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SOLAR BUILD

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Integration of Solar Technologies into Buildings in Mediterranean Communities

Electronic guide

CRES

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ΚΑΠΕ
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1 Introduction

The project SOLAR-BUILD[1], financed by the European Commission (INCO programme) is expected to contribute significantly to the uptake of solar technologies to meet cooling, electricity and heating needs in buildings in the Mediterranean communities, through the establishment of new links and information exchange between relevant professional fields.

Under this frame, this e-guide has been compiled, so as to form a basis for the diverse market actors & stakeholders including: architects, building engineers, solar technology manufacturers / retailers, local authorities / municipalities, central government departments, in order to help understand the capability in Mediterranean countries and increase awareness on solar applications (both thermal and PV) in buildings.

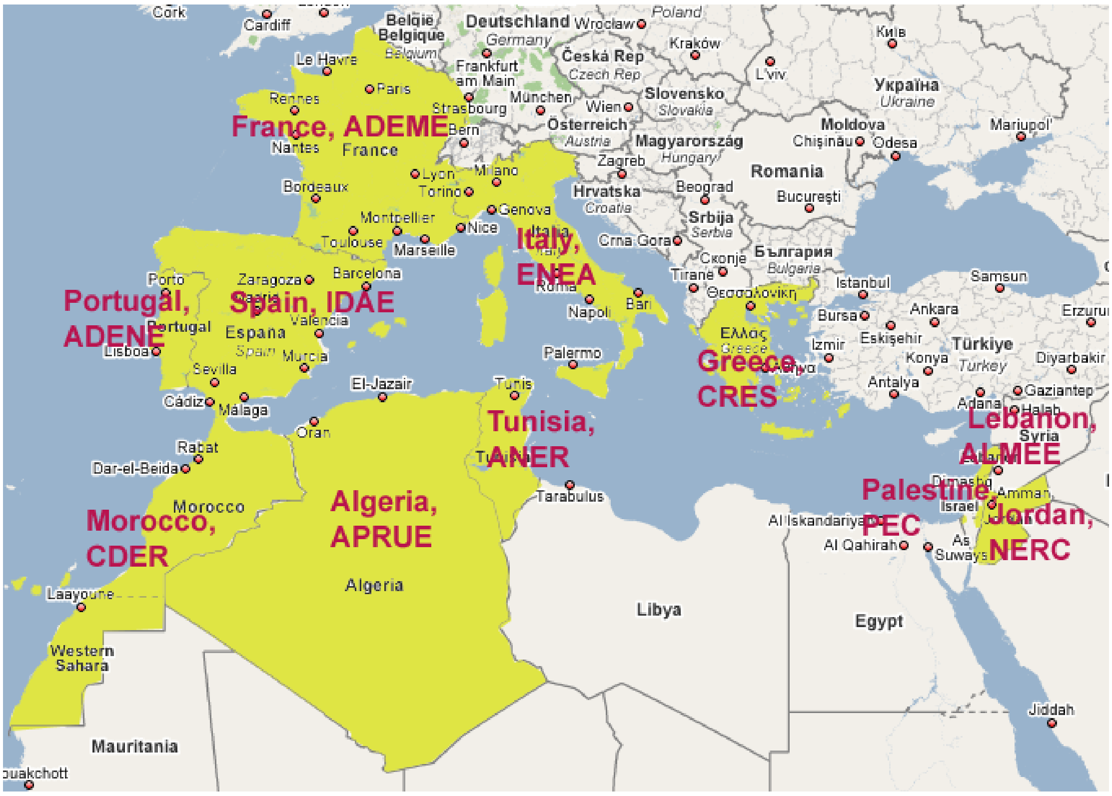

Figure 1. Map of participants per country in the SOLAR BUILD project [source of map: http://maps.google.com]

As can be seen in Figure 1, the eleven countries participating in SOLAR-BUILD are: France, Spain, Portugal, Morocco, Algeria, Tunisia, Italy, Greece, Lebanon, Palestine, Jordan[2]. As can be observed in Figure 2, the solar potential of all these

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[1] For further information concerning the SOLAR-BUILD project please visit the project site: http://www.cres.gr/solarbuild/

[2] Apart from the 11 institutes from each country that participate in the project (ADEME from France, IDAE from Spain, ADENE from Portugal, CDER from Morocco, APRUE from Algeria, ANER from Tunisia, ENEA from Italy, CRES from Greece, ALMEE from Lebanon, PEC from Palestine and NERC from Jordan), UMAR (Union of Mediterranean Architects) is also a participant in this project.

Mediterranean countries is of the same magnitude, especially for their coastal areas in the Mediterranean Sea. Nonetheless, due to various reasons, discussed bellow, thermal solar and photovoltaic technologies have penetrated in different ways and proportions in the energy market of each country.

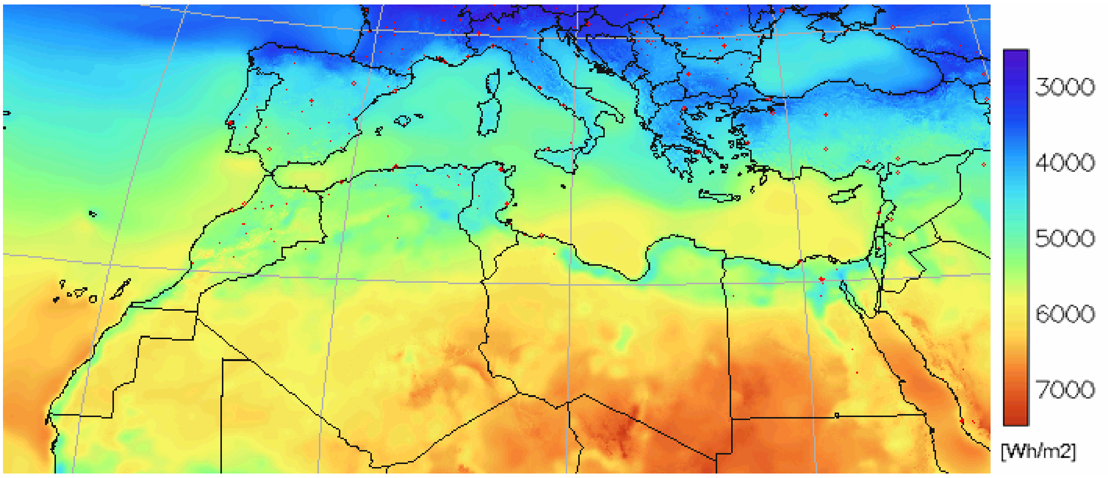


Figure 2. Annual solar potential of the Mediterranean area [source: Photovoltaic Geographical Information System (PVGIS), http://re.jrc.ec.europa.eu/pvgis]

2 Relevant trends, developments in Europe and Mediterranean Countries

2.1 France – Facts and Figures

Metropolitan France is located between 41° and 50° geographical latitude in the Northern hemisphere, in the western part of Europe, in the North Temperate Zone. It covers 551,695 km^2. Other parts of the country are allocated in North and South America, the Caribbean, the Indian Ocean, the Pacific Ocean and the Antarctica.

The economy of France is one of the most developed in the EU. The industry includes the fabrication of cars, electric equipment, machines and chemical products and it is equally an agricultural country, with many exports within the EU. Its economy today is moving towards the industry of services, including commercial activities, tourism, telecommunications and health.

2.1.1 Climate

There are four climatic types in France. The west of France benefits from a maritime climate, with mild, humid winters and cool summers, with frequent rainfalls. The central area of the country has continental climate, with longer and hotter summers and less mild winters. From Perpignan to Montpellier, Marseille and Nice the climate is Mediterranean, along the coast, with hot, dry summers and mild, humid winters. The fourth climatic type is the mountainous climate, with temperatures influenced mainly by the altitude, with long winters with snow.

There is great solar potential variation in France, ranging from approximately 2,000kWh/m^2 in the Mediterranean (similar to the potential of Greece and North Africa) to 1,200kWh/m^2 in the North (similar to the potential of Germany or Poland).

2.1.2 Building and Energy Data

In 2006 the building sector in France (both commercial and private) represented 46% of the total energy consumption at a national level and 25% of the emissions of greenhouse gases. During the last 30 years the energy consumption of this section has increased by 30%, due to the larger number of buildings, the improvement of comfort and the tardiness of adopting technical actions for energy savings.

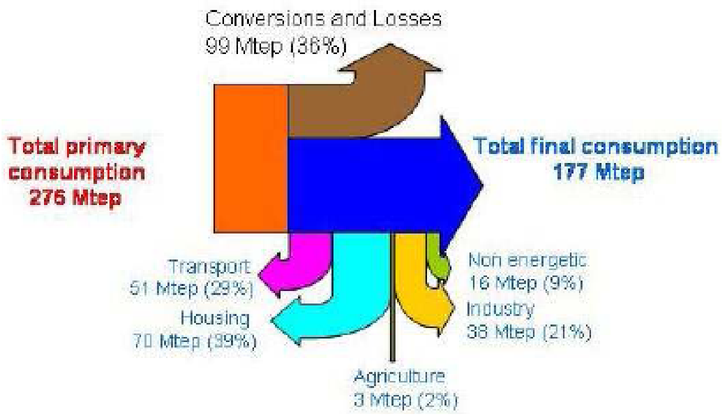


Figure 3. Total and primary energy consumption per end-use sector in France in 2004 [source: Ministère de l'Economie, de l'Industrie et des Finances – cited by ADEME]

2.2 Spain – Facts and Figures

Spain consists of Peninsular Spain, which is located between the Mediterranean Sea and the Atlantic Ocean, two archipelagos, one in each sea, and two autonomous cities in North Africa. The Spanish mainland is bordered by the Mediterranean Sea to the south and east, by the Cantabric Sea that includes the Bay of Biscay to the north and by the Atlantic Ocean and Portugal to the west. Spanish territory also includes the Balearic Islands in the Mediterranean and the Canary Islands off the African coast. It shares land borders with Portugal, France, Andorra, the British overseas territory of Gibraltar, and Morocco. With an area of 504,030 km², Spain is the second largest country in Western Europe.

