Climate Investment Funds

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CLEAN TECHNOLOGY FUND
INVESTMENT PLAN FOR CONCENTRATED SOLAR POWER IN THE MIDDLE EAST AND NORTH AFRICA REGION

Clean Technology Fund Investment Plan for Concentrated Solar Power in the Middle East and North Africa Region
Executive Summary

Introduction

1. This Clean Technology Fund Investment Plan proposes CTF co-financing of $750 million, which will mobilize an additional $4.85 billion from other sources, to accelerate global deployment of Concentrated Solar Power (CSP) by investing in the CSP expansion programs of five countries in the Middle East and North Africa (MENA): Algeria, Egypt, Jordan, Morocco and Tunisia. Specifically, the Investment Plan will:

- Enable MENA to contribute the benefit of its unique geography to global climate change mitigation -- no other region has such a favorable combination of physical and market advantages for CSP
- Support the deployment of about 1 Gigawatt of generation capacity, amounting to about 15% of the projected global pipeline and a two-fold increase in the current global installed capacity
- Support associated transmission infrastructure in the Maghreb and Mashreq for domestic supply and exports, as part of Mediterranean grid enhancement that will enable the scale up of CSP through market integration in the region
- Leverage over US$ 3 billion in public and private investments for CSP power plants, thereby almost tripling current global investments in CSP
- Support MENA countries to achieve their development goals of energy security, industrial growth and diversification, and regional integration

2. The International Energy Agency has identified concentrating solar power (CSP) as one of key technologies that "are at the heart of the energy technology revolution because they can make the largest contributions to reducing greenhouse gas emissions". However, CSP (like most new technologies) has higher costs and risks than current technologies. "It is only through technology learning as a result of marketplace deployment that these costs are reduced and the product adapted to the market" (IEA). The greater the scale of such deployment, the earlier such technologies will be commercialized. Therefore, international collaboration is required to accelerate the global deployment of technologies such as CSP through targeted schemes that provide positive incentives for their adoption at scale.

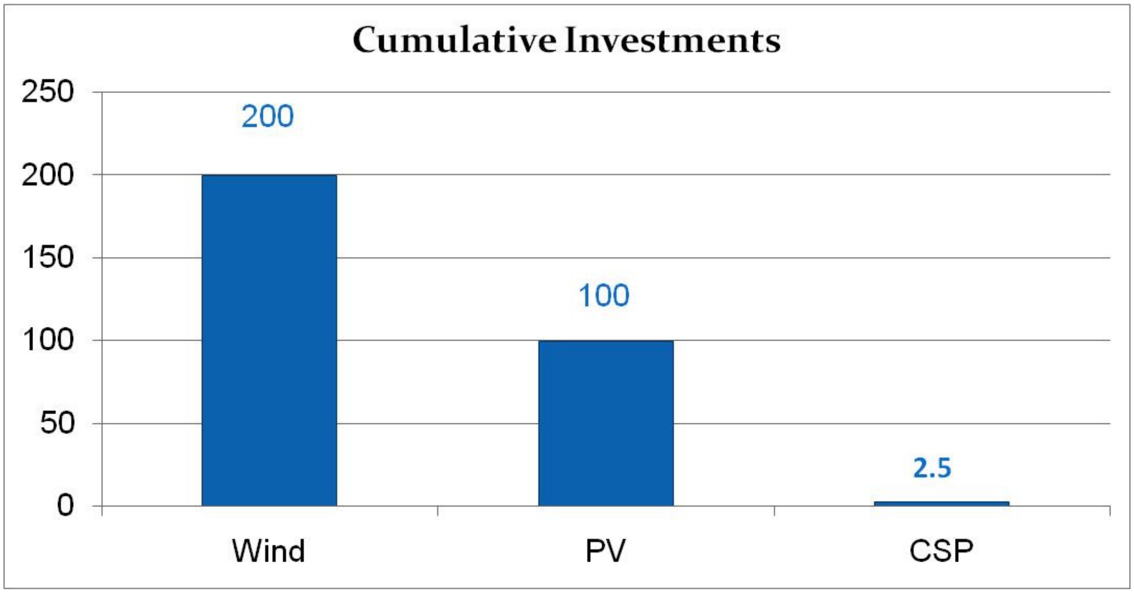
Global and Regional Context

3. A confluence of three global and regional factors provides a unique opportunity for the CTF to finance transformational actions in the MENA region. These investments would constitute a dominant part of the countries' ambitious strategies for deployment of low carbon technologies, have the scale to shape the course of global CSP market development, and deliver benefits that transcend climate mitigation by providing broader environmental and economic co-benefits. The three enabling factors are:

4. *First, CSP is a technology that is of particular interest to utilities, but with unexploited manufacturing scale economies:* CSP could be cheaper relative to PV on a per kWh basis in most cases and is more scalable and more consistent with a centralized and dispatchable generation model. Its adoption and replication by utilities is therefore more assured. CSP is a relatively simple technology with few high-cost materials or proprietary components. If the demand for CSP is scaled up, then equipment costs can fall very substantially, since it has yet to benefit from cost savings that often come from manufacturing scale.

5. CSP is a large-scale, proven technology for generating energy using the power of the sun. The industry is experiencing growth driven by government support schemes, such as tax incentives in the US and feed-in tariffs in Spain. At the end of 2008, approximately 482 MW of capacity of commercial plants were in operation and announced projects by the end of 2008 were in the range of 6-7 GW. However, at the global level, cumulative investment in CSP is still modest compared to investments in other renewable energy technologies. The proposed CTF investment program would almost triple global investments in the technology (see figure 1).

Figure 1 - Global Investments in Renewable Energy Technologies (US$ billion)



6. High initial capital costs are the most important barrier to the expansion of CSP. As much as 87 percent of the cost of electricity produced by a solar thermal plant is related to the initial capital investment and installation cost. Therefore, a CSP plant costing $4,000/KW operating at capacity factors of 22-24 percent can be around four times as expensive as combined cycle gas turbine plants. However, there is broad consensus in industry assessments that CSP has high cost-reduction potential, due to three factors:

- Manufacturers have yet to benefit from economies of scale, such as longer and more automated production runs, purchasing power on sourcing components and materials, and bigger R&D budgets. The history of PV suggests that doubling of capacity leads to a 20 percent reduction in costs.

- Technical improvements can be realized in certain components and these can be accelerated when companies' R&D respond to increased global demand. For example, between 1991 and 2004, technology advances helped reduce O&M costs by 30 percent and improve annual solar-to-electric efficiency by 20 percent for parabolic trough systems.

- Increased demand will result in a more diverse supply chain which will reduce component costs. Larger companies, with experience in achieving economies of scale through mass production, are also entering the market in anticipation of market growth.

7. A deployment program of 10-12 utility-scale CSP plants in a number of countries would send a strong signal to the market that would enable industry to plan manufacturing capacity expansions, which is central to driving down costs.

8. *Second, the MENA region has physical attributes that makes it particularly promising for CSP scale-up:* The region has amongst the world's best production conditions for solar power: abundant sunshine, low precipitation, and plenty of unused flat land close to road networks and transmission grids. As a result of these physical conditions, MENA is the developing region where the economies of scale that are necessary for global deployment of CSP can be achieved at the lowest cost.

9. *Third, market dynamics in the MENA region can provide a strong enabling environment for large-scale investments:* The consumption of electricity in MENA is growing faster than that of any other region in the world and countries are increasingly looking to scale-up renewable energy to diversify fuel mix away from hydrocarbons and enhance energy security to meet growing demand. In particular, the following factors that factors that would help develop domestic markets for power generated from CSP plants:

(a) For oil and gas importing countries, development of indigenous resources is essential to enhance the energy security and economic security. For example, in Jordan imports are equivalent to about 19.5 percent of the GDP.
(b) For oil and gas producing countries, an energy strategy focused on CSP and other renewables would help in freeing-up the increasingly valuable oil and gas resources for more value added utilization such as in industry, for sale in other remunerative domestic and export markets, and to retain option value for future use.
(c) Pursuing this relatively new technology brings additional benefits to the economy as it offers a new opportunity for industrial diversification and job creation; For example in the El-Kureimat pilot CSP project under implementation in Egypt, about 50 percent of the components are fabricated locally. For some of the key components such as mirrors and receivers, there are only a few manufacturers globally and MENA countries could benefit from the "first mover" advantage as the CSP scale-up starts taking shape.
(d) The opportunity exists to export "green electricity" to high paying markets in the Northern Mediterranean countries and thereby help address the affordability issue surrounding the large scale absorption of renewable electricity in domestic markets by cross-subsidizing domestic supply from the "premium consumers" in the EU.

Rationale for CTF Co-financing

10. The proposed gigawatt-scale deployment through 10-12 commercial-scale power plants, over three to five year timeframe, would provide the critical mass of investments necessary to attract significant private sector interest, benefit from economies of scale to reduce cost, result in organizational learning in diverse and several operating conditions, and manage country and technical risk.

11. *Potential for GHG reduction:* The proposed project pipeline will avoid or reduce about 1.7 million tons of carbon dioxide per year (at 24% CF) from the energy sectors of the countries. This would amount to around 1% of the total energy sector CO_2 emissions and about 0.5% of the total emissions from these countries. If the program is successful and replicated, the global benefits would be far larger. The transformational objective of this investment plan is served not by choosing short-run least-cost approach for GHG emission reductions (which could be pursued through energy efficiency or wind power) but rather by accelerating the realization of economies of scale for a technology that could be least-cost over the longer term, and be replicated in other countries with high GHG emissions.

12. *Demonstration potential:* The proposed program is regional in structure, but global in objective. Together with the planned capacity additions in the U.S, Europe and elsewhere, cost reductions and institutional learning that will be achieved through this program will facilitate faster and greater diffusion of this technology in other countries in Asia, Latin America and Africa that have significant potential for CSP. Estimates for realizable CSP potential vary from 20-42 GW by 2025 (DLR 2004) with opportunities in China, India, Iran, Israel, Portugal, South Africa, Spain, and the U.S. Brazil, Chile, Peru and Argentina are other potential markets for CSP development.

13. Learning curves show the rate of improvement in performing a task as a function of time, or the rate of change in average cost (in hours or dollars) as a function of cumulative output. Based on the experience in California, 12 percent cost reductions were calculated for each doubling of capacity. Industry interviews undertaken recently show projected cost reduction of 2-3 percent reductions annually

14. *Development impact:* For oil and gas importing countries, development of indigenous resources is essential to enhance their energy security and economic stability. For oil and gas producing countries, an energy strategy focused on CSP and other renewables would help in freeing-up the increasingly valuable oil and gas resources for more value added utilization such as in industry, for sale in other remunerative domestic and export markets, and to retain option value for future use. Exports of renewable energy would bring economic benefits through increased revenues, which will help finance the acceleration of renewable energy penetration within domestic markets.

15. Scaling-up of CSP can also provide a catalyst for an increase in manufacturing in the MENA region. If there is an assured demand for large capacity additions at the GW scale, manufacturing of precision components like the receiver tubes and mirrors may also become viable in the region. ESTELA, an industry group, estimates that if 20 GW of solar thermal capacity is added in the Southern Mediterranean countries, a total of 235,280 jobs would be created including 80,000 in manufacturing (40,000 on site and 40,000 in Europe); 120,000 in construction and 35,280 in O&M.

16. *Implementation Potential:* MENA countries have taken concrete steps towards power sector restructuring, which has contributed to their economic growth and expanded access to electricity. It is evident that sustained absorption of renewable energy in the domestic market will be only achievable by overcoming systemic barriers, such as energy subsidies and introduction of favorable policies that will encourage commercial utility operations. All five countries being considered in this investment plan have taken concrete steps in this direction. In Morocco, Tunisia and Jordan, energy subsidies are low by regional standards. Egypt has initiated a reform program for reducing energy subsidies. Similarly, electricity tariffs are low in Algeria; the government's objective is to gradually adjust domestic energy prices to international levels, but this process is likely to be slow. Although subsidies hamper the development of CSP market, all the governments envisage that energy efficiency and renewable energy over the medium to long term can actually help reduce governments' burden of high subsidies.

17. Due to rising costs for conventional power and higher demand for electricity, many countries in the region have been developing targets for renewable energy, and in many cases, explicit sub-targets for each technology. In addition to wind power of which there are many projects under construction or operating in MENA, CSP could be the next renewable energy technology to be utilized at scale. National targets for the share of renewable energy sources (RES) in power generation range from 6 to 20 percent by 2020. Taking into consideration key national commitments among CTF-eligible countries, it is proposed that the <u>CTF regional investment plan focus on five countries – Algeria, Egypt, Jordan, Morocco, and Tunisia</u> -- markets in which transformational outcomes are most likely:

- The Government of Algeria has introduced a national program for integration of renewables with an objective to reach five percent of power generation by 2017 and a long-term target of achieving 20 percent renewable energy power by 2030. Further, the long-term goal is to be met primarily from the CSP (70 percent CSP, 20 percent wind and 10 percent PV) which would make it among the world's most ambitious CSP programs. Through a March 2004 decree, the Government also introduced incentives for electricity production from renewable energy plants, including a feed-in tariff.

- The Government of Egypt has committed to increasing the share of renewable energy to 20 percent by year 2020 as a means of meeting growing electricity demand and achieving the economic objective of utilizing natural gas for higher value purposes. A key element of the plan for scale-up of renewable energy is the emphasis on renewable energy placed in the new Electricity Law, recently endorsed by the Cabinet and scheduled to be presented to Parliament for ratification during early 2010. Under the new law, a funding mechanism mobilizes funds from the export sale of gas saved by renewable energy.

- The Government of Jordan's energy policies have been shaped by the fact that it is almost entirely dependent on fuel imports for its energy requirements. In December 2007, the Government adopted an energy sector strategy, which, inter alia, increased emphasis on renewable energy and energy efficiency. The updated strategy sets a target of seven percent of the country's energy mix to come from renewable sources by 2015 and 10 percent by 2020.

- The Government of Morocco has articulated a broad vision to address energy security in light of the fact that Morocco's energy balance is dominated by imported fossil fuels. Key elements of the Government's strategy include: diversifying and optimizing the energy mix around reliable and competitive energy technologies, in order to reduce the share of oil to 40 percent by 2030; making energy efficiency improvements a national priority; and integrating into the regional energy market, through enhanced cooperation and trade with both other Maghreb countries and the EU countries. On November 2 2009, the Government unveiled a Moroccon Solar Plan aimed at achieving a 42 percent renewable energy target by 2020 and has a 2000 MW long term target for solar power including CSP by 2020.

- The Government of Tunisia has emphasized the role of energy conservation since the 1980s, due to the fact that Tunisia is a net importer of energy and the country has become vulnerable to supply disruptions and price volatility. The Government has recently announced a "Tunisian Solar Plan" for implementation during 2010-16. The plan identifies 40 projects in the areas of wind, solar, and biomass. The expected funding is in the range of Euro 2 billion, with about Euro 1.4 billion from the private sector.

18. *Additional costs and risk premiums:* CSP is not economically competitive with fossil fuel based power generation in the current market settings. A CSP plant with US$4,000/kW capital cost operating at 30% capacity factor would be 2.46 times as expensive as combined cycle gas turbine, the most likely business as usual candidate power plant in most countries in the MENA region. The objective of the CTF Investment Plan is to mobilize sufficient concessional and carbon finance to complement commercial and MDB lending, as well as sponsor equity, to bring the levelized cost of electricity of CSP power to within the range of wind power. Export of part of the energy would require a lower sales price on the local markets to achieve the required profitability, depending on the quantities to be sold in the export market, or reduce the need for additional donor concessional support.

19. The regulatory framework and the grid infrastructure to support "green" energy trade in both the EU and MENA countries are evolving and hence uncertain. In EU, the policy and regulatory

environment for green energy trading is becoming stronger following the EU renewable energy directive[1]. In MENA, private sector development of renewable energy is starting to gain momentum due to a range of co-benefits. The enabling environment, however, will only be strengthened with experience. In the early stages, countries on both sides of the Mediterranean will focus on benchmarking of prices and contractual arrangements -- in effect there would be "regulation by contract". With more experience, this environment will improve. By providing concessional financing for CSP scale-up, CTF buys-down the upfront risk for investors in MENA countries.

20. For CSP plants to be developed within MENA region countries for meeting domestic demand, significant infrastructure bottlenecks are not expected. It should however be noted that some projects may need transmission lines within countries (specifically, in Jordan and Tunisia) due to the location of the plants in relation to the existing grid. However, a greater challenge is trade of power between countries in MENA and in Europe. The proposed investment plan therefore includes two transmission projects to enable MENA exports to Europe. One is in Jordan to reinforce the Mashreq's connection to Europe, and the other connects Tunisia to Italy to facilitate North African exports. These transmission projects are an integral part of the investment plan because they will buy down the market access risk for potential private investors in CSP generation in MENA.

21. *Results Indicators*: The proposed results indicators for the investment program would be:

- GHG reductions of at least 1.7 million tons of CO_2-equivalent per year
- Approximately 900 MW of installed CSP capacity
- $4.85 billion of co-finance mobilized, including sufficient concessional financing to ensure viability of CSP plants
- Declining cost of the solar field in $/m2 over the life of the program

[1] Directive 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources. The EU parliament adopted this directive in December 2008.

Table 1: Indicative Financing Plan
(in US$ millions)

	CTF	Equity/Govt. contribution	Commercial/ other Debt	Official Financing (Concessional and non-concessional)	WBG	AfDB	Total
Generation	$670	$540	$640	$1,238	$537	$429	$4,054
Transmission and associated infrastructure	$80	$200	$650	$70	$400	$150	$1,550
	$750	$740	$1,290	$1,308	$937	$579	$5,604

Table 2: List of CSP Projects in pipeline

Country	No. of Projects	Location	Capacity (MW)	Est. cost (US$ million)	CTF Contribution (US$ million)
Algeria	3	Megahir	80	322	58
		Naama	70	285	51
		Hassi R'mel II	70	285	51
Egypt	2	Kom Ombo	70	370	51
		Marsa Alam[2]	30	270	44
Jordan	2	Maan Province	100	418	72
		Aqaba-Qatrana transmission		410	40
Morocco	3	Tan Tan[3]	50	240	35
		Ain Beni Mathar	125	525	90
		Ouarzazate	100	440	72
Tunisia	3	IPP-CSP Project	100	450	73
		ELMED-CSP	100+	450	73
		Tunisia-Italy transmission		1140	40
Total	13		**~900 MW**	**5,604**	**750**

[2] This is a project with 8 hr storage so the size of the solar field will be equivalent to a 60 MW project.
[3] This is a CSP-desalination project

Table of Contents

Acronyms and Abbreviations

AFD	Agence Française de Développement
AfDB	African Development Bank
ANME	National Agency for Energy Conservation (Tunisia)
APRUE	Agency for the Promotion of Rational Use of Energy (Algeria)
CCGT	Combined Cycle Gas Turbine
CDER	Centre for the Development of Renewable Energy Sources (Morocco)
CO_2	Carbon Dioxide
CPV	Concentrating Photovoltaics
CSP	Concentrated Solar Power
CTF	Clean Technology Fund
DANIDA	Danish International Development Agency
DII	DESERTEC Industrial Initiative
EC	European Commission
EIB	European Investment Bank
ESMAP	Energy Sector Management Assistance Program (World Bank)
ESTELA	European Solar Thermal Electricity Association
EU	European Union
FIT	Feed-in tariff
FNME	National Energy Efficiency Fund (Algeria)
GCC	Gulf Cooperation Council
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse gas
GTZ	German Technical Cooperation
GW	Gigawatt
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IEA	International Energy Agency
IFC	International Finance Corporation
IPP	Independent Power Producer
IRR	Internal Rate of Return
ISCC	Integrated Solar Combined Cycle
IsDB	Islamic Development Bank
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
KfW	German Development Bank
kWh	kilowatt-hour
LFR	Linear Fresnel Reflector
MDB	Multilateral Development Bank
MED	Multi Effect Distillation
MEDELEC	Mediterranean Liaison Committee of Electricity Associations
MEDRING	Mediterranean Electrical Ring
MEMR	Ministry of Energy and Mineral Resources

MENA	Middle East and North Africa region
MSF	Multi Stage Flash
MSP	Mediterranean Solar Plan
MW	Megawatt
MWh	Megawatt-hour
NEAL	New Energy Algeria
NREA	New and Renewable Energy Authority (Egypt)
O&M	Operations and Maintenance
OME	Observatoire Méditerranéen de l'Energie
ONE	Office National de l'Electricité (Morocco)
PNME	National Energy Efficiency Program
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PV	Photovoltaics
R&D	Research and Development
RECREE	Regional Centre for Renewable Energy and Energy Efficiency
RES	Renewable Energy Sources
RO	Reverse Osmosis
SFD	Saudi Fund for Development
STEG	Société Tunisienne de l'Electricité et du Gaz
TFC	Trust Fund Committee (Clean Technology Fund)
toe	tonne of oil equivalent
UAE	United Arab Emirates
UfM	Union for the Mediterranean
UNFCCC	United Nations Framework Convention on Climate Change
US	United States of America

1. Overview

1. The global energy economy will need to decarbonize power generation substantially in order to achieve a sustainable energy future. This will require large-scale shifts to renewable energy for power generation. The International Energy Agency has identified concentrated solar power (CSP) as one of the key technologies that "are at the heart of the energy technology revolution because they can make the largest contributions to reducing greenhouse gas emissions."

2. However, CSP (like most new technologies) has higher costs and risks than current technologies. "It is only through technology learning as a result of marketplace deployment that these costs are reduced and the product adapted to the market" (IEA). The greater the scale of such deployment, the earlier such technologies will be commercialized. Therefore, international collaboration is required to accelerate the global deployment of technologies such as CSP through targeted schemes that provide positive incentives for their adoption at scale.

3. This Investment Plan proposes to strategically utilize Clean Technology Fund (CTF) concessional financing to accelerate global adoption of the technology by supporting the CSP expansion programs of countries in the Middle East and North Africa (MENA) region. MENA receives some of the most intense solar radiation in the world and has potential access to premium markets for solar energy. However, the realization of that enormous potential requires the mitigation of substantial upfront risk –hence the proposed Investment Plan. In particular, the Investment Plan for scaling-up concentrating solar power in Middle East and North Africa will:

- Enable MENA to contribute the benefit of its unique geography to global climate change mitigation-no other region has such a favorable combination of physical and market advantages for CSP.
- Support the deployment of about 1 Gigawatt of generation capacity (about 15% of the projected pipeline globally) in five CTF-eligible countries that have demonstrated strong commitment to participate: Algeria, Egypt, Jordan, Morocco and Tunisia.
- Support associated transmission infrastructure in the Maghreb and Mashreq for domestic supply and exports, as part of Mediterranean grid enhancement that will enable the scale up of CSP through market integration in the region.
- Leverage over US$ 3 billion in public and private investments for CSP power plants alone (thereby almost tripling current global investments in CSP), and
- Support MENA countries to achieve their development goals of energy security, industrial growth and diversification, and regional integration.

2. Global and Regional Context

4. A confluence of three global and regional factors provides a unique opportunity for the CTF to finance transformational actions in the MENA region. These investments would

constitute a dominant part of the countries' ambitious strategies for deployment of low carbon technologies, have the scale to shape the course of global CSP market development, and deliver benefits that transcend climate mitigation by providing broader environmental and economic co-benefits. The three enabling factors are:

a) CSP is a technology that is of particular interest to utilities, but with unexploited manufacturing scale economies: CSP could be cheaper relative to PV on a per kWh basis in most cases and is more scalable and more consistent with a centralized and dispatchable generation model. Its adoption and replication by utilities is therefore more assured. CSP is a relatively simple technology with few high-cost materials or proprietary components. If the demand for CSP is scaled up, then equipment costs can fall very substantially, since it has yet to benefit from cost savings that often come from manufacturing scale.

b) MENA region has physical attributes that makes it particularly promising for CSP scale-up: The region has amongst the world's best production conditions for solar power: abundant sunshine, low precipitation, and plenty of unused flat land close to road networks and transmission grids.

c) Market dynamics in the MENA region can provide a strong enabling environment for large-scale investments: The consumption of electricity in MENA is growing faster than that of any other region in the world and countries are increasingly looking to scale-up renewable energy to diversify fuel mix away from hydrocarbons and enhance energy security to meet growing demand. The region's industrial base, its need for industrial diversification, and business environment make it favorable for the local manufacturing of CSP equipment. As this industry is at an early stage of development globally, MENA would also have a "first-mover" advantage in industry scale-up. In the Mediterranean Basin and Gulf Region as a whole, opportunities to trade "green" electricity are opening up, stimulated by the subsidies and premium tariffs available in European markets (and increasingly in MENA markets also). The revenue from export to European markets would enable the development of CSP electricity supply in MENA markets.

