electricity system.

After the completion of those efforts, the project was extended to Lebanon, Libya and Gaza/West Bank (the latter was officially included in 2008). There are currently 400 kV connections between Spain, Morocco, Algeria, and Tunisia and around 400-500 kV interconnections between the national power systems of Egypt, Iraq, Jordan, Lebanon, Syria, Libya, Turkey, and Iran [1].

Table 2-2 shows the main electrical interconnections in the region by 2009 [1]. It is worth highlighting that Israel constitutes a synchronous bloc and is not connected to the neighbouring countries, except Gaza/West Bank.

Table 2-2: Main electrical interconnections existing in the region in 2009

Source: [1]

Countries	Length (km)	Voltage (kV)	Capacity (MW)	Status
Algeria-Tunisia	35.5	90	74	In operation
	60	90	63	
	65	150	14	
	60	225	217	
	160	400	961	Under construction
Egypt-Jordan	13	400	550	In operation
Egypt-Libya	180	220	240	In operation
Lebanon-Syria	22	400	1000	Functional[17]
Morocco-Spain	61	400	700	In operation
	61	400	700	
Morocco-Algeria	49	225	235	
	67	225	235	
	230	400	2400	
Syria-Jordan	60	400	1000	In operation
Syria-Iraq	140	400	1000	Under construction
Syria-Turkey	61.6	400	1000	Functional
Tunisia-Libya	2x110	225	2x217	Second test on April 2010
	160	225	217	
	330	400	961	Planned for 2015
Tunisia-Italy	200	400	1000	Planned for 2016

Although MPC seem to be well interconnected, the regional exchange of power has been lower than the available interconnection capacity (see Figure 2-7). Despite the existing infrastructure, Intra-Maghreb electricity trade is very feeble [15], especially when the needs, availability of resources, and the geographical proximity are considered. In 2006, only 0.7 TWh were exchanged, representing 0.7% of the total energy consumption in the region. [18] Even though Libya and Tunisia have been linked since 2003, they have not started trading electricity yet.

The only significant amount of exchanged electricity is between Morocco and Spain (3.6 TWh as of 2007). A new 400kV line linking Algeria to Morocco is expected to facilitate the purchase of Algerian electricity by Spain. At present, there is an average of 200 GWh annual power trade among Algeria, Morocco, and Tunisia.

The region also faces lack of synchronization among the interconnected systems [1]. The electricity networks of Morocco, Algeria, and Tunisia are synchronised with continental Europe's UCTE network. Nonetheless, neither the Libyan nor the Egyptian network are synchronised with their neighbours and/or continental Europe.[19] Israel constitutes a synchronous bloc and is not connected to the neighbouring countries, except Gaza/West Bank.

17 A "functional" line is connected in island and cannot be considered as a proper country connection in operation. In fact two connections "functional" connections are between Turkey and Syria and between Lebanon and Syria.

18 Regional power trade is modest compared to power trade in the EU and the wider Mediterranean Region.

19 In 2005, a failed synchronisation attempt was made between Libya and Tunisia.

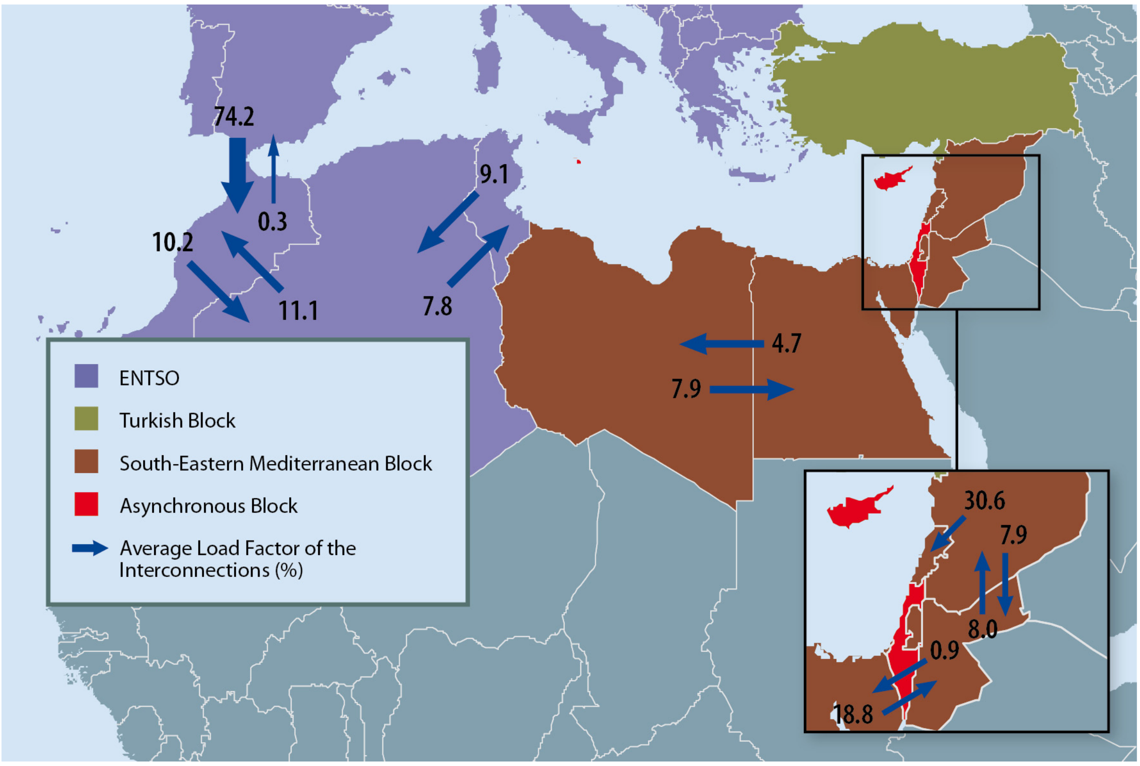

Figure 2-7: Mediterranean electricity blocks and rate of utilization of the interconnections in the year 2008 (%)

Source: Based on [16]

2.5. Stakeholders dealing with RE

RE policies in the region are typically led by a line ministry responsible for the energy sector. In some countries, this activity is complemented by energy regulatory authorities (Algeria, Egypt, Gaza/West Bank, Israel, and Jordan) as well as agencies responsible for the promotion of renewable energies (all countries apart from Israel and Lebanon).

Table 2-3 summarises the main stakeholders involved in the energy sector, especially those with RE responsibilities. Further details on the responsibilities of each stakeholder are reported in Part II – Country section.

Table 2-3: Stakeholders dealing with RE by country

Sources: Various, as detailed in the country chapters (Part II)

Country	Ministry	Renewable energy agency	National electricity operator	Energy regulatory authority
Algeria	MEM	NEAL	SONELGAZ	CREG
Egypt	MEE	NREA	EEHC	ERA
Gaza/West Bank	MENR	PEA	GEDCo	PENRA
Israel	MNI	No	IEC	PUA
Jordan	MEMR	NERC	NEPCO	ERC
Lebanon	MEW	No	EDL	LCEC
Morocco	MEMEE	ADEREE MASEN	ONE	No
Syria	MoE	NERC	PEEGT, PEED	No
Tunisia	MIT	ANME -STEG EN	STEG	No

The role of RE agencies is to implement the policy of the government on the ground. In order to be effective, this function cannot be properly conducted either by those responsible for the design of RE policies (line ministry) or by those in charge of the distribution of electricity services (utilities). The former are typically characterized by lengthy and heavy procedures, which prevent a smooth and flexible implementation of RE 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 RE agencies which are separated from both policy formulation authorities and service providers are the best guarantees for the implementation of RE policies.

The role of an energy regulatory authority (or ERA) is to prevent political discretion in the implementation of energy policies, especially in the case of private sector provision. Regulatory agencies are legally independent from the line ministry and they behave as an impartial decision-maker responsible for the enforcement of contracts and the quality of services standards.

2.6. OVERVIEW OF THE INSTITUTIONAL AND REGULATORY FRAMEWORKS

During the last two decades, MPC countries have developed different institutional schemes for the promotion of renewable energies. Approaches differ from country to country but the majority of them have moved towards more ambitious objectives in terms of RE development. Public

initiatives such as the MSP and private programmes such as Desertec or Transgreen have contributed to this trend.

Almost all the countries have passed legislation regulating the RE sector or are in the process of approval. Nevertheless, incentive measures for the development of RE are rather limited. Only a few of these regulations foresee the support of RE development by feed-in tariffs; more often only simplified authorisation procedures or tax exemptions are in place. Third Party Access is only allowed in Algeria, Israel, Morocco, and Tunisia (in Tunisia, only for auto-producers).

RE technologies require subsidies to be financially sustainable. Further details on the legislative framework and RE support mechanisms are reported in Part II – Country section.

Table 2-4: Legislative framework in the MPC

Sources: Various, as detailed in the country chapters

Countries	RE legislation	Feed-in tariffs	Other supporting mechanisms	Third Party Access	IPP
Algeria	Yes	Yes	No	Yes	Yes
Egypt	Under Development[20]	No	Yes	No	Yes
Gaza/West Bank	No	No	No	No	Yes
Israel	No	Yes	Yes	Yes	Yes
Jordan	Yes	No	Yes	No	Yes
Lebanon	No	No	No	No	No
Morocco	Yes	No	Yes	Yes	Yes
Syria	Under Development[21]	No	No	No	No
Tunisia	Yes	No	Yes	Yes (self producers)	Yes

[20] The 2010 electoral calendar is expected to slow down the approval of RE laws.

[21] In 2002, the Syrian government launched a master plan ("Masterplan for Energy Efficiency and Renewable Energies – MEERE-) for the development of renewable energy. The plan is expected to run until 2030. Currently, the plan is being up-dated with collaboration from GTZ.

2.7. Assessment of RE Projects

The total electricity capacity of the projects identified amounts to 10.3 GW. About 2.2 GW corresponds to projects which are at an advanced stage of development, of which, however, only 0.6 GW have a financial plan. The other 8.1 GW are at different degrees of maturity. Pre - feasibility studies have been carried out for 3.2 GW, while the 4.9 GW are at the identification stage. It should be noted that projects identified represent only a small part of the wind and solar potential of the region. Therefore, more RE capacity could be developed in the period up to 2020. Table 2-5 summarizes RE projects and their preparation stage.

Table 2-5: Identified RE projects to be implemented by 2020, by level of preparation and technology[22]

Source: MWH calculation

	Feasibility study (FS) [MW]	Pre-feasibility study (PFS) [MW]	Identification stage (IS) [MW]
Wind	1,671	1,862	350
Solar	231	1,378	4,210
Hydro	332	0	300
TOTAL	2,233	3,240	4,860

Maturity of projects is also linked to the maturity of the underlying technologies. Most of the mature projects concern wind energy (1.7 GW out of 2.2 GW), while most of the less mature ones are solar energy projects (87%). Out of the total new capacity identified (10.3 GW), solar projects (both PV and CSP) account for 56%[23], whereas on-shore wind accounts for 38%, the balance (6%) covered by hydropower projects.

Most of the RE projects are located in Morocco (36%) and Jordan (25%). Morocco and Egypt have the largest share (40%) of RE projects at a FS. Jordan and Israel have the largest number of projects at an identification stage. Figure 2-8 shows the RE projects by country, technology, and maturity level.

Wind technology represents most of the proposed additional RE capacity in the region. This is particularly the case of Egypt and Morocco, where wind projects are at an advanced stage of preparation.

[22] Additional data from Lebanon brought information of three more projects at an identification stage. Although they were not taken into account in the model (project list, LEC calculation, subsidies calculation), they were included for illustration purposes on Figures 2-7 and 3-3.

[23] Depending on the technology mix chosen by Morocco for its 2,000MW solar plan, CSP could represent between 59% and 93%, respectively, of the total solar capacity identified.

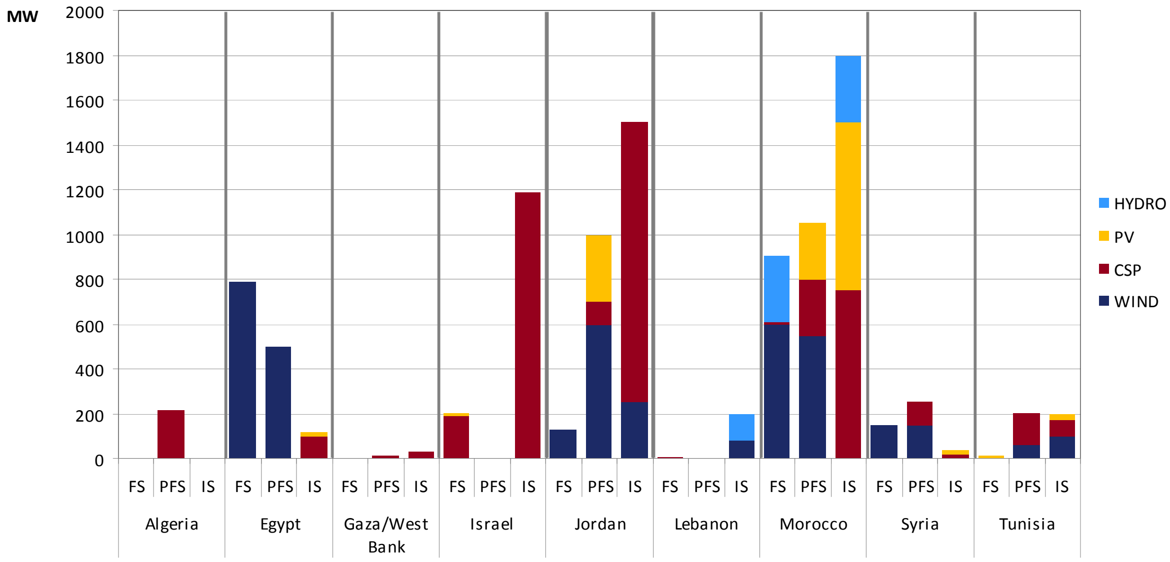

Figure 2-8: Summary of identified RE projects by country [24]

Source: MWH/EIB modelling results

[24] In Morocco, the 2 GW solar plan does not identify which technology will be used between CSP and PV. For the purpose of the calculations in the report, an intermediary case of 50% CSP and 50% PV has been considered.

3. DESIGN AND SIMULATION OF SCENARIOS

3.1. SUMMARY

Two scenarios ("low" and "high") have been established, on the assumption of a progressive implementation of the RE capacity identified over the period 2010-2020 and taking account of the maturity of the different projects.

Under the "low" scenario, only the more mature projects are implemented and a capacity of 3.9 GW is reached by 2020. Under the "high" scenario, all the projects identified are implemented in the period 2010-2020. The two scenarios correspond to 19% to 52% of the MSP target for 2020 respectively. In order for the MPC to play a significant role in meeting the RE objective of the MSP, it is necessary to accelerate the implementation of their programmes, with particular emphasis on the development of the less mature projects identified in the study. If only the low scenario is realized, the region will continue to play a very marginal role in the RE sector.

The costs of producing electricity from RE sources vary depending on the different technologies. Currently, wind electricity cost is close to that of power from fossil fuels. On the other hand, solar electricity cost is significantly higher than that of power from fossil fuels. Nevertheless, the gap between the costs of producing electricity from solar and from conventional energies is expected to narrow. In the long term, both the reduction of the costs of solar technology and the increase of the costs of fossil fuel is expected to make solar electricity competitive with fossil fuels'. Whereas power from PV technologies is expected to be competitive with fossil fuel's before 2020, power from CSP technologies is expected to be competitive with fossil fuels's between 2020 and 2025. Cost reductions depend on each of the countries under analysis.

Subsidies are to play a significant role in the promotion of RE in the region. The discounted (cumulative) subsidy requirements to implement the identified RE projects in the MPC range from (in real 2010 terms) EUR 330 million (low scenario) to EUR 1.2 billion (high scenario).

Finally, the implementation of the identified RE projects in the region could save between 100 (low scenario) and 250 (high scenario) million tonnes of CO_2 by 2040.

3.2. INTRODUCTION

Different scenarios of investments in RE were simulated. For that purpose, a modelling was conducted under the following parameters:

- Levelised Energy Cost (LEC) [25] of RE technologies in each country and comparison with the conventional energy LEC over the period 2010-2020;

[25] Levelised Energy Cost (LEC, also called Levelised Cost of Energy or LCOE) is a cost of generating energy (usually electricity) from a particular system. It is an economic assessment of the cost of the energy-generating system, including all the costs over its lifetime: initial investment, operations and maintenance, cost of fuel, cost of capital. In this study, LEC is always quoted in EUR/MWh. LEC for RE technologies has been estimated taking a reference plant for each technology in each country for the calculation of the energy production. For the countries where the location of reference plants was not yet identified, the most solar irradiated area of the country has been considered. This assumption is based on the fact that the new RE plants will probably be installed in the area within the country where the RE source is largely available. More details on the actual calculations performed in the context of this study can be found in Appendix 4.

- Subsidies required to make economically viable the selected RE projects. The modelling took into account different implementation scenarios up to 2020 and the effects of their implementation up to 2040 (the estimated end of all projects' life);
- Avoided CO_2 emissions after the implementation of the selected RE projects during the period 2010-2040;

3.3. SCENARIOS

As described in details in Section 2.2 "Methodology for Projects' Assessment and Data Gathering", projects were assessed according to their level of preparation, and classified into three main categories:

- Feasibility Study Stage (FS);
- Prefeasibility Study Stage (PFS);
- Identification Stage (IS);

The modelling for the implementation of RE projects in the period 2010-2020 took into account a pessimistic (low) and an optimistic (high) scenario.

- Pessimistic Scenario (**Low**): 100% of projects at a FS stage + 50% of projects at a PFS stage are implemented;
- Optimistic Scenario (**High**): 100% of projects at a FS stage + 100% of project at a PFS + 100% of projects at an IS stage are implemented;

In order to estimate the feasibility of projects for which data was not available, different assumptions were established.

- Projects at a FS stage were assumed to be implemented in the period 2010-2014;
- Projects at PFS and IS stages were assumed to be implemented in the period 2015-2020;[26]

3.4. METHODOLOGY

The assessment was completed with information provided by the relevant stakeholders through personal interviews, phone conversations, and e-mail exchanges. For none of the listed projects was the relevant technical documentation (i.e. feasibility studies, land property documentations, equipment quotations, etc.) reviewed in detail. Therefore, the information on reference plants was mainly based on publicly available documents and additional assumptions from EIB's and the consultants.

Appendices 1 and 4 provide the formulas and assumptions used to calculate the cost of electricity production (LEC). As shown in Figure 3-1, common data by technology was assumed for all countries. In addition, country-specific data were used, via reference plants (Appendix 5) for which capacity factors were considered. Appendices 4 and 5 describe both types of data.

[26] The provisional period for the implementation of IS and PFS projects was estimated by distributing linearly the total installed capacity during the selected timeframe.

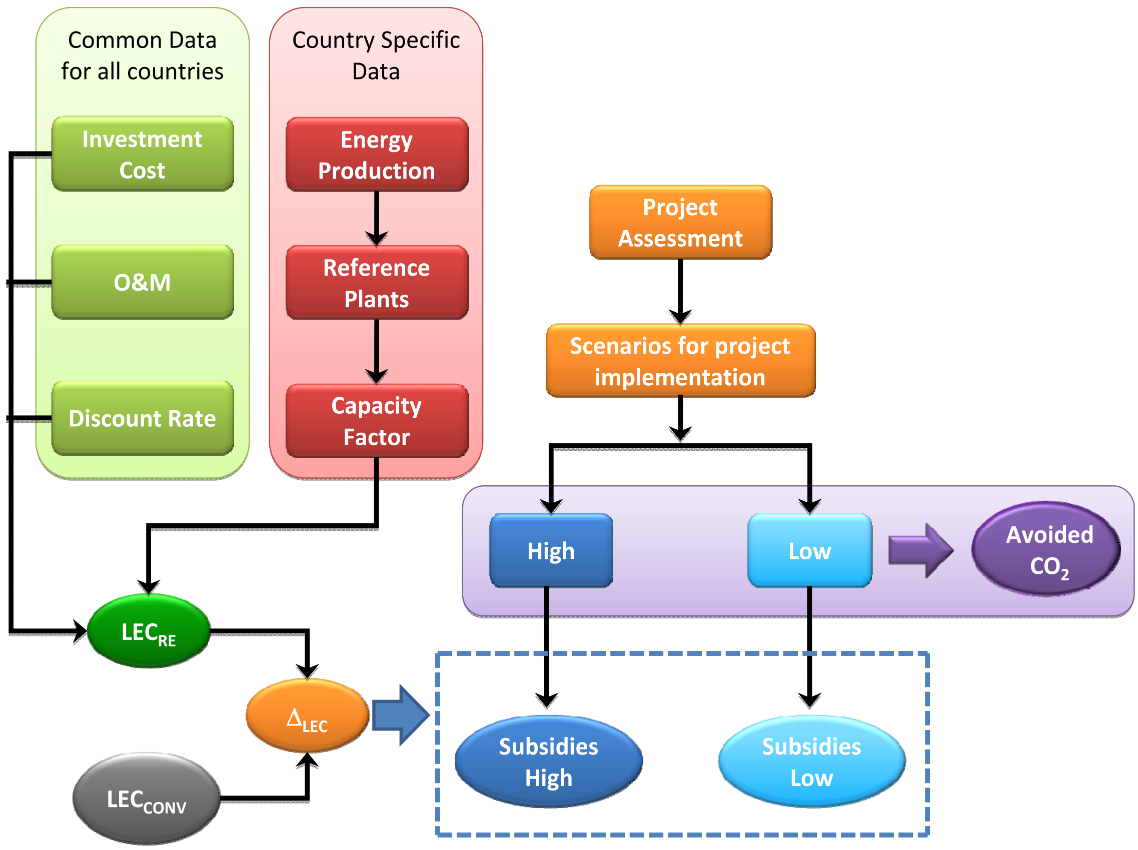

Figure 3-1: Overview of the methodology used for the modeling

Source: MWH elicitation

Unitary Investment costs [€/W] for RE technologies are expected to decrease in the next ten years. Decreasing investment costs by technology were assumed as shown in the assumption book (Appendix 3).

The cost of power production from fossil fuel plants was estimated by country as described in Appendix 4. Cost estimates have been based on assumptions regarding cost development for the various RE technologies and on alternative fossil fuel generation costs[27]. Concerning alternative fossil fuel generation, the main assumption was related to energy price scenarios, particularly natural gas and imported coal, based on the latest IEA baseline energy price scenarios. Lower gas prices have been considered in the gas exporting countries than for the gas importing countries, to reflect the difference in gas transportation costs. In addition, the cost of displaced energy is based on base-load generation costs for wind projects, whereas it uses mid-merit generation costs for solar projects.

The calculation of the economic cost of RE projects took into account the following parameters:

1. For each technology, the difference between the cost of electricity from renewable energy technologies and the cost of electricity from fossil fuels technologies (namely ΔLEC) was estimated for every year between 2010 and 2040;
2. The electricity generated by the identified RE projects was calculated by scenario;

[27] Calculation based on feasibility studies when available or using regional averages.

3. The subsidy was calculated as the product of ∆LEC (if the cost of electricity from renewable technologies is greater than the cost of electricity from fossil fuel technologies) and the generated electricity by year of implementation up to the plant's end of life.

Subsidies (or "economic cost") needed to implement selected RE projects by scenario were also calculated. Estimated subsidies correspond to the additional cost involved in replacing conventional energy with RE.

The avoided CO_2 emissions were estimated for each scenario using the CO_2 emission factors for electricity production by country, as reported in the assumption book (Appendix 3).

3.5. RESULTS

3.5.1. RE PROJECTS FOR THE PERIOD UP TO 2020

As shown in Figure 3-2: Additional RE capacity against MSP target, installed capacity in the most optimistic scenario (high) is low compared to the MSP target. However it does not include Turkey [28] It is also much lower than the estimated additional RE capacity to be deployed by 2020 (based on the national RE targets announced by the different countries). In order for the MPC to play a significant contribution to the MSP target, it will be necessary to accelerate the implementation of their programmes, with particular emphasis on the least mature projects identified in the study. If the region only reaches the goals envisaged in the low scenario, MPC will continue to play a very marginal role in the RE sector.

The implementation of the identified projects will increase significantly the RE electricity capacity in the MPC region (excluding hydropower[29]). Under the two considered scenarios, it will increase from 0.5% in 2008 to 3.3% (low scenario) and 8.9% (high scenario). Although this is a substantial increase, these percentages are significantly lower that the expected EU average by 2020 (around 25%).[30]

[28] The potential new RE capacity in Turkey for the period 2010-20 has been estimated by the EIB at about 20 GW. See Appendix 1.

[29] If current hydro capacity were included in the RE figures, the share of RE capacity would be close to 20%.

[30] Estimated from the Commission's working document SEC(2008) 2871 Volume I 13 11.2008. European Commission, Brussels. http://ec.europa.eu/energy/strategies/2008/doc/2008_11_ser2/strategic_energy_review_wd_future_position2.pdf [Accessed 06 May 2010].

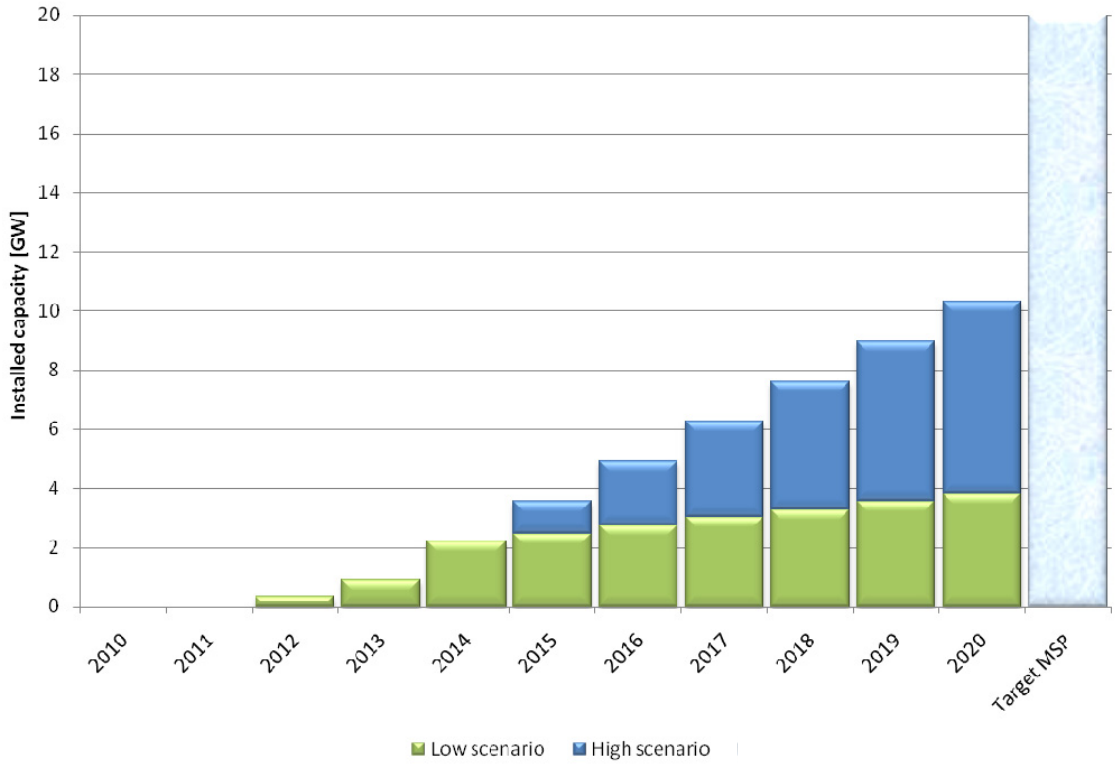

Figure 3-2: Additional RE capacity against MSP target

Source: MWH modelling results

Figure 3-3 shows the breakdown of additional installed capacity by scenario for all MPC in the period 2010-2020. In the most pessimistic (low) scenario, only a few solar projects are expected to be implemented by 2020.

