Value Chain Analysis of Solar Technologies and Services

in the Meknes-Tafilalet Region

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Foreword & acknowledgements

It is with great pleasure that we publish the "Value Chain Analysis of Solar Technologies and Services in the Meknes-Tafilalet Region". The research in this study, conducted by the author Helene Kirémidjian has contributed to the design and implementation of activities to strengthen the value chain, including the promotion of solar heating in the hotel sector and strengthening the services sector through the creation of a regional network of installers dedicated to renewable energy, called the RESOVERT. By mapping the landscape of major players in the solar sector and by characterizing the relationship between them, this study is intended to serve any private operator, civil-society stakeholder, public partner or donor that promotes renewable energy in Morocco and in particular in the region of Meknes-Tafilalet. This work on the solar energy industry is merely one of the activities included in an ongoing effort and collaboration between several agencies to make the region of Meknes-Tafilalet the destination of choice for sustainable investment in Morocco. This document is printed on 100% recycled paper. We hope this analysis will encourage you to join us in our efforts to encourage sustainable investment in the Meknes-Tafilalet region.

Lara Goldmark
Director of the Program
USAID's "Improving the business climate in Morocco"

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Acronyms

Environment and Energy Conservation Agency	ADEME
Moroccan Association of Wind and Solar Industry	AMISOLE
National Agency for Energy Conservation	ANME
Regional Academy of Education and Training	AREF
Renewable Energy Development Center	CDER
Clean Development Mechanisms	CDM
General Confederation of Moroccan Enterprises	CGEM
Canadian International Development Agency	CIDA
Moroccan Center for Clean Development	CMDP
Regional Investment Center	CRI
Dispositif Global de Financement Leasing	DGFL
Decentralized Rural Electrification	DRE
European Development Bank	EDB
Energy Efficiency	EE
European Environment Agency	EEA
National School of Agriculture	ENA
Energy Service Companies	ESCOS
European Solar Thermal Industry Federation	ESTIF
Global Environment Fund	GEF
Solar Results Guarantee	GRS
German Technical Assistance	GTZ
Gigawatts per hour	GWH
KfW Banking Group *(Kredistanstalt für Wiederaufbau)*	KFW
Thousand dirham	KMAD
Dirham	MAD

Department of Energy, Mines, Water and Environment	MEMEE
Mega watt	MW
New Information and Communication Technologies	NTIC
Office of Professional Training and Employment	OFPPT
National Electricity Office	ONE
Global Rural Electrification Program	PERG
National Program of Renewable Energy Development and Energy Efficiency	PNDREE
Photovoltaic Panels	PV
Pilot Program for Decentralized Rural Electrification	PPER
Mediterranean Solar Plan	PSM
United Nations Development Programme	UNDP
Renewable Energy	RE
Renewable Energy Certificate	REC
Renewable Energy Payment	REP
Renewable Portfolio Standards	RPS
Small and Medium Enterprise	SME
Tunisian Company of Electricity and Gas	STEG
Solar Water Heater	SWH
Tonne Oil Equivalent	TOE
United Nations Conference on Trade and Development	UNCTAD
Union for the Mediterranean	UPM
United States Agency for International Development	USAID
United States Dollar	USD
Value Added Tax	VAT
Peak Watt	WP

Executive summary

Morocco does not produce fossil fuels and as a result it depends on imports for up to 97% of its energy needs. The constant growth in demand for electricity (7.5% in 2008) is therefore a large constraint for the National Electricity Office (ONE).

However, this unfavorable energy context represents an opportunity for Morocco to develop its renewable energy sector, reduce its dependence on fuel imports, and meet its energy needs in a sustainable and independent manner. Indeed, Morocco is full of potential for renewable energy, including solar energy with 5.5 kWh/sq. m/j, or 3,000 hours of sunshine per year.

The solar technologies (photovoltaic and solar thermal) market has existed in Morocco for several decades. It has grown stronger over the past ten years thanks to several national programs, including Promasol for solar thermal energy and the Global Rural Electrification Program (PERG) for decentralized photovoltaic energy. Despite the governmental support for the solar industry - in the form of direct grants to providers within the framework of the PERG and technical assistance within Promasol - a large potential market remains untapped. Indeed, it is estimated that the solar thermal park could reach 440,000 sq. m in 2012 and up to 1,700,000 sq meters of solar panels by 2020, a large increased from the 240,000 sq. m in place in 2008. With regard to photovoltaic energy, the market for connecting self-produced electricity to the grid is being developed through ONE's national program called Chourouk as well as the export of solar energy to industrialized countries under the Union for the Mediterranean (UPM)'s Solar Plan.

To enable the Meknès-Tafilalet region to attract private, foreign, or local investment in this sector, USAID's "Improving the Business Climate in Morocco" Program conducted an analysis of solar energy value chains in Meknès-Tafilalet. This study aims (i) to highlight existing potential markets (ii) to analyze Moroccan and foreign institutional frameworks to benchmark tools fostering the development of solar value chains, (iii) to identify constraints and opportunities related to their development, and (iv) to make recommendations to improve their viability and competitiveness. The main conclusions of the study are:

(1) Incentives and institutional frameworks. Although they represent a real investment opportunity for the future, solar value chains have developed in industrialized countries in large part thanks to: direct subsidies (by offering a premium to individuals buying renewable energy equipment); indirect subsidies (tax credits); the establishment of preferential financial tools (reduced interest rates); and incentivizing or binding regulatory frameworks (a "feed-in tariff" [1] set at a cost higher than traditionally-produced electricity, of most use in urban areas, requirements to include solar water heaters in new buildings, or other options).

Signatories of the Kyoto Protocol (and of Appendix 1) pledged to reduce their greenhouse gas emissions by 5% from 1990 levels by 2012. This may partly explain industrialized countries' rationale for promoting technologies that have not yet reached their "break-even point". Non-signatory countries like Morocco benefit from financial incentives through clean development mechanisms (CDM), which provide funding for projects targeting the reduction of greenhouse gases. Morocco has no commitment to reduce CO_2 levels, and thus far has not established a subsidy system to promote these environmental energy sources as the majority of industrialized countries have done.

However, Morocco has some important institutional advantages. First, the Ministry of Energy, Mines, Water and Environment (MEMEE) has demonstrated clear political will to promote renewable energy and energy efficiency through its new "Energy Plan". The plan's objective is to increase renewable energies to 10% of the national energy balance by 2012 - in contrast to the current level of 4%. Secondly, the regulatory environment is quickly evolving with the adoption of a new law on renewable energy allowing for private production of electric energy and its sale or its export abroad; a law on energy efficiency is also being developed. Finally, an Energy Development Fund of 1 billion USD is available to promote this sector.

(2) Markets. Markets for solar thermal and photovoltaic energies are analyzed independently in this report because they differ greatly from one another [2]:

- *Solar water heaters.* The market for solar thermal energy in Morocco is dominated by the individual solar water heater, which has a homogeneous customer profile. According to the CDER, in 2006-2008 an average of 76.5% of the market catered to private use by higher income home owners (those owning villas or vacation homes). Solar water heaters for collective use only represented 23.5% of the market.

  Nearly all solar water heaters in Morocco are imported. There are only three local solar water heater manufac-

[1] The "feed-in tariff" is the price by a service provider of a unit of electricity generated by a source of renewable energy by a third party. This price can be set to provide an incentive for private producers if it is higher than that of traditional electricity. Source: European Environment Agency (EEA).

turers and a dozen CDER certified brands are marketed. The majority of heater-producing countries are around the Mediterranean and Europe, such as Tunisia, Greece, Spain, Turkey, Israel, and France, but also including Australia and China. Meanwhile, more and more low cost brands and products, whose origins are unknown and thus problematic, are invading the market, offering lower quality products and damaging the image of the solar industry as a whole.

Today, the Meknes-Tafilalet region has untapped market potential in the following sectors: (I) housing (6,883 new units constructed in 2007 including modern Moroccan villas, houses and buildings), (ii) tourism (currently 4,600 sq. m of solar collectors), (iii) education (currently 3,982 sq. m of solar collectors), (iv) health (currently 870 sq. m), and (v) industry (opportunity to incorporate solar water heaters into the production process).

The tourism sector is seen as the most competitive sector, offering investments that can be amortized in about five years' time based on energy savings.

- *Photovoltaic energy.* Unlike European countries where the largest market share is the connection to national electricity system (grid-connection), Decentralized Rural Electrification (DRE) (i.e. the provision of photovoltaic panels to households in rural and isolated areas) through a national program, the PERG (1998-2008) represents most of the Moroccan market. Highly structured by the ONE, the photovoltaic market in Morocco remains "institutional" and dominated by ONE's concessionaires within the PERG, to the detriment of local enterprises with a smaller production capacity. However, new pilot projects have emerged in 2009 in some regions of the Kingdom under the national *Chourouk* program (2009-2015). These activities indicate a change in ONE's strategy, or at least a willingness to test the feasibility of linking photovoltaic energy to the grid. The potential market currently includes: (vi) the Decentralized Rural Electrification of schools and clinics, (vii) the production of solar electricity connected to the grid (ONE's *Chourouk* program), and (viii) the export of solar energy to countries around the Mediterranean (especially to countries part of the Union for the Mediterranean (UPM)).

(3) The value chain. The major constraints preventing the development of both solar channels identified in this study are:

Service providers are the weakest link in chain. Service providers [3] are typically small enterprises with less than five employees who work primarily without contracts or invoicing systems and provide limited services that often do not include marketing, counseling, after-sales service, etc. These micro enterprises do not have sufficient funds to grow their businesses, nor the proper training to extend their solar activity. Indeed, the solar energy sector is only a small proportion of their total business. Therefore, this segment of the market is stagnant and all the other links in the chain suffer the consequences: customers lack confidence in the technology and do not know who to turn to when their equipment fails; the final price and quality of the products varies from one retailer-installer to another; importers fear their image will be negatively affected by installers, who lack the loyalty of their suppliers and the professionalism required by their clients.

Difficulties of public access to solar energy products. Solar products are too expensive for the general public, which is why today the market is either focused on villa and vacation home owners for solar thermal energy, or, in a market highly subsidized by the state (ONE), for photovoltaic energy through Decentralized Rural Electrification. Moreover, there is a lack of involvement from the banking system, which does not offer financial products tailored to the purchasing power of households. In addition, advertising for such technologies is still very limited in Morocco, and poorly organized service providers do not actively market their products. Many opportunities to reach new customers are therefore lost.

Lack of a qualitative approach to solar channels. Although the CDER has developed certification for equipment and installation of renewable energies these must be strengthened both in terms of quality and use. These tools are not mandatory and do not structurally frame solar value chains in Morocco.

Reinforcement through incentive, institutional and regulatory frameworks. Morocco is changing its institutional framework with MEMEE's new "Energy Plan" to promote renewable energy and energy efficiency in Morocco. However, financial incentives are still weak and the government's direction, particularly regarding its position on grid connection for photovoltaic energy, still needs to be clarified.

To develop solar value chains and remove the constraints identified in this analysis, the study recommends that the following actions be taken:

(i) Improve professionalism in the services sector by developing a network for installers and service providers. The network will enable these firms to share certain costs and to benefit from in-depth trainings to address some of the failures in the value chain (storage, transport, supply/delivery, and prospecting/marketing), and to formalize their mode of operation;

[2] Since this study focuses on solar technologies marketed mainly in Morocco, "concentrated" solar technologies often used for solar power plants are not included in this study.

[3] In the solar value chains, service providers are companies that are normally responsible for the installation, maintenance and after-sales service of products.

(ii) **Promote a development approach fostering the value chain at the local level,** including through public tenders;

(iii) **Carry-out awareness raising actions** targeting potential customers to communicate about niche markets that already offer a return to the investor;

(iv) **Develop ways to finance solar technologies adapted to the purchasing power of customers** through preferential loan rates, or in collaboration with Moroccan companies in charge of electricity distribution, using electric bills as a medium to reach customers;

(v) **Strengthen training in the renewable energy sector** and stimulate the development of R&D in this field;

(vi) **Establish a system of "taxation" on traditionally-produced energy in order to improve the competitiveness of solar technologies,** which may be accomplished through a gradual reduction of gas subsidies (indexed on oil prices) so as to not penalize society's poorest segment;

(vii) **Encourage electricity production through solar energy by developing a solar incentive policy of "feed-in tariff",** by setting the price of electricity produced by a solar source higher than the selling price of traditionally-produced electricity over a given period;

(viii) **Require the inclusion of solar water heaters in new building plans**, and prepare an adequate solar thermal product supply;

(ix) **Ensure the quality of equipment and related services imported to and produced in Morocco** by strengthening and increasing the use of Moroccan certification for equipment and the CDER's certification for authorized installers.

Morocco may not have the means to implement all these recommendations at the same time. Indeed, without a policy of subsidies for solar value chains, the state cannot act immediately to influence the prices of solar equipment (through the political incentive of the "feed-in-tariff" for photovoltaic energy or price premiums for the purchase of solar water heaters). If it wishes to develop its new energy strategy Morocco must therefore find alternative ways to promote these industries, ones that require less financial investment. To stimulate demand for clean energies and to reduce Morocco's dependency on fossil fuels while taking into account local constraints, this study offers an overview of the measures outlined above, and provides short and medium term recommendations at three main levels of analysis: the value chain, supporting markets and regulation. They are:

(i) **Strengthen the services sector** to ensure that service providers become reliable partners for local or international investors wishing to establish a business in the region or the Kingdom and to ensure that consumers have confidence in the technology;

(ii) **Develop financial products tailored to the clients' purchasing power** to facilitate the purchase of solar products and stimulate demand;

(iii) **Reduce subsidies on fossil fuels** to improve the competitiveness of renewable energy particularly with regard to natural gas, the main competitor of solar thermal energies.

Introduction

This study on solar energy technologies in the Meknes-Tafilalet region was conducted by USAID's "Improving the Business Climate in Morocco" Program in the summer of 2008. It was undertaken to provide an overview of potential regional markets, and the organization of solar (thermal and photovoltaic) value chains. The aim is to develop business partnerships between stakeholders in the local and international supply chains and to attract sustainable investment to the region.

Indeed, this study aims to contribute to the development of a regional strategy to attract investors sensitive to sustainable development by: creating a conducive environment for investment (regulation, incentives, information on investment opportunities and markets, etc.); and developing partnerships that support the sale of solar energy technology and investment in the development of a solid and competent local industry. Thus, while providing potential investors with a portfolio of information relating to markets and local partners, this study examines the nature of commercial relationships throughout the solar-thermal and photovoltaic value chains in order to propose recommendations to improve their sustainability.

Background on the study and value chain selection

In the spring of 2007, USAID's "Improving the Business Climate in Morocco" Program undertook three regional studies to identify opportunities and constraints to private investment in seven regions of Morocco. Among them was the region of Meknes-Tafilalet, famous for its water resources, its agricultural potential, its wildlife, and its imperial past. However, the greatest potential of the region, previously known as the "water basin of Morocco," has also been associated with the most alarming constraints: the depletion of natural resources and desertification. Having recognized environmental degradation as a threat to economic growth, and wishing to attract sustainable "green" investment funds, the region is now striving to transform these constraints into opportunities: in February 2008, the region launched its sustainable investment promotion strategy.

In the fall of 2007, the Program conducted a study on the most promising opportunities of the region. The study revealed the potential of three key sectors: "organic" agriculture, ecotourism and renewable energy (including the Clean Development Mechanisms (CDM)). Relying on these results, the region, including the Regional Investment Center (RIC) in Meknes-Tafilalet which gave birth to this initiative, chose to promote the renewable energy sector by exploiting the wind, solar, biomass and biogas potential, and to focus its efforts on autonomous energy production, development of services and technologies related to renewable energy - including solar energy, energy efficiency in construction and industry - and promoting the region as an ideal host for investments related to renewable energy.

In addition to offering a variety of investment opportunities, renewable energy allows Moroccan enterprises to access supply sources of alternative energy, to cope with rising energy prices, and to maintain their competitiveness in global markets.

In order to boost the energy sector including regional and local services and related technologies, CDER has developed (in collaboration with UNDP) the Energy House program. This program and the micro-energy service providers in rural and urban areas (who promote marketing, installation, and maintenance of renewable energy equipment) are key partners for local and international investors wishing to promote their technologies through a reliable and competent interface.

With the aim to bring manufacturers and suppliers of renewable energy technologies together and to choose Meknès-Tafilalet as a priority location for investment, the program opted to carry out a study on solar energy value chains in the region, one of the sunniest in Morocco. The study aims to identify, characterize, and quantify opportunities relating to the services and technology markets associated with solar thermal and photovoltaic channels, while identifying the various elements of these chains and characterizing the nature of the commercial relationship between them.

Methodology

Value chain analyses describe the process of a selected product from production to sale to the final consumer, and the stakeholders and functions involved. This technique has been used for decades by the private sector, including in the food industry, as well as international development experts and academic researchers. The activities undertaken throughout the chain can be contained in a single enterprise or distributed among various companies. Similarly, these activities can be located in the same geographical area or dispersed in several places.

The productivity and efficiency of a value chain depends on the performance of each upstream stakeholder (producers of raw materials, components of products and services), and downstream stakeholders (distributors, transporters, retailers). On the one hand, if a link on the chain is weak, the whole chain's competitiveness suffers, and on the other hand, better organization of some stakeholders may also improve the competitiveness of the entire chain. This methodology allows us to analyze the opportunities and constraints inherent to a sector, to propose recommendations to develop these sectors, to

improve competitiveness, and to increase market share for specific stakeholders.

Traditionally, a value chain study analyzes the flow of a product, the transformation process from raw material to distribution in end markets. Given that most solar technologies marketed in Morocco are imported from abroad, however, this study is somewhat inverted: it examines the access of these technologies to local Moroccan markets. The aim is to identify the extent to which producers and technology providers can become investors, contributing to the development of the sector and strengthening local stakeholders. To this end, special attention was paid to the analysis of local markets and to the identification of opportunities for reorganizing the weaker links of the chain. In addition, because solar technologies assessed in the present study-particularly photovoltaic products - have not yet reached their full level of profitability, foreign policies and promotional tools were assessed and compared with those in place in Morocco.

Fifty qualitative interviews facilitated the data collection process. Interviews were conducted both at central and regional levels with representatives of eleven public authorities, three ONE concessionaires, nine technology importers, fifteen service providers, ten clients, and two other stakeholders - an international organization and a Moroccan association specializing in wind and solar technologies (see list - opposite).

The study began by analyzing foreign regulatory, institutional, and incentive frameworks, based on secondary sources (studies, articles and press, websites of the departments in charge of the energy sector), as well as research at the local level, which included semi-directive interviews with the MEMEE and other the authorities and agencies concerned.

The value chain analysis was then conducted starting with the most upstream stakeholders on the chain to the end markets, in order to identify the exact path of the products and services analyzed. Interviews with importing enterprises and ONE concessionaires were semi-directive and were carried out using a questionnaire to guide the discussion. Several criteria have also helped guide this inverse study: the power distribution (ability to negotiate), the intensity of vertical and horizontal collaboration, and access to information about products and markets.

The study was initially used internally by the Program in order to design interventions targeting market profitability. To this end, a group of five students from the Columbia University in New York City was invited to Morocco for a week in January 2009 in order to prioritize potential markets according to viability for the investor. The tourism sector is seen as the most competitive sector, thanks to the savings made by replacing traditional energy use by solar energy.

This period also helped to consolidate the information gathered through interviews and to present the results of the study to national and regional partners, including the Meknès-Tafilalet Regional Investment Center (RIC) and the Renewable Energy Development Center (CDER).

Public stakeholders

- Ministry of Energy, Mines, Water and Environment (MEMEE);
- General Confédération of Moroccan Enterprises (CGEM);
- Regional Delegations of Tourism;
- Regional Delegation for Industry;
- Regional Delegation for Housing;
- Regional Delegation for Health;
- The Urban Agency of Mèknes;
- The Regional Education and Training Academy (AREF);
- Moroccan Center for Clean Development (CMPP)
- Renewable Energy Development Center (CDER);
- National Electricity Office (ONE) (national and regional).

Private stakeholders

- ONE concessionaires: Isophoton, Sunlight Power, Temasol;
- Importers: Sococharbo, Noor Web, Atcoma, First Metal, Calpark, Batitherme, Phototherme, Giordano Maroc, Energy Poles ;
- Fifteen service providers, including a dozen Maison-Energie;
- Ten clients: households, hotels and hospitals.

Other

- Moroccan Association of Wind and Solar Industry (AMISOLE);
- United Nations Development Program (UNDP).

Part I • Moroccan energy policy and development tools for the solar energy value chains

This section presents background information on Morocco's energy policy and the new Moroccan energy strategy, which is for the first time clearly oriented towards promoting energy efficiency and renewable energies. This section also provides an analysis of other major policies and financial tools used in countries where solar channels are the most developed, as well as supporting regulations and activities in Morocco.

I. Morocco's energy strategy

As a non-fossil fuel producer, Morocco depends on imports for up to 97% of its energy needs [4]. Commercial energy consumption remains relatively low, amounting to 14.7 Million Tonnes Oil Equivalent (MTOE) [5] in 2008, nearly 0.46 TOE/capita/year, despite a sustained increase in consumption averaging 5% per year from 2000 to 2007 [6].

According to statistics from the Ministry of Energy, Mines, Water and Environment (MEMEE) [7], Morocco's energy invoice amounted to 70.6 billion dirham (MAD) in 2008, and has nearly tripled since 2002 (from MAD 19.1 billion). Regarding power consumption, average annual growth is 7.5%, with 24,002.8 net gigawatt-hours (GWH) of electricity used in 2008. This increase in the Moroccan energy bill is partly due to the increase in oil and gas prices. Indeed, up to 58% of national energy needs are satisfied by petroleum products [8]. It is also interesting to note that about 70% of the electricity consumed comes from imported coal and fuel [9].

In order to offer affordable prices to consumers, the Moroccan government massively subsidizes energy imports. For oil, subsidies amounted to MAD 10.7 billion in 2007, and for gas they were 3.7 billion MAD in 2005 [10]. Hence, the government, and more specifically the *Caisse de Compensation*, must bear any increase in the price, since the changes are generally not passed on to consumers.

Faced with this level of dependence on the outside world and fluctuations in energy prices, Morocco must increase efforts to diversify its sources of energy and to enhance its national resources, particularly through the promotion of renewable energy (hydraulic, wind, solar and biomass).

In a clear sign that Morocco is moving towards renewable energies, His Majesty Mohammed VI spoke to this issue during the *Fête du Trône* celebration on July 30, 2008: *"The issue of energy also arises as a fundamental problem that must be addressed through a vision for the future. The aim is to ensure the security of energy in our country, to diversify sources of domestic energy using green alternatives, and to ensure rational use of the latter"*. [11]

Morocco has huge potential in renewable energy. According to the MEMEE, this potential is about 6,000 megawatts (MW) for wind power. Indeed, Morocco has 3,500 km of coastline with regular winds blowing at an average speed of 8 to 11 meters per second. For solar energy, the potential of Morocco amounts to 5.5 kwh/sq. m/day, that is 3000 hours of sunshine per year. In terms of hydraulics, 200 usable sites were identified. Biomass also has great potential in Morocco and a study is planned for 2009 to measure the biomass potential that can be converted into energy.