5. The implementation of this program will result in a two fold increase in the current global installed capacity of a new technology that is at the cusp of commercial development globally. Moreover, the program utilizes the best solar resources in the world to help bring down costs of production. A gigawatt[4] level deployment of CSP in the region over a 3-5 years time frame representing 10-12 commercial-scale power plants in multiple countries would account for about 15% of the planned capacity additions globally. This deployment would provide the critical mass of investments necessary to attract significant private sector interest, benefit from economies of scale to reduce cost, result in organizational learning in diverse and several operating conditions, and manage country and technical risk. A program at this scale would firmly establish the region on the path of achieving multiple gigawatts of installed CSP capacity

[4] This is also consistent with estimates by other agencies including industry associations and NGOs. The reference scenario recently published by Greenpeace/ESTELA/SolarPaces (2009) foresees 488 MW by 2015 and 1,113 MW by 2020 in the whole of Africa, assuming that most could be installed in North Africa. The moderate scenario reaches 3,968 MW by 2020, and the advanced Scenario 4,764 MW. The Mediterranean Solar Plan has an even more ambitious target of achieving 10-11 GW of CSP by 2020.

and provide the stimulus necessary for a globally transformative replication in other regions. Details regarding the proposed projects are provided for each participating country as an Annex to this document.

6. The following sections elaborate on each of the three main factors that contribute to this transformational opportunity.

2.1 Technology Overview

7. CSP is a large scale, proven technology for generating energy using the power of the sun. Using focused sunlight, mirrors heat a working fluid which then generates high-pressure steam that drives a conventional turbine. The two main advantages for CSP compared to PV are its scalability and storage so that power can be dispatched when needed.

8. There are a variety of approaches to CSP including power towers, Linear Fresnel, Dish-Stirling and Parabolic troughs. The parabolic trough is a fairly mature technology and can start to be scaled-up at the 100 MW level. Tower and Linear Fresnel Reflector (LFR) technologies have been demonstrated at smaller scales globally and could start implementation at scale-up at 50 MW levels or so. Dish-Stirling technology offers high efficiencies but has been demonstrated at kilowatt scale only. Table 1 below compares the technical characteristics of the different technologies. Concentrating Photovoltaics (CPV) technologies are also an attractive emerging option but can be implemented at the scale of a few MW at most with current technologies.

Table1: Parameter comparison of CSP technologies

Technology	Plant capacity in MW	Average efficiency	Concentration	Capacity factor	Hybri-dization	Storage possible
Parabolic Trough	30-200	14-15 %	70-80	25-70 % (depending on storage capacity)	Yes	Yes
Solar Tower	10-100	14-17 %	300-1000	25-70 %	Yes	Yes
Fresnel	10-200	10-12 %	25-100	25-70 %	Yes	Yes
Dish-Stirling	0.01-0.04	18-25 %	1000-3000	25 %	Yes	No

Source: Müller-Steinhagen (2004) and Fraunhofer ISI (2009)

9. CSP technology has been the subject of research in the US and Europe since the 1970's. Around 354 MW of trough power plants were installed in the Mojave Desert of California from 1984 to 1991 (Grama, 2008). However, adverse economic conditions hindered the development of the nascent solar thermal industry and development was suspended during the 1990s.

10. Today, the CSP industry is experiencing a revival driven by government support schemes, such as tax incentives in the US and feed-in-tariffs in Spain. At the end of 2008, approximately 482 MW capacity of commercial plants were in operation *(see Table 2)* of which almost 419 MW were installed in the US, 63 MW in Spain and another 0.36 MW in Australia (Trieb, 2009). The large majority of the plants use parabolic trough technology.

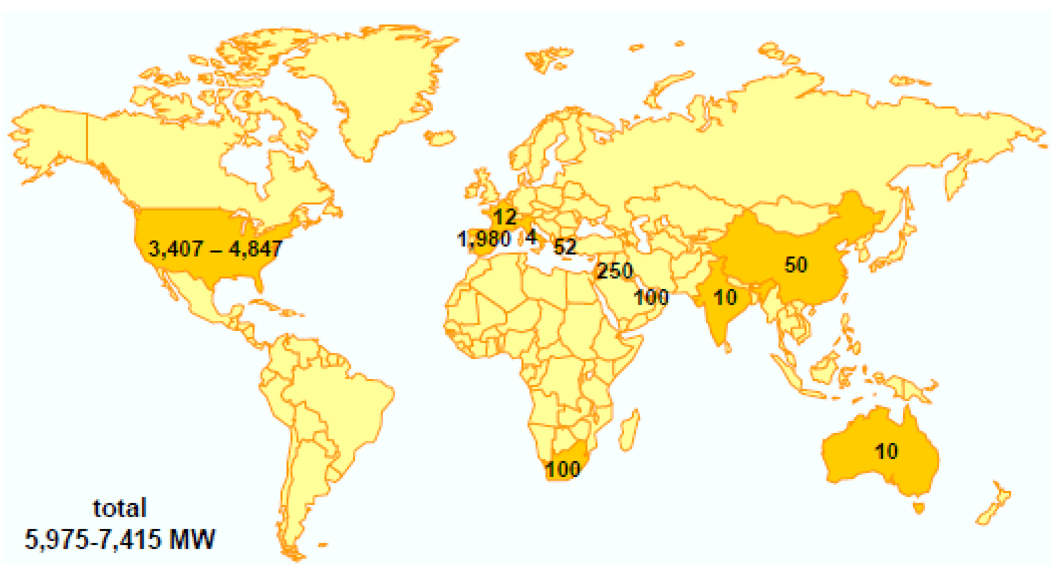
Table 2 – CSP Plants in operation at the end of 2008

Plant name	Net Power Capacity [MWe]	Type	Constructor	Country	Year of initial operation
SEGS 1	13,8	Parabolic trough	Luz	USA	1985
SEGS 2	30	Parabolic trough	Luz	USA	1986
SEGS 3	30	Parabolic trough	Luz	USA	1987
SEGS 4	30	Parabolic trough	Luz	USA	1987
SEGS 5	30	Parabolic trough	Luz	USA	1988
SEGS 6	30	Parabolic trough	Luz	USA	1989
SEGS 7	30	Parabolic trough	Luz	USA	1989
SEGS 8	80	Parabolic trough	Luz	USA	1990
SEGS 9	80	Parabolic trough	Luz	USA	1991
Arizona Public Services Saguaro Project	1	Parabolic trough	Solargenix Energy	USA	2006
Nevada Solar One	64	Parabolic trough	Acciona/ Solargenix Energy	USA	2007
PS10	11	Tower	Abengoa Solar	Spain	2007
Liddell Power Station	0.36	Fresnel reflector		Australia	2007
Andasol 1	50	Parabolic trough	Solar Millenium and ACS/Cobra	Spain	2009
Puerto Errado 1	2	Fresnel reflector	Tubo Sol Murcia, S.A.	Spain	2009

Source: Trieb, 2009

11. Announced projects by the end of 2008 were in the range of around 6-7 GW as shown in Figure 1 below, with bulk of the pipeline in the U.S and Spain.

Figure 1 – Announced CSP installation plans at the end of 2008[5]

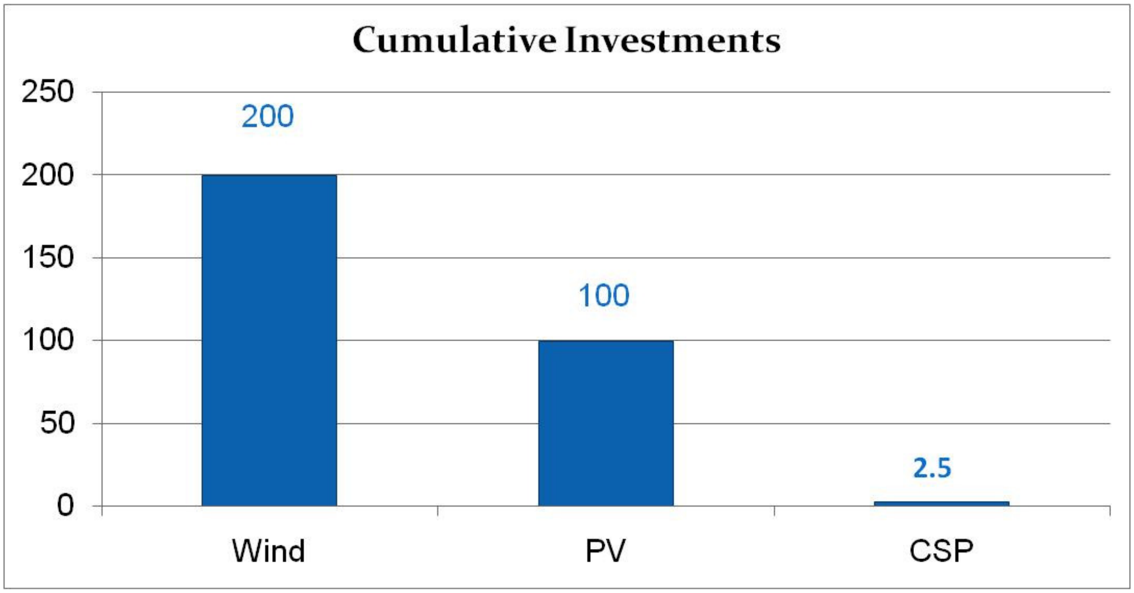


Source: Trieb, 2009

[5] This figure does not include CSP projects proposed under this MENA CSP Investment Plan.

12. However, at the global level, cumulative investment in CSP is still very small compared to investment in other renewable energy technologies. Wind energy technology has witnessed cumulative investments of around US $200 billion and solar photovoltaics over US$ 100 billion (with much of these investments in the last 30 years). Cumulative investment in CSP projects is only about US$ 2.5 billion as shown in Figure 2 below. The proposed CTF supported program will therefore almost triple global investment in the technology.

Figure 2 - Global Investments in Renewable Energy Technologies (US$ billion)



13. CTF support will finance investments in five countries: Algeria, Egypt, Jordan, Morocco and Tunisia to support CSP scale-up. Although these investments are not high for individual countries, as a whole this regional approach is expected to have a transformative impact on the global CSP industry.

Table 3 - CTF Request by country

Country	**CTF request (US$ million)**	**Total program costs (US$ million)**
Algeria	160	892
Egypt	95	640
Jordan	112*	828*
Morocco	197	1205
Tunisia	186*	2040*
Total	**750**	**5604**

*includes transmission investments

14. High initial capital costs are the most important barrier for the expansion of CSP. As much as 87 percent of the cost of electricity produced by a solar thermal plant is related to the initial capital investment and installation cost, with the remaining 13 percent being the cost of operating and maintaining the plant (Grama, 2008). Estimates range the capital costs between

$4000 and $6000 per kW for typical capacity factors in the range of 22-24 percent. Therefore, a CSP plant is still not competitive with fossil-fuel fired plants or even with wind energy plants. For example, CSP plant costing US$4,000/kW operating at capacity factors of 22-24 percent can be around four times as expensive as combined cycle gas turbine plants.

15. However, there is broad consensus in industry assessments that CSP has high cost reduction potential, due to three factors. First, manufacturers have to yet to benefit from economies of scale. The history of PV suggests that doubling of capacity leads to a 20 percent reduction in costs. Scale benefits include longer and more automated production runs, purchasing power on sourcing components and materials, and bigger R&D budgets. Furthermore, if the average CSP system size increases to several hundred MW, this is likely to work out cheaper per MWh because of the scale leverage on a central turbine and grid connection (Merrill Lynch). There have been several estimates on the cost reduction possibilities – for example one estimate predicts a reduction from US$ 4,943/kW for a 100 MW in 2007 to US$ 3,157/kW for a 200 MW plant in 2015, reflecting a decrease of 8.6 percent per year (CSP Today, 2008).

16. Second, technical improvements can be realized in certain components and these can be accelerated when companies R&D respond to increased global demand. For example, between 1991 and 2004 technology advances helped reduce O&M costs by 30 percent and improve annual solar-to-electric efficiency by 20 percent for parabolic trough systems (Electric Power Research Institute, EPRI, 2007). Solar thermal companies are exploring more cost effective construction of collectors, wider diameter absorber tubes to reduce pumping costs and direct steam generation in receivers. New optical configurations (mirror alignment, tracking systems, and types of transfer of fluids) could lead to higher efficiencies or load factors. Companies are also exploring different storage materials and reflective surfaces that could lead to higher efficiencies. Finally, one third of the system cost is construction/installation, so improvements in structural design and introduction of new materials would reduce the weight of systems (transport costs) and complexity (installation costs).

17. Third, increased demand will result in a more diverse supply chain which will reduce component costs. New entrants are entering the market for components that are currently supplied by a small number of companies. Larger companies, with experience in achieving economies of scale through mass production are also entering the CSP market in anticipation of market growth. The recent acquisition of Solel solar systems by Siemens AG is a case in point.

18. A gigawatt-scale regional CSP deployment program has the potential to drive cost reductions by virtue of volume production, increased plant size, and technological advance. Given the uncertainties of future business, supply industries have operated on the basis of serving one-off customers instead of setting up complete R&D, large-scale manufacturing, and operations and maintenance programs. The result is very high cost, underexploited economies of scale and limited investment in R&D leading to technology development and innovation.

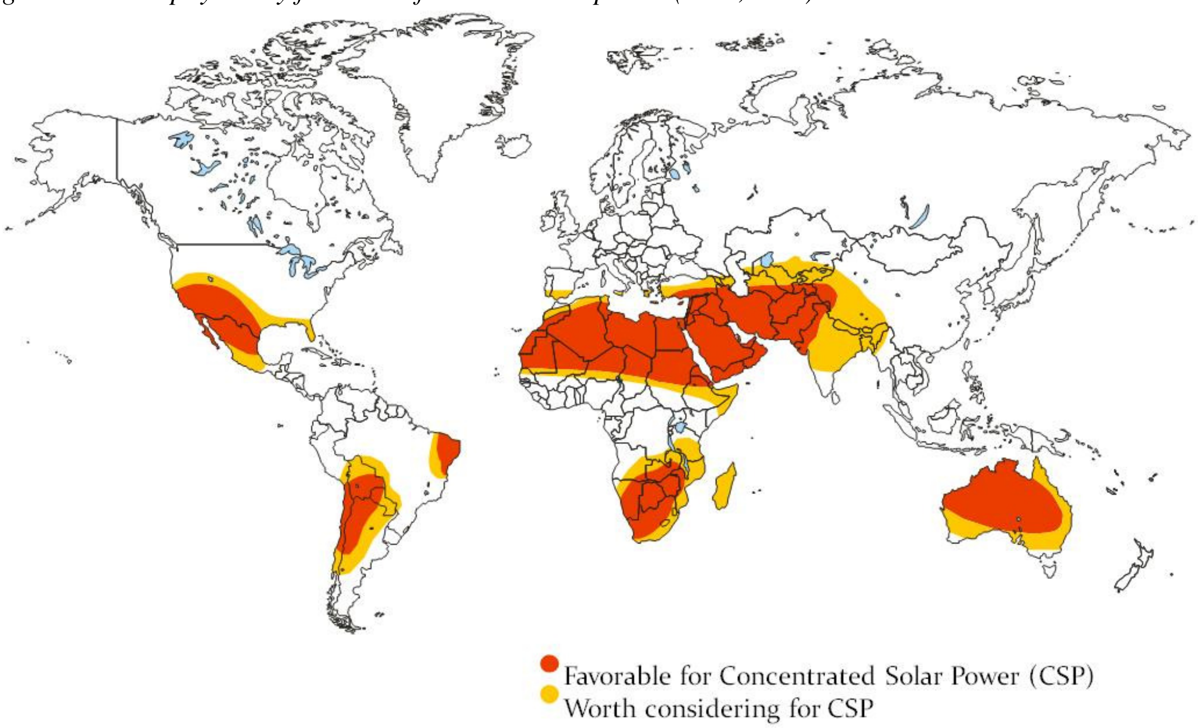
19. A deployment program of 10-12 utility-scale CSP plants in a number of countries would send a strong signal to the market that would enable industry to plan manufacturing capacity expansions, which is central to driving down the costs of solar thermal technology and production processes. The proposed CTF-supported CSP program would thereby make a major contribution to accelerating global market momentum

2.2 Geographic Factors in MENA Favor CSP

20. As shown in the figure below (Figure 3), many arid and semi-arid parts of the world are physically suitable for CSP development including the whole of the MENA region, Southern Africa, parts of India and Pakistan, parts of Brazil and Chile, Mexico, South Western USA and Australia. Of these areas MENA and South-Western USA/Mexico are particularly attractive for early market development given the land availability and proximity to large high-paying markets.

21. In short, the cost reductions through economies of scale that the world needs can be achieved most cheaply in those two regions, and MENA therefore is the developing region in which the economies of scale are cheapest. As a result of those economies of scale, deployment of CSP to other regions would subsequently accelerate.

Figure 3: Areas physically favorable for CSP development (DLR,2005)



22. The MENA region has among the world's best physical conditions for production of solar power: abundant sunshine, low humidity, and plenty of unused low-cost flat land close to road networks and transmission grids. The driest parts of the Sahara receive as little as 2 cm of rainfall/year and the wettest regions average 4 inches annually, considerably less than the 5 inches per year averaged in Mojave desert, a focal point of CSP development in the US (Slavin, 2009). The direct normal irradiance (DNI) in the region is in the range of 2,200-2800 $kWh/m^2/year$ and is attractive for concentrated solar power (CSP) based generation.

23. Due to these conditions, the potential for power generation is enormous compared to regional and global energy demands- roughly 2% of the Sahara desert could meet the world demand and 0.4% could meet the EU demand (DLR, 2005; Gelil, 2007; ESTELA, 2009). A

detailed spatial analysis that considered adjustment for siting factors including croplands, density of population, shifting sand dunes, salt flats, protected areas, availability of road and transmission infrastructure estimates that about 110,000 Sq Km of land -the size of Bulgaria- is suitable for medium term development (Ummel and Wheeler, 2008). This would translate to about 20 GW of solar potential at an average radiation of 2500 kWh/m^2/year.

2.3 Regional Energy Market Factors

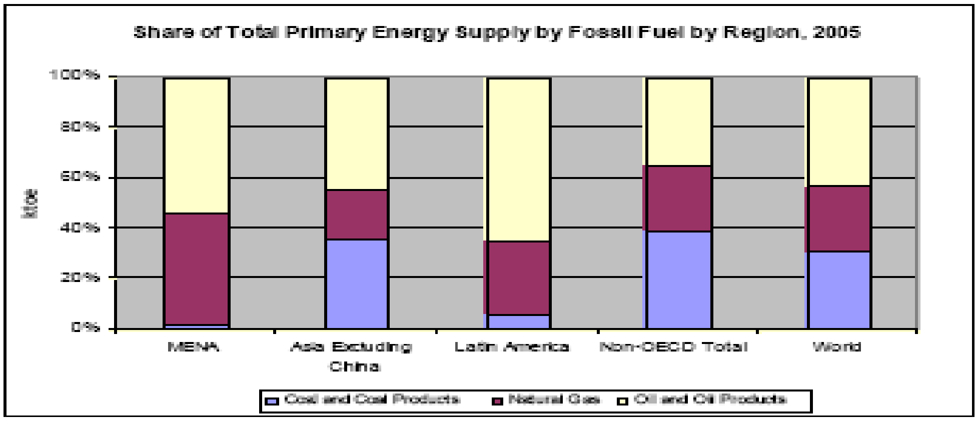
24. Energy use trends in MENA are driving the need for energy efficiency and diversifying supply options. According to a World Bank study on Energy Efficiency in the MENA region, MENA's total final consumption of energy has grown faster than that of any other region since 1980. Today, the region's "energy intensity" is estimated at 0.18 toe per thousand US dollars in 2005 PPP terms (/'000US$2005PPP), 60 percent higher than that of OECD countries (0.11toe/'000US$2005PPP), and 40 percent above the world's average energy intensity of 0.13. The energy intensity of the region's economies is not explained simply by differences in their energy resources. While energy-abundant countries such as Iraq and UAE are among the most energy-intensive, some energy importing countries (for example, Lebanon and Jordan) are also energy intensive (World Bank, 2009).

25. Nearly all the region's primary energy comes from indigenously produced fossil fuels. The region uses about 7 percent of the world's total fossil fuel energy, 98 percent of which comes from oil and natural gas, compared with 69 percent for the world overall (Figure 4). The region consumes about 30 percent of its production of fossil fuels, and exports the rest. Countries range from very high levels of exports to very high import-dependence. Of the 19 countries in the region, five —Djibouti, Israel, Jordan, Morocco, and West Bank and Gaza—depend heavily on imports.

26. Since 1980, MENA's total final consumption of energy has grown faster than that of any other region in the world. That growth reflects the expansion of energy-intensive industries in the Gulf states, as well as the need to supply more electricity to growing populations (World Bank, 2009). For example, the electricity demand is growing by 7% in Jordan since 2004 (MEMR, 2009) and 7-8% in Egypt.

Figure 4– Share of Total Primary Energy Supply by Fossil Fuel by Region, 2005

Figure 1.1.Mena is dependent on oil and gas , 2005



Source: IEA database

27. According to the World Resources Institute data estimates[6], in 2008 the MENA region contributed 6 percent of the world's energy related greenhouse gas (GHG) emissions—i.e., 2205.3 Mt of CO_2 equivalent. More than 50 percent of emissions came from oil combustion; very little came from coal when compared with the rest of the world (IEA/OECD, 2007). Four MENA countries—Egypt, Saudi Arabia, UAE and Iran—rank among the 11 countries worldwide with the fastest increase in emissions.

28. The power sector is the leading sector with the highest CO_2 emissions for most MENA countries, contributing to 44% of CO_2 emissions for the MENA region. The transportation sector contributes 22% of CO_2 emissions in the MENA region, similar to the world average and higher than Asia excluding China and Latin America excluding Mexico. The industry sector contributes another 20% of CO_2 emissions in the MENA region (Zhang, 2008).

29. Power production in North Africa has gone up in absolute numbers from 90 TWh in the year 1990 to 250 TWh in 2008 based on data of the *Arab Union of Producers, Transporters, Distributors of Electricity (AUPTDE)* and *Energy Information Administration (EIA).* This increase in electricity production corresponds approximately to an annual growth rate of 4.8 percent between 1990 and 2008. Such growth is expected to continue in the future based on forecasts of regional groups such as Observatoire Méditerranéen de l'Energie (OME) that forecasts an average annual growth of about 3.3 percent through 2030. Given the growing energy demand in the region, there are several factors that would help develop domestic markets for power generated from CSP plants:

[6] Eighteen MENA countries are Parties to the UNFCCC. Of these, thirteen (13) have submitted their initial national communication to the COP, while five countries (Kuwait, Libya, Qatar, Sultanate of Oman and Syria) did not meet yet this UNFCCC requirement. As a result, the official national GHG inventories are available only for 13 countries of the region, and most of them related to the reference year 1994, except Egypt and Saudi Arabia (1990), Yemen (1995), and Israel (1996). The official GHG figures are therefore no longer representative of the emission profiles of the region.

(e) For oil and gas importing countries, development of indigenous resources is essential to enhance the energy security and economic security. For example, in Jordan imports are equivalent to about 19.5 percent of the GDP.

(f) For oil and gas producing countries, an energy strategy focused on CSP and other renewables would help in freeing-up the increasingly valuable oil and gas resources for more value added utilization such as in industry, for sale in other remunerative domestic and export markets, and to retain option value for future use.

(g) Pursuing this relatively new technology brings additional benefits to the economy as it offers a new opportunity for industrial diversification and job creation; For example in the El-Kureimat pilot CSP project under implementation in Egypt, about 50 percent of the components are fabricated locally. For some of the key components such as mirrors and receivers, there are only a few manufacturers globally and MENA countries could benefit from the "first mover" advantage as the CSP scale-up starts taking shape.

(h) The opportunity exists to export "green electricity" to high paying markets in the Northern Mediterranean countries and thereby help address the affordability issue surrounding the large scale absorption of renewable electricity in domestic markets by cross-subsidizing domestic supply from the "premium consumers" in the EU.

30. Of the above, item (d) is significant as a way to begin CSP market development as it would cross-subsidize green energy use in MENA. There is a clear market opportunity for CSP-generated power - in the EU for a combination of environmental and energy security reasons, and increasingly also in MENA due to the co-benefits. But the regulatory framework and the grid infrastructure to support this (in both regions) is evolving and hence uncertain. In the EU, the policy and regulatory environment for green energy trading is becoming stronger following the EU renewable energy directive[7]. In MENA, private sector development of renewable energy is starting to gain momentum due to a range of co-benefits (as discussed above). The enabling environment, however, will only be strengthened with experience. In the early stages, countries on both sides of the Mediterranean will focus on contractual arrangements -in effect there would be "regulation by contract." With more experience, this environment will improve. By providing concessional financing for the CSP scale-up, CTF buys-down the upfront regulatory risk for investors in MENA countries.

31. Due to rising costs for conventional power and fast growing demand for electricity, many countries in the region have been developing targets for renewable energy, and in many cases, explicit sub-targets for each technology. In addition to wind power of which there are many projects under construction or operating in MENA, CSP could be the next renewable energy technology to be utilized at scale. National targets for the share of renewable energy sources (RES) in power generation range from 6 to 20 percent by 2020. Taking into consideration key national commitments among CTF-eligible countries, it is proposed that the <u>CTF regional</u>

[7] Directive 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources. The EU parliament endorsed this Directive in December 2008.

investment plan focus on five countries – Algeria, Egypt, Jordan, Morocco, and Tunisia - markets in which transformational outcomes are most likely.[8]

- The Government of Algeria has introduced a national program for integration of renewables with an objective to reach five percent of power generation by 2017 and a long-term target of achieving 20 percent renewable energy power by 2030. Further, the long-term goal is to be met primarily from the CSP (70 percent CSP, 20 percent wind and 10 percent PV) which would make it among the world's most ambitious CSP programs. In order to meet these ambitious targets, New Energy Algeria (NEAL) has been established by Sonatrach (with 46 percent ownership), Sonelgaz (45 percent) and private Algerian companies (9 percent) to implement solar projects. The first 25 MW solar power project at Hassi R'mel is under implementation and three new projects are under various stages of consideration. Through a March 2004 decree, the Government also introduced incentives for electricity production from renewable energy plants, including a feed-in tariff.