The consideration of technology shares in RE projects allowed the identification of a consistent gap between high and low scenarios. The difference was particularly evident in the cases of Jordan, Morocco, and Israel, where various projects are at an early stage of preparation, in particular solar projects. On the contrary, in countries like Egypt and Syria, with a higher degree of RE project implementation, this gap is less significant.

Countries have focused on different technologies to promote RE. For instance, countries like Israel, Jordan, and Morocco have preferred to develop solar technologies. On the other hand, countries like Egypt expect to rely mainly on wind energy.

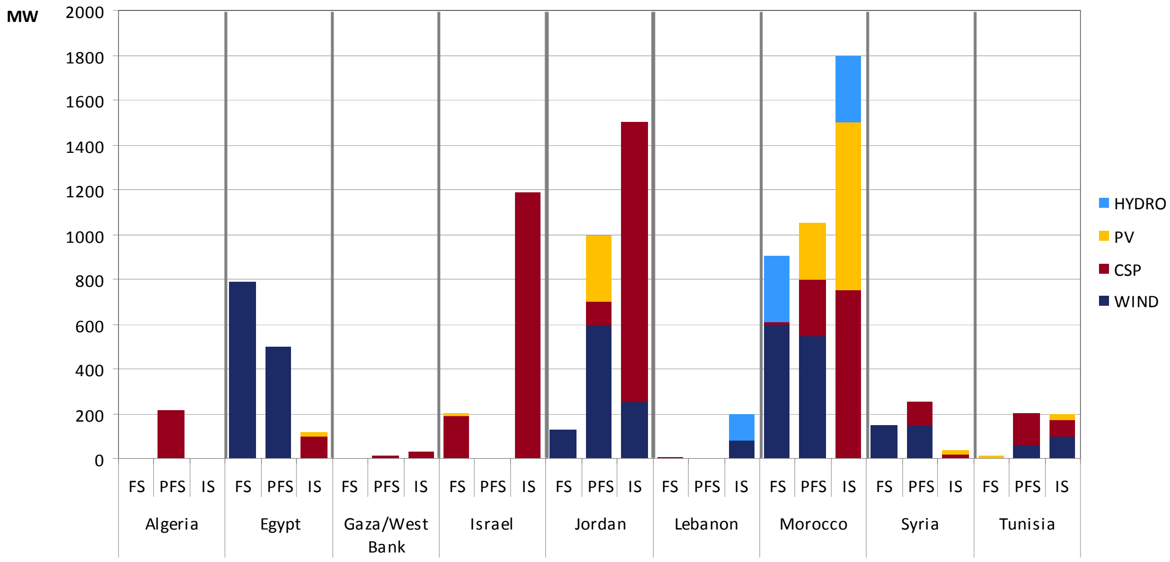

Figure 3-3: Additional RE installed capacity by scenario in 2020[31]

Source: MWH/EIB modelling results

3.5.2. Investment needs for new RE capacity identified

The evaluation of the investment needs depends on assumptions concerning expected cost development for the different technologies. The estimates of current investment cost used in the study are based on the EIB's experience in the region or elsewhere, notably in the EU Member States. The study assumes that cost will gradually decrease (slowly in the case of on-shore wind and faster for solar technologies[32]).

Under the low scenario investments needs amount to EUR 7 billion by 2020 in 2010 prices and in the high scenario over EUR 21 billion (Figure 3-4). A large share of investment needs relates to solar projects, in particular under the high scenario (36% in the low scenario and 69% in the high scenario). These investments are a small share of the total investments in electricity generation in the region (between EUR 120 and 140 billion for the same period[33]) in the low scenario, but may represent up to 18% of the total in the high scenario.

The investment cost of the projects in an advanced stage of preparation (2.2 GW) is about EUR 1.5 billion, but only three wind farms included in this group (about 600 MW) have a tentative financing plan in place.

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[31] In Morocco, the 2 GW solar plan does not identify which technology will be used between CSP and PV. In order to conduct the calculations, an intermediary case of 50% CSP and 50% PV was considered.

[32] Based mainly on EU studies carried out in the context of the different EU technological platforms.

[33] Based on World Energy Outlook 2009, IEA and Mediterranean Energy Perspectives 2008, OME.

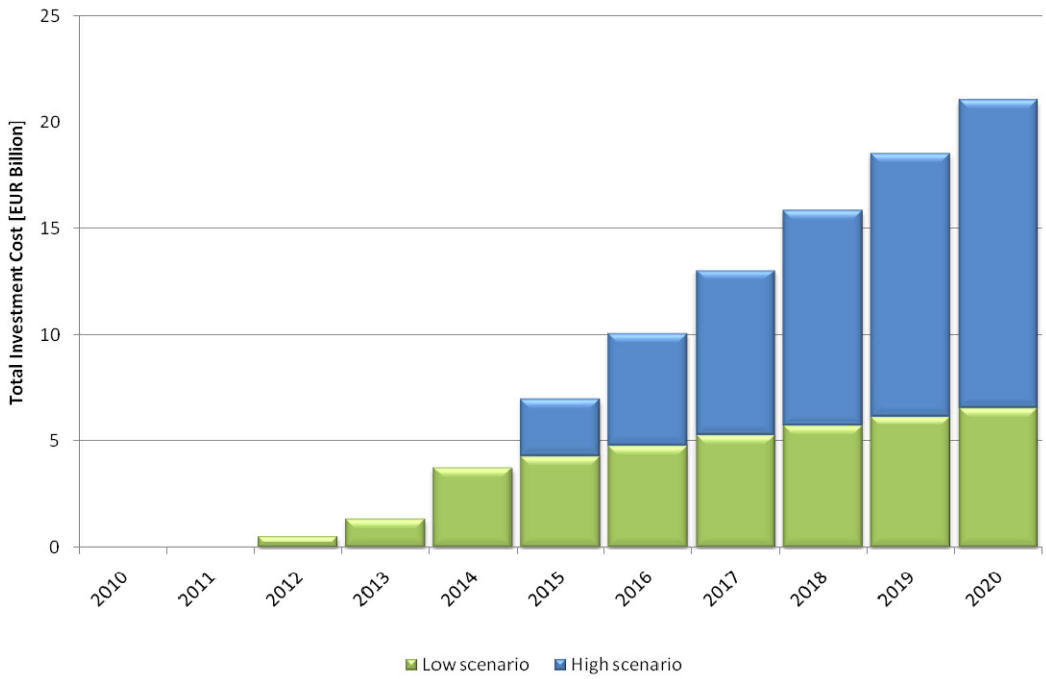

Figure 3-4: Cumulative investment needed for new overall RE capacity for the low and high scenarios

Source: MWH/EIB modelling results

3.5.3. COST OF RE PROJECTS IDENTIFIED BY COMPARISON TO CONVENTIONAL GENERATION

The study compares the cost of electricity generation in the projects identified with the cost of the alternative fossil fuel generation that will be replaced. On the basis of the hypotheses presented in Section 3.5.2 a LEC calculation was conducted for all countries.

The results of the regional LEC trend (Figure 3-5) show that the cost of electricity in the wind energy projects identified is similar to or slightly lower than the cost of the alternatives at present. Wind energy becomes very competitive in relation to the alternatives in 2020 (average wind costs around 39% less than base-load electricity for the region in 2020). In the case of solar technologies, the cost is currently substantially higher than the alternatives at present (68% more for PV and 108% more for CSP), but it is close to the alternatives in 2020 (18% lower in the case of PV and still 3% higher in the case of CSP). [34]

[34] When comparing PV and CSP, besides the LEC difference, there are two other important aspects to consider (they were not included in the model, for simplicity purposes). The first is variability. Although PV benefits from diffuse light while CSP does not, in countries where direct normal irradiance is important CSP can be made much less variable than PV and even dispatch-able. Less variability in CSP is explained by the influence of thermal storage and/or fuel back-up. The second aspect is even more important, and relates to load curves and time of use costs. In Algeria and Morocco, and possibly in other countries of the region, the peak demand is driven by lighting, and thus starts immediately after sunset. As a consequence, the possibility of storing the heat collected during day time and producing electricity also or only after sunset allows CSP to cover the peak demand with a small increase in LEC (if any, the cost of thermal storage might be entirely compensated by a smaller turbine, depending on the exact configuration). On the contrary, PV could only offer the same with very important electricity storage costs.

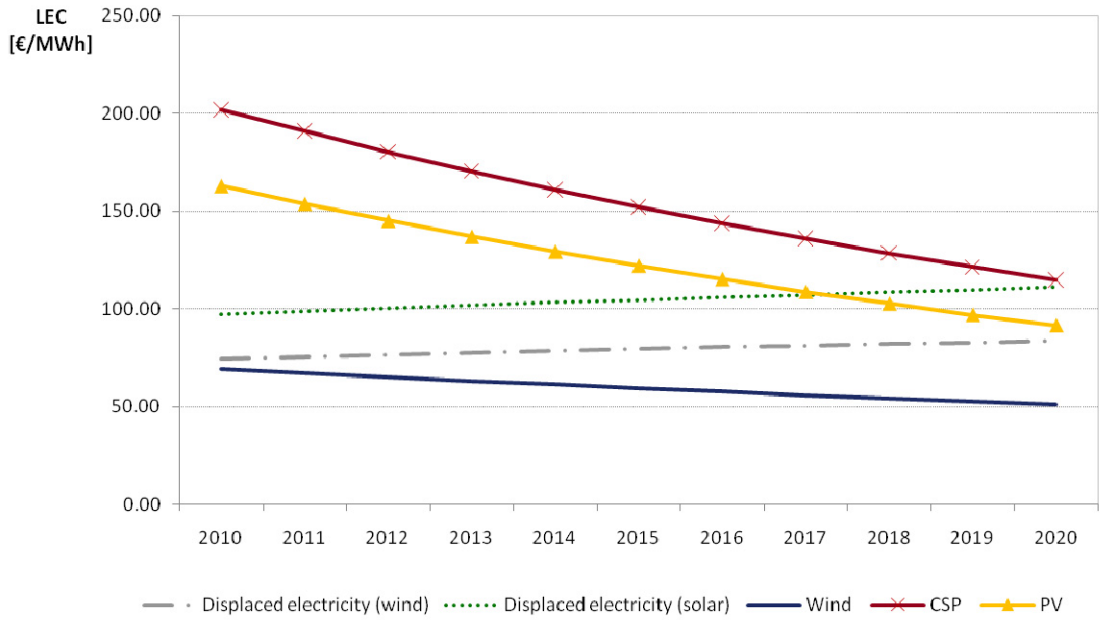

Figure 3-5: Regional LEC trend evolution for different technologies 2010-2020

Source: MWH modelling results

Since common data for all countries has been assumed for investment and operation and maintenance (O&M) costs by RE technology, the LEC value varies depending on the assumed reference plants' load factor (i.e. the greater the load factor, the lower the LEC).

3.5.4. SUBSIDIES

Wind energy appears already competitive in the region, while solar technologies – in particular CSP – require subsidies to be economically sustainable. The implementation of the solar projects identified will need subsidies to cover the difference between their cost and the cost of the fossil fuel alternatives for as long as they are more expensive than the alternatives. These subsidies are calculated, in net present value terms (at a 5% discount rate), at EUR 328 million in the low scenario and EUR 1.2 billion in the high scenario.

Table 3-1 summarises the total discounted subsidies (in real 2010 currency) required by scenario and by technology for the countries in the region. For the high scenario the level of subsidies needed up to 2040 is € 1.1 billion.

Table 3-1: Total discounted (2010) subsidies by scenario and country

Source: MWH modelling results

	CSP		PV	
	High Scenario [M€]	**Low Scenario [M€]**	**High scenario [M€]**	**Low scenario [M€]**
Algeria	108.4	54.2	0.0	0.0
Egypt	23.6	0.0	0.0	0.0
Gaza\West Bank	17.4	2.2	0.1	0.0
Israel	481.7	179.7	6.2	6.2
Jordan	216.4	8.0	2.7	1.4
Lebanon	5.0	5.0	0.0	0.0
Morocco	145.6	23.0	17.2	2.1
Syria	67.5	28.1	2.1	0.0
Tunisia	75.5	24.7	1.6	1.5
Total	1,141	325	30	11

As shown in the table, Israel is the country with the largest share of subsidies needed for RE in the region. High levels of subsidies in Israel are largely explained by the significant number of solar projects. In fact, subsidies in Israel represent 55 % of CSP and 56% of PV, respectively, of the total regional subsidies in the low scenario.

Algeria, Syria, and Tunisia follow Israel in terms of the degree of implementation of CSP projects (low scenario). On the contrary, Jordan and Morocco have a significant number of CSP projects at an early stage of preparation (high scenario).

Regarding solar PV projects, Morocco has the largest share of subsidies requirements in the high scenario. In fact, Morocco's 2 GW solar plan represents 34% of the identified solar projects in the region.

3.5.5. AVOIDED CO_2 EMISSIONS FROM THE IMPLEMENTATION OF IDENTIFIED RE PROJECTS

On the basis of the CO_2 emissions of the alternative fossil fuel generation that the projects replace, the identified projects are expected to yield significant reduction in CO_2 emissions. This reduction will reach 36-65 million tCO_2 by 2020 and 100-250 million tCO_2 by 2040, respectively in the low and high scenarios. (Figure 3-6),

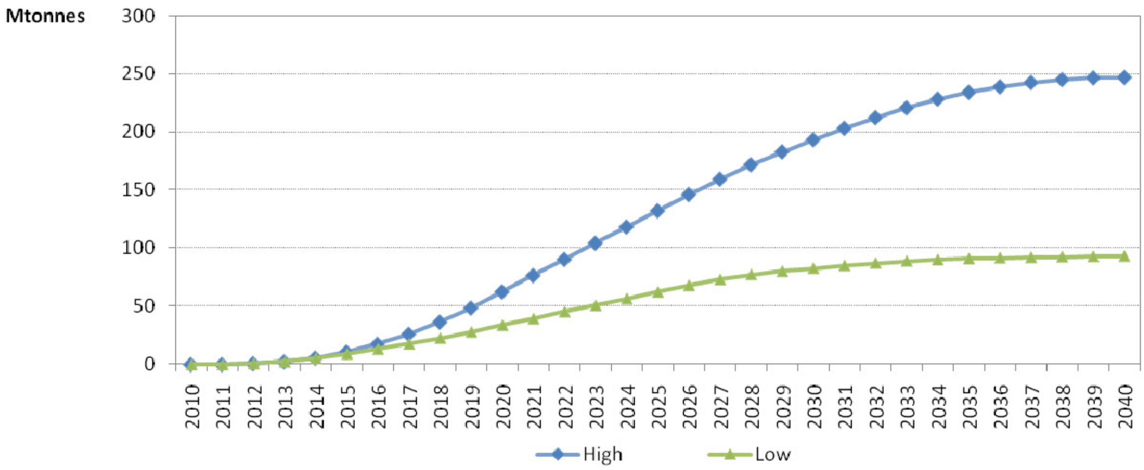

Figure 3-6: Avoided cumulative CO_2 emissions trend 2010-2040

Source: MWH modelling results

Emission factors in the region vary significantly among countries. For instance, Egypt and Tunisia benefit from a relatively low emission factor (0.47 and 0.48 tCO_2/MW, respectively) compared to Israel and Morocco (0.77 and 0.78 tCO_2/MW, respectively). Countries' differences are mainly explained by the share of hydropower production and natural gas in the energy mix. Countries with an important share of these sources benefit from lower emission factors.

As shown in Figure 3-7 and Figure 3-8[35], most of the avoided CO_2 emissions are saved in countries where emission factors are higher and which have the largest number of RE projects, i.e. in Morocco and Jordan. Lebanon registers the lowest emissions' savings (only 0.1 M tonnes).

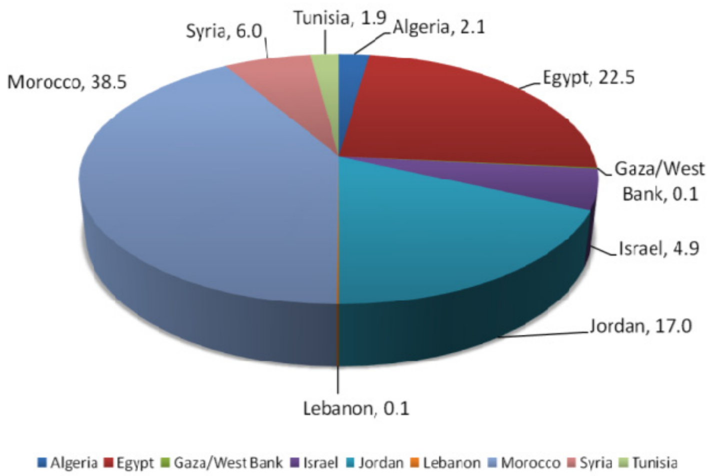

Figure 3-7: Avoided CO_2 emissions (M tonnes) by country [2040] in the low scenario

Source: MWH modelling results

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[35] It should be noted that those savings were estimated assuming a constant electricity emission factor. In fact, due to both the increase of green power and the improvement of power generation efficiency, emission factors could decrease significantly by 2040.

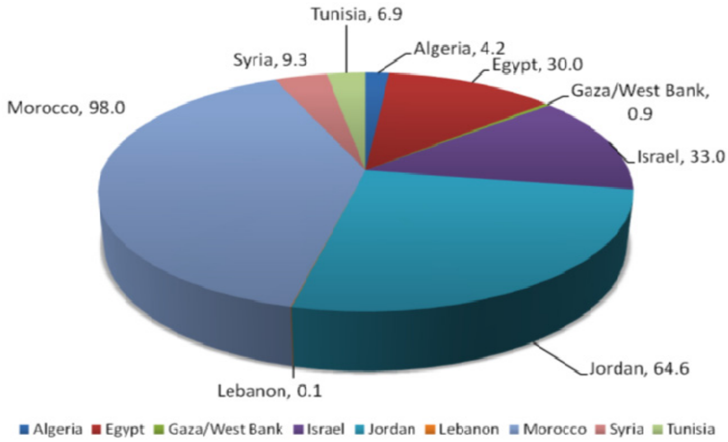

Figure 3-8: Avoided CO_2 emissions (M tonnes) by country [2040] in the high scenario

Source: MWH modelling results

4. REGIONAL CONSTRAINTS TO DEVELOP IDENTIFIED RE PROJECTS AND MEASURES TO OVERCOME THEM

4.1. SUMMARY

Both renewable and "clean" energy have become important items in the agenda of Mediterranean Partner Countries. Governments of the region recognize the positive contributions and impacts of renewable energy on the environment and the region's long term growth. Moreover, there is also an expectation that the development of RE could be a powerful engine of job creation and technological improvement. Among other initiatives, countries of the region have established targeted regulations and incentives, as well as renewable energy institutions to promote the use of clean technologies. Nonetheless, countries are still "learning by doing" in the implementation of RE projects.

Despite significant progress, RE projects in the region face important constraints for their full development. Identified key barriers for RE development are i) economic and financial, ii) organisational (institutional and regulatory), and iii) technical (related to electric grid capacity). The large scale implementation of RE projects is the biggest challenge for MPC countries.

The following paragraphs describe the three main constraints for RE development in the Southern and Eastern Mediterranean region:

- The main obstacle to the implementation of solar projects (CSP and PV) is financial and is related to the need of subsidies to make electricity generation from RE economically viable vis-a-vis electricity from conventional sources. If a significant part of the subsidies comes through RE power exports to the EU, there will be the need to expand the international electricity transmission capacity with the EU.
- The second most significant constraint is regulatory. The implementation of the identified RE projects will require technical assistance for project preparation as well as support for the adoption of appropriate regulatory frameworks. Moreover, such regulatory frameworks are critical for attracting investments in the RE sector.
- The third constraint is related to the regional electricity transmission networks. In order to increase the maximum RE capacity, MPC countries will need to reinforce their electricity transmission networks and adapt their grid codes.

4.2. CONSTRAINTS TO THE FULL IMPLEMENTATION OF IDENTIFIED RE PROJECTS

The next paragraphs identify and describe the main constraints to the full development of the identified RE projects in the region over the period 2010-2020.

4.2.1. ECONOMIC AND FINANCIAL CONSTRAINTS

Figure 4-1 illustrates the region's financial constraints for the implementation of RE projects. It compares countries' system average rates[36] (SAR) with the cost of producing RE power.

[36] The system average rate is the average selling price of electricity within each country.

4.2.1.1. Gap between power production cost from renewables and alternative (fossil) fuels

The main obstacle to all solar and some wind projects identified is the need for subsidies to cover the difference between the cost of generation from the RE plant and the cost of their fossil fuel alternatives. As illustrated by the modelling conducted in Chapter 3, the cost of producing RE power is often higher than conventional power costs. Solar energy is the most costly technology to develop, requiring subsidies to bridge the financial gap with conventional energy.

Although it is expected that the unit of solar investment cost will decrease overtime, the pace of the reduction cannot be known with certainty. Solar technologies show different evolutions. Whereas power from PV technologies is expected to be economically sustainable before 2020, CSP electricity cost could remain high over the whole period 2010-2020. CSP technologies, however, provide additional benefits (compared to PV) related (inter alia) to the possibility to store energy.

Oil and gas exporting countries (Algeria, Egypt, and Syria) show the widest financial gap between solar and conventional energies' power costs. On the other hand, wind power appears competitive with conventional energy in terms of power production costs. At a country level, wind energy is only competitive for net oil and gas importing nations; in exporting countries wind technology becomes competitive in the short and medium terms.

4.2.1.2. Fossil fuel subsidies

In addition for some countries which are major fossil fuel producers (e.g. Algeria and Egypt) subsidies on fossil energy in the Mediterranean region widen the financial gap for the RE projects. Fossil energy is significantly subsidized [11], which is reflected in power tariffs below cost (see Figure 4-1).[37] The System Average Rate (SAR) [38] for MPC has a range between 20€/MWh (Egypt) and 70€ /MWh (Israel), while average LECs for wind and both solar PV and CSP lie respectively at 69€/MWh, 163€/MWh and 202€/MWh. Subsidies widen the price gap between fossil and renewable electricity.

[37] Hydrocarbon producing countries (Algeria, Egypt, Syria) consider that the selling price of electricity reflects the effective cost of production (which is different than the opportunity cost), arguing that this is a way for their citizens to benefit from the income generated from the country's resources.

[38] The system average rate is the average selling price of electricity within each country. This is an interesting indicator to follow and compare to the economic cost of generating electricity, to see to which extent they are aligned (or otherwise).

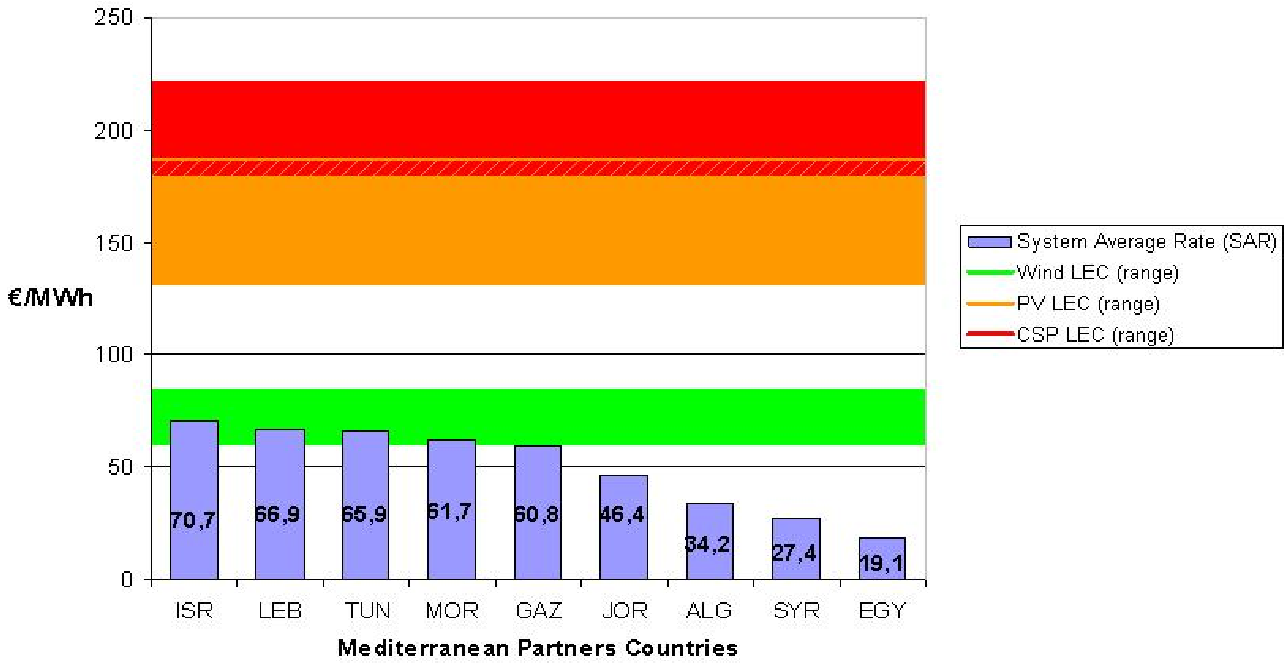

Figure 4-1 System Average Rates [39] vs LEC of RE in MPC (2008)[40]

Source: Adapted from [12] using modelling results

4.2.1.3. Lack of definition of modalities to export RE power to EU countries

No practical proposals using Article 9 of the RE directive have been identified, thereby limiting the proportion of the financing gap that could be filled through RE exports to Europe. This can be seen as a financial constraint in that it limits the amounts of RE which could be bought by EU countries with higher (feed-in) tariffs.

As shown by the modelling results, carbon credits can only cover a small fraction of the financing gap: around 20% in the low and 34% in the high scenarios, based on conservative assumptions on the price of these credits[41]. The rest has to be covered by subsidies from other countries, including in the context of exports of RE energy to the EU, on the basis of the Article 9 of the new EU directive on RE (2009/28/EC).