2.2.1 Climate

The climate varies in Spain, due to its large size. It is generally characterised as Mediterranean, with hot, dry summers and mild, rainy winters. The vast central plateau, or Meseta, has a continental climate with hot, dry summers and cold winters. Rain generally falls in spring and autumn. The mountains surrounding the plateau have higher rainfall and often experience heavy snowfalls in winter. North of the Cantabrian mountains, the Basque Country, Cantabria, Asturias and Galicia have maritime climate, with cool summers and mild winters. The weather is often cloudy with frequent rainfall. On the Mediterranean coast, the climate is moderate with rain in spring and autumn. Murcia has an almost African climate and is characterised by numerous palm trees. Rainfall is low and the "calina", or heat haze, is common during summer. On the Atlantic coast, summers are cooler and fairly heavy rainfall occurs during winter. Inland, summers are hot and the rainfall decreases. The Balearic islands have a maritime climate, with cool, wet winters and warm, dry summers. The Canary Islands have an even warmer climate. The coastal areas are fairly mild, but the interior, especially in arid areas of Tenerife, can get very hot during the day with cold nights. Mount Teide is often snowcapped in winter and the vast majority of rain falls in winter. Solar radiation varies from less than 3.8kWh/m^2 in the North to more than 5.0kWh/m^2 in the South.

2.2.2 Building and Energy Data

Economic growth spurred by EU membership has led to increases in energy consumption in Spain. Its energy demand has increased over 100% since the mid-1970s. The Iberian Peninsula has limited energy resources, so Spain depends upon imports for the bulk of their energy needs. Attempts to develop domestic energy sources have focused on hydropower and renewables. Recently, renewables have been very developed in Spain, reaching 6.8% of the total energy production of the country in 2006, 0.05% being solar thermal and 0.03% photovoltaic (Figure 4).

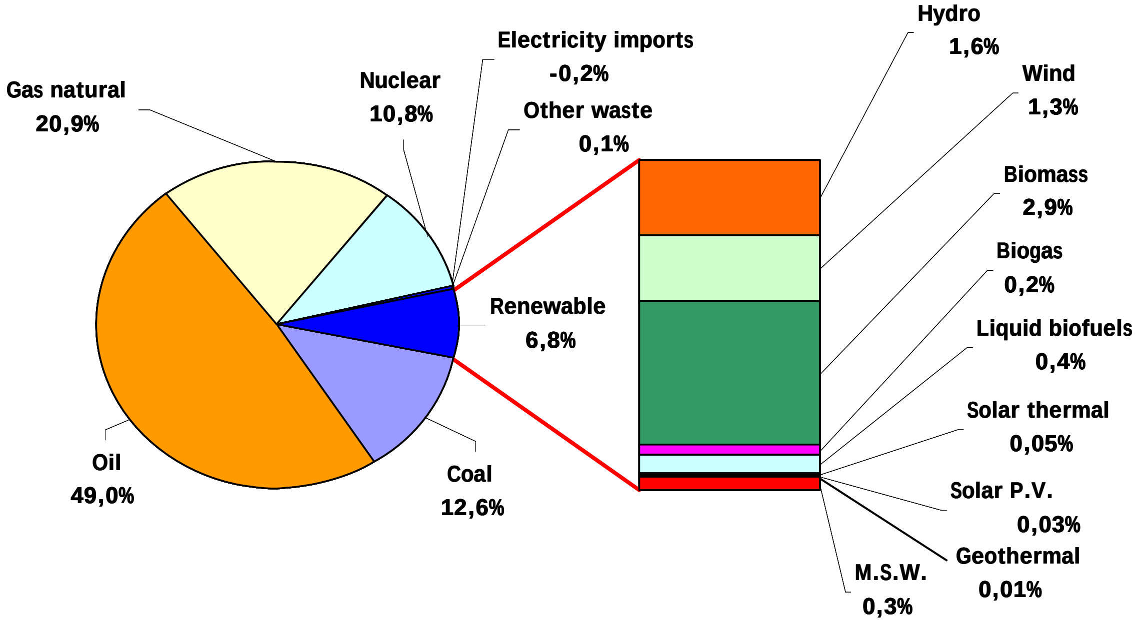


Figure 4. Total energy consumption in Spain in 2006 by type of energy source [source: IDAE]

2.3 Portugal – Facts and Figures

Portugal is the West end of Europe. To its west and south is the Atlantic Ocean, to the east and north Spain. In the 2001 census, the population was 10,356,117, of which 51.7% was female, 48.2% was male and 0.1% undefined or mixed.

2.3.1 Climate

Summers are hot and dry throughout Portugal, particularly in the Algarve, which experiences very little rain. Winters are cold and wet, particularly in the northern and west coast regions.

Portugal has the highest solar radiation availability as percentage in the EU. Its irradiation ranges from 14 to 17 MJ/m^2/day.

2.3.2 Building and Energy Data

Regarding the energy sector, Portugal strongly depends on external energy sources (Figure 5). Energy consumption increases with a rate of 3.5% from 1990 to 2004, while electric consumption duplicates in each 20 years (Figure 6). Buildings (household and service sector) have a strong impact on the energy consumption of Portugal and especially in electricity consumption; they are responsible for 30% of the final energy consumed in the country and of 62% of the electricity (Figure 7). In most households, sanitary water heating in responsible for 50% of the energy demand associated with comfort, while air conditioning and lighting are responsible for 25% each.

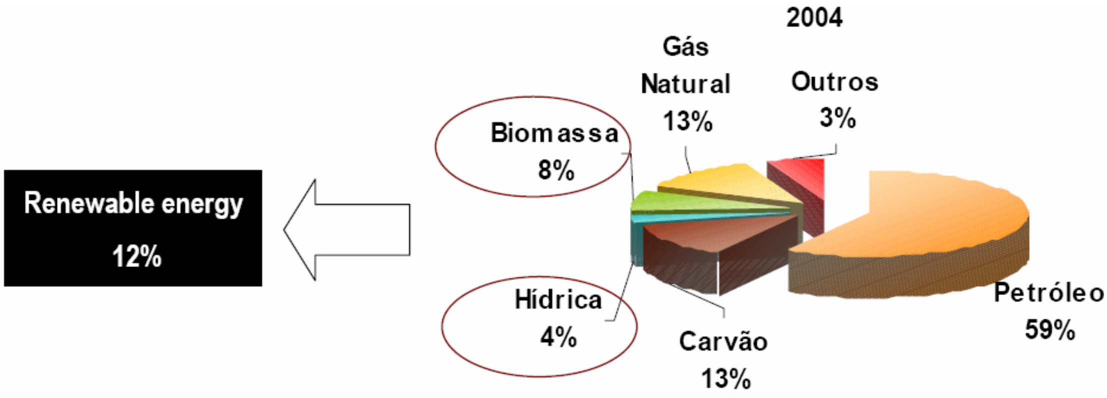


Figure 5. Energy consumption in Portugal per source in 2004 [source: DGGE – cited by ADENE]

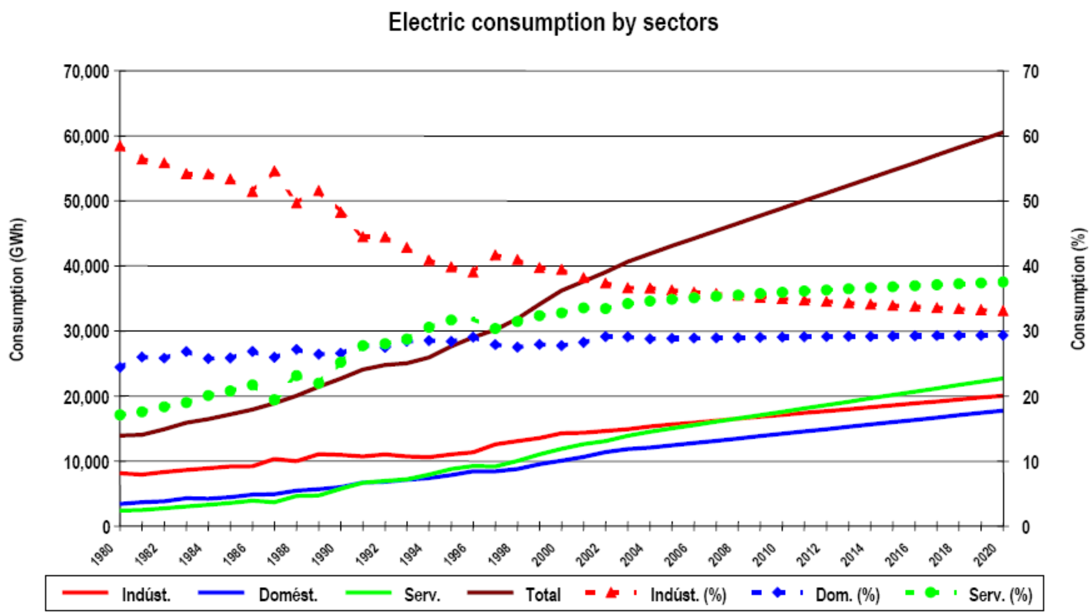


Figure 6. Electric consumption by sector in Portugal from 1980 with prediction to 2020 [source: ADENE]