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[4] Among neighboring countries exporting energy to Morocco are: Algeria, Spain, Saudi Arabia, China, South Africa and Eastern Europe.
[5] Tonne oil equivalent (TOE) measures how many tons of oil would be consumed to provide the amount of energy required.
[6] Liaison Energie-Francophonie No. 78, "Transforming the energy constraint into an opportunity: the case of Morocco", p. 85.
[7] MEMEE's website.
[8] MEMEE, "Outline of the Energy Strategy 2020-2030, big ideas" (Monday, July 21, 2008).
[9] http://www.jeuneafrique.com/Article/LIN08068lonesnoisne0/-choc-petrolier-ONE-economies-d-energie-L-ONE-soustension.
[10] Study of the solar thermal market in Morocco (2006, CDER).
[11] Excerpt from the speech of His Majesty King Mohammed VI on Throne Day (July 30, 2008).

Today, the share of renewable energies in the national energy balance is 4%[12]. It represents nearly 10% of the electrical energy produced through the mobilization of water resources and the establishment of the first windmill parks. The box below describes the main renewable energy projects in Morocco that are generating high power electricity that can be connected to ONE's national electricity grid.

Projects based on renewable energy generating electricity power in Morocco

Morocco has significant renewable energy resources that can be exploited for the production of high power electricity that can be connected to the national electric grid. Several channels linked to renewable energy exist for this purpose: the most developed technical applications are the wind farms, thermo-solar power plants, energy recovery from biomass and cogeneration.

Projects completed or underway in Morocco:

- *Essaouira wind farm* with a capacity of 60 MW. The overall investment is estimated at 790 million MAD, and is funded by the German bank KFW and ONE. Its implementation and operation are performed by ONE. In service since March 2006.

- *Wind farm in Tangier* with a capacity of 140 MW, funded by the EIB, KFW and ONE. The construction and operation will be carried out by ONE. The overall project cost is estimated at 1,800 million MAD. The windmill park is currently under construction and commissioning is scheduled for July 2009.

- *Ain Beni Mathar's thermo-solar power plant* (Combined cycle. A solar panels park that has a capacity of 470 MW, including 20 MW in solar will work with natural gas. Distribution will be provided from the Maghreb-Europe gas pipeline through a 12 km long direct ramp.

Source: Website of the Ministry of Energy, Mines, Water and Environment (MEMEE).

Taking into account the potential to overcome the energy constraints of the country, the MEMEE has redefined its strategic vision to promote renewable energy and energy efficiency by implementing the National Program of Renewable Energy Development and Energy Efficiency (PNDREE).

On a global level, the aim of this plan is to ensure a continuous supply of energy in Morocco at a competitive cost. It is based on five strategic pillars:

- Security of energy supply;
- Diversification of energy forms and sources;
- Widespread access to energy;
- Energy at the lowest cost;
- Energy efficiency.

On the supply side, the Ministry has focused its strategy on promoting energy self sufficiency through renewable energies. As for demand, the Ministry aims to save energy through the promotion of energy efficiency in buildings and public infrastructure. MEMEE set specific objectives in both of these areas under the PNDREE: increasing the share of renewable energies from 4% to 10% by 2012 in the energy balance, and by 20% of the electricity balance, while saving an estimated 15% by 2020.

In practice, by 2012 this program will install 1,000 MW of high power equipment based on wind and solar energies[13]. As for Decentralized Rural Electrification, Morocco has set the target to equip 150,000 rural households and buildings (mosques, schools, health facilities) with photovoltaic panels as part of its Rural Electrification Program (PERG)[14]. By late July 2007, 44,719 households were equipped with solar panels for household lighting.

To accomplish these goals, Morocco also needs to reform its institutional framework and implement an appropriate legal framework dedicated to renewable energies and energy efficiency promotion to encourage national and international capital to be invested in the sector. In parallel, the role of the Renewable Energy Development Center (CDER), a public authority under the MEMEE whose mandate is to promote renewable energy in Morocco, will be strengthened at both strategic and operational levels. A draft law revising the structure of the CDER into a national agency for the development of renewable energy and energy efficiency is pending.

CDER's new missions will include:

- propose incentive measures to develop renewable energy and enhance energy efficiency;
- propose and disseminate standards and quality labels for renewable energy equipment;
- comment on draft laws and regulations relating to developing renewable energy and energy efficiency[15].

This change will also mean implementing supporting and monitoring measures to ensure the success of the national program. This support will be provided at the regional level in Greater Casablanca, Meknes-Tafilalet, Souss-Massa-Draâ, the Oriental and Tadla-Azilal.

According to the CDER, and as shown in the table below, real opportunities for large-scale penetration of renewable energies exist beyond 2012. In the words of Mrs. Haddouche, Director of CDER until April 2009 and of Mr. Taoumi her Senior Adviser, *"Such prospects will trigger a new dynamic in the energy sector with new investments at the level of about MAD 30 billion, creating over 22,000 stable jobs and reducing carbon emissions by approximately 18 million tonnes per year*[16]*."*

[12] This includes the hydraulic and excludes biomass.
[13] [14] Liaison Energie-Francophonie No. 78, "Transforming the energy constraint into an opportunity: the case of Morocco", p. 85.
[15] Circular on CDER's reorganization.
[16] Liaison Energie-Francophonie No. 78, "Transforming the energy constraint into an opportunity: the case of Morocco", p. 85.

Table 1 - Potential for renewable energy in Morocco

In MW installed or sq. m	Potential achievable in 2012	Potential achievable in 2020
Wind	1,060	3,260 à 8,700
Photovoltaic energy	80	2,000
Solar concentrator	180	800
Biogenic energy sources	300	1,400
Solar heating	394,000	1,700,000

Source: Liaison Energie-Francophonie No. 78.

Before analyzing Morocco's institutional context and the accompanying measures implemented to promote renewable energies in detail, this study presents the tools used by foreign countries to develop solar industries. This information provides background for the comparison with Morocco that follows.

II. An overview of policy and international financial tools for the promotion of solar energy

This section reviews the main policies and financial tools used in countries where solar energy markets are the most developed in order to compare them with the Moroccan experience analyzed in the next section. There are two main categories of tools that have helped develop solar channels abroad: regulatory and financial incentives (subsidies, preferential taxation, housing regulation, etc.), and financial products or payment methods adapted to clients. For each of these categories, examples from abroad are analyzed.

Regulatory and financial incentives. Today, solar technologies remain expensive. Until these technologies have fully reached their break-even point, some countries have established financial incentives, such as grants, to develop their markets.

Regarding photovoltaic energy, two main tools are used, the first in Europe and the second in the United States:

(i) *The "feed-in tariff".* i.e the price paid to service providers by a third party for a unit of electricity generated by renewable energy. This price may be set by regulation to provide an incentive for private producers [17]. Indeed, electricity from a solar source is more expensive to produce than conventionally produced electricity. Many European governments have adopted a subsidized approach to develop the connection of photovoltaic panels to the grid by setting the price of each kWh produced from a renewable energy source at a price exceeding the prices of conventionally produced electricity. Let us compare the price per kWh in France: 0.102 €/kWh selling price [18] against 0.30 to 0.55 € / kWh [19] purchase price from private producers by EDF in France. Germany is a very advanced country in this field and has doubled its electricity market based on renewable energy from 2000 to 2007 [20]. Regressive by 5% per year, the "feed-in tariff" in Germany has been regulated at a price ranging from 48.78 to 51.8 € c / kWh over 20 years. This amount has been calculated so as to provide an adequate profit to investors.

(ii) *Renewable Portfolio Standard (RPS).* This system, quite developed in the United States and to a lesser extent in Europe, is a regulatory measure requiring electrical services to produce a portion of their electricity using renewable energy over a defined period of time. For example, the state of Texas in the United States plans to reduce CO_2 emissions by 3.3 million tonnes annually with its RPS, and aims to achieve production of 2,000 megawatts of renewable energy by 2009 [21].

A popular tool in this context are Renewable Energy Certificates (REC). Also known as "Green certificates" (*certificat vert*) in Europe, RECs guarantee the origin of the renewable energy, and can be marketed among third parties.

Indeed, as many individuals and organizations are willing to pay for electricity generated by renewable sources, the RECs are becoming somewhat of a "currency" for the renewable energy market. They are certified and monitored by authorized organizations, which vary from one country to another. A unique number is assigned to each REC, which also includes information on the owner. Through this system, only one person can claim ownership of a REC. In general, it is equivalent to producing a megawatt hour, but this figure varies across programs and countries.

[17] European Environment Agency (EEA).

[18] Energy and Environment in the Franche-Comté region, AJENA, argus de l'énergie, June 2008, www.ajena.org.

[19] This price is 30 €c/kWh + 25 €c / kWh in "integration premium" for new construction. This premium is intended to facilitate the development of standard components of new construction projects including the production of photovoltaic electricity. It is intended to offset the increased costs of such components. It amounts to 25 €c / kWh for installations located in continental France and 15 €c / kWh for those located in Corsica, in the overseas departments and in Mayotte.

[20] "Feed-in tariffs and renewable energy in the USA - A policy update", by William Rickerson, Florian Bennhold, and James Bradbury, (May 2008).

[21] Pew Center on Global Climate Change - http://www.pewclimate.org/what_s_being_done/in_the_states/rps.cfm.

Many stakeholders use the RECs. In the United States this tool allows various levels of government (federal and state or local) to meet their environmental objectives concerning the share of energy to come from renewable sources as required under the Renewable Portfolio Standards [22]. Meanwhile, more and more individuals and organizations are purchasing these certificates to meet environmental benchmarks, improve their corporate image, reduce air pollution, and protect against a future increase in electricity prices [23]. Australia also allows households equipped with solar water heaters to benefit from these certificates and reduce the cost of investment, providing subsidies to solar heating under some conditions according to the number of RECs created [24].

Both tools have generated much debate in the international community regarding their capacity and efficiency to promote renewable energy. In determining the "feed-in tariff" over a given period at a given incentive level, the government offers the investor a high degree of stability and security, which stimulates the production of emerging technologies still too expensive for the market. The advantage of RECs is to attract technologies that have already reached their break-even point. These tools therefore complement one another, and can instead be used at different stages of solar industry development. Traditionally inclined towards RPS and RECs, the United States began adopting regulations to incentivize the "feed-in tariff" in the last two years. A proposed federal law for the "feed-in tariff" [25] was developed in May 2008 [26].This development is not made at the expense of RPS and RECs, which can be used in combination to an incentive use of "feed-in tariff".

Concerning solar thermal, other financial incentives have been introduced in Europe that also apply to solar photovoltaic technology in some cases. They are:

(iii) *The "direct" and incentive grant.* It is calculated mainly in two ways: as a percentage of the investment cost; or as a bonus at the time of purchase (per square meter of panels installed). The amount varies from country to country and depends on the type of installation (individual or collective) and the client profile (company or individual). For example, in Germany, the grant starts at 40 Euros/sq. m for personal facilities and up to 70 Euros/sq. m for community facilities. For any community facility exceeding 40 sq. m, financial support covers 30% of the investment cost. This form of subsidy is also temporary and digressive: on January 12, 2007, Germany chose to reduce its subsidies to individual solar water heaters and to increase those for "collective" solar water heaters in order to promote the latter [27].

(iv) *Tax deduction.* Some countries indirectly subsidize these technologies by offering a tax deduction to customers, including on income tax. In Greece, individuals may benefit from a tax deduction of 20% of the investment cost in solar thermal and businesses may see deductions of between 60% and 100%. France also offers an important tax credit, up to 50% of the cost of the investment [28] for solar thermal or photovoltaic technologies[29]. Some countries also offer reduction of the Value Added Tax (VAT) on purchase and sale of equipment (this is the case in Morocco).

[22] Electricity and RECs are most often marketed separately.
[23] U.S. Environmental Protection Agency (EPA), "Renewable Energy Certificates" (July 2008).
[24] To achieve this, the RECs must prove a CO_2 reduction.
[25] Jay Inslee, Member of Congress, introduced a federal law for the "feed-in tariff" to which he refers as "Renewable Energy Payment (REP).
[26] Wilson Rickerson, Florian Bennhold Bradbury and James, "Feed-in tariffs and renewable energy in the USA - A policy update (May 2008).
[27] This grant also exists for photovoltaic panels, particularly in the case of Decentralized Rural Electrification.
[28] This credit applies to the purchase cost of all-taxes-included supplies photovoltaic and thermal systems, net of collective subsidies and bonuses. It does not include the cost of labor to install. Financial caps exist depending on the type of client (individual, married couple, business, etc.).
[29] The difference between a tax deduction and a tax credit, is that when the tax deduction exceeds the cost of income tax, the state pays the difference in the case of a tax credit.

The table below presents a non-exhaustive list of the various regulatory and financial incentives used in major foreign markets.

Table 2 - Examples of financial and regulatory incentives in foreign markets

Country	Solar Thermal	Solar Photovoltaic
Germany	**"Purchase premiums"** (since 2007): *Individuals:* CESI* : 40 €/m² CESC** : 70 €/m² *Private and collective facilities:* 20-40 sq. m or 3 rooms minimum: 210 € /sq. m More than 40 sq. m: 30% of the investment.	**"Feed-in tariff"** (2006) *:* 48.78 to 51.8 €c/ kWh over 20 years Gradual decrease of 5% / year 5 €c / kWh bonus for systems integrated on the building's façade.
France [30]	**Tax deduction** (up to end 2009) *Individuals:* a 50% tax credit of the investment for individuals Grants from local administrations.	**Tax deduction** (up until the end of 2009): *Individuals:* a 50% tax credit of the investment for individuals **"Feed-in tariff"** *2006: metropolitan France: 30 € c / kWh + 25 €c / kWh of "integration" bonus; Corsica and the French DOM (overseas administrative departments): 40 c € / kWh + 15 c € / kWh of "integration" bonus.*
Spain		**"Feed-in tariff"** (2006): the Royal Decree imposes a purchase price based on a percentage of the average electricity price in the current year, namely: • Up to 100 Wp: 5.75 times the average price for 25 years or 44.04 c € / kWh, and 4.6 times afterwards. • *Up to 100 Wp:* 3 times the average price for 25 years or 22.98 c € / kWh, and 2.4 times afterwards.
Austria	**Grants:** *Individuals* [31]**:** 600 to 1700 € (CESI) 1100 to 3500 € (CESC) *Private facilities by the federal government:* subsidy of 30% of the investment	
Greece	**Tax deductions and subsidies** *Individuals:* tax deduction of 20% on the investment; *Companies:* tax deduction of 60 to 100% on the investment or subsidies ranging from 20 to 40% of eligible costs.	
Italy	**Tax Deductions** *Individuals:* tax deduction of 55%	**"Feed-in tariff":** The Decree of February 19, 2007: purchase price varies depending on the power and the type of installation, over 20 years Greater than 20 kWp on the ground and not integrated: 36 € c / kWh. Gradual decrease of 2% per year from 2009.
United States	**Tax incentives:** Tax credit for investments at the federal level	**Renewable Portfolio Standard (RPS) and Renewable Energy Certificates (REC):** 33 states have adopted an RPS and the RECs are accessible to every citizen. **"Feed-in tariff"** Eight states have adopted or are in the process of adopting a "feed-in tariff" incentive regulation. A proposal Federal legislation is also underway.

[30] The 2005 Finance Act and website of the ADEME.
[31] These prices vary depending on the Länder.

Australia	**Grants and Renewable Energy Certificates :** Grants [32] up to USD 1,600 per solar water heater installed, depending on the level of greenhouse gases avoided and number of Renewable Energy Certificates obtained, and the type of installation - new construction or change in an existing regular installation.	
Tunisia [33]	**Grants:** *Residential installations:* subsidy of 20% of the investment; *Collective facilities:* subsidy of 10% on the investment	**Regulations:** Legalization allowing for self production of renewable electric energy and cogeneration (December 2008).

**CESI: individual solar water heater / ** CESC: collective. solar water heater / Sources: An overview of renewable energies in Europe, Observ'ER 2007; Plan Bleu Samir Amous ; ADEME ; Rickerson, Bennhold, Bradbury, "Feed-in-tariff and renewable energy in the USA" (2008).*

As for solar water heating, other regulatory measures may be specifically dedicated to one or several areas:

(v) *Regulations in construction.* Incentives can also be provided through the regulatory framework, particularly in the construction sector. For instance, some countries such as Belgium [34] do not require planning permission for installation of solar panels. Other countries, however, require the installation of solar panels in specific areas. For example, in Marburg, Germany [35], a law stipulates that any new house built in the medieval part of the city has to be equipped with solar panels (see table below).

The table below shows the main examples of regulatory incentives in the construction industry.

Table 3 - Regulatory incentives in the building industry

Country	Solar Thermal	Solar Photovoltaic
Spain	The Technical Code of Construction requires the installation of solar panels in new buildings from 2005 [36].	
Germany	In Marburg: a law provides that any new house built in the medieval part of the city be equipped with solar panels of 1 sq. m per 20 sq. m of surface area, for both heating and hot water (2008) [37].	
Belgium	Exemption planning permission for the installation of solar panels (2005) [38].	
Israel	Law making mandatory the installation of solar heating for any housing construction. This law does not apply for industries and buildings, but applies to hospitals, retirement homes, hotels and schools. 90% of these establishments are equipped with solar heaters [39].	

Sources: planetenergie.org; rtbf.be; energie.wallonie.be; enerzine.com.

[32] These grants may be administered at the federal, state or local level.
[33] Plan Bleu, Samir Amous, APEX conseil.
[34] From December 3, 2005, following an amendment of the Walloon Code (Aménagement du Territoire, de l'Urbanisme et du Patrimoine "CWATUP"), installation of solar panels is exempt from urban planning permission, provided that all panels are mounted on the roof and do not appear over the roof, or that it is embedded in the roof incline, and provided that it does not imply any derogation of laws, decrees and regulations.
[35] The installation of solar panels is charged to the owners with a bill estimated at between 4,000 and 10,000 Euros, to which must be subtracted about 3,000 in State subsidies. Those who refuse the measure can be fined at up to 1,000 Euros.
[36] http://www.planetenergie.org/spip/spip.php?article367.
[37] http://www.rtbf.be/info/societe/environnement/lallemagne-teste-le-solaire-obligatoire.
[38] http://energie.wallonie.be/fr/les-panneaux-solaires-dispenses-du-permis-d-urbanisme.html?IDC=6307&IDD=11425.
[39] www.enerzine.com.

Finally, another tool exists that does not offer financial incentives, but allows for financially able consumers to install photovoltaic panels in their homes and thus benefit from a reduction in their electricity bills; it is called the "Net metering". This tool, primarily used in the United States, allows the consumer to 'store' electricity generated by a renewable energy source in the grid. In most cases, the production of solar electricity is passed on to the customer's next electric bill by showing a reduced number of kilowatt-hours consumed (equivalent to the price of conventional electricity) [40] or on the overall invoice for the whole year, thanks to an electric meter able to recognize electricity produced via renewable sources.

The box below presents the details of this tool and the impact it can have on the organization of the electric distribution service.

"Net-Metering" in the United States

This tool, developed to encourage American consumers to use renewable energy sources, particularly solar energy, is used on a limited basis in about 35 states in the United States. By allowing private producers to insert excess electricity produced by photovoltaic panels into the grid, the consumer can "store" electricity in the network and to use it later, giving the customer the opportunity to maximize their production. In most cases, the amount of kilowatt / hour produced by the consumer is "credited" on the next invoice or at the end of the year at the sale price of traditionally-produced electricity.

On the supply side, "net-metering" also benefits electrical service providers. Producing and injecting photovoltaic energy into the network enables them to reduce the burden in the electrical system during peak periods. Thus, solar energy could be a substitute for the perpetual need to build new electric infrastructure to meet this ever growing electric demand.

Source: Green Power Project, site of the Department of Energy of the United States.

For a country like Morocco, with an imbalance in the supply and demand of electricity and no means in the short term to implement a policy incentive of the "feed-in tariff", this tool would fill a portion of its electric imbalance particularly during peak periods, and would encourage people who can afford it to buy solar equipment. This would be a first step before increasing the use of photovoltaic power connected to the grid when the cost of the solar technologies will have dropped in the years to come. The CDER recommends using this tool in Morocco.

Other tools may also indirectly benefit the solar industry, namely:

(i) *The 'Cap-and-trade "system:* to establish a maximum level of CO_2 emissions for the country, based on company owned "licenses" that can be sold. Enterprises and other stakeholders having reduced their emissions can sell their licenses to other, more polluting enterprises. Signatory countries of the Kyoto Protocol and of Appendix 1 use this system and most would like to extend it beyond the end of the protocol in 2012.

(ii) A tax on polluting energy: by taxing CO_2 - producing energy, this tool would make renewable energy more competitive compared to fossil fuels. Another solution in the same vein would be to impose a capped price for polluting energy such as oil and diesel. This kind of tool would give investors price stability based on which they could invest heavily in the field of renewable energy and develop R & D necessary for these channels to really take off. This system is the one the United States' current administration would like to implement at home. Some countries have already implemented this: in Germany, an ecological tax reform consisting of taxing some types of fossil energies has been in force since 1999 (excluding coal).

With the Kyoto Protocol ending in 2012, experts worldwide are questioning which tool will be best suited for the international community in the coming years. The main critiques of the two tools are described as follows: although the carbon tax would provide stable market information on prices it would not guarantee a reduction in CO_2 emissions. The "cap-and-trade" system, however, precisely encourages reductions in these emissions. The important point to note here is that regardless which tool is selected, both will improve competitiveness of renewable energy compared to polluting energies. This change cannot be planned in detail, but it will happen no matter what.

Of course, the most direct route to reducing CO_2 emissions is to reduce energy consumption through energy efficiency, i.e. reducing energy demand.

This simple idea has major impacts on the electrical industry today. Indeed, the latter benefits from the growing demand for electricity and construction of new electric infrastructure - in particular to meet demand during peak periods. This business model is at odds with the concept of energy efficiency [41]. From these findings, the "decoupling plus" concept was developed:

(iii) *The "decoupling plus".* This concept proposes to break with the idea that profit from the electricity sector must necessarily come from the increase in electricity demand. The state of California, for example, pledged

[40] Green Network Project, website, Department of Energy of the United States, http://apps3.eere.energy.gov/greenpower/markets/netmetering.shtml.
[41] Thomas Friedman dans son dernier livre « Hot, Flat, and Crowded » (2008).

to reduce the growth in power demand by 2020 through energy efficiency. Specifically, electricity providers may advise users to acquire appliances that are more energy-efficient. An audit will then account for the cost of these energy efficiency actions and the energy savings made. The financial model still needs to be elaborated, but the idea would be that the difference could be divided as income between the provider and the consumer, so that each party would receive an economic incentive[42].

Thus, the concept of "decoupling plus" may also indirectly benefit solar technologies by saving energy, as is the case for the solar water heater.