This would also imply the need to develop the electricity transmission capacity with EU countries, as the existing capacity is limited, and as for some countries there is currently no physical interconnection with Europe.

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[39] Please note that the represented SAR are 2008 figures, whereas PV LEC, CSP LEC and Wind LEC are 2010 figures.

[40] ISR = Israel, LEB = Lebanon, TUN = Tunisia, MOR = Maroc GAZA = Occupied Palestinian Territories, JOR = Jordan, ALG =Algeria, SYR= Syria, EGY = Egypt

[41] An indicative conservative price of 10 EUR/tCO_2 was used in this calculation.

4.2.2. ORGANIZATIONAL CONSTRAINTS

4.2.2.1. WEAK REGULATORY FRAMEWORKS

MPC currently suffer from weak regulatory frameworks, constituting a major obstacle to the development of RE projects identified. Regulation acquires especial importance in view of the increasing participation of private investment in RE. Even though the electric and gas sectors in MPC are still largely dominated by national monopolies, the recent years have experienced a gradual engagement of the private sector in the RE power generation sector.

The existence of good regulation is a major incentive to private investors as a well designed regulatory framework is supposed to take due account of both political and economic risks and recognize the financial viability of investments.

In addition, the implementation of RE laws through decrees is a slow process, affecting the full applicability of incentives and other RE development measures. MPC also show low levels of inter-sector coordination and communication, which slows down the promotion of projects and leads to duplication of efforts.

Experiences from certain EU Member States demonstrate the importance of such a regulatory framework for the development of RE technologies. They also show that, in the case of RE technologies, which are cost competitive with alternatives (such as on-shore wind in most of the countries), the regulation is not dependent on public budget availability.

4.2.2.2. LIMITED PROJECT PREPARATION EXPERIENCE

Limited experience with RE and missing background information (e.g. on actual RE resources) can block the development of some project proposals. During the investigation undertaken for this study, the need was noted in some cases to develop the background information for the development of RE energy projects, for example wind and solar resource measurements or potential locations. However, these issues were not specifically covered by this study. In addition, support for the development of specific projects and regulations (general studies, feasibility studies, etc.) seems to be needed for many projects, considering the limited experience in developing such projects, notably solar projects.

4.2.3. TECHNICAL AND PHYSICAL CONSTRAINTS

4.2.3.1. GRID ACCESS AND CAPACITY ISSUES

Access to the grid and available grid capacity for RE projects is not a pressing constraint but it has the potential to affect the implementation of projects in the medium to long terms. When RE project proposals have been carefully defined, as is the case with the majority of the identified projects in the countries, the consideration of access to the grid and grid's availability for absorbing RE power have been already integrated in the project location and its structuring. Therefore, in the short to medium term these considerations are not identified as strong constraints to RE deployment. In the future, however, it is possible that more attractive project locations are in desert areas or other remote place with high RE resources. The

significant distance between these areas and the grid could then be a limit to the implementation of these projects[42]; they could also require the installation of a suitable network.

4.2.3.2. Concerns on RE impact on electricity network capacity

There is anecdotal evidence in some countries of obstacles to developing RE, even if they are competitive. This is often related to limited policy support and limited experience with RE, notably concerns regarding their impact on the stability of electricity networks. The most common reason mentioned by the countries' institutions for the limited development of RE energy is the variable nature of its power output, stemming from the intermittency of the RE resources. In this context some MPC are currently assessing whether there is an optimum and / or maximum penetration level for renewable energy on their grids. The European experience could provide MPC with different practices on the assessment of appropriate levels of RE (notably wind) penetration [13][43] more specifically, the European experience seems to suggest that a wind penetration level of up to 25% has sustainable[44] integration costs [14] [45]

4.2.3.3. Limited generating capacity and synchronization

Mediterranean electrical systems lack surplus in generating capacity and synchronisation to enable exchanges. In the 2010-2020 period, however, there is no evidence that this limits the possibility of secure power back up from neighbouring countries required and develop RE projects. The public authorities interviewed by the consultants noted that the development of the planned RE energy projects will require a reinforcement of the countries' electricity grids. In addition, the reinforcement of the interconnections among the countries of the region can also contribute to a certain extent to the integration of more RE capacity in the national systems. At present, actual power trade taking place in the region is characterized by cross-border electricity transactions limited to small volumes and mainly taking place under short-term power exchanges regime, based on daily or seasonal load variation or significant equipment outages.

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[42] In fact on a similar note, other environmental & physical factors (besides issues of grid connection) linked to project siting could be issues for the future projects, in the case where the most attractive RE resources are located in remote or difficult locations. Another notable example is water availability, which for some technologies could be a constraint to the development of projects.

[43] In Western Denmark supply area, wind energy covers approximately 25% of electricity demand in a normal wind year and it is not a technical constraint to handle more (as it is perceived by some MPC countries), it is rather a regulatory constraint. The grid operation models and procedures for managing more wind power in the system are developed and grid operators should be enabled to use them. Also, the experience of Spain, Denmark and Germany that have large amount of wind power in their power system shows that the existence of an upper limit for RE penetration into the existing grids is likely to be an economic and regulatory issue rather than a technical one.

[44] The use of the word "sustainable" in this context refers to the fact that the level of capacity from wind is reliable, and thus can be integrated within the economic dispatching of the whole electric system. Previously utilities had to secure a back up from conventional sources to mitigate the potential failure of a wind power plant.

[45] The actual economic impacts and integration determinants are very much dependent on the power system considered. In particular, they depend on the structure of the fuel generation mix, its flexibility, the demand pattern, and the power market mechanisms. They also depend on the organisational aspects of the power system and the strength of the grid.

4.3. COUNTRIES' STRATEGIES

The following paragraphs describe the main strategies already adopted by MPC in their efforts to address obstacles to RE development.

4.3.1. STRATEGIES TO ADDRESS FINANCIAL AND ECONOMIC CONSTRAINTS

4.3.1.1. CONCESSIONAL FUNDS

Concessional funding has played a key role in the promotion of RE projects in MPC. Its main contribution to the development of RE is the reduction of costs of renewable vis-a-vis conventional energy. After some successful use of these funds in wind projects (which made wind competitive with conventional energy), governments of the region expect concessional funding to have a similar impact on solar initiatives.

For their solar projects, MPC are currently requesting bidders to include a concessional funding in their proposals. This is the case in Syria and Tunisia. In Morocco as well, the government has recently requested bidders to include concessional funding in the call for expression of interests to complete the 500 MW project in Ouarzazate.[46]

The international community also relies on different financial mechanisms or facilities to encourage RE. One example is the European Union's Neighbourhood Investment Facility (NIF). Through European Financial institutions, the NIF provides financial support for RE projects in MPC. Normally, NIF support to RE projects helps leverage additional funding, including concessional types.[47] Another example is the World Bank's Clean Technology Fund (CTF). The CTF provides co-financing to major projects in the Middle East and North Africa region (MENA).[48] These various financial mechanisms help RE projects to mobilize additional resources from other sources. For example, in June 2009, EIB, AFD, and KfW launched the MSP Cooperation Mechanism. They have earmarked EUR 5,000 million to promote and develop RE and EE projects for the next five years starting in 2010.

4.3.1.2. LOCAL RE INDUSTRIES

A larger number of local RE equipment manufacturers could increase production and bring innovation, expanding RE technologies and reducing their cost in the long term. The region presents interesting examples of local RE entrepreneurs. For instance, El Sewedy's factories in Egypt started manufacturing components of wind farms such as wind towers, rotor blades, and the electrical components required to connect to the grid. In Syria, a local PV panel factory has recently started production with a potential of 15 MW/yr.

[46] Ouarzazate is Morocco's most advanced solar project. MASEN aims to have it fully implemented by 2015.

[47] The European Commission has earmarked a total amount of € 700 million for the NIF, which have been complemented with € 54 million from direct contributions of Member States. Total investment costs of NIF-projects amount to more than € 9,000 million, including more than € 1,400 billion in the energy sector of MPC. The 500 MW CSP project in Ouarzazate is in the NIF-pipeline.

[48] The World Bank Clean Technology Fund Investment Plan proposes co-financings of US$ 750 million. This co-financing is expected to mobilize an additional US$ 4,085 million from other sources. CTF has recently invested in the expansion of CSP programmes in Algeria, Egypt, Jordan, Morocco and Tunisia.

4.3.2. STRATEGIES TO ADDRESS ORGANIZATIONAL CONSTRAINTS

4.3.2.1. ENCOURAGEMENT OF PRIVATE SECTOR INVOLVEMENT

The region has encouraged private sector participation in the generation of electricity through three main avenues: (i) for self consumption with possibility of selling the power in excess to the utility; (ii) as an IPP for selling electricity to the single buyer; (iii) as a private generation for export.

Morocco and Tunisia are examples of the first approach. They have developed detailed regulation promoting power generation from RE by major electricity consumers (i.e. EnergiPro in Morocco and self-generation programme in Tunisia). Third party access and wheeling charges are included within this framework. Even though generation for self consumption is a good strategy to engage the private sector in RE development, this approach limits what a private producer can generate beyond his own use.

Almost all countries of the region have allowed the development of IPPs. Through this scheme, the generated electricity is sold to a single buyer, the national utility, with a tariff defined in a negotiated PPA. Wind energy producers could take particular advantage of this approach. In fact, wind energy is becoming progressively competitive with conventional energy and private promoters could enter the sector as far as their selling price is compatible with the avoided cost of power generation from conventional sources. There are, however, major difficulties for the private sector to agree on a “fair” price to be paid by (in most cases) local utilities for their green electricity.

The third avenue to promote private participation is to allow the exports of power from RE sources. Morocco has gone beyond the rest of the countries, developing specific legislation. Through the ELMED project, Tunisia is considering power exports of 300 MW.

4.3.2.2. LEARNING BY DOING IN CONCRETE RE DEPLOYMENTS

The implementation of RE projects has allowed the identification of different good practices. Egypt and Morocco, and to a lesser extent Tunisia, are usually mentioned as good regional examples of wind energy development.

Contrary to wind development, solar technology is at its first steps in the region. Countries like Egypt and Morocco have installed, respectively, 312 MW and 116 MW of wind capacity and only 20 MW through CSP pilot projects. The choice of the most appropriate CSP technology (parabolic trough, solar tower, fresnel, dish-stirling) and size is still under evaluation in most cases. Notable solar projects being currently prepared include Morocco’s 500 MW Ouarzazate Solar plant. In Tunisia, a 2 MW PV plant is under construction.[49] An additional 13 MW is expected to be installed by STEG in residential and public buildings. Finally, in Jordan private investors are exploring the construction of a 100 MW (PV) plant in Sham Ma’an.

Integrated Solar and Combined Cycle (ISCC) plants are also being developed in the region. In Algeria, the first ISCC plant (150 MW total) is currently under construction at Hassi R’mel, with its 25 MW solar component expected to be commissioned by the end of 2010. This project will give valuable experience to Algerian authorities in the development, construction, and operation of an

[49] The project is being promoted by STEG and ANME (public) for the residential sector.

ISCC [2]. In Egypt, the first ISCC plant (140 MW total) is currently under construction at Kuraymat (South Cairo), with its 20 MW solar component also expected to be commissioned by the end of 2010. In Morocco, the first pilot ISCC plant (140 MW, with 20 MW solar CSP) was commissioned in May 2010 in Aïn Béni-Mathar.

4.3.2.3. EURO-MEDITERRANEAN COLLABORATION EFFORTS SURROUNDING RE

There are several initiatives at the regional level aimed at developing expertise in RE. Even though they constitute a positive sign, they remain limited when compared to the challenges the region is facing. [18]

In the context of the European Neighbourhood Policy and the EuroMed Energy Cooperation initiative, the European Commission has promoted different regional initiatives in the Mediterranean region.

There are currently four main regional initiatives supported by the EU [50]. The Euro Mediterranean Energy Market Integration Project (MED-EMIP) was created as the catalyst for EU-Mediterranean energy cooperation. The initiative emphasizes energy security and sustainability through enhanced dialogue and information exchange. Also supported by the EU, MEDREG is a network of energy regulators from 20 Mediterranean countries. The third initiative is MEDENER. Created in 1997, MEDENER is a network of twelve national energy agencies from both shores of the Mediterranean. It is aimed at exchanging information, experiences, and know-how among members; designing EE and RE working projects and their submission to national and/or international authorities; developing partnerships with regional and international organizations; representing member agencies in international forums. Finally, MEDREP is the Mediterranean Programme for RE. Launched by the Italian bilateral aid agency in 2002, it promotes a favourable context for the RE market. Institutions such as the OME, the International Energy Agency (IEA), UNEP, and the World Bank are partners in this initiative.

4.3.2.4. IMPROVEMENT OF THE INSTITUTIONAL SETUP

MPC have taken important steps to improve the institutional and regulatory frameworks for the development of RE. Almost all countries have created dedicated agencies for promoting renewable energy. A noticeable example is Morocco's MASEN which is actively engaged in the development of large size solar projects (from 500 to 2,000 MW). Some countries, most notably Algeria, Morocco, and Jordan, have passed comprehensive renewable energy laws. Tunisia decided to regulate the RE sector on a case by case basis (i.e. self RE generation for the local market with possibility of selling the excess to the utility up to a fixed amount). Countries like Algeria, Egypt, Israel, and Jordan went beyond the rest of the region and are establishing energy regulators.

4.3.3. STRATEGIES TO ADDRESS TECHNICAL CONSTRAINTS

4.3.3.1. REGIONAL INTERCONNECTIONS AND SYNCHRONIZATION EFFORTS

There are different examples of interconnection and synchronization initiatives in the Mediterranean region. At present, around 400-500 kV connect the national power systems of

[50] These do not include the latest initiative of the European Commission called "Paving the Way", which was officially launched on 6 October 2010 in Brussels.

Egypt, Iraq, Jordan, Lebanon, Libya, Syria, Turkey, and Iran (ELJIST). Moreover, a regional power network in a synchronized regime with the European Network of Transmission System Operators for Electricity (ENTSO-E) exists between the EU and North African countries. There is also a regional power network linking eight countries of the Mashreq region. The interconnection capacity between Libya and Tunisia is being currently tested.

4.3.3.2. Current interconnection capacity and plans with Europe

Interconnection with Europe is relatively modest and the prospects for further developments are uncertain [17]. There is currently only one interconnection between Morocco and Spain (2 x 700 MW). An additional 700 MW capacity for this interconnection is being assessed, however the project is at a conceptual stage and it is unlikely to be completed before 2016. Future, although not yet defined, interconnections include 1,000 MW between Italy and Tunisia,[51] and 1,000 MW between Syria and Turkey (functional). Other projects, with no estimated timeline for implementation, include 1,000 MW between Algeria and Italy, 2,000 MW between Algeria and Spain, and 1,000 MW between Libya and Italy.

4.4. Additional measures to overcome identified constraints

4.4.1. Additional measures to overcome economic and financial constraints

Providing financial support for the development of RE until these energies become competitive, is a way of accelerating expected cost reductions (e.g. in the case of solar[52]) and anticipating future benefits. Nevertheless, the provision of subsidies or feed-in tariffs to promote RE is currently not an option for many MPC. Financial resources, either from the State or the utility, are already scarce. Both the government and electricity utilities are facing increasing pressure from a rapid growth of electricity demand and below the cost's tariffs. Anticipating cost reduction in RE is also a way of supporting local manufacturers. Producers of RE technologies are mainly located in Europe and USA. The deployment of RE could promote new industries and business in the region (for example, wind technology in Egypt). The following paragraphs identify suggested interventions to reduce the gap of power production costs between conventional and renewable energy.

4.4.1.1. Bridging the gap by finding a mix between countries' resources and others

Determining who will pay for anticipating the reduction of costs in RE is the most critical challenge. In the short and medium terms, it could be argued that manufacturer's countries of RE technology should contribute to bridging this gap. In the long term, when costs of power production using solar equipment are supposed to become closer to conventional energy's, the promotion of RE could be a responsibility of MPC.

A middle ground for both approaches could be technology exchange and energy development agreements between MPC and European countries. Through these schemes, MPC would grant tax and import duty credit to European producers, when a minimum share of the equipment's

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[51] Scheduled for 2016, with only 300 MW available for RE exports.

[52] As it was the case for wind, solar energy equipments manufacturing could benefit from economies of scale and technology evolution, which will bring the costs down if higher demand is manifested.

parts is produced locally, while European countries could provide feed-in tariffs for RE to be imported to Europe.

4.4.1.2. Promoting the deployment of RE projects through existing funds

A second measure could involve the use of existing mechanisms such as FEMIP Trust Fund and the Neighbourhood Investment Facility, which could facilitate the development of RE and EE projects through the use of voluntary resources. Given limited resources, priority should be given to:

a) Technical assistance for project identification and design, development of capacity building, and promotion of planning tools as well as design of institutional measures;

b) Direct financial support through equity and guarantees, which could mobilise additional funding by the private sector and institutional investors. Given the magnitude of the financing gap, subsidies to interest rates might not be an efficient use of trust funds;

c) Promotional activities to disseminate the experience of pilot RE and EE projects as well as best practices across the region.

4.4.1.3. Making use of Article 9 of the EU Renewable Energy Directive

This option would allow the further development of RE through the export upgrade of MPC. A major access to the EU energy market would drive investments and technology towards RE, increasing efficiency and reducing costs. Despite this option's potential, MPC face different constraints to its implementation (see section 4.2.1 on economic and financial constraints). In particular, accession modalities have not been yet defined, and actual RE power purchase proposals have not yet been formulated.

4.4.1.4. Financial harmonization among International Financial Institutions

As highlighted earlier in the text (cf. section 4.3.1on strategies to address financial and economic constraints), European multilateral and bilateral financial institutions are already involved in the financing of RE projects in the region. The magnitude of the cost envisaged for implementing RE projects until now has already required the bundling of funds in order to support concrete project implementation. Given the scale of the envisaged RE programmes, more co-financing and co-operation will be needed. In this context, an institution like the Barcelona Secretariat of the Union for the Mediterranean could play a coordination role for the various financial institutions. Moreover, it could help to attract additional investment to finance RE projects in the region.

4.4.2. Additional measures to overcome organizational constraints

4.4.2.1. Promotion of a fair and transparent institutional set up for RE

The implementation of the identified project proposals will require Technical Assistance for project preparation as well as support for the adoption of the appropriate regulatory frameworks. Moreover, regulatory frameworks are critical for attracting investments in the RE sector. An effective institutional framework needs clear and stable "rules of the game" to achieve an optimum use of national resources by both public and private sectors. In order to be effective, institutional measures are to be integrated into a comprehensive energy policy including not only legal but also economic and financial considerations. The following paragraphs identify critical aspects of an institutional setup for RE:

- Investment rules for private operators in natural gas projects could be considered for RE projects targeting exports. Available options include concession rules defining the shares of local and foreign participation in total investment and output and a levy on profits to provide governments with additional resources;
- In order to guarantee a reasonable rate of return, large scale RE generation projects should be protected from macroeconomic and political risks. For that purpose, a set of risk mitigation measures should be introduced in concession contracts and regulatory policies. In exchange, investors should not expect extraordinary but reasonable long term profits;
- In small and medium scale RE projects, producers should be given the option of negotiating their tariffs directly with consumers and granted third party access to the grid. This option applies to projects developed by major consumers or by private investors to satisfy major consumers' needs;
- The establishment of an independent regulator could reduce political discretion, helping to secure investments in RE projects;
- Primary energy prices and electricity tariffs should (as much as possible) reflect projects' costs and profits. Prices should be, ideally, updated in a gradual manner;
- The sustainable development of a regional power market would require the establishment of objective technical, economic, and financial procedures;
- The development of local manufacturing of RE equipments would need clear legal, economic, and financial measures to expand and develop.

4.4.2.2. Strategic government support and capacity building to support local RE industries

Government support is critical for the development and upgrade of local RE manufacturers. The local industry should be given opportunities to take part in infrastructure and resource based projects and asset acquisitions where those are globally competitive. The successful development of local initiatives could help in the medium and long term to reduce the costs of RE technologies. Moreover, it would allow the growth of local skilled technicians in the RE field.

The promotion of local industries should be conducted in a participatory manner, engaging project proponents, local manufacturers, and key service providers. A critical aspect of government support is the provision of capacity building opportunities for local enterprises. Capacity building programmes should be particularly focused on the needs of the local industry.

The purpose of capacity building could be to promote and exchange best practices. The programmes could focus on the following components: (i) workshops to exchange practices on institutional effectiveness and regulatory compliance and (ii) study tours and workshops aimed at analysing the experiences of existing CSP/PV plants (e.g. in the USA, Spain, Germany) and the MPC region.

In addition, a series of studies could be conducted to assess the development of the RE manufacturing industry. There already local industries producing parts for RE projects. For instance, there are factories producing parts of wind mills in Egypt and Morocco. Exploring the feasibility of regional manufacturing hubs in partnership with European governments in wind or solar technology could be another useful subject of analysis.

4.4.3. Additional measures to overcome technical constraints

4.4.3.1. Reinforcement of electricity transmission networks

In order to increase their systems' maximum RE capacity, MPC countries will need to reinforce their electricity transmission networks and adapt their grid codes. In addition, if a significant part of the electricity produced by RE project proposals rely on subsidies from exports to the EU, there will be the need to expand the international electricity transmission capacity with the EU.

In addition, in the medium to long terms the closure of the MEDRING could be considered as a key technological option to increase regional power trade. Whether it is done in AC mode [53] or using HVDC devices is still being discussed. Nevertheless complex economics and dynamic problems call for a complete appraisal before closing the ring with the installation of HVDC devices across selected cut-sets/borders.

4.4.3.2. Provision of capacity building on technical aspects

At the national level, alleviating the perception that RE are constrained by grid availability and capacity could be carried out via a targeted capacity building programme. Some of the programme components could include:

- System operation and methods of integrating RE power into the global power system, taking into account the generation capacity mix, the interconnection level to neighbouring systems, and load variations;
- Development of accurate methods for short term forecasting of wind and solar power;
- Presentation of new technologies of wind farms which can function as (virtual) power plants with the capability of delivering a range of grid supporting services such as frequency and voltage control;
- Preparation of adapted technical requirements for grid codes; and
- Conducting of dynamic system studies integrating improved connection practices of RE power.

In addition capacity building activities could be complemented by studies on the development of cross-border transmission and trade. Power integration in the Mediterranean region is a potential avenue to transform wind and solar technologies into large scale industries. The deployment of wind and solar energy can also benefit from complementarities among the countries of the region in terms of load curve patterns and overall energy generation mix.

[53] Focusing on AC mode could be considerably difficult to implement, requiring sophisticated defence plans. Moreover, it may not significantly increase the Net Transfer Capacities, which could reach in the best scenario 400 MW at 400/500 kV. [19] In addition, synchronization may not necessarily address the dynamic problem.

5. CONCLUSIONS

Progressively, MPC are accelerating the development and use of renewable energy. These efforts are consistent not only with an increasing regional awareness about conventional energy scarcity and global environmental challenges but also with the decisive support of the international community to RE development in the region. In fact, the announcement of the MSP and its target of 20 GW additional RE capacity by 2020 has triggered the interest of both public and private sectors in the development of clean technologies.

This is illustrated notably in the ambitious national RE targets set by the Mediterranean Partner Countries. Were planned targets met, the region could reach 26.1 GW of additional RE capacity by 2020, fulfilling the MSP objective of 20 GW by 2020. However at present, actual projects identified in the national pipelines represent a total capacity of 10.3 GW only. The difference between the national targets and the current pipeline underlines the fact that Mediterranean Partner Countries are fully aware of the region’s huge potential with regards to RE deployment, although the means to achieve national objectives are not yet in place.

The study has identified approximately 90 projects in the Mediterranean Partner Countries. Out of the identified 10.3 GW project pipeline, 21 % of project proposals are at feasibility stage, 31 % at a pre-feasibility stage, 46 % at an identification stage, and 2 % are under construction.

The investments needed to implement the projects identified are significant, with the lion share for solar projects. However, these investments represent only a modest part of the investment needs in power generation that the region will require in the coming years.

Most of the more mature project proposals are onshore wind (1.7 GW), which have an electricity generation cost generally similar to or lower than base-load electricity. Additionally, up to 2.3 GW of onshore wind projects have been identified up to 2020. Nevertheless the current penetration rate of wind power is limited. The adoption of more advanced tools for system and grid design and operation, better interconnections with neighbouring countries, and favourable pricing and regulation measures could improve wind power development.

On the contrary, the cost of electricity in solar projects is substantially higher today than the fossil fuel alternatives (88 % higher on average), but their cost is expected to decrease considerably and be close to the alternatives by 2020. The main constraint for a larger deployment of solar energy in the region remains financial. Until solar technologies become competitive with conventional energy, subsidies will be needed to cover the financial gap between the cost of generating electricity from solar plants and the cost of generating electricity from fossil fuel sources. Financial sources to cover subsidies could be carbon credits, concessional funds, and even some (European) feed-in tariff resulting from the application of Article 9 of the EU RE Directive. Moreover, the development of such projects will require Technical Assistance (TA) for project preparation as well as support for the adoption of appropriate regulatory frameworks. Such regulatory frameworks are indispensable also for attracting investments in the RE sector in the region.

The reinforcement of countries power networks, some regional interconnections and the export of electricity from RE sources to Europe could also have a positive impact on the expansion of renewable energies. Mediterranean Partner Countries will need to reinforce their electricity transmission networks as well as adapting their grid codes, in order to increase the maximum RE capacity acceptable in their systems. In addition if a significant part of the subsidies comes through electricity exports to the EU, this will imply a need to expand the international electricity transmission capacity with the EU. Policy-makers and operators would also benefit from capacity building programmes.

PART II – COUNTRY ANALYSIS

6. ALGERIA

6.1. OVERALL PRESENTATION OF THE ENERGY SECTOR

6.1.1. OUTLOOK OF ENERGY SUPPLY, RENEWABLE ENERGY'S SHARE, AND COUNTRY'S TARGETS

Algeria's total installed power capacity and electricity generation are, respectively, 8,502 MW and 40,000 GWh (2008). In this gas rich country, gas is both the primary energy source of electricity generation and one of the country's export commodities. Hydro-power is the only renewable energy in the country, deploying 230 MW of installed capacity. [1]

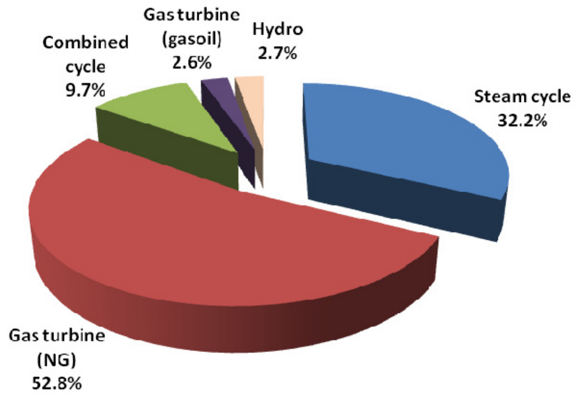

Figure 6-1: Energy source share of installed electricity capacity in Algeria

Source: [1]

Algeria aims to reach 5 % of RE installed capacity by 2017 (750 MW) and 20% by 2030. In order to reach these targets, it is estimated that by 2020 the additional RE installed capacity should be around 1,000 MW. Once targets are achieved, RE sources in Algeria are expected to have the following share: 70 % of concentrating solar power, 20 % of photovoltaic, and 10 % of wind [2].