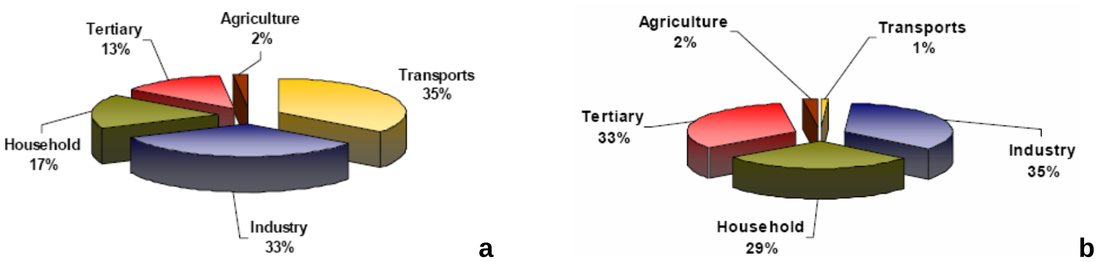


Figure 7. (a) Total and (b) electric energy consumption per end user in Portugal [source: ADENE]

2.4 Morocco – Facts and Figures

Morocco lies across the Strait of Gibraltar on the Mediterranean and looks out on the Atlantic from the northwest shoulder of Africa. Algeria is to the east and Mauritania to the south. On the Atlantic coast there is a fertile plain. The Mediterranean coast is mountainous. The Atlas Mountains, running north-eastward from the south to the Algerian frontier, average 3,353 m in elevation.

2.4.1 Climate

Morocco's climate is moderate and subtropical, cooled by breezes off the Mediterranean Sea and the Atlantic Ocean. In the interior, temperatures are more extreme, winters can be fairly cold and summers very hot. Marrakech has an average winter temperature of 21ºC and summer temperature of 38°C. In the Atlas Mountains temperatures can drop below zero and mountain peaks are snow capped throughout most of the year. The winter in the north of the country is wet and rainy, while in the south, at the edge of the Moroccan Sahara, it is dry and bitterly cold.

Morocco has significant solar potential. The annual average solar radiation over the country ranges from about 2,800 hours to 3,400 hours in the northern and southern parts of the country, respectively. Solar radiation ranges from 4.7 to 5.6 kWh/m^2/day (on a horizontal plane).

2.4.2 Building and Energy Data

The building sector develops very rapidly in the country, with a rate of 100,000 new buildings per year, since 2005. It is responsible for 17% of the total energy consumed in the country, while 20% of the household income is consumed in energy bills. The energy consumption in the country has a rising trend.

The energy consumed in the building sector is divided into:

- 20% for sanitary hot water
- 10% for household electric appliances, light and TV
- 70 % for cooking and heating

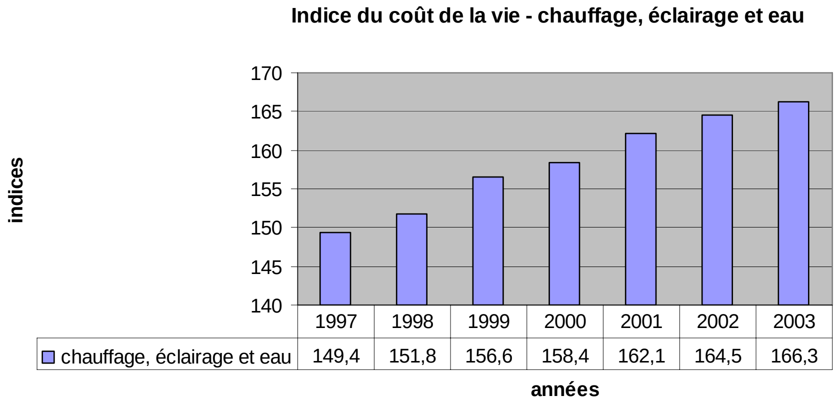


Figure 8. Indexes of life cost, regarding heating, lighting and water in Morocco, from 1997 to 2003 [source: Direction de la statistique – cited by CDER]

The building sector is a key sector in the Moroccan society, economy, financing and work;

- In the financial frame: The capital of buildings has increased, oriented towards long term productive employment. The sector of buildings and public works contributes to the GDP (Gross Domestic Product) by 8%.
- In the economic frame: The added value in the construction activity has passed 1.8 million € in 2002 to 2.05 million € in 2004, with a 15.5% increase.
- In the social frame: Social equilibrium, quality of life, and the production of healthy environments that new constructions offer. Also more than 60% of the population of Morocco which is under 30 years old need to buy houses.
- In the occupational frame: 11% of the direct employments are in the construction sector (not taking into consideration the informal work).

The building sector also contributes to the development of the private sector, with the emergence of a dynamic, construction industry.

2.5 Algeria – Facts and Figures

Algeria is in the North of Africa. It borders with Tunisia to the South-East, Libya to the East, Nigeria to the South-East, the Sahara, Mali and Mauritania to South-west and Morocco to the west. Its area is 2,381,741 Km² (85% of which is desert). Its coastal line is 1,200 km in the Mediterranean. The population of Algeria is 33.8 millions, 65% of which are less than 30 years old. 4.4 million live in its capital, Alger.

2.5.1 Climate

The climate of Algeria is divided into three climatic zones; the Mediterranean, in the coastal cities, with winter temperatures ranging from 8^{o}C to 15^{o}C and summer temperatures from 25^{o}C to 35^{o}C. In the central part of the country, in the mountains of Kabylie and Aurès, winter temperature varies from -7^{o}C to 5^{o}C, while summer temperature from 35°C to 40°C. In the South, in the Sahara, temperature varies from 15°C to 28°C in winter, and reaches more than 45°C in summer.

2.5.2 Building and Energy Data

The building stock of Algeria is about 6 million, more than 800,000 of which are more than 50 years old. The construction rate is increasing, being more than 135,000 buildings/year to 200,000 buildings/year in the period 1999-2004.

The most common construction is reinforced concrete, with brick walls and 5cm void space between the two 10cm brick works. Thermal insulation is limited only on the roofs, usually 4cm polystyrene.

Heating is mostly made with stoves of natural gas. Exceptionally, there are central heating systems in some buildings. Butane, crude oil and electricity are also used for heating.

Air conditioning is mostly made through “split systems” The most common ones are the 9,000, 12,000, 18,000 and 24,000 BTU.

The residential sector is responsible for 35% of the total national energy consumption. 37% of this is covered by natural gas, 30% by GPL (mainly butane) and 14% electricity.

2.6 Tunisia – Facts and Figures

Tunisia is in the North of Africa, with a total area of 164 km^2. It borders with Algeria to the west, Libya to the south-east and to the north and east with the Mediterranean.

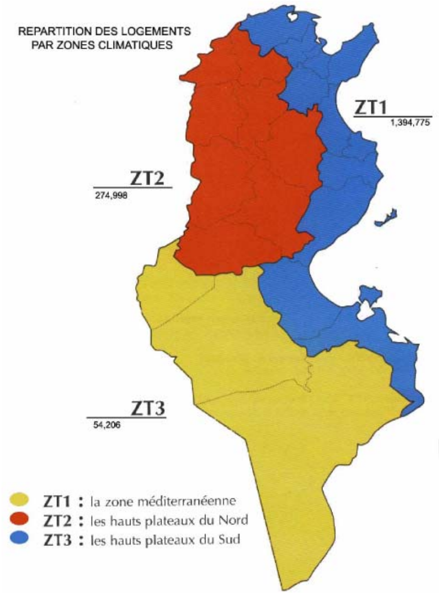
In 2006 Tunisia had approximately 10.2 millions inhabitants. Education, health and social services are very important for its economy. It is oriented towards the development of its human resources. The private sector has been encouraged to play an active role in the economy. Thus, a market economy has developed, based on the agricultural sector, the manufacturing industries and the tourist industry.

The economy of Tunisia has created an attractive environment for investors from the EU, Japan and the USA. Approximately 2,600 foreign companies have made direct investments or joint-ventures with local partners.

2.6.1 Climate

The climate of Tunisia is Mediterranean, with average temperatures from 11°C to 29°C. Its solar potential is high, suitable for solar thermal and electric applications.

ANME has developed a simplified, three-zone climatic system, for the formulation of the thermal regulations of buildings, as can be seen in Figure 9.



Zone ZT1, which includes the seaboard from Bizerte to Gabès

Zone ZT2, which includes the North and Centre to the seaboard, including Jendouba and Gafsa

Zone ZT3, where Tozeur, Kébili and Tataouine are.

Figure 9. Simplified climatic zones of Tunisia [source: ANME]

2.6.2 Building and Energy Data

According to the 2004 census, Tunisia had 2,500,830 buildings. In 1994 they accounted for 1,865,522, with an average annual increase rate of 2.95% for the period 1994-2004. In Figure 10, the increasing tendency of building construction can be seen, from 1975 to 2004.