Financial tools. Finally, some countries have developed innovative financial tools adapted to the purchasing power of customers. These financial instruments include:

(i) *Credit or interest rate subsidies.* Some loans with preferential rates work to improve the energy performance of housing, through insulation or installation of solar water heaters, such as Banque Populaire's Eco Habitat loan or the Credit Agricole's "Green Loans" in France. Some Governments also subsidize credits used to finance renewable energy projects. This is the case of Tunisia, which offers a two-point bonus on the interest rate.

(ii) *Refunds adapted* to the purchasing power of households. Some countries have seen their credit institutions develop appropriate financial products adapted to the purchasing power of customers in collaboration with electricity distributors. This applies to Tunisia, through its PROSOL program, which offers an original system incorporating the reimbursement of loans in the electricity bill paid to the public body in charge of the electric sector, the Tunisian Company of Electricity and Gas (STEG).

Tunisia is an innovative case study combining not only financial tools adapted to the purchasing power of customers, but also direct subsidies to consumers allowing them to ease the cost of investment. The box below describes in detail the mechanisms at work through the PROSOL program, and the recent institutional reforms and regulations for solar thermal energy.

The case of Tunisia

The case of Tunisia should be analyzed in depth due to its geographical, economic and cultural proximity with Morocco. Tunisia is also cited as an example by Moroccan solar industry professionals regarding the promotion of solar thermal heating. However, large differences remain, namely in terms of country size and Tunisia's lesser dependence on imported energy. Indeed, Tunisia recorded an energy balance deficit for the first time in 1994, which was restored and then returned to deficit in 2001. Renewable energies represented 0.6% of primary consumption in Tunisia in 2004 and reach 13.6% when including biomass, which is used a great deal in rural areas for the preparation of bread and cooking.

Although Tunisia has no obligation to reduce greenhouse gas emissions, it has established an active policy to promote renewable energy. Recently, the country has launched a development program for solar water heating on a large scale with the ambitious goal of reaching 620,000 sq. m by 2010. Morocco's annual energy plan includes the goal of 440,000 sq. m by 2012.

On the incentive plan, Tunisia has developed a system of bonuses awarded by the *Fonds National de Maîtrise de l'Energie* with a 20% subsidy on investment in the field of solar thermal heating, 20% subsidies for all investments on energy efficiency made by energy companies, 50% subsidies on the cost of energy audits, and 50% subsidies on investments in demonstration projects in the fields of renewable energy[43].

At the regulatory level, the circular 2004-72 consolidated laws on incentives, clarified the concept of "energy control", and increased bonuses dedicated to energy control actions. A decree (No. 2005-2234) established a 20% bonus for the acquisition of a solar water heater. The Finance Act No. 2005-106 established the National Energy Control Fund. At the institutional level, Tunisia has also strengthened the mandate and resources of the *Agence Nationale de Maîtrise de l'Energie*, in existence since 1985.

From the *Fonds National de Maîtrise de l'Energie*, Tunisia has developed proposals for innovative financial mechanisms such as an Investment Fund, specific funding lines, loan guarantee funds, etc. Tunisia launched the PROSOL program to promote residential solar water heating with a system combining a subsidy system, bonus on interests and the granting of credit by banking services. Reimbursement is arranged between private banks and the state through which the client reimburses the solar water heater by monthly payments added to the electricity bill. The cost also diminishes over time thanks to the energy savings generated by the use of the solar water heater.

[42] Ibid, p186.

[43] Plan Bleu, « Efficacité Energétique et Energie Renouvelables, Tunisie - Résumé de l'Etude Nationale », Samir Amous, APEX Conseil, Mars 2007.

Specifically, an individual wishing to purchase a solar water heater has to meet with the STEG, electricity bill in hand. STEG pays for the installation and a contribution of about 100 dirhams is added to the client's invoice, to repay the solar water heater over seven years. This is profitable for the customer who benefits from a reimbursement mode suitable to their purchasing power, and a reduced electricity bill over the medium term.

Source : Plan Bleu, Samir Amous, APEX conseil.

It should be noted that the development of this tool in Tunisia was facilitated by the monopoly that STEG has on electricity distribution. In Morocco, the situation is different, as the ONE shares the market with other distribution entities. The development of this tool in Morocco would thus require a wide coordination effort between these various stakeholders.

Thus, it is clear that foreign countries have combined a variety of tools, including financial incentives, regulatory measures or innovative financial products to finance solar technologies to develop the solar energy industry. The following section presents an overview of policies and financial tools available in Morocco.

III. Regulations and supporting tools in Morocco

With its new energy strategy in place, Morocco is in the process of establishing a promising and encouraging new regulatory framework. To achieve its objectives the MEMEE has designed reforms and supporting activities to assist in the development of renewable energies and energy efficiency. However, these breakthroughs remain relatively small if we look at the scale of resources used by some industrialized countries.

Indeed, a large difference remains between developed and developing countries at this level: developed countries have ratified Appendix 1 of the Kyoto Protocol and pledged to reduce their greenhouse gases emissions, while the non-signatory countries of this Appendix are more compatible with an incentive carbon credit generating system that supports them to finance projects reducing greenhouse emissions. There is therefore an obligation for developed countries, which does not exist in Morocco, to mobilize funding to implement incentives for new technologies that have not yet reached their break even point.

Financial incentives. Today, Morocco does not have a widespread policy of direct subsidies as is the case in foreign countries where the solar energy industry is more developed. However, in terms of taxation, Morocco has already initiated some reforms. As a result of lobbying by the CDER and the Moroccan Association of Wind and Solar Industry (AMISOLE) in recent years, the VAT has dropped from 20% to 14% on solar equipment.

A 1 billion USD Fund for Energy Development has also been created through grant payments and a contribution from the Hassan II Fund [44]. A study, expected to be released in 2009, is underway to determine precisely the future use of this fund. Broadly speaking, its purpose is to strengthen and preserve energy production capacity, particularly from renewable energy, and reduce energy dependence while providing financial support to enhance energy efficiency, including through studies, technical assistance and support to Energy Service Companies (ESCOS).

This fund represents a great opportunity to develop markets related to renewable energy, including solar energy and could enable Morocco to greatly improve its energy policy, and implement innovative tools. Ultimately it could become an engine of sustainable and human development. To this end, the Moroccan Government should be firm and know how to prioritize amongst the many solicitations that are expected.

Table 4 - Budget distribution of the Energy Development Fund in Morocco

Sources	Amounts (million USD)
Kingdom of Saudi Arabia	500
United Arab Emirates	300
Contribution of the Hassan II Fund for economic and social development (for investment)	200

Source: MEMEE.

Regarding solar photovoltaic energy, the Office National de l'Electricité (ONE) established a large scale national program of highly subsidized Decentralized Rural Electrification between 1998 and 2008, the Global Rural Electrification Program (PERG). In 2009, a first program aiming to connect solar panels to the network was created to produce electricity, not only for consumption, but particularly in rural areas where solar energy is more cost effective than the traditional network connection, also to insert the energy surplus into the network. To date, a few pilot projects are under implementation through a subsidized financial model that offers the private producer a reduction in their electricity bill in exchange for inserting some of their electric production back into the grid. The ONE is thinking about a less subsidized financial structure for this program in the future.

[44] MEMEE's website, Presentation, "Outline of the Energy Strategy 2020-2030", Press Kit, July 10, 2008.

Regulatory incentives. It is in the area of regulatory and institutional reforms that Morocco is making the most progress. For instance, interministerial agreements were signed in July 2008 between the MEMEE and the departments of Tourism, Housing and Urban Development, Education, and Industry and Health (ongoing) to promote renewable energy and energy efficiency in Morocco. These agreements set out targets in terms of the solar thermal park, with a total of an additional 200,000 sq. m installed by 2012.

A circular provides for the integration of renewable energies and energy efficiency in the government, public institutions and in local communities. This circular encourages the widespread use of solar water heaters and low energy light bulbs in public institutions and in both existing and new construction. This circular has been adopted but has, however, no binding power.

Morocco is also developing a Code of Energy Efficiency in the building sector. Developed under the renewable energy promotion policy of the Moroccan government, the UNDP-GEF, and the CDER, this project responds to three issues: (i) the lack of energy considerations in the design, construction, equipment and management of buildings, (ii) the significant increase in energy expenditures due to expectations of quality of service and social comfort from users, and (iii) the increase of oil prices that weighs heavily on the national energy bill [45].

Three key sectors are targeted: health, tourism, and housing. The effort to improve energy efficiency will focus on three pillars: (i) the design of buildings, (ii) the operation of equipment (air conditioning, heating, etc.), and (iii) energy management in buildings. The project will also entail pilot activities to demonstrate the profitability of proposed investments.

A decree allowing the access of private electricity producers to the network and the increase of the production threshold from 10 MW to 50 MW has also been adopted [46]. Indeed, to meet the growing demand for electricity in Morocco, the Dahir on the creation of the ONE is being amended [47] to allow for energy self production from fossil and renewable national sources.

The idea is: "to agree with producers or groups of producers by mutual agreement to concede some of the electricity production, for their exclusive use, ***from national fossil or renewable energy resources*** *including wind power."*

This law also allows private producers to access the transport network where conditions will be established within the framework of agreements concluded with ONE: "These agreements provide, among other things, for the technical details of works and ***access to the transport network*** *and the commercial conditions pertaining to transport, supply and purchase of electricity."*

The total production capacity of the projects developed may reach up to 2,000 MW: "The entire production capacity of all projects developed under these agreements ***shall not exceed 1,000 MW.*** *However,* ***this limit can be increased if needed, by the authority within the limits of 2,000 MW.****"*

Finally this legislation is aimed at private producers willing to invest in electricity production by increasing the private production threshold from 10 to 50 MW: *"Apart from such agreements, this proposed draft law provides for the organization of the means of producing electrical energy to the ONE exclusively,* ***while increasing the self-production threshold from 10 MW to 50 MW****".*

In addition, a framework law on Renewable Energy was passed by the Government Council in March 2009 and by the Council of Ministers in April 2009. It features eleven principles (see Appendix 2) whose main elements are the authorization to produce electricity from renewable energy sources for a third party, i.e. the market and to reinject it back into the high and very high voltage network. This law also allows commercializing this production at the international level, i.e. to export it. This new regulation may allow Morocco to make a leap in the development of solar energy channels depending on application decrees that are instituted. Draft legislation is also underway on energy efficiency. The table on the next page presents an overview of the law on renewable energy.

These major regulatory reforms are set in a Moroccan context of electricity provision that is rather problematic. Indeed, the Moroccan electricity market is characterized by an imbalance between supply and demand. The strong growth in demand for peak power, estimated at 7-8% by ONE for the last five years, compared to 5-6% previously [48] is a major constraint for the ONE. In collaboration with the MEMEE, an emergency plan to manage the electricity demand has been created to include the establishment of a national steering committee chaired by the Prime Minister and an interdepartmental committee, chaired by the MEMEE, as well as the establishment of working groups for the preparation of roadmaps for emergency measures to manage the electric supply and demand balance during the 2008-2012 period.

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[45] CDER's Project Sheet, "Draft Code of energy efficiency in buildings in Morocco."

[46] Draft law No. 16-08 amending and supplementing Dahir No. 1-63-226 of 14 Rabii I 1383 (Aug 5, 1963) and establishing the National Electricity Office.

[47] After being adopted unanimously by the House of Councilors at its meeting of Tuesday, July 22, 2008, the draft law No. 16-08 amending and supplementing Dahir No. 1-63-226 of 14 Rabii I 1383 (Aug 5, 1963) on the creation of ONE, adopted on Wednesday, July 23, 2008 by the productive sectors Commission of the House of Representatives. The text was adopted at the Council of Government and Ministers, 1st and 2nd chambers.

[48] ONE, "Priority Action Plan and governance of the electricity sector (March 2009) http://www.mem.gov.ma/Assises2009/PDF/Expose/pnap.pdf.

Thus, through its new energy policy, Morocco will work on both the country's supply and demand for energy. By promoting renewable energies, particularly for the production of electricity, the government intends to diversify the energy supply and to give it more autonomy; on the demand side, by promoting energy efficiency, the government intends to decrease the national energy demand. But, to reach a larger scale, this effort cannot be isolated from a policy stimulating demand for "clean energy". Pending technological advances that will allow the price of clean energy sources to become comparable to fossil fuels, this study considers that regulation should start today to enable clean technologies to be competitive with fossil fuels through a combination of financial and regulations incentives.

The draft law on renewable energy

This law aims to encourage Moroccan and foreign private companies to invest in renewable energy by facilitating the production and commercialization of the energy produced. The major breakthroughs are the following:

- *Authorization and notification.* This bill establishes precisely the conditions for granting authorizations and declarations of economic activity related to wind farm, solar and biomass power plant exploitation. A permit is required for any capacity equal to or greater than 2 megawatts while a simple statement is valid for power capacities of less than 2 megawatts on a site or group of sites belonging to a single operator.

- *Exporting.* Another novelty is that renewable electricity producers are authorized to supply the national market, and, once the country's reserve margin is met, to export.

- *Transportation.* This law also enables renewable electricity producers to build direct transport lines for their own use (for export) if necessary, through a concession agreement with ONE. Indeed, the current power grid would not have the capacity to support the volume of electricity produced if Morocco were to achieve its potential for renewable energy.

Source : La Vie Eco, " Energie Renouvelable, ce que contient le projet de loi", 4 avril 2009, http://www.lavieeco.com/economie/13372-energies-renouvelables-ce-que-contient-le-projet-de-loi.html.

Financial tools. Most financial institutions in Morocco do not currently offer special conditions to fund projects relating to renewable energy. However, the CDER has established "FOGEER," a fund dedicated to financing renewable energy and energy efficiency projects, in order to involve leasing companies in its development programs.

This fund works in coordination with a financial leasing mechanism, the *Dispositif Global de Financement Leasing* (DGFL), also developed by CDER. FOGEER is thus intended to guarantee investment credits granted by leasing companies to Moroccan enterprises and operators willing to invest in this area. The task is entrusted to DAR AD DAMANE, which manages the fund on behalf of the CDER. More details about this tool can be found in the Supporting Markets section (Part 2).

Quality assurance tools for products and solar services. A critical ingredient to improve quality in the solar industry is to certify equipment and authorize service providers. The development program for Moroccan solar water heaters, PROMASOL, includes the Ministry of Energy, the Global Fund for the Environment (GEF) and the United Nations Development Program (UNDP). This body called for global action to improve the quality of solar equipment through the implementation of a Guarantee of Solar Results charter (GSR) and enforcement tools, including: Moroccan standards governing the solar water heater industry; the opening of two labs to test the sensors and solar systems; certification and labeling of quality equipment; and lastly, the creation of an accreditation committee of installers in accordance with procedures in force at the CDER. To this end, a quality label has been established for equipment that meets the standards set in force. To date, a dozen products have been certified by CDER laboratories.

Figure 1 - The CDER label of product certification.

Although CDER's certification acts as a quality seal, solar professionals in Morocco are not obliged to use it to market their products. Moreover, CDER's certification is criticized by the private sector in Morocco for being either too soft or too redundant with regard to other international certification labels. When it comes to services such as equipment certification, a specialized license in solar technology installation is also not compulsory and neither certification nor approval are reinforced by incentives to encourage their use. Tunisia, by contrast, has a public quality control system that is run by the National Agency for Energy Management (ANME), which has been put in place to authorize suppliers and product models, among other things. In France, grants for solar water heaters are conditional on the use of licensed installers.

Figure 2 - The CDER label for authorized installers.

Although ambitious goals have been set through MEMEE's new "Energy Plan" and the development of the institutional and regulatory framework in Morocco are promising, the country still has a lot to accomplish at both the regulatory and financial levels to develop the solar energy industry. The final recommendations made in this study provide an overview of potential actions that could work in Morocco. The next section analyzes the value chain of each solar channel to identify opportunities and obstacles to the development and competitiveness of solar products currently sold in Morocco. The purpose of this section is to present readers the various products, existing markets, services supported in these sectors, and key stakeholders structuring the market.

Part II • Characteristics of the value chains

Traditionally, a value chain study consists of analyzing the transformation process of a product from raw material to the final product delivered to markets (see Methodology in the introduction). Given that most of the solar technologies marketed in Morocco are imported from abroad, this study is somewhat "inverted": it looks at the proliferation of these technologies in Moroccan markets, with the aim of identifying the extent to which technology producers and suppliers can become investors, thus contributing to the development of the sector and the strengthening of local stakeholders. To this end, the report focuses on local market analysis on the one hand, and on the other hand it identifies opportunities to strengthen the weak links in the chain.

The two value chains analyzed here are the solar thermal and photovoltaic. These products are very different both in terms of technology and market organization. Thus, the steps of each value chain will be analyzed independently in this study.

The following section provides a brief introduction on solar products sold in Morocco, followed by a detailed mapping of the value chain. This is followed by a presentation of the main functions carried out by the various stakeholders of the chain, which include:

- Production (plus assembly for photovoltaic installations);
- Importation and distribution;
- Product installation, maintenance and after-sales service;
- Transportation.

This study also provides an analysis of end markets according to well defined criteria, including the current Moroccan market and an assessment of potential markets in the Meknes-Tafilalet region.

For the solar thermal channel, the main potential markets in the region of Meknes-Tafilalet are:

- The tourism sector, because of the profitability of the investment;
- The housing sector because of its scale;
- The education and health sectors due to social development considerations.

For the photovoltaic channel, the main potential markets are:

- The decentralized rural electrification of schools and health facilities through a strong commitment from the Ministry of Education;
- Grid connection as part of a new national program developed by the ONE, which allows for electricity generated by solar energy to enter the network.
- Exports to Europe of electricity produced by renewable sources as part of UPM's "Solar Plan" (Union for the Mediterranean).

Finally, this study analyzes the nature and role of the various key players throughout the value chain and their relationships to each other. These are:

- Producers/importers;
- Service providers;
- Supporting markets.

This section concludes with the identification of the main constraints and opportunities inherent in the Moroccan solar value chains.

I. Products

This section describes the characteristics defining the main solar thermal and photovoltaic products. This includes the basic principles of operation, their price, their use and their main specifications.

1.1. Solar thermal products in Morocco

The solar water heater represents a great opportunity for Morocco as an alternative to fossil fuels. Morocco has fantastic solar potential: 1 sq. m of solar thermal collection in Morocco can produce between 600 and 800 kWh per year and in Morocco the solar resource available is about 5.5 kWh/sq. m/day. Sunshine duration varies between 2,400 and 3,400 hours a year.

A solar water heater is composed of a solar collector pane and a tank to store water heated by solar energy. The solar collector pane is a glass chest containing a plate and black heat absorbing metal tubes, which receive solar radiation and heats liquid antifreeze (heat transfer fluid). To overcome any seasonal lack of sunshine, an auxiliary power system is used based on fuel, gas, electricity or wood. Three types of technologies are mainly used in Morocco: the **thermosiphon solar water heater, the forced circulation solar water heater, and the vacuum-tube solar collector.** The first two are relatively well established in Morocco, while the third entered the Moroccan market several years ago and was first certified by CDER in 2009.

A **thermosiphon** solar water heater works as follows: a natural flow of water (combined with antifreeze) - natural

convection - is achieved as a result of variations in water density based on temperature: the hot (low density) water in the solar sensor flows towards and into the tank, and is replaced by the cooler (greater density) liquid coming from the tank. The tank's center of gravity must be located above the solar collector's center of gravity.

The motion of the water/ antifreeze mixture can also be achieved using a pump when the temperature exceeds that of the water in the tank; this is called **forced circulation.**

A solar water heater exists mainly in two forms: one single piece, the **"monobloc"**solar water heater, and the solar water heater **with separated elements.** In the monobloc solar water heater, the solar sensors and the tank are assembled and placed outside the building, while for solar water heaters with separate elements, the tank is located in a different room in the house or in a nearby building and sensors are installed on the roof. This solution more frequently requires forced circulation. Although thermosiphon models also exist installation presents a challenge because the tank must be placed above the solar collector.

The **vacuum-tube solar collector** consists of solar panels made up of a series of glass tubes through which a heat-collecting tube passes. The tube wall is doubled, and the inner tube is covered by a substance (aluminum nitride) that absorbs sun rays. Vacuum-tubes are used to avoid convective heat loss from the absorber and a special treatment is applied to the absorber to prevent radiation. To be effective, the inner tubes must be at a pressure below 10-3 Pa. A tube becomes useless if it is not completely airtight. These tubes therefore do not require additional encasing as is the case with conventional sensors described above. The thermos bottle effect allows for better performance during winter, as heat is trapped inside the tube. The tubular sensor optimizes the capture of energy when the sun is low (at the start and end of the day) or when the roof's exposure is not ideal. It also allows the use of water as a coolant instead of antifreeze. 70% of solar water heaters installed around the world, particularly those used in Germany, are vacuum-tube solar collectors. This technology is mainly produced in China.

Vacuum-tube solar collector marketed in Morocco.
Source: USAID Program.

Generally speaking, two types of warranties apply to customers on solar water heaters:

(i) The warranty for individual installations varies between 5 to 8 years;

(ii) Warranties for collective installations are those applied in the context of Guarantee of Solar Results (GSR) [49] developed by CDER, that is, one year of verification and one year of confirmation.

The prices of this technology in Morocco vary between 9,000 and 24,000 dirhams, depending on the size of the tank. For individual installations (monobloc), the price grid is as follows:

- 150 Liters: MAD 9,000 to 11,000, all taxes included,
- 200 Liters: MAD 11,000 to 15,000, all taxes included,
- 300 Liters: MAD 15,000 to 19,000, all taxes included,
- 500 Liters: starting at MAD 24,000, all taxes included.

For vacuum-tube solar collectors, prices vary according to diameter (18 to 58 cm) and the number of tubes (10 to 30), as well as the tank capacity. For example, a 200-liter solar water heater costs approximately MAD 11,000 all taxes and installation fees included.

The box on the next page provides a simple method to estimate the consumption of a household. As for requirements for collective water heaters, feasibility studies on a case by case basis must be implemented to accurately measure the needs for hot water for health facilities.

[49] Guarantee of Solar Results is a mechanism established by the CDER through which the tenderer agrees with the contractor that the solar installation is capable of delivering the annual average amount of solar thermal energy expected. This amount is subject to the estimated consumption of hot water.

Estimated hot water need per household

Let us take the example of a family of six living in a villa. The ideal capacity of one solar water heater necessary to meet the hot water needs of this family is 300 liters. This number is arrived at through a simple calculation: a personal solar water heater heats water to 70 °C on average, yet a temperature of only 22-25 °C is necessary for a hot shower. To calculate the actual capacity of an individual solar water heater in terms of single hot showers, we must increase its capacity by two. A 300 liter solar water heater can actually produce 600 liters of hot water. Since a human being consumes an average of 80 to 120 liters of hot water per shower, and we calculate at least one shower per day per person, an individual solar water heater of 300 liters will provide six to eight showers a day. The table below shows the key elements of this estimate.

Table 5 - Energy requirements for an individual installation

Housing Type	Number of people	Hot water needs per day (liters)	Capacity of individual solar water heater (liters)
Villa	6	600	300

Source: Interview with a Moroccan importer.