- The Government of Egypt (GoE) has committed to increasing the share of renewable energy to 20 percent by year 2020 as a means of meeting growing electricity demand and achieving the economic objective of utilizing natural gas for higher value purposes. A key element of the plan for scale-up of renewable energy is the emphasis on renewable energy placed in the new Electricity Law, recently endorsed by the Cabinet and scheduled to be presented to Parliament for ratification during early 2010. Under the new law, a funding mechanism to be implemented by the GoE to fulfill its proclaimed support for renewable energy includes funds from the export sale of gas saved by the renewable energy. A 2500 MW wind scale-up program is under implementation in Egypt and the first CSP project is also under implementation. The capacity expansion plan for Egypt also includes 150 MW CSP capacity to be implemented by 2017 as part of its renewable energy strategy. This includes an innovative CSP project that incorporates thermal storage for eight hours. The Government of Egypt is a champion of renewable energy in the region and has taken significant leadership in this regard through the creation of a regional Renewable Energy and Energy Efficiency Center, supported by EC, GTZ and Danida, and is co-President of the Mediterranean Solar Plan.

- The Government of Jordan's energy policies have been shaped by the fact that it is almost entirely dependent on fuel imports for its energy requirements. In December 2007, the Government adopted an energy sector strategy, which, inter alia, increased emphasis on renewable energy and energy efficiency. The updated strategy sets a target of seven percent of the country's energy mix to come from renewable sources by 2015 and 10 percent by 2020.[9] As such, Jordan is taking concrete steps to develop its renewable energy resources,

[8] Countries may access CTF funding if they are eligible for Overseas Development Assistance (ODA) and if there is an active MDB lending program. In MENA, Morocco, Algeria, Tunisia, Egypt, Iraq, Lebanon, Yemen and Jordan are currently eligible under these criteria. GCC countries are in the same category as Libya. Syria is ODA eligible but there isn't currently an active MDB lending program. Libya is not ODA eligible, and therefore there is no MDB lending program. However, in GCC countries, Syria and Libya there is the potential for MDB technical assistance for a solar scale-up program. West Bank and Gaza is ODA eligible and in receipt of an active MDB lending program, but CTF design did not envisage the inclusion of countries which are not MDB shareholders.

[9] Total primary energy supply in 2007 amounted to 7.4 million ton of oil (mtoe) equivalent, of which 0.1 mtoe was from renewable energy source (mainly solar energy), 4.9 mtoe was from oil and oil products, 2.4 mtoe was from natural gas, and a residual quantity of net imported electricity. Source: Jordan Department of Statistics, *Energy Balance 2007*.

including development of wind, solar, and landfill gas. With respect to CSP, the first pilot facility and training center is being proposed under grant support from the European Commission, which is expected to be announced by June 2010. The first commercial scale CSP project is being proposed in the range of 100 MW as a private sector project in the Maan province in Southern Jordan.

- The Government of Morocco has articulated a broad vision to address energy security in light of the fact that Morocco's energy balance is dominated by imported fossil fuels. To address the challenges of energy security, sustainable development and competitiveness, the government has formulated a new strategy which was unveiled at the National Energy Conference ("Assises de l'Energie") on March 6 2009. The objectives of the strategy are: energy security, availability of energy to all Moroccan households and businesses at competitive prices, energy demand management, promotion of national expertise and development of technological know-how and environmental protection and climate change mitigation

  To achieve these objectives, the key elements of the strategy are:

  - Diversify and optimize the energy mix around reliable and competitive energy technologies, in order to reduce the share of oil to 40 percent by 2030
  - Develop the national renewable energy potential, with the objectives of increasing the contribution of renewables to 10-15 percent of primary energy demand by 2012
  - Make energy efficiency improvements a national priority
  - Develop indigenous energy resources by intensifying hydrocarbon exploration activities and developing conventional and non-conventional oil sources
  - Integrate into the regional energy market, through enhanced cooperation and trade with both other Maghreb countries and the EU countries

  On November 2 2009, the Government unveiled a Morocco Solar Plan aiming at achieving a 42 percent renewable energy target by 2020 and has a 2000 MW long term target for solar power including CSP by 2020. ONE is currently implementing the first Integrated Solar Combined Cycle (ISCC) Project with a 20 MW solar field at Ain Beni Mathar. In the medium term, three projects, totaling about 275 MW, are being considered for implementation and financing by CTF. This includes an innovative CSP-desalination project. However, the proposed plants for financing would be adjusted to align with the Moroccan Solar Project.

- Tunisia has been a pioneer among developing countries in terms of energy management policy, having formulated and implemented a policy for rational use of energy and promotion of renewables as early as 1985. The energy intensity stopped increasing in the 1990s, and has since then declined to the lowest level in the MENA region. The 11th Development Plan (2007-2011) sets the broad direction of energy policy, including gradual reduction in energy subsidies, and calls for a scaling up of investment in energy efficiency and renewable energy. Given the urgency to intensify energy conservation efforts, the Government has formulated in 2008 a 4-year Energy Conservation Program (4ECP) for the period 2008-2011.

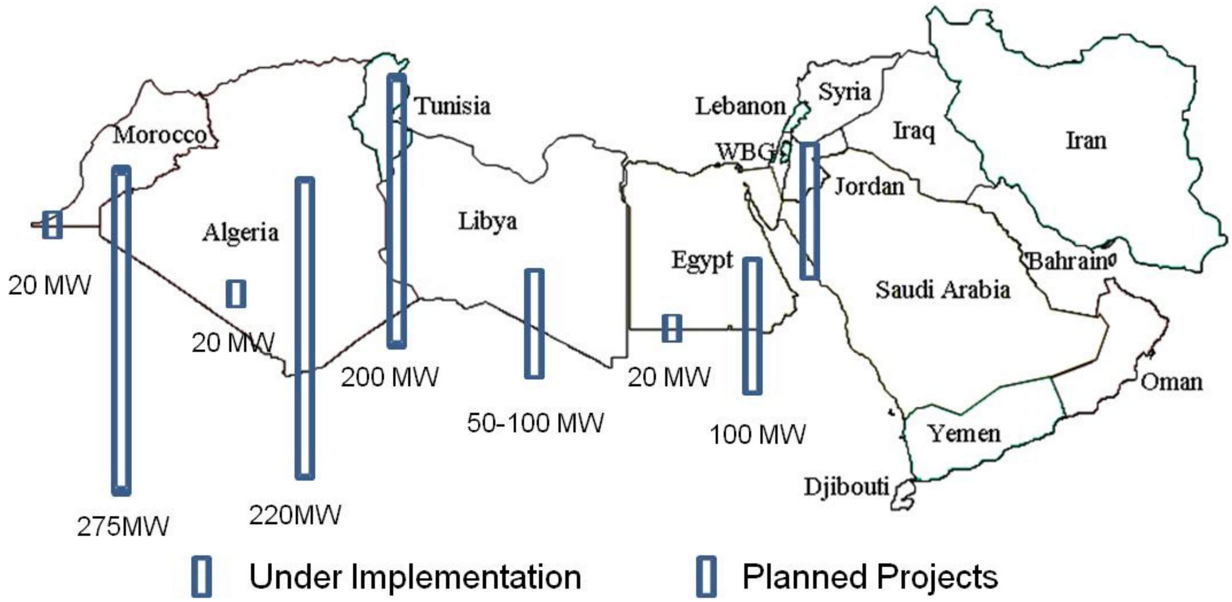
  The Government has recently announced a "Tunisian Solar Plan" for implementation during 2010-16. The plan identifies 40 projects in the areas of wind, solar, and biomass. The expected funding is in the range of Euro 2 billion, with about Euro 1.4 billion from the private sector. In the area of CSP, the Government has plans to implement three projects totaling about 225 MW as part of the solar plan.

Table 4 – Renewable energy targets in MENA countries

Algeria	▪ 2017: 5 % power generation based on renewable energy ▪ 2025: 10 % power generation based on renewable energy ▪ 250 MW CSP planned based on feed-in tariffs (300 % bonus-system) ▪ 450 MW cogeneration
Egypt	▪ 2010: 3 % electricity demand from renewable energy ▪ 2020: 20 % of the electricity from renewable energy, of which 12 % from wind ▪ Planned feed-in tariff for smaller plants (wind, solar)
Jordan	▪ Government committed to increase renewable energy share (7 % by 2015, 10 % by 2020) ▪ Renewable energy law proposed to be approved as part of the general energy law ▪ "Energy Strategy" aims at target of 300- 600 MW solar (PV and CSP) by 2020 ▪ Jordan Renewable Energy and Energy Efficiency Fund (Jordan REEF) being planned
Morocco	▪ 2020 : 42 % contribution of renewable energy to electricity generation ▪ Renewable law approved by Council of Ministers- now due for Parliamentary approval ▪ Target for CSP: 2000 MW by 2020
Tunisia	▪ 2012: 4 % contribution of renewable energy ▪ Investment incentives for renewable ▪ Feed-in tariffs and self-generation policy for renewables expected

Source: OME 2008, Fraunhofer, 2009

Figure 5 – Planned CSP projects in MENA

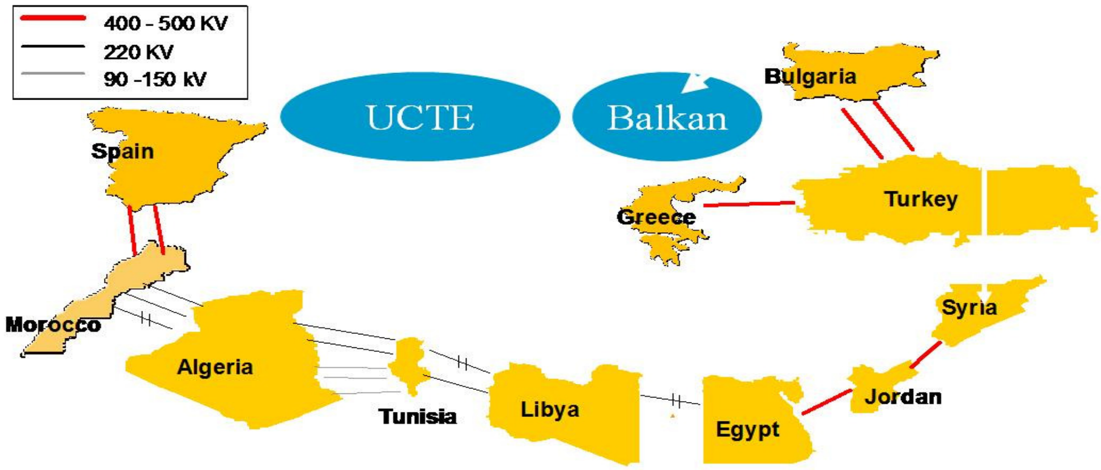


32. Regional energy market integration, which results in larger and more diversified power generation capacity than in isolated national markets, promotes the development of renewable energy, a common objective of all MENA countries as a way to enhance energy security and to mitigate climate change. Regional integration permits sharing of back-up reserves, which are necessary to guarantee reliability of supply in the presence of intermittent sources of supply like renewable, and the creation of a market of sufficient size to justify the development of a local industry at scale to serve those markets.

33. Regional integration brings other benefits such as, optimization of resources, more efficient use of infrastructure, a better framework for competition (which leads to cost declines) and the development of regional scale energy companies that can compete on world markets.

34. Strengthening of interconnections within MENA and between MENA and Europe is important in this regard (see Figure 6 below). The proposal for interconnections include (a) the strengthening, completion and successful operation of the MEDRING and (b) direct interconnections between MENA countries and Northern Mediterranean countries such the proposed Tunisia-Italy line. There are several critical constraints that need to be overcome within countries and between countries to realize the MEDRING and achieve increased power transfer capability within countries and with Europe. For example, the Egypt-Jordan is weak link that needs to be strengthened for enhancing trade through Syria and Turkey. Trials are currently underway to synchronously connect Turkey with the European system. Reinforcement of the Egypt-Jordan transmission corridor is critical to the scale-up of renewable energy in general, and CSP in particular.

Figure 6 - The proposed MEDRING Transmission Interconnection



Courtesy: MEDELEC

35. The enabling environment for the regional CSP scale-up program will also be strengthened by development in the European Union. In December 2008, the EU adopted a landmark piece of legislation that will drive the expansion of renewable energy in its member countries and neighboring regions. Each of the 27 EU member states will be obliged to increase its share of energy from renewable sources in gross final consumption of energy[10] from 8.5 percent today to 20 percent by 2020. Article 9 of the Directive defines flexibility measures between EU Member States and non-EU countries, referred to as third countries. According to this Article, electricity physically imported from third countries consumed in the European Union counts towards the targets of EU Member States. Besides this important requirement two additional criteria have to be fulfilled:

- Plants have been installed or added renewables capacity due to refurbishment for all constructions after June 25th 2009.
- The amount of renewable electricity produced and exported has not received support from a support scheme of a third country other than investment aid granted to the installation.[11]

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[10] The gross final consumption of energy is the sum of: gross final consumption of electricity from renewable energy sources, gross final consumption of energy from renewable sources for heating and cooling, and final energy from renewable sources consumed in transport.

[11] In this context the renewable electricity generated in third countries is recognized to be consumed in the Community if:

- an equivalent amount of electricity to the electricity accounted for has been nominated to the allocated interconnection capacity by all responsible Transmission System Operators in the country of origin, the country of destination and, if relevant, each third country of transit;
- an equivalent amount of electricity to the electricity accounted for has been firmly registered in the schedule of balance by the responsible Transmission System Operator on the Community side of an interconnector; and
- the nominated capacity and the production of electricity from renewable energy sources by the installation concerned by the transfer refer to the same period of time.

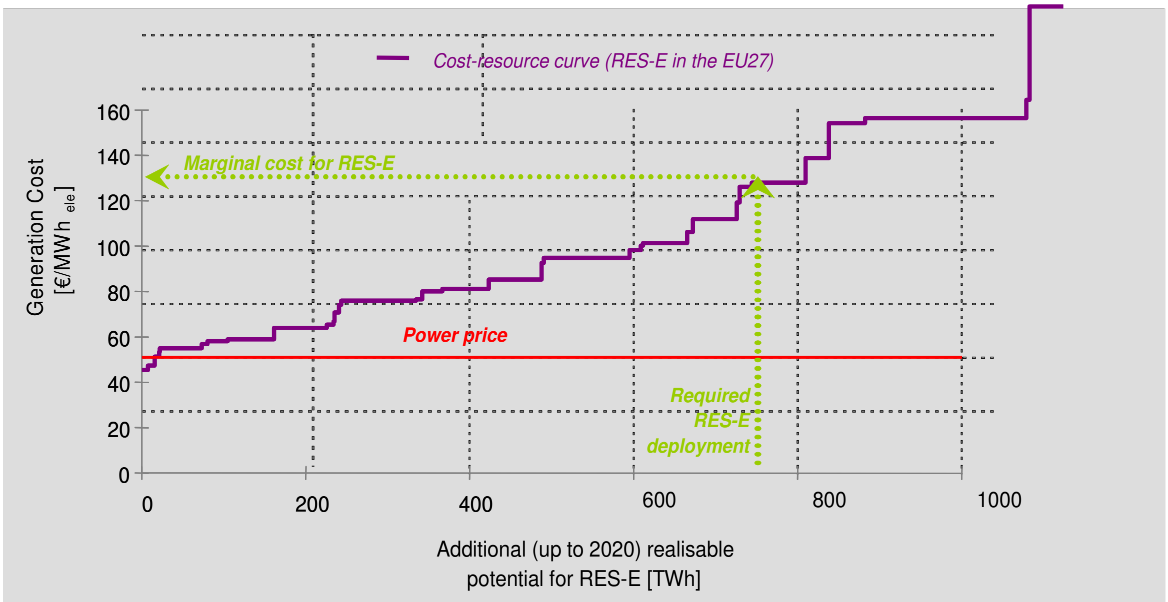
36. If the conditions are fulfilled, EU Member States may decide to support imported RES electricity from third countries within their national support schemes - in effect EU countries could make their subsidized tariffs available to MENA producers. CSP plants financed under the MENA CSP program could be eligible for such sale of electricity to Europe, thereby generating revenues to improve the projects' financial viability and reducing the amount of concessional support needed for the program. As the EU regulatory framework is only in the process of being formulated, this creates a significant regulatory risk premium for investors in MENA countries. The proposed CTF support, potentially deployed alongside guarantees from the multilateral development banks, will help mitigate this risk for the MENA countries.

37. The program would help some MENA country CSP projects attain viability through access to EU markets. However, the distribution of costs and benefits to the EU and MENA countries would be analyzed during project preparation for each relevant project based on the structure of the power purchase agreements to ensure that adequate benefits accrue to the MENA side. Private sector involvement in MENA, as well as utilization of broad based financing sources will also help ensure appropriate sharing of costs and benefits, as will be the objective of MENA and EU governments to foster replicable projects which can help scale-up CSP in the Mediterranean region.

38. Summing up the required imports of all EU countries, there is a deficit of about 109 TWh (or about 25 GW of CSP or other renewable energy) that needs to be covered via imports from other countries - inside or outside the EU. This accounts for 3.7 % of the total required RES deployment by 2020 (2985 TWh). This presents a market opportunity for MENA countries to export power generated from CSP.

39. A rough presentation of the supply curve for new renewable electricity installations for the year 2020 is shown in Figure 7. When comparing the estimated marginal cost for target achievement in Europe with the estimated costs of CSP generation in MENA countries, one finds that CSP could fit well into the range of prices for RES electricity to be expected in Europe. This means that importing power from CSP plants in MENA is competitive with the national generation of electricity from RES in some countries.

Figure 7 - Schematic presentation of the supply curve for renewable electricity for the EU-27



Note: The estimated amount needed to fulfill the target of the renewable energy Directive and the corresponding price level is shown.

40. In conclusion, the development of new CSP plants must be seen in a regional, rather than country-by-country context as (a) developing a critical mass of CSP plants in the region creates a much more powerful demonstration effect than doing so within one country; (b) a regional approach would maximize economies of scale by creating substantial manufacturing demand for critical CSP technology components such as mirrors, receiver tubes and control equipment; and, (c) enhanced interconnections between the MENA countries, and with the EU market, are an important factor taking into account the interest from EU countries in importing substantial amounts of CSP-generated electricity at attractive (subsidized) prices.

3. Rationale for CTF Co-financing

3.1 Potential for GHG reduction

41. Based on the projects being currently discussed, a first-order attempt was made at estimating the emissions reductions/avoided from the deployment of the proposed CSP projects in North Africa. Since each of these projects will supply power to a large grid, a more detailed analysis of the prospective load dispatch scheduling in each grid will be required to calculate actual emissions reduced[12] or avoided.

42. The emission factors for each proposed project was calculated using the energy sector emissions for each country and the energy generation using data from the ESMAP report from March 2008: *Opportunities for Mitigating the Environmental Impact of Energy Use in the*

[12] Emissions reduced are quantified if the renewable energy source displaces current emissions from fossil fuel sources

Middle East and North Africa Region and the Little Green Data Book from the World Bank. The expected generation from each plant is multiplied with the emissions factor for the country's energy sector to calculate the reduced or avoided reductions. For the given pipeline, the CSP Scale-up Initiative will avoid or reduce about 1.7 million tons of carbon dioxide per year (at 24% CF) from the energy sectors of the countries. This would amount to around 1% of the total energy sector CO_2 emissions and about 0.5% of the total emissions from these countries.[13] If the program is successful and replicated, the global benefits would be far larger.

43. The transformational objective of this investment plan is served not by choosing short-run least-cost approach for GHG emission reductions (which could be pursued through energy efficiency or wind power) but rather by accelerating the realization of economies of scale for a technology that could be least cost linger-term, and be replicated in other countries with high GHG emissions.

3.2 Demonstration Potential

44. The proposed program is regional in structure, but global in objective. Together with the planned capacity additions in the U.S, Europe and elsewhere, cost reductions and institutional learning that will be achieved through this program will facilitate faster and greater diffusion of this technology in other countries in Asia, Latin America and Africa that have significant potential for CSP. Estimates for realizable CSP potential vary from 20-42 GW by 2025 (DLR 2004) with opportunities in China, India, Iran, Israel, Portugal, South Africa, Spain, and the U.S. Brazil, Chile, Peru and Argentina are other potential markets for CSP development.

45. In the developing world, the implementation of the MENA CSP program would have an immediate impact in South Africa and India where CSP development is a key priority within their low carbon strategies. CSP development is being considered in South Africa as part of its CTF investment plan and in India a number of public and private sector activities are underway to implement CSP projects.

46. In June 2008, the Government of India (GoI) announced the National Solar Mission (NSM) under the National Action Plan for Climate Change (NAPCC) for aggressive increase in deployment of solar energy in the total energy mix, and is aimed at making solar energy cost competitive with fossil fuels. The NSM, which will be officially launched on November 14, 2009, has a target of installing 20,000 megawatts of solar power in India (including PV) by 2020 and 100,000 megawatts by 2030. With the first pilot projects planned for commissioning in about one year, the country will gradually start acquiring experience and moving up on the CSP technology learning curve.

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[13] Potential Sources of Error and Data Sensitivities:

- *Current versus future emissions* - This analysis uses the current emissions from the energy sector of each country for comparison and not the projected emissions when these new CSP projects come online. For a proper comparison of the emissions avoided/reduced, the data used should be for the projected capacity and dispatch schedule.
- *Capacity factor* – The capacity factor assumed for the analysis is 30%. The capacity factor of each project will depend on various factors like availability of storage, dispatch priority in the grid and operational plant availability. In the event of variance of actual capacity factor from the expected average, the actual emissions reduction will vary.
- *Changes in proposed pipeline* – This analysis uses the projects pipeline as listed in the concept note of the CSP Scale-up Initiative. In the event that some projects are added or taken away from the list, the emissions projections will vary.

47. Learning curves show the rate of improvement in performing a task as a function of time, or the rate of change in average cost (in hours or dollars) as a function of cumulative output. A specific characteristic of the learning curve is that cost declines by a constant percentage with each doubling of the total number of units produced. The sources of cost reductions are production changes (process innovations, learning effects and scaling effects), product changes (innovations, design standards, redesign) and changes in input prices. Based on the experience in California, the 12% cost reductions were calculated for each doubling of capacity. However, as there have only been three doublings, it is advisable to use a range of 8% to 15% for each doubling of parabolic trough technology in the future (Enermodal, 1999).

48. Future cost reduction of the Parabolic trough can be described by learning curves based on recent market developments, current market prices for new CSP plants (in this model data of *Andasol1* and *Nevada One* are used to develop baselines of the learning curve) and the prediction of future market growth. Industry interviews undertaken recently revealed an expectation of 2-3 % reductions annually (Fraunhofer ISI,2009). For all technologies, cost reductions are possible for most technical components of each technology. The following table shows the possible impact on the different parts of the technology by improved materials, efficient mass production and enhanced technological and process experience of the CSP companies.