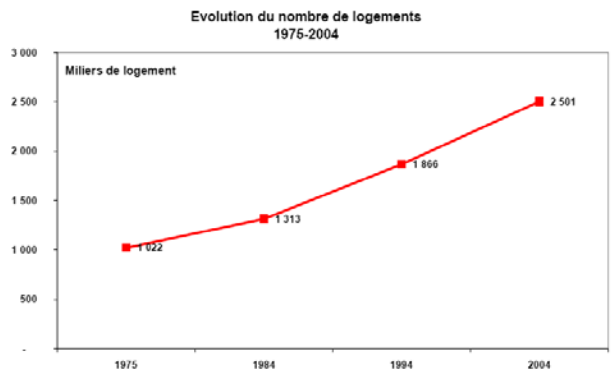


Figure 10. Evolution of the number of buildings from 1975 to 2004 in Tunisia [source: ANME]

According to the Institute of National Statistics (INS), five types of dwellings are distinguished;

- Houche (traditional house);
- Villa;
- Studio;
- Apartment;
- Rudimentary dwelling

The following graph shows the different types of dwellings in the years 1994 and 2004.

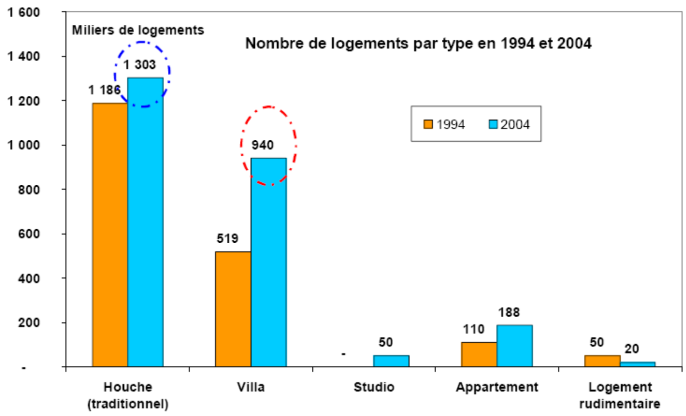


Figure 11. Number of buildings per type in Tunisia, in 1994 and in 2004 [source: ANME]

In 2005, the energy demand in Tunisia reached 5,7Mtep. The industrial and transport sector are responsible for the greatest energy demand (33% and 31%, respectively), followed by the residential sector, services and agriculture, which all together are responsible for 36% of the energy demand.

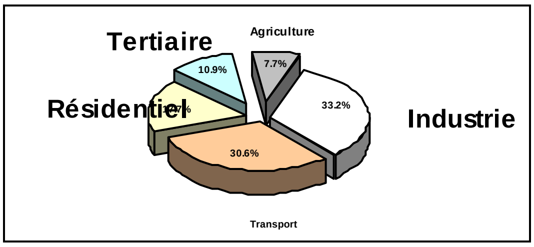


Figure 12. Final conventional energy consumption per sector in Tunisia in 2005 [source: ANME]

The tendency for energy consumption is to increase; in 1980 it was 2.3Mtep, reaching the more than double (5.7Mtep) in 2005, with an annual average increasing rate of 3.6% for this period. The increase of energy demand in each sector can be seen in Figure 13.

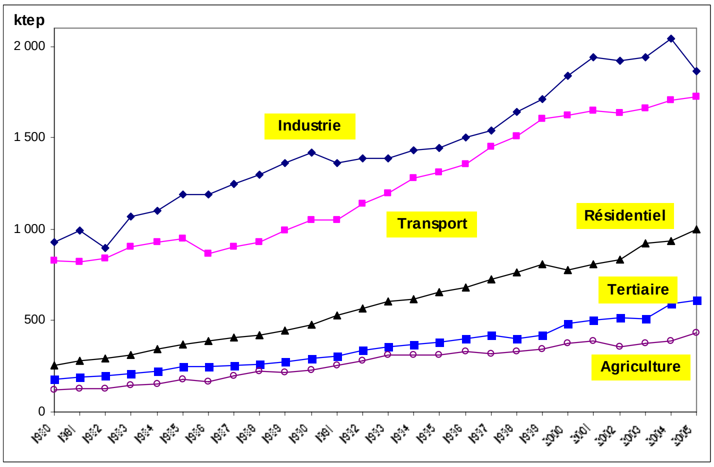


Figure 13. Energy demand evolution in the industrial, transport, residential, agricultural sector and services in Tunisia for the period 1980-2005 [source: ANME]

Regarding energy consumption in the building sector, it was responsible for 940kTep in 2004, equivalent to 16% of the final energy consumption. The main gas consumption in dwellings is cooking (38%), followed by heating (26%). Households consume on average 1,200kWh annually (1,500kWh in urban spaces and 600kWh in rural areas). Refrigerators are responsible for 40% of the annual consumption of residencies, followed by lighting, TV, responsible for approximately 20% each. In the following graph the electric consumption of households is shown analytically.

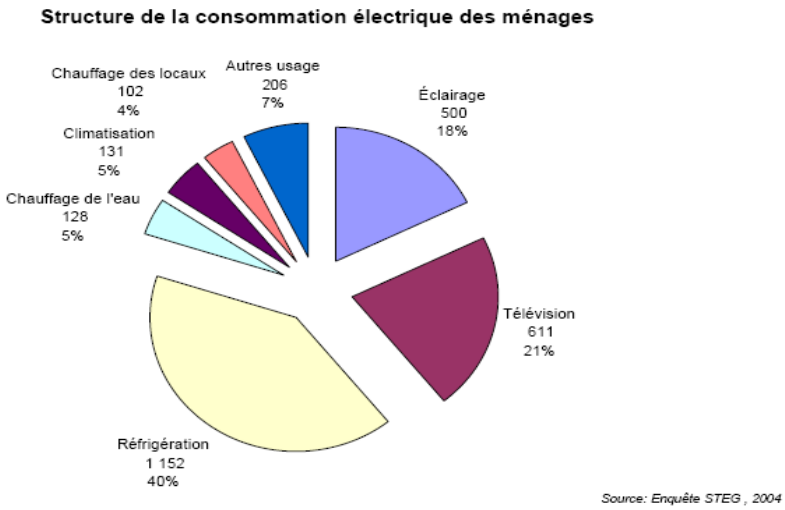


Figure 14. Electric consumption of households in Tunisia [source: Enquête STEG, 2004 – cited by ANME]

2.7 Italy – Facts and Figures

Italy is the fourth country with reference to the population (58.948.000 Inhabitants) in the EU and the seventh with reference to the area, with a surface of 301.338 km^2. The Italian territory is placed between 35° and 47° north parallel. It is a peninsula, starting from north (alpine arch) and goes into the Mediterranean Sea, with also the islands of Sardinia, Sicily and smaller islands. It shows a big coast development (about 7,458 km) and many hilly zones (41.6%), mountainous zones (35.2%) and less flat land zones (23.2%); the average altitude is about 337 meters over level of the sea.

Italy is a member of the G8. It is the 7^{th} economic power in the world with a $1{,}791 \cdot 10^9$\$ PIL[3]. The principal economic activities of the country are tourism, fashion, chemical industry, motor-car industry and food industry.

2.7.1 Climate

Italy has subtropical Mediterranean climate in its south zone (summer temperature over 40°C) and continental temperate climate in the north zone (winter temperature under –20°C).

The global solar radiation value on horizontal surface depends on different latitudes; the yearly average solar radiation is 1,500kWh/m^2 throughout the country.

[3] FMI, 2007

2.7.2 Building and Energy Data

According to the results of the 2001 census on population and dwellings, buildings in Italy are 12.8 millions. About 88% of these are residencies, 6.5% are for other uses (hotels, offices, commerce and industry, communications, transport, other uses) and the remained 5.5% are abandoned buildings.

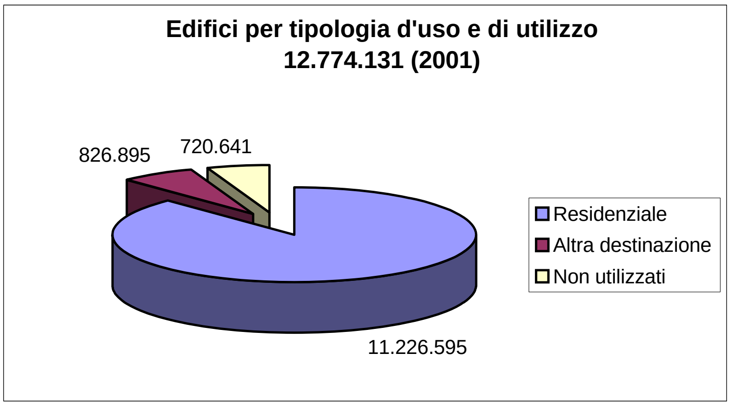


Figure 15. Typology and use of buildings in Italy in 2001 [source: ENEA]

More than 30% of the Italian residential buildings were built before the end of 1940. 50% of the building stock was built in the period from the end of 1950 and the beginning of the 1980. Figure 16 shows the time distribution of the construction of buildings, in seven periods. In the period 1999-2003, new buildings were built with a rate of approximately 77,000 new buildings per year; of those 66% was for residential use (Figure 17). In the period 2001-2003, new buildings are constructed with an average rate of 8% per year for residential buildings, and 0.7% per year for non residential buildings. During the same period the refurbishment of existing buildings was developed with a ratio of 12% per year.