The last characteristic of a solar water heater, but one of the most relevant ones for this analysis, is its competitiveness with fossil fuels. Indeed, all the professionals interviewed agreed that this product is very competitive and even presents a cost savings depending on the traditional energy a solar installation replaces or supplements. According to the CDER, solar water heaters may reduce energy use by up to 80% [50] depending on the amount of sunshine on the site and the type of "traditional" energy used. Replacement of traditional energy production by solar technologies will provide considerable savings not only on the annual energy bill, but also on maintenance costs and maintenance of the other traditional energy facilities (electricity, gas, fuel, etc.). The profitability of the solar water heater is calculated depending on savings made year after year. The lifetime of the solar technology compared to conventional energy is therefore crucial.

Indeed, consider the examples of the electric water heater and gas water heater. Although gas, a direct competitor for solar water heaters, is heavily subsidized in Morocco [51], and electric water heaters are cheaper than solar water heaters, the latter remains competitive due to its longer lifespan. Indeed, the lifespan of a solar water heater is 15 to 20 years against 5 years for the gas or electric water heater.

Individuel solar thermal installation in housing.
Source: P.A. Parfond.

The next table compares the solar water heater to its two competitors, presenting the main specifications of these technologies (lifespan, warranty, investment cost, and CO_2 emission) [52].

Table 6 - Comparative analysis of production for hot water systems

	Electric Water Heater	Gas Water Heater	Solar Water Heater
Investment in MAD	1700	2,000	9,000
Cost over 20 years in MAD	41,000	24,000	9,000
Sustainability	5 to 8 years	5 years	15 to 20 years
Warranty	3 years	1 year	8 years
CO_2 emission in g/kWh	900	300	0

Source: CDER and MEMEE.

[50] This rate can also reach 100% at times but sensors may overheat - especially during the summer.
[51] Note however that although it is funded today, there is no guarantee that the CEG will be funded in the future.
[52] These numbers are obtained from energy meters installed at all of CDER's collective facilities under the Guarantee of Solar Results.

Over a 20 year lifespan, the solar water heater is clearly more economical than its electric and gas counterparts with total costs of MAD 9,000 against MAD 41,000 and MAD 24,000, respectively. Of course, these amounts must be put into perspective, as an auxiliary energy source is most often used to complement solar power for cloudy days and the lifespan of a solar water heater may vary greatly depending on the quality of the material, its maintenance, and its use by clients.

However, the solar water heater industry in Morocco has another competitive selling point over fossil fuels: there are a high number of accidental deaths in Morocco due to the use of gas water heaters, which are often of poor quality. Thus, security is a real asset of solar thermal technology use in Morocco.

1.2. Photovoltaic products in Morocco

The solar cell, the basic unit of a photovoltaic solar panel, typically produces 1.3 W for an area of 100 sq. cm. To produce more power, identical solar cells are assembled to form a solar module (or photovoltaic panel). The serialization of several solar cells adds the voltage up to the same electrical current, while a multiple series connection adds the electric currents up while maintaining voltage. Most photovoltaic solar panels intended for general use are made up of thirty-six cells made out of mono or polycrystalline silicon and connected in series for an output of twelve nominal volts.

As for solar water heaters with separate elements, solar modules are scalable and adaptable to the customers' energy demand. To choose the proper scaling, the amount of sunshine and estimated energy needs must be known before installation.

To understand the basic characteristics of a solar panel, this section presents a brief classification of solar collectors (technical specifications, performance and composition), prices, uses, and correspondence between customers' energy needs and the appropriate technology.

Generally speaking, three main technologies exist for solar photovoltaic panels. They are detailed in the table below, namely **monocrystalline, polycrystalline** and **amorphous cells** [53] .

Table 7 - Characteristics of the main silicon-based PV technologies

Techniques	Performance	Specifications	Price
Monocrystalline cells (1st generation)	12 to 16 %	A single crystal is produced from a block of silicon; high production cost	↑
Polycrystalline cells	12 %	A crystal is produced from a block of multiple silicon crystals; high production cost	
Amorphous cell	6 to 10 %	Very thin layers of silicon are vaporized on glass, flexible plastic or metal, in a vacuumed environment; production costs are much lower	

Source: Idée Maison, Issue #4, « L'électricité solaire : la solution photovoltaïque » (2008).

In general, the calculations by CDER energy professionals estimate a yield of 15% of sunlight into energy per photovoltaic cell, but the better the performance, the more expensive the technology.

Other technical processes are in use abroad, including in the United States, such as superimposing independent semiconductor layers, which are able to capture a wider wavelength and achieve better results than with conventional silicon-based sensors [54]. The industry is experimenting with the superimposition of three junctions to achieve a performance of up to 41.1% [55].

There are 4 main possible uses for PV solar panels:

(i) **Decentralized electrification:** photovoltaic installation for the private household use, i.e. independent of ONE's power grid (especially in rural areas);

(ii) **Connection to the network ("on-grid"):** where electricity produced by the photovoltaic installation is inserted into ONE's power grid (especially in urban areas);

(iii) **Solar energy for water pumping:** Solar energy can be used to pump water for irrigation and household consumption;

[53] Sensors are all silicon-based. Today, science is focused on finding new materials so that the industry is not dependent on a specific resource and on reducing production costs.

[54] Indeed, conventional sensors can achieve a near infrared wavelength of 800 to 1,200 nm, against 1,850 nm for stacked layers technology.

[55] Sciences & Vie, « *Le solaire, pourquoi on peut enfin y croire ?* », mai 2009, p 60.

(iv) **Off-grid connection in remote sites:** some sites, such as military bases and telecommunications facilities are isolated from ONE's electric lines. These large scale facilities are often at the center of a public-private partnership between companies and the Moroccan government. This use, although important in Morocco, is not covered in this study.

Photovoltaic panel.
Source: USAID Program.

For an "off-grid" connection, the following equipment is necessary:

- A solar module;
- Batteries/accumulators (often made out of lead);
- A regulator to control the charge/discharge of the accumulators;
- An inverter to convert direct current (CC) into alternating current (AC). This is not mandatory in the case of an off-grid connection and depends on usage.

For a grid connection, a production and distribution meter is necessary, but a regulator and batteries are not necessary. For those concerned about the aesthetics of building, photovoltaic tiles or slates exist on the European market.

The capacities of common commercial products available for this type of installation are as follows [56]:

- 50 WP: This power allows a rural home to satisfy its needs for domestic lighting only;
- 75 WP and 100 WP: for domestic lighting and a black and white TV set;
- 200 WP: capable of powering lighting, a television, and a refrigerator.

Internationally, the price of a peak Watt is approximately MAD 35-40. Added to this are the costs of auxiliary equipment and installation fees. The final prices charged in Morocco vary greatly between retailers. According to professionals interviewed, prices - installation included - can vary from 50 to 180 MAD per WP. This price difference is an indicator of one of the characteristics of the photovoltaic technology market in Morocco: the quality variability of marketed products and services offered (installation, maintenance, after sales service).

Definitions

The **peak Watt (WP)** characterizes the power of a photovoltaic panel. On average, a peak Watt corresponds to the power of a single crystal cell measuring 100 mm x 100 mm. The peak power represents the power delivered by the panel at the peak power point (in the diagram intensity/voltage) and a solar radiation of 1,000 W/sq. m (standard spectrum) with a cell at 25 ° C.

The **kilowatt hour (kWh)** is a unit of energy measurement worth 3.6 megajoules. It is mainly used to measure electrical energy. It is the energy corresponding to a power of 1 kilowatt for a one hour period.

Source: Actu-Environnement Website.

From 1998-2008, Morocco implemented a decentralized rural electrification program, the Global Rural Electrification Program (PERG). Because the PERG was highly subsidized by ONE, it provides an attractive price to consumers. Under the 10-year concession, ONE contracted several, mostly foreign, companies to oversee everything from marketing to installation, maintenance and after-sales service.

The most common marketed product is the 75 WP photovoltaic panel, for which the ONE pays a subsidy of MAD 4,500. The customer pays a deposit of MAD 700 to 900 as well as monthly installments of 65 MAD for 10 years. The final price of the product (subsidy included) can be estimated at about MAD 116 per WP, instead of MAD 176 without this grant.

For on-grid PV panels, Morocco is putting in place a program called *Chourouk*, allowing for the production of solar electricity and the possibility of inserting the excess production into the network and providing those that produce energy themselves with a reduction on their electricity bill to compensate for the electricity produced by solar energy.

Another technology that uses solar energy to generate electricity is **parabolic** trough technology. This consists of rows of cylindrical-parabolic mirrors, (i.e. a cylinder cut transversely) where light is focused on a tube filled with a synthetic oil flow. When brought to 390 degrees, the oil transfers its heat via a heat exchanger to a pressurized steam circuit, activating a turbine. This technology can convert 16% of the solar energy into electricity. It is not covered in this study.

[56] These figures are based on the types of technologies proposed by ONE under the PERG program.

II. Mapping the value chain of solar thermal and photovoltaic channels in Morocco

2.1. Value chain of solar thermal products

The main functions identified in the solar water heaters value chain are as follows:

Production. The production of solar water heater is mainly done abroad. However, one importer [57] also manufactures solar water heater tanks locally and two local producers exist in Morocco (Rabat and Meknes).

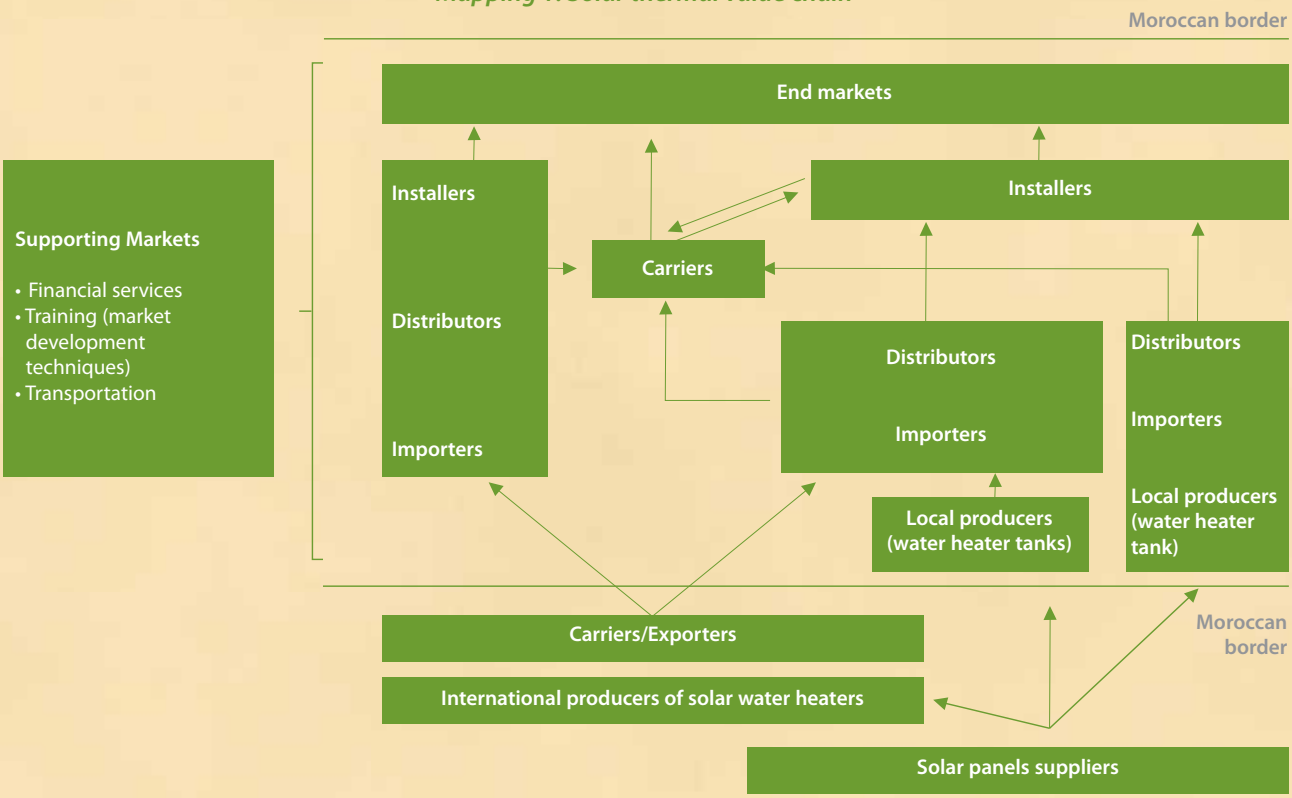
Importation and distribution. In most cases, solar water heaters are imported in one piece from foreign suppliers (solar panels and tanks) and directly distributed to installers or retailers-installers. Distribution is most often not managed by specialized companies with showrooms and storage spaces; rather it is carried out by importers, installers, and small companies acting as resellers.

Installation, maintenance and after sales service. Regarding solar water heaters, it is quite common for importers to install their own equipment in order to ensure optimal installation and to preserve their reputation. However, no one can really do without the service providers network (resellers-installers, installers and Energy Houses), which is responsible for selling, installing and maintaining the equipment. Even if an importer outsources the installation and retail, it is not uncommon to see that same importer take charge of customer service for quality assurance purposes. Commercial links also exist between Energy Houses, retailers-installers and installers: Energy Houses have limited storage space and thus rely on resellers to stock up on materials.

Prices of installation vary between MAD 500 (for a 150 L solar water heater) and MAD 2,000 (for a 300 L solar water heater). These prices also depend on the quality of facilities and after-sale services offered to customers (maintenance, etc.).

Transportation. Importers usually subcontract transportation - delivery of equipment to installers and retailers - to local businesses. Transport is also handled by the installers when delivering products to their customers. Transportation fees to source equipment from their suppliers are often borne by installers. Transportation costs are estimated to be 15 to 20% of their total costs and may go up to 30% depending on distance traveled. Based on interviews with importers, there is a multiplying factor of 2.5 between the purchase price for imports from abroad and the final resale price on end markets. This multiplying factor can go up to 3.5 in some cases.

Mapping 1: Solar thermal value chain



[57] It should be noted, however, that this is possible partly because the importer has experience in the manufacture of gas water heater and that investment in machinery had already been made.

2.2. Value chain of photovoltaic products

The value chain associated with the photovoltaic channel has a unique structure, largely because of ONE's involvement.

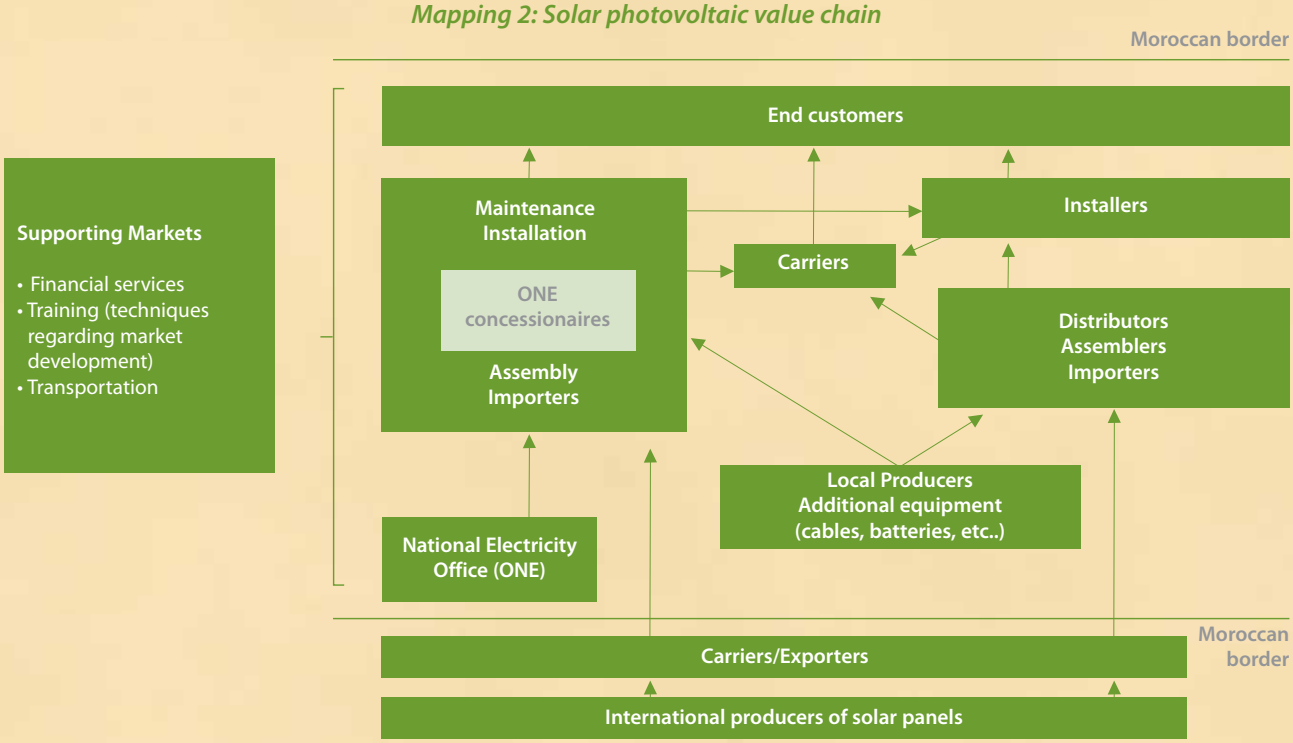
Production and assembly. While there has been progressive development of local production in terms of equipment related to PV panels (intended for electricity production), such as batteries and electrical equipment and even regulators needed for photovoltaic installations, the production of solar sensors is exclusively done abroad [58]. Some importers assemble these additional parts in their own factories (mainly located in Casablanca). ONE's concessionaires tend to be subsidiaries of foreign companies operating in Morocco. Thus, the production is done abroad in the parent company and some distributors also source additional equipment (batteries and electrical equipment) locally. These distributors assemble the parts themselves.

Importation and distribution. Some importers specialize in the marketing of photovoltaic technology and also sell related products such as solar water heaters. These companies take charge of distribution to installers or other resellers-installers. ONE concessionaires, in contrast, support not only the marketing of products but also the installation, maintenance and after-sales service of products for a ten year period under the Global Rural Electrification Program (see below).

Installation, maintenance and after sales service. Importers-distributors usually deal directly with service providers in terms of equipment installation. For solar water heaters, for example, maintenance and after-sales service are not guaranteed in most cases by the importers. Conversely, through ONE's concessions under the Global Rural Electrification Program (photovoltaic installations), distributors sign up over a ten-year period to become authorized service providers (authorized by ONE), and provide installation, maintenance, and customer service. In addition, these companies collect payments and monthly installments. Indeed, the client's down payment to distributors is immediately transferred to an account belonging to ONE. ONE then repays this amount (deposit) as well as the investment subsidy to the distributor within ninety days.

Transportation. Transportation is usually subcontracted to local businesses by importers, to deliver equipment to the installers and distributors, and by installers themselves when delivering products to their customers. Transport costs, to stock up on material from suppliers, are also often borne by installers.

Mapping 2: Solar photovoltaic value chain



[58] CasaInvest, *"Photovoltaïque, un marché qui décolle"*, p 14.

III. End Markets

This section provides an analysis of end markets for solar thermal and photovoltaic technologies sold in Morocco. Because the products of these two channels are very different both in the technology and in their use, the market analyses for these two technologies were conducted separately. However, it is noted that these technologies can be complementary. Indeed, some markets can include multi-technology solutions combining thermal and photovoltaic technologies.

3.1. End markets for the solar thermal industry in the Meknes-Tafilalet region

The global market for solar thermal energy is dominated by China, which accounts today for more than 100 million sq. m of installed panels. According to the EurObserver 'ER report 2007, at the end of 2006 the European solar thermal park was estimated at approximately 20,400,270 sq. m, led by Germany, followed by Greece and Austria. The box below outlines the main trends of the most developed global markets in the solar thermal sector.

Main world markets for solar thermal

China
The world's largest producer of solar water heaters, primarily **vacuum-tube solar collector** models, China is also the world's largest market, with a solar thermal park of 108 million sq. m according to the latest figures from the "China Solar Water Heater Market Report, 2008". In 2007, this market reached a growth rate of 30% which represents the annual installation of 23.4 million sq. m of solar panels - slightly more than the current European market. Twenty manufacturers share this market, whose annual production value is estimated at CNY100 million each. In addition, China owns the largest manufacturer in the world, the Himin Chinese group with a production estimated at 1 million solar water heaters per year according to the "Renewable Energy World" journal. According to a planning report, solar water heaters systems operating in China will reach 150 million sq. m in 2010, an increase of approximately one third of its current park.

Europe
Although five times smaller than the Chinese market, the European market grew at the rapid rate of 46% in 2006, according to the "Solar Market in Europe" report-Markets and Trends in 2006" written by the European Solar Thermal Industry Federation (ESTIF). This represents growth of approximately 2.1 GWth in new facilities, the equivalent of about 3 million sq. m of solar collectors installed. The explanations for this strong growth, as reported by ESTIF, are: rising oil prices, strengthening of the government's incentive programs in several countries and the Russian gas cutoff at that time. According to the EurObserver 'ER report 2007, the total capacity in operation in late 2006 in Europe was estimated at 14.3 GWth, meaning 20,400,270 sq. m in solar thermal panels. The table below presents the solar thermal park of six European countries. The most dynamic areas are Germany, Greece and Austria, outpacing the other countries with solar thermal parks of several million sq. m.

Major solar thermal parks in Europe (2006)

Country	Sq. m	MWth
Germany	8,574,000	6,001.8
Greece	3,287,200	2,301.0
Austria	2,838,700	1,987.1
France	1,160,400	812.3
Italy	866,350	606.4
Spain	681,700	477.2
Total	**20,400,270**	**14,280.2**

Source: EurObserver 'ER 2007.

United States
The U.S. market has grown substantially in recent years, thanks not only to increases in the prices of conventional energy sources, but also to public incentives (both at federal and state levels). Indeed, the installation of solar water heaters increased strongly in 2006 due to increased tax credits on investments at the federal level. Installations have quadrupled since 2005 on the 48 continental states. Before 2006, half the sales of solar water heaters in the US were installed in Hawaii because of tax credits and other incentives. However, this market remains below its European and Chinese counterparts with a total number of facilities amounting to 193,000. Moreover, the solar thermal market in the US has a different structure from other major foreign markets. Indeed, the solar thermal industry is dominated by swimming pool solar heating with 317,000 installations sold during the1993-2008 period.

Source : "China Solar Water Heater Market Report, 2008"; EurObserver' ER 2007; "Solar Market in Europe - Markets and Trends in 2006" by ESTIF; Solar Energy Industry Association (SEIA) and Prometheus Institute, "US Solar Industry Year in Review (2007)".