The first Integrated Solar and Combined Cycle (ISCC) plant (150 MW) is currently under construction at Hassi R'mel, and has a 25 MW CSP component. This initiative is expected to provide Algeria with valuable experiences in the development, construction, and operation of an ISCC plant [2].

6.1.2. STAKEHOLDERS DEALING WITH RENEWABLE ENERGY

The following paragraphs identify the country's major stakeholders and describe their main responsibilities in the RE field.

- Ministry of Energy and Mining (MEM): it is in charge of formulating the country's RE policy and the design of the regulatory frameworks. It also designs RE promotion tools;

- New Energy Algeria (NEAL): it is the country's renewable energy agency. The agency is in charge of encouraging the domestic production, use, and export of renewable energy. It was established by both the Algerian government and Algeria's national energy companies. [20];
- Algerian Electricity and Gas Corporation (SONELGAZ): it is the provider of electricity and gas in Algeria. Its main responsibilities are the production, transportation, and distribution of electricity and the transportation and distribution of gas; [21]
- Algerian Research, Production, Transportation, Processing and Trade of Hydrocarbons Corporation (SONATRACH): it is the largest oil supplier in Algeria and Africa. The company is involved in the exploration, production, pipeline transportation, processing, and retailing of hydrocarbons and their derivatives [22]. It is also one of the shareholders of the Algerian Energy Corporation. Together with SONELGAS, it is co-financing Hassi R'mel CSP project;
- Algerian Energy Corporation (AEC): created by Sonatrach and Sonelgaz, it is involved in the development of projects in the following areas: production of electrical energy; energy transport; sea water desalination [23].

6.1.3. RE LEGISLATION

A law was passed in 2004, establishing an ambitious programme for the promotion of renewable energies in electricity generation. The programme establishes a support fund and a renewable energy institute (Institute of Applied Energy -IAE-) [24]. The law was further complemented by Executive Decree 07-293 issued in 2007 [25][54], which included third party access to the electricity and gas transmission and distribution grids. It also defined connection modalities.

6.2. RE PROJECTS' ASSESSMENT

6.2.1. IDENTIFIED RE PROJECTS

The following table summarizes the current RE projects in Algeria:[55]

[54] The Decree was issued on September 26th 2007.

[55] Information on RE projects in Algeria was retrieved from available public documents.

Table 6-1: Identified ISCC projects in Algeria

ALGERIA - Integrated Solar and Combined Cycle (ISCC)									
Number.	**Project**	**Promoter**	**Capacity [MW]**	**Cost [M€]**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
1	Mehaïr (Wilaya d'El Oued)	Public [NEAL]	**Option 1:** 400 MW of which 70 MW solar **Option 2:** 480 MW of which 80 MW solar	690	2013	feasibility study		PFS	[2]
2	Naama, sud-ouest Algérie	Public [NEAL]	400 MW of which 70 MW solar	N/A	2015	N/A		PFS	[2]
3	Hassi R'mel II	Public [NEAL]	400 MW of which 70 MW solar	690	2017	N/A		PFS	[2]

6.2.2. Modelling results

Figure 6-2 shows the estimated LEC trend for different power producing technologies in Algeria over the period 2010-2020. As an oil exporter country, Algeria presents a relatively low cost of power production from fossil fuels. Therefore, there is a wide economic gap between this cost and that of power from solar technologies. Similar to other countries of the region, the use of solar power technologies is more expensive than other RE technologies (such as wind). Indeed, the combination of both technological maturity and the abundant availability of wind in Algeria (the average wind load factor is 35%) make wind power production cost lower than that of conventional energy throughout the years. Power produced from PV technologies becomes economically more competitive than conventional energy before 2020.

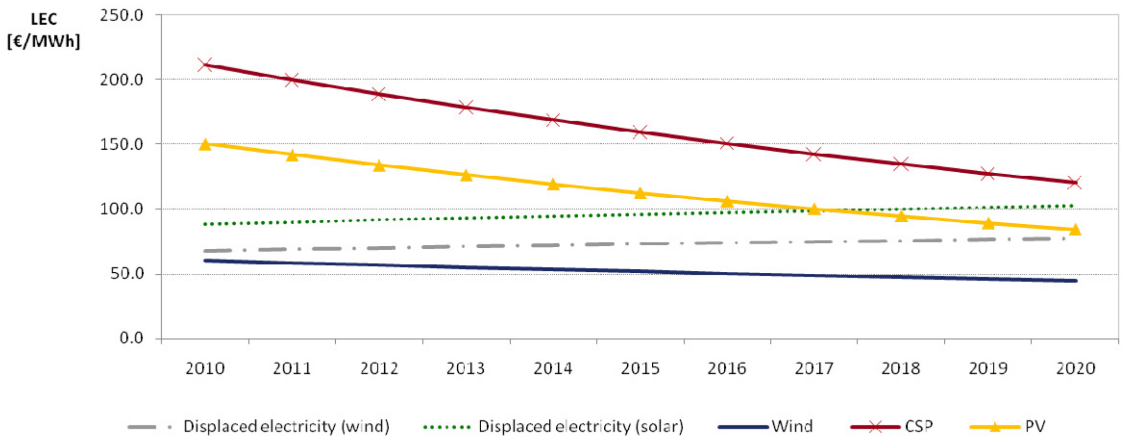

Figure 6-2: LEC trend for different power producing technologies 2010-2020 in Algeria

Source: MWH modelling results

Figure 6-3 shows the cumulative avoided CO_2 emissions in the high and low simulated scenarios. Due to the small number of RE projects, saved CO_2 emissions remain limited. The implementation of the identified RE projects is expected to reduce 2.1 Mtonnes of Algeria's emissions in the period 2010-2020. More specifically, the implementation of the RE projects would reduce up to 0.1 Mtonnes per year in the low scenario and 0.2 Mtonnes per year in the high scenario. By 2040, the identified project proposals could have contributed to an expected CO_2 emission reduction of a total of 4.2 Mtonnes.

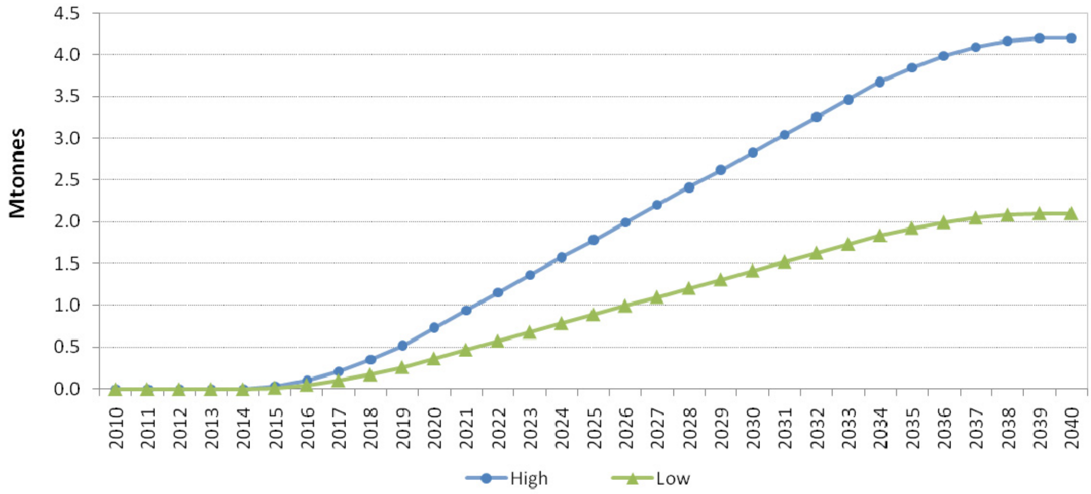

Figure 6-3: Cumulative avoided CO2 emissions over 2010-2040 in Algeria

Source: MWH modelling results

6.2.3. CONSTRAINTS FOR RE DEVELOPMENT

The main constraint to RE projects in Algeria has been identified as financial. There is still a significant gap between the low costs of conventional vis-a-vis the higher costs of renewable power (especially solar). Wind power nevertheless appears competitive vis-a-vis conventional energy in the short term.

In addition the conditions to access the European market and the modalities for benefiting from Article 9 still need to be defined.

Finally interconnections with other countries have not been identified as constraints to RE project proposals currently on the ground. Nevertheless, it is worth noting that two interconnection projects with Europe are being planned. One would connect Algeria with Spain (2,000 MW of capacity) and the other would connect Algeria with Italy (1,000 MW of capacity).[56]

[56] The implementation date was not available.

7. EGYPT

7.1. Overall Presentation of the Energy Sector

7.1.1. Outlook of Energy Supply, Renewable Energy's Share, and Country's Targets

Electricity demand in Egypt is growing rapidly. According to the Egyptian Electricity Holding Corporation (EEHC), energy demand in Egypt is expected to grow at an annual average rate of more than 6% up to 2012 [1].

The country's total installed power capacity is 20,801 MW (2008). Figure 7-1 aggregates the different energy sources by their share in Egypt's total installed power capacity. Steam turbines and combined cycle technologies represent the main technologies used for electricity generation. Renewable energy installed capacity is mainly made of hydro power and wind.

In terms of new installation capacity, wind and solar power are the main renewable energy sources expected to grow. Based on the information provided by the New and Renewable Energy Authority (NREA), the wind power installed capacity should reach 550 MW by the end of 2010. On the other hand, hydro power capacity potential is almost saturated.

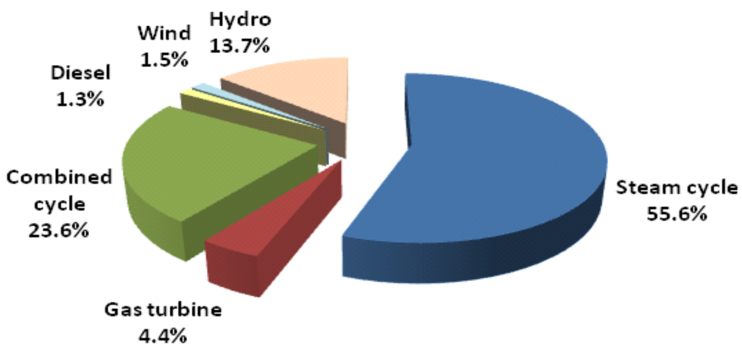

Figure 7-1: Installed capacity share in 2008 in Egypt

Source: [1]

In February 2008, the Supreme Council of Energy adopted a plan to cover 20 % of the country's total generated electricity with RE by 2020. According to this plan, wind energy would provide 12 % (7,200 MW) of the total RE target [3]. The remaining renewable power would come from hydro, solar, and biomass sources. Egypt's Renewable Energy Authority (NREA) expects the solar contribution to be in the order of 120 MW (100 MW CSP and 20 MW PV) by 2020.

7.1.2. Stakeholders dealing with Renewable Energy

The following paragraphs identify the country's major stakeholders and describe their main responsibilities in the RE field.

- Ministry of Electricity and Energy: it is in charge of guaranteeing the country's energy security. Some of its policy priorities include the diversification of energy resources, the improvement of energy efficiency, the promotion of energy conservation as well as the utilization of renewable energy [4];

- New & Renewable Energy Authority (NREA): it was established in 1986 as the national focal point for the introduction and promotion of renewable energy technologies. One of its policy objectives is the generation of electricity at a commercial scale, respecting the use of energy conservation measures [4];
- Egyptian Electricity Holding Corporation (EEHC): it is Egypt's electricity provider. The company is obliged to supply electricity to all types of consumers according to international performance standards, the sector environmental, social, and economic determinants, and the terms and conditions set by the Regulatory Agency for Electric Utilities and Consumer Protection. It is in charge of coordinating, supervising, and monitoring its affiliated companies' activities in the fields of generation, transmission and distribution of electricity [3].

7.1.3. RE LEGISLATION

A new electricity law, drafted by the Ministry of Electricity & Energy, is currently subject to constitutional approvals [26]. The law reflects ongoing market reforms, strengthens the regulatory agency, and provides incentives to the private sector for the utilization of RE. The law does not include feed-in tariffs.

Box 1:

Key features of the new electricity law in Egypt

Source: [26]

Among others, the law includes the following provisions:

- Establishment of a competitive electricity market, based on bilateral contracts and the concept of eligible customers;
- Introduction of Third Party Access (TPA);
- Establishment of a Transmission System Operator (TSO), assuring its independence and full unbundling from other sector participants;
- Ratification of tariffs by the regulatory agency;
- Provision of land lease agreements to qualified developers of wind projects;
- Anticipation of nominal leasing fees in wind farms to promote their economic profitability;
- Different incentives to encourage private sector investment in RE projects:
  - Free land licence for RE projects during the plant lifetime;
  - Free bird migration studies;
  - Free environmental impact assessment;
  - Guaranteed Power Purchase Agreement for 25 years;
  - No Income Tax;
  - No Sales Tax;
  - Custom duty free for all imported equipment;
  - Carbon Credits.

Table 7-1 shows the RE projects for which financial funds have been already secured.[57]

Table 7-1: Identified projects for which financial funds have been already secured in Egypt

Project	Promoter	Technology	Capacity [MW]	Commissioning date	Project status
Zafarana	Public [NREA]	WIND	120	May 2010	Under construction
Kuraymat, South Cairo	Public [NREA]	ISCC	140 MW of which 20 MW CSP	End 2010	Final adjustment for commissioning

[57] According to the methodology explained in paragraph **2.1** (Part I of this report), these projects are not included in the assessment exercise.

7.2. RE PROJECTS' ASSESSMENT

7.2.1. IDENTIFIED RE PROJECTS

Table 7-2, Table 7-3, Table 7-3, Table 7-4 and Table 7-5 describe RE projects in Egypt. [58] Data was collected during interviews with NREA and other stakeholders.

[58] Most of the data presented in the tables of this chapter is based on information received from consulted stakeholders as of April 22nd 2010. A few key data have been updated whilst finalising the report in September 2010. The changes between the initial data provided by consulted stakeholders and the hereby presented data have been clearly identified and justified with footnotes.

Table 7-2: Identified Wind Projects in Egypt

EGYPT - Wind Power									
N.	**Project**	**Promoter**	**Capacity (MW)**	**Cost (M€)**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
1	Gulf of El-Zayt	Public [NREA]	220	430	2014	Feasibility study completed	Project will be developed under EPC rules.	FS	[27]
2	Gulf of El-Zayt	Public [NREA]	250	425	2014	Ongoing bidding process	Project will be developed under BOO rules. Land preparation & EIA studies were conducted by NREA.[59]	FS	[27]
3	Gulf of El-Zayt	Public [NREA]	200	340	2013	Tendering process is under preparation	Project will be developed under EPC rules. The invitation for bidding was announced in mid April 2010.	FS	[27]
4	Gulf of El-Zayt	Private [ITAL – GEN]	120	192[60]	2012 - 2013	Feasibility study completed	Project will be developed under IPP rules. EIA & wind speed measurement were completed.	FS	[27]
5	Gulf of El-Zayt	Public [NREA]	140 + 40	Total cost N/A	2014	Under preparation	Project will be developed under EPC rules in two stages. The preliminary financial approval has been issued.	PFS	[27]
6	Gulf of El-Zayt	Public [NREA]	120	183.5	2013	Pre-feasibility study completed	Project will be developed under EPC rules. On March 30th 2010, a consultant was hired to conduct the feasibility study.	PFS	[27]
7	Nile West Bank	Public [NREA]	200	N/A	2015	Under preparation	Project will be developed under EPC rules. A consultant will be hired to conduct a feasibility study.	PFS	[27]

[59] A workshop for wind speed measurements was organised on January 2010. Six pre-qualified consultants for technical assistance works and 10 IPP bidders have been short listed.

[60] Estimation based on typical specific installation costs.

Table 7-3: Identified CSP projects in Egypt

EGYPT - Concentrated Solar Power (CSP)									
N.	**Project**	**Promoter**	**Capacity (MW)**	**Cost (M€)**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
8	Kom Ombo	Public [NREA]	100	362[61]	N/A	Conceptual stage	Project will be developed under EPC rules.	IS	[27]

Table 7-4: Identified PV projects in Egypt

EGYPT - Photovoltaic Power (PV)									
N.	**Project**	**Promoter**	**Capacity (MW)**	**Cost (M€)**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
9	Location to be defined	Public [NREA]	20	80	N/A	Conceptual stage.	Project will be developed in different stages.	IS	[27]

Table 7-5: Identified Hydro projects in Egypt

EGYPT – Hydro Power									
N.	**Project**	**Promoter**	**Capacity (MW)**	**Cost (M€)**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
10	New Assuit Barrage	Public [NREA]	32	64[62]	2015	Project at a tendering stage.		FS	[27]

[61] Estimation was supplied by NREA. The initial cost was in US$. Currency conversion factor was 1 $ = 0.69 €.

[62] Estimation was based on typical specific installation costs.

7.2.2. MODELLING RESULTS

Figure 7-2 shows the trends of power production costs from different technologies for Egypt in the period 2010-2020. As an energy exporter country, Egypt presents a relatively low cost of power from fossil fuels. Therefore, there is a wide economic gap between this cost and solar power production cost. Nevertheless, the prospects for RE in Egypt appear one of the most encouraging in the region. For instance, load factors are the regional highest for all the technologies. By 2020, typical PV and wind plants (as listed in the project proposals) could save, respectively, 30% and 40% of production costs for each MWh produced. By 2020 also, CSP technologies could produce power at approximately the same cost as from fossil fuels.

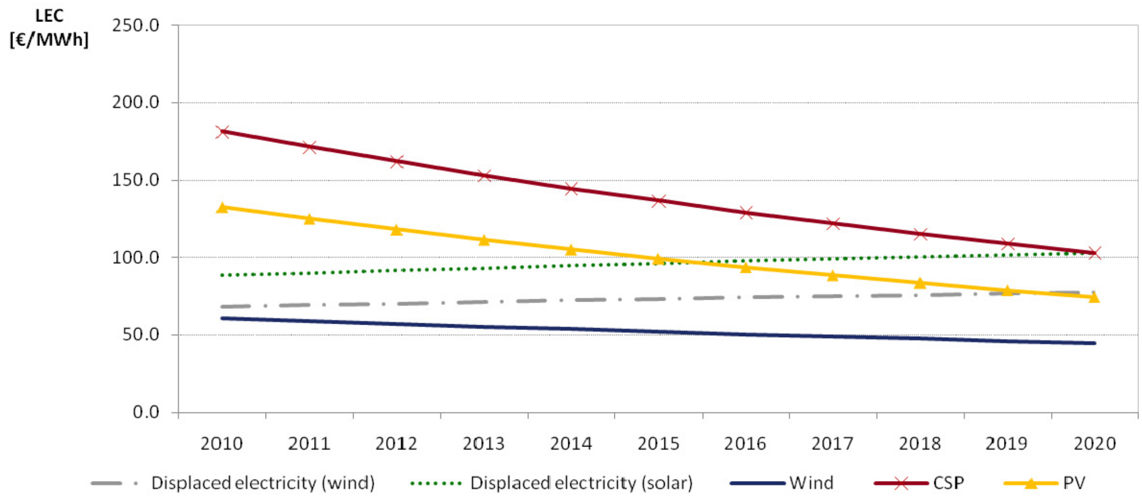

Figure 7-2: LEC trend in Egypt

Source: MWH modelling results

Figure 7-3 shows the cumulative avoided emission in the two simulated scenarios. Due to Egypt's large installation of hydro capacity, the electricity emission factor is considerably lower than countries like Jordan (-30%) and Morocco (-40%). If all implemented, the identified RE projects will reduce Egypt's emissions by up to 1.5 Mtonnes per year in the low scenario and up to 2 Mtonnes per year in the high scenario. By 2040, the cumulative reduction would be of 22.5 Mtonnes in the low scenario and 30 Mtonnes in the high scenario.

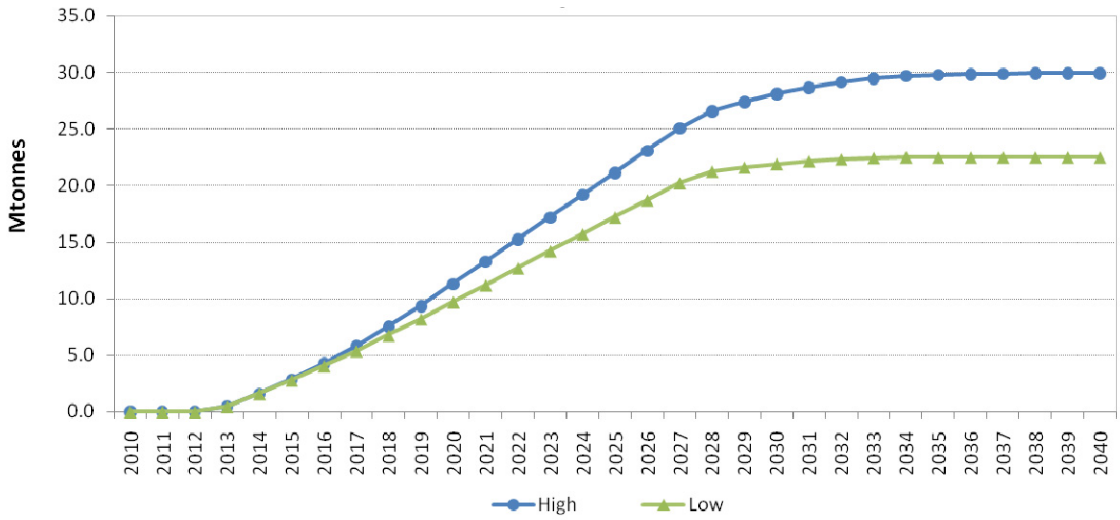

Figure 7-3: Cumulative avoided CO2 emissions in Egypt

Source: MWH modelling results

7.2.3. CONSTRAINTS FOR RE DEVELOPMENT

Egypt appears to present one of the best prospects for RE development in the Southern and Eastern Mediterranean region. According to NREA, the country has good transmission networks and future projects will improve RE distribution.[63]

Egypt's main RE challenges can be found at the economic and institutional levels. In terms of the former, the gap between the cost of production of solar power and that from fossil fuels represents a major obstacle for the development of RE. On the other hand, PV and wind technologies are better positioned than CSP vis-a-vis conventional energy. In terms of the latter, the Electricity Law is still under discussion. The law includes the development of a competitive electricity market and the introduction of Third Party Access.

[63] A new project will connect Samalout to Gabal El Zeit, allowing the distribution of RE produced in this area. Moreover, within the Saudi Arabia connection, the refurbishment of substation is under implementation which will contribute to the improvement of this area's capacity.

8. GAZA/WEST BANK

8.1. Overall Presentation of the Energy Sector

8.1.1. Outlook of Energy Supply, Renewable Energy's Share, and Country Targets:

No RE capacity is currently installed in Gaza/West Bank. Almost all (98%) the electricity demand is imported from Israel, the remaining demand coming from Egypt and Jordan. There is only a 62.5 MW power plant (2008 data). The plant is fuelled with diesel, generating about 410 GWh annually [1].

No institutional RE plans were identified, although some RE projects exist at different stages of implementation.

8.1.2. Stakeholders dealing with Renewable Energy

The following paragraphs identify the major stakeholders and describe their main responsibilities:

- Gaza Electricity Distribution Corporation (GEDCo): it is the local electricity provider, distributing electricity to all the areas under the control of the Palestinian National Authority [28]. The company is owned by the Palestinian National Authority and its decision-makers are the the Palestinian Energy and Natural Resources Authority, the Ministry of Finance, the Gaza Governorate, municipalities, and local councils;
- Palestinian Energy and Natural Resources Authority (PENRA): it is responsible for the development and rehabilitation of the internal electricity networks as well as the main electricity lines. PENRA is also in charge of the development of the rural electricity project and the rehabilitation of Gaza's electricity generation station [29];
- Palestinian Energy & Environmental Research Centre (PEC): it is a national R&D institution responsible for the study of renewable energies and energy efficiency in Gaza/West Bank. PEC has an independent financial management, which is audited by both the Palestinian Energy Authority and the Ministry of Finance [30].

8.1.3. RE legislation

The new electricity law, passed in May 2009, does not give strong support to RE. There is only one disposition stating the importance of RE in Gaza/West Bank. No annexes or implementation directives to the law have been issued.

Neither feed-in tariffs nor third party access are currently available. Moreover, the electricity network is rather limited. There is just a medium and low voltage grid. Nevertheless, an EU project to reinforce the network is under consideration by PEA. This agency expects the project to be completed within 36 months from the contract's initiation day.

8.2. RE Projects' Assessment

Identified RE Projects

Table 8-2, Table 8-2 and Table 8-3 present the different projects that were identified during MWH

interviews with Palestinian authorities.[64]

Table 8-1: Identified Wind projects in Gaza/West Bank

GAZA/WEST BANK - Wind power									
N.	**Project**	**Promoter**	**Capacity (MW)**	**Cost (M€)**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
1	Hebron	Public	0.75	1.2[65]	End 2011	Tendering for design is under preparation.	This wind turbine will be dedicated to supply electricity to a new hospital in Hebron: "Al Ahli".	FS	[31] [32]

Table 8-2: Identified CSP projects in Gaza/West Bank

GAZA/WEST BANK - Concentrated Solar Power (CSP)									
N.	**Project**	**Promoter**	**Capacity (MW)**	**Cost (M€)**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
2	Jericho	Public	10	15-16[66]	N/A	Ongoing feasibility study	WB is financing this project. A Swiss consultant is conducting a feasibility study, which will be completed by July 2010.[67]	PFS	[31] [32]
3	EU – "Solar for Peace" programme	Public	20 - 40	50 - 130	N/A	On hold	PENRA formally requested the EU to split the project in an Israel part and West Bank/Gaza part and to use these funds to contribute in financing project n. 2.	IS	[31] [32]

64 Most of the data presented in the tables of this chapter is based on information received from consulted stakeholders as of March 1st 2010. A few key data have been updated whilst finalising the report in September 2010. The changes between the initial data provided by consulted stakeholders and the hereby presented data have been clearly identified and justified with footnotes.

65 Estimation based on assumed typical specific cost.

66 The original data was expressed in USD. Currency conversion factor: 1USD = 0.69€

67 Based on the outcomes of the study, WB will contribute with a grant to the project and seek financing for the remaining part (approx. 9.7 – 10.4 M€). PENRA will own and operate the plant.