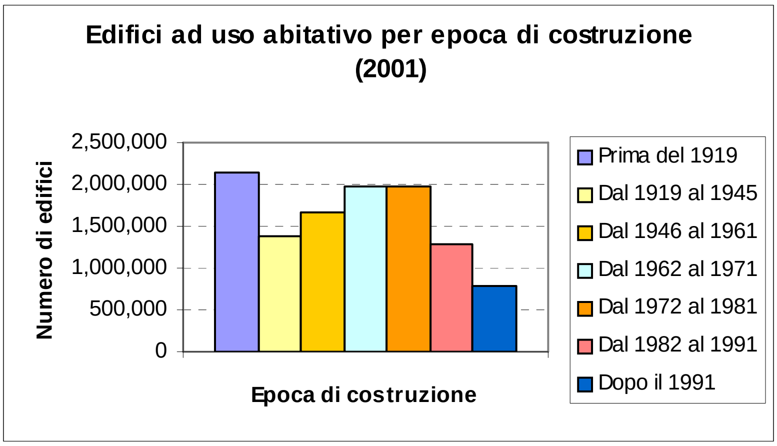


Figure 16. Building stock and period of construction in Italy in 2001 [source: ENEA]

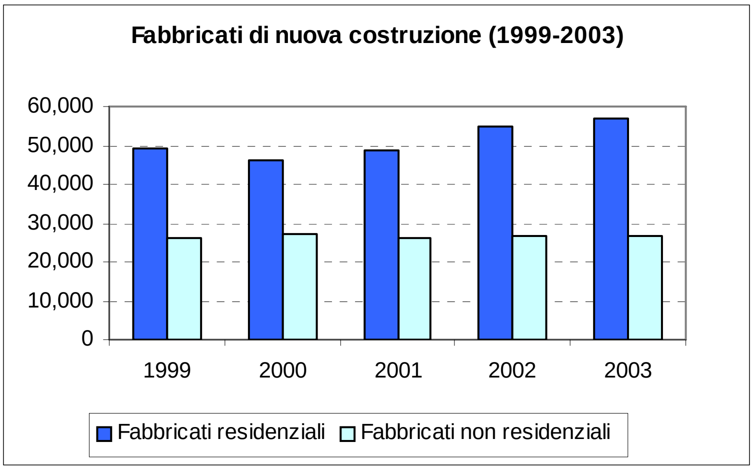


Figure 17. New constructions in Italy (period 1999-2003) [source: ENEA]

Italy's energy needs are about 197.8Mtep (2005). The country strongly depends on energy's importations that amount to 167.72 Mtep (2005), 84.8% of the total need. 88% (and over) of the energy consumption derives from non renewable sources (natural gas 36%, petroleum derived products 43%, solid fuels 9%); 7% is produced from renewable energy sources.

The energy consumption for the civil sector (residential, tertiary, public administration services), in the period from 2000-2005 grows with an average of 3.5%. In 2005 this energy demand was about 47.1 Mtep. The energy consumption of residential buildings is two times more than the non residential ones. In the non residential sector the consumption for air conditioning is more important, while in the residential sector the production of sanitary hot water and heating spaces accounts for 80% of the energy demand.

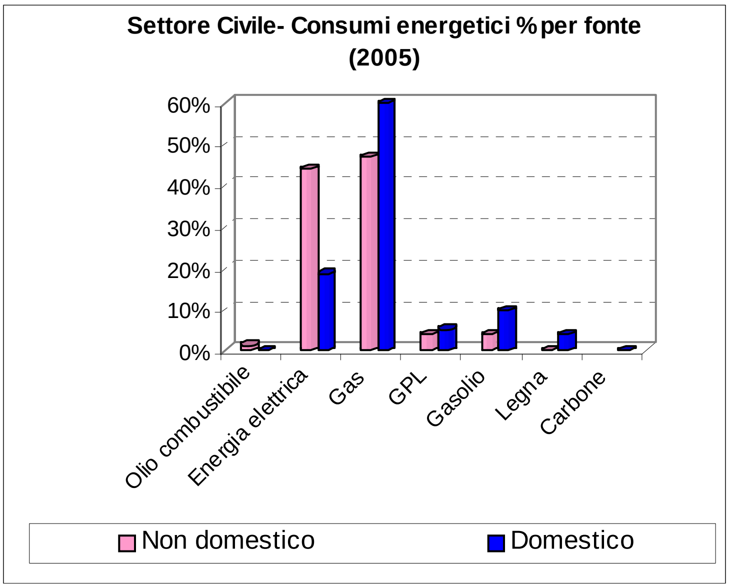


Figure 18. Energy consumption in the civil sector (residential, tertiary, Public Administration services) per type of energy source in Italy in 2005 [source: ENEA]

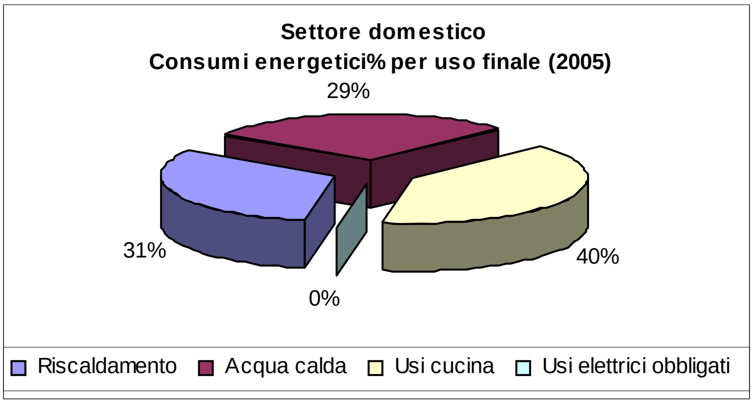


Figure 19. Energy consumptions per final use in the domestic sector in Italy in 2005 [source: ENEA]

2.8 Greece – Facts and Figures

Greece is located in the south-eastern Europe (between the 34° and 42° parallel N, with a meridional extent from 19° to 28° E), on the Southern end of the Balkan Peninsula. The country consists of a large mainland at the southern end of the Balkans; the Peloponnesus peninsula and numerous islands (around 3,000). About 80% of Greece consists of mountains and hills, thus making Greece one of the most mountainous countries of Europe. It has a total area of 131,957 km^2 and the population rises up to 11,170,957 (estimate 2007), with a growth rate of 0.18%. Athens is the capital and the largest city, with a population of 3,361,806. Almost two thirds of the population live in urban areas.

Greece has a mixed capitalistic economy with a large public accounting for about 40% of GDP and with per capita GDP at least 75% of the leading euro-zone economies. The economy is mainly based on agriculture with 20% of the workforce employed in this sector. 59% of the workforce is employed in the sector of services and 21% in the sector of industry and construction. Even if Greece is an agricultural country, the agricultural contribution to the economy is only 15%. The industries which contribute the most to the economy are the tourist industry and shipping.

2.8.1 Climate

The climate in Greece is typical of the Mediterranean climate, with mild, rainy winters, relatively warm and dry summers and, generally, extended periods of sunshine throughout most of the year. A great variety of climate subtypes, always within the Mediterranean climate frame, are encountered in several regions of Greece. This is due to the influence of topography (great mountain chains along the central part and other mountainous bodies) on the air masses coming from the moisture sources of the central Mediterranean Sea. Thus the weather in Greece varies from the dry climate of Attiki (Athens' greater area) and East Greece in general, to the wet climate of Northern and Western Greece. In climatological terms, the year can be broadly subdivided into two main seasons: The cold and rainy period lasting from mid-October until the end of March, and the warm and dry season lasting from April until September. During the first period the coldest months are January and February, with, a mean minimum temperature ranging, on average, between 5°C -10°C near the coasts and 0°C – 5°C over the mainland, with lower values (generally below freezing) over the northern part of the country. Winters are milder in the Aegean and Ionian Islands compared to Northern and Eastern mainland Greece. The warmest period occurs during the last ten days of July and the first ten days of August, when the mean maximum temperature lies between 29°C and 35°C.

2.8.2 Building and Energy Data

As can be observed in the following tables, residential buildings represent about 72-77% of the total building stock in Greece (2.5 million residential buildings in 1990). Moreover, 30% of the residential building stock concerns urban and 18% semi-urban areas.

Table 1. Building stock by type of use [source: National Statistical Service, Total number of buildings per use in Greece (inventory 2000)]

Total number of buildings (exclusive use)	Domestic buildings	Churches - Monasteries	Hotels	Industrial buildings - laboratories	School buildings	Commercial buildings and offices	Car parks	Hospitals	Other	Mixed use	**Total (exclusive use and mixed use)**
3.577.355	2.755.570	43.463	22.830	31.422	16.804	111.097	510	1.961	593.698	413.615	**3.990.970**

Table 2. Age of building stock [source: National Statistical Service, Total number of buildings per use in Greece (inventory 2000)]

Total number of buildings	Before 1919	1919-1945	1945-1960	1961-1970	1971-1980	1981-1985	1986-1990	1991-1995	1996-	Under construction	Not registered
3.990.970	199.510	406.633	665.315	761.182	737.575	404.303	297.348	241.615	191.739	57.430	25.320

The most intense construction work was in the 1960s when the construction work address to a percentage of 19% of the total building stock. In the period 2000-2004, there is an increase in construction permits of a percentage of 18%. From the registered permits, a percentage of 50-54% corresponds to new building works and extensions to 13 – 17%.