Table 5 - Cost reduction of CSP technologies

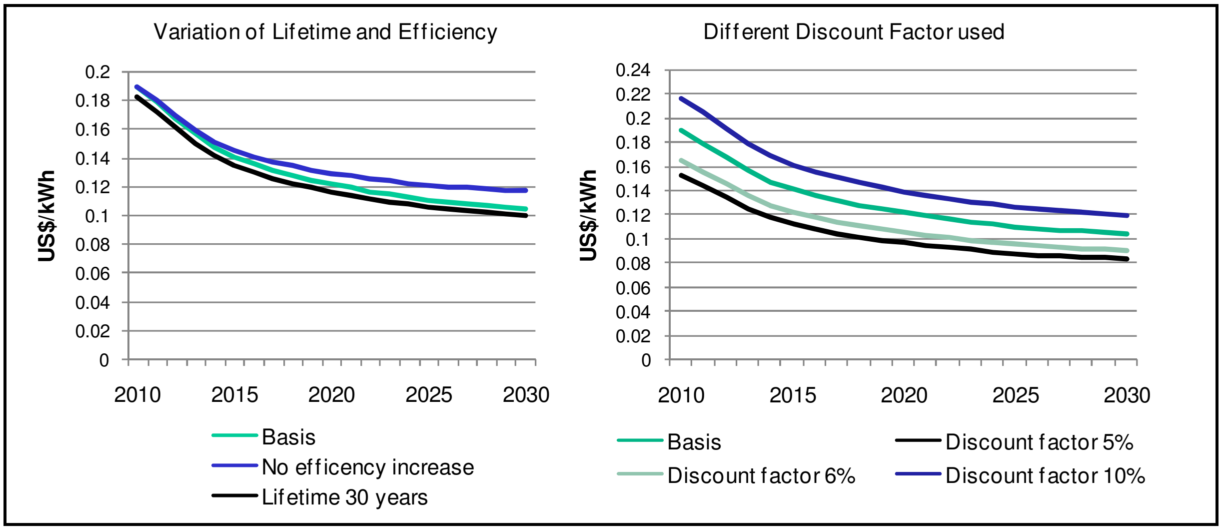
Parabolic Trough	Solar Tower	Fresnel Technology	Dish-Stirling
Innovative structures (up to 28 %)	Larger heliostats above 100 m² (up to 12 %)	Linear Fresnel collector field (up to 3 %)	Mass production for 50 MW (up to 38 %)
Front surface mirrors (up to 19 %)	Larger module size (up to 15 %)	Thermal storage (up to 15 %)	Brayton instead of Stirling cycle (up to 12 %)
Advanced storage (up to 19 %)	Ganged heliostats (up to 8 %)	Reduced pressure losses (up to 7 %)	Improved availability and O&M (up to 11 %)
Reduced pressure losses (up to 16 %)	Advanced storage (up to 10 %)	Increased fluid temperature (up to 6 %)	Increased unit size (up to 9 %)
Dust repellent mirrors (upto to 16 %)			Reduced engine costs (up to 6 %)
Increased solar field outlet temperature (up to 15 %)			Increased engine efficiency (up to 6 %)

49. Learning curves can provide a cost forecast for the next 20 years. The sensitivity analysis for a parabolic trough plant with various parameters shows different trends based on a world-wide market development of 60 GW until 2030 (Fraunhofer ISI, 2009). [14]

[14] Learning curve analysis by Fraunhofer (2009) is based on Plant specific input data of a Parabolic Trough plant (50 MW with storage)

- Based on an investment in 2009: 390 Mio. US$
- Discount factor: 8 %
- Annual Direct Normal Irradiation on plant site: 2300 kWh/m²/a
- Annual electricity output 200 GWh (includes a storage system for 7 hours which is important to cover evening hours), additional use of natural gas of 12 %
- Operating and maintenance costs: annual 2 % of initial investment volume
- Lifetime of CSP power plant: 25 years

Figure 8 - Sensitivity analysis of CSP learning curve



50. The replication potential of the proposed MENA CSP program is strengthened by its strong relationship with the Mediterranean Solar Plan (MSP) whose vision[15] is to take the world-scale renewable energy potential of the South, and the green electricity needs of the entire Mediterranean Basin, and transform it into a massive opportunity - by linking large scale power production from renewable energy resources (including solar) as well as suitable energy efficiency and demand side management options through reinforced transmission grids to demand centers of the Mediterranean region, both in the North and the South.[16] This would provide an opportunity to satisfy regional demands for green electricity, and an opportunity to promote regional integration and energy security in the Mediterranean and beyond. This would also be an opportunity to use clean technology as an investment stimulus at a time of regional economic recession, and to create "green jobs."

51. Looking to the future, a proposal named DESERTEC was put forth by the Trans-Mediterranean Renewable Energy Cooperation (TREC). The solar plan envisages a network linking North Africa and Europe that will tap the vast solar and wind resources of North Africa to bring clean energy to Africa and Europe. Based on the DESERTEC concept a consortium of 12 large companies of the energy, technology and finance sector (including Munich Re, Siemens, Cevital, Deutsche Bank, RWE, EON, Schott Solar) formed a DESERTEC Industrial Initiative (DII) in October 2009 that will conduct feasibility studies and develop project plans to realize a large solar electricity export from the MENA to Europe. On their first meeting in July 2009 in Munich the consortium emphasized their intention to invest € 400 billion over the next 40 years to supply 15 % of the European electricity market by imported solar electricity produced in

- Long-term cost advantage in comparison to Spain up to 19 % (lower wages, cheaper land use, lower production costs)
- Increasing overall plant efficiency up to 17 % by 2030

[15] The European council approved in principle the Union for Mediterranean (UfM) in 2008, presided over concurrently by France and Egypt. Proposed regional initiatives under the UfM to enhance regional cooperation include de-pollution of the Mediterranean, maritime and land highways, civil protection, Mediterranean Solar Plan (MSP), higher education and research and the Mediterranean business development initiative.

[16] Demand-side management energy efficiency measures may also be needed to facilitate the grid integration of solar power.

North African CSP plants. In the first phase, DII will focus on advocacy for opening the EU market to MENA CSP exports. In the medium term, the CTF program will provide the necessary industry and government experience, and market development to enable the large scale private sector investments envisaged by DII members.

52. The proposed MENA CSP program would build a strong foundation for the visionary and ambitious initiatives such as the MSP and the DESERTEC Industry Initiative by implementing projects in the immediate future which could then be replicated on a wider scale in the region.

3.3 Development Impact

53. From the development perspective of the countries in the region, scaling-up of solar energy is attractive due to its impact on fuel savings and energy security, industrial diversification, increasing revenues from exports, and as a vehicle to promote economic integration in the region as it could foster increased trade and knowledge exchange

54. As indicated earlier, for oil and gas importing countries, development of indigenous resources is essential to enhance the energy security and economic security. For oil and gas producing countries, an energy strategy focused on CSP and other renewables would help in freeing-up the increasingly valuable oil and gas resources for more value added utilization such as in industry, for sale in other remunerative domestic and export markets, and to retain option value for future use.

55. Exports of renewable energy would bring economic benefits through increased revenues, which will help finance the acceleration of renewable energy penetration within domestic markets as export revenues increase the profitability of MENA renewable energy power plants.

56. Scaling-up of CSP can also provide a catalyst for an increase in manufacturing in the MENA region. For the plants under implementation, roughly 30 percent of the hardware is locally manufactured. If there is an assured demand for large capacity additions at the GW scale, manufacturing of precision components like the receiver tubes and mirrors may also become viable in the region.

57. ESTELA estimates that if 20 GW of solar thermal capacity is added in the Southern Mediterranean countries, a total of 235,280 jobs would be created including 80,000 in manufacturing (40,000 on site and 40,000 in Europe); 120,000 in construction and 35,280 in O&M. Furthermore, the creation of these jobs will allow for the development of a permanent educational system (schools, vocational training institutes, etc.) to continuously train skilled manpower, i.e. technicians, engineers, developers etc. (ESTELA, 2009). To sum up, the scaling-up of CSP can spur local production and create new jobs, while meeting long term energy security and diversification goals of countries in the region.

3.4 Implementation Potential

3.4.1 Energy Sector Policies and Institutions

58. MENA countries have taken concrete steps towards power sector restructuring, which has contributed to their economic growth and expanded access to electricity. Some countries have privatized the distribution function, and others have elaborated new electricity laws that create a regulatory body and unbundle natural monopoly functions (transmission) from potentially competitive functions (generation and supply).

59. Most countries (Morocco[17], Algeria, Tunisia, Egypt, and Jordan) have introduced independent power producers (IPPs) on the basis of long-term power purchase agreements (PPAs). As a result, about 16 percent of the current installed capacity of Morocco, Tunisia, and Egypt is in the hands of private producers. In distribution, Jordan has privatized distribution companies while Morocco awarded distribution concession contracts (Casablanca, Rabat, Tangiers and Tetouan) to private companies. In Egypt, six companies are licensed to distribute electricity in different areas.

60. The share of private generation should slightly increase over the coming years with the completion of several projects in Algeria, Morocco, Tunisia and Jordan. The introduction of the new electricity laws, such as in Egypt, may further increase the share of the private sector in power generation.

61. Irrespective of the form of liberalization which is likely to prevail, most of the governments and energy utilities are favorable to introducing competition and regional trade, and to introduce the following reforms:

- Legal separation of activities within the gas and electricity sectors;
- Corporatization[18] of public enterprises;
- Introduction of the private sector for new power generation or energy production;
- Corporatization or privatization of the distribution function;
- Move gradually toward cost-reflective pricing
- The need to gradually go beyond single buyer arrangements towards third party access.

62. It is evident that sustained absorption of renewable energy in the domestic market will be only achievable by overcoming systemic barriers, such as energy subsidies and introduction of favorable policies that will encourage commercial utility operations. All the countries being considered in this investment plan have taken concrete steps in this direction. In Morocco, Tunisia (less than 2% of GDP) and Jordan (~ 3% of GDP), energy subsidies are low by regional standards. Egypt has initiated a reform program for reducing energy subsidies - For example, electricity tariffs are being raised by an average of 7.5% per year since 2006. Similarly, electricity tariffs are low in Algeria: around 6 USc/kWh for residential customers, and a little

[17] Where more than 60% of electricity is generated by private companies (mainly with foreign shareholders) including RE generation from wind

[18] Corporatization refers to the transformation of state assets into state-owned corporations in order to introduce corporate management techniques to their administration.

over 3 USc/kWh for industrial users (source: Enerdata). The government's objective is to gradually adjust domestic energy prices to international levels, but this process is likely to be slow.

63. In order to anchor the renewable energy scale-up efforts, dedicated agencies have been established in each country to promote increased awareness, technical advice, and defining guidelines. Agencies include: The Centre for the Development of Renewable Energy Sources (CDER) in Morocco, which is being transformed into an Energy Conservation and Renewable Agency, the Agency for the Promotion of Rational Use of Energy (APRUE) in Algeria, the National Agency for Energy Conservation (ANME) in Tunisia, and the New & Renewable Energy Authority (NREA) in Egypt (European Commission, 2009).

64. The detailed description of the policy and regulatory conditions for renewables is presented in country Annexes attached to this document. The first private sector projects in most cases are likely to follow an approach of "regulation by contract" whereby long-term PPAs are signed with bidders offering the best price offers. Experience gained from this procurement-based approach will help develop viable policies and framework conditions for further CSP development in these countries such as introduction of comprehensive feed-in-tariffs (FIT). Countries are already following such an approach for development of large scale wind projects in markets such as Egypt, Jordan and Morocco and this approach is expected for CSP also.

65. Over the years, countries in the region have built up their capacity in the area of renewable energy. Ambitious wind energy projects have been implemented or are under implementation, sometimes with innovative contractual and financing mechanisms (Morocco – EnergiPro[19] and Tunisia STEG are developing the same type of arrangement for big industrial consumers). A variety of contractual and financing solutions have been applied to develop wind farms, including concessions with private developers, loans on concessional terms from multilateral and bilateral organisations, or long term contracts with self-producers, sometimes including wheeling arrangements.

66. Renewable energy projects under implementation range from Government (Egypt) and utility-sponsored (ONE in Morocco) to public-private partnerships based model (Algeria, UAE). In view of the varying electricity market characteristics in these countries, the proposed CSP scale-up program will be open to different types of implementation models involving the private and the public sector. In general, there is a movement toward increased private sector participation in power generation and this will be reflected under this program.

67. In Morocco and Jordan IPP models are being proposed for the CSP program, while projects in Algeria and Libya are likely to be based on public-private partnership (PPP), such as the first CSP project under implementation in Algeria. Egypt is likely to follow a PPP model or a public model. The transmission projects will be public projects.

[19] EnergiPro: Within the framework of its new strategy, the ONE offers to big industrial consumers the possibility of producing their electricity from renewable energies, by forwarding over its transport network the electricity from their production sites to their consumption sites, for an incentive payment to the price of transit.

3.4.2 Environmental and Social Issues

68. The construction and operation of CSP projects potentially leads to a variety of environmental and social impacts that would need to be identified, assessed, monitored and mitigated. The World Bank and African Development Bank have prior experience in this area based on the two GEF funded CSP projects in Egypt (WB/JBIC) and Morocco (WB/AfDB) that are under implementation. The projects have followed environment and social guidelines of the respective institutions. Table 6 summarizes the key impacts and their mitigation options (see Annex 6 also). It is worth pointing out that most, if not all, of these impacts are likely to be site-specific rather than regional or cross-boundary in nature.

Table 6 - Key potential environmental and social impacts from CSP, and mitigation options

Impacts from CSP	**Mitigation options**
Construction	
Environmental	
Land use (construction of CSP, precluding other use of the same and adjacent lands)	Careful evaluation of alternative locations, avoidance of conservation or recreational areas as project area; consultation with nearby communities. Include evaluation of relevant effects from associated infrastructure (e.g. transmission lines) early on in the process.
Construction impacts (e.g. construction waste)	Safe construction, waste disposal.
Fire risk from solar converters at high temperatures, including risk of out-gassing from panel components.	Measures against overheating (coolants) and relevant warning / monitoring systems
Impacts on local flora and fauna	Re-establishment of local flora and fauna where possible. Relevant impact studies need to establish seriousness of this impact and whether mitigation is possible – or whether e.g. endemic species are present.
Social	
Land tenure and ownership issues.	Resettlement framework to be prepared once investment plan approved.
Potential expropriation and resettlement of the population living in the project area	Compensation in line with OP 4.12.
Impacts on existing infrastructure (which may have to be demolished to make way for the project site). Note that in case of CSP impact may come from CSP-associated infrastructure (e.g. transmission lines) more than from CSP installation itself.	Relevant infrastructure to be moved or to be rebuild elsewhere as appropriate.
Effects on local communities of the influx of workers	Process to be accompanied by relevant specialists (notably health specialists).
Operation	

Environmental	
Routine or accidental release of chemicals: e.g. anti-freeze or rust inhibitors in coolant liquids. Also heat transfer fluids likely to contain harmful chemicals.	Safety measures against such release – mostly through relevant components being leak-proof, regularly maintained, cleaned and periodically replaced by appropriately trained staff
Safety issues for workers, notably but not exclusively arising from high levels of radiation	Use of special sunglasses and other protective devices.
Cooling water: use of water and, where water returned into the system, problem of dealing with thermal discharges	Appropriate constraints, use of dry cooling where use of wet cooling would result in water shortage, use of thermal discharges in nearby industry where feasible.
Social	
Loss of long-term livelihoods from inability to use land that now is the project area.	Alternative livelihoods programs for local communities.

Source: Project Appraisal Documents; Tsoutos et al 2005; Biswas et al 1992; Downing 1996; and conversations with WB environmental safeguards staff.

69. These issues will be dealt with in the context of individual projects in line with relevant World Bank/AfDB/IFC procedures. Based on the implementation experience of the Egypt Kureimat project and the Morocco Ain Beni Mathar project, the social and environmental impacts are reasonably well understood.

70. One of the key issues for the region while considering a CSP program is the availability of water. The water requirements for a CSP plant are no different from the needs of conventional power plants, except for cleaning, but this issue does need careful consideration because of the siting of CSP plants in arid locations. In this regard, experience from Morocco and elsewhere indicates that water savings to be had from hybrid cooling systems and air cooling systems vis-à-vis wet cooling are considerable. Additional water savings generated by air cooling over hybrid cooling outweigh the rather marginal additional performance and cost penalty associated with this technology. Nonetheless, the decision on the cooling technology ought to be made in each instance taking local water availability and cost into account. Given water scarcity in many parts of the MENA region, hybrid and air cooling technologies are likely to be frequently a preferable option.

71. In addition, desalination of seawater is considered to be one of the options to meet the water requirements for the proposed CSP Scale-up in the Middle East and Northern Africa region (MENA). While the MENA region is one of the world's most water-stressed regions, with 16 out of the 20 countries facing water stress, it is also a world leader in desalination deployment, with 55% of the world's desalination capacity. The desalination capacity additions are expected to increase by 2011, almost doubling from 2006 standards. Given the increasing demands for water across the region, the increase in installations is expected to continue until 2025.

72. Desalination of seawater to reach levels acceptable for human consumption or industrial purposes is a highly energy intensive process and is thus conducted only in regions of high water stress. Multi Stage Flash (MSF) or Multi Effect Distillation (MED) evaporation techniques are

the most commonly used, while Reverse Osmosis (RO) use is growing. While MSF and MED rely on a mix of heat and electricity input, RO relies exclusively on electricity input. MED is more efficient than MSF and is increasingly leading the new capacity installations.

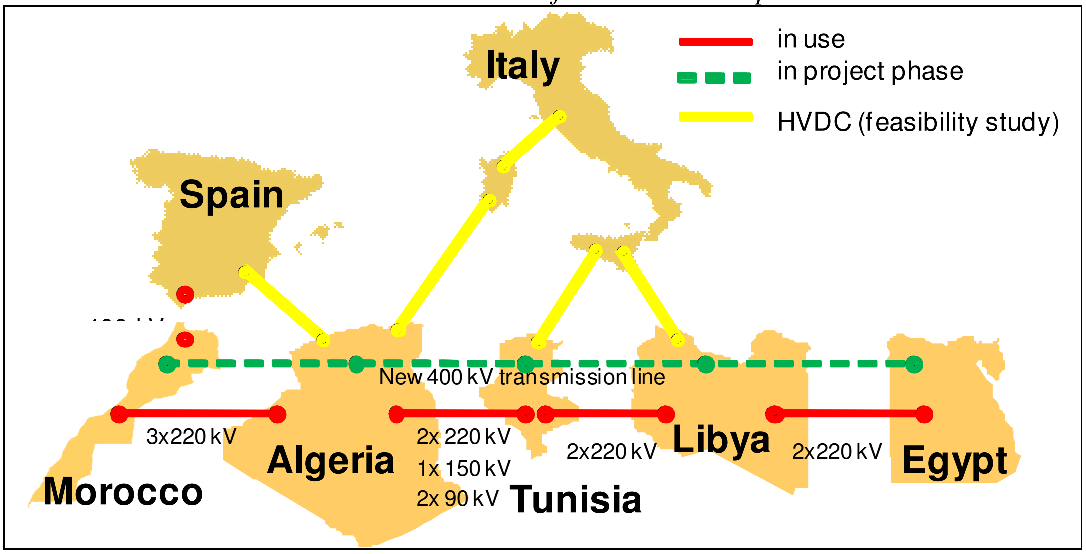
73. Given the assumptions of water requirements of 2.8 to 3.4 m^3/MWh and capital costs of \$1500-2000/m^3/d for MSF and \$900-1700/m^3/d for MED, the additional capital costs required for the desalination equipment come to about \$33-37/kW. For the MENA CSP plan of 1000MW, this amounts to an additional \$33m, assuming that each plant reaches the economies of scale required for these costs. Since desalination is a mature technology in the region, these costs can be stated with a reasonable degree of accuracy. The additional solar field required would be in the order of 1 to 3 percent. Oversizing the solar field can provide energy for a larger desalination plant, which could provide drinking and/or potable water for the local community.

3.4.3 Transmission Infrastructure bottlenecks

74. For CSP plants to be developed within MENA region countries for meeting domestic demand, significant infrastructure bottlenecks are not expected. It should however be noted that some projects may need transmission lines within countries (specifically, in Jordan and Tunisia) due to the location of the plants in relation to the existing grid. However, a greater challenge is trade of power between countries in MENA and in Europe. As indicated in an earlier section, the only existing transmission line between North Africa and Europe connects Morocco and Spain in the Straits of Gibraltar with a capacity of 2x700 MW. Because of the short distance of about 40 km, HVAC transmission lines can be used at this connection point between North Africa and Europe (longer undersea connections would need to be HVDC). There are plans for Spain and Morocco to increase this capacity in the near future and other undersea connections across the Mediterranean are planned. For the Mashreq countries, interconnection through Turkey will be possible once its interconnection with the European grid is operational, and the Mashreq grid has been reinforced.

75. The proposed investment plan therefore includes two transmission projects to enable MENA exports to Europe. One is in Jordan to reinforce the Mashreq's connection to Europe, and the other connects Tunisia to Italy to facilitate North African exports. These transmission projects are an integral part of the investment plan because they will buy down the market access risk for potential private investors in CSP generation in MENA. They will therefore greatly enhance the demonstration and replicability impacts of the program

Figure 9 - Possible Transmission lines within North Africa and to Europe



76. The most modern undersea HVDC connection in Europe *NorNed* was commissioned between the Netherlands and Norway (580 km) after a 5-year development in 2008. It uses a voltage of 450 kV and a capacity of 700 MW that costs about 600 Mio Euro. The losses of this comparable line are specified at 4 percent for the whole line, including 0.6 percent in each converter station. That results in a loss of 4.8 percent per 1000 km in an undersea cable.

77. In the following table, transmission losses were calculated for the possible interconnections between North Africa and Europe. Depending on the distances between the MENA countries and Europe the losses range between 3 and 5 percent for the HVDC transmission line. These losses have to be incorporated in export electricity prices. The costs were taken from the feasibility studies for these HVDC lines and depending on the cable length, capacity and used voltage.

Table 7 - Parameter overview for transmission lines

Transmission Line	Length	Technology	Capacity	Voltage	Status	Losses[20]	Costs
Morocco-Spain	60 km	HVAC	2x700 MW	400 kV	existing	3.0 %	150 Mio. US$
Algeria-Spain	240 km	HVDC	2x1000 MW	400 kV	Feasibility studies	2.4 %	650 Mio. US$
Algeria-Italy	800 km	HVDC	1000 MW	500 kV	Feasibility studies	5.0 %	975 Mio. US$
Tunisia-Italy	400 km	HVDC	500 MW	400 kV	Feasibility studies	3.1 %	780 Mio. US$
Libya-Italy	580 km	HVDC	1000 MW	400 kV	Feasibility studies	4.0 %	650 Mio. US$

78. The investments for HVDC transmission add 1-2 cent $/kWh on the Levelized Electricity Cost (LEC) of CSP. An investment program for a large CSP scale-up will obviously need to include these grid costs.

[20] Losses of HVDC: based on NorNed

4. Risk Assessment

79. Potential Risks and Mitigation Measures for the MENA CSP program are summarized below:

Table 8 - Risk Assessment

Potential risks	Rating after mitigation [21]	Mitigation measures
Reduced private sector interest as a result of global economic slowdown.	S	Many countries in the region have experience with private power generation projects. Lessons from the implementation of Independent Power Producers (IPP) projects will be incorporated. Different PPP models and if necessary publicly financed projects will be considered. Technical assistance for developing a robust framework for private sector participation would be strengthened.
Higher than expected capital costs	M	Program will be open to different types of CSP technologies and procurement approaches to ensure the best possible competitive environment.
Weak institutional capacity	M	Program will coordinate donor technical assistance for participating countries to ensure adequate capacity is built to implement and manage large CSP projects. Regional (Algeria, Egypt, Morocco, Abu Dhabi) and global experience (U.S, Spain) in CSP will be incorporated in the implementation of projects under the program.
Slow electricity and fuel price reform in MENA limits CSP scale-up	S	MENA countries are undertaking price reform, although some are faster than others. Like other IPPs, CSP projects will be subject to regulation by contract with PPAs that incorporate above-average tariffs. MENA countries are also increasingly seeing the virtues of CSP for saving subsidized fuel for higher value-added uses than power generation. Falling CSP capital costs through economies of scale will bring CSP towards grid parity, and accelerate deployment. In short, the price environment for CSP in MENA is challenging, but is expected to improve.
Inadequate market access due to high generation costs, uncertain regulatory reform, and underdeveloped transmission infrastructure	S	International markets: There is strong commitment from EU partner countries to meet the 2020 targets and policy environment for import of green electricity from MENA countries. EU directive issued in December 2008 allows for imports from third countries and EU countries are to announce their individual policies by June 2010 (but establishing the track record for these policies will take longer). Inclusion of transmission projects in the investment plan also buys down the market access risk. Domestic markets: Countries are beginning to integrate renewable energy power within their systems and have planned for suitable levels of CSP, wind etc considering their costs. The projects proposed within this program fall within the generation expansion plans of individual countries, and energy security/fuel saving objectives which underpin tariff support (see below under slow price reform).

[21] Rating of 4: high (H), Substantial (S), Moderate (M), Low (L)

Potential risks	Rating after mitigation [21]	Mitigation measures
Risk of MENA Governments and CTF subsidizing green energy use in Europe	M	The distribution of costs and benefits to the EU and MENA countries would be analyzed during project preparation for each relevant project based on the structure of the power purchase agreements to ensure that adequate benefits accrue to the MENA countries. The risk is mitigated by private sector involvement on the supply side (so that attractive tariffs will be needed), and by the strong desire of governments both sides of the Mediterranean to see scale-up and hence to have replicable arrangements. In addition, an approach utilizing broad-based financing sources and competitive sourcing of investors would also mitigate this risk. The overall intention of the program is for green energy consumption in Europe to subsidize the scale-up of CSP in MENA (and hence globally).
Environment and social issues delay projects	M	WB/IFC/AfDB safeguards policies will apply to all interventions as for any other investment.
Overall Rating	S	

5. Economic and Financial Analysis

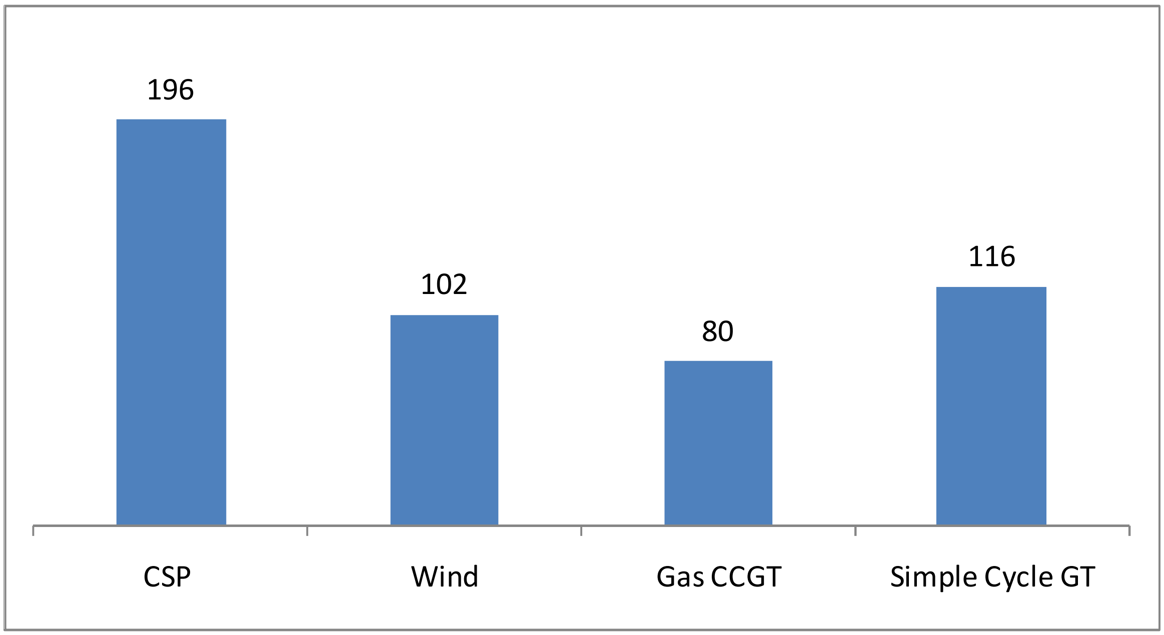
80. The economic and financial analyses presented here are for indicative purpose. The actual analyses from individual projects using field data would be different from what presented here. Nevertheless, the overall conclusions from the economic analysis – CSP is not economically competitive with fossil fuel based power generation in the current market settings – is not expected to change. The economic competitiveness of a CSP plants depends mainly on the level of capital cost and the capacity factor. For example, a CSP plant with US$4,000/kW capital cost operating at 30% capacity factor would be 2.46 times as expensive as combined cycle gas turbine, the most likely business as usual candidate power plant in most countries in the MENA region (please see Figure 10). On the other hand, the levelized cost of the same CSP plant would increase by 50% to US$294/MWh if capacity factor decreases to 20%. Note that the CSP plant would be most expensive than other alternatives even if we consider the cheapest CSP technology currently available.