Table 8-3: Identified PV projects in Gaza/West Bank

GAZA/WEST BANK - Photovoltaic Power (PV)									
N.	**Project**	**Promoter**	**Capacity (MW)**	**Cost (M€)**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
4	Jericho	Public	0.3 – 0.5	3.5–4.1[66]	End of 2011.	Ongoing feasibility study	A consultant is conducting a feasibility study, which will be completed in few months.	PFS	[31] [32]
5	EU - "Solar for Peace" program.	Public	0.350	N/A	N/A	On hold.	PENRA formally requested the EU to split the project in an Israel part and Gaza/West Bank part and to use these funds to contribute in financing project n. 2.	IS	[31] [32]

8.2.1. MODELLING RESULTS

Figure 8-1 shows the estimated LEC trend for different producing technologies in Gaza/West Bank over the period 2010-2020. As an energy importer, Gaza/West Bank presents a relatively high cost of power production from fossil fuels. Such a high cost has not yet incentivized the use of solar energy. Indeed, only by 2020 could power production costs from PV and CSP technologies be in the range of power production costs from fossil fuels. A potential explanation to the lack of development of PV and CSP technologies is Gaza/West Bank's poor climate conditions for solar energy. Power production cost from wind technologies is currently comparable to that of fossil fuels.

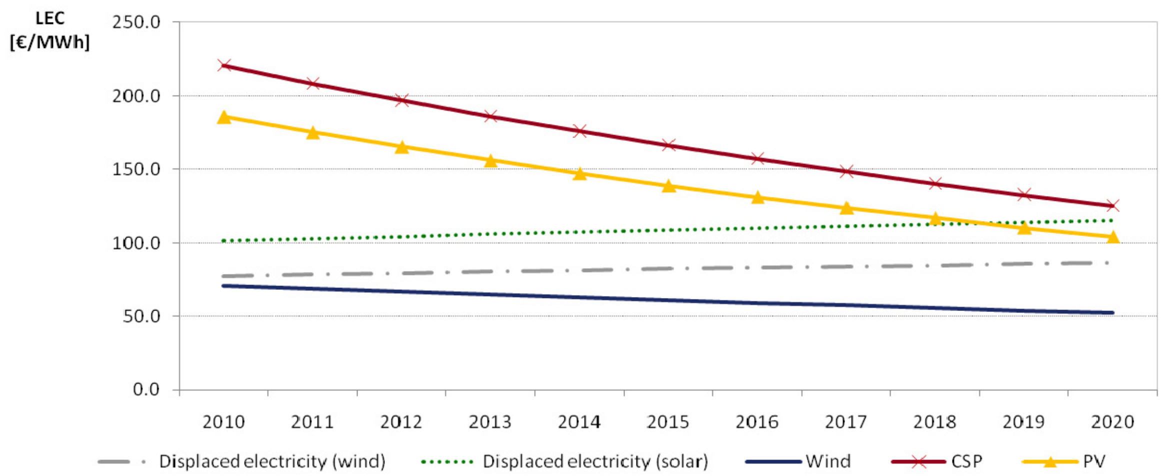

Figure 8-1: LEC trend in Gaza/West Bank

Source: MWH modelling results

Figure 8-2 shows the cumulative avoided CO_2 emission in the two simulated scenarios. If all implemented, the identified RE projects could reduce CO_2 emissions in Gaza/West Bank by up to 7,000 tonnes per year in the low scenario and up to 45,000 tonnes per year in the high scenario.

Based on similar estimations, by 2040 Gaza/West Bank could achieve a cumulative reduction of 0.14 Mtonnes in the low scenario and of 0.9 Mtonnes in the high scenario. The significant gap between the low and high scenarios is explained by the low levels of development (early stages of preparation) of the RE projects.

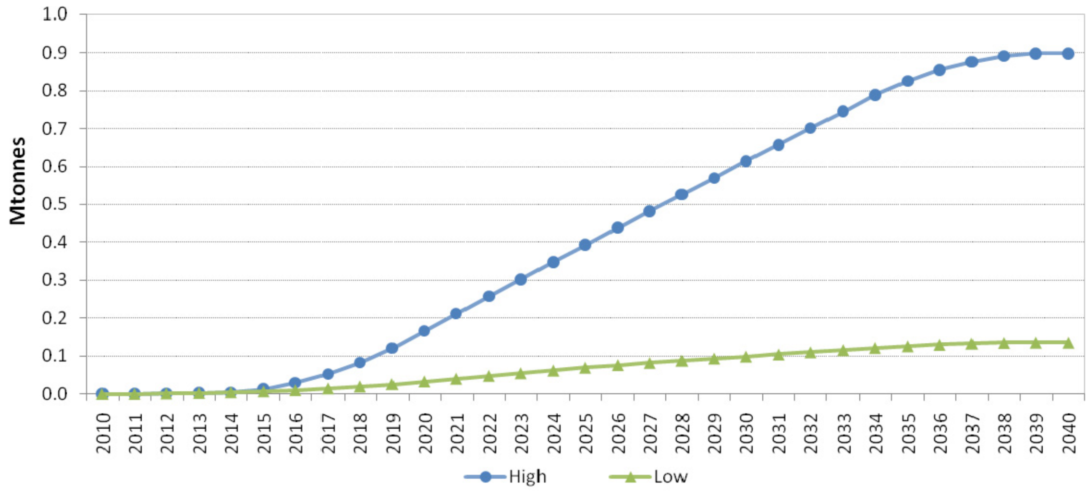

Figure 8-2: Cumulative avoided CO_2 emissions in Gaza/West Bank

Source: MWH modelling results (2010)

8.2.2. CONSTRAINTS FOR RE DEVELOPMENT

Gaza/West Bank faces significant financial constraints to support the implementation of projects. According to PENRA, the main obstacle is accessing the necessary funds to allow the development of RE projects. Another significant barrier is the lack of fiscal revenues to implement subsidies. Like other countries of the region, in Gaza/West Bank subsidies are a critical aspect for the feasibility of RE initiatives.

Institutionally, Gaza/West Bank presents low capacity levels to undertake RE planning and project implementation. The new electricity law does not provide support for RE development. Moreover, there is no regulation for power generation and international tendering procedures.

Finally, both conventional and renewable energy face significant “physical” challenges in Gaza/West Bank. In general, the use of land for energy generation purposes has been dependent on political and security developments. On top of this, there is no high voltage network in Gaza/West Bank. The existing medium and low voltage network requires to be reinforced in order to allow the installation of power plants and a reliable transmission. [68]

[68] PEA is currently negotiating a contract with the EIB and the EU to finance the strengthening of the electricity network. The project would finance the installation of 4 substations (two in the Northern area, one in the Central area, and one in the Southern area of Gaza/West Bank). PENRA mentioned that the World Bank has hired a consultant to perform a renewable energy assessment study with the objective of drawing a wind and solar map for the region.

9. ISRAEL

9.1. OVERALL PRESENTATION OF THE ENERGY SECTOR

9.1.1. OUTLOOK OF ENERGY SUPPLY, RENEWABLE ENERGY'S SHARE, AND COUNTRY TARGETS

Israel's installed capacity and electricity generation is, respectively, 11,336 MW and 50,411 GWh (2007). Electricity from renewable energy sources currently represents 0.1 % of the country's total generation [33]. Israel's renewable energy sources are hydro and wind power (Figure 9-1) [5].

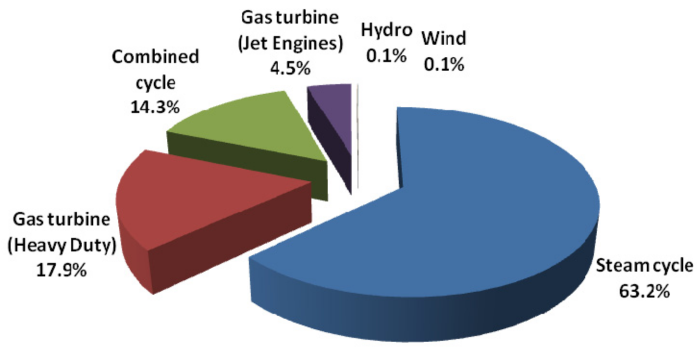

Figure 9-1: Installed capacity share in Israel (2007)

Sources: [33]

The Israeli government has set a target of 10 % of RE by 2020 [5]. Once achieved, it would be equivalent to approximately 2,250 MW RE capacity, including 140 MW of biomass, 1060 MW of wind, and 1050 MW of PV installations [35].

9.1.2. STAKEHOLDERS DEALING WITH RENEWABLE ENERGY

The following paragraphs identify the country's major stakeholders and describe their main responsibilities in the RE field:

- Ministry of National Infrastructures ("MNI"): it is responsible for the formulation of RE policies in the country. The Ministry aims at implementing Government Decision No. 4450 (as of January 29th 2009), which sets a target of 10% of RE sources in Israel's total energy generation 2020 [5];
- Public Utility Authority (Electricity) ("PUA"): it is responsible for the determination of the tariffs and the division of quotas between actual and potential producers of RE [5];
- Ministry of Finance ("MoF"): it is in charge of launching a tender for the establishment of three RE power plants (2 thermal-solar power plants and one PV power plant) [5]. The ministry is part, together with the Ministry of National Infrastructures, of the Inter-ministerial Tender Committee.

9.1.3. RE LEGISLATION

Israel has a well defined institutional setup for RE development. The Electricity Law 5756-1996 regulates the electricity sector in Israel. Its main mandate is to ensure the reliability, availability, quality, and efficiency of electricity distribution in the country. It also promotes the conditions for competition and cost minimization in the electricity sector [5]. On the other hand, the Electricity Economic Law regulates the bidding procedures for granting electricity production licenses for RE projects. Among energy authorities, PUA regulates power plants by determining tariffs and quota per each technology [34].Israel provides energy producers with a wide range of incentives to utilize renewable energies. Existing supporting mechanisms for RE initiatives include tax cuts, facilitation of land availability, investment grants, and feed-in [5]. Table 9-1 reports RE electricity feed-in tariffs for the different technologies.

Table 9-1: Feed-in Tariffs in Israel

Source: [5]

Beginning of operations	**Tariff for wind turbine with a capacity up to 15 kW** **€/kWh (Agorot per kWh)**	**Tariff for wind turbine with a capacity of over 15 kW and up to 50 kW** **€/kWh (Agorot per kWh)**	**Tariff for a PV facility with a capacity greater than 50 kW** **€/kWh (Agorot per kWh)**
2008	-	-	0.44 (218)
2009	0.27 (135)	0.35 (172)	0.41 (205)
2010	0.27 (134)	0.34 (168)	0.41 (204)

9.2. RE PROJECTS' ASSESSMENT

9.2.1. IDENTIFIED RE PROJECTS

Table 9-2 and Table 9-3 present the different identified RE projects. The information was provided by the Ministry of National Infrastructures (MNI).[69]

[69] Most of the data presented in the tables of this chapter is based on information received from consulted stakeholders as of March 6th 2010. A few key data have been updated whilst finalising the report in September 2010. The changes between the initial data provided by consulted stakeholders and the hereby presented data have been clearly identified and justified with footnotes.

Table 9-2: Identified CSP projects in Israel

ISRAEL - Concentrated Solar Power (CSP)									
N.	**Project**	**Promoter**	**Capacity [MW]**	**Cost [M€]**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
1	Ashalim	Public [MoF]	80 – 110	350-600[70]	End 2013	Bids expected to be submitted on 11/30/2010.		FS	[34]
2	Ashalim	Public [MoF]	80 – 110	350-600[70]	End 2013	Bids expected to be submitted on 11/30/2010.		FS	[34]
3	Dimona	Public [MNI]	200	530[71]	N/A	Conceptual stage	Land identification	IS	[34]
4	Misor Yamin	Public [MNI]	200	530[71]	N/A	Conceptual stage	Land identification	IS	[34]
5	Tzomet Negev	Public [MNI]	200	530[71]	N/A	Conceptual stage	Land identification	IS	[34]
6	Negev	Private [Shikun & Binui]	120	320[71]	N/A	Conceptual stage	Discussion of the Outline Plan No. 10	IS	[34]
7	Urim	Private [Sunray]	100	265[71]	N/A	Conceptual stage	Discussion of the Outline Plan No. 10	IS	[34]
8	Nevatim	Private [Sunray]	50	130[71]	N/A	Conceptual stage	Discussion of the Outline Plan No. 10	IS	[34]
9	Moshav Tidhar	Private [Sunray]	10	26[71]	N/A	Conceptual stage	Discussion of the Outline Plan No. 10	IS	[34]
10	Moshav Zruaa	Private [Sunray]	35	92[71]	N/A	Conceptual stage	Discussion of the Outline Plan No. 10	IS	[34]
11	Eilot	Private [Eilat - Eilot]	220	580[71]	N/A	Conceptual stage	Preparation of EIA	IS	[34]
12	N/A	Private [Kibbuz Ktura]	50	130[71]	N/A	Conceptual stage	Preparation of plans	IS	[34]

[70] Estimated by MWH on the basis of average investment costs.

[71] Ministry of National Infrastructures estimate based on 3.6 M$/MW; currency exchange rate: 1.364 $/€.

Table 9-3: Identified PV projects in Israel

ISRAEL - Photovoltaic Power (PV)									
N.	**Project**	**Promoter**	**Capacity [MW]**	**Cost [M€]**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
13	Ashalim	Public [MoF]	15	50-70	End 2013	Bidding process.		FS	[34]

9.2.2. MODELLING RESULTS

Figure 9-2 shows the estimated power production cost trend for different technologies in Israel over the period 2010-2020. As an oil importer country, Israel presents a relatively high power production cost from fossil fuels. Solar PV and CSP power production costs are also relatively high. A potential contributor to a high LEC in solar energy is Israel's limited climate endowments for the development renewable technologies, especially solar. On the other hand, the cost of power from wind technologies is currently comparable to that from fossil fuels. Solar power is expected to become competitive with fossil fuel power in 2020.

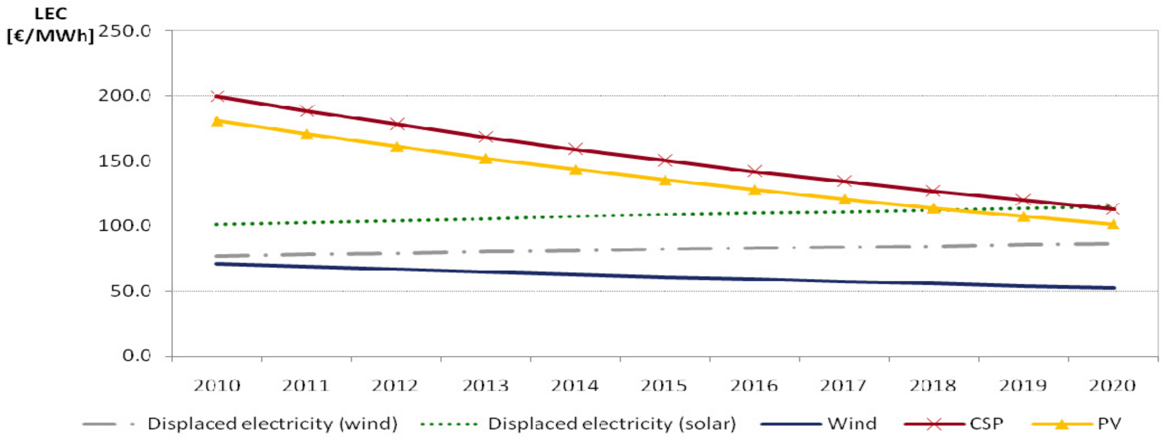

Figure 9-2: LEC trend in Israel

Source: MWH modelling results

Figure 9-3 shows the cumulative avoided CO_2 emissions in the two simulated scenarios. Were all RE projects in Israel implemented, CO_2 emissions could be reduced by up to 0.2 Mtonnes per year in the low scenario and by up to 1.6 Mtonnes per year in the high scenario. Based on similar estimations, by 2040 Israel could achieve cumulative savings of 5 Mtonnes in the low scenario and of 33 Mtonnes in the high scenario. Moreover, in the same context of full project implementation, Israel could contribute with up to 13% of the CO_2 emissions' savings in the region.

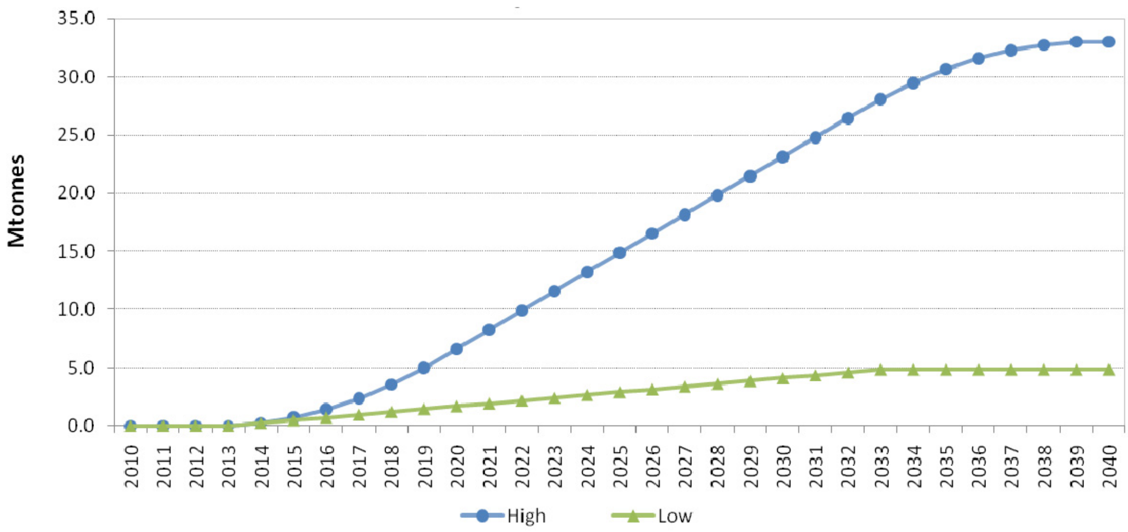

Figure 9-3: Cumulative avoided CO_2 emissions in Israel

Source: MWH modelling results

9.2.3. CONSTRAINTS FOR RE DEVELOPMENT

Like in other countries, Israel faces significant financial constraints to support the implementation of projects. The country, however, has established a well designed framework for RE development, allowing feed-in tariffs and third party access.

Another constraint for RE development in Israel is the lack of interconnections with neighbouring countries (apart from Gaza/West Bank), which will not allow exporting RE within the region and, eventually, to the EU.

10. JORDAN

10.1. Overall Presentation of the Energy Sector

10.1.1. Outlook of Energy Supply, Renewable Energy's Share, and Country Targets

In Jordan, total installed capacity and electricity generation are, respectively, 2,534 MW and 13,216 GWh. RE contribute with 0.69 % of the country's total installed capacity [1].

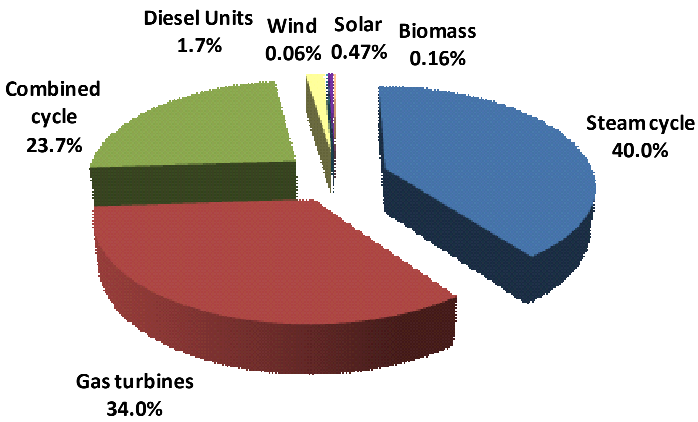

Figure 10-1: Installed capacity share in Jordan (2008)

Source: [1]

The Ministry of Energy and Mineral Resources (MEMR) has set a RE target in total primary energy of 7 % by 2015 and of 10 % by 2010. Based on these projections, by 2020, the RE target would be articulated into the following expected installed power capacities [72]:

- 600 MW wind power
- 600 MW solar power

10.1.2. Stakeholders dealing with Renewable Energy

The following paragraphs identify the country's major stakeholders and describe their main responsibilities in the RE field

- Ministry of Energy and Mineral Resources (MEMR): it has primary responsibility for the formulation of energy policies, including planning and sector co-ordination [36]. The ministry is also responsible for setting the policies to achieve the country's energy goals;
- National Energy Research Centre (NERC): it is responsible for research, development, and the provision of training in the fields of new and renewable energy. Its activities are concerned with raising awareness on energy efficiency in different economic sectors. It is also regarded as one of the most advanced science and technological centres of the Higher Council for Science and Technology [37] in the country.

[72] MEMR also includes plans for 30-50 MW of waste-to-energy plant(s); for the purpose of the assessment in this report, however, such technology using Municipal Solid Waste as an energy fuel was not considered as renewable energy.

- Electricity Regulatory Commission (ERC): it was established after a Council of Ministers' decision of January 2001. The agency's mission is to enforce the rights of consumers and to solve their disputes with the service providers. It is responsible for a) restructuring the electricity sector under the premises of equality and fairness; b) guaranteeing the provision of electricity services to consumers; c) ensuring that electricity companies provide high quality services; d) ensuring that electricity services are provided at competitive prices e) overseeing, monitoring, and solving consumers complaints [38].
- Electricity National Corporation (NEPCO): since 1996, it is the private sector successor of the state-owned Jordan Electricity Authority. It is responsible for: a) the provision of electricity at high levels of reliability, continuity, and quality; b) meeting environmental standards and developing good business practices in the exchange of electricity with neighbouring countries; c) the consolidation of the company's corporate governance; d) achieving an optimal level of investment in the transmission of electricity; e) contributing to technology transfer, the promotion of national and international investments opportunities in the electricity sector, and the creation of jobs for Jordanian professionals [39].

10.1.3. RE LEGISLATION

Jordan has recently passed Law 3\2010 ("Renewable Energy & Energy Efficiency Law). [73] The law does not include feed-in tariffs.

[73] Law 3\2010– "Renewable Energy & Energy Efficiency Law"- was passed in February 2010. No implementation directives of the law have been issued yet.

Box 2:

Key features of the new electricity law in Jordan

Source: [6]

- Authorization to MEMR to issue public tenders on a competitive basis for the development of RE projects (in accordance with MEMR's development plan);
- Interested parties can present proposals for the development of RE projects. Proposals need to meet specific criteria;
- Dispatching priority given to RE. All energy output from RE plants has priority on the national grid and must be purchased pursuant to a PPA;
- Provision of incentives for RE interconnection and licensing. The law obliges NEPCO to assume the costs of line interconnections between the project and the nearest substation;
- It allows the so-called "Net Metering". Small RE projects and residences having RE systems can sell power to the grid at the same purchase price pursuant to instructions to be issued by ERC;
- Establishment of a Renewable Energy & Energy Efficiency Fund. The objective of the fund is to provide financial support to RE projects in order to meet the country's Energy Strategy. Resources originate in budget allocations and international donations. The allocation of funds, however, is still to be defined.

10.2. RE Projects' Assessment

10.2.1. Identified RE Projects

Table 10-1, Table 10-2 and Table 10-3 present the different identified RE projects. The information was provided by MEMR.

Table 10-1: Identified Wind projects in Jordan

JORDAN - Wind Power									
N.	**Project**	**Promoter**	**Capacity [MW]**	**Cost [M€]**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
1	Al-Kamsha	Public	40	60	2011	Tendering process	International tender has been issued under BOO rules. The tendering is at its final stage.	FS	[6]
2	Fujeij	Public	90	120	2012	Tendering process	International tender has been issued under BOO rules. Pre-qualification list has been announced. RfP has been issued in July 2010 [74]	FS	[6]
3	Maan	Public	150	200	2015	Conceptual Stage	Wind speed and quality measurements programme to be tendered in 2012.	IS	[6]
4	Aqaba	Public	100	130	2014	Conceptual Stage	Wind speed and quality measurements programme to be tendered in 2011.	IS	[6]
5	Irbid and Ajloun	Private [EJRE]	200	250	2014	Pre-feasibility		PFS	[6]
6	Karak and Tafeleh	Private [EJRE]	200	250	2014	Pre-feasibility		PFS	[6]
7	Wadi Musa and Shobak	Private [EJRE]	200	250	2015	Pre-feasibility		PFS	[6]

[74] At the time MEMR provided information on the progress regarding the procurement process, the RfP had not been issued yet.

Table 10-2: Identified CSP projects in Jordan

JORDAN - Concentrated Solar Power (CSP)									
N.	**Project**	**Promoter**	**Capacity [MW]**	**Cost [M€]**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
8	Quairah (Maan CSP)	Public	100	300	2013 - 2015	Fundraising		PFS	[6]
9	Maan Governorate	Private [EJRE]	Total 600 by 2020 (First stage 100-150)	First stage cost 400	N/A	Conceptual Stage	CSP Base Load without storage	IS	[6]
10	Maan Governorate	Private [EJRE]	Total 600 by 2020 (First stage 200)	First stage cost 500	N/A	Conceptual Stage	CSP with storage	IS	[6]
11	Rashadiyah cement plant.	Private [EON Climates & Renewables]	50	250	N/A	Conceptual stage		IS	[6]

Table 10-3: Identified PV projects in Jordan

JORDAN - Photovoltaic (PV)									
N.	**Project**	**Promoter**	**Capacity [MW]**	**Cost [M€]**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
12	MDA Industrial Park	Private [Kawar Energy & others 65%]	100	400	2015	Pre-feasibility study	Land and equipment choice identified	PFS	[6]
13	Maan Governorate	Private [EJRE]	First stage 50 (total 200 by 2020)	First stage cost 200	2015	Pre-feasibility study	CPV plant	PFS	[6]

10.2.2. MODELLING RESULTS

Figure 10-2 shows the power production cost trend modelled for different technologies in Jordan over the period 2010-2020. As an energy importer country, Jordan presents a relatively high power production cost from fossil fuels. Power from wind technologies appears currently competitive with fossil fuel electricity. Moreover, by 2020 the cost of producing electricity from wind sources is expected to be about half of the cost of producing electricity from fossil fuel plants. By the same year, a similar trend is expected from solar energy. Solar energy is largely available in Jordan and PV/CSP load factors are among the highest of the region.