The recorded percentage of renovation projects (to the overall amount of permits for new buildings as well as renovations, without any data on the type of renovation actions) was 4.5%, 4.7%, and 5.5% for the years 1997, 1998, and 1999, respectively. However, a new construction market has started growing during the last years in Greece; an increasing number of construction enterprises focus their activities on building renovation projects. Most of these renovation projects are not recorded, as permit processes are costly and time consuming. However, due to building stock ageing and refurbishment needs, this particular market segment is growing fast. For the period 2000-2004, from the registered permits, a percentage of 8–10% corresponds to renovation projects.

Current common building practice is based on reinforced concrete structure with brick walls. Since 1980, exterior building elements are insulated; beams and columns are insulated externally, exterior walls are made of double brick construction with insulation in between; roofs are either flat with insulation placed above the concrete slab or pitched with tiles placed above a wooden or concrete structure with internal insulation. Old buildings (built before 1980) are uninsulated and represent approximately 80% of the building stock.

Heating systems are either central or non central, using mainly diesel or, the most recent ones, natural gas. Cooling is made by RAC units, which are being installed at ever increasing rates. Very few older buildings use water cooled central systems. In buildings of the tertiary sector heat pumps (air to water or VRV systems) are also used for cooling.

Final energy consumption has increased by 39% since 1990. All sectors, especially households and commerce, have followed similar growth rates. Transport is the most energy-consuming sector (above EU-27 average of 31%), while households and industry exhibit a total share of 47% in final energy consumption. Oil dominates in terms of types of energy consumed, followed by electricity.

Regarding the domestic and tertiary sector, the improving standards of living resulted in continuously increasing levels of energy consumption. Energy demand for cooling, lighting and other office equipment in the tertiary sector is also increasing.

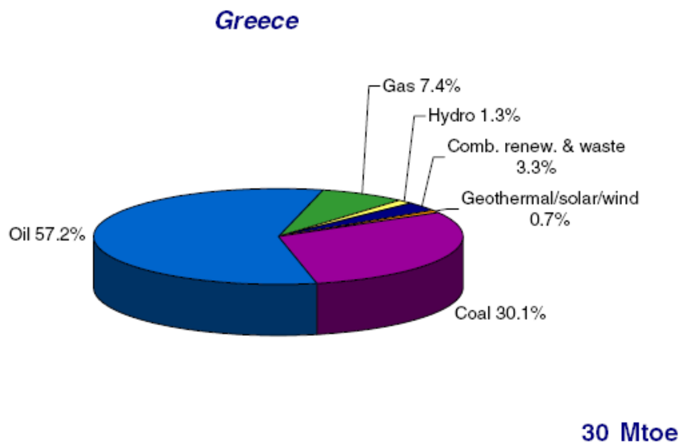


Figure 20. 2004 Share of Total Primary Energy Supply in Greece [source: CRES]

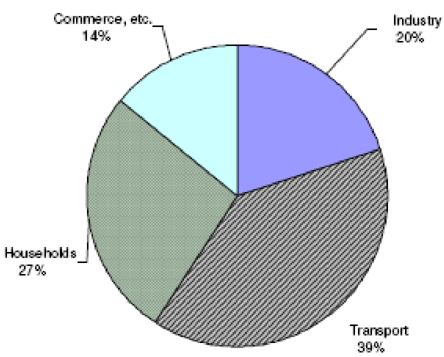


Figure 21. 2004 Final Energy Consumption by Sector in Greece [source: CRES]

Table 3. Energy consumption by end use [source: D-base ODYSEE, Energy Efficiency Indicators, 2006]

Domestic sector

	2000	2001	2002	2003	2004
Electricity consumption					
Mtoe	1,222	1,25	1,29316	1,414	1,449
Final consumption					
Mtoe	4,50597	4,65961	4,89224	5,459	5,361
Electricity consumption for space heating					
Mtoe	0,202341	0,207169	0,220395	0,24038	0,22889
Final consumption for space heating					
Mtoe	3,188419	3,301778	3,502341	3,941595	3,829323
Electricity consumption for water heating					
Mtoe	0,101989	0,104423	0,097135	0,10605	0,112547
Final consumption for water heating					
Mtoe	0,223737	0,230714	0,22577	0,244118	0,22827

Tertiary sector

	2000	2001	2002	2003	2004
Final consumption of the tertiary sector					
Mtoe	1,3069	1,4656	1,540411	1,657	1,769
Electricity consumption of the tertiary sector					
Mtoe	1,054	1,1378	1,206483	1,288	1,363

Other: n.a.

2.9 Lebanon – Facts and Figures

Lebanon covers an area of 10,452 km^2, and consists of a narrow coastal strip of land adjacent to the Mediterranean Sea, more than 100 km long. Lebanon has a population of about 4 million people, 70% of which live in urban areas. Import and export is totally free. GDP for the year 2004 is estimated to have been 21,400 million USD with 1.5% annual growth rate. The main industry comprises cement plants.

Lebanon is located on the eastern coast of the Mediterranean Sea in the Middle East. The country can be divided into four topographical regions (Figure 22):

(1.) The coastal plain that becomes a narrow strip in the north.
(2.) The coastal mountain range or Lebanon Mountains that are a series of crests and ridges.
(3.) The Central Plateau that consists of the Syrian Plain and part of the Bekaa valley.
(4.) The eastern mountain range which comprises the remainder of the Bekaa Valley and rises to form the Jabal ash Sharqi or Anti-Lebanon Mountains as well as the Jabal ash Sheikh or Mt. Harmon, which forms the eastern border with Syria.

Figure 22. Map of Lebanon and information on its topographic regions [source: ALMEE]

2.9.1 Climate

The climate of Lebanon is Mediterranean, with the temperature in the capital Beirut ranging from 5°C in winter up to 32°C in summer. The comparison of the average temperature in August and July for different locations in Lebanon shows that August is the hottest month in Lebanon, while January is the coldest month.

The average annual precipitation in Lebanon is 830 mm, and lasts only during four months of the year. Some of 6,000-km^2 lands are under irrigation, with about 90% of national food production dependent on irrigation.

Lebanon has large solar potential, with approximately 3,000 hours of sunshine per year and 4.8 kWh / m^2 average annual radiation.

2.9.2 Energy and Building Data

Lebanon is not an oil or coal producer and the energy consumed is totally based on imported oil derivatives. The use of any form of Renewable Energy is very limited. 25% of Lebanon's final energy consumption is consumed in the industrial sector, 30% in the residential, public and commercial sectors, and the remaining 45% in the transport sector. The energy sector is in a continuous deficit since 99% of its primary energy needs is imported and based on oil derivatives. Since the end of the civil war, the national energy bill has been increasing regularly: it went up 250% in the period 1992 - 2000.

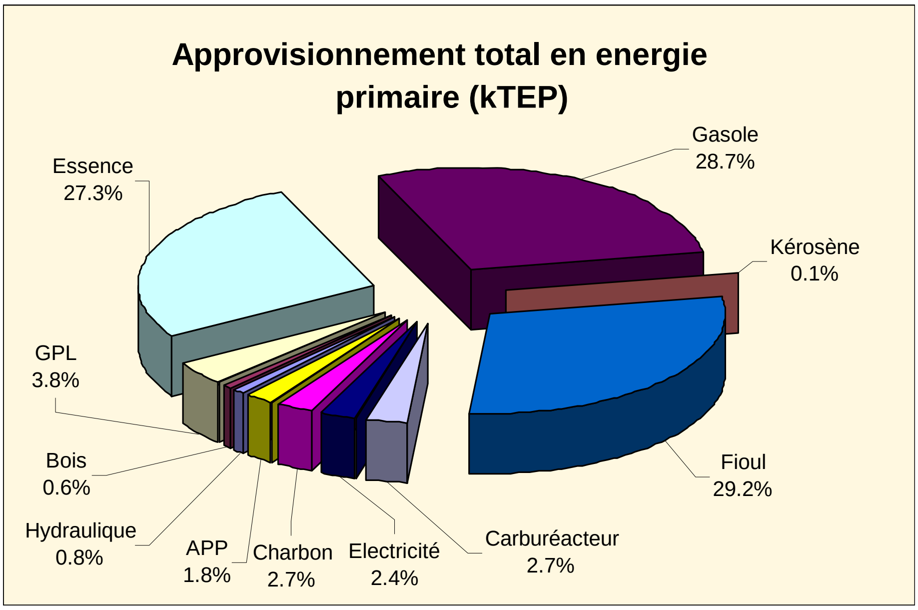


Figure 23. Share of Total Primary Energy Supply in Lebanon [source: ALMEE]

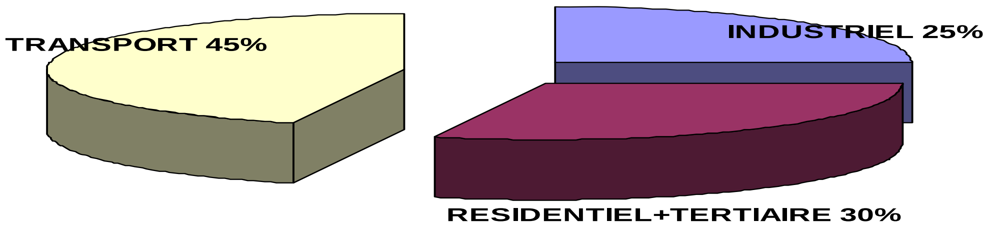


Figure 24. Final Energy Consumption by Sector in Lebanon [source: ALMEE]