Table 9 - Data used in Economic Analysis of CSP[22]

[22] Note: Data on capital cost (or overnight construction costs), O&M costs, capacity factor and heat rate data are from various sources such as CUC (2008), NEA/IEA (2005), Lazard (2009). Fuel price data are from Razavi (2008). We used fuel price escalation rate of 2.6% per year which was utilized by USDOE for long-term gas price forecasting.

	Solar CSP	Wind	Gas CCGT	Simple Cycle GT[23]
Plant Economic Life (yr.)	25	25	25	25
Discount rate	10%	10%	10%	10%
Capacity Factor	30.0%	27.0%	90.0%	90.0%
Capital Costs US$/kW	4000	1,931	813	735
Variable O&M ($/MWh)	-	-	2.40	3.36
Fixed O&M ($/kW-yr.)	74.4	28.8	11.15	11.52
Nominal heat rate (GJ/MWh)	-	-	6,917	10,807
Fuel Price (US$/GJ)	-	-	7.385	7.385
Economic Costs (US$/MWh)	196	102	80	116

Figure 10 - Levelized Costs of CSP technologies as compared to gas fired power plants (Unit: US$/MWh)



81. The CSP technology would not be economically competitive with natural gas fired combined cycle power plants unless (i) capital costs of CSP were reduced by 55%, or (ii) fuel price for CCGT were increased by 182% or (iii) combinations of substantial reduction of CSP capital cost with large increase in gas price (for example, 25% reduction of capital costs of CSP together with 105% increase in gas price).

82. The environmental benefits of CSP, such as climate change mitigation and reduction of local air pollution, are significant. For example, 1 MWh of electricity produced from CSP would reduce 0.51 tons to 0.83 tons of CO_2 emissions in MENA countries. This implies that even if the

[23] Simple cycle gas turbine normally operates at very low capacity factor (CF) because of relatively expensive fuel costs, hence some studies assume very low CF (e.g., 10%) for it. In this study, we however assumed capacity availability factor instead of capacity utilization factor. While simple cycle GT is available for operation 90% of time, it is a different issue that the economic dispatchability of this technology would vary depending upon gas price.

CO_2 mitigation is sold at US10/tCO_2, the economic costs of CSP would be reduced by US$5/MWh to US$8/MWh. If the carbon credits can be sold at US$25/ t$CO_2$, the economic costs of CSP would reduce by US$13/MWh to US$21/MWh. The economics of CSP would deteriorate if market price of natural gas drops. For example, if the price of natural gas drops to US$5/GJ from US$7.4/GJ currently assumed in the analysis, the levelized cost of combined cycle power plant decreased by 26% to US$59/MWh from US$80/MWh in the current analysis. Similarly, levelized cost of simple cycle gas plant decreased by 28% to US$83/MWh.

83. Besides high investment costs, there are other important barriers to CSP development: subsidies to fossil fuels, insufficient transmission infrastructure, and immature storage technology.

84. All MENA countries currently provide substantial subsidies to natural gas, which distort prices and hinder the development of solar thermal technologies. Natural gas is made available at less than US$1/GJ (Razavi, 2008) to power producers in many MENA countries, which reflects around 90% subsidies on the market value of gas. Investments in CSP would free up the valuable gas sold at subsidized prices that could be utilized for higher value added end-uses. This has been one of the key drivers for MENA countries to pursue energy efficiency and renewable energy options. On one hand, subsidies hamper the development of CSP market, but on the other hand these options (energy efficiency and renewable energy including CSP) help reduce government high subsidies.

85. The storage technology in CSP plants needs further development. Currently, there is only one commercial plant with this technology in operation in Spain. Storage development will be a key factor for increasing the annual output of CSP plants, and therefore increasing their competitiveness. A large thermal storage system with a storage capacity of up to 7 hours can provide electricity during periods without sunshine and thus supply power during peak demand in the evening. The higher investment for a storage facility, such as a molten salt thermal storage tanks (with a storage capacity of approximately 1000 MWhth) is compensated by the higher reliability and flexibility that will allow the plant operator to dispatch the solar energy to the grid when wholesale prices are higher.

86. A key consideration in the preparation of the CTF investment plan is the combination of financing terms and instruments needed to bring CSP closer to the cost of other renewable energy sources, such as wind power, that are beginning to be adopted by countries in the MENA region. Given the high capital costs, the financial viability of CSP plant depends on several factors such as capital costs of the plant, capacity factor, financing terms, tariff affordability, fiscal incentives, and level of carbon revenue. A number of scenarios could be developed with varying assumptions to analyze the financial viability of CSP projects with different funding packages.

87. As one example, a 100 MW plant without storage could cost roughly US$ 420 million. Assuming a conservative capacity factor of 22.5%, debt/equity ratio of 75:25, commercial financing debt terms 7% interest and 18 yr repayment, and a 15% internal rate of return on

equity, a “no-support” levelized cost of energy would be in the range of about 31.0 US cents/kWh[24].

88. The same project with about US$ 72.5 million low-interest debt from CTF (i.e. CTF contribution of 16% of total costs), an additional US$ 150 million debt at concessional financing, US$ 78 million commercial debt at market terms and US$ 105 million equity yields a levelized energy cost around 19.1 US cents/kWh including carbon revenues at about US$ 15/ton of carbon credits. Export of part of the energy would require a lower sales price on the local markets to achieve the required profitability, depending on the quantities to be sold in the export market, or reduce the need for additional donor concessional support. If 50% of the power is exported at 26 US cents/kWh, then the effective local tariff would reduce to 12 US cents/kWh. The following table depicts some of the possible scenarios (8% return on equity, 12% return on equity and 15% return on equity) for financial costs of CSP power in levelized US cents/kWh with varying levels of support from domestic as well as international sources. Scenario (C) in Table 10 corresponds to the project example described with US$ 72.5 million CTF financing

Table 10 - Scenarios for Levelized Tariffs considering different financing packages

	Levelized tariffs @ 8% Equity IRR (US$/kWh)	Levelized tariffs @ 12% EIRR	Levelized tariffs @ 15% EIRR
(A) No support	0.240	0.281	0.311
(B) 100% tax holiday, carbon finance at US$ 15 / ton of CO2, CTF at US$ 725,000 /MW	0.197	0.225	0.247
(C) B + concessional financing at US$ 1.5 mil/MW -- public project	0.157		
(D) C (private project)		0.177	0.191

6. Investment Program and Financing Plan

89. The total cost of this IP is US$ 5.6 billion of which the CTF is requested to provide co-financing of US$ 750 million (see table 12 below). Assuming a gigawatt-scale generation program, the total financing requirements would be in the order of $4.0 billion for generation projects, with the CTF contributing around 16.5 percent of the total cost (US$ 670 million). It is proposed that CTF provide an investment support of about $0.725 million per MW of installed CSP capacity for each project. This would provide a positive incentive for large-scale deployment of CSP and for supply industries to reduce costs, since higher project costs would translate into a smaller percentage of CTF concessional funding in a project's financing plan. Discussions with the private sector suggest that sponsor equity would account for approximately

[24] The assumptions for the financial modeling are consistent with the economic analysis presented earlier.

25 percent of a particular project which translates to about US$ 1 billion for the generation projects, including equity financing from IFC and AfDB as well. Additional official financing requirements would be in the range of about US$ 1.24 billion, including concessional financing of about US$ 1 billion from donors. The remainder of the financing would be leveraged through a combination of commercial debt and multilateral and bilateral donor funding. This will also include the World Bank Group and the African Development Bank, which will blend CTF resources with their investment lending and/or partial risk guarantees.

90. The pipeline also includes two transmission projects (both public investments) to facilitate domestic and export sale of CSP-generated power (one to interconnect the North African grid to Italy and hence to elsewhere in Europe – the Tunisia-Sicily interconnector – and the other to reinforce the Jordanian section of the Mediterranean Ring). These investments total about $1.6 billion. Table 11 below provides a list of proposed generation and associated transmission projects in the Investment Plan.

Table 11 – List of CSP Projects in pipeline

Country	**No. of Projects**	**Location**	**Capacity (MW)**	**Est. cost (US$ million)**	**CTF Contribution (US$ million)**
Algeria	3	Megahir	80	322	58
		Naama	70	285	51
		Hassi R'mel II	70	285	51
Egypt	2	Kom Ombo	70	370	51
		Marsa Alam[25]	30	270	44
Jordan	2	Maan Province	100	418	72
		Aqaba-Qatrana transmission		410	40
Morocco	3	Tan Tan[26]	50	240	35
		Ain Beni Mathar	125	525	90
		Ouarzazate	100	440	72
Tunisia	3	IPP-CSP Project	100	450	73
		ELMED-CSP	100+	450	73
		Tunisia-Italy transmission		1140	40
Total	13		**~900 MW**	**5,604**	**750**

[25] This is a project with 8 hr storage so the size of the solar field will be equivalent to a 60 MW project.
[26] This is a CSP-desalination project

91. The above portfolio would be managed jointly by the World Bank, IFC and the AfDB in close consultation with interested donors, who might take the lead in project appraisal in certain cases. These proposals will retain flexibility to respond to dynamic market conditions and as-yet unidentified market opportunities. World Bank Group and AfDB will report semi-annually to the TFC on progress in project preparation, feasibility and engineering studies, procurement, and construction, as well as mobilization of concessional and commercial financing. This would enable the committee to regularly assess implementation status and determine the need for resource re-allocations. The estimated timetable for project implementation is summarized in Annex 7.

92. The proposed indicators for the projects under program would be (a) GHG reductions; (b) Energy generated; (c) level of concessional finance mobilized and (d) cost of the solar field in $/m2.

93. Several European financial institutions (EIB, AfD and KfW) presented a joint non-paper in which they announced their intention to work closely together on these issues. They will - on a provisional basis - earmark funds (€ 5 billion) for the 5 coming years dedicated to renewable energy and energy efficiency in the MENA region. In addition, grant resources of at least $20 million per year from the EU Neighborhood Investment Fund could also be available. These resources are targeted more broadly than the scope of the CTF Investment Plan - in terms of countries and low carbon technologies. Actual funding decisions, including the level of concessionality, would be determined on a project-by-project basis starting with projects where feasibility studies have been undertaken or underway, including with European donor funding. The coordination with European donors has already begun during the preparation of this investment plan and will continue during the preparation of project feasibility studies, dialogue with partner countries on CSP policy framework development, coordination with European partners for securing financing and during implementation.

94. JICA's Cool Earth Initiative, which offers concessional "Climate Change" ODA loans, could also be a suitable co-financing mechanism for CSP projects. Discussions are underway with the agency on the further course of action. Similarly, discussions are underway with the Spanish development agencies for possible concessional co-financing options. The Islamic Development Bank and the Saudi Fund have indicated that they would consider co-financing opportunities on a project-by-project basis.

95. The key instruments proposed for the implementation of this CTF Investment Plan would be loans and grants and possibly guarantees.

96. **Grants:** Grant funds would be utilized for advancing preparatory work with respect to each of the program areas. In particular, CTF preparatory funds are required for additional feasibility work, structuring of private sector elements including agreements such as power purchase agreements. The grants will assist clients implement the proposed projects in a manner that would catalyze replication. At the same time, this will aim to solidify the long-term impact of market transformation by strengthening local capacity, awareness, and know-how of CSP by sharing lessons learned through market promotion activities. The lessons learned from initial experiences could be cross fertilized in MENA and beyond and reduce the learning curve for new market entrants. The total CTF preparatory funds required would be in the range of US$ 13

million[27] related to CSP projects. These preparatory funds would/are being supplemented by other sources including EC, ESMAP, FAPA, Japan PHRD, PPIAF and others to the extent of $ 15 million.

97. **Loans:** The proposed investment plan would utilize the CTF loan instrument in conjunction with co-financing from other sources including private sector, IBRD, African Development Bank, IsDB, AFD, SFD, KfW, EIB, JICA, JBIC, Spanish agencies, private sector and other donors.

Table 12 - Financing Plan (US$ million)

	CTF	**Equity/Govt. contribution**	**Commercial/ other Debt**	**Official Financing (Concessional and non-concessional)**	**WBG**	**AfDB**	**Total**
Generation	$670	$540	$640	$1,238	$537	$429	$4,054
Transmission and associated infrastructure	$80	$200	$650	$70	$400	$150	$1,550
	$750	$740	$1,290	$1,308	$937	$579	$5,604

98. **Guarantees**: In addition to the above instruments, it likely that the CSP scale-up program would need risk mitigation instruments such as guarantees to stimulate private sector interest in the program. The guarantees could be accessed through MIGA, IBRD and/or AfDB.

99. **Carbon Finance:** Carbon revenues are incorporated in the revenue streams as part of the financing plan but these will need to be validated during preparation of each project. An approved methodology already exists based on the 100 MW Shams project under implementation in Abu Dhabi. A program of activities (POA) will be developed for this program based on the existing methodology and new methodology to be developed for projects involving export of power to EU countries to appropriately account the renewable energy imports and purchase of carbon credits that may be applicable only for the part of energy consumed in the domestic MENA markets.

100. **Global Environment Facility (GEF):** In addition to the above sources, early discussions are underway to explore GEF co-financing for the identified projects, including for providing technical assistance support to the participating countries.

[27] The amount is subject to further verification after the CTF preparation funds become available and its rules finalized.

7. Consultations

101. During the preparation of this investment plan upstream analytic work and field level stakeholder consultations were undertaken. Coordination with key complementary initiatives such the Mediterranean Solar Plan (MSP) proposed under the Union for Mediterranean (UfM), meetings organized by the League of Arab States, NGO consultations, and participation in CSP industry meetings (including with Desertec Industry Initiative) were useful. In addition to the above, bilateral/multilateral meetings were held with OECD, multilateral, Arab and Islamic donors (Kuwait Fund, JBIC, JICA, Saudi Fund, Abu Dhabi Fund, Arab Fund, Islamic Development Bank, KfW, EIB, AFD, and EC/Europe Aid etc.) and Government agencies in France, Germany, Spain and Italy as well. A regional launch workshop was held in Rabat during June 11-12 where the participating MENA countries presented their long-term and immediate CSP strategies, and there have also been numerous bilateral consultations with MENA countries in the Mediterranean region and in the Gulf.

102. An investment plan preparatory meeting for a wide range of stakeholders was organized in Tunis during Oct 21-22. This pivotal Tunis investment plan meeting was attended by about 200 participants from the various sections of stakeholders including countries, private sector, financial institutions, donors, and civil society institutions. The key participating countries included Algeria, Egypt, Jordan, Morocco, and Tunisia.

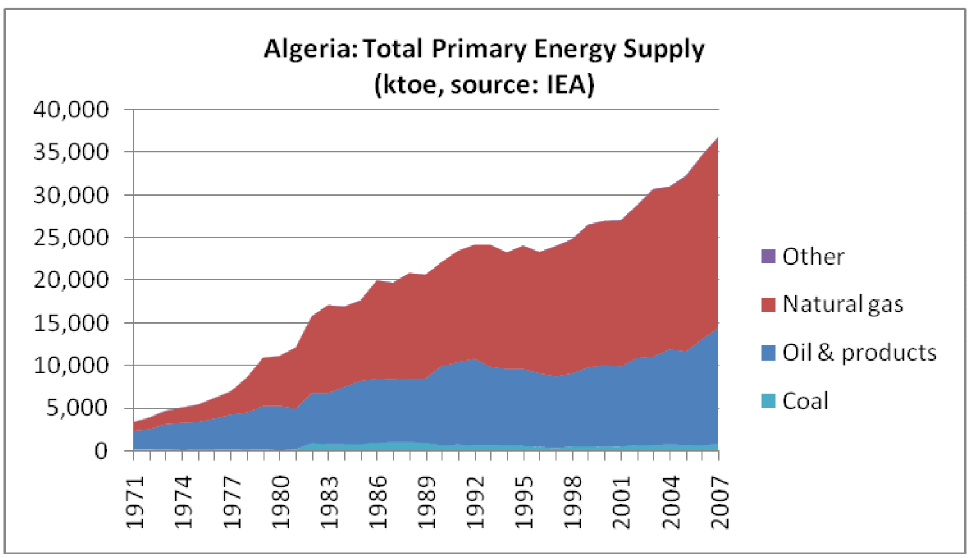
ANNEX 1 – ALGERIA

I. Policy and Regulatory Background

1. Energy Sector Overview

Algeria plays a central role in the energy world, as it is a major producer and exporter of oil and natural gas. In 2008, Algeria produced approximately 1.4 million barrels per day (mbbl/d) of crude oil, of which 85% was exported, and 86.5 billion cubic meters (bcm) of natural gas, of which 70% was exported, mostly to Europe. Algeria was the fourth largest crude producer in Africa, and the sixth largest natural gas producer in the world (after Russia, the United States, Canada, Iran and Norway). Oil and gas export revenues account for more than 95% of Algeria's total export revenues, around 70% of total fiscal revenues, and 40% of gross domestic product (GDP).

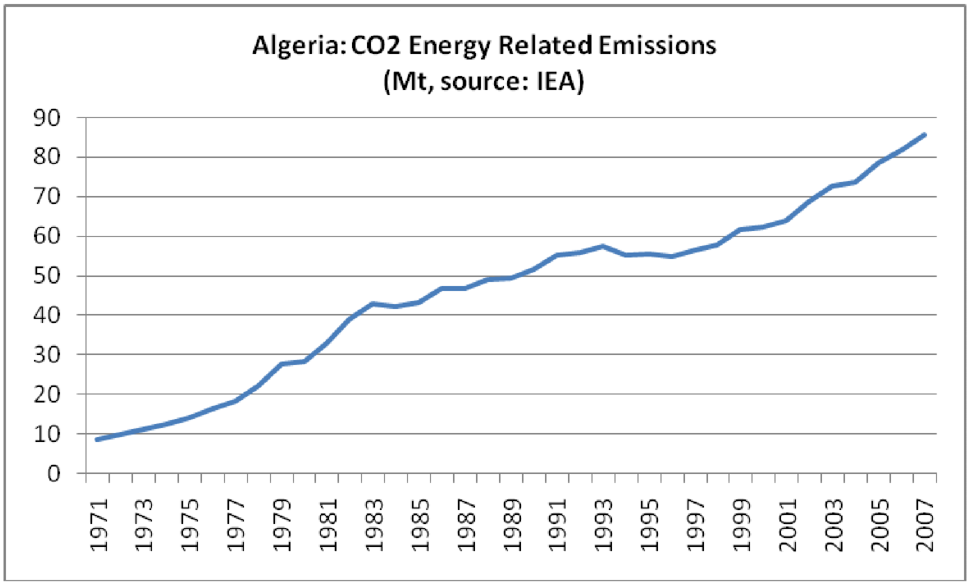
Compared to other developing countries with a similar GDP, Algeria's energy consumption is high: 1.2 toe and 840 kWh of electricity per capita. However, these figures include self-consumption and losses in the energy sector due to LNG exports. The share of oil in the country's overall consumption fell from 40% in 1990 to 34% in 2007; the share of gas increased from 57% to 64%. In industry, gas accounts for nearly 53% of final consumption. Gas consumption also increased substantially in the residential sector, and in 2007 accounted for 46% of final energy consumption.



The country is connected to Europe through two gas pipelines, to Italy via Tunisia, and to Spain via Morocco. Three additional pipelines are in development: Medgaz, linking directly Algeria to Spain, Galsi, from Algeria to Sardinia and the Italian mainland, and Trans-Saharan, from Nigeria to Algeria. This pipeline would make it possible for Nigeria to export part of its production to Europe through Algeria. With it, Algeria would not only be an energy hub between North Africa and Europe, but between the whole African continent and Europe. Algeria also has four liquefied natural gas (LNG) plants, with a fifth one in development (LNG accounts for one third of Algeria's gas exports). The hydrocarbon sector is dominated by state-owned Sonatrach, whose objective is to increase the gas export capacity form the current 65 bcm per year, to 85 bcm per year around 2010-2012, and 100 bcm per year by 2015.

2. GHG Emissions

CO2 emissions from energy use have increased by 3% per year since 2000, reaching almost 100 Mt in 2007.



3. Electricity Sector Policy Framework

Sonelgaz is the state-owned electricity and downstream gas utility. Total installed power generation capacity amounts to 8.9 GW, approximately 50% of which are open cycle gas turbines, 12% combined cycle gas turbines, 35% conventional steam turbines and 3% hydraulic. Over 90% of the electricity production is based on natural gas, the balance originating from fuel oil/diesel and hydropower. Electricity prices are low in Algeria, especially for residential customers, thanks to low internal gas prices.

A 2001 law makes it possible for independent power producers (IPPs) to enter the generation segment. Sonatrach has entered the IPP business in partnership with Sonelgaz: the two companies established a 51/49 joint venture called Algerian Energy Company (AEC), mostly to invest in power generation. The four existing IPPs account for 2.9 GW. They are mostly owned by AEC and other public sector companies, but also have significant international ownership: Black & Veatch owns 5% of Kahrama, SNC Lavalin owns 20% of Skikda 2 and 26% of Hadjret Ennous, Siemens owns 49% of Berrouaghia, and Mubadala (Abu Dhabi) owns 25% of Hadjret Ennous.

To keep up with electricity demand growth, 8-10 GW of new power generating capacity are expected to be built by 2015, about 70% of which would be built by IPPs. Electricity tariffs are low in Algeria: around 6 USc/kWh for residential customers, and a little over 3 USc/kWh for industrial users (source: Enerdata). This is due to low internal prices for natural gas: it is estimated that industrials and power producers pay significantly below 1 USD/Mbtu for it, while current export prices are over 8 USD/Mbtu. The government's objective is to gradually adjust domestic energy prices to international levels, but this process is likely to be slow.

Algeria has an important potential for power generation from renewable sources, for the domestic market as well as for export to the European market. The current share of renewables is not very significant in the total energy balance, but an ambitious development program was set up, with a specific law in 2004, including incentives for electricity production from renewable, and the creation of a support fund and a renewable energy institute (IAER: Institut Algérien des Energies Renouvelables).

By 2017, 5% of the power generated in Algeria is expected to be from renewable. By 2030, Algeria aims at generating 20% of its electricity from renewable sources, 70% of which from CSP, 20% from PV and 10% from wind. The country's strategy to develop renewable energy sources and implement a low carbon economy fully supports its efforts to reduce vulnerability to oil prices and hydrocarbon exports. Algeria intends to become a leading nation in the renewable sector, including in manufacturing components, thanks to abundant domestic resources and targeted policies.

Algeria is also involved in the carbon capture and storage (CCS) technology, with one of the very few functioning projects in the world. The gas from the In Salah field has a high CO2 concentration, which needs to be decreased to reach pipeline specifications. After removal, instead of being released into the atmosphere, the CO2 is re-injected into an aquifer that is part of the same geological formation as the gas field.

II. CSP within National Energy Policy

In view of the increasing energy intensity, the Government has emphasized energy efficiency and renewable energy options. The National Energy Efficiency Fund of Algeria (FNME) was created in 2000 (Decree no. 2000-116), with the objective of financing energy efficiency investments as well as the budget of the National Energy Efficiency Agency (APRUE) and the projects it manages under the National Energy Efficiency Program (PNME), FNME's annual budget is estimated at AD 500 million (Euro 57 million). The resources of the funds include taxes on natural gas (AD 0.00015/btu) and electricity (AD 0.02/kWh), and an initial government contribution of AD 100 million (Euro 1.15 million). Additional resources may include taxes on energy intensive equipments, penalties, loan reimbursements, and government or other contributions.