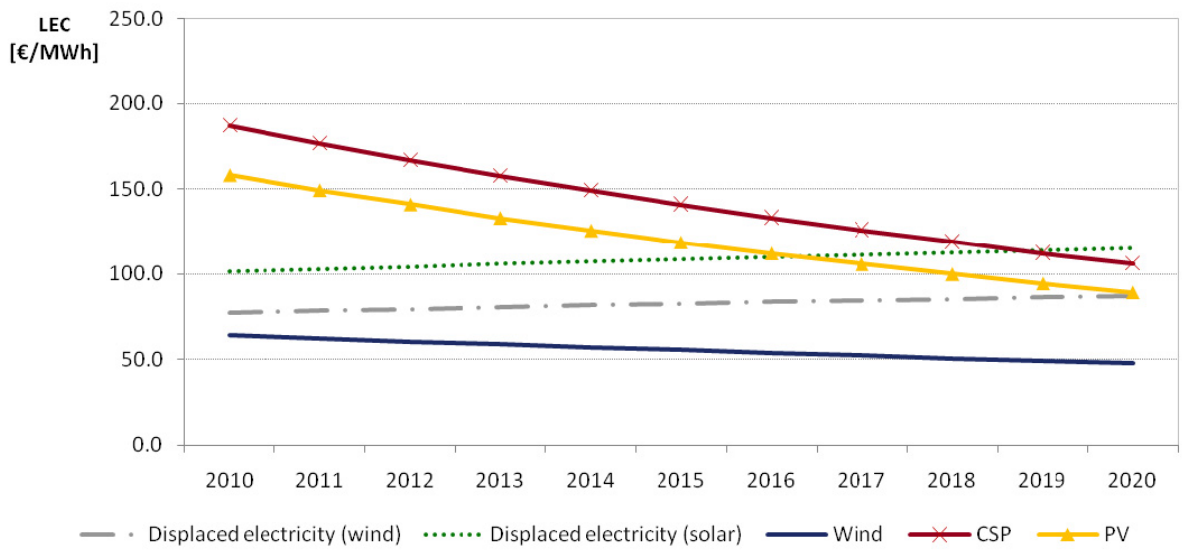

Figure 10-2: LEC trend in Jordan

Source: MWH modelling results

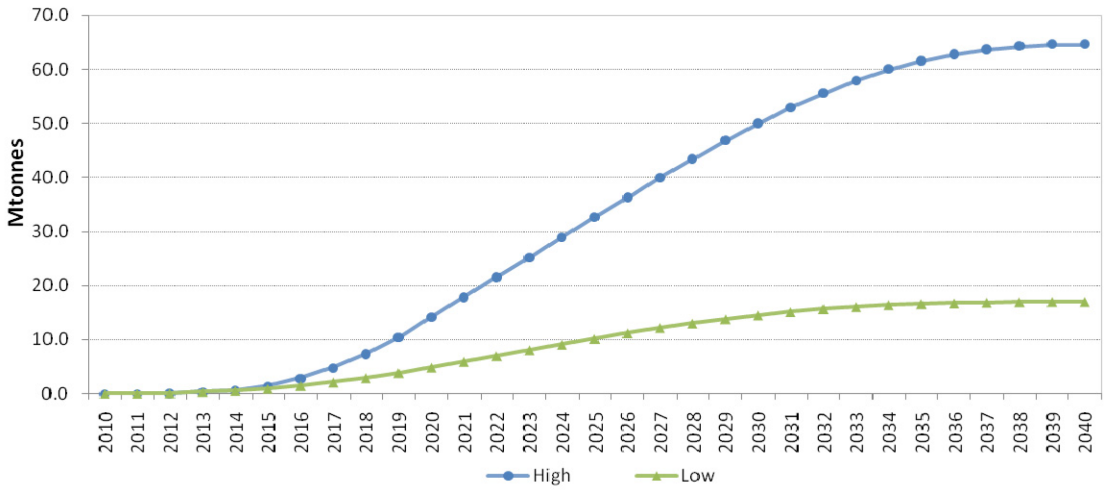

Figure 10-3 shows the cumulative avoided CO_2 emissions in the two simulated scenarios. Were all identified projects in Jordan implemented, CO_2 emissions could be reduced by up to 1 Mtonnes per year in the low scenario and by up to 3.7 Mtonnes per year in the high scenario. Based on similar estimations, by 2040 Jordan could achieve a cumulative CO_2 reduction of 17 Mtonnes in the low scenario and of 65 Mtonnes in the high scenario. Moreover, in the same context of full project implementation, Jordan's contribution to the region's CO_2 savings could reach 18 % in the low scenario and of 26% in the high scenario.

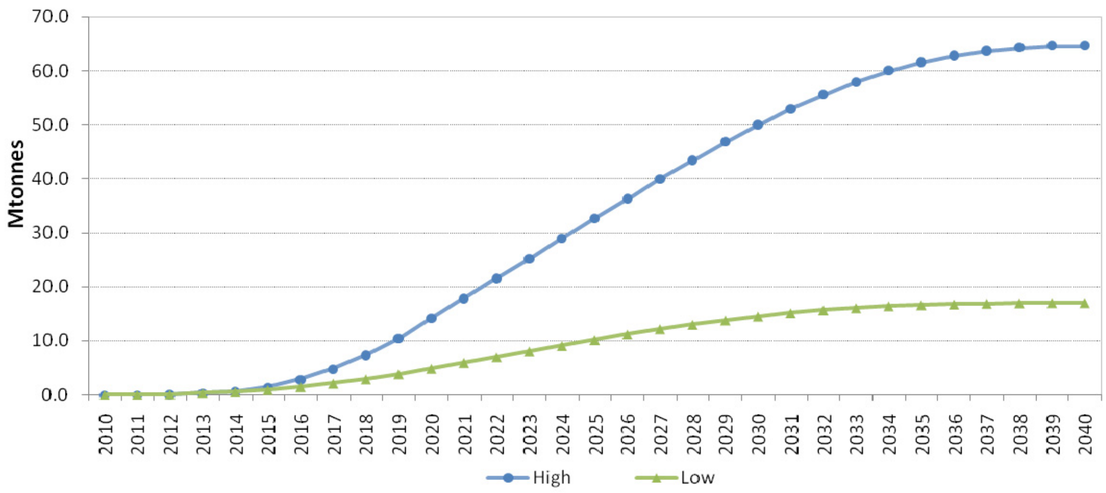

Figure 10-3: Cumulative avoided CO2 emissions in Jordan

Source: MWH modelling results

10.2.3. CONSTRAINTS FOR RE DEVELOPMENT

The gap between the costs of producing electricity from CSP and from conventional sources represents a major barrier for the development of CSP technology. On the other hand, the cost of electricity generation from wind sources is as competitive as the costs of producing electricity from fossil fuel plants. Although the selling price of electricity in Jordan is low, there are no identified plans in the near future to increase tariffs.

At the institutional level, the recently passed Renewable Energy & Energy Efficiency Law constitutes a major landmark in the promotion of RE in Jordan. Nevertheless, no directives to implement the law have been issued so far. Moreover, no feed-in tariffs are in place and third party access is not allowed.

Finally, Jordan faces significant physical constraints. Both the interconnections with neighbouring countries (Gaza/West bank and Syria) and the electricity network would need to be reinforced. The reinforcement of Jordan's transmission network is necessary to enhance the electric connectivity between the Mediterranean region and Europe. It is also necessary to integrate Jordan's renewable energy resource to the south of the national grid. Finally, the improvement of the electricity network would contribute to avoid the current bottleneck in the middle region of Jordan.

11. LEBANON

11.1. Overall Presentation of the Energy Sector

11.1.1. Outlook of Energy Supply, Renewable Energy's Share, and Country's Targets

Lebanon's total installed electricity capacity and electricity generation are, respectively, 2,304 MW (2008) and about 10,624 GWh. Lebanon is an energy importer, receiving 99 % of its primary energy from external sources. The remaining 1 % comes from renewable energies, mainly hydro [1].

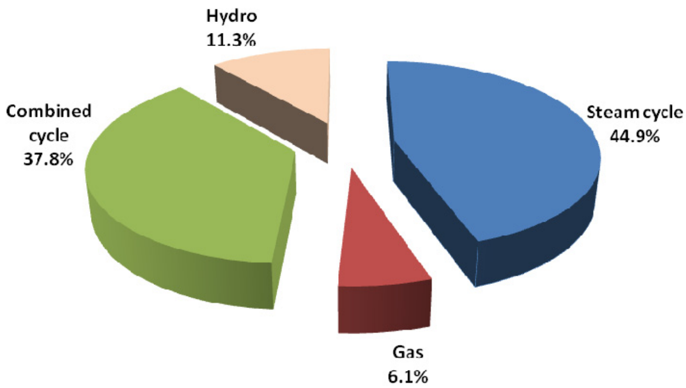

Figure 11-1: Installed capacity share in Lebanon (2008)

Source: [1]

In August 2009, through the "Beirut Declaration on the Mediterranean Solar Plan", Lebanon committed to playing a significant role in the implementation of the MSP [40]. As a result of the Beirut Declaration, in March 2010, Lebanon' Water and Energy Ministry announced a goal of 12 % usage of renewable energy by 2020 [7].

11.1.2. Stakeholders dealing with Renewable Energy

The following paragraphs identify the country's major stakeholders and describe their main responsibilities in the RE field:

- Ministry of Energy and Water: it is Lebanon's main policy formulator in the water and energy sectors. The Ministry is composed of three directorates: the General Direction of Hydraulic and Electric Resources, the General Direction of Exploitation, and the General Direction of Petroleum [41];
- Lebanese Electric Corporation (EDL): it is responsible for the generation, transmission, and distribution of electricity in Lebanon. It is a state-owned enterprise, which controls over 90 % of the Lebanese electricity sector [42];
- Lebanese Association of Solar Industries (ALI): it is an economic organization grouping industrials manufacturers from all over Lebanon. ALI advocates for a balanced industrial development for all Lebanese regions. The Association seeks to create and maintain an environment which is favourable to industrial investment, growth and development [43];
- Lebanese Association for Energy Saving & the Environment (ALMEE): the organization advocates for a sustainable and harmonious development of Lebanon, with special

emphasis on energy savings and the environment. ALMEE is particularly committed to global environmental issues (Kyoto and Montreal protocols) and has developed mechanisms for greenhouse gas emissions [44];

- Lebanese Centre for Energy Conservation (LCEC): it is a national organization affiliated to the Lebanese Ministry of Energy and Water. LCEC addresses end-use energy conservation and renewable energy at the national level. It supports the Government of Lebanon in the development and implementation of national strategies that promote the efficient and rational uses of energy, including renewable energy, at both generation and consumer levels.

11.1.3. RE LEGISLATION

The country's lack of energy legislation has been an obstacle for the development of RE. No feed-in tariffs are currently available and third party access is not allowed.

11.2. RE PROJECTS' ASSESSMENT

11.2.1. IDENTIFIED RE PROJECTS

Table 11-1, Table 11-2 and Table 11-3 present the different identified RE projects. Information was provided by ALMEEL, LCEC, and the United Nations Development Programme (UNDP). [75]

Table 11-1: Identified Wind projects in Lebanon

LEBANON Wind Power									
N.	**Project**	**Promoter**	**Capacity [MW]**	**Cost [M€]**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
1	To be defined	Private Sector	60-100	115-195	2013	Identification stage		IS[76]	[45]

Table 11-2: Identified Hydro projects in Lebanon

LEBANON - Hydro Power									
N.	**Project**	**Promoter**	**Capacity [MW]**	**Cost [M€]**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
2	To be defined	Private Sector International Loans	40	200	2015	Identification stage		IS[76]	[45]
3	To be defined	Private Sector International Loans	80	500	N/A[77]	Identification stage		IS[76]	[45]

[75] Most of the data presented in the tables of this chapter is based on information received from consulted stakeholders as of February 25th 2010. A few key data have been updated whilst finalising the report in September 2010. The changes between the initial data provided by consulted stakeholders and the hereby presented data have been clearly identified and justified with footnotes.

[76] These projects were not included in the modelling exercise, due to the fact that they were only available through LCECP and UNDP in the final stages of review for this report (September 2010).

[77] This project is planned in "the long term", no commissioning date is defined yet.

Table 11-3: Identified CSP projects in Lebanon

LEBANON - Concentrated Solar Power (CSP)									
N.	**Project**	**Promoter**	**Capacity [MW]**	**Cost [M€]**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
4	Zahleh Centre – Bekaa Valley.	Private [ZEC, ADM, ALMEE].	5	25	N/A	Feasibility study	Pilot project promoted by private companies, which will provide the land.	FS	[46]

11.2.2. Modelling results

Figure 11-2 shows the estimated power production cost trend modelled for different technologies in Lebanon over the period 2010-2020. As an energy importer country, Lebanon presents a relatively high cost of power from fossil fuels. The country has significant availability of solar energy and a reasonable potential for the generation of wind energy. Wind power appears currently competitive vis-a-vis fossil fuels'. On the other hand, PV produced power is still more expensive than fossil based power [78]. The cost of producing electricity through PV technology could become competitive with fuel-based electricity from 2017 onwards.

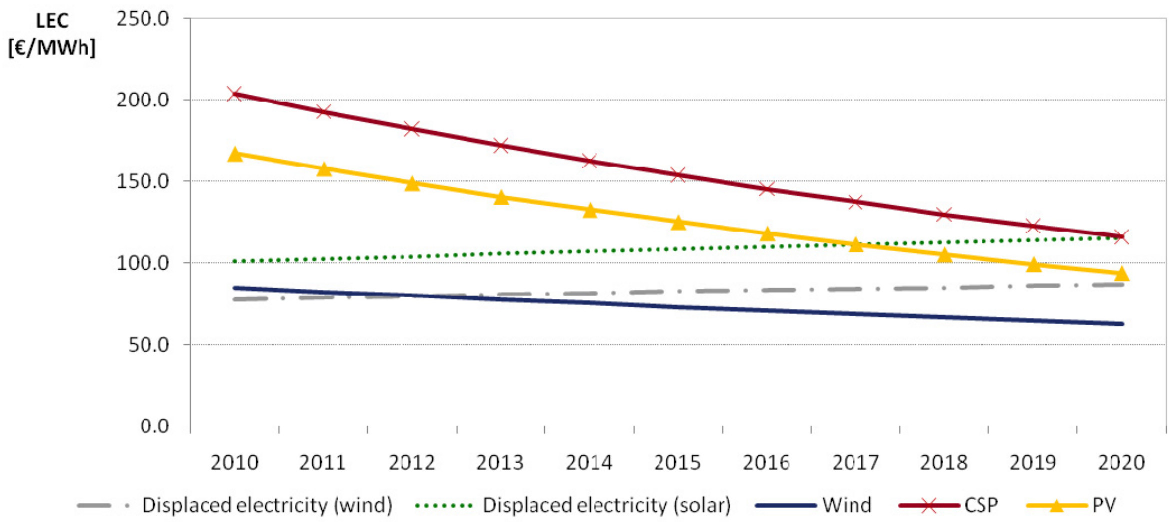

Figure 11-2: LEC trend in Lebanon

Source: MWH modelling results

Figure 11-3 shows the cumulative avoided CO_2 emissions in the two simulated scenarios. Were all identified projects in Lebanon implemented, CO_2 emissions could be reduced by up to 5,000 tonnes per year in both low and high scenarios. Based on similar estimations, by 2040 Lebanon could achieve a cumulative CO_2 reduction of 0.1 Mtonnes. [79]

[78] Although competitive, wind technology is not as competitive as in other countries due to a low load factor.

[79] Since only one RE project was included in the modelling exercise, the trend is the same in both the scenarios. After the plant's decommissioning in 2033, no additional CO_2 emission reduction were estimated.

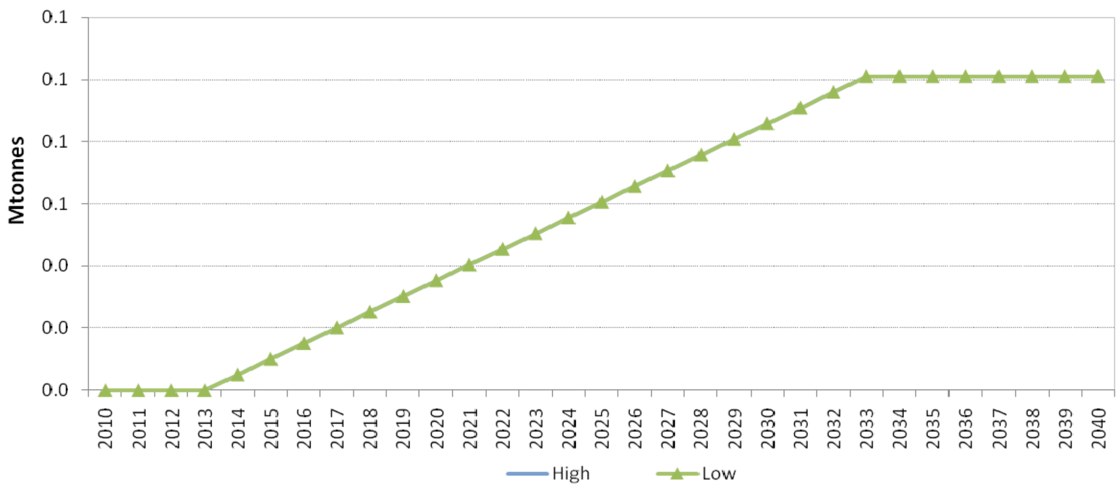

Figure 11-3: Cumulative avoided CO_2 emissions in Lebanon

Source: MWH modelling results

11.2.3. Constraints for RE development

As in most countries of the region, the main constraint for the deployment of RE at present, especially for solar projects, is financial. Indeed, there is currently a wide gap between the cost of solar power and that of power produced from fossil fuels. On the other hand, the production of electricity from wind energy is already competitive with the cost of producing electricity from conventional sources.

At the institutional level, there is no sector specific regulation. Moreover, neither feed-in tariffs nor third party access are allowed.

Finally, the electrical network in Lebanon requires reinforcement. Both national power generation and energy imports from Syria are not sufficient to cover the periods of peak demand, and power outages occur daily [80].

[80] In Lebanon, the peak demand is 3,500 MW. The country's maximum power generation is 2,304 MW.

12. MOROCCO

12.1. Overall Presentation of the Energy Sector

12.1.1. Outlook of Energy Supply, Renewable Energy's Share, and Country's Targets

In Morocco, total installed capacity and electricity generation are, respectively, 5,293 MW and 20,308 GWh (2008). Morocco has a significant share of RE in its total electricity installed capacity. Hydro is the largest renewable energy in Morocco with a participation of 32,7 % in the country's total installed capacity. At present, only hydro and wind energies have been implemented [1]. In the period 2002-2008, the consumption of electricity experienced an annual growth of 7.5 %.

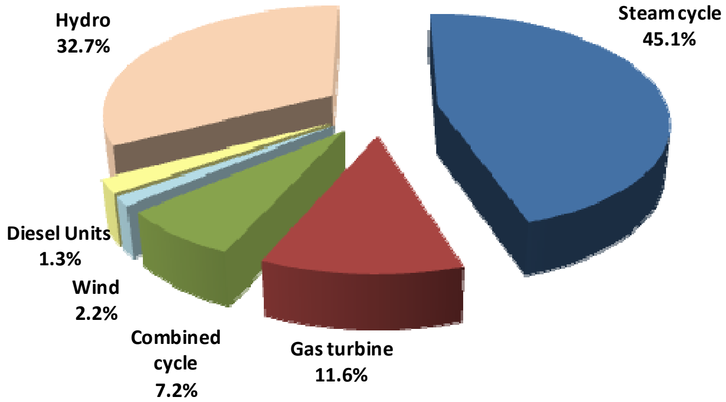

Figure 12-1: Installed capacity share in Morocco (2008)

Source: [1]

Morocco's Solar Plan launched in November 2009 envisages a 42 % share of RE in the country's total installed capacity by 2020. This target would be achieved by installing 2,000 MW of wind, 2,000 MW of solar, and 2,000 MW of hydro powers [8].

Morocco has a significant wind potential which could be used, after fulfilling the local demand, to export RE energy to EU countries. A critical mechanism to allow exports of RE to Europe is article 9 of the EU Electricity Directive. Currently, Morocco has not defined the export modalities. Morocco exports electricity to the EU through the 2x700 MW of electrical interconnections with Spain[81] and imports 18 % of its demand from Spain.

12.1.2. Stakeholders dealing with Renewable Energy

The following paragraphs identify the country's major stakeholders and describe their main responsibilities in the RE field.

- Ministry of Energy, Mining, Water, and Environment (MEMEE): it is the main decision-maker in the energy sector. It prepares and defines the RE strategy, including the design

[81] In order to reinforce the existing interconnection, an additional 700 MW interconnection with Spain is under consideration.

of the regulatory framework and the promotion of tools for the development of RE projects (i.e. incentives for private sector participation);

The following entities report to MEMEE:

- National Electricity Office (ONE): it is Morocco's electricity provider. The agency is responsible for the satisfaction of electricity demand at the best possible cost and quality of service [47];
- National Water Office (ONEP): it is Morocco's provider of water services. Within the agency, the Planning Department has a leading role in the analysis, design, implementation, management, and production of water and waste management services [48];
- Renewable Energy and Energy Efficiency Agency (ADEREE): it is responsible for implementing the government policy in the fields of renewable energies and energy efficiency (excluding what is covered by MASEN below);
- Moroccan Agency for Solar Energy: it is responsible for the oversight and monitoring of solar electricity generation programmes and projects (design, selection of locations, studies, selection of operators, implementation and operational follow ups)

12.1.3. RE LEGISLATION

In 2010, the Parliament passed three laws aimed at promoting RE: (i) the RE law (13.09 of January 13th 2010), (ii) a law creating the National Agency for the Promotion of Renewable Energy and Energy Conservation (16.09 of January 13th 2010), and (iii) a law creating the Moroccan Agency for Solar Energy (57.09 of January 14th 2010).

Box 3:

Key features of the new RE laws in Morocco

Source: [49][50]

- Level the playing field for both public and individual institutions to produce electricity from RE;
- Establishment of an authorisation regime for RE projects with a capacity of 2 MW or more;
- Request of a preliminary declaration for new or upgraded installations that (i) produce electricity from RE sources with less than 2 MW and more than 20 kW and which are owned by the same operator on one or various sites, or (ii) produce 8 MW of more of thermal energy ;
- Electricity generated from RE sources can only be connected to the national grid (MV, HV) at conditions to be determined by the regulator;
- No conditions apply in the case of electricity from RE sources which is provided by a unique promoter at less than 20 kW;
- RE projects with a capacity of 2 MW or more can only be implemented if they are proposed by ADEREE, the concerned local authorities, and the national transmission grid operator;
- The commercial conditions of electricity buy-out have to be established in an agreement between the power provider and the consumers;
- Third Party Access;
- Private RE producers are allowed to export electricity through the national transmission grid;
- Private producers of RE are authorised to implement dedicated HVDC transmission lines for exports whenever the capacity of the national transmission grid is limited.

12.2. RE PROJECTS' ASSESSMENT

12.2.1. IDENTIFIED RE PROJECTS

Table 12-1, Table 12-2, Table 12-3 and Table 12-4 present the identified RE projects in Morocco. [82] Information was collected during the interviews held with the Moroccan authorities and the sector stakeholders.

[82] As of February 24th 2010.

Table 12-1: Identified Wind projects in Morocco

MOROCCO - Wind Power									
N.	**Project**	**Promoter**	**Capacity [MW]**	**Cost [M€]**	**Commissioning date**	**Project status**	**Comments**	**Cate-gory**	**Source**
1	Tarfaya	Public [ONE]	300	414	April 2012	Bidding[83]	Project will be developed under BOO rules.	FS	[49]
2	Touahar	Public [ONE]	100	150	2016	Ongoing studies	A study assessing the connectivity of the wind farm to the national grid was finished. Wind measures were completed.	PFS	[49]
3	Al Marsa - Laayoune	Private [CIMAR]	50	N/A	2016	-	EnergiPro Programme[84]	PFS	[49]
4	Sandouk - Ksar Sghir	Private [ENDESA]	60	N/A	2016	-		PFS	[49]
5	Foum Al Wad - Laayoune	Private [ENDESA]	140	N/A	2016	-		PFS	[49]
6	Haouma - Ksar Sghir	Private [NAREVA]	100	160[85]	2012	Feasibility study completed. Conditions of implementation are being discussed.		FS	[49]
7	Foum Al Wad - Laayoune	Private [NAREVA]	100	160[85]	2012	Feasibility study completed. Conditions of implementation are being discussed.		FS	[49]
8	Cap Sim - Essaouira	Private [YNNA HOLDING]	20	N/A	2012	Agreement with ONE has been signed. Wind measurement has been conducted, but investment decisions still to be confirmed by operator.		PFS	[49]
9	Fardiwa - Ksar Sghir	Private [YNNA HOLDING]	50	N/A				PFS	[49]
10	Foum Al Wad - Laayoune	Private [AVANTE]	50	N/A				PFS	[49]
11	Jbel Haouch Ben Kreea - Tanger	Private [ASMENT]	30	N/A				PFS	[49]

[83] Technical proposals of the submitted bid are being evaluated.

[84] EnergiPro is a programme launched by ONE. Through this programme, major energy consumers or producers can develop electricity from RE for their own use. ONE buys the excess of generated power and secures third party access according to modalities defined within an agreement between ONE and the self-generators/producers. Agreements have been already signed between ONE and both national industries and foreign operators for a total of 750 MW of installed capacity (regions of Laâyoune, Essaouira, Taza and Tanger).

[85] Estimation based on typical specific costs of 1600 EUR/kW.

MOROCCO - Wind Power									
N.	**Project**	**Promoter**	**Capacity [MW]**	**Cost [M€]**	**Commissioning date**	**Project status**	**Comments**	**Cate-gory**	**Source**
12	Jbel Khelladi - Ksar Sghir	Private [UPC]	50	80[86]	2012	Feasibility study completed and ongoing negotiations for PPA.		FS	[49]
13	Foum Al Wad - Laayoune	Private [UPC]	50	80[86]	2012	Feasibility study completed and ongoing negotiations for PPA.		FS	[49]
14	Lemsid - Boujdour	Private [NATURE FUEL MAROC]	50	N/A	2012	Ongoing feasibility study.		PFS	[49]

Table 12-2: Identified Hydro projects in Morocco

MOROCCO - Hydro Power									
N.	**Project**	**Promoter**	**Capacity [MW]**	**Cost [M€]**	**Commission-ing date**	**Project status**	**Comments**	**Category**	**Source**
15	Agadir	Public [ONE]	300	420	2014	Feasibility study completed	Bidding process scheduled for June 2010.	FS	[49]
16	To be defined	Public [ONE]	300	420	2017/18	Conceptual stage	Commissioning expected between 2016 and 2017.	IS	[49]

Table 12-3: Identified CSP projects in Morocco

MORROCO- Concentrated Solar Power (CSP)									
N.	**Project**	**Promoter**	**Capacity [MW]**	**Cost [M€]**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
17	Tan Tan	Public [ONE, ONEP]	5 to 10	30 to 60	2014	Ongoing feasibility study	Project for water desalination. The appropriate technology is under analysis.[87]	FS	[49]

[86] Estimation based on typical installation specific costs of 1600 EUR/kW.

[87] The following schedule has been agreed: a) bidding process to take place in 2012; b) construction to be planned between 2012 and 2013; and c) commissioning to take place in 2014.