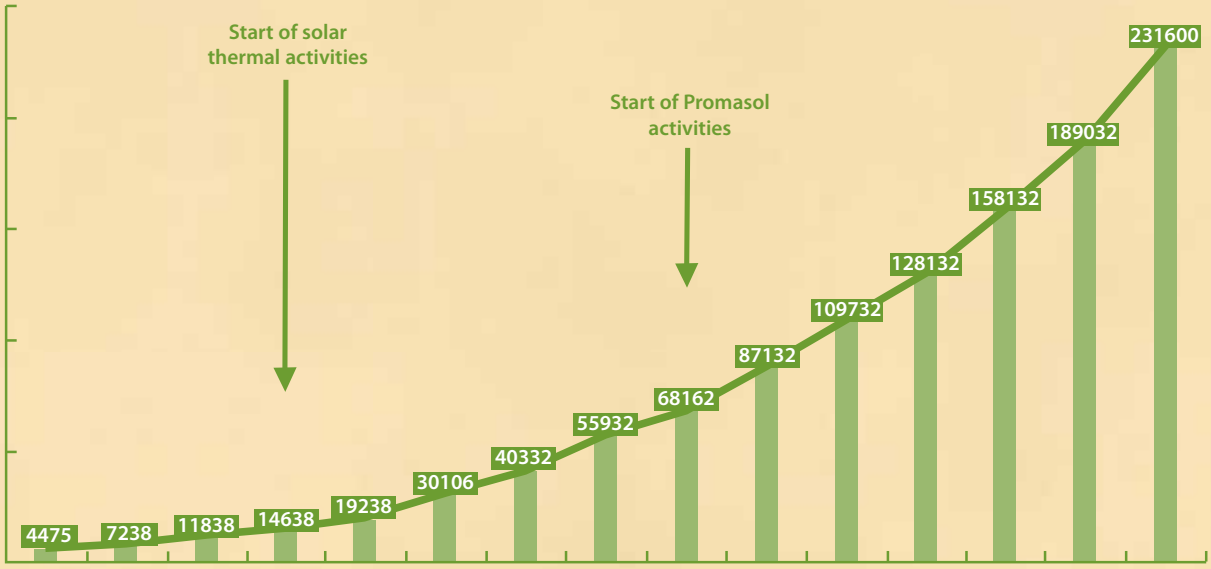
Although still behind its northern neighbors, the solar thermal market in Morocco has developed a lot over the past decade, from approximately from 15,000 sq. m of solar water heaters in 1997 to 200,000 sq. m in 2007. In 2008 the solar thermal park was estimated at approximately 240,000 sq. m. The chart below, traces the evolution of the solar thermal park in Morocco. We notice that after the inception of CDER's PROMASOL program in 2002, the solar thermal park almost tripled over five years.

As for the potential national market, the CDER has estimated that there will be 440,000 sq. m [60] of solar panels by 2012 - a figure that has roughly doubled in four years (an addition of 200,000 sq. m). Moreover, according to a study carried out by GTZ (2007), the solar thermal market could reach 1,700,000 sq. m of solar panels by 2020.

On July 8th, 2008, as part of an action plan for energy efficiency in the construction and industry sectors, the MEMEE signed cooperation agreements with the following Ministries: Education, Higher Education, Professional Training and Scientific Research, Tourism and Handicrafts, Housing, Planning and Development of Space, Industry, Trade and New Technologies. A signature from the Department of Health is also pending. These agreements set specific goals to be achieved by 2012 for each identified sector in terms of installed solar panel area. The table on the next page details the nature of these objectives and summarizes the content of these agreements.

If one compares the Moroccan market with that of Tunisia, we note that Morocco is well ranked, with 240,000 sq. m of solar thermal park in 2008 as compared with 80,000 sq. m for Tunisia in the same year. Tunisia has, however [61], increased from 8,000 to 80,000 sq. m during the period of 2004-2008, thanks to the PROSOL program. Morocco remains less ambitious than Tunisia, setting a target of 440 000 sq. m of solar thermal panels by 2012 compared to Tunisia's goal of 620,000 sq. m of solar panels by 2010, and use of innovative mechanisms promoting of thermal power installed under PROSOL.

Graph 1 : Solar thermal park in Morocco (1994-2008)



Source : CDER [59].

[59] These results are based only on imports and do not take into account local manufacture.

[60] CDER undertook the calculation of the potential solar thermal park in 2012 for Morocco. For the purpose of this study; CDER calculated the current total solar thermal park potential for the Meknes-Tafilalet region.

[61] The PROSOL program is explained in the section "An overview of policy and international financial tools for the promotion of solar energy."

Table 8 - Summary of interdepartmental agreements signed between the MEMEE and the Ministries concerned

Ministries concerned	Conventions Contents - Achievements by 2013
Improving Energy Efficiency (EE) in the housing sector	• Establishing a Habitat-Energy circular; • Installing 213,000 sq. m of solar water heaters; • Use of 4 million low consumption light bulbs; • Identification of demonstration projects for equipment and energy efficiency technologies and renewable energy; • Communication and awareness; • Mobilization and support; • Training; • Scientific research.
Improving EE in the education sector	• Drafting a circular; • Installing 13,000 sq. m of solar water heaters; • Use of 1.5 million low consumption light bulbs; • Electrification of schools facilities by PV units; • Improving heating system in schools located in mountain regions; • Identification of 15 demonstration projects; • Mobilization and support; • Training.
Improving EE in tourism	• Drafting a Tourism-Energy circular; • Installing 18,000 sq. m of solar water heaters; • Generalization 300,000 low consumption light bulbs; • Identification of 10 demonstration projects; • Communication and awareness; • Mobilization and support; • Training.
Improving EE in industry	• Conducting energy audits in companies with high energy consumption; • Optimization of the energy consumption audited companies (implementation of audit recommendations); • Training; • Capacity building and monitoring; • Publicity campaigns and communication; • Standardization and Certification.

Source: MEMEE

Although relatively well developed, today's solar water heater market in Morocco is very homogeneous: it is dominated by the individual solar water heater. Customers are mostly homeowners of villas or holiday homes, with sufficient income for this kind of purchase. The CDER has estimated that for the 2006-2008 period, 76.5% were individual installations and the remaining 23.5% were public or private collective installations. Collective solar water heaters still offer considerable market opportunities. This study proposes to analyze these markets at the regional level and to rank them according to priority, taking into account three main criteria: return on investment, market size, and for public markets the government's commitment to develop this sector.

Solar thermal energy in the tourism sector: a profitable investment

Tourism is one of the most dynamic economic sectors in the Meknes-Tafilalet region and offers an attractive potential market for hotel owners willing to invest in solar thermal technology.

Indeed, the cost effectiveness of a solar water heater depends on the conventional energy typically used for heating sanitary water as this calculation is based on energy savings generated by the switch to solar energy. The higher the cost of the fossil fuel source used, the more a solar heater option becomes a cost effective solution.

Solar energy will save both on the annual energy bill and on the costs usually incurred for the maintenance of its conventional energy installations. Moreover, according to interviews conducted with hotel professionals in the region, oil remains a widespread energy source for heating water, and electricity is sometimes used as an auxiliary energy. These sources are very expensive to use, making solar thermal very competitive for hotel managers looking to reduce their energy bill. Hoteliers interviewed for this report were aware of this waste of resources and mentioned that they were thinking about converting their water heating system to gas. The time is therefore very appropriate for these institutions to adopt solar energy.

Based on analysis of actual cases in Morocco, a study conducted by DPI Ingénierie, a research firm, estimated the amortization of such investments to be between five and six years depending on fossil fuel used and the constraints observed in the field. Hotel owners believe this timeframe is ideal to make this change. The table below shows the main conditions and operating characteristics of three case studies to calculate the gross profitability of this type of investment. These three cases make use of, respectively coal, propane and fuel. Note that these calculations are estimates, as any calculation of this kind requires a technical and financial study on a case by case basis [62]. Data required may include the number of days of sunlight, the site's positioning, energy consumption, traditional energy source and additional traditional energy source used to complement solar energy, etc.

The hotel sector is also attractive because of the scale of its market potential. Indeed, the region accounts for 188 listed hotels, representing a total of 7,800 residents. The table below provides the classification and the number of establishments in the region and number of beds available - all necessary elements to calculate hot water needs.

According to CDER calculations the regional potential in the tourism sector in 2008 was 4,600 sq. m of solar thermal panel, which corresponds to a production of 3.2 GWhth / year, or 277 tonnes per year of oil equivalent. This calculation only considers listed institutions, namely: one to four stars hotels, tourist homes, guest houses and bed & breakfasts.

Table 9 - Operating conditions and profitability of collective solar thermal facilities in the Moroccan tourism industry

	Case study 1	Case study 2	Case Study 3
Number of rooms	60	48	174
Fuel Type	Coal	Propane	Fuel
Energy consumption per year in MAD (tax excluded)	137,000	371,106	350,550
Solar Energy contribution in kWh / year	28,987	29,967	196,102
Surface required (sq. m)	24	40	204
Investment cost (MAD)	120,000	200,000	1,020,000
Amortization (months)	77.83	50.27	76.62

Source: DPI Ingénierie.

Table 10 - Tourism facilities in the Meknes-Tafilalet region

Type of tourism infrastructure	Units	Number of beds
Ranked establishments, including:	*188*	*7,800*
"Starred" Hotels:	53	5,970
4 *	14	3,078
3 *	15	1,572
2 *	11	788
1 *	13	532
Guesthouses	12	162
Tourist hostels	20	820
Tourist Residences	6	510
"Starred" bed & breakfasts	16	223
Campsites	10	1,652 sites
Unranked establishments	*126*	*2,720*

Source: Meknes-Tafilalet's Regional Delegation of Tourism.

[62] DPI Ingénierie, a research firm, states that the values presented are estimates and based on supporting evidence. They show reference assessments to illustrate and summarize but these numbers may differ from actual values. These values are no way endorsed, offered or guaranteed.

Collective solar water heater with separated elements.
Source : CDER.

Monobloc solar water heater.
Source: USAID Program.

If the region equipped these establishments with solar technology, 2,470 tons of CO_2 emissions would be prevented annually (see Table 12). The region could also qualify for funding under the CDM.

The same forecast for this sector at the national level are also encouraging, with a projection of 18 000 sq. m of solar collectors to be achieved by 2012. The calculation includes all existing and new buildings aniticipated by the Ministry by 2012. In 2006, Morocco had 618 classified hotels, 120,000 beds.

One of the main obstacles in developing this market is the lack of information about this technology. Firstly, profitability is still unknown. Secondly, it depends not only on the client's use but also on the quality of installation and maintenance performed throughout the product's lifespan (fifteen to twenty years). Quality counseling and professional feasibility studies are necessary to ensure the proper use of solar thermal equipment over time. Some past experiences, where these conditions were not met, have had negative press among customers and have hindered market development.

The solar thermal in housing: a large market

Housing is the sector offering the widest market potential. The Moroccan government builds 150,000 houses per year in the Kingdom. The objectives set under the cooperation agreement signed between the MEMEE and the Ministry of Housing and Urban Development provides for the establishment of 213,000 sq. m of solar panels by 2012 in Morocco. This assessment includes various types of construction, namely: villas (area> 200 sq. m), modest villas (area <200 sq. m) and high-class apartments. Indeed, although the current market for solar water heaters focuses primarily on equipment of villas and holiday homes for individual solar water heaters, other niches such as modest villas and buildings (specifically high and middle class apartments) exist.

Newly constructed buildings are a priority, because dwellings that have already been built rarely include hot and cold water pipes on the roof which would allow for solar water heater installation without incurring additional costs [63]. Thus, from 2005 to 2007, the region had an average of 130 new villas per year in urban municipalities, an average of 332 new dwellings, and 3,050 apartments and 222 modest villas in 2007. The market potential amounts to a total of 8,848 sq. m of solar panels in the region of Meknes-Tafilalet, according to CDER's calculations, with 2,748 sq. m for villas and modest villas [64]. This potential represents a production of 6,193,600 kW/h th and would be equivalent to 533 TOE year. It would also prevent the emission of 4,744 tons of CO_2 per year.

Regarding social and affordable housing, the CDER, in partnership with the Directorate of Technical Habitat, evaluated the possibility to include solar water heaters in this type of housing in the context of the Interministerial Convention for Energy Efficiency and Renewable Energy Promotion. The findings indicate this project would be unprofitable and difficult to implement. On the one hand, solar water heaters are too expensive for a social housing budget. On the other hand, solar water heaters take up too much space in this type of housing; they have an average size of approximately 50 sq. m.

[63] This factor has often been cited as a discouraging constraint by potential customers interviewed.

[64] This calculation is based on statistics from the Regional Delegation of the Ministry of Housing, Urbanism and Planning for the year 2007, and includes only villas, modest villas and apartments, with the exception of public housing.

One of the main obstacles in developing this market is the limited cost savings of such investment for a home owner. Indeed, the energy used by households in this sector is generally gas, which is highly subsidized by the state. This makes investing in a solar water heater less interesting than for the hotel sector, for example, where fuel and electricity are more commonly used. Although solar water heaters are competitive with gas and electricity over a twenty year period (see Table 6 "Comparison of hot water production technologies in Morocco), this period is too long for the average household.

Unless the inclusion of solar water heaters becomes mandatory in construction or community facilities are established to achieve economies of scale, this sector may develop very slowly. Morocco has already made some progress in this area, however, with demonstration projects including solar water heaters in buildings of new towns. The box below presents two major existing initiatives.

Projects underway in the housing sector

1. The development of the partnership agreement between the CDER and Society Development Al Omran Béni Mellal (signed on November 6th, 2008) to support the new city of Lakhiayta Sahel (1,300 ha for 300,000 inhabitants) in incorporating energy efficiency measures, including 100,000 sq. m of solar thermal collectors in the 50,000 new dwellings planned to be built;

2. In 2007-2008 the PROMASOL program supported Al Omran Tamesna to equip villas with solar water heaters. 202 individual thermosiphon solar systems have been installed (300-liter capacity each), totaling an area of 808 sq. m.

Source: CDER.

In this sense, a Habitat-Energy circular signed on November 6th 2008 between the MEMEE and the Ministry of Housing, Urban and Planning is optimistic. This circular recommends that private operators include hot and cold piping in the terraces for all new construction and that public operators do the same with solar water heaters. Although encouraging, this circular currently has no binding force, and its compliance depends only on the operators' goodwill. In contrast, other Mediterranean countries have changed their building codes. In 2005, Spain amended its building regulation [65] under the Renewable Energy Plan 2005-2010 (PER). This new codes require the installation of solar collectors in the construction of new homes or rehabilitated homes. The PER, in turn, requires that 60% of energy consumption of these new buildings come from a solar thermal source.

The solar thermal park in the existing schools and health infrastructures: a factor of social development

Schools and universities infrastructure.
Today, the education sector offers important potential in two ways: the provision of solar thermal technology to boarding schools in rural areas, and to universities in the region.

Currently, rural boarding schools in the region have no access to hot water. Most of them have signed agreements with the surrounding hammams (public baths) so that students can enjoy hot showers about once a week. Access to hot water would significantly improve the students' quality of life, but this investment is not cost effective: first, since hot water is not available in the dormitories, the profitability of solar thermal installation cannot be calculated from avoidance gains [66]; second, the budget allocated to the hammams would not allow for an amortization of the cost of investing in solar energy under a reasonable period of time. Such projects therefore need a strong public commitment. As such, the Department of National Education plans to install 13,000 sq. m of solar water heaters by 2012 as part of the convention relating to energy efficiency and renewable energy signed with the MEMEE in July 2008, which is encouraging.

On campuses, the potential exists both for existing infrastructure and new construction. Solar water heaters can be used to provide showers in the university dormitories. In 2006, Morocco had 27 university campuses, including 32,000 residents.

The box on the following page outlines these statistics for the region's educational and health infrastructure. There are 21 boarding schools, totaling 62 dormitories, or 3,124 residents in the region. According to CDER's calculations, this represents a solar thermal park potential of 1 250 sq. m of solar collectors. The energy produced by equipping these facilities would be equal to 875,000 kWh th/year, the equivalent of 75 TOE/year. Such a project would also avoid 670 tons/year of CO_2 emission, which would enable the project to receive CDM funding.

[65] The *"Codigo Tecnico de la Edificacion"* (CTE).
[66] Avoidance gains are energy savings and therefore financial gains generated through alternative technologies based on fossil fuel replaced by solar thermal technologies.

Solar thermal installation in Al Akhawayn University, Ifrane - *Source: CDER.*

Rural boarding schools in the region:
- 21 boarding schools
- 62 dormitories
- 3,124 residents

University campuses in the region
- Public:
  - On the Meknes campus: 1,456 beds
  - On the Errachidia campus: 1,600 beds
- Private (in Meknes):
  - Dar Ettalib campus: 438 beds
  - Gabri campus: 400 beds
  - Other: 350 beds
- Private institutions under construction (in Meknes):
  - Near the Ecole Superieure des Arts et Metiers: 898 beds
  - Next to the Arts Faculty: 324 beds
  - Next to the Law Faculty: 2,000 beds

These dormitories will be completed in 2010-2012.
Total = 8 dormitories or 7,466 beds.

Source : Regional Academy of Education and training and Moulay Ismail University

Similarly, university campuses represent great potential. The region has two public university campuses, with potential for 1,320 sq. m of solar collectors; three private university campuses, with potential for 640 sq. m; and three private university campuses (under construction), with potential for 1,718 sq. m. In total, the university campuses represent a potential market of 3,982 sq. m. The total regional potential in the education sector for solar thermal therefore equals 5,232 sq. m area of solar collectors.

Al Akhawayn University, a private institution located in Ifrane, provides an example of the potential of this sector. In 2004, under the PROMASOL program, the university installed a collective forced circulation water heater system of 120 sq. m to heat the dormitories' showers. With coverage ratio of 73.6% of energy needs, this installation provides a return on investment in five years. This kind of project therefore offers excellent amortization ratios.

Table 11 - Characteristics of the solar thermal installation in Al Akhawayn University, Ifrane

Specifications	Value
Total plant area	120 m²
Capacity	4,000 litres
Annual Solar thermal gains	79 kWh/an
Auxiliary energy	Electric water heater
Energy saving	95,000 MAD / year
Return on investment timeframe	5 years
Solar coverage area	73.6% of energy needs
Date of commissioning	2004

Source: CDER

Health care buildings. Buildings devoted to health care, particularly units making use of hot water such as hospitals, urban and community health centers, and clinics with labor rooms, represent an estimated potential of 870 sq. m. The table below illustrates the type and number of health care region.

Total of 279 public health infrastructures:
- 13 hospitals
- 9 local hospitals
- 54 urban health centers
- 68 community health centers
- 38 clinics equipped with labor rooms
- 97 rural clinics

Source: Regional Delegation of Health in Meknes-Tafilalet

The region includes 13 hospitals, 9 local hospitals, 54 urban health centers, 68 community health centers, and 38 clinics equipped with labor rooms for a total of 182 public health care buildings that can be equipped with solar water heaters in region - the health clinics are not taken into account.

The Department of Health is currently negotiating to sign an agreement with the MEMEE to install 8,000 sq. m of solar collectors by 2012 throughout the Kingdom.

Other uses of solar thermal in the region

The industrial sector also has potential demand for solar thermal energy. Indeed, the region is rich in agribusiness, and collective solar water heaters could be used for hot water in showers. Moreover, the agriculture sector is highly developed in the region, and solar heaters could be used on farms using hot water in the production process. Plum and apple cultures and milk production were identified as appropriate options during interviews with local stakeholders. To illustrate this, the *Ecole Nationale d'Agriculture* (ENA) of Meknes has contacted an importer of solar water heaters located in the region to gain access to hot water for activities related to the processing of dairy products.

Table 12 - Summary of market potential for solar thermal in the Meknes-Tafilalet region

Concerned areas	Existing potential in sq. m	Equivalent energy in TOE/year	CO_2 emission avoided in ton/year
Tourism	4,600	277	2,470
Housing	8,848	533	4,744
Education	5,232	315	2,805
Health	870	52	470
Total	19,550	1,177	10,489

Source: CDER.

3.2. End markets for photovoltaic channel in the Meknes-Tafilalet region

Today nothing prevents a Moroccan household from installing solar photovoltaic panels with their own budget, except perhaps the high cost of the technology. The photovoltaic market is structurally very different than that of solar thermal. As reported by a ONE's concessionaire interviewed as part of this study, *"The photovoltaic market in Morocco is unlike that of solar water heater. While the latter represents a real private market, the current market for photovoltaic can be described as "institutional"*. In fact, unlike European countries, where most of the market share represents on-grid connection to the national electricity network through "feed-in-tariff" incentive policies, the decentralized rural electrification program (ERD) (i.e. equipping the household with PV panels in rural and remote areas) continues to represent the majority of the Moroccan market. Having been supervised by ONE under two programs, the Decentralized Rural Electrification Pilot Program (PPER) and the Global Rural Electrification Program (PERG), ONE stands out as a major factor structuring the Moroccan market.

The table below outlines a brief historical development of the photovoltaic industry in Morocco through four phases since the 1980s.

History of photovoltaic in Morocco

The market for photovoltaic panels in Morocco is about thirty years old and has evolved over four phases:

- **Phase 1 (1983-1985): A national context fostering the development of photovoltaic energy** - At the time, Morocco was marked by a major rural exodus, a severe drought, and levels of rural electrification not exceeding 14%. Increasing access to drinking water and electricity became a priority for the government. This period marked the establishment of the CDER as a study and research center dedicated to renewable energy. Photovoltaic technologies gained a lot of attention and were seen as a possible response to these challenges in rural life.

- **Phase 2 (1985-1990): The trial period** - Pilot projects emerged to demonstrate the technical feasibility of solar technologies, as well as their social feasibility, as sudden access to electricity and water may disrupt habits in traditional rural societies. Under these pilot projects, technologies were made freely available to people in Southern provinces to test drying techniques, rural electrification and pumping water techniques.

- **Phase 3 (1990-1995): Launching regional programs** - Following these pilot projects, several donors, such as USAID, the French Development Agency (AFD), the German GTZ, and the Canadian Agency for International Development (CIDA), developed programs dedicated to renewable energy. During this phase, ONE established the Decentralized Rural Electrification Pilot Program (PPER), equipping villages with photovoltaic panels, specifically around cities such as Safi, Casablanca and Errachidia. A conclusion from this phase was that the photovoltaic industry can contribute to rural development. In addition, some technical problems related to batteries and regulators were solved. These problems had, at the time, tarnished the reputation of solar technologies. Overall, the goal was to evaluate the social integration of these technologies at the national level.

- **Phase 4 (1995-present): The Global Rural Electrification program (PERG), a national approach** - While the PPER program focused on the equipment warranty, Morocco has now adopted a lasting approach focusing on a guarantee of good quality service. This was done through large tenders with distributors over a period of ten years. The PERG represents a great effort towards the universal access to electricity in rural areas.

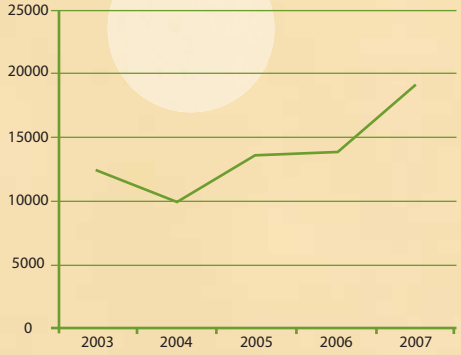
Source: Interview with CDER representatives.

One of the striking findings from the evolution of the photovoltaic channel in Morocco is that, in parallel with phases 2 and 3 of the trial period for this technology, the private sector had developed independently and was interested in the import and assembly of PV panels and the production of auxiliary equipment. The PERG completely changed the private landscape by giving most contracts to major foreign companies. Since then, according to interviews with importers, Moroccan firms are struggling to stay in the market.