The FNME finances investments through grants, subsidized loans, or loan guarantees, under five major programs: the 'Eco-Light' program which aims to disseminate 1 million CFLs to households, with a 50% subsidy of the price; the 'Eco-Building' program which aims to construct 600 high energy efficiency housing units, and to contribute from the fund 80% of the incremental costs as well as the feasibility studies; the 'Al-Sol' program which aims to disseminate solar water heaters in households, with a 40 percent subsidy on the investment cost, and subsidized loans for 50 percent of the cost; the "Clean Air" program to facilitate the conversion of private cars to natural gas, with subsidzed loans on the total conversion cost (equipment plus labor); and the 'Industrial' program, covering the cost of energy audits and feasibility studies up to AD 700,000, and subsidies on investments of up to 20% for electricity projects, 30% for thermal projects, and 10% for cogeneration projects.

While Algeria only has moderate wind conditions, with the best wind regimes found in uninhabited desert areas in the South, it enjoys an exceptional solar potential. More than 2 million square km receive a yearly sunshine exposure equivalent to 2,500 kWh per square meter. The government seeks to create a solar-gas synergy, taking advantage of the country's abundant resources in both energies.

New Energy Algeria (NEAL) has been established in 2002 by Sonatrach (45%), Sonelgaz (45%) and the private Algerian company SIM (10%). NEAL's mission is the development of solar and other renewable energy production. A first Integrated Solar and Combined Cycle (ISCC) plant is currently under construction at Hassi R'mel. This project will give Algeria valuable experience in the development, construction and operation of an ISCC:

- Location: Hassi R'mel, where Sonatrach operates Algeria's largest gas field
- Technology: hybrid parabolic trough/gas-fired combined cycle
- Capacity: 25 MW CSP, 150 MW in total
- Area: 152 ha
- Cost: EUR 315 million
- Commissioning: August 2010
- EPC contractor: Abengoa
- Offtaker: Sonatrach

Three further hybrid units are to be completed by 2015, with 70-80 MW CSP capacity for each one of them. They will be scale-ups of Hassi R'mel, and are part of the government's plan to develop renewable energy production and exports in Algeria.

III. Planned Project(s) under MENA CSP Scale-up Program

Meghaïr Project – 70-80 MW

<u>Project Description</u>

Two options are being considered for this project, which will be located in Meghaïr, in the southeast part of Algeria. Both would include a 270-280 ha solar island using parabolic trough:

- Option 1: power production only, total capacity 400 MW, of which 70 MW CSP
- Option 2: integrated desalination/power production, total capacity 480 MW, of which 80 MW CSP (the plant would treat local brackish water)

The plant would serve the domestic market. It could be either public or PPP.

<u>Implementation Readiness</u>

A feasibility study has been launched. It will take 8 months to be completed. The bidding process would then take 6 months, and construction 30 months.

Financing Plan

Option 2 would cost up to USD 1 billion, including the desalination unit. For the CSP part, assuming a construction cost of around USD 4,000 per kW, investment would be around USD 300 million. The equity contribution of the sponsor would be around 30%, i.e. USD 80 million. CFT would contribute approximately 730 dollars per kW, i.e. a total of about USD 58.4 million (19.5%). The remaining 50.5% would blend other concessional funds and commercial loans (possibly with ECA and/or IFI risk coverage).

Project / US$ million	**CTF**	**Other Concessional Funds**	**Equity**	**Commercial/ECA debt**	**Total**
Meghaïr	$58.4	$90	$85	$88.6	$321.6

Timetable

Activity	**Date**
Concept note review	March 2010
TFC review, MDB appraisal	December 2010
Board Approval	April 2011

Naama Project – 70 MW

Project Description

This project would be technically identical to Meghaïr Option 1: pure ISCC, total capacity 400 MW with 70 MW parabolic trough. It would be located in Naama, in southwest Algeria.

Implementation Readiness

Commissioning is expected in 2015.

Financing Plan

Project / US$ million	**CTF**	**Other Concessional Funds**	**Equity**	**Commercial/ECA debt**	**Total**
Naama	$51.1	$80	$85	$68.9	$285

Timetable

Activity	Date
Concept review	June 2010
TFC review, MDB appraisal	March 20111
Board Approval	May 2011

Hassi R'mel II Project – 70 MW

Project Description

This project would be technically identical to Meghaïr Option 1 and Naama: pure ISCC, total capacity 400 MW with 70 MW parabolic trough. It would be located in Hassi R'mel, adjacent to the plant currently in construction.

Implementation Readiness

Commissioning is expected in 2017.

Financing Plan

Same cost and financial structure as Naama.

Project / US$ million	**CTF**	**Other Concessional Funds**	**Equity**	**Commercial/ECA debt**	**Total**
Hassi R'Mel II	$51.1	$80	$85	$68.9	$285

Timetable

Activity	Date
Concept Note Review	September 2010
TFC review, MDB appraisal	September 2011
Board Approval	October 2011

ANNEX 2 – EGYPT

I. Policy and Regulatory Background

1. Energy Sector Overview

The primary energy demand has grown at an average annual rate of 4.64% during the last 25 years (1981/1982 – 2004/2005). During the same period, the oil demand has grown at an average annual rate of 3.34% while the increase in natural gas demand was much faster, at 13% annual rate.

The total primary energy supply in Egypt from fossil fuels is estimated to be 2,461 PJ (or about 58.6 mtoe)[28] with 51% from oil and oil products, 47% from natural gas and 2% from coal and coal products. Figure 1 below shows the growth in the total primary energy supply in Egypt.

Electricity demand is growing at 7-8% per year, which implies adding about 1,500-2000 MW per year over the next several years (current installed capacity is close to 22,000 MW). The increase in energy demand has been met primarily by increased use of fossil fuels (Figure 1), leading to the high energy and carbon intensity of the economy. The Government's power generation expansion plan is based primarily on natural-gas fired combined-cycle and steam technology, supplemented by wind power and nuclear plants. About 60% of the domestic natural gas production is utilized by the power sector and the domestic gas demand is increasing, both in power generation and in other uses, competing with increasing gas exports through pipelines and LNG terminals.[29] These trends are driven by the Government's objectives to (a) reduce the use of fuel oil, gasoline and LPG in the domestic market; (b) to position itself as a global exporter of natural gas; and (c) foster regional integration through the interconnection of natural gas pipelines.

Egypt ranks among the 11 countries in the world showing fastest growing GHG emission. The analysis undertaken as part of the National Strategy Studies (NSS) in 2002 indicates that by 2017 emissions could reach more than three times the 1990 levels. The overall energy sector (including transport) is expected to remain by far the largest source, with the growth rate of 4.9%.

To meet the growing electricity demand, the Ministry of Electricity and Energy (MoEE), with endorsement from the Cabinet, adopted the following power sector development strategy: (i) increased use of efficient fossil-fuel generation technologies (CCGT and supercritical steam boilers) ; (ii) large scale development of Egypt's renewable resources with the goal of having 20% of its installed generation capacity in the form of renewable by 2020 ; and (iii) stepping up efforts for more efficient consumption of electricity.

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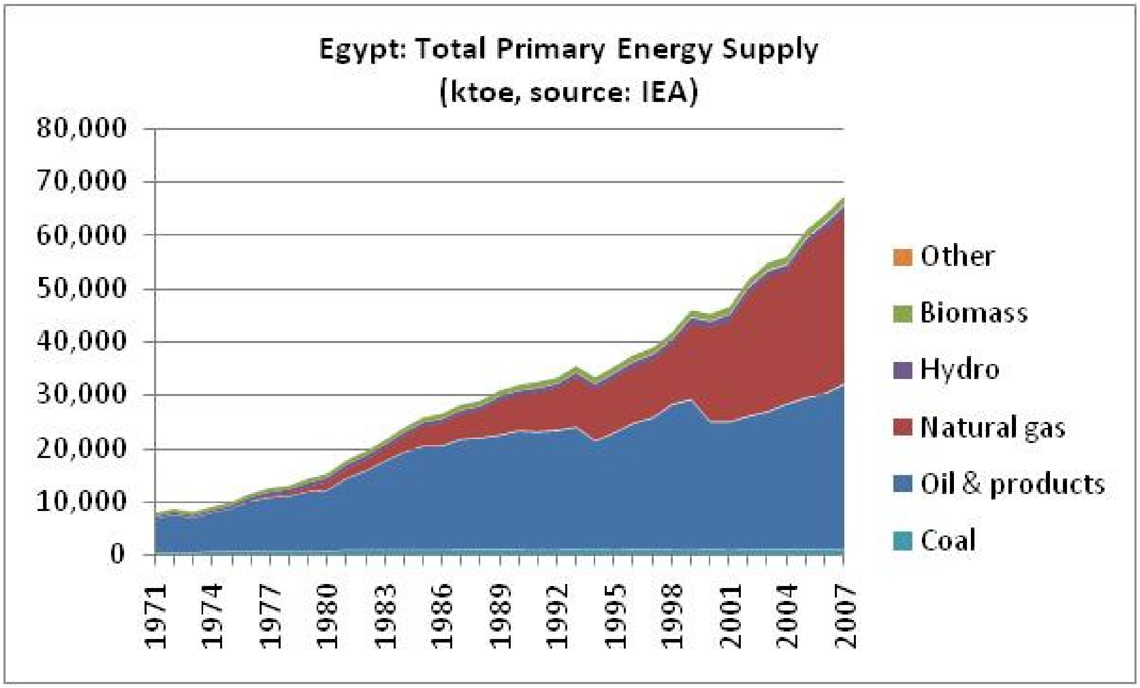
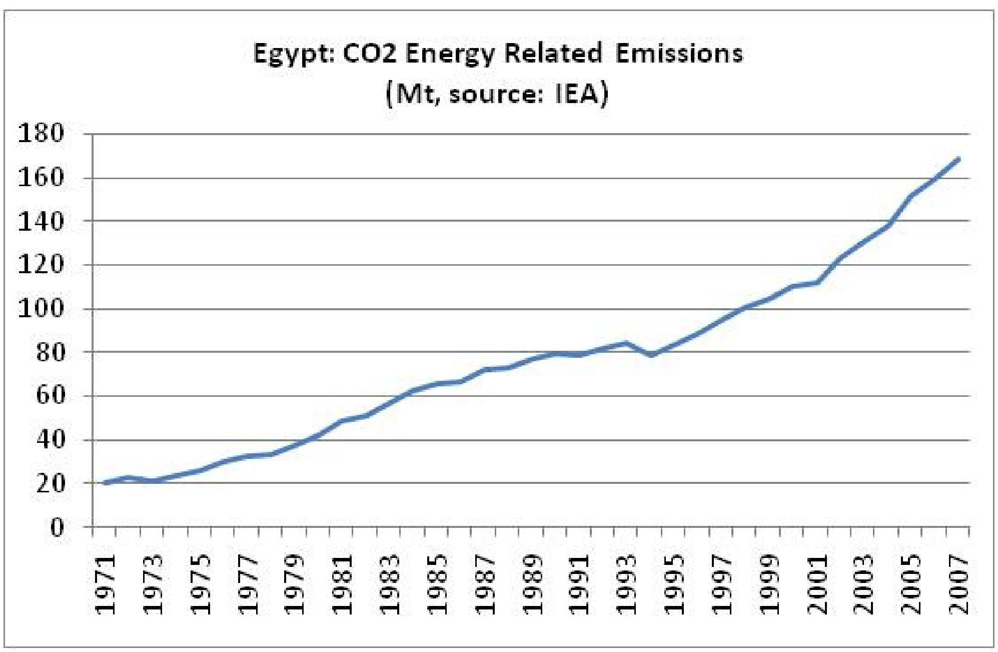
[28] PJ denotes a petajoule (10^{15} Joule), and GJ denotes a gigajoule (10^{9} Joule). One Joule is equivalent to about 947.82 MBTU (Million British Thermal Units) or about 0.000278 Wh (watt-hours). One mtoe (million tons of oil equivalent) is equivalent to about 42 PJ.

[29] Egypt is connected via the Arab Gas Pipeline with Jordan, Syria and Lebanon and by pipeline to Israel.



2. GHG Emissions

Co2 emissions from energy uses have been increased by over 7 % per year since 2000, reaching about 168 Mt in 2007



3. Electricity Policy Framework

Reform of the electricity sector in Egypt began in the mid-1990s with the unbundling of the electric utility and the decision to introduce private sector financing through Independent Power Producers (IPPs). The most significant reforms to date include (i) the unbundling of the sector and setting the stage for future competition and privatization; (ii) the creation of the regulator and its work to date on performance benchmarking and the drafting of the new Electricity Law; (iii) the introduction of IPPs; and (iv) price increases.

After the currency devaluation in 2003, the GOE put a hold on additional IPP transactions. In essence, years of low consumer tariffs had not prepared the electricity sector to absorb sudden increases in tariffs to IPPs consequent on the currency devaluation. The Government is now considering PPP in the sector that does not rely on the single-buyer model. Combined with the tariff increases, moving away from the single buyer model is expected to introduce a more sustainable form of risk-sharing with the private sector. The Government has taken initial steps towards this with the stipulation in the draft law that no new licenses will be issued to supply electricity from the national grid to new energy-intensive industries.

II. CSP within National energy policy

The Egyptian sector policies include: diversifying energy resources, improving energy efficiency (EE), applying energy conservation measures and promoting renewable energy (RE) utilization, mainly from wind and solar. A Governmental commitment towards RE utilization targets to increase renewable energy production up to 20% by 2020. Recognizing the importance of energy efficiency, the GoE has prepared a National Energy Conservation plan and plans to establish a multidisciplinary agency to lead the energy efficiency program implementation. The commitment of the GoE to energy efficiency is also evident on the supply side in energy generation - the first power plant based on super critical boiler in the MENA region is under implementation. The 600-MW Ain-Sokhna thermal power plant, financed by the World Bank and the African Development Bank, is an example of donor collaboration in large infrastructure projects. An energy efficient lighting scale-up is being planned in association with the electricity distribution companies for CFL dissemination program. An energy efficiency program for small and medium enterprises is under implementation by the Credit Guarantee Company (CGC) is under implementation and some of the distribution companies are also providing support to their industrial consumers in the implementation of EE activities.

As renewable energy electricity generation technologies, particularly wind and Concentrated Solar Power (CSP) have matured, the renewable energy strategy of Egypt has given the utmost priority to the large scale renewable energy electricity generation projects which can serve both national and regional objectives of achieving fossil fuel savings, environment protection, creation of jobs and technology transfer. The electricity generation expansion plan for Egypt includes achieving a total solar capacity of 150 MW by 2017.

Egypt possesses among the best resources in the region, reaching almost 30% of the total potential in the region. MED-CSP is a study carried out for MENA countries estimated Egypt's solar thermal electricity generating potentials at about 73,656 TWh/year.

Presently, a 140 MW Integrated Solar Combined Cycle (ISCC) power plant is under construction to be operative by mid of 2010. The solar share is about 20MW capacity. The project's implementation is undertaken by Egyptian company ORASCOM for the Solar Island and the Spanish company IBERDROLA for the combined cycle island. The Egyptian long-term vision includes the implementation of CSP power projects for developing new communities in the vast desert as well as exporting the green energy to Europe via Mediterranean interconnection links, taking into consideration the enhancement of local manufacturing of CSP components to improve the economics of solar thermal power projects.

In order to achieve increased penetration of renewable energy, including CSP, a key element of the plan for scale-up is the emphasis on renewable energy placed in the new Electricity Law, scheduled to be presented to parliament for ratification during early 2010. Under the new law, a funding mechanism to be implemented by the GoE to fulfill its proclaimed support for renewable energy includes funds from the export sale of gas saved by renewable energy.

The project is designed for the realization of the national and regional development objectives which include:

- Conservation of the depleting natural energy resources mitigating global warming through the reduction of Green House Gases "GHG" emissions.
- Supporting the development of relevant local industries and transfer of knowledge from other countries and among the countries in the region.
- Creation of opportunities for steady and stable investment and growth as well as a sizeable job creation in Egypt and the region.
- Support economic development in new areas.
- Contribute to the regional electricity exchange through integration of the generation unit and the interconnected regional grids.

III. Planned Project(s) under MENA CSP Scale-up Program

Kom Ombo Project - 70 MW

Project Description

Given the excellent solar --resources of Egypt, the proposed project is a 70 MW Power Plant using the proven parabolic trough technology at a location 65 km north of Aswan along the Nile river.

A site screening of the potential site indicates its suitability for developing a CSP project, particularly:

- 7.5 sq km of land owned by Governorate with slight slope in the east.
- High insulation with cloudiness factor less than 20% and a DNI of 2500 kWh/m^2/year
- Acceptable wind speeds and atmospherics.
- Availability of cooling water from the Nile river that is approximately 3 km away.
- Proximity to electrical grid as the site is about 4 Km through the Kom Ombo substation.
- Availability of easy road access to the Aswan-Luxor desert highway

Implementation readiness

Pre-feasibility work is being undertaken and expected to be ready by Dec 2009 and the TORs for consultancy services are under preparation. The feasibility study is expected to be supported as part of EC/KfW assistance to Egypt for developing a renewable energy master plan.

Financing Plan

The tentative financing plan for this project includes financing from the CTF, Government contribution in the form of equity and additional contribution from the donors.

Project / US$ million	**CTF**	**Official funds**	**Equity**	**Commercial/ECA debt**	**Total**
Kom Ombo	$51	$171.	$148	-	$370

Timetable

Activity	**Date**
Concept Note Review	July 2010
TFC review, MDB appraisal	March 2011
Board Approval	May 2011

Marsa Alam 30 MW Project (with 8 hr storage)

Project Description

The second proposed project is a 30 MW project (with 8 hr Thermal storage) at a location 225 km south of Hurghada in the Governorate of Red Sea. The proposed location is a touristic area with several resorts in the vicinity. The proposed project will also utilize the parabolic trough technology but will supply to an independent 220 kV grid in the area.

Site screening indicates that the potential site is suitable for a CSP project in light of the following characteristics namely:

- 2 sq km of flat land owned by Governorate is available for project development.
- High insolation with cloudiness factor less than 20% and a DNI of 2700 kWh/m2/year
- Acceptable wind speeds and atmospherics.
- Cooling water would be available from the Red Sea that is approximately 3 km away
- Availability road access to the Marsa Alam- Edfo highway.
- This project will supply power to a regional grid.

Implementation Readiness

The project is expected to implemented as a public private partnership (PPP) project in association with the Governorate of Red Sea and the Canal distribution company. The project will gain from the previous PPP experiences in Egypt.

Financing

The tentative financing plan for this project includes financing from the CTF, Government contribution in the form of equity and additional contribution from the donors.

Project / US$ million	**CTF**	**Official finacing Funds**	**Equity**	**Commercial/ECA debt**	**Total**
Marsa Alam	$43.5	$127	$39.5	60	$270

Timetable

Activity	**Date**
Concept note reviw to CTF	May 2010
TFC review, MDB appraisal	March 2011
Board Approval	May 2011

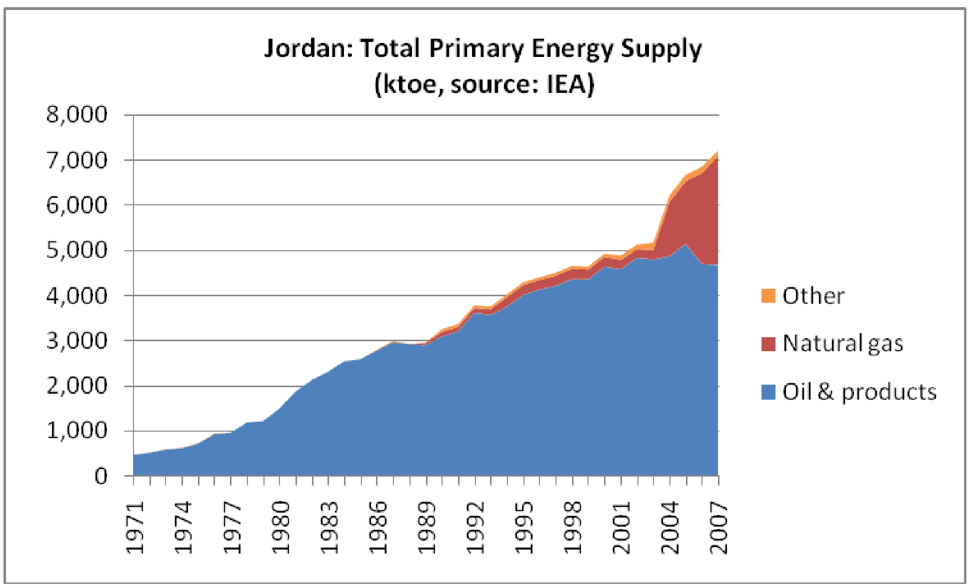
ANNEX 3 – JORDAN

I. Policy and Regulatory Background

1. Energy Sector Overview

Jordan's energy demand has increased rapidly in recent years. Reflecting this demand growth, the primary energy supply increased from 4.9 million tons of oil equivalent (mtoe) in 2000 to 7.2 mtoe in 2007[30]. Electricity generation grew even faster and went up from 7.4 TWh to 13.0 TWh in the same time span[31]. Since Jordan is lacking conventional sources of energy, the country needs to import almost all of its primary energy needs (over 90 percent). The country is therefore vulnerable to oil price shocks and is implementing a strategy to mitigate this.

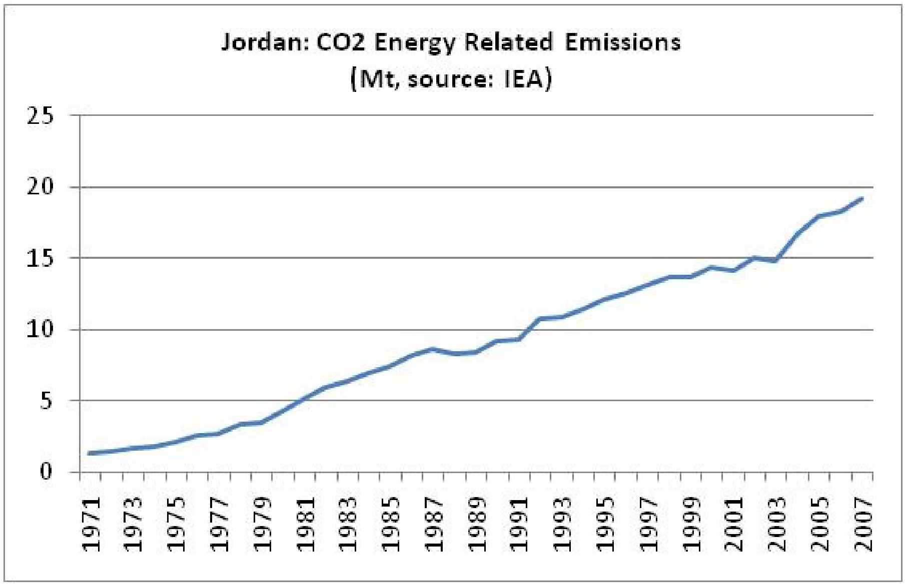
The Government has made significant efforts in institutional reform in the energy sector by moving towards privatization and promoting public-private partnerships. In the electricity sector, only one generation company (Samra Electric Power) and the transmission-and-dispatch company (National Electric Power) remain entirely government-owned. The largest generation company (Central Electric Power), new green-field IPPs, and all three electricity distribution companies are privately owned. Most importantly, electricity tariffs are determined on an overall commercially viable and cost-reflective basis, thus ensuring adequate investment in generation, transmission and distribution.



2. GHG emissions

[30] Source: International Energy Agency
[31] Source: National Electric Power Company

The GHG emissions have grown at an average of about 5% per year from 2000 reaching 20 Mt in 2007.



3. Electricity Sector Framework

Jordan was one of the first countries in the region to initiate fundamental reforms in the electricity sector and has made significant progress in carrying out the reform. The power industry has been unbundled into two generation, one transmission, and three distribution companies. The larger generation company, Central Electricity Generation Company (CEGCO), and all three distribution companies are now privatized, with a significant private cross-ownership between generation and distribution. New generation plants are built as IPP projects. The state-owned National Electric Power Company (NEPCO) operates electricity transmission network and the wholesale electricity market, which is based on a single-buyer model. The power sector is regulated by an autonomous Electricity Regulatory Commission (ERC), established in 2001. Electricity tariffs are largely cost reflective with some cross-subsidies embedded in the tariff structure.

II. CSP within National Energy Policy

The Government adopted an energy sector strategy in December 2007, which, inter alia, increased emphasis on renewable energy and energy efficiency. The updated strategy sets a target of 10 percent of the country's energy mix to come from renewable sources by 2020, up from 1 percent in 2007[32]. As such, Jordan is taking some concrete steps to develop its renewable and alternative energy resources, including development of wind, solar, landfill gas, oil shale and nuclear power generation program.