Table 12-4: Identified CSP/PV projects in Morocco

MOROCCO - Concentrated Solar Power/Photovoltaic (CSP/PV)									
N.	**Project**	**Promoter**	**Capacity [MW]**	**Cost [M€]**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
18	Ouarzazate	Public [MASEN]	500	1553	2015	The call for expression of interests was made in March 2010. Request for prequalification closed in early October 2010.[88]	Different technical and financial options are being assessed.[89]	PFS	[50]
19	Aïn Béni Mathar	Public [MASEN]	400	N/A	2016 to 2019	Conceptual stage	-	IS	[50]
20	Foum Al Ouad (Layoune)	Public [MASEN]	500	N/A	2016 to 2019	Conceptual stage	-	IS	[50]
21	Boujdour	Public [MASEN]	100	N/A	2016 to 2019	Conceptual stage	-	IS	[50]
22	Tarfaya	Public [MASEN]	500	N/A	2016 to 2019	Conceptual stage	-	IS	[50]

12.2.2. Modelling results

Figure 12-2 shows the power production cost trend modelled for different technologies in Morocco over the period 2010-2020. As an energy importer country, Morocco presents a relatively high cost of power from fossil fuels. Solar energy is largely available in the country, and Morocco has the highest solar irradiation values in the Southern and Eastern Mediterranean region. According to the modelling results, by 2020 electricity produced from solar sources could be competitive vis-a-vis electricity produced from conventional sources.

[88] Short list expected to be finished by November 2010.

[89] One option is to adopt a modular size (such as 5x100 MW or a more efficient breakdown). The project will be financed by the Moroccan Government. Power is to be sold to the local market. PPA is to be negotiated with ONE.

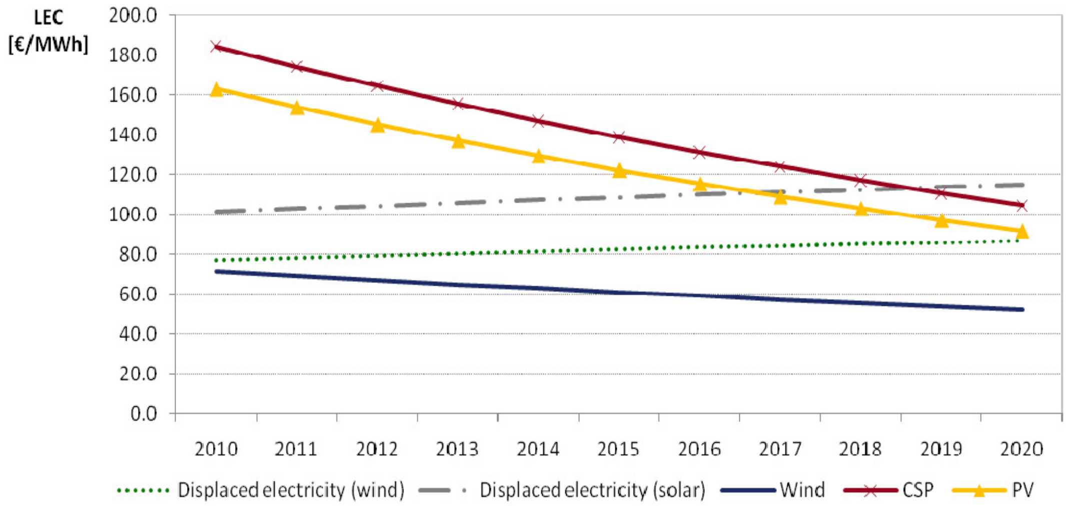

Figure 12-2: LEC trend for Morocco

Source: MWH modelling results

Figure 12-3 shows the cumulative avoided CO_2 emissions in the two simulated scenarios. Were all identified projects implemented in Morocco, CO_2 emissions could be reduced by up to 2.3 Mtonnes per year in the low scenario and by 5.4 Mtonnes per year in the high scenario. Based on similar estimations, by 2040 Morocco could achieve cumulative savings of 40 Mtonnes in the low scenario and of 100 Mtonnes in the high scenario. Moreover, in the same context of full project implementation, Morocco would contribute to the region with up to 41 % of emissions' savings in the low scenario and with up to 40 % of savings in the high scenario.

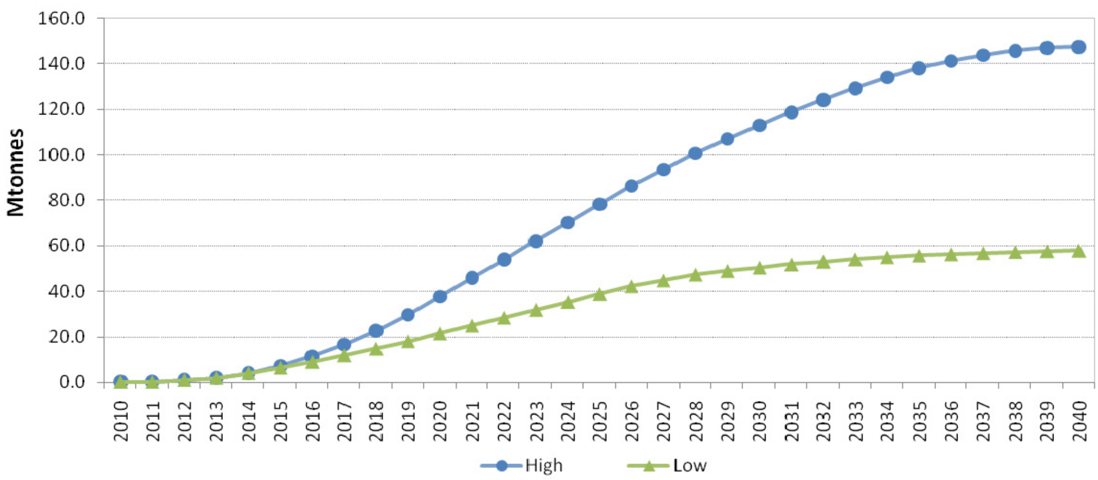

Figure 12-3: Cumulative avoided CO_2 emissions in Morocco[90]

Source: MWH modelling (2010)

[90] In Morocco, the 2 GW solar plan does not identify which technology will be used between CSP and PV; for the purpose of the calculations, an intermediary case of 50% CSP and 50% PV has been considered.

12.2.3. CONSTRAINTS FOR RE DEVELOPMENT

Morocco is one of the Mediterranean Partner Countries with the highest development of renewable energies so far. Nevertheless, like most countries of the region, the main constraint to the deployment of RE at present, especially for solar projects, is financial. This is a constraint for solar power production and technology deployment at large scale (both for domestic supply and exporting purposes), as envisaged in the country's ambitious Solar Plan.

Morocco also faces constraints at the institutional level. Despite the recent approval of the energy law, there are currently no incentives in place for the promotion of RE in the country. For instance, the lack of feed-in tariffs is blocking the acceleration of RE deployment. At the physical level, Morocco needs to reinforce its national grid.

13. SYRIA

13.1. Overall Presentation of the Energy Sector

13.1.1. Outlook of Energy Supply, Renewable Energy's Share, and Country's Targets

In Syria, total installed capacity is 7,700 MW (2008). Hydro is currently the only renewable energy source developed in Syria and represents a fifth of the country's total installed power capacity (Figure 13-1). According to energy projections, the power peak will at least double in the next 20 years. [1].

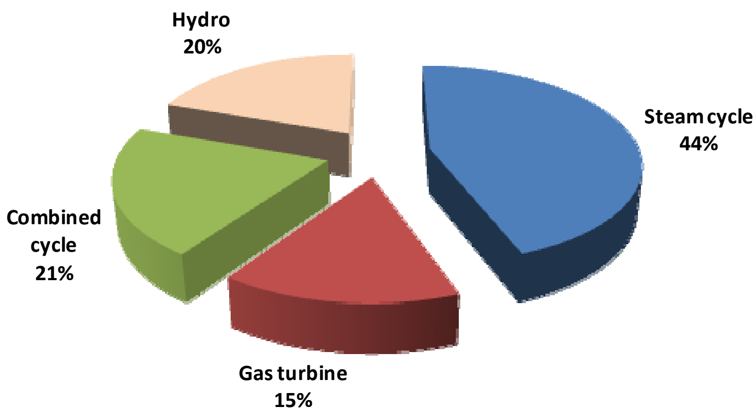

Figure 13-1: Installed capacity share in Syria (2008)

Source: [1]

The Ministry of Electricity has set a target of 6,000 MW of renewable power capacity by 2030. Were national targets achieved, 50 % of the total RE installed capacity would come from solar sources; the remaining 50 % would originate in wind technology [9]. All RE projects are publicly funded. In most of the cases, the structure with which these projects are envisaged uses a BOO (Build Own Operate) contract complemented by a tailor-made PPA for the renewable electricity.

13.1.2. Stakeholders dealing with Renewable Energy

The following paragraphs identify the country's major stakeholders and describe their main responsibilities in the RE field.

- Ministry of Electricity: the Ministry of Electricity is in charge of the formulation of energy policies in Syria. Some of its responsibilities include the design of plans to cover the country's electricity demand as well as the formulation of energy policies aimed at promoting economic and social development. [52];
- National Energy Research Centre (NERC): affiliated to the ministry of electricity, NERC defines RE strategies, including the promotion of institutional and economic incentives for the development of alternative energies' technology;
- Electricity Generation and Transmission Corporation (PEEGT): affiliated to the Ministry of Electricity, it is responsible for electricity generation and transmission;
- Electricity Distribution Corporation (PEED): affiliated to the Ministry of Electricity, it is responsible for the distribution of electricity.

13.1.3. RE LEGISLATION

A new energy law is under parliamentary consideration [51] (see Box 4).

Box 4:

Key features of the energy law drat in Syria

Source: [9]

- Participation of the private sector in energy generation (both conventional and renewable) and the operation of distribution networks.
- Establishment of a regulatory agency;
- Measures to encourage the use of renewable energy;
- Restructuring of the electricity sector.

13.2. RE PROJECTS' ASSESSMENT

13.2.1. IDENTIFIED RE PROJECTS

Table 13-1, Table 13-2 and Table 13-3 present the identified RE projects in Syria. Information was collected during the interviews held with the Syrian authorities.

Table 13-1: Identified Wind Projects in Syria

SYRIA - Wind Power									
N°	**Project**	**Promoter**	**Capacity (MW)**	**Cost (M€)**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
1	Al Sukhna	Public [PEEGT]	50 – 100	140[91]	2013	A feasibility study has been completed.	PEEGT appointed IPA Energy, Water Economics and Norton Rose as consultants. Project expected to be launched in 2013/2014. [92]	FS	[53]
2	Al Hijana	Public [PEEGT]	50 – 100	140[91]	2013			FS	[53]
3	Daraa Region (Gabageb)	Public [PEEGT]	100	140	N/A	Pre-feasibility study completed	PEEGT intends to develop the project via an EPC contract.	PFS	[9]
4	Homs (Qatineh)	Public [NERC]	50	70	N/A	Pre-feasibility study completed	Pilot project aimed at strengthening the capacity of local engineers and technicians in all project's phases.	PFS	[9]

Table 13-2: Identified PV projects in Syria

SYRIA - Photovoltaic Power (PV)									
N°	**Project**	**Promoter**	**Capacity (MW)**	**Cost (M€)**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
5	Palmyra	Public [NERC]	20	60	N/A	Conceptual stage	Solar potential and land availability. Pilot project.	IS	[9]

[91] This investment cost is estimated by PEEGT based on 100 MW installed capacity.

[92] This information was modified from that provided through the interviews, which took place in February 2010. The changes don't affect the modelling results but reflect the latest knowledge on the project proposal, as of September 2010.

Table 13-3: Identified CSP projects in Syria

SYRIA - Concentrated Solar Power (CSP)									
N°	**Project**	**Promoter**	**Capacity (MW)**	**Cost (M€)**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
6	Palmyra	Public [NERC]	20	70	N/A	Conceptual stage.	Solar potential and land availability. Pilot project.	IS	[9]
7	Raqa Region	Public [PEEGT]	100	350	N/A	Ongoing pre-feasibility study.	-	PFS	[9]

13.2.2. MODELLING RESULTS

Figure 13-2 shows the power production cost trend modelled for different technologies in Syria over the period 2010-2020. As an oil exporter country, Syria presents a relatively low cost of power from fossil fuels. Therefore, there is a wide gap between this cost and that of solar power production. The production of electricity from CSP technology currently costs approximately twice as much as producing electricity from conventional sources. Electricity from PV technology could become competitive with fossil fuels' by 2020.

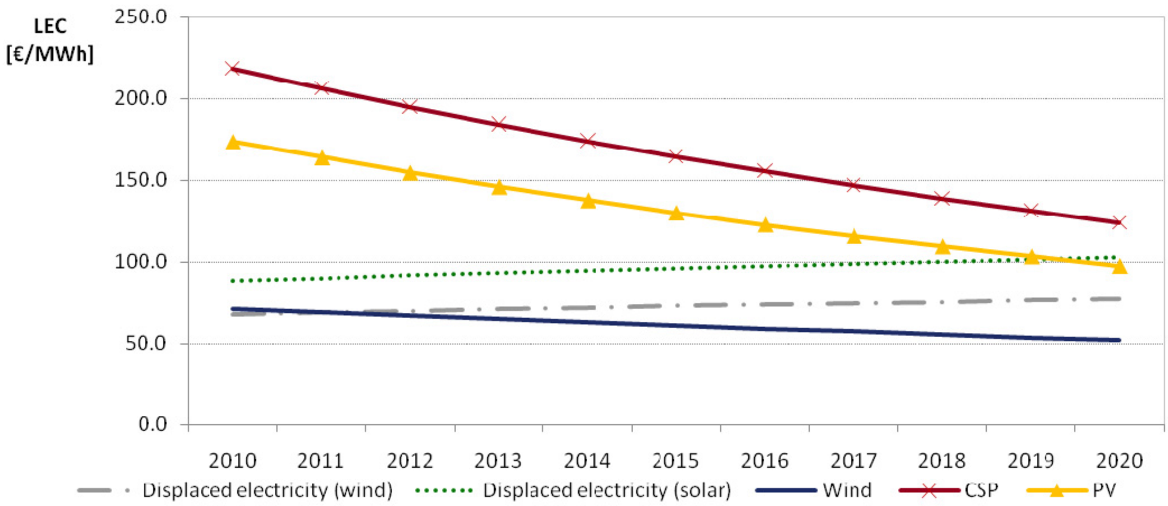

Figure 13-2: LEC trend in Syria

Source: MWH modelling (2010)

Figure 13-3 shows the cumulative avoided CO_2 emissions in the two simulated scenarios. Due to its installed hydro power capacity, Syria has a relatively low electricity emission factor. Were all the projects identified in Syria implemented, CO_2 emissions could be reduced by up to 0.4 Mtonnes per year in the low scenario and by 0.6 Mtonnes per year in the high scenario. Based on similar estimations, by 2040 Syria could achieve cumulative savings of 6 Mtonnes in the low scenario and 9 Mtonnes in the high scenario.

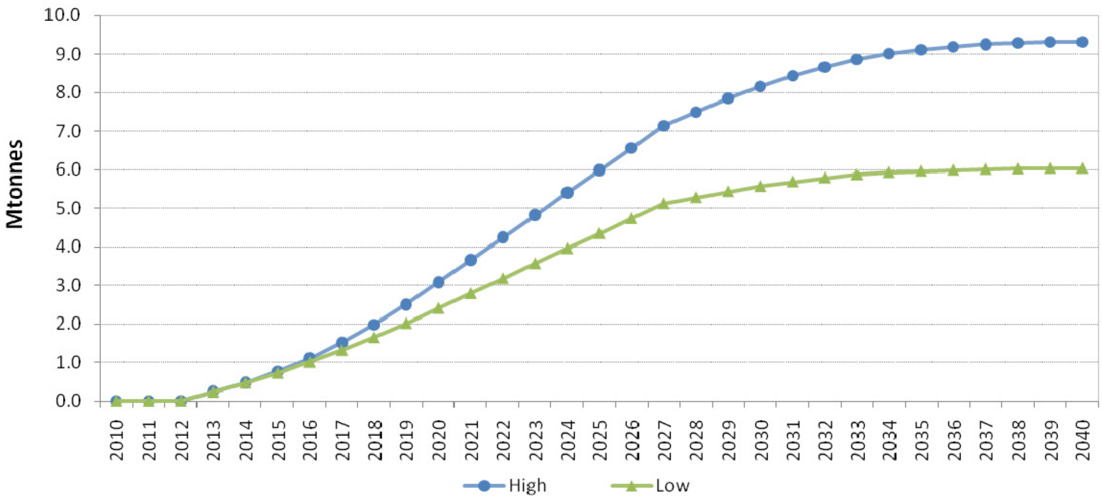

Figure 13-3: Cumulative avoided CO_2 in Syria

Source: MWH modelling (2010)

13.2.3. CONSTRAINTS FOR RE DEVELOPMENT

The gap between conventional and RE electricity generation costs is a major barrier for the development of alternative energies, especially solar technology. Increasing average electricity tariffs is not being foreseen in the near future.

At the institutional level, RE constraints are related to the lack of a legal framework for the promotion of alternative technologies. In fact, the electricity law is still under discussion [93]. Moreover, PEEGT faces different institutional capacity shortcomings in the design and implementation of RE projects.

Due to its perceived unpredictability[94], PEEGT intends to limit the level of renewable power sources on the Syrian grid, especially that of wind power [95]. Mentioned ceiling on wind power plants would be set at between 10-20% of the overall installed capacity. Concretely, however, this should not constitute a constraint to the deployment of the projects proposal identified, considering that their estimated cumulated capacity would be far below the "RE ceiling" discussed.

Finally, the export of electricity from RE sources to the EU could be jeopardized by the island mode connection with Turkey. In this context, Syria could be prevented from using the benefits of article 9 of the EU Electricity Directive. According to PEEGT, the development of a high voltage DC interconnection between Syria and Turkey is the best option to allow RE exports [54].

[93] PEEGT believes it will be passed soon [54].

[94] As explained in Part I – Chapter 4, anecdotal evidence gathered in the region and in Syria, seem to point to the negative perception of renewable power technologies and their potential "problematic" integration onto their power grids. Experience (inter alia) from the European countries seems to suggest this is not a real constraint.

[95] In case of a failure in the base load plants, wind systems protect themselves by disconnecting from the grid.

14. TUNISIA

14.1. Overall Presentation of the Energy Sector

14.1.1. Outlook of Energy Supply, Renewable Energy's Share, and Country's Targets

Tunisia's total installed capacity and electricity generation are, respectively, 3,316 MW and 5,000 GWh (2008). Electricity from renewable energy sources is around 1 % of total electricity generation; half of this percentage belongs to hydro and the other half to wind [1]. The country's primary source of electricity generation is natural gas, of which Tunisia is a net importer.

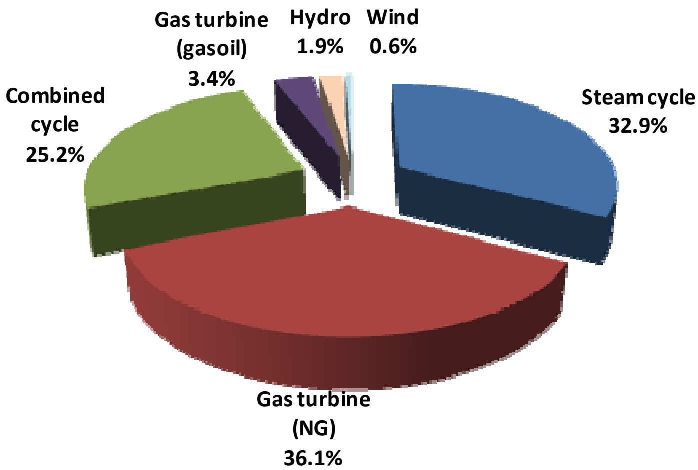

Figure 14-1: Installed capacity share in Tunisia (2008)

Source: [1]

Through the Tunisian Solar Plan (TSP), Tunisia expects to increase the RE share from 0,4 % in 2008 to 10 % in 2020.[96] By 2014, the TSP projects a 4 % RE share in total electricity generation [10]. By 2014, the national grid is expected to absorb up to 10 % capacity from RE. The TSP was officially endorsed on December 11th 2009. The government is currently implementing different initiatives to reinforce the national grid and allow a higher share of RE in electricity generation. For instance, the 1,000 MW interconnection project with Italy is expected to be operational by the end 2016.

14.1.2. Stakeholders dealing with Renewable Energy

The following paragraphs identify the country's major stakeholders and describe their main responsibilities in the RE field.

- Ministry of Industry, Energy, and Technology (MIT): it is responsible for the formulation of the country's energy policy. It prepares and defines the RE strategy and the regulatory framework for RE provision;

[96] This increase would correspond to 660 MW of new RE capacity.

- National Electricity and Gas Corporation (STEG): it is responsible for the generation, transmission, and distribution of electricity and the processing, transmission, and distribution of natural gas. It is also the single buyer for IPP projects and other electricity produced by the private sector (industry, commercial, households). It is the promoter of some hydro and wind energy projects and is developing programmes for CSP and PV projects;
- National Agency for Energy Conservation (ANME): it is responsible for implementing the government's energy conservation policy [55];
- STEG-Renewable Energy (STEG-ER): its main role is to provide technical expertise in the field of RE technologies;

14.1.3. RE LEGISLATION

Decree 2009-2773 of September 28th 2009 [56] defines the conditions for the transmission of electricity generated from RE sources and the selling of electricity from the same sources to the utility.

Box 5:

Key features of Decree 2009-2773.

Source: [57][58][59]

- Exclusive sales of electricity from RE sources to STEG must not exceed 30 % of the country's total RE generated electricity; the limit can only be exceeded if electricity comes from biomass produced energy and is within 15 MW;
- The power installed capacity for generating electricity must be within the limit of subscribed power with STEG at low voltage level;
- Tariffs1 applied to electricity generated from renewable energy to STEG:
- Projects connected to high and medium voltage grid: the STEG general high voltage tariff of the day is applied (the average annual price for 2009 was equal to 92 millimes 1/kWh (0.051 €/kWh);
- Projects connected to the low voltage grid: STEG calculates the difference between the electricity supplied by the consumer to the grid and the electricity provided by STEG to the consumer. This difference will be used to calculate the next electricity bill for the consumer;
- Third party access is only allowed for power auto-producers (i.e. producers of electricity destined to their own consumption, in most cases industrial stakeholders).

Table 14-1 shows the RE projects for which financial support has been already secured. [97]

[97] These projects were not included in the assessment. The methodology was explained in paragraph **2.1** of Part I.

Table 14-1: Identified projects under construction in Tunisia

Projects under construction						
Project	**Promoter**	**Technology**	**Capacity (MW)**	**Cost (M€)**	**Commissioning date**	**Project status**
Residential	Public [STEG - ANME]	PV	2	11	2010 - 2011	Under construction

14.2. RE PROJECTS' ASSESSMENT

14.2.1. IDENTIFIED RE PROJECTS

Table 14-2, Table 14-3 and Table 14-4 present the identified RE projects in Tunisia. Information was collected during the meetings held with Tunisian authorities and sector stakeholders. [98]

Table 14-2: Identified Wind projects in Tunisia

TUNISIA – Wind Power									
N.	**Project**	**Promoter**	**Capacity [MW]**	**Cost [M€]**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
1	Bizerte	Private and Public [Auto producers]	31	100[99]	2011-2014	Ongoing feasibility study (expected to be finished by December 2010).	Specific wind measurements have been conducted for 8 major industries (including 5 cement plants). Good wind conditions have been identified.[100]	PFS	[57]
2	Feriana		15						
3	Gafsa		15						
4	Borj Cedria		1						
5	Not defined yet	Private.	100	156	2016	Conceptual stage.	Suitable locations have been pre-identified. The regulatory framework and the interconnection with Italy are not ready yet.[101]	IS	[57]

98 Most of the data presented in the tables of this chapter is based on information received from consulted stakeholders as of February 24th 2010. A few key data have been updated whilst finalising the report in September 2010. The changes between the initial data provided by consulted stakeholders and the hereby presented data have been clearly identified and justified with footnotes.

99 Total cost provided for the implementation of the 4 projects.

100 Feasibility study was completed for 1 cement plant (16 MW), the rest studies will be ready in June 2010. CDM funding is being requested by 3 plants (PIN prepared). Transport and electricity tariffs have been agreed with STEG.

101 The regulatory framework for the development of wind projects by the private sector is expected to be finalized in 2012. The interconnection with Italy is expected in 2016. Given the project's potential and the interest shown by private investors, a project could be implemented after commissioning of the interconnection (around 2017).

Table 14-3: Identified CSP projects in Tunisia

TUNISIA - Concentrated Solar Power (CSP)									
N.	**Project**	**Promoter**	**Capacity [MW]**	**Cost [M€]**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
6	To take place in the Southern region, but not defined yet.	Public [STEG]	25 – 50	85[102]	2014	Ongoing feasibility study.	FS is being prepared by Lahmeyer. It should be completed by the end of 2010.	PFS	[58]
7	Not defined yet.	Private [ELMED]	100	311	2016	Ongoing bidding process.	Selection of bid winner by the end of 2010. PPA and other contracts to be signed in 2011. Construction to take place in 2012-2016. Expected to be commissioned in 2016.[103]	PFS	[59]
8	Not defined yet.	Private	75	250	N/A	Conceptual stage.	Implementation after commissioning of interconnection with Italy (2016).	IS	[57]
9	EL BORMA	Public - Private [SITEP]	35 MW CC+ 5 MW CSP as an option.	54	N/A	Ongoing pre-feasibility study.	-	PFS	[57]

[102] Cost estimation for 25 MW.

Table 14-4: Identified PV projects in Tunisia

TUNISIA - Photovoltaic Power (PV)									
N.	**Project**	**Promoter**	**Capacity [MW]**	**Cost [M€]**	**Commissioning date**	**Project status**	**Comments**	**Category**	**Source**
10	Not defined yet.	Public [STEG]	10	35.6	2016	Ongoing feasibility study.	FS is being prepared by Lahmeyer. It is expected to be finished by the end of 2010.	IS	[58]
11	Not defined yet.	Private	10	35.6	N/A	Conceptual stage.	No Pre-feasibility study has been prepared.	IS	[57]
12	Residential and public buildings.	Public [STEG]	13	70	2014	Tendering phase.	Bids are under evaluation for projects of 3 MW. Expected to be implemented in 2010.[104]	FS	[58]

14.2.2. Modelling results

Figure 9-2 shows the estimated power production cost trend, modelled for different technologies in Tunisia over the period 2010-2020. As a fossil fuel importer country, Tunisia presents a relatively high cost of power from fossil fuels. Cost of solar power is currently higher than that from fossil fuels. Based on similar estimations, it is expected that PV and CSP power could become competitive vis-a-vis fossil fuels' respectively, by 2016 and 2020. Wind power cost appears currently lower than that from fossil fuels.

[104] Bidders have to include in their bids a concessional funding proposal. Requests for proposals have not been issued for projects of 10 MW. Implementation is expected in 2014.