In addition, some companies that had become ONE concessionaires under the PERG, complained about the ambiguous nature of some situations. One importer recalls: *"today the market no longer allows me to carry on decentralized rural electrification independently; out of 7,000 installations, 2,500 remain in our warehouse because ONE made us uninstall them under the PERG. Presidents of the "Communes" would come asking the ONE for an on-grid connection, not a solar installation."* According to him, the problem is that ONE does not have a clear mapping of areas in Morocco indicating what setup would be the most appropriate: decentralized photovoltaic energy or an on-grid connection. A serious study on areas where PV panels are more profitable than the traditional network connection would foster a better market structure. Thus, there is a kind of dual policy in which the MEMEE promotes the use of renewable energies to reduce energy costs in Morocco, while encouraging the pursuit of a decentralized rural electrification program emphasizes access to traditional electric power (on-grid).

It is difficult to trace the evolution of market size from the origin of this industry in 1980 due to lack of reliable statistics. However, statistics from the *Office des Changes*, represented in the graph above, show changes

Graph 2: imported Photovoltaic Units (75 WP)



Import of photovoltaic cells

Source: Statistics derived from the Office des changes (Exchange Control Office).

Photovoltaic energy of 75 WP

in the volume of imports from 2003 to 2007. Solar panel imports have indeed increased nearly one third in four years, from 12,524 to 19,269 units of 75 WP between 2003 and 2007. A slight decrease, however, can be noted in 2004, probably due to the significant increase in the price of silicon [67], the basic material of a photovoltaic panel, due to the upturn in the market for semiconductors at that time. This chart is based on the raw data contained in the table below, which shows the number of photovoltaic panels imported in tons, and the corresponding value in thousands of dirhams. The most common model used for decentralized rural electrification has been the 75 WP panel. It was used as a benchmark for the evolution of imports. To obtain the equivalence in the unit selected, the price in thousands of MAD has been divided by the price of a WP estimated at MAD 33 (the price on average over this period on the international market) through one of ONE's concessionaires, then divided by 75 to get the number of photovoltaic panels of 75 WP imported during this period.

Table 13 - Photovoltaic cells imports from 2003 to 2007

Type of solar energy	2003 (tons)	Value In KMAD	2004 (tons)	Value In KMAD	2005 (tons)	Value In KMAD	2006 (tons)	Value In KMAD	2007 (tons)	Value In KMAD
Photovoltaic cells	134	30,997	119	24,816	156	33,723	152	34,421	271	47,693

Source: Office des changes.

[67] According to Reuters, following the market upturn of semiconductors in 2004 the price of a kilo of pure silicon, trading at $6, was multiplied by ten, http://www.fiec.org.br/artigos/energia/lenergie_solaire_est_penalisee_par_le_prix_du_silicium.htm, 1/23/04.

Rural electrification has been the main market for photovoltaic energy in Morocco to date and the outcomes of the PERG provide a good assessment of the scale of this market. This program (approved by Government Council in August 1995) has been ongoing since 1996. In late 2002, ONE sped up the pace of this program in order to expand access to electricity to over 35,000 villages, representing more than 12 million citizens in rural areas by 2008 instead of 2010 as originally planned. This was achieved by using about 91% on-grid electrification and up to 7% through decentralized electrification, mainly through photovoltaic installations. In late July 2007, 30,255 villages were electrified (44,719 households) with solar PV systems for lighting [68].

Regarding the Meknes-Tafilalet region, the table below indicates the number of electrified villages under the PERG in late June 2007 using solar energy. Thus, out of 2,806 villages electrified through solar photovoltaic installations in the Kingdom, 430 villages are located in Meknes-Tafilalet, which represents approximately 15.5% of the national market. The Meknes-Tafilalet region, especially the Province of Khénifra, has greatly benefited from this program.

Table 14 - Villages of the region electrified with photovoltaic installations (late June 2007)

Communes	Number of electrified villages
El Hajeb	57
Errachidia	59
Ifrane	67
Khénifra	247
Meknès	0
Total	**430**

Source: ONE.

The PERG is now closing down because its contracts with ONE concessionaires finished in late 2008. By 2007 ONE announced that the rate of rural electrification had reached 93%. This figure includes both the on-grid connections and solar installations. The size of this market has thus been greatly reduced. Moreover, some precautions need to be taken into account in interpreting this number as regions are not uniformly affected. Other markets are developing today - schools and health facilities - in terms of decentralized electrification, on-grid connection of electricity produced by solar energy and its export to Europe under UMP's "Solar Plan".

Decentralized Rural Electrification for schools and health facilities

Under the PERG program there were scattered attempts to equip schools, clinics and mosques, but the expected results were never obtained. Indeed, ONE had offered its concessionaires the opportunity to equip these public places in photovoltaic panels without any contractual constraint. ONE provided technologies and installed them through its distributors, but the safekeeping of the equipment had not been taken into consideration because it was the responsibility of Ministries. Cases of theft of solar panels on schools were reported, especially during the Summer and school holidays.

Equipping schools in rural and remote areas represents a huge, under-exploited potential market in terms of solar photovoltaic installations, while educational buildings in urban centers are less so due to their location near the conventional electricity network. This sector is also a great opportunity for social development in the region - lack of lighting and poor access to latrines and clean water are often cited as reasons that students drop out of school. Recognizing these constraints, the Department of Education has developed a rehabilitation policy for schools, offering solar energy as a partial solution to this situation.

The region includes about 850 schools, the vast majority in rural areas (494 rural schools against 322 in cities) according to statistics from the AREF in Meknes-Tafilalet. This figure includes all categories of schools, including primary, high school and higher education institutions. Moreover, it is important to note that for primary schools, each so-called "academic institution" consists of both a center and several nearby satellite schools. The 422 primary schools listed in rural areas therefore actually represent 1,464 buildings. In total, the region accounts for 1,547 schools in rural areas, all categories taken together.

To accurately measure this sector's market potential, it is important to know the number of academic institutions with no access to electricity. The table on the next page details the various sources of energy giving access to lighting (per institution category).

[68] Liaison-Energie-Francophonie n°78.

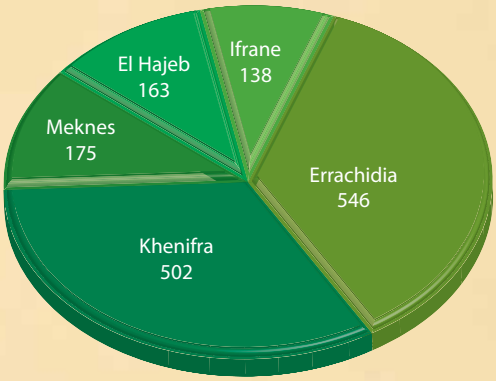
Table 15 - Sources of electricity in schools in rural areas, Meknes-Tafilalet region

Types of academic institutions	Connection to the electricity network	Solar Panel	Generator	Other	Total
Primary school	549	28	5	882	1,464
High-school	52	0	2	9	63
Higher education institution ("qualifiant")	19	0	1	0	20
Total	620	28	8	891	1,547

Source: Regional Academy of Education and Training Meknes-Tafilalet.

There are therefore approximately 1,550 rural academic institutions in the region, of which 991 schools have no access to electricity, 620 academic institutions are connected to ONE's grid, and only 28 are equipped with solar technology. The provinces of Errachidia and Khénifra offer even more potential due to the high number of academic institutions in each. The figure below gives us the percentage of schools in rural areas by province. The Province of Errachidia is the least connected province to ONE's network.

Figure 3: Number of schools in rural areas by province



Source: AREF Meknès-Tafilalet.

The institutional environment is favorable to the development of photovoltaic panels in this sector. Indeed, three years before the end of its ten-year Action Plan, the Ministry of Education launched an "Emergency Plan" to close the gap in the rehabilitation of schools by 2012. This plan provides for schools' access to electricity, water and sanitation.

The Ministry's stated objectives by this date are the following: (i) 100% of schools should have access to water and (ii) 80% of schools should have access to electricity, including 20% from PV panels[69]. The AREF recalls that the school dropout rate is primarily due to lack of latrines, clean water and electricity. Moreover, the need for electricity will only increase in the future with the creation of multimedia rooms, etc. The Convention on Energy Efficiency in the Education Sector also includes the electrification of school by PV panels in its plan.

In the health sector, there is potential to equip rural health buildings with photovoltaic installations wherever they are not connected to the grid. The table below details the type of existing health buildings and gives an estimate of this market, as the number of infrastructure equipped with solar technology in the region is not available.

Table 16 - Public health Buildings by province

Type of building	Meknes	El Hajeb	Ifrane	Khenifra	Errachidia	Total
Hospital	4	1	2	2	4	13
Local Hospital	0	2	2	0	5	9
Urban Health Center	27	1	5	11	10	54
Community Health Center	5	4	4	13	12	38
Community Health Center equipped with a labor room	14	9	3	21	21	68
Rural Clinic	16	3	22	24	32	97

Source: Direction régionale de la santé publique.

[69] These figures were provided by the Regional Academy of Education and Training (AREF) in Meknes-Tafilalet during an interview with its director.

Thus, 203 rural buildings could benefit from solar energy, a figure that includes clinics and community health centers with or without labor rooms. Some companies have already tried to penetrate the market by installing photovoltaic panels in villages near Ouarzazate (35 households) as well as in schools and mosques, thanks to the full coverage of the investment cost by municipalities.

The Chourouk on-grid connection, a national program

The production of on-grid solar electricity offers the greatest opportunity in terms of scale in Morocco. Indeed, it represents the bulk of the photovoltaic market in northern countries through the implementation of "feed-in tariff" incentive policies. Beginning in early 2009 Morocco has been actively developing this market, having launched the very first program enabling reinjection of electricity generated by a solar source into the grid. The program was named *Chourouk*. Pilot projects are being implemented in the Meknes-Tafilalet region to test this project. Meanwhile, the MEMEE energy strategy stipulates the provision of 10% of electricity though renewable energy by 2012, including 20% dedicated to electricity production. This 20% represents primarily wind power up to 1,000 MW and solar photovoltaic up to 500 MW by 2015 [70]. Based on the concept of diversifying energy sources, the *Chourouk* program aims to convert ONE's urban and semi urban customers to solar energy.

This program has two components: "*Chourouk* housing" and "*Chourouk* production". Completion of the first component is scheduled to take place in five installments between 2009 and 2013. The aim is to equip 200,000 customers with PV panels, photovoltaic microcogeneration power plants, ranging from 0.5 to 10 kW. This technology will ease the pressure exerted on gas turbines and other fossil fuel-driven processes. It is estimated this project will prevent greenhouse gas emissions of up to 50,000 tons per year.

ONE took the lead on the effort to demonstrate this technology by equipping its office in Casablanca with PV panels with a capacity of 49 kilowatts. Moreover, a contracting company has already been chosen to conduct two other pilot projects in the Meknes-Tafilalet. These projects will include the installation of 1,200 micro photovoltaic plants with capacity varying between 0.5 and 1 kW, to supply populations in Errachidia and Benguerir. The aggregate power of these facilities will be 1 MW in total, financed by concessional loans. Another pilot, which consists of equipping 200 households in the Ouarzazate region, is funded by a FADES donation and is currently being launched [71]. For the remainder (approximately 200 to 300 MW) projects are not defined yet, and ONE has not disclosed any information on options. These projects will most likely begin around 2010 [72]. Three plants will be built under the "Chourouk Production" component: one in Ouarzazate with a capacity of 50 to 100 MW, one in Boujdour (with a 5-10 MW capacity) and one in Dakhla (with a 1-3 MW capacity).

The on-grid connection provides more opportunities than the decentralized rural electrification: solar panels may produce up to 500 Wp, which represents 8 to 10 times the power of a photovoltaic installation for decentralized electrification. Moreover, on-grid connection is relevant in urban (and semi-urban) areas, which offer simpler working conditions than decentralized electrification. According to a calculation made by the CDER, the potential market for photovoltaic on-grid connection in the Meknes-Tafilalet region is estimated at 100 to 150 MW.

Although promising for the future of on-grid photovoltaic energy, the *Chourouk* project is not well aligned with market forces. In Germany, consumers can buy a solar panel, install it freely on their roof and sell their renewable electricity production at a good price to the state thanks to incentive policies in place, such as the "feed-in tariff ". However, the model used in the Chourouk pilot projects provides only a certain reduction on the electricity bill to customers, and the solar technology remains ONE's property. According to interviews conducted with ONE's officials, this model might not be renewed. ONE is looking for a financial package that is more driven by market dynamics and less focused on subsidies. This will only be fully achieved if the regulatory framework allows ONE to directly purchase electricity produced by solar energy from a third party.

Union for the Mediterranean's "Solar Plan" (UPM)

Like other Mediterranean countries, the export of solar-generated electricity represents a huge opportunity for Morocco. Indeed, the Mediterranean Solar Plan, one of the Union for the Mediterranean's flagship projects [73] aims to increase the development of renewable energies and to improve the Mediterranean region's energy efficiency. The plan includes the construction of 20 GW of generating capacity in renewable energy and a 20% reduction in energy consumption through energy efficiency by 2020. The plan states that the electricity will be consumed by the local market but also exported to the European Union [74]. This project will help stimulate competition and innovation between North African countries, as each has the opportunity to become a privileged

[70] The figure for the photovoltaic energy was mentioned in an interview with a representative from ONE.
[71] These figures are derived primarily from an article: "Solar energy to improve the rate of rural electrification in Morocco" published on May 9, 2008 in Soir Echos.
[72] According to an interview with an official at ONE in Casablanca.
[73] Launched on July 13, the Union for the Mediterranean (UPM) brings 43 countries together around a common project: to promote a new cooperation and development policy in the Mediterranean region.
[74] http://www.actu-environnement.com/ae/news/plan_solaire_mediterraneen_6435.php4.

partner for European markets. Morocco is well positioned: according to La Vie Eco, out of the sixty pilot projects selected under the Solar Plan, twenty were presented by Morocco [75].

Thus, photovoltaic markets exist at various levels: at the local level through decentralized rural electrification, at the national level with the possibility to connect all the power generated by renewable energies to the grid; and at the international level, by exporting solar energy to countries with a lower level of sunshine per year. Understanding how to connect these various levels of production is the next step. The box below, presents a vision of how the photovoltaic market could look in the future.

ONE's traditional grid.

PV panels in the future: towards an "Intelligent network"

The biggest challenge for the years ahead is to successfully connect the various electricity generating solar technologies: from household private production to large scale solar fields in the desert or other remote sites, and including linking countries to one another. Given the current centralization of existing electricity systems, the challenge is great. Yet, according to *Science & Vie*, a specialized French scientific magazine, "there is a solution in the form of three scalable complementary networks: the "Micro grid"; the "Smart Grid", and the "Super Grid".

The Micro grid. It enables consolidation of all private producers at the local level, with a grouping of private producing units (houses, residences, etc.) supervised by a computerized control center. Each of these units is then connected at the regional or national level to a Smart Grid on which solar power plants connect. All this orchestrated by "a smart dispatch unit" which draws its information from sensors installed on each Micro grid. This control center not only avoids power surges by regulating the system, but it is also likely to allow consumers to adjust their power consumption according to electricity prices.

The Smart Grid. It would consist of "smart sensors" capable of collecting temporal data on power consumption and measuring demand. Distribution companies would then pay more for energy consumed during peak periods. When electricity is expensive, the consumer can turn off appliances (refrigerators, heaters, etc.) only to turn them on again when the price of electricity becomes more affordable. This would lead to substantial energy savings. Some authors have even envisioned the creation of small boxes to program appliances that can be accessed remotely from a Blackberry, an iPhone or any other mobile device. This is what Thomas Friedman states in his book "Hot, Flat, and Crowded" (2008), which imagines the next 20 years with the presence of a "Smart Black Box "in every dwelling, capable of giving the customer the amount of energy consumed by each appliance, and the corresponding price of electricity, at any moment. Just as different types of plans exist for mobile phones, the customer will be able to choose his preferred economic option. The Smart Grid therefore allows both reduced energy costs and increased use of solar energy, thus removing the pressure on electrical infrastructure while “unclogging” peak hours. The Smart Grid can respond to meteorological hazards faced by renewable energy technologies - wind variability, bad weather and absence of sunshine for solar energy -adapting the power consumption to the availability and intensity of these natural resources. To go even further, the author imagines Smartcars running on electricity and becoming genuine storage units of electricity to be inserted into the network

[75] http://www.lavieeco.com/economie/13372-energies-renouvelables-ce-que-contient-le-projet-de-loi.html.

when the electricity price increases during peak periods. The Smartcar, which can source directly from the network by plugging it to the point of sale, can calculate the quantity of electricity stored overnight (thanks to batteries) that can be resold to the network by using the data from the usual trips and by keeping a reserve for contingencies.

The Super Grid. Finally, to connect the national Smart grids between countries, Super grids should be developed. They can be compared to an "electricity highway" capable of conveying large amounts of electricity from a country to another. While some companies, such as IBM, have already developed aspects of the Smart Grid on a small scale, organizing the development of this three-tier architecture remains a challenge for electrical engineers.

Source: Sciences & Vie, "Solaire, Pourquoi on peut enfin y croire", May 2009, and Thomas Friedman "Hot, Flat, and Crowded" (2008).

IV. Producers and importers of solar technologies

4.1. Solar thermal technology

Solar water heaters are mostly imported by Morocco. Only two local manufacturers of solar water heaters exist in the country: Tropical Power in Rabat and Phebusol in Meknes. These companies chose not to participate in this study and their products are not certified by the CDER. Another Casablanca-based company also manufactures solar water heater tanks, and assembles its own solar water heaters locally [76]. This technology is certified by the CDER.

Production. Producers of solar technologies supplying Morocco are mainly located on the Mediterranean coast, including Tunisia, Greece, Turkey and Israel, the European Union, with Spain and France, as well as Australia and China, the last of which provides mainly vacuum-tube solar collectors. The fifteen year-old solar thermal market in Morocco has undergone successive waves of imported goods, originally importing products from Europe and Australia, and then from Turkey and Greece.

Marketed products. To deliver these goods in Morocco, solar technology producers develop exclusive commercial contracts with importers-distributors based in Morocco. A dozen solar water heater brands are certified by the CDER and the most popular model is the thermosiphon. In 2008, a new company was established in Rabat selling vacuum-tube solar collectors imported from China. It received CDER certification in early 2009. China is by far the largest producer of solar water heaters in the world and specializes in vacuum-tube solar collectors. While this final product is now the most widespread model on the planet, this market is just beginning to emerge in Morocco and has yet to be completely accepted by professionals.

The table on the next page details the various solar water heater brands certified by CDER, their country of origin, their importing companies, and their main specifications (capacity, etc.).

[76] This company partially produces solar water heaters and always imports solar collectors. Professionals regard it as a local manufacturer because it manufactures and assembles solar water heaters in Morocco. This company produced gas and wood water heaters in the past, which enabled it to switch easily to solar water heaters.

Table 17 - Summary of CDER-certified solar water heaters sold in Morocco

Brands marketed	Country of origin	Local Importers	Product Specifications
Gioca	Turkey	Atcoma	150, 200 and 300 liter capacity CDER Certified in 2003 and 2007.
Solahart	Australia	Sococharbo	180, 320 and 440 liter capacity CDER certified product in 2003.
Edwards	Australie	Immosolar	Capacité de 180, 350 et 440 litres Produit certifié CDER en 2004.
Imperial	Turkey	First Metal	150, 200, and 300 liter capacity CDER certified product in 2007.
BP Solar	Spain	Energies Continues	150, 200, and 300 liter capacity CDER certified product in 2004.
Capsolair [77]	Israel	Capsolair	150, 200, and 300 liter capacity CDER certified product Company sold.
Giordano	Tunisia/France	Phototherme Giordano Maroc	Capacity of 150, 200, 300, and 500 liter CDER certified product in 2003.
Dimas Solar	Greece	Noor Web	150, 200, and 300 liter capacity CDER certified product in 2007.
Energy Poles	China	Energy Poles	Vacuum-tube solar collectors CDER certified product in 2008.
Elecmar		MEGASUN	CDER certified product.
Olympic Sun	Greece	SPOLYTEN	150 and 200 liter capacity CDER certified product in 2004.

Source: CDER.

Importation and distribution. Importers are generally small firms with fewer than 50 employees who take responsibility for retailing and distribution either directly to customers or through resellers-installers. Some importers note that the distribution component tends to be absent in Morocco and is filled by microenterprises (less than 5 employees) that are directly in charge of resale and often provide installation services. The importer does not need to pay the distributor and deals directly with these microenterprises at a lower cost. However, due to their size these companies cannot support the marketing, service, and storage functions that would be offered by larger and better organized firms. The size of the distributor and installer network varies between 5 and 50 service providers depending on the region within Morocco.

Services provided. Importers provide warranties of 5 to 8 years on equipment, passed through from warranty agreements signed with their international manufacturers /suppliers. However, in practice, some resellers and installers complain of a lack of discipline in this area. However, importers may work without a commercial contract with their installers, and without maintenance and after sales servicing contracts with their customers when they directly support installation. In addition, importers deal just as much with installers and retailers/installers that are not CDER-approved as they do with authorized installers. Indeed, CDER authorization for installation is not mandatory in Morocco. However, their "exclusive relationship" with suppliers requires them to maintain a high quality image, and some importers do maintain their facilities themselves and provide a service-oriented approach - keeping direct contact with clients and ensuring a timely response - in terms of maintenance.

[77] This company no longer exists.

Importers focus their attention on large Moroccan cities like Casablanca, Rabat, Agadir and Marrakech. In the Meknes-Tafilalet region the market is dominated by brands sold by a public company linked to MEMEE. Their advantage is a result of their long presence in the region in related products. Indeed, during the last 20 years the company has sold heaters, pools and plumbing equipment and continues to benefit from name recognition. As evidence of the regional market growth, this company's sales more than tripled between January 2006 and August 2008. The products sold in the Meknes-Tafilalet region are somewhat different than those sold in southern regions, however, as they are usually closed circuit and designed to be resistant to frost.

4.2. Photovoltaic technology

The global photovoltaic park is growing rapidly, with an average of 35% per year since 1998. In early 2008, world photovoltaic power was estimated at 10 GW [78] against 1,200 MW in 2000. Today, virtually all solar panel production is done in Japan, in the United States and in Europe. Four companies share half the market: Sharp, Kyocera, BP Solar and Mitsubishi Electric. The other major manufacturers are: German (Q Cells, RWE Schott Solar and Deutsche Cell), Japanese (Sanyo), U.S. (Shell Solar) and Spanish (Isofoton) [79].

Production. Solar collectors are not produced in Morocco; they are generally imported from European countries (Spain, France, etc.). Related equipment such as regulators and inverters are also produced abroad (Germany, Spain, Holland, etc.), while batteries, electrical cables and switches are produced in Morocco by companies like Ifrikia, Casabloc and Nexans. The following table lists the brands and origins of all the equipment related to the functioning of solar panels.