Subsidies for oil products were removed on February 8, 2008, resulting in a significant increase in the prices of oil products. This was accompanied by a compensation package which will

[32] Total primary energy supply in 2007 amounted to 7.4 million ton of oil (mtoe) equivalent, of which 0.1 mtoe was from renewable energy source (mainly solar energy), 4.9 mtoe was from oil and oil products, 2.4 mtoe was from natural gas, and a residual quantity of net imported electricity. Source: Jordan Department of Statistics, *Energy Balance 2007*.

amount to about USD 620 million[33]. Structural reforms in the hydrocarbon sector have been slower but are underway, with the intention to restructure and liberalize the oil market. To mitigate the impact of the price increase and to control increase in energy demand, the Government has placed high emphasis on energy efficiency. The World Bank, working other donors, is assisting the Government in operationalizing key elements of the energy strategy including development of an institutional framework for energy efficiency

Solar energy in Jordan has a particularly strong growth potential. Solar energy has been historically utilized as an energy source for water heating and cooling applications, water pumping, and photovoltaic for communications. A resource assessment done by Lahmeyer International in 2006 estimated a technical potential solar power generation in Jordan at over 6,000 TWh per annum, which exceeded domestic end-use electricity consumption of 11.5 TWh in 2008. As part of the aforementioned energy sector strategy, the Government is keen to further expand solar energy usage, including increasing household solar heating, photovoltaic application, and large-scale solar power generation[34]. The Government expects installed solar power capacity of between 300 – 600 MW by 2020, much of it likely to come from Concentrated Solar Power (CSP). Tangible steps in this regard are being undertaken by the government and private sector alike.

The government has taken concrete measures with regard to scaling-up renewable energy, including the granting of import tax exemption for renewable energy equipment. A Jordan Renewable Energy and Energy Efficiency Fund (Jordan REEF) and the relevant enabling legislation have been designed. The Jordan REEF will help mobilize financial and technical support for renewable energy and energy efficiency effort, including government's budgetary contribution. The draft renewable energy promotion law has been wrapped under a unified energy law (covering power, oil and gas, and renewable energy) for a single parliamentary approval. As such, Jordan is ready to move to the next phase of program execution, paving the way for more progress. In view of the proposed institutional developments and the movement towards cost-reflective pricing in the electricity sector, penetration of CSP in the domestic market is feasible but export of CSP based generation to Europe would make it more attractive for sustained development.

With respect to CSP, a first CSP project is underway in the kingdom. Supported through 10 million Euro European Union funding that is expected to be granted by the end of the year, a 5 MW CSP plant will be built in the south of the country. The plant will provide electricity to the grid and serve as a training center for the National Energy Research Center, aiming at promoting CSP technology in Jordan and enhancing capability of local workforce.

[33] Subsidies for LPG, which were supposed to have been eliminated after March 31, 2008, are still in effect.
[34] Jordan is targeting 25 percent of households to be equipped with solar water heating by 2015 (up from 14 percent in 2008); Source: Jordan Ministry of Energy and Mineral Resource, *Opportunities for CSP Projects in Jordan,* a presentation at the June 11 – 12, 2009 workshop on MENA Regional CSP Scale-up Program, Rabat, Morocco.

III. Planned Projects under MENA CSP Scale-up Program

CSP Power Station at Ma'an - 100 MW

Project description

The project seeks to construct and operate a 100MW CSP plant in Ma'an governorate in south-eastern part of Jordan. The area is conducive to solar power production, with solar resource assessment indicating a good daily average solar radiation of 5 – 7 kWh/m2. Furthermore, the proposed area is accessible to the existing electricity transmission grid. The land is owned by the government and will be leased out at no cost to the project developer.

The applicable technology is open at this point, and it is expected to be determined by a competitive tendering process either for (i) a turnkey IPP developer (in the case of a BOO, BOT, or BTO project) or (ii) for an EPC arrangement (in the case of a public sector project). However, due to scarce water resources in Jordan, an air cooling system will be preferable. The project aims to sell the electricity generated to the National Electric Power Company (NEPCO), the electricity single-buyer in Jordan, under a long-term Power Purchase Agreement (PPA). The PPA governs the terms of the electricity purchase by NEPCO, including electricity tariffs.

Implementation Readiness

Jordan has chosen a public-private partnership model for its recent electricity generation project development. To date, two green-field IPPs have been successfully solicited on an internationally competitive selection BOO basis. Therefore, the government through MEMR and NEPCO has a proven readiness to implement a CSP project via a public-private partnership model.

Moreover, the sole government-owned power generation company, Samra, has been successfully adding generation capacity through competitive bidding of EPC contracts. If required, Samra has the institutional readiness to implement a CSP project.

Financing Plan

Project / US$ million	**CTF**	**Official Funds**	**Equity**	**Commercial/ECA debt**	**Total**
Ma'an	$72.5	$145.5	$100	100	$418

Timetable

Activity	**Date**
Project concept review	January 2010
TFC review, MDB appraisal	October 2010
Board approval	December 2010

Reinforcement of the Jordanian 400 kV corridor to accommodate Renewable Energy Projects

Reinforcement of Jordan's transmission network is necessary to enhance electric connectivity between the MENA region and Europe. It is also needed to integrate Jordan's renewable energy resource in the south to the national grid.

In order to increase CSP based electricity generation in Jordan and its optimal utilization, there is a need to strengthen the grid in the southern part of the country, in particular the Aqaba-Amman 400 kV line. This section of the transmission, although currently connected, has been identified in various studies in the MEDRING context as posing a severe constraint for increasing the electricity trade within the region. If Jordan's excellent CSP potential is to be fully and optimally utilized, overcoming this infrastructure bottleneck is critical. As such, this project will facilitate the integration of renewable energy resource in the south of Jordan; enhance renewable power transfer and trading among interconnected countries up to the EU; and increase transfer capability among interconnected countries.

Project description

As Jordan is a main crossing point for many electrical interconnection projects such as the existing seventh electric interconnection project (EIJLLPST) which aims to connect the electrical networks in Egypt, Iraq, Jordan, Lebanon, Libya, Syria, Palestine and Turkey, and the future interconnection projects such as the electrical interconnection project of the Mediterranean countries (MEDRING), and the project of the Pan Arab Electrical Interconnection, therefore upgrading the Egypt-Jordan-Syria Interconnection will increase the exchange capability from 550 MW to 1,100 MW via the interconnected countries.

The submarine cable between Jordan and Egypt was designed as DC cable and operated now on AC mode, the upgrading of the submarine cable needs to add an 1100 MVA AC/DC converter station at the Egyptian side of the project and 1100 MVA AC/DC converter station at the Jordanian side of the project, also it is required to reinforce the substation capacity at the Egyptian side by adding another (500/400 kV) 750 MVA transformer at Taba substation. It is also required to reinforce the Jordanian transmission network from Aqaba to Amman by adding a 400 kV double circuit overhead transmission line with a length of about 365 km connecting Aqaba 400 kV substation located in the South of Jordan with Amman Area passing through Wadi Araba valley, the Dead Sea, then to Qatrana 400kV S/S then to west of Amman S/S 400kV to reach the existing 400 kV Samra substation, also there is a need to reinforce the interconnection between Jordan and Syria by adding another 160 km single over head line 400kV.

CTF financed portion involves the construction of a new 180-km 400 kV double-circuit transmission line from the existing Qatrana 400 kV substation (south of Amman) to the Samra 400 kV substation (north-east of Amman) and to a new Amman West 400 kV substation. This section is proposed for CTF funding as this strengthening would be required for possibility of transferring power to the north and it needs to accelerated within Jordan's transmission investment plan.

Implementation Readiness

NEPCO is solely responsible for the construction, operation and maintenance of Jordan's electricity transmission network. It was established in 1996 and currently owns and operates over 800 km of 400 kV and over 2,800 km of 132 kV transmission line and associated infrastructure in Jordan. In 2007, NEPCO oversees about US$ 90 million of transmission network investment program. The company therefore is experienced and possesses the required technical, financial and human resources to implement the project.

Specific to the project, the 180-km 400 kV transmission line Qatrana - Samra will be designed according to the prevailing technical standards of NEPCO comprising a double-circuit line with the two circuits in a vertical formation with two overrunning earth-wires of which one will be an optical earth-wire. Conductors are of type 560/50 ACSR/ACS (aluminum conductor aluminum clad steel reinforced), two conductors per phase. The line route from Qatrana to Samra substations does not involve any particularly difficult sections, running basically through hilly and dry lands. The Amman-West 400kV substation will be designed according to the prevailing technical standards of NEPCO comprising two 400MVA transformers (400/132kV) and outdoor 400kV & 132kV switchgears.

Financing Plan

Project / US$ million	**CTF**	**Official Funds**	**Equity**	**Commercial/ECA debt**	**Total**
400 kV Egypt-Jordan-Syria strengthening	$40	$300	$70	-	$410

Timetable

Activity	**Date**
Project concept review	February 2010
TFC review, MDB appraisal	October 2010
Board approval	December 2011

ANNEX 4 – MOROCCO

I. Policy and Regulatory Background

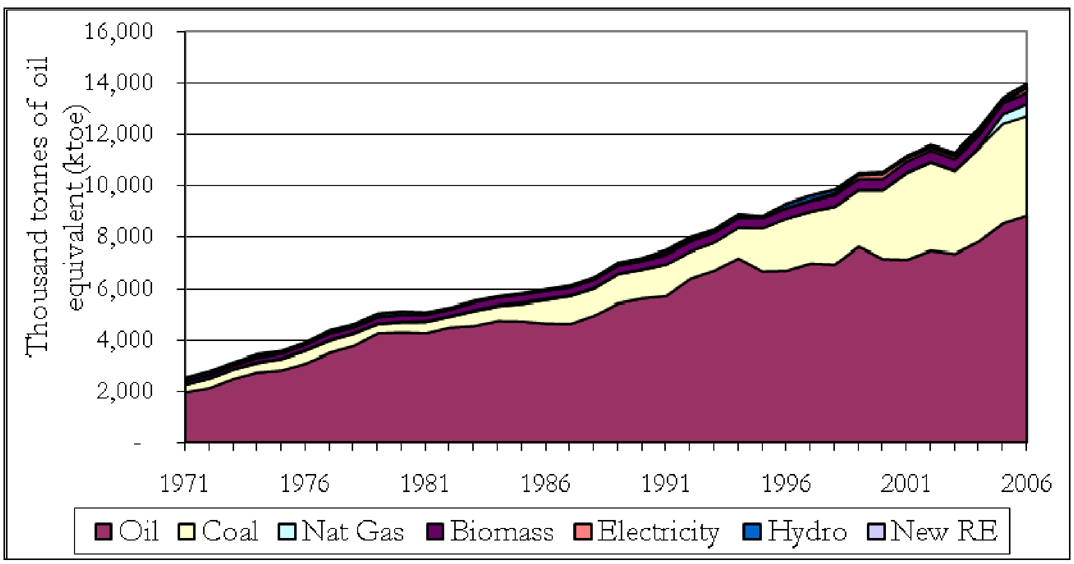
1. Energy Sector Overview

Increasing population and strong GDP growth are driving rapid increases in Morocco's energy needs. From 2000 to 2006, total primary energy supply in Morocco rose an average of 4.2 per cent annually and electricity demand rose an average of 8.2% annually from 2000 to 2006. Government and other projections forecast continued high growth in energy demand.

In 2006, fossil fuels made up 95% of total primary energy supply (TPES), substantially higher than the world average of 81%. Crude oil and petroleum products accounted for 63% of total supply, coal for 28% and natural gas for 4%.

Morocco's primary energy supply is dominated by imported fossil fuels and the country imports 95% of its energy needs. Import dependency has steadily risen as domestic resources are depleted and energy demand rises.

Figure 1 - Sources and Growth of Total Primary Energy Supply (toe), 1971-2006



Source: IEA

Like the country's overall energy mix, the electricity sector is heavily dependent on fossil fuels which in 2006, accounted for 94% of total generation. Morocco also relies on electricity imports from Spain to meet demand, in 2008 importing 4,261 GWh, or 18% of total electricity supplied to the system.

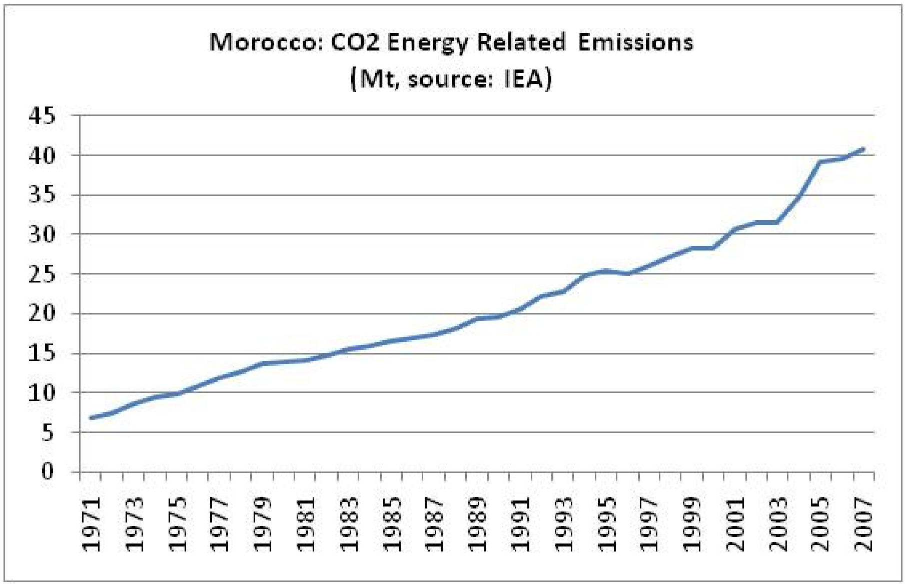
The electricity sector is the key driver to increasing CO_2 emissions in Morocco. The disproportionate use of fossil fuels, the growing use of coal for power generation and rapid electricity demand increases in the power sector has led to growth in CO_2 emissions due to electricity generation from about 1 Mt in 1971 to more than 15 Mt in 2007. Electricity currently accounts for slightly less than 50% of the country's overall emissions, by far the greatest contributor to the national emissions profile.

The Moroccan power sector is dominated by the Office National de l'Electricité (ONE), a State owned entity. It holds a monopoly in transmission. Since 1994, ONE has been allowed to sign contracts with private players in generation. Private generators currently account for about 68% of the electricity produced in Morocco: Jorf Lasfar Energy Company, a 1,350 MW coal fired plant; Energie Electrique de Tahaddart, a 380 MW gas fired combined cycle, and Compagnie Eolienne du Détroit, a 50 MW wind farm. New private projects include an extension of the Jorf Lasfar plant, a new coal fired unit in Safi, and a number of wind farms, including a large one in Tarfaya. In the distribution segment, municipal operators have been active since 1961 and private operators since 1997. ONE is in charge of distribution in rural areas and a few urban centers, and of direct delivery to around 90 large customers. In spite of sharp increases in international fuel prices, residential electricity tariffs in Morocco have been almost stable in the past few years, slightly below 1 MAD/kWh (13 USc/kWh in 2008). Industrial tariffs, which on average are higher than residential tariffs, have increased markedly in 2007, and again slightly in early 2009.

Morocco has a successful history of independent power producers (IPPs) bringing investment to the sector and delivering efficient, reliable electricity. IPP success is largely attributable to the country's strong and supportive legal and regulatory environment which, starting with law Dahir 2-94-502 in 1994 allowing calls for competitive tender for private electricity production of greater than 10 MW, has provided the proper incentives and security for local and international investors to enter the country. This legal context would apply directly to and support the CSP projects described herein which are to be structured as IPPs.

2. GHG Emissions

GHG emissions in Morocco have grown at an average annual rate of about 6.3% from 2000 reaching over 40 Mt in 2007.



II. CSP within National energy policy

The Government of Morocco has set out several programs to meet its specific energy objectives, especially as regards energy security and low carbon energy developments. To address the challenges of energy security, sustainable development and competitiveness, the government has formulated a new strategy which was unveiled at the National Energy Conference ("Assises de l'Energie") on March 6 2009. The objectives of the strategy are: energy security, availability of energy to all Moroccan households and businesses at competitive prices, energy demand management, promotion of national expertise and development of technological know-how and environmental protection and climate change mitigation.

To achieve these objectives, the key elements of the strategy are:

- Diversify and optimize the energy mix around reliable and competitive energy technologies, in order to reduce the share of oil to 40% by 2030
- Develop the national renewable energy potential, with the objectives of increasing the contribution of renewables to 10-15% of primary energy demand by 2012
- Make energy efficiency improvements a national priority
- Develop indigenous energy resources by intensifying hydrocarbon exploration activities and developing conventional and non-conventional oil sources
- Integrate into the regional energy market, through enhanced cooperation and trade with both other Maghreb countries and the EU countries.

CSP is a major component of Morocco's planned use of renewable energy to achieve multiple energy objectives. Strong solar resources make Morocco a prime location to site CSP plants and thus promote security of supply through use of a domestic resource that brings added diversity to the generating portfolio. On November 2 2009, the Government unveiled a new solar plan aiming at achieving a 42% renewable energy target by 2020 and has a 2000 MW long term target for solar power incl. CSP by 2020. Realization of this target would lead to emissions reduction of at least 4.2 million tones of CO2 annually, savings of 600 thousand tonnes of oil equivalent annually and the creation of 15,000 jobs.

Morocco sees development of CSP and other renewables as an important part of its strategy to increase ties with the power sectors of neighboring countries and generally enhance the energy integration of the region as a whole. Expanded interconnections with other countries allow for increased renewable penetration since they provide a larger market in which to sell and a larger portfolio of generating plants within which the renewable plants would operate. Most renewable technologies – including CSP – are not fully dispatchable.[35] Incorporating them into a larger market would increase their dispatchability and therefore enhance their utilization. Equally important, connections to Spain provide access to the markets of the European Union (EU). EU has expressed high-level support for CSP development in North Africa, EU targets on minimum levels of renewable use by 2020 may create highly profitable opportunities to export "green electricity" such as that generated by CSP to Europe. Viability of CSP and its integration in the Moroccan grid is expected largely to be achieved by exercising the export options suitably.

Morocco has a number of traits that increase the probability that one or more CSP plants can be successfully developed, financed, constructed and operated without undue delay. These factors also increase the probability of the successful development of substantial follow-plants that, based on the experience of the CTF-supported plants, can be operated on a more commercial basis.

a. Experience with CSP Technology: Morocco already has extremely valuable CSP experience with the Ain Beni Mathar thermo-solar currently under construction. Ain Beni Mathar includes a natural gas-fired combined cycle plant integrated with a 20 MW CSP facility. Experience with both CSP technology as well as integrating CSP power into the national grid provides a key advantage in development of future plants.

b. Excellent Solar Resources: Along with much of North Africa and the Middle East, Morocco has some of the best solar resources in the world. This increases the intensity of electricity generation and the length of time for which the plant is generating, while decreasing both capital cost ($/kW of installed capacity) and levelized generation cost ($/MWh). Morocco also has sizable tracts of available land with excellent insolation on which to site CSP plants. Due largely to such excellent natural resources, the US Department of Energy estimates that the overall cost of generating electricity in CSP is nearly 25% less in North Africa than it is in southern Spain where a number of plants are currently in operation and others are planned.

c. Stable Financial and Contractual Environment: Structuring the plant as an IPP brings numerous advantages, including minimized additional debt to ONE; ability to attract a range of private and public financing; and optimized plant construction and operation driven by profit considerations. However, an IPP requires robust, reliable contracts, in particular the PPA. Morocco's stable political and regulatory environment as well as ongoing experience with IPPs allows it to use this model effectively and get the benefits thereof.

[35] CSP with storage improves dispatchability of solar thermal plants but it is unclear whether the first commercial CSP plants deployed in the MENA region will have this option.

d. Proximity to EU Markets: Morocco's existing interconnection with the EU through subsea power lines to Spain will support successful development of CSP plants. Follow-on plants can sell to the EU market at attractive prices, thus creating profit motives for the private sector to invest more in the CSP sector in Morocco.

III. Planned Project(s) under MENA CSP Scale-up Program

Ain Beni Mathar Project: 125 MW

Project Description

The Ain Beni Mathar project is planned as an extension of the facility currently under construction, which combines a gas-fired combined cycle plant with an integrated CSP field of 20 MW. The CSP component of the plant would be expanded by 125 MW. Such a plant expansion at an existing site has numerous advantages. The site is well known and has sufficient availability of water for cooling and regular cleaning of the mirrors. In addition, the site is linked to transmission lines with sufficient capacity to service electricity generation from both the plant under construction and 125 MW from an expansion.

There is available land to construct a 125 MW solar field and the measures to identify and mitigate any environmental impacts have been put in place in relation to the first plant at Ain Beni Mathar. Likewise on the social side, mechanisms have already been developed and put in place to compensate people whose land is being used for the plant under construction and could be extended for any new plant. A new plant would be perceived positively by the local population as an economic opportunity.

While a 125 MW CSP addition at Ain Beni Mathar has some advantages in sharing the site as noted, it would not be technically integrated into the existing plant. Sizing for the solar field and the turbines has been optimized for the 20 MW CSP island and cannot at this point be amended. In addition, there is insufficient availability of natural gas to replicate an integrated gas-CSP approach and thus the new facility would be a stand-alone CSP plant.

Implementation Readiness
The project is close to ready for implementation. The main reason for this is that the project would be on the same site as the existing Ain Beni Mathar site. Thus, most of the preparatory site work will already have been done, notably work relating to sufficiency of insolation; availability of water; availability of transmission capacity; and various aspects of environmental and social impact assessment. Full feasibility studies and relevant economic and financial analyses for the projected expansion would, however, remain to be conducted.

Financing Plan

Project / US$ million	**CTF**	**Other Concessional Funds**	**Equity**	**Commercial/ECA debt**	**Total**
Ain Beni Mathar	$90	$127	$148	$160	$525

Time Table

Activity	**Date**
Project concept review	March 2010
TFC review, MDB appraisal	December 2010
Board approval	February 2011

Ouarzazate Project – 100 MW

Project Description

The Ouarzazate CSP plant of 100 MW under development has many advantages relating to its siting. The preferred siting at this point is at Tamez Ghitene, north of national road P32 and approximately 12 km from the city of Ouarzazate (100 000 inhabitants) itself. It has an area of about 10 km^2, sufficient for housing a solar park of greater than 500 MW.

At a high altitude (1,160 m above sea level) in a dry region at the edge of the Sahara Desert, the site has excellent solar radiation potential with measured solar direct insulation of 2,364 $kWh/m^2/yr$. The site is generally flat with only modest slopes of about 1%, which would not require substantial land works to prepare for a solar field. The Ouarzazate site (approx. 3300 ha) has good proximity to highways, transmission lines and water resources. An access road of 4 km would link the site to the national highway system at an approximate cost (including fences and a warehouse) of $2.8 million. The transmission grid is 3 km from the site and the nearest substation is 9 km from the site. The site could access the Mancour as Dehbi reservoir (only 3 km away) for its cooling and mirror cleaning needs.

Implementation Readiness

Pre-feasibility analysis of a 100 MW CSP plant on this site has already been conducted. Readiness for implementation is facilitate by the sites strong connection with existing water availability and transmission lines sufficient to export the generated electricity. Nevertheless, more preparatory work would still remain to be done.

Financing

The tentative financing plan for the project is as follows:

Project / US$ million	CTF	Other Concessional Funds	Equity	Commercial/ECA debt	Total
Ouarzazate	$72.5	$100	$117	$150	$440

Timetable

Activity	Date
Concept review	June 2010
TFC review, MDB appraisal	January 2011
Board Approval	March 2011

Tan Tan CSP-Desal Project: 50 MW

Project Description

This CSP project is proposed as an innovative project that will help meet both power and water needs in the town of Tan Tan. Several countries in the MENA region have expressed their interest in developing CSP for desalination needs and this would be a regional model that could be replicated widely.

The project area (225 ha, easily enough for the 50 MW maximum project size) is located at 80 m above sea level near the town of Tan Tan (70 000 habitants) in southwestern Morocco. The local insolation is appropriate for the project, with 2000 kWh / m^2 / p.a. There are links to transmission lines of 225 kV, with sufficient capacity to service electricity generation from the 50 MW project. A 30 year PPA is foreseen and cooling needs are to be met from a desalination plant based on Reverse Osmosis (RO) membrane desalination technology. The project will provide for the drinking water needs of the town of Tan Tan.

Implementation Readiness

The pre-feasibility work is well advanced and the institutional approach for implementation is has also been prepared. The project preparation can proceed well if funds are available.