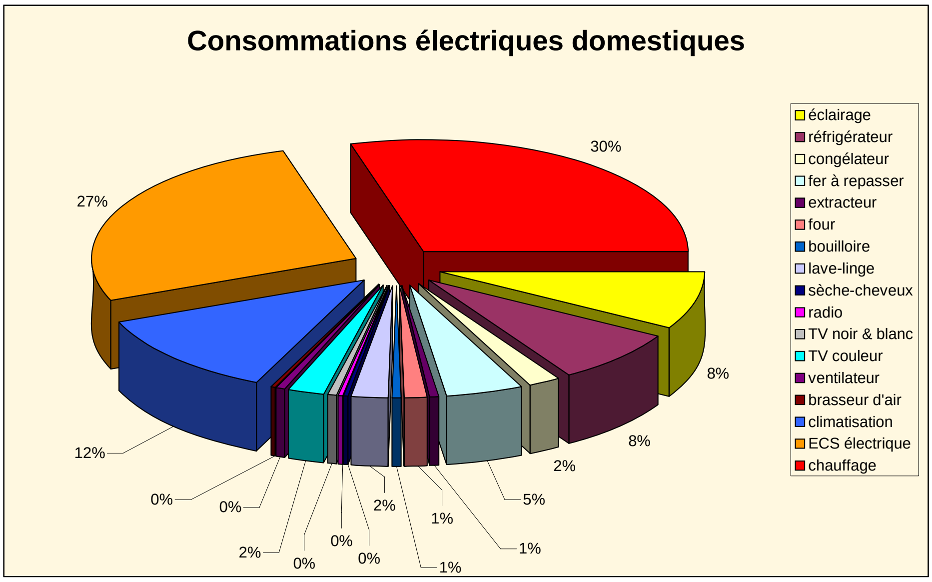


Figure 25. Domestic electric consumption in Lebanon [source: ALMEE]

2.10 Palestine – Facts and Figures

Palestinian Territories (West Bank & Gaza Strip, a part of historic Palestine 26,323 km^2) lies on the western edge of the Asian continent and the eastern extremity of the Mediterranean Sea, between 34^{o}20'– 35^{o}30' E and 31^{o}10'– 32^{o}30 N. It is comprised of two land areas; the West Bank 5,879 km^2, and the Gaza Strip 365 km^2, a total area of about 6,244 km^2, including the area of about 2,000 km^2 for some 200 Israeli settlements.

The total population is about 3,699,767 inhabitants (census 2004, PCBS), of which about 2,336,254 millions live in the West Bank and about 1,363,513 million live in Gaza Strip. The population growth rate is about 3.7% and the average household size is about 6.4 persons.

The Palestinian economy is based largely on services. In 2003 the various service sectors accounted for 64% of GDP, with manufacturing, mining, construction and transport together, accounting for the balance. According to the Palestinian Central Bureau of Statistics (PCBS), the GDP grew by about 50% from 1994 - 1999, which is equal to about 8.5% per year on average. It then declined by 15% from 1999 to 2002, because of the effect of the Intifada. It increased by 16% from 2003 to 2005, but declined again by 6% in 2006. The standard of living for the large portion of the population has fallen dramatically, GNI per capita fell by 26% in 2002 and poverty levels increased accordingly. The Gross Domestic Product (GDP) per capita is about 890 €.

2.10.1 Climate

Palestine's elevation ranges from 300 m below sea level in the Jordan Valley, to sea level along the Gaza Strip seashore, reaching 1000 m above sea level in some locations in the West Bank (WB). The climate of Palestine as a whole and of the West Bank in particular, is of the Mediterranean type, marked by mild, rain winter and prolonged dry and hot summer. The climatic conditions vary widely; the coastal climate in the Gaza Strip is hot and humid during summer and mild during winter; the average daily mean temperature ranges from 25^{o}C in summer to 13^{o}C in winter. The climatic condition in the WB is characterised by hot humid summer and relatively heavy rains winter in the semi-coastal area of the WB, cold winter and mild summer weather in the highlands, and hot summer and warm winter in Jordan Valley. The annual temperature in the West Bank shows the lowest temperatures in the mountain region. The northern mountains register an annual average temperature of 15.5°C to 17.8°C.

The solar potential of Palestine is high (5.46 kWh/ m^2/day) which makes it feasible for all types of solar energy applications such as solar thermal energy and photovoltaic electrification.

2.10.2 Energy and Building Data

The building construction sector showed a rapid increase (as indicated by the number of constructed offices and apartments) in the Palestinian territories between 1994 and 2000 with the establishment of the Palestinian Authority. It slowed down after the start of the Intifada in 2000. However the unstable political situation in Palestine affects the economic growth as it affects the establishment of new industries and businesses in the area. The fast growth in the construction sector makes it a priority in any energy efficiency and renewable energy program for Palestine.

Excluding the so called “J1” area in the Jerusalem governorate, there were 256,900 housing units in the West Bank and 132,800 in the Gaza Strip in existence in 1997. Building construction started to increase after the start of the peace process in the region (1993) with an average of 12,700 newly licensed housing units built per annum in the period 1996 - 2000. The majority of these licensed buildings were in the West Bank, comprising 79% of all licensed building areas and equal to 7.6 million square meters in the period 1996 - 2000. The average number of rooms per unit was 3.3 in the West Bank compared to 3.6 in the Gaza Strip. The majority of these units were used for housing purposes: 83.6% in the West Bank and 88.6% in the Gaza Strip.

The Palestinian energy sector is in an unusual case; the sector is relatively small compared to other countries, with no developed domestic resources for commercial energy. It relies to a large extent on imported energy, either directly from Israel or under the Israel authorities for oil products. The domestic resources are restricted to limited production of biomass, small private electricity generation and solar energy. Operating and developing the energy system in Palestine is one of the serious challenges faced by the Palestinian Authority because of policies, restrictions and actions imposed by the Israeli Authority. Despite the difficulties of recent years, energy demand continued to grow quite rapidly. This growth can be explained by the fact that energy consumption in households and other service sectors accounts for 71.3% of the total consumption.

The Total Primary Energy Supply (TPES) for the year 2004 accounted 1205 kTOE. The indigenous production (renewable) contributed 19% of TPES, while the remains were imports from Israel. Energy share of fuels in TPES is illustrated in Figure 26.

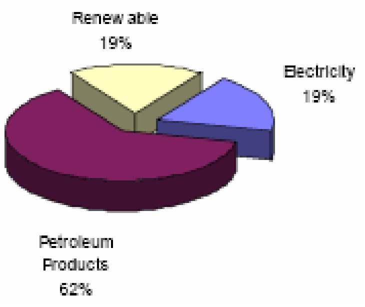


Figure 26. Energy share by fuel type, in Palestine in 2004 [source: PEC]

2.11 Jordan – Facts and Figures

The Hashemite Kingdom of Jordan borders to the north with Syria, to the east with Iraq and Saudi Arabia, to the south with Saudi Arabia and the Gulf of Aqaba. The area of Jordan is 89,213 km^2. Amman is the capital and largest city of Jordan. Its population is 5,350,000 with a growth rate of 2.6%.

The principal geographical feature of Jordan is an arid plateau that thrusts abruptly upward from the eastern shores of the River Jordan and the Dead Sea, reaching a height of about 610 to 915 m (2,000 to 3,000 ft), then sloping gently downward towards the Syrian Desert in the extreme east of the country.

Jordan's economy is free market oriented prices (except for a few subsidised goods); interest rates and wages are generally determined by market forces. The main economic indicators in Jordan for the year 2004 are shown in Table 4.

Table 4. Main economic indicators of Jordan for the year 2004 [source: NERC]

Growth rate of GDP at fixed producer prices	7.5%
Growth rate of GDP at current producer prices	12.6%
Per capita GDP	1515.6 JD*
Total export of goods and services	3955.1 MJDs
Total import of goods and services	6518.3 MJDs
Inflation rate	3.4 %

*Jordan Dinar (JD) = $1.4

2.11.1 Climate

The climate of Jordan is predominantly Mediterranean. It is marked by sharp seasonal variations in both temperature and precipitation; hot dry summer and cool wet winter. Summer starts around mid May and winter starts around mid November, with two short transitional periods in between (autumn and spring).

Jordan has abundant supplies of solar energy, with relatively high average daily solar radiation of 5.6 kWh/m^2/day, since it lies in the ''global Sunbelt'' between 29° 11´ and 32° 42´ N latitudes. The sunshine is more than 300 days annually; this can be considered sufficient to provide enough energy for solar heating/cooling and PV applications.

2.11.2 Building and Energy Data

Jordan is growing fast in terms of population and energy consumption. According to the available figures from the Department of Statistics in 2004, the number of existing dwellings is 1,204 million and the average annual required dwellings is around 28,063. For the next twenty years, it is expected that Jordan will need around 500,000 new dwellings. Table 5 shows figures related to the construction sector.