Importation and distribution. Photovoltaic panels are mainly sold by importers-distributors in Morocco of which some are ONE concessionaires working under the Global Rural Electrification Program (PERG). Indeed, as the final market analysis shows, solar photovoltaic energy in Morocco has mainly developed through decentralized rural electrification and, in a more sustained manner over the last 10 years, throughout ONE's PERG program. While a private market had developed in Morocco before the arrival of the PERG, since the inception of the PERG program the market has been dominated by subsidiaries of European manufacturers through ten-year long concessions with ONE. Moroccan importers, who mostly lack the capacity to apply for such tenders, have been unable to take fully advantage of this market.

However, one advantage of the PERG is the service oriented approach that ONE has developed over time as part of its concessions with private companies. Since the beginning of the PERG in 1998, three successive approaches have been implemented by the ONE: the direct approach, fully executed by ONE's teams, the semi-direct approach where the assembly, and after-sales service are provided by a private company, and the 'Fee for Service' approach in which the private service provider offers a complete "energy" service to the customer. Launched in 2002, Fee for Service agreements have included the supply and installation of photovoltaic panels, the installation of domestic electrical components including bulbs and accessories, and a maintenance service agreement including the replacement of equipment for a ten-year period.

Table 18 - Brands and origin of products complementary to photovoltaic panels

Additional equipment	Brands and country of origin of the products
Batteries (Morocco)	Ifrikia Africable Nexans Casabloc
Electric cables and switches (Morocco)	Sofa Elecmar Ifrikia
Regulators (abroad)	Steca (Germany) Phocos (Germany) Moving Star (Spain)
Converters (abroad)	Steca Master Volt (Holland)

Source: Interviews with importers.

[78] Sciences & Vie, *"Le solaire, pourquoi on peut enfin y croire ?"* May 2009, p 55.
[79] http://www.mieuxvivresig.ch/particuliers/electricite/connaitre-l-electricite/les-nouvelles-energies-electriques/lenergiesolaire/index.lbl.

ONE has three major distributors in Morocco: Isofoton (Spain), Temasol (France) and SunLight Power (Morocco). Other Moroccan importers that have won ONE's first tenders are Noor Web and Phototherme. The technologies provided are photovoltaic kits of 50, 75, 100 and 200 WP. ONE's concessionaires have up to 70 employees involved in the installation, maintenance, after-sales service and customer follow-up. According to interviews with distributors, the return on investment is estimated at two to three years, with a profit of less than 10%; this figure depends, however, on trip lengths and remoteness of the provinces serviced. The box below outlines PERG's financial terms.

Financial terms of the PERG

Electrification by photovoltaic kits is partly funded by the ONE directly to the provider, whose share per solar installation varies according to the system selected: MAD 4,500 for a 75 WP solar panel to MAD 13,000 for the 200 WP model. The client participates by providing an up front payment of MAD 700 to 900 and a monthly fee of MAD 65 for ten years (the equivalent of MAD 2 per day, which corresponds to the energy budget of candles, gas lamps or batteries of households over a ten-year contract life) payable directly to the distributor. The distributor passes the deposit on to ONE, which repays him within ninety days, along with the equipment subsidy. Based on interviews with distributors, the deposit and the grant represent about 80% of the investment cost and the remaining 20% are amortized by monthly installments paid by the customer over the ten year period.

To facilitate the financing of solar panels by customers, some distributors have approached microfinance organizations. Synergies and pooling of costs can be achieved between ONE concessionaires and microfinance institutions, with the concessionaires in charge of collecting the monthly payments from customers and the microfinance institutions in charge of collecting reimbursement on credits on a weekly or monthly basis. The results of these initiatives have been quite limited however. Concessionaires have felt that the interest rate given to customers was too high, and they preferred to give the 'credit' directly to their clients to facilitate the up front payment, by offering the possibility to pay back in three installments without interest.

Source: ONE Website and interviews with distributors.

Generally, importers-distributors not affiliated with ONE are small businesses with fewer than 50 employees. Solar photovoltaic technology rarely makes up the bulk of their activity, and interviews showed that the margin earned between the purchase of a solar panel from the manufacturer and its resale to end customers is around 10%. Indeed, their revenue comes largely from activities other than photovoltaic energy (ventilation, heat pump and electrical equipment) or other solar activities (solar thermal), with between 40% and 80% of activity not related to solar energy. Meanwhile, those who were working almost exclusively with the solar photovoltaic industry ten years ago saw their business shrink drastically with the arrival of the PERG, such that it may now be less than 80% of their total activity in certain cases. Finally, decentralized rural electrification of households no longer represents the primary market for importers-distributors. Indeed, the most important customers come from specific sectors such as telecommunications, defense, or public transport, including the ONCF for railway crossings.

Services provided. As for the solar thermal industry, companies that do not belong to ONE's dealership network sell their equipment directly to customers and work with their own network of installers, or they sell directly to retailers-installers. Warranties on equipment are not widespread in this segment of the market. Some offer a ten-year warranty on material and a one-year warranty for the installation, but these conditions vary considerably from one company to another. Accompanying services are poorly developed, as will be analyzed in more detail in the next section.

V. Service providers

Based on interviews conducted with professionals, two main marketing and installation channels for solar products exist: through importers-distributors themselves, or through installers or retailers-installers, some of which have benefited from CDER's "Energy House" program (see the box on the next page). This section focuses on analyzing the characteristics of installers and resellers-installers in the Meknes-Tafilalet region. One of the particularities of these companies is the marketing of both solar thermal and photovoltaic technologies at the same time. Both channels will be addressed together in this section.

An Energy House and a consultant for the program.
Source: USAID Program .

CDER's Energy House Program

The "Energy Houses" are microenterprises whose main activities are development and promotion of local energy services. They were launched under a program initiated by the CDER, based on the PERG and ONE's prior programs, such as the Pilot Program of Rural Electrification (PPER) initiated in 1988. A major component of PPER was *la Maison de l'Électricité* (Electricity House), a facility producing and distributing energy for a village, including charging PV panel batteries. With the PPER evolving into the PERG, the Electricity House also evolved towards a new structure: the Energy House. The first had non-profit status, while the second is a microenterprise. The commercial offerings of Energy Houses expanded to include both photovoltaic panels and other renewable energies, such as solar thermal.

One major difference between Energy Houses and others installers is that to be granted the status of Energy House an installer needs to obtain an installation license from the CDER. For this, CDER provided young entrepreneurs with a number of technical trainings. Indeed, more than twenty training sessions and twenty certification tests relating to the installation of solar water heaters and photovoltaics were organized for about four hundred business people in Morocco, from which two hundred fifty could operate throughout the kingdom.

The program focuses on four areas of training:

- *Microenterprise management:* business plans, management tools, legal and fiscal considerations, investment and financing;
- *Technical aspects of renewable energies:* varying depending on the future location of the entrepreneur (rural or urban). The topics covered are: systems and products on the market, technical features, standards and labels, scale & design, installation, servicing and maintenance;
- *Young entrepreneur certification:* training and testing the two types of solar panels (solar water heaters and photovoltaic);
- *New Technologies of Communication and Information (NICT):* introduction to computers.

According to the CDER, the Meknes-Tafilalet region has twenty Energy Houses, of which about half are operating in the solar sector. Most of these microenterprises sell solar water heaters; half sell solar photovoltaics and about a third provide equipment for solar water pumping. On average they have ten years of experience. The majority of them have business facilities and some have a storage location (less than 50 sq. m on average).

Sources: Interviews and field visits with the Energy Houses, and a follow-up report prepared by CDER: "Programme M-E, consultant - accompagnement".

Installers are typically microenterprises with a maximum of four or five employees, sourcing their equipment directly from the importer, or going through a retailer, and installing the product. Some of them only sell the technology without doing the installation: they are called retailers-installers. The activity related to solar energy is generally not their main activity. Most often, the solar industry only represents 5% to 15% of their activity, although in some cases it may go as high as 50%. Their main activity is installing swimming pool heating systems, or plumbing and electrical equipment.

Services provided. Services provided are often limited to the delivery and installation of equipment and maintenance services are not very proactive or preventive. In some cases, the maintenance becomes a retention tool: by making it free, the retailer-installer hopes to retain customers and attract others. It consists mainly of descaling water tanks and cleaning solar panels once or twice a year. Maintenance is often included in the after sales service, illustrating the struggle that these companies are undergoing to take advantage of what should represent the most bulk of their activities, i.e. services.

It is interesting to note that some major importers who have a strong commitment to quality with regard to their international suppliers, given their exclusivity contracts, often prefer to ensure the after-sales and maintenance services themselves in order to preserve their reputation. Meanwhile, installers, who do not have that kind of commitment with their suppliers, can freely increase the number of products sold, and may focus less on retaining customers. This can become a problem for an importer as a poor quality product may damage its brand and brand recognition may be weakened if the installer sells a wide variety of products.

Transportation. Transportation costs to supply the equipment to the importer fall most often to the installer. In some cases, importers provide tailored distribution services such as free delivery with the purchase of three and more solar water heaters. This distribution policy can motivate installers to purchase multiple products to reduce distribution costs. Customers are charged the delivery fee for a solar water heater after the product has been installed. According to data collected during interviews, the sale price of the product is often marked up by 15-20% over the purchase price from the importer, including delivery and installation charges.

Marketing. Marketing efforts are often quite passive and done by word of mouth. Indeed, one of the characteristics of service providers is their proximity to potential customers: because the bulk of their activity is not in the solar industry, they can reach out to their existing customer base with solar-product related promotions. This marketing strategy is still under-exploited by service providers however, as they lack the advanced knowledge about solar products necessary to advise potential customers.

Bargaining power. Overall, we observed that most of these companies work without any commercial contract with their suppliers and customers, and without an invoicing system. This situation negatively impacts installers by weakening their bargaining power with their customers. As summarized by one importer, *"since the installers network is very disorganized in the region, clients have a tendency to negotiate prices when the installers come to install the goods. The installers are the one who pay the price."* This is also the case with suppliers. Some installers complain: *"the prices importers offer us are not sufficient to cover transportation costs: they consider us as simple workers, as this was factory work"*.

Certification. This refers to another equally problematic issue: the recognition of installers' skills. Indeed, importers deal both with certified and uncertified (CDER) service providers devaluing the certification. Some installers remarked that: *"The problem is that as installer certification is not widespread, we, authorized installers are not valued. For example, plumbers who work in the solar industry may do it without proper training and without knowledge of these technologies and yet they take market share."*

A vicious cycle thus emerges: the shortage of approved service providers in the Meknes-Tafilalet region forces importers and retailers to resort to non-certified installers. This devalues the skills and expertise of certified installers and places them in competition with people who are less qualified and less invested in the solar energy sector.

However, some approved service providers note that not being accredited is not always a sign of incompetence. On the one hand, many service providers have expressed dissatisfaction with the content and quality of training provided by CDER, and on the other hand, some are not aware of the existence of these trainings. One importer commented: *"Some service providers have been working in the solar sector for ten years without accreditation yet they have acquired quality field experience."*

Funding. Financial capacity among small businesses remains very limited and these companies lack working capital. This limitation sometimes manifests itself in late payment to their suppliers, earning them a reputation as credit risks. This reinforces the "race for the most competitive margin", which encourages service providers to source their products at the lowest prices from multiple suppliers, often at the expense of the quality of products sold. Furthermore, installers usually pay their suppliers up front and they lack the financial capacity to offer financing methods adapted to the purchasing power of their customers (low income in rural areas) to stimulate customer demand and make these technologies accessible to the poorest segment of the population.

Thus, we observe that several functions of the value chain that are typically the responsibility of the service providers are failing, including market research, marketing, maintenance and after-sales service of products. In addition, a special cross-cutting issue common to all these issues arises: the lack of organization in the service sector. This applies to commercial links between service providers and importers and their customers and the lack of practical recognition of installer's accreditation. The vertical relationships between service providers and other stakeholders in the value chain are very limited. While service providers should be safeguarding the branding of materials and bringing more customers to their suppliers, there is a mutual lack of trust with service providers complaining of being treated as "mere workers" and suppliers complaining of a "lack of fidelity".

As for the horizontal level, service providers tend not to collaborate with one another and they complain of the individualistic attitude of their counterparts. Yet they would have much to gain by working together, through the sharing of resources, knowledge and skills. For example, transport costs for their supplies, equipment delivery to customer could be shared by making collective orders. Because of this lack of cooperation, service providers also lose some market share. In fact, the cost of transportation can sometimes be an obstacle to the delivery to remote clients. Because service providers are not organized by recognized and defined geographical areas, some prefer not to serve a client rather than assigning work to an installer operating within the geographical area in question.

However, some service providers are more open than others, as evidenced two projects undertaken by an Energy House in the Errachidia Province:

- Creating an association, the *Association Marocaine pour l'Environnement et le Développement des Energies Renouvelables*, based in Meknes, and whose goal is to create an Energy House network in the region;
- Creating a quality charter in order to standardize the quality of services provided by Energy Houses.

Unfortunately, these initiatives have not been continued by installers in part due to the geographical distance and lack of coordination between members.

The next section analyzes the various markets supporting the solar industry in Morocco.

VI. Supporting Markets

Supporting markets for the solar industry are relatively small in Morocco. This section will briefly introduce the inventory of these key markets, namely: financial stakeholders and financing tools available, training institutions in the field of renewable energy and companies engaged in the transportation sector.

Financial tools. In Morocco most financial institutions do not offer special conditions to fund projects related to renewable energies, as is the case in Tunisia through the PROSOL program. However, the CDER established a fund dedicated to providing guaranteed financing for projects in renewable energy and energy efficiency, the "FOGEER". This dynamic is supported by a financial leasing mechanism, the *Dispositif Global de Financement Leasing* (DGFL), also developed by CDER. The FOGEER fund is thus intended to guarantee investment credits granted by Moroccan leasing companies and operators willing to invest in this area, entrusted to DAR AD DAMANE who manages the fund on behalf of CDER. The FOGEER account is structured by the development of "channels" (solar water heaters, wind, energy efficiency, etc.) in the form of dedicated sub accounts. The table (opposite) presents the eligibility criteria for this fund.

Table 19 - Criteria for Eligibility of FOGEER

Eligible investments	Any investment related to renewable energies and energy efficiency, including those concerning collective solar water heaters.
Eligible projects	Any project meeting the sequencing and implementation modalities defined in the DGFL: any project whose funding package is between MAD 300,000 and 2,500,000 maximum.
Eligible companies	Any operator or agency involved in the industrial, commercial or services sector.

Source: CDER.

The fund's guarantee covers up to 70% of the investment credit granted with a maximum commitment of MAD 1,500,000 for the "FOGEER". Furthermore, the warranty only covers the principal, excluding interest, commissions, late interest, fees and accessories. The FOGEER also offers a 1.5 point bonus interest rate compared to a classic bank rate.

Today, the FOGEER accounts for approximately twenty projects, of which the majority are focused on the tourism sector. A similar tool for projects in the public sector is being developed by CDER.

Training. Trainings in the field of renewable energy, especially in the field of solar energy, are mainly provided by the public sector under two CDER programs. Through the Energy House program [80], CDER provides training to service providers, leading to accreditation on solar technologies covering the photovoltaic, solar thermal and solar water pumping technologies. Through PROMASOL's technical and financial assistance [81] CDER established a mobile training unit on solar thermal technologies in a training center in Marrakech as part of the cooperation between CDER and the A*gence de l'Environnement et de la Maîtrise de l'Energie* (ADEME). In addition, the Office for Vocational Training and Job Promotion (OFPPT) provides training in the field through its various training institutes (ISTA, ITA) and its offices around Morocco.

[80] This program is explained in detail in the section on service providers.
[81] This program is presented in Part 1 Section 3 of "Regulations and supporting tools in Morocco".

On the private side there are approximately ten consulting firms specializing in this field and providing services ranging from technical and financial feasibility studies to counseling and training sessions. Some technology providers (local importers or foreign companies subsidiaries) also train their employees or subcontractors. Although no special courses exist in the region Al Akhawayn University is positioned as a leader in the region, offering a few training units on these topics and operating an 'incubator' center for business creation.

Transport. The cost of transporting goods and services in Morocco is not competitive. According to a study by the United Nations Conference on Trade and Development (UNCTAD), transport costs represent 14.3% of the value of imported goods, which is one of the highest rates in the region, compared to 11.4% for Algeria, 7.3% for Tunisia and 4.7% for Turkey.

Indeed, as recorded in interviews with importers, in 2005, sending a container from Shanghai to Antwerp or from Antwerp to Tangiers cost about the same amount - 500 to 600 euros. Land transport also suffers from the influence of the informal sector and industry structure including the absence of insurance, or its prohibitive cost where available, and equipment that is an average of thirteen years old. Storage is also quite costly in Morocco, and many small importers prefer not to deal with stock.

However, the face of the transportation industry is changing with the extension of the port of Tangiers (Tanger-Med) and its transformation into a true hub of shipping containers from around the world. Rates are at around 160-200 Euros for standard containers of 20-40 feet, which complies with the international rates in force.

VII. Constraints and opportunities

To turn towards the recommendations to develop the solar energy industry in Morocco, this section summarizes the main constraints and opportunities identified. Four types of constraints have emerged from this study: service providers; market access; quality assurance; and the regulatory and incentives framework. This section highlights the existing opportunities in each of these areas.

Service providers: a strategic link

This analysis has identified the services sector as both the weakest link in the chain and the most strategic one. Indeed it offers great opportunities for the future development of solar value chains. Most service providers work without commercial contracts or invoicing systems, and they tend not to proactively develop those services that would build and maintain their customer base. These micro enterprises do not have sufficient funds to run their business, nor do they have relevant training to extend their activities in solar technologies as the solar industry represents just a small share of their total activity. The installers are not sufficiently trained on the solar products they sell. Moreover, most of the time, they do not market their products nor provide educational information to potential customers. Thus, the market stagnates and all the other links in the chain suffer the consequences: clients do not trust the technology available and do not know who to contact in case of a problem and importers suffer from the installers' lack of loyalty and lack of professionalism.

However, the proximity of service providers to potential customers is a great development opportunity for solar channels. Indeed, before entering a new market, any investor, whether local or international, seeks a reliable, competitive and market-responsive partnership. Service providers, because of their location and geographic mobility, their existing regional infrastructure, their logistical means, their networks and their direct customers, have the potential to become this perfect partner. To achieve this, they should strengthen their coordination, and exchange of information and expertise. Moreover, because the stakeholders in the services sector both work for thermal and photovoltaic channels, an intervention at this level will benefit both channels at once.

For a widespread access to solar products

Solar products are not easily accessible to the public in Morocco due to high prices, the lack of financial tools adapted to the purchasing power of clients and limited communication and advertising about these products.

First, solar products are too expensive for the majority of the population. This is why the current markets usually focus on villas and holiday homes owners for solar thermal technologies or on rural electrification through photovoltaic panels, which is highly subsidized by the government (ONE). There is also a lack of involvement by the banking system, which does not offer financial products tailored to the purchasing power of households. Moreover, since solar water heaters are a one-time purchase, service providers cannot afford to offer financial plans such as installment payments to their customers.

Second, advertising on this kind of technology remains very limited in Morocco so that customers wishing to purchase or learn about solar technology do not know how to get the necessary information. Moreover, service providers are poorly organized - marketing initiatives are not actively pursued, and many opportunities to educate customers are lost. Experience shows that the economic argument is a decisive factor for customers, as solar thermal helps reduce energy costs. The study has shown that customers do express curiosity about solar products, something that needs to be exploited through large

scale advocacy and communication campaigns, with a particular focus on the possibilities for cost savings available over traditional energy sources in the hotel industry and elsewhere.

Towards a qualitative approach to equipment and services.

Globally there appears to be a race for the "most competitive margin" from service providers, which negatively impacts quality. Indeed, service providers look to sell the least expensive products and undercut the competition on price rather than through quality products and services. Similarly, although equipment certification and specific licenses for solar technology installation exist in Morocco, they must be strengthened both in terms of quality and use. Also, because they are not mandatory it does not play a structural role in framing the evolution of the solar technologies industry.

Yet, thanks to the extensive work conducted by CDER to develop a quality approach for the industry in Morocco, a great opportunity exists to encourage professionals to certify both their products and services by making these certifications a requirement for incentive mechanisms (tax incentives, preferential market or information access, credits, etc.). Furthermore, CDER's certification and authorization is costly and the short term benefits for private companies are not very clear.

An evolving regulatory framework

Morocco is developing its energy strategy with MEMEE's new "Energy Plan" that promotes renewable energies and energy efficiency in Morocco. However, incentives are still weak and the direction of the government, especially in terms of photovoltaic technologies, still needs to be clarified.

For solar thermal technology, many suppliers complain of "unfair" competition exerted by the gas water heater industry thanks to government subsidies to promote this energy source. In addition, many importers believe solar energy should not be taxed as it is not a significant source of financial resources for the state.

For the photovoltaic channel, ONE is a direct stakeholder in market development through its subsidized programs. We have seen that Moroccan firms benefited only marginally from tenders under the PERG. Furthermore, Moroccan regulation does not allow ONE to buy electricity directly from the private producer of renewable energy, as is common abroad in "feed-in tariff" incentive policies.

However, there have been some significant improvements. Regarding the solar thermal channel, some departments - housing, education, tourism, industry, etc. - have signed agreements with the MEMEE, leading to draft circulars, as was the case for the housing sector. For this sector, the circular encourages public actors to include solar thermal technologies in new construction, and encourages private stakeholders to build connections to hot and cold water on rooftops. Although these are not binding, this kind of text is a first step towards better inclusion of solar thermal technologies. In this same spirit, a more compelling energy efficiency code is being prepared. This institutional and regulatory context represents an opportunity to achieve concrete improvements and better integration of solar energy in the Moroccan construction sector.

The Renewable Energy Law authorizing electrical production and export of renewable sources energy, sent to the Cabinet in April 2009, represents a major opportunity for the photovoltaics market. The *Chourouk* program is the first application of this legalization supporting private energy production via solar sources. However, since the financial structure of this kind of project is not yet defined the debate on developing legislation to permit the purchase of solar electricity by ONE remains open. The time is ripe for local public and private entities to demonstrate that this market will not develop without "feed-in-tariff" incentive policies.

Part III • Conclusion

This study has given readers an overview of the structure of solar thermal and photovoltaic energy industries in the Meknes-Tafilalet region, the constraints and opportunities faced by each stakeholder throughout the value chain and the potential markets in the region. The study also helped readers become familiar with the existing policies and tools promoting these channels abroad, and to better understand the specifics in Morocco.

Before presenting the recommendations of this study, it is worth recalling the areas this study did not address. While it identified the emergence of a local production industry in Morocco, especially in Meknes-Tafilalet, this industry could not be addressed in-depth due to the reluctance of local stakeholders to contribute to this study. Thus, a separate feasibility study is required. Moreover, while the global supply of solar technologies is much broader than the segments discussed here, this study deliberately focused on technologies sold in Morocco, supplementing the analysis with information on other technologies when relevant. Finally, the export of solar energy produced by PV panels was analyzed only briefly since this study focuses on local Moroccan markets.

This section introduces long term recommendations for each level of analysis of the value chains addressed in this document, and proposes a "prioritization" or sequencing of these recommendations in the short and medium term. The idea is to identify steps to stimulate demand for solar energy in the short term in order to make Morocco more attractive to potential investors.