Financing

Project / US$ million	CTF	Other Concessional Funds	Equity	Commercial/ECA debt	Total
Tan Tan	$36.25	$61	$72.75	$70	$240

Time Table

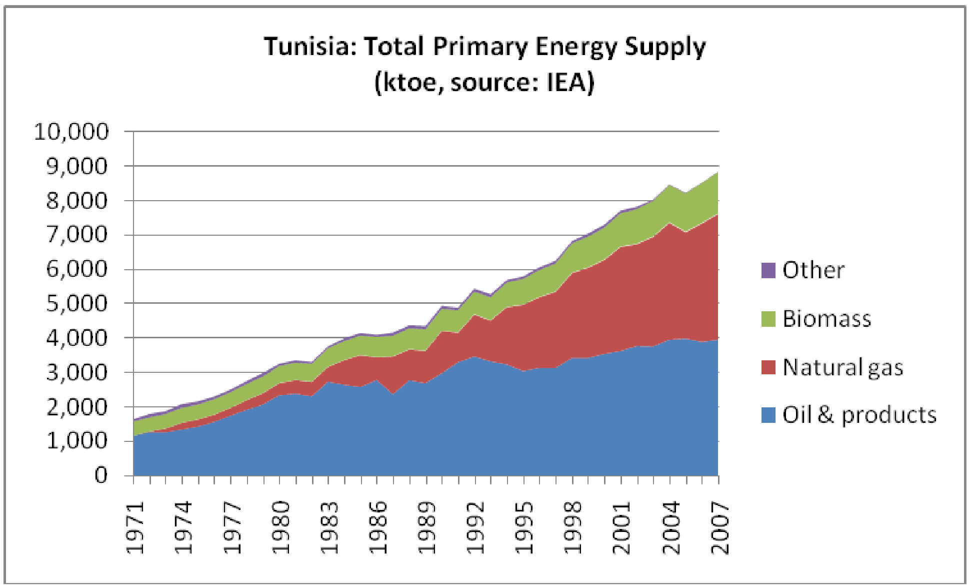
Activity	Date
Concept review	March 2010
TFC review, MDB appraisal	October 2010
Board Approval	December 2010

ANNEX 5 – TUNISIA

I. Policy and Regulatory Background

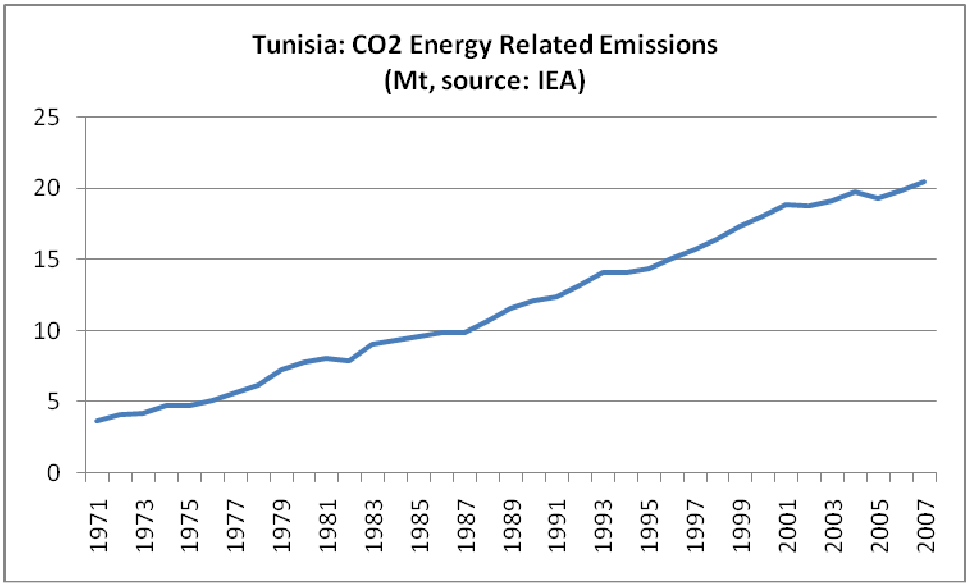
1. Energy Sector Overview

Until the late 1980s, Tunisia was characterized by an energy surplus, and the energy sector was a major driving force of economic development. Since the early 1990s, the energy surplus has turned into a deficit, and Tunisia has become a net importer of energy since 2001. Tunisia's primary energy demand is nearly entirely based on oil and gas. Natural gas was first introduced in the early 1980s and has been capturing a rapidly increasing share of primary energy demand, nearly 50% in 2008. The production of electricity is almost entirely based on natural gas, which is a source of concern: the high level of dependency on hydrocarbons make the country vulnerable to disruption in the international oil and gas markets and to price volatility, especially if local resources are declining and if the country has to rely increasingly on imports.



2. GHG Emissions

Tunisia has been working on a national program for the reduction of greenhouse gas emissions. The program is based on the rational use of energy and the promotion of renewable and clean energies. CO_2 emissions from fuel combustion have increased by approximately 60% since 1990; since the year 2000 they have increased by just 5%.



3. Electricity Sector Policy Framework

The vertically integrated utility Société Tunisienne de l'Electricité et du Gaz (STEG), which was established in 1962, generates approximately 70% of Tunisia's power, and has a monopoly over transmission and distribution of electricity (and gas). A benchmark of STEG with other utilities in the region indicates a relatively good performance, with unit fuel consumption (ton of oil equivalent per kilowatt hour produced) below that in the other Comité Maghrébin de l'Electricité (COMELEC) countries. Transmission losses are also lower than in the other Maghreb countries, as are outages. Tariffs have increased significantly during the period 2005-2008. In 2008, the average electricity price was around 16 USc/kWh for residential consumers, and close to 10 USc/kWh for the industry. STEG's generation fleet amounts to 2.9 GW, of which 2.7 GW are primarily gas fired: 1.0 GW of conventional steam cycle capacity, 1.3 GW of open cycle gas turbines, and 0.4 GW of combined cycle capacity. In addition, STEG owns and operates 62 MW of hydro capacity and 55 MW of wind capacity.

Following a 1996 law reforming the electricity sector, Tunisia's first independent power producer (IPP), Carthage Power Company (CPC), a 470 MW combined cycle gas turbine (CCGT) plant, went on line in 2002 and now generates 22% of the country's electricity. The only other private producer is a smaller 30 MW plant (El Bibene), commissioned in 2003, that burns an oil field's associated gas. The law of February 9, 2009 on energy conservation extends the possibility for enterprises for self-generate electricity, and allows them to sell excess generation to STEG (up to 30% of a company's own production).

New projects under development include two gas fired combined cycle plants for STEG, Ghannouch (400 MW, under construction, to be commissioned in 2011) and Sousse (400 MW, to be commissioned in 2013). A new IPP, a 350-500 MW CCGT is planned near Bizerte, for commissioning around 2015.

Diversification of the fuel mix is planned through the development of wind and the introduction of solar power. Coal is also an option, as well as nuclear energy in the longer term. Two wind farms, located near Bizerte and totaling 120 MW of capacity, should come on line in 2010. The ambitious ELMED project (see below) includes an interconnection with Italy and 1,200 MW of generating capacity (400 MW for the domestic market, 800 MW for export). This capacity should at least include 200 MW of renewable energy, possibly solar. Whether the fossil fuel fired component of the project will use natural gas or coal is yet to be determined.

II. CSP within national energy policy

The country has emphasized the role of energy conservation since the 1980s. Tunisia has been a pioneer among developing countries in terms of energy management policy, having formulated and implemented a policy for rational use of energy and promotion of renewables as early as 1985. The 11th Development Plan (2007-2011) sets the broad direction of energy policy, including gradual reduction in energy subsidies, and calls for a scaling up of investment in energy efficiency and renewable energy. The Tunisian Solar Plan was launched in 2009 for the period 2010-2016. It aims at increasing the share of renewable energy and energy efficiency: 40 projects have been identified (in solar, wind, biomass, etc.), for a total investment amount of 2 billion euros, 1.4 of which to be provided by the private sector. Over the period 2005-2030, Tunisia expects to save 100 mtoe of fossil fuels thanks to its energy conservation efforts, 80% from energy efficiency, 20% from renewable.

Tunisia enjoys a promising solar potential, with an average Direct Normal Irradiance (DNI) of over 2,000 Wh/m^2/year. The proposed ELMED project could be favorable to development of renewable energy projects including CSP projects. The ELMED project itself includes a generation component with a sizeable CSP component (which would benefit from the contracted capacity on the interconnector). In addition, the non-ELMED CSP plants would benefit from priority dispatch on the un-contracted capacity of the upcoming Tunisia-Italy link.

A CSP prefeasibility study was undertaken for a 25 MW plant, with 5 sites (in 3 regions) identified in the southern part of the country (one of which close to the sea, which would make cooling easier and less costly than in other locations). A feasibility study of the 5 sites is now under way with KfW (and EU financing). It should be finalized by June 2010 and will select two sites, one for a first 25 MW project, and one for a large scale 100 MW IPP project. The first 25 MW project is likely to be located at Zarzis and is likely to be implemented as a public project by the STEG based on the parabolic trough technology.

Besides grants and soft loans, several instruments are being considered to finance the development of solar energy in Tunisia: State subsidies, tax breaks, electricity feed-in tariff, etc.

II. Planned Project(s) under MENA CSP Scale-up Program

IPP-CSP Project – 100 MW

Project Description

The main characteristics of the project would be as follows:

- Project sponsor: private operator, to be selected through competitive bidding
- Location: one of the remaining 4 sites of the prefeasibility study, after a site is chosen for the first 25 MW plant
- CSP capacity: 100 MW
- CSP technology: to be determined, with preference for parabolic trough
- Power evacuation: the preselected sites are close to STEG's high voltage grid
- Power offtake: priority for export through ELMED. This plant will not be part of the ELMED project itself, but would take advantage of the 200 MW un-contracted capacity of the interconnector, for which priority will be given to renewable energies

Implementation Readiness

The feasibility study is under wayand should be finalized before June 2010.

Financing Plan

Project / US$ million	**CTF**	**Other Concessional Funds**	**Equity**	**Commercial/ECA debt**	**Total**
IPP- CSP (100 MW)	$72.5	$127.5	$100	$150	$450

Timetable

Activity	**Date**
Concept note review	May 2010
TFC review, MDB appraisal	December 2010
Board Approval	February 2011

ELMED-CSP Project – 100+ MW

Project description

The ELMED project includes a 1,000 MW interconnector between Tunisia and Italy, and a 1,200 MW generation complex. The two components of the projects will be legally and financially separated. Total cost would be around USD 3 billion. All components of the project are expected to be commissioned by 2015-2016. CTF support is proposed for 100 MW of CSP within the generation complex of this project. CTF would also finance about 35% of the Tunisian equity contribution to the ELMED interconnector costs, so that a high proportion of the non-contracted energy transfer capability is used for CSP. 80% of the interconnector will be contracted to the ELMED generation complex, including its CSP component. While priority is expected to be given to renewable energies on the remaining 20%, there is no exclusivity at this stage for any specific type of energy. CTF financing would ensure that a significant proportion - if not all - of the free interconnection capacity is reserved for CSP, including the IPP-CSP project that is included in the CTF investment plan.

Interconnection

- Sponsor: STEG-Terna joint venture
- 1,000 MW in total, 400 kV HVDC, approximately 200 km, between Cap Bon and the Sicilian coast
- 800 MW reserved for the export component of the generation complex
- The remaining 200 MW to be offered in priority to renewable energies (including the IPP-CSP project described in the above section)

Generation complex

- Sponsor: private developer and operator, to be determined through competitive bidding
- 1,200 MW in total
- 400 MW for the domestic market, on a least cost basis, benefiting from a PPA with STEG
- 800 MW for export to Italy, with offtake arrangements under the responsibility of the sponsor
- Expected renewable sub-component, part of the 800 MW export component: at least 100 MW of CSP capacity
- Fuel for the non-renewable capacity: to be determined by the project sponsor.

Implementation Readiness

A partnership agreement was signed in 2009 between STEG and Terna, the Italian grid operator, regarding the interconnection. A STEG/Terna joint venture in charge of managing the prefeasibility studies and the bidding process was also created, ELMED Etudes SARL. 16 international sponsors expressed their interest during a pre-bidding exercise in 2008. A formal request for proposal is expected to be launched before end 2009, for final selection in 2010. The interconnection and the generation complex will be two separate projects, although it is anticipated that many banks will want to be involved in both projects. The Request for Proposals (RFP) will be quite open in terms of specifications and contractual arrangements: choice of fuel, size and specification of renewable component, offtake agreement in Italy.

Financing

The ELMED-CSP project would probably be a separate project from the fossil fuel fired plant. It would probably need to be of 200 MW of capacity to take advantage of economies of scale. However, a phased approach could be considered, starting with a 100 MW tranche. Ultimately, it could be as large as 300 MW, or even more.

Project / US$ million	**CTF**	**Other Concessional Funds**	**Equity**	**Commercial/ECA debt**	**Total**
ELMED- CSP	$72.5	$127.5	$100	$150	$450
Transmission	40		100	1000	1140
ELMED total	112.5	127.5	200	1150	1850

Timetable

Activity	**Date**
Concept Note Review	November 2010
TFC review and MDB appraisal	October 2011
Board Approval	December 2011

ANNEX 6 - Water Needs for CSP Development

Estimating water needs to for CSP with different cooling technologies

Water requirements of cooling of trough type CSP plants are similar to any steam cycle power plant based on conventional energy sources ranging from 2.5-3.4 cu.m/MWh. The water needs are much smaller for dish systems, while being about 30% smaller for power tower, as seen in table below. Mirror cleaning needs are additional (done about 6 times a year) but are only about 8-15% of the annual water cooling needs.

Table 2: Comparison of consumptive water use of various power plant technologies using various cooling methods

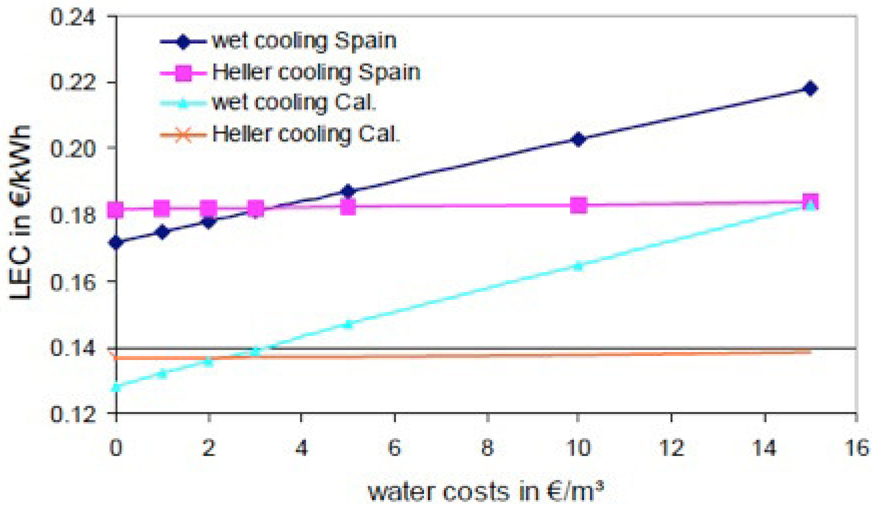
Technology	Cooling	Gallons / MWhr	Perform. Penalty*	Cost Penalty**	Reference
Coal / Nuclear	Once-Through	23,000 – 27,000***			1, 3
	Recirculating	400 - 750			1, 3
	Air Cooling	50 - 65			1, 3
Natural Gas					
	Recirculating	200			4
Power Tower	Recirculating	500 - 750			(estm.)
	Combination Hybrid Parallel	90-250	1-3%	5%	10, 11
	Air Cooling	90	1.3%		9
Parabolic Trough	Recirculating	800			5
	Combination Hybrid Parallel	100-450	1-4%	8%	7, Appx. A
	Air Cooling	78	4.5-5%	2-9%	6, 9
Dish / Engine					
	Mirror Washing	20			5
Fresnel	Recirculating	1000			(estm.)

Source: US DOE Report to US Congress: Reducing Water Consumption of Concentrating Solar Power Electricity Generation (US DOE 2009)

However, given that cooling needs constitute by far the largest water needs of CSP, and given that this is the particular environmental issue often discussed with respect to CSP scale-up, it is worth looking at the key technology options for CSP cooling and their respective key characteristics: wet (‘evaporative’) cooling; dry cooling; and hybrid (‘Heller’) cooling.

There has only been limited research so far on when to use which cooling technology. Initial data from the German Institute for Thermodynamics give insight on the impact of local water costs on levelized cost in CSP projects in Spain and California, focusing on a comparison between wet and hybrid ('Heller') cooling. The results indicate that wet cooling is only preferable to Heller cooling at very low water cost levels.

Figure 1: Impact of water cost on levelized cost of CSP plants in Spain and California



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Source: Dersch et al.

Overall, this study concluded that water consumption was reduced by 97% when switching from wet to Heller cooling, with minimal performance impact. Indeed, for the Californian case, the impact on performance in the higher desert temperatures was more than outweighed by the benefits of better annual insulation.

Method for water needs calculation of CSP projects in MENA

Based on this information, our team obtained data on the capacity and technology of the proposed portfolio of CSP projects in MENA, and established the likely annual generation of each of these projects from average annual generation figures of CSP projects of that capacity level. Subsequently, two data sets (one from the NREL (2009), one from the Department of Energy, DOE) of general estimated water needs for different cooling options at various output levels were obtained, and project-level water needs calculated for each of the projects (distinguishing between the 'tower' and 'trough' technologies of CSP). We then calculated the percentage of water used by air cooling and hybrid cooling vis-à-vis wet cooling for each technology, project and data set:

Table 3: Percentage of water used by air cooling and hybrid cooling vis-à-vis wet cooling for each technology, project

Project Name	Hybrid cooling water use as %age of wet cooling water use (estimate range)	Air cooling water use as %age of wet cooling water use (estimate range)
Algeria (Hassi-R'mel)	12.5 - 56.2	9.7-12.5
Algeria (Meghair)	12.5 - 56.2	9.7-12.5
Algeria (Naama)	12.5 - 56.2	9.7-12.5
Egypt (Kom Ombo)	12.5 - 56.2	9.7-12.5
Egypt (Marsa Alam)	12.5 - 56.2	9.7-12.5
Jordan (Maan Province)	18.0 - 33.3	12.0 - 18.0
Morocco 1 (Ain Beni Mathar)	12.5 - 56.2	9.7-12.5
Morocco 2 (Ourzazate)	18.0 - 33.3	12.0 - 18.0
Morocco 3 (Tan Tan)	12.5 - 56.2	9.7-12.5
Tunisia (ELMED-CSP)	12.5 - 56.2	9.7-12.5
Tunisia (IPP-CSP)	12.5 - 56.2	9.7-12.5

These calculations suggest that

- for air cooling and for the lower end of the estimates range of hybrid cooling, water use is only in the lower double-digit percentage range of wet cooling.
- for the higher end of the estimates range of hybrid cooling, water use is at a third to slightly over half of wet cooling.

Where water availability and cost is an issue and wet cooling to be replaced with hybrid or air cooling, the decision between hybrid and air cooling therefore comes down to the relative performance and cost penalty of each vis-à-vis wet cooling. The Department of Energy also provides figures on the performance and cost penalties associated with the use of hybrid cooling and air cooling. These figures are provided below.

Table 4: Performance and Cost Penalties

		Performance Penalty	Cost Penalty
Tower	Wet cooling	None	None
	Hybrid	1 – 3%	5%
	Air cooling	1 – 3%	?
Parabolic Trough	Wet cooling	None	None
	Hybrid	1 – 3%	8%
	Air cooling	4.5 – 5%	2 – 9%

Thus, water savings to be had from hybrid cooling systems and air cooling systems vis-à-vis wet cooling are considerable. Additional water savings generated by air cooling over hybrid cooling (at least at the upper end of the estimates range) outweigh the rather marginal additional performance and cost penalty associated with this technology. Nonetheless, the decision on the cooling technology ought to be made in each instance taking local water availability and cost into account. However, given water scarcity in many parts of the MENA region, hybrid and air cooling technologies are likely to be frequently a preferable option.

Site-specific water availability data from the MENA region

This section gives detail on water availability for a selection of some of the currently proposed CSP projects in the MENA region. In so doing, it notably draws on relevant project documents (complete EIAs, where available).

Morocco 1 (Ain Beni Mathar): an EIA and recent World Bank site visit confirm that a considerable amount of water is available, sufficient for the proposed CSP project (World Bank 2009). Nonetheless, the EIA stipulates that the volumes of cooling water to be drawn from the aquifer should not exceed predetermined maximum amounts in order to maintain the current balance of the resource.

Morocco 2 (Ourzazate): The region has general water scarcity, aggravated by a severe drought over the past 10 years. The most significant and suitable water source for this project is the Mancour ad Dehbi reservoir. It is primarily fed by the river Dades with its relative constant flow of 5×10^6 m^3 per year. In addition, multiple creeks carrying melted snow from the High Atlas feed the reservoir in spring. The water is judged by local experts to have excellent quality with high purity, softness and non-corrosiveness. However, the elevation of the project site is about 100 meters above the mean water level of the reservoir, making pumping mechanisms necessary (with the associated energy needs).

Jordan (Maan Province). Ground water is available at the site, as well as the possibility of drawing water from the Disi pipeline which will be passing close to the site. Air cooling has already been chosen by the developer as the cooling option, reducing prospective water use dramatically.

In Egypt, one of the proposed sites is near river Nile and other is close to the red sea so water availability is not likely to be an issue. In Algeria, the proposed projects are likely to utilize air cooling approach and in Tunisia, the choice will be based on the feasibility study results.

Meeting energy and water needs jointly: combining CSP and desalination

One further consideration that has arisen in this context is the use of CSP to drive desalination plants, where a small proportion of the water from this desalination plant would then be used to meet the CSP plant's water needs; the rest would be used to meet the region's other water needs.

While a long implementation time frame should be expected (CSP desalination shall need some 10 to 15 years from today in order to reach a significant share in MENA water supply), CSP desalination has the highest potential to supply the most economic (<€0.3/m3) and sustainable water to the region. Moreover, all relevant desalination technologies are improving. Given the dearth of alternatives to secure the region's water supply (e.g., with subsurface water withdrawal having reached over 1000% of the safe limit in some countries), this option will become increasingly important.

Initial World Bank-internal figures on the level of water and electricity needed in a combined CSP and desalination-'scenario' for the regional CSP scale-up plan yield the following results: for a 1000MW initial configuration of the plan, assumed to run for an average of 7 hours a day, the water requirements of the plants would require 0.56% to 2.8% of the electricity output, depending on the kind of technology utilized.

Regarding capital costs, given the assumptions of water requirement of 2.8 to 3.4 m^3/MWh and capital costs of \$1500-2000/m^3/d for Multi Stage Flash (MSF) and \$900-1700/m^3/d for Multi Effect Distillation (MED), the additional capital costs required for the desalination equipment come to about \$33-37/kW.[36] For the CSP plan of 1000MW, this amounts to an additional \$33m, assuming that each plant reaches the economies of scale required for these costs. Since desalination is a mature technology in the region, these costs can be stated with a reasonable degree of accuracy. The additional solar field required would be in the order of 1 to 3%.

Oversizing the solar field can provide energy for a larger desalination plant, which could provide drinking and/or potable water for the local community. The feasibility of providing a larger solar field in order to produce electricity for desalination can be established if the cost of water in the region is available. The factors that may significantly influence the cost of water from desalination, from this elementary analysis are firstly the capacity factor of the CSP plants, and secondly the requirement of water for cleaning of the solar field.

Conclusion

CSP scale-up may lead to a number of specific social and environmental issues, though few of these 'CSP-specific'-issues have so far arisen in actual CSP projects. For the most parts, CSP projects are likely to give rise to the 'standard' safeguards issues of an infrastructure project of the relevant size. With the planned CSP scale-up throughout the region, spatial analyses that will

[36] Figures from "CSP for Desalination", presentation by Lotus Solar Technologies, June 2nd/ 3rd, Abu Dhabi.

likely be used anyway for information on e.g. solar radiation levels or terrain slope, should also provide information on key safeguards-relevant site criteria (e.g. land cover and use, population density, or location of water and protected areas). [37]

CSP requires water, and this – in line with the relevant cooling options and their water needs – has to be planned for. It is likely that dry cooling and Heller cooling will be the best option for most CSP projects in the region, given the region's water scarcity, the large water savings to be had from dry and Heller cooling over wet cooling, and the limited performance penalties associated with the dry and Heller cooling options.

[37] A first application of such spatial analyses for MENA-CSP is presented in Ummel, Kevin and Wheeler, David (2008): Desert Power: The Economics of Solar Thermal Power Generation in the Middle East and North Africa Center for Global Development, Washington DC.

ANNEX 7 – Project Implementation Schedule

Country	Project	3Q - FY10 Jan-Mar	4Q - FY10 Apr-June	1Q-FY11 Jul-Sep	2Q-FY11 Oct-Dec	3Q-FY11 Jan-Mar	4Q-FY11 Apr- June	1Q-FY12 Jul - Sep	2Q-FY12 Oct - Dec
Algeria	Meghaïr	PCN Review[38]			TFC Review[39]		Board Approval		
Algeria	Naama		PCN Review			TFC Review	Board Approval		
Algeria	Hassi R'mel II			PCN Review				TFC Review	Board Approval
Morocco	Ouarzazate		PCN Review			TFC Rev. & Board Approval			
Morocco	Ain Beni Mathar	PCN Review			TFC Review	Board Approval			
Morocco	Tan Tan	PCN Review			TFC Rev. & Board Approval				
Tunisia	ELMED - CSP				PCN Review				TFC Rev. & Board Approval
Tunisia	IPP - CSP		PCN Review		TFC Review	Board Approval			
Jordan	Ma'an	PCN Review			TFC Rev. & Board Approval				
Egypt	Kom Ombo			PCN Review		TFC Review	Board Approval		
Egypt	Marsa Alam		PCN Review			TFC Review	Board Approval		
Jordan Transmission	Qatrana-Samra-Amman	PCN Review			TFC Review				Board Approval
Tunisia Transmission	ELMED				PCN Review				TFC Rev. & Board Approval

[38] Project Concept Note (PCN) review is the first formal internal procedure at the World Bank Group for project processing.
[39] Trust Fund Committee of the Clean Technology Fund

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