Table 5. Number of permits, area and cost for new buildings (Residential & non-Residential) [source: NERC]

Indicator	2002	2003	2004
1. Number of Permits	11,601	11,829	14,248
Residential Buildings	10,667	10,978	13,077
Non-Residential Buildings	934	851	1,171
2. Total Area of Buildings (000 m^2)	4,693	5,283	6,829
Residential Buildings	3,907	4,476	5,761
Non-Residential Buildings	786	807	1,068
3. Estimated Cost (USD 000)	705,711	827,138	1,092,480
Residential Buildings	585,224	706,944	934,530
Non-Residential Buildings	120,487	120,194	157,950
4. number of licensed dwellings	23,313	25,824	35,052

It is clearly seen from the table above that the number of licensed square meters for residential buildings is 18 times higher than the licensed area for non-residential. The majority of buildings (residential and commercial) in Jordan are usually built with white stones. The rest are built with cement bricks and concrete. Building construction in Jordan pays little attention to energy efficiency and environmental protection measures through design or construction. In the upscale areas central heating using diesel oil is common for space heating while small stoves using kerosene or LPG is used in lower income areas. Efficient lighting such as CFL or lighting control gear is very common in residential buildings. Solar water heaters are not mandatory (only 14% of buildings have SWH).

Most energy used in buildings is in the form of electricity and fuel. Heating, cooling and lighting are the major energy demands in buildings.

The residential and commercial sectors in Jordan consumed in 2006 4,306 GWh electricity, and 1,864,000 tons oil equivalent of fossil fuels, emitting about 7 million tons of CO_2 into the atmosphere, according to the Ministry of Energy and Mineral Resources (ENERGY 2006 – Facts & Figures). The graph bellow shows the energy pie in Jordan for the year 2006.

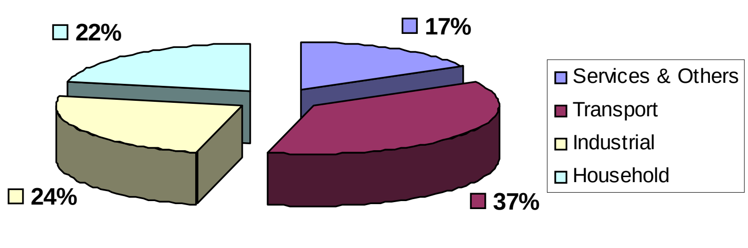


Figure 27. Final energy consumption by sector in Jordan in 2006 [source: NERC]

The graph shows that the building sector (residential & commercial) consumed 39% of the total Energy consumption in Jordan, while accounting for around 49% of the total electricity consumption. In addition to that, the building sector consumes a lot of energy (electricity & fuel) during construction activity. Table 6 shows the quantity of consumed energy during construction activity by type of energy in 2004. Based on the energy consumption figures and number of dwellings, the estimated energy consumption in the residential sector per dwelling is around 0.88 toe.

Table 6. Consumed energy during construction activity by kind of energy in 2004 [source: NERC]

Number of Enterprises that use energy	Electricity (MWh)	Diesel (M^3)	Gasoline (M^3)	Fuel (000 M.T)	Gas (000kg)	Kerosene (000 M.T)
1038	23267	94401	1652	4.83	53375	6.87

3 Issues of technology / knowledge transfer and adaptation

3.1 France

The solar thermal market in France (both individual and central) has more than doubled between 2004 and 2005 (more than 100,000m^2 installed) and continues with a great growth (+81% between 2005 and 2006). This evolution is mainly due to the quality measures and the assistance from ADEME. There is no national statistical data for the number of installations of each solar thermal type (public, private, integrated etc), neither the number of installations per day.

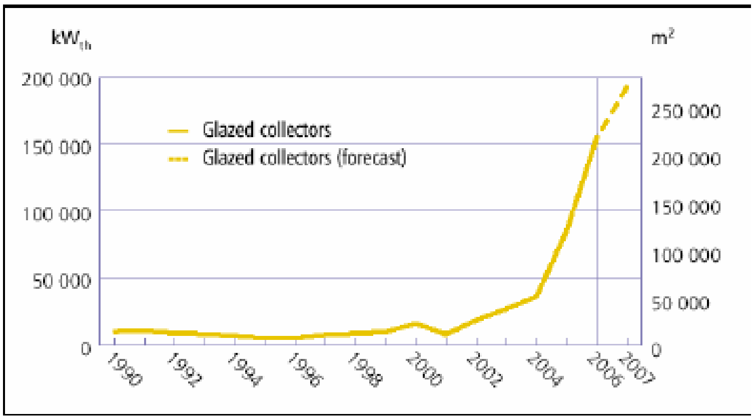


Figure 28. Installed solar collectors in France [source: ESTF – cited by ADEME]

Regarding photovoltaics, the situation in France is very promising, as certain improvements have been made recently. In 2006 the annual installed capacity doubled in relation to 2005 and quadrupled in relation to 2003. A 14,4MW capacity was financed and the total installed capacity rose above 40MW.

The "Plan Pluriannuel d'Investissement" (PPI) set the objective of 490MW installed in 2015, of which 100MW will be in metropolitan France.

The main different technologies that exist in France, in a chronological order, are the following:

- Installations in isolated sites for the electrification of rural, decentralised areas, which were firstly developed in the 1980ies with assistance from the State and the "Electricité de France" (EDF). They were applied in cases where they offered an economic solution, in relation to connecting these areas to the grid.
- At the beginning of the 1990ies the market of connected to the grid installations opened with pilot installations and it has developed since 2002, thanks to funding projects. In 2006, the connected to the grid installations represent more than half the installed capacity.
- The small installed systems on individual dwellings' roofs are the most dominant systems in the market. The large scale projects are not so many. The first central PV (1,35MW) started producing electricity in December 2006 in the Réunion.

There is no central statistical data for the number of installations of each type and there is no way to collect data about the installations made every day. There are no specific norms regarding PVs for the BIPV. Taking into consideration the strategy for the development of the BIVP market, one can suppose that approximately 80% of the installed systems up to date are BIVP systems on the roofs of houses.

3.2 Spain

Spain has been very active in promoting solar energy applications. In Spain the Renewable Energy Plan was approved in Cabinet Meeting in August 2005. Since then the growth rate of the solar thermal applications has been increasing rapidly, from 8% in 2004 to 11% in 2005 and 26% in 2006, reaching over 135,000m^2 solar collectors having been supplied and installed in the country. The objective is to reach 4,200,00m^2 installed solar collectors in Spain in 2010, as can be seen in Figure 29. Up to date, there have been several solar thermal installations, with a flourishing market.

The main solar thermal applications are flat-plate collectors for sanitary hot water and swimming pool heating. There have also been other applications, such as solar cooling, heating with radiant elements and industrial processes. Today there are more than 12 manufacturers in Spain, with manufacturing capacity over 200,000m^2, which is continuously expanding because of the market expectancies.

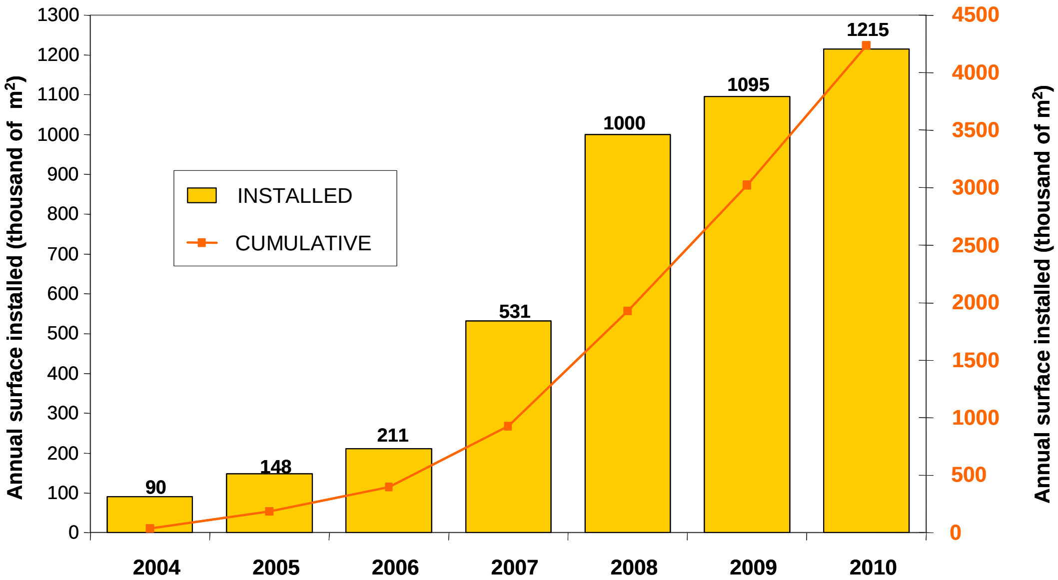


Figure 29. Expected trend of the solar thermal market in Spain [source: IDAE]

Regarding photovoltaics, it is a sector in constant growth. Spain is among the leaders in Europe in this sector, with the largest installed PV capacity after Germany (118.1MW in 2006, according to EurObservÉR 2007), expected to reach 400MW in 2010 (Figure 30). Similarly to the solar thermal applications, the growth rate of PV applications has been increasing significantly since 2005, from 39% in 2004 to 54% in 2005 and 105% in 2006.

Today, the stand-alone installations are 15MW, the fixed PV installations that are less than 100kW are 205MW, while with tracking technology they are 112MW. The installations greater than 100kW reach 31MW. Two main types of installations can be found; on buildings and on the ground, the later being generally plants of large size.

New technologies and materials are encouraged in the PV sector in Spain. In 2009 the production line of silicon is expected to finish, from mineral to photovoltaic module, because of the starting of plants to produce polysilicon. Today the PV sector is made up of more than 400 firms with 25 years experience in manufacturing and project developments, making the country a leader in innovative PV projects.

