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.
- **Aïn 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]: Circular on CDER’s reorganization.
[^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.
Before analyzing Morocco’s institutional context and the accompanying measures implemented to promote renewable energy 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. 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 against 0.30 to 0.55 € /kWh 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. 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 CO2 emissions by 3.3 million tonnes annually with its RPS, and aims to achieve production of 2,000 megawatts of renewable energy by 2009.

A popular tool in this context are Renewable Energy Certificates (REC). Also known as “Green certificates” 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.

Table 1 - Potential for renewable energy in Morocco

| Source: Liaison Energie-Francophonie No. 78. |

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

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” was developed in May 2008. 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.

(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 for solar thermal or photovoltaic technologies. Some countries also offer reduction of the Value Added Tax (VAT) on purchase and sale of equipment (this is the case in Morocco).

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(22) Electricity and RECs are most often marketed separately.
(24) To achieve this, the RECs must prove a CO2 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**

<table>
<thead>
<tr>
<th>Country</th>
<th>Solar Thermal</th>
<th>Solar Photovoltaic</th>
</tr>
</thead>
</table>
| 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 €/kWh over 20 years  
  Gradual decrease of 5% / year  
  5 €c / kWh bonus for systems integrated on the building’s façade. |
| France        | 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**: 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% |
| 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. |

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**Notes:**
- [n](1) The 2005 Finance Act and website of the ADEME.
- [n](2) These prices vary depending on the Länder.
Australia Grants and Renewable Energy Certificates:
Grants 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 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).

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 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, 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>
<thead>
<tr>
<th>Country</th>
<th>Solar Thermal</th>
<th>Solar Photovoltaic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>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).</td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td>Exemption planning permission for the installation of solar panels (2005).</td>
<td></td>
</tr>
<tr>
<td>Israel</td>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>

Sources: planetenergie.org; rtbf.be; energie.wallonie.be; 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) 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 CO₂ 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 CO₂ - 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 CO₂ 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 CO₂ 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 (iii). 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

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(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.
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.

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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 or renewable energy resources.

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.

(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.
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.


**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.](image-url)
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.
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.

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) 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.

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149 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.