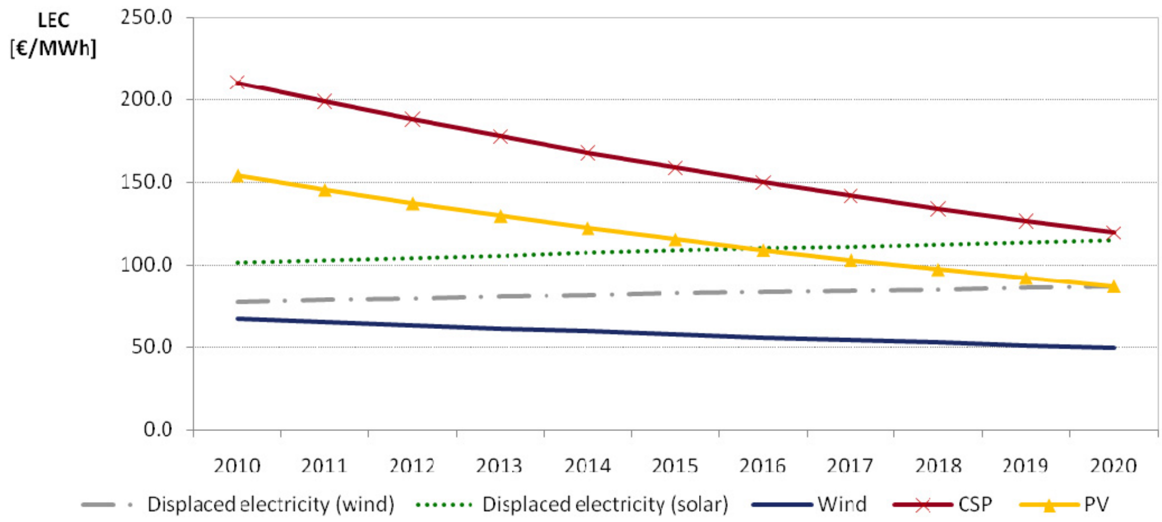

Figure 14-2: LEC trend in Tunisa.

Source: MWH modelling results

Figure 14-3 shows the cumulative avoided CO_2 emissions in the two simulated scenarios. Were all the identified RE projects in Tunisia implemented, CO_2 emissions could be reduced by up to 0.1 Mtonnes per year in the low scenario and by 0.4 Mtonnes per year in the high scenario. Based on similar estimations, by 2040 Tunisia could achieve cumulative savings of 2 Mtonnes in the low scenario and 7 Mtonnes in the high scenario.

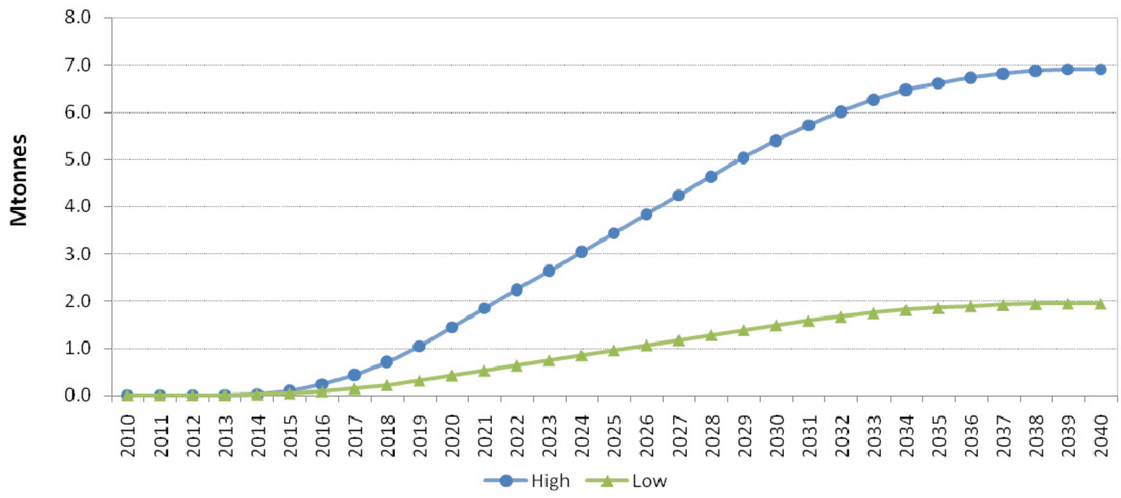

Figure 14-3: Cumulative avoided CO_2 emissions in Tunisia

Source: MWH modelling results

14.2.3. Constraints for RE development

Higher costs of electricity from RE than from conventional sources is the main obstacle for RE development, especially solar energy, in Tunisia. Increasing electricity tariffs from conventional sources is not being foreseen in the near future.

Tunisia also faces significant institutional constraints. The legislation in force only allows major electricity consumers to produce RE electricity for their own use, preventing the expansion of the industry. Independent private operators cannot produce electricity from RE for the local market,

although authorizations can be extended for exports. Moreover, third party access is only allowed for self-producers. Finally, RE in Tunisia could be also benefited from the definition of the modalities to implement Article 9 of the EU directive. The government has not yet defined the modalities which would allow exporting electricity from RE to the EU, but a related study is being prepared by the Italian government.

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APPENDICES

Appendix 1 – RENEWABLE ELECTRICITY GENERATION POTENTIAL IN TURKEY

After coal, renewable energies are the largest contributor to Turkey's domestic energy production[105]. More than half of renewables used in Turkey are composed of combustible renewables and waste; the rest of renewable includes hydro, geothermal, and wind. The majority of combustible renewables and waste used in Turkey are non-commercial fuels, typically wood and animal products used in residential areas for heating purposes[106].

Turkey is the largest electricity market in the South Eastern Europe region and has recently experienced a rapid growth of electricity demand. Since the economic crisis in 2001, electricity consumption has grown at an annual rate of 8 %[107]. As a consequence of the recent financial crisis, the demand of electricity dropped by 2% in 2009. Moreover, the Turkish Electricity Transmission Corporation (TEIAŞ) estimates a low increase in the demand of electricity during 2010 and 2011. Between 2012 and 2018, electricity demand is expected to increase at an annual rate of 7 %.

The Turkish system has a total installed generation capacity of about 42 GW. Gas, hydro, and lignite & hard coal account, respectively, for 35%, 33%, and 25% of the total generation capacity. While there appears to be a generous capacity margin, it should be noted that the availability of hydropower is dependent on hydrological conditions. Moreover, the plant availability of some power stations is low. From 2005 to 2009 the average utilization rates of plants fell from 40% to 37%. This is reflected in the sources of electricity generation. Electricity generated from gas fired plants accounted for 46% (90 TWh) of total electricity generation. Hydro and other sources accounted, respectively, for 37 TWh and 2 TWh of total electricity supply.

Due to a sustained growth of electricity demand and declining plant availability, power cuts are likely in the short term. The grid operator predicts a system peak between 51 and 55 GW by 2018. Installed capacity is forecasted to reach 55 GW by 2016[108]. In order to ensure the security of supply, considerable levels of investment will be needed[109]. Excluding hydro, electricity generation from renewable energies account for 2% of installed capacity (883MW). The generation of electricity from renewable energies has been growing rapidly, nearly doubling from 2008 to 2009. Wind power is the largest source of electricity generation, deploying 800 MW (2009). The rest of the renewable energies are geothermal (80 MW), photovoltaic (<1 MW), and biomass (<3 MW).

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[105] In 2007, energy from renewable sources amounted to 9.6 Mtoe (10% of TPES). The country's peak in the use of renewable energy was in 1990 when 9.7 Mtoe renewables were used (although this meant 18% of the TPES then).

[106] Due to the substitution of non-commercial by commercial fuels, the use of biomass for residential heating has declined.

[107] In 2009, the total consumption of electricity reached 194 TWh. According to the methodology explained in paragraph 2.1 (Part I of this report), these projects are not included in the assessment exercise.

[108] IEA Energy Statistics – Energy Balances for turkey 2007

[109] Turkey's Ministry of Energy and Natural Resources (MENR) estimates that capacity will have to double (80 GW) by 2020.

Turkey has a formidable renewable energy potential. The MENR, through the Electricity Energy Market and Supply Security Strategy[110], has set specific targets for renewable energy generation. By 2023, the MENR expects the share of renewable energy to be 30 % of the country's total generation capacity[111]. By 2020, Turkish authorities estimate that 20 GW of electricity generation will come from renewable energy sources. Table 1 shows the energy mix in the period 2010-2020.

Technology	**2010 (MW)**	**2020 (MW)**	**Target 2023**
Thermal	27000	45000	No target
Hydro	14000	24000	37000
Wind	800	10000	20000
Geothermal	80	500	600
Solar	0	0	No target
Other RES – E	3	25	No target

Table 1: Potential Fuel Mix Evolution 2010 - 2020[112]

Source: Various sources including TEIAŞ, Government Ministries, and EMRA

Hydro:

Hydro is the predominant renewable energy source (13.7 GW). Despite the significant share of hydro in total electricity generation, the General Directorate of Hydraulic Works (DSI) estimates that 65% of Turkey's hydro potential is still untapped[113]. The country expects to fully develop its hydro potential by 2023 (37 GW). Nevertheless, this goal is unlikely to be achieved. There is lack of grid capacity in relevant areas and not all construction facilities are available[114].

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[110] Resolution 2009/11 Electricity Energy Market and Supply Security Strategy Paper, MENR Sept. 2009.

[111] This is a 20 % increase from 2010.

[112] Various Sources; Turkish Electrical Energy 10 year Capacity Projection 2009-2018, TEIAŞ June 2009.

[113] Turkey Water Report 2009, General Directorate of State Hydraulic Works 2009.

[114] There are currently about 3.7 GW under construction and a further 7.5 GW have been licensed. TEIAŞ estimate that between 5.4 GW and 6.7 GW of this capacity will connect to the system by 2016.

Wind:

Installed wind farm capacity has grown rapidly since licensing began in 2002. There are currently 800 MW of installed capacity. Turkey has a substantial wind potential[115]. By 2023, Turkish authorities expect to reach 20 GW of installed capacity[116]. The energy regulator (EMRA) has received in excess of 75GW of applications for RE projects' grid connections; however the bulk of these is targeting overlapping areas and considerably exceeds the available grid capacity. Considering the current network constraints and assuming that the competition of applications for geographic areas is resolved, TEIAŞ estimates that by 2020 a maximum of 10 GW of wind energy will be delivered. By offering the highest contribution fees, overlapped applications (more than 600) will compete to obtain a generation license.

Solar:

According to the Energy Potential Atlas of Turkey, an area of 4600 km^2 is feasible for investments in solar applications. Turkey's maximum technical potential could reach 380 TWh[117]. Although a number of off grid applications exist, there are currently no companies holding a license to generate electricity using solar power for exports. Due to the inadequacy of feed-in tariffs, no solar power plant applications will be received until the enactment of the amendments to the RES Law[118].

Geothermal:

There is a marginal utilization of Turkey's 2000 MW geothermal potential (80MW connected to the system). By 2023, the government expects to reach 600 MW of installed capacity. Four sites with electricity production potential have been awarded in 2008. Another tender for 29 sites is being prepared by MENR.

Conclusions and prospects for RE development:

Turkey's limited progress in the development of RE is explained by inappropriate incentives, poor regulations, and an inadequate grid. In an effort to achieve the country's 2023 targets, the government has announced an amendment to the 2005 Law on the Use of Renewable Energy Resources for Electricity Production (RES Law). The new bill provides higher feed-in tariffs and additional incentives for investments in RE[119]. It also promotes the use of Turkish technology.

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[115] In 2009 there was over 600 MW of wind generation under construction.

[116] Wind in Power 2009 European Statistics, EWEA Feb. 2010.

[117] Solar Radiations and Insulation (sic) Durations in Turkey (2001). General Directorate of Electrical Power Resources Survey and Development Administration.

[118] The Ministry of Agriculture and Rural Affairs is currently working on a regulation to determine the agricultural land on which solar power plants cannot be legally established. The regulation is considered a positive step by wind energy investors.

[119] Although its enactment was expected in June 2009, the amendments have been delayed due to the Ministry of Economy's disproval. According to the Ministry of Economy, extending financial incentives to RES investments would increase pressure on the fiscal budget and affect Turkey's trade commitments with the EU and WTO. At the moment the proposed amendments are being reviewed by the MENR and will require final approval by the Ministry of Economy.

The bill proposes the following rates:

Onshore wind	EUR 0.08 per kWh
Offshore wind	EUR 0.12 per kWh
Geothermal	EUR 0.09 per kWh
PV	EUR 0.25 per kWh
STEG	EUR 0.20 per kWh
Biomass	EUR 0.14 per kWh
Marine	EUR 0.16 per kWh

The government has made significant progress by addressing regulatory and grid bottlenecks. In order to reduce network congestion, the energy regulator (EMRA) has recently negotiated technical standards with TEIAŞ for new renewable connections and locational transmission pricing. The government has also committed to providing TEIAŞ with financial and other necessary resources to secure electricity supply through renewable energies.

Appendix 2 – CONTACT LIST

The following list identifies the institutions and/or companies that provided information and data for the study.

COUNTRY	INSTITUTION OR COMPANY
Egypt	Delegation of the European Union in Egypt
	Egyptian Electricity Holding Company
	Egyptian Electricity Regulatory Commission
	Energy Efficiency Improvement & Greenhouse Gas Reduction (GEF/UNDP)
	Local office of the European Investment Bank
	JICA
	KfW
	Ministry of Electricity and Energy
	NREA
	World Bank
Gaza/West Bank	European Commission Office for the West Bank and Gaza Strip
	PENRA (Palestinian Energy and Natural Resources Authority)
Israel	Delegation of the European Union to the State of Israel
	Israel Institute of Technology
	Ministry of Finance
Jordan	ERC
	Delegation of the European Union in Jordan
	European Jordanian Company for Renewable Energy Projects LLC
	Kawar Energy
	MEMR
	Ministry of Planning and International Cooperation
	NEPCO
	NERC
Lebanon	ADM Energy
	ALMEE

COUNTRY	INSTITUTION OR COMPANY
Morocco	AFD
	CDER
	Local office of the European Investment Bank
	GTZ Coopération Technique Allemande
	MASEN
	Ministry of Energy, Mining, Water, and the Environment
	ONE
	ONEP
	World Bank Office in Morocco
Syria	Delegation of the European Union to Syria
	Ministry of Electricity
	NERC – Ministry of Electricity
	PEEGT – Ministry of Electricity
Tunisia	AFD
	AfDB
	ANME
	Local office of the European Investment Bank
	GTZ
	JICA
	MDCI
	MIEPME
	STEG

Appendix 3 – ASSUMPTION BOOK

ECONOMIC PARAMETERS		SOURCE
Fuel price	Assumed fossil fuel (crude oil, natural gas, steam coal) price in the Reference/Stable Scenarios of the IEA World Energy Outlook until 2030. Real terms.	[60]
Real discount rate [for all countries]	5%	EIB

Levelised Electricity Cost from conventional sources

	Country type	
EUR/MWh	*Energy **Importer** (Morocco, Tunisia, Jordan, Israel, Lebanon, Palestine)*	*Energy **Exporter** (Algeria, Egypt, Syria)*
2010		
Wind on-shore	77.21	67.86
Solar (CSP and PV), Hydro	101.37	88.75
2015		
Wind on-shore	82.47	73.12
Solar (CSP and PV), Hydro	108.66	96.53
2020		
Wind on-shore	86.79	77.40
Solar (CSP and PV), Hydro	115.04	103.16
2025		
Wind on-shore	90.96	81.61
Solar (CSP and PV), Hydro	121.24	114.36
2030		
Wind on-shore	95.13	85.78
Solar (CSP and PV), Hydro	127.43	120.56
2035		
Wind on-shore	99.30	89.95
Solar (CSP and PV), Hydro	133.62	126.75
2040		
Wind on-shore	103.46	94.11
Solar (CSP and PV), Hydro	139.39	103.52

Renewable energy technologies

On Shore Wind		
Data	***Value***	***Source***
Lifetime [years]	15	EIB – MWH
Capacity factor [%]	25-35%	Based on reference plant
Capital cost (unitary) [€/W]	1.6	EIB – MWH (average of different on-shore wind farm projects in various countries)
O&M costs (share of capex)	2%	EIB – MWH
Learning rate - cost decrease	3%	[61]

Solar PV		
Data	***Value***	***Source***
Lifetime [years]	20	EIB – MWH
Capacity factor [%]	16.6% - 24.9%	Estimated by country based on PVGIS (http://re.jrc.ec.europa.eu/pvgis/)
Performance Ratio (Balance of Plant Efficiency)	75%	Assumed PRs for typical commercial plants: 75 % by 2010, 80% by 2020 - [62]
	80%	
Capital cost (unitary) (€/Wp)	3	[62]
O&M costs (share of Capex)	1%	EIB – MWH
Learning rate - cost decrease	5.0%	[62]

Solar CSP (no storage, 15% gas hybridization)		
Data	***Value***	***Source***
Technology	Parabolic through, with no storage	EIB – MWH
Lifetime [years]	20	EIB – MWH
Capacity factor [%]	22.8% - 27.8%	Average load factor calculated by interpolating calculated data from SAM software, applied to reference plants DNI values
Direct normal irradiation		If available will be taken for a reference plant site
Capital cost (unitary) [€/W]	4	Assumed investment costs of 4 €/W for trough [4.5 €/W for power tower] technology by 2004.
O&M costs (share of Capex)	3%	EIB – MWH
Learning rate - cost decrease	5.5%	[63]

Hydro		
Data	***Value***	***Source***
Lifetime [years]	40	MWH assumption
Capacity factor [%]	depending on country	Reference Plants
Capital cost (unitary) [€/W]	2	MWH assumption
O&M costs (share of Capex)	1.5%	MWH assumption

CO2 calculation (average electricity CO2 emission factor (tCO2/MWh)) (Source: [64])

Country	***CO_2 emission factor for electricity production [t/MWh]***
Algeria	0.671
Egypt	0.471
Gaza/West Bank	0.767
Israel	0.767
Jordan	0.66
Lebanon	0.667
Morocco	0.778
Syria	0.587
Tunisia	0.482

Appendix 4 – METHODOLOGY FOR LEC CALCULATION

LEC calculation for conventional plants:

LEC for conventional energy sources (displaced LEC) was calculated based on a different electricity mix for both exporter and importer countries and for the different renewable energy sources (i.e. solar and wind). They contribute to different parts of the load curve.

Based on average solar / wind production profiles, assumptions were made with regards to the type of electricity displaced by renewable generation in the countries of the region. Solar is expected to cover mostly peak and mid-peak demand whilst wind power is assumed to displace mostly base load electricity.

Ideally, models of the electricity systems in each country would be needed to assess the "displaced LEC" for both technologies. Nevertheless, due to the lack of data, an approximate assessment was undertaken, taking into consideration whether the particular country was an "oil/gas importer" or "oil/gas exporter"[120].

In the case of "importer" countries (i.e. Morocco), solar electricity was assumed to replace the fixed cost of an open-cycle gas turbine peaker fuelled by diesel plus the variable cost of a mix of combined-cycle gas turbines and open-cycle gas turbines. For "exporter" countries (i.e. Algeria), the mix assumed open-cycle gas turbines and gas-fired steam cycles, the latter being gradually replaced by combined-cycle gas turbines.

For both "importer" and "exporter" countries, wind power was assumed to displace the full costs of generation in a Combined Cycle Gas Turbine (working at 6000 hours/year).

Inputs on energy prices and their forecasted evolution (oil, gas) were based on the IEA scenarios [60]. Accordingly, the conventional LEC increase in time reflects the expected trend in regional energy prices.

CO_2 benefits (eq. to 10 EUR/tCO_2) were also included in the calculation of the conventional LEC. Indeed, aside from potential carbon credits, it could be argued that reducing CO_2 emissions in the region would entail a benefit which is at least equivalent to the conservative value used above.

LEC for conventional displaced electricity (and the assumed opportunity costs of solar and wind electricity in the different countries covered by the study) is shown in Appendix 3.

LEC calculation for RE plants:

Levelised Energy Cost (LEC) is the cost of generating energy (usually electricity) for a particular system. It is an economic assessment of the cost of the energy-generating system over its lifetime, including initial investment, operations and maintenance, cost of fuel, and cost of capital.

It is calculated using the following formula:

$$LEC = \frac{\sum_{t=1}^{n} \frac{I_t + M_t + F_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}}$$

Where:

- LEC = Average lifetime levelised electricity generation cost
- I_t = Investment expenditures in the year t
- M_t = Operations and maintenance expenditures in the year t
- F_t = Fuel expenditures in the year t
- E_t = Electricity generation in the year t
- r = Discount rate
- n = Lifetime of the system

In this study, LEC is always quoted in EUR/MWh terms.

LEC for RE technologies was estimated based on a reference plant for each technology. In the case of countries in which the location of reference plants was not identified, the most solar irradiated area of the country was considered. This assumption is based on the fact that the new RE plants will probably be installed in the area where the RE source is mostly available.

Investment expenditures:

A unitary investment cost [€/W] was assumed by technology. Investment cost for RE technologies is expected to decrease in the next 10 years (2010 – 2020). A decrease rate have been assumed and applied every year as reported in the assumption book.

Operations and maintenance expenditures:

O&M costs have been assumed as a percentage of the total investment cost. Considering the development of the RE industry in the region and the emergence of locally trained technicians, O&M costs have been assumed to decrease at the same rate as investment expenditures.

Fuel expenditures:

It only applies to CSP technologies. It was taken into account in the O&M cost.

Electricity generation:

The calculation of the energy production in year t for a given reference plant has been calculated based on the following formula:

$$E_t = P_y \times Cf \times H$$

Where:

E_t = Yearly Energy production (MWh)

P_p = Installed Power (MW)

C_f = Capacity Factor (%)

H = 8760 h (hours in one year)

Capacity Factor

For each technology the capacity factors have been estimated as follows:

- Wind

  A reference plant has been identified for each country and capacity factors retrieved by available documents. Capacity factors were limited to 35 % as a maximum value and 25 % as a minimum value. A 30% capacity factor was assumed when data was not available.

- CSP

  A reference plant has been identified for each country. For the countries in which the location of reference plants could not be identified, the most insulated area of the country was considered.

  The main parameter affecting the capacity factor of a given CSP plant is the Direct Normal Irradiation (DNI). DNI for the reference plants was retrieved from the NASA website [65]. SAM software was used to estimate the capacity factor at different DNI. Since SAM works only for the United States, DNI and capacity factors were correlated.

- PV

  A reference plant was identified for each country. In countries where the location of the reference plants could not be identified, the most solar irradiated area of the country was considered.

  The global solar irradiation for the reference plants locations was retrieved from the PVGIS website [66]. The irradiation on a 25° inclined surface was considered for the capacity factor calculation [121].

  Since the balance of plant performance ratio (PR) is expected to increase in the next 10 years, the capacity factor is expected to grow accordingly for new projects. The increase of the capacity factor was taken into account in the model. An annual capacity factor was also calculated.

[121] The PV modules must be placed perpendicularly to the sun rays. Taking into account the maximization of electricity produced over a year, 25° was chosen as a typical value for the Mediterranean countries included in the study.

Discount rate:

The discount rate *r* took into consideration the cost of capital, including the balance between debt-financing and equity-financing, and an assessment of the financial risk. The discount rate value has been assumed equal for all the countries in the region. Its value is reported in Appendix 1.

Lifetime of the system:

Typically, LEC is calculated over a lifetime of 15 to 40 years. Projects' lifetimes were assumed for each technology (Appendix 1).

Appendix 5 – REFERENCE PLANTS

The following tables show the reference plants considered for the LEC modelling:

Wind:

Reference plants were selected by screening the most advanced projects (FS). When data was not available, reference plants were selected from less advanced projects (PFS and IFS). When data was not available from neither advanced nor less advanced projects, existing operating plants and/or papers showing wind measuring campaigns were considered.

Country	Reference Plant Location	Reference Plant Size [MW]	Load Factor	Source
Algeria	Adrar	30	35.0%	[67]
Egypt	Zafarana	120	35.0%	[3]
Gaza/West Bank	Hebron	0.75	30.0%	Average value assumed.
Israel	No reference site available	50	30.0%	Average value assumed.
Jordan	Al- Kamsha	40	33%	[68]
Lebanon	No reference site available	50	25.0%	Minimum value assumed [69]
Morocco	Tarfaya	300	30%	Assumed value.
Syria	Homs - Qatineh	50	30%	Assumed value.
Tunisia	Sidi Daiud	100	31.60%	Existing operating plant data.

Solar:

For solar (PV and CSP) technologies, the most advanced projects were used as reference plants. In case of data unavailability, the most solar irradiated area was selected.

PV

Country	Reference Plant Location	Reference Plant Size [MW]	Year	Load Factor
Algeria	Most solar irradiated area	1000	2010	20.5%
			2020	21.9%
Egypt	Most solar irradiated area	20	2010	23.3%
			2020	24.9%
Gaza/West Bank	Jerico	0.55	2010	16.6%
			2020	17.7%
Israel	Ashalim	15	2010	17.1%
			2020	18.2%
Jordan	MDA Industrial Park, Maan	100	2010	19.5%
			2020	20.8%
Lebanon	Most solar irradiated area	100	2010	18.5%
			2020	19.7%
Morocco	Ouarzazate	500	2010	18.9%
			2020	20.2%
Syria	Palmyra	20	2010	17.8%
			2020	19.0%
Tunisia	Most solar irradiated area	13	2010	20.0%
			2020	21.4%

CSP

Country	Reference Plant Location	Reference Plant Size [MW]	Load Factor
Algeria	Meghaïr (Wilaya d'El Oued)	75	23.76%
Egypt	Kom Ombo	100	27.78%
Gaza/West Bank	Jerico	10	22.81%
Israel	Ashalim	95	25.24%
Jordan	Queira	100	26.91%
Lebanon	Zahleh Centre - Bekaa Valley	5	24.71%
Morocco	Ouarzazate	500	27.34%
Syria	Raqa Region	100	23.04%
Tunisia	Most solar irradiated area	100	23.92%

Summary Report – October 2010

European Investment Bank

EUROMED

Facility for Euro-Mediterranean Investment and Partnership

The Mediterranean Solar Plan (MSP) is one of the priority projects of the Union for the Mediterranean and aims at coping with the challenges posed by energy demand increases, security of supply and environmental sustainability in the Euro-Mediterranean region. Its objective is to develop an additional renewable energy capacity in the region of 20 GW by 2020 along with the necessary electricity transmission capacity, including international interconnections.

At the Nice Ministerial Conference on Industry in November 2008, the Euro-Mediterranean Ministers requested the European Investment Bank (EIB) to propose a road map for renewable energy in the Mediterranean region under the umbrella of the MSP.
This study contributes to this objective. It aims at assessing the level of maturity of the existing or planned renewable energy projects in the different Mediterranean Partner Countries, the economic impacts of developing these projects, as well as the main obstacles that may affect their implementation.

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