I. Recommendations

Using the development constraints and opportunities for solar channels described earlier, the following section identifies long term actions to develop markets while reinforcing the value chain. The recommendations comply with the proposed structure of the value chain analysis and are divided into three categories: those related to the value chains, supporting markets for the solar value chains, and the regulatory and institutional framework.

The solar value chains

1. Strengthen the service sector in the Meknès-Tafilalet region by bringing service providers into a network built on business partnerships to improve their competitiveness and enhance their integration in the value chain.
The service sector has emerged as the weakest link on the value chain because of their lack of organization and their isolation from their counterparts. These small businesses will benefit greatly through improved collaboration.

Indeed, service providers will improve their competitiveness if they share on logistical expenses (storage space, transport) or import their products collectively. In terms of markets, the network will provide members with a framework to formalize their work methods and enhance their integration in the value chain, improving their negotiating capacity with suppliers. The network will also benefit from information, communication and training facilities enabling individuals to enhance their skills. For any local or foreign supplier/investor wishing to penetrate markets in the region, this network will become a reliable and professional interface to develop business partnerships for the benefit of strengthening the actors in the chain.

USAID's "Improving the Business Climate in Morocco" program has pursued work along these lines through the creation of the first network of renewable energy installation specialists in Morocco: "RESOVERT" (the Green Network). It includes a dozen members and extends throughout the whole Meknes-Tafilalet region. The box on the next page traces the major achievements and key objectives of this network.

RESOVERT, an introduction

RESOVERT, the first network of renewable energy installers and service providers in Morocco operating today in the Meknes-Tafilalet region seeks to foster trade partnerships between national and international technology suppliers - potential investors in the region - and between local installers and service providers. It aims to ensure quality service for the customer and to contribute to the attractiveness of the region in terms of renewable energy. This network was formed through a partnership between USAID's program and CDER.

Facilitated by a coordinator, RESOVERT focused its actions on three main areas:

1. *The pooling of resources and services available to the network*: storage space, transportation means, commercial space, technical equipment, etc.

2. *Improved professionalism*: the network has resources and tools to improve professionalism and credibility with investors. Namely:
   - A "quality charter" that sets out members' commitments to transparency, quality and professionalism;
   - Contract templates: outsourcing, product invoices, maintenance and after sales service.
   - Estimates and invoices templates;
   - Appropriate means of internal communication: business cards, letterhead.

3. *Training:* training units to improve members' technical and leadership skills are being carried out in partnership with CDER and the main training coordinators in the region.

Members' profiles are as follows:
- Average age: 41 years;
- Service providers with at least one CDER certification per member;
- Total experience for the network: 98 years;
- Average company age: 7 years;
- Number of jobs: 25 permanent, 26 temporary;
- Average size of business premises: 47 sq. m;
- Average size of storage spaces: 81 sq. m.

Several technology providers, including branches of foreign companies, have expressed their willingness to invest in training and capacity building to benefit network members while building business partnerships with RESOVERT.

Source: USAID Program.

RESOVERT members, facilitator and partners.
Source: USAID Program.

2. Promoting a development approach fostering value chain strengthening at the local level, including through public tenders.

Two new market opportunities make it important to focus on the development of the local workforce. On the one hand, private production of photovoltaic electricity for local consumption and export represents the future of the photovoltaic sector. This development cannot be achieved without strengthening the capacity of local stakeholders and links between them and other actors in the value chain. Meanwhile, the Government has shown interest in the development of this local industry through the creation of an industrial zone dedicated to renewable energy in Oujda called "Kyoto Pole". This zone was launched in early July 2008 with a compelling incentive to have a 35% rate of added value at the local level. Local expertise is growing slowly in the production of some equipment auxiliary to PV cells such as batteries and electrical equipment as well as the water tank for solar water heaters. The development of these markets will not be achieved without strengthening the capacity of local stakeholders and a better integration of actors in the value chain.

The way in which tenders are constructed may determine the importance given to foreign companies and Moroccan SMEs. Indeed, if one looks at the PERG, this program has excluded a large proportion of importing Moroccan SMEs and service providers. The tenders were not proportional to their capacity and therefore benefitted foreign firms.

Thus, ONE's request for submissions could support the inclusion of more Moroccan companies by reducing the number of clients to be reached per concession. This would ensure that a minimum of materials produced in Morocco would be used by the distributors and that the existing service providers would be integrated as subcontractors to these concessions in a more systematic manner, so they can benefit from trainings and transfer of expertise.

3. Build awareness among potential customers to communicate the return on investment of market niche offerings.

Solar technologies are expensive but some niche markets now offer a fair return for the private investor. During the interviews, we noted a lack of knowledge on investment profitability in terms of solar technologies, existing products and marketing channels. This lack of information hampers the development of solar markets. Some service providers have taken initial steps such as scheduling product demonstrations and by including marketing activities in their budget. However, these events have had a rather limited impact.

To address this constraint, while leveraging niche markets that are already providing a return for private investors, we recommend organizing communication campaigns focusing on the competitive aspect of solar technologies in relations to conventional energy sources such as electricity and fuel. These campaigns should inform people about the profitability of such investments, the existing modes of financing and the various technologies available. Tourism is the first industry targeted. To develop these markets, awareness building activities have been conducted by the IBCM program (see box below).

Awareness campaigns

On March 13th, 2009 USAID's "Improving the Business Climate in Morocco" in partnership with the Regional Investment Center (RIC) in Meknes-Tafilalet and the Center for Renewable Energy Development (CDER), organized a workshop promoting solar water heaters in the hotel sector. The objective of this event was to demonstrate the economic advantage of equipping buildings with solar water heaters, gradually meeting the region's peak tourism demand. This event targeted all types of classified hotels and related tourism institutions in the region, namely: luxury hotels (3 to 5 stars), tourist lodges, guest houses and cottages.

Presentations were made on the profitability of such investments and on the existing financial tools available - including CDER's FOGEER, a guarantee fund. Some hotels already equipped with solar technologies shared their experiences with the audience. Five tourism establishments, including three hotels, a rural cottage home and a holiday residence located in the provinces of Meknès and Errachidia demonstrated their commitment to equipping their establishment in solar thermal technology by signing letters of intent. Two of them are scheduled to agree on a partnership agreement with the CDER under the FOGEER guarantee fund, through which financial and technical feasibility studies will be supported.

Source: USAID's Program.

Recommendations related to supporting markets

1. Encouraging the development of financial products adapted to customers' purchasing power, in collaboration with public and private agencies responsible for energy resource management, and promoting access to finance for Moroccan SMEs committed to renewable energies.

The high cost of solar technology in Morocco remains a major obstacle to its widespread use. Meanwhile, few financial mechanisms have been put in place to ease the payment financial burden. There is a major initiative in Morocco in this area: the FOGEER guarantee fund whose use remains limited.

Indeed, in 2007 the CDER established the FOGEER guarantee fund, to guarantee up to 70% of the amount of investment in renewable energies made by Moroccan companies, which includes a bonus rate of one and a half points on the interest rates. This fund is used in correlation with a lease financing mechanism. However, this mechanism applies only to investments above MAD 300,000, an amount still inaccessible to small institutions (households, bed & breakfasts, etc.). To date, about twenty applications for this fund are being processed, but only one project has been completed [82]. Under this mechanism the technology provider requested by the client must commit, over a three year period, to a Guarantee of Solar Results (GSR) contract developed by the CDER [83]. This sets the required performance levels for the installation, which must be met by the supplier under penalty of refunding the customer. While this "GRS contract" is a factor in ensuring the quality of the installation and after-sales service, the interviews revealed that this mechanism is not always welcome by the supplier. The quality approach is not yet well structured in Morocco and communication efforts on benefits and conditions are needed to increase the use of this tool.

For smaller projects, no specific financial investment tool exists in renewable energy in Morocco, except for a few random cases. Nowadays, in most cases, a solar water heater is paid for in cash once it is installed. One option is to develop innovative ways to reimburse customers for products through a system of monthly installments based on the needs of the consumer. As the photovoltaic industry developed innovative financing schemes - under the PERG or independently from ONE [84], with a down payment and monthly installments, the solar thermal chain could consider this model and develop its own funding arrangements.

[82] A cannery in Agadir.

[83] The three year period starts after an "auditing" period of 365 days.

[84] A few former ONE concessionaires have developed financing methods providing funding flexibility solutions to customers through down payments and monthly installment solutions adapted to their income level.

However, there is an added difficulty for solar thermal technology. In terms of photovoltaic energy, ONE's concessionaires often report directly to the customer to collect the down payment and the monthly installments. In the case of the solar thermal value chain, importers sell mainly to retailers or installers and have no direct relationship with the customer. While ONE's concessionaires can afford to offer this mode of reimbursement, this is not necessarily the case for service providers, who, generally speaking, have less financial capacity. For service providers to offer this option, credit would first need to be granted more easily, or, service providers could also receive a graduated payment plan on the original equipment from the supplier, which is not currently the case.

Provision for consumer credit could also be considered, as this is a well developed area for other types of products in Morocco. Also, so as to generalize these mechanisms, innovative financial products can be developed in collaboration with public and private bodies responsible for the distribution of power resources, as is the case in Tunisia. Through its PROSOL program, Tunisia has developed a unique system including the repayments of loans in the customers' electricity bill (paid to the STEG, a public body) thereby securing the repayment of loans while obtaining favorable interest rates. This program includes, among other things, a two point bonus on the interest rates charged by credit institutions. Morocco could therefore follow that example, although this work would require a sustained coordination effort between the various bodies that manage the distribution of electricity in Morocco - the ONE and other distribution authorities. Tunisia benefits in this case from the fact that the STEG has a monopoly on electricity distribution.

2. Strengthening training in renewable energy and stimulating R&D in this field.

The study reveals a significant need to train service providers and to value CDER-issued installer licenses. According to the interviews, courses for service providers are mainly provided by the CDER through PROMASOL and Energy House programs. Other channels exist among technology providers and training organizations, such as the OFPPT and Al Akhawayn University in Ifrane.

It is therefore recommended that (i) trainings undertaken by the CDER be better publicized so that the maximum number of service providers can be reached, (ii) public-private partnerships between CDER, other training agencies and solar technology providers be developed, thus enabling all parties to stay aware of market needs through education and information on cutting edge technologies and best practices; (iii) promote the development of specialized curricula in the field of renewable energies by public and private training bodies.

One of the major problems faced by installers is the devaluation of their expertise and the lack of recognition of the CDER certification, so it is important that any training in this field carried out by private or public organizations incorporate and integrate CDER's license for solar technology installation.

The regulatory and institutional framework

1. Establishing a taxation system of traditional energies, as well as preferential tax treatment for renewable energies, in order to improve the competitiveness of solar technologies. This can be accomplished through a gradual reduction of gas subsidies (which are indexed on oil prices) so as to not penalize the poorest segment of the population.

The solar water heater's biggest competitor is the gas water heater. Butane gas is heavily subsidized by the government, and knowing that gas prices are indexed on oil prices, fluctuations of crude is mitigated by the government through a compensation fund. To make solar water heaters more competitive in the market compared to conventional energy sources, gas subsidies must be reduced. However, this reduction must be gradual so as not to penalize the poorest segment of the population, which in any event generally has lower levels of energy consumption than households with higher incomes. The gas subsidy would therefore be maintained for the poorest segment and would be gradually reduced as gas consumption increases.

Another measure to improve solar technologies' competitiveness with fossil fuel is to establish a preferential tax treatment for solar technologies. Today, these technologies already benefit from a VAT reduction on hardware sold (from 20% down to 14%), but this has been reported as insufficient by the private professionals interviewed. Meanwhile, services relating to solar energy remain taxed at up to 20% VAT. While service providers are struggling to make solar costs effective, we also recommend applying a preferential tax on service and maintenance.

2. Encouraging electricity production through renewable energy sources, including solar, by developing a "feed-in tariff' incentive policy that sets the purchase price of solar-produced electricity at a higher level than the price of "traditional" electricity over a given period of time.

Besides waiting for the price of PV panels to come down drastically in the coming years, a "feed-in-tariff" policy incentive is recommended for Morocco to develop this sector. This will encourage private electricity generation through solar energy, as well as increase involvement from private companies who will offer the most cutting-edge technologies. The regulation must send a clear and stable signal to the market stakeholders by setting the purchase price of electricity produced by a solar source at an "incentive level", that is to say more than the price charged for conventional electricity on the market.

ONE's *Chourouk* program has been able to provide a partial market signal indicating a willingness to promote the grid connection to solar energy, but without providing any financial plan providing enough profit to encourage consumers and private producers to get equipped with the new technology. By proposing a reduction of the electricity bill in exchange for electricity generated by solar energy, and not a purchase per kilowatt hour, this program offers its customers neither the possibility to calculate their own profitability, nor to own their equipment, as the solar installation remains the property of ONE. By offering a higher price than conventional electricity, Morocco would stimulate demand for solar energy which would, in turn, encourage technology providers to penetrate this market by offering the most innovative technologies.

3. Making the inclusion of solar water heaters in new buildings mandatory in the medium term and preparing the supply of solar thermal related technologies.

A major obstacle to the widespread use of solar thermal energy in Morocco is the lack of systematic inclusion of solar water heaters in new buildings. Indeed, 150,000 houses are built in Morocco each year - a huge potential. These days, private companies consider this omission as a real issue in terms of technical feasibility. In practice, eliminating this obstacle would entail incorporating a hot and cold water connection on new building's roofs in anticipation of possibly installing a solar water heater.

In some countries, like Spain or Israel, solar water heaters have become mandatory in some types of buildings. In Spain, the Technical Code of Construction requires the installation of solar panels in new buildings. In Israel, a law makes it mandatory to include solar thermal technology in public service buildings such as hospitals, schools, or retirement homes. Without going that far, we recommend making the provision of a potential inclusion of solar water heaters installations in new constructions' plans mandatory - something that would primarily imply installing connections to hot and cold water on the roofs of new buildings. The final decision to incorporate a solar water heater or not would therefore have to come from the owner for private homes and from the government for public buildings.

However, the requirement to include solar water heaters in the plans of new buildings should be supported by an increase in supply both at the technical and technological levels. Indeed, the current structure of the value chain would not allow for suppliers to absorb such an increase in demand. The distribution network, which is weak today, should be strengthened and industrial production should then be encouraged. Indeed, importing foreign equipment does not constitute a lasting solution.

4. Improving the quality of solar value chains by making equipment certification and installers' accreditation mandatory in Morocco.

Product certification plays a key role in a market structure. It is the guarantee of quality and trust between the merchant and the customer. However, in Morocco the added value of having a certification of solar equipment is questioned by many professionals. Some find that it is not strict enough, while others question the need to re-certify equipment that has already been certified by foreign standards, namely European ones.

This study considers the reinforcement of CDER's certification as essential in order to develop the quality approach of solar value chains in Morocco. This reinforcement could be two-fold. First, to respond to those who consider it too soft - thereby allowing the dissemination of poorly made products in the market - the CDER certification could be applied at several levels so as to best reflect differences in quality. This would allow consumers to differentiate the high quality suppliers from the others, while providing them with more information on the quality of the products sold. Second, to avoid duplication of certification efforts and to discourage new players on the market to adopt it, a list of international certifications recognized in Morocco should be established. This would facilitate access to CDER certification by allowing products already certified abroad, and appearing on this list, to be recognized in the CDER certification process.

CDER certification is not mandatory in Morocco, with the negative effect of encouraging the illegal importation of equipment of any kind, since the prospect of non-certification is not a deterrent to penetrate the market. Once the certification process is strengthened, it will be highly recommended to make it mandatory.

A parallel debate should begin regarding CDER's accreditation to install solar technologies. The government or other stakeholders could develop a number of incentives to encourage use of CDER-certified installers. This could include financial incentives, such as decreasing the VAT on services carried out by any authorized installer as well as the requirement of certified products and accredited installers for public tenders.

Furthermore, CDER's certification could also be strengthened by giving more recognition to installers established in the region. It is therefore recommended

that an online installers' directory be created for the area. This list could be hosted on the Meknes Regional Investment Center's website and with other local partners. Formalizing accredited installers should stimulate non-accredited installers to seek certification in order to benefit from this positive publicity. Moreover, it should allow investors to have a precise and clear view on the location of service providers and to adapt better to the market.

II. Recommendations priorities

Before closing this study, there is one remaining task. Due to the resources required, it is unlikely that Morocco can implement all of the above mentioned recommendations in the short and medium terms. Therefore, these recommendations must be prioritized to provide clear guidance on steps needed to develop the solar sector. Morocco has not yet set in place a large scale generalized subsidy policy to develop solar channels as is the case in Europe through the development of "feed-in tariff" incentive policies for photovoltaic technology and bonuses granted for the purchase of solar thermal technologies (depending on the total area covered of solar water heaters installed). Although the use of subsidies to finance a few major projects in renewable energy, together with a portion dedicated to the project at "lost equity" is being considered under the *Fonds de Développement Energétique Marocain*, the present study examines possible short-term actions to implement in order to develop the solar channel markets in Morocco, until technological advances allow for the reduction of costs and make it more accessible for the public.

The idea is to focus on actions to increase demand for renewable energy in order to develop markets and to make Morocco more attractive for suppliers and potential investors. In this context, this study suggests priorities for the recommendations, focusing on one recommendation for each of the three categories analyzed: the value chain, the supporting markets, and the regulatory framework. The study concludes by outlining what each of these items implies for the customer, supplier and Moroccan government.

The value chain. The most urgent recommendation is to strengthen the service sector. Indeed, in this transitional period during which solar technologies are still expensive, and where technological breakthroughs are still needed to improve price competitiveness, Morocco should take this opportunity to strengthen local stakeholders throughout the chain. There is a particular need to strengthen the system of service providers - the weakest link and yet the most strategic one in the chain - to enhance attractiveness to investors. Any foreign company that gets a foothold in Morocco, or any local company willing to penetrate another region's market, will be looking for a reliable and professional partner. Encouraging the development of a network appears to be the most effective method to develop the competitiveness of service providers, their capacity and skills. In addition, strengthening services will, at the same time, increase the consumers' confidence in these new technologies.

Supporting markets. The first item Morocco must address is the creation of financial tools adapted to the purchasing power of consumers. One tool exists in Morocco, the FOGEER. It helps private investors mitigate risk, but the minimum MAD 300,000 investment required does not enable use for small buildings, such as private residences, holiday homes and bed & breakfasts. If Morocco wants to support universal access to solar technologies without waiting for the prices of products to come down, credit institutions will have to develop financial products either using a consumer credit model, leasing, or through the electricity bill by collaborating with organizations responsible for public electrical distribution.

Regulatory framework. While waiting for the subsidies to stimulate demand for renewable energy, other tools requiring less financial investment from the government are possible in the short term. Among these tools, there is a "taxation" system of conventional energy. In the Moroccan context, this entails reducing subsidies for fossil fuels, especially oil and gas. This tax will make fossil fuels more expensive while increasing the competitiveness of solar technology, especially solar water heaters. Currently, Morocco does not have the necessary resources to artificially improve the price of solar technologies through subsidies. Yet, it could achieve it the same ends by reducing subsidies on fossil fuels.

Thus, by simply implementing these three recommendations, *a consumer* will be assured that they will benefit from after sales service and maintenance and that they will be able to afford this technology through a loan. Such a loan may be granted by a credit institution in collaboration with the supplier - allowing the customer to repay the equipment by monthly installments - or in collaboration with energy management agencies on the energy bill (energy savings made by replacing fossil

energy with solar energy allow the customer to pay the cost of investment spread over a fixed period of time). Meanwhile the cost advantages will continue to go up as fossil fuel subsidies are decreased.

As for *technology providers*, they are more likely to enter new markets in Morocco - or to expand their markets in other regions for local suppliers - if they know that they can benefit from strong partnerships with a network of professional, CDER certified installers. Furthermore, the suppliers do not fear weak reimbursement for solar technologies by their customers, since monthly installments can be subtracted directly from the clients' electricity bill (in this case, the state pays the supplier up front for the cost of the technology through credit institutions). Moreover, the tax on fossil fuels should allow the supplier to have a stable price indicator, making solar technologies competitive, and should allow the introduction of ever more efficient technologies in the market.

And finally for the *government*, the country will be better positioned to accommodate investors while creating jobs nationwide and stimulating a small portion of the economy. It will also have stimulated credit institutions by encouraging them to diversify their offerings, and by working with energy distribution government agencies. Finally, Morocco should be able to reduce its energy bill by reducing its subsidies on fossil fuels, and more importantly, it will be using energy from renewable sources. Thus, implementing these reforms will increase demand for renewable energies and reduce Morocco's dependence on imported energy.

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Appendices

Appendix 1 - CDER's assumptions for calculating potential markets

Schools and Higher Education

University dorms: 40 liters per person.
Rural boarding schools: 30 liters per person.

General points

1 kWh is equivalent to 0.766 Kilograms of CO_2 avoided.
1kWh = 8.6 * 10-5 TOE.
1 sq. meter produces 700 kWh / year.
Cost per sq. m: MAD 5,000 all taxes incl. with VAT at 14 %.

Health

Health Centers	Solar Water Heater (SWH)
Hospitals	20 litres par lits
Urban health center (pop<30,000)	0
Urban health center (pop>30,000)	0
Urban health center with delivery room	2 sq. m per center (150 liters)
Municipal health center	0
Municipal health center with delivery room	2 sq. m per center (150 liters)
Delivery/labor center	2 sq. m per center (150 liters)
Rural clinics	0

Tourism

Category	Ratio (liter)	Capacity SWH (liter)
4*	80	272,960
3*	60	132,300
2*	40	47,840
1*	30	21,120
Hostels	50	41,000
Vacation home	50	31,500
Listed bed & breakfasts	40	10,120
Guesthouses	60	18,240

Sourc : CDER.

Appendix 2 - Principles of the renewable energy draft law passed before the government council in March 2009

Point #	Principle
1	**A permit system** applied to the construction, operation, capacity expansion or modification of plants producing electricity from energy sources;
2	**A reporting requirement** prior to the implementation, operation, capacity expansion or modification of plants producing electricity from renewable energy sources;
3	**Definition of areas of the country** for potential development sites of wind energy;
4	**Connection of plants producing** electricity from renewable energy to the national high or very high voltage grid;
5	**Definition of terms and conditions** for the application of this draft law concerning the connection of electric power from renewable energy sources to the national medium-voltage grid;
6	**Marketing** of electricity produced from renewable energy sources;
7	**Meeting** the needs of the domestic market;
8	**Operators right to produce** electricity from renewable energy sources on behalf of a consumer or a group of consumers connected to the high and very high voltage grid, under a contract which provides the commercial terms of supply of electricity;
9	**Exportation** of electricity produced from renewable energy sources after national needs are met, using the national network or in case of insufficient capacity available, the possibility for the operator to use the power lines as part of a concession agreement established with the national power grid operator;
10	**Principle of access** to the national transportation system for operators of electricity production facilities from renewable energy sources;
11	**Monitoring, recording violations and criminal and administrative sanctions.**

Source: Bachir THIAM, L'Economiste, "L'arsenal juridique pour commencer : 11 grands principes approuvés par le Conseil du Gouvernement » (3/14/09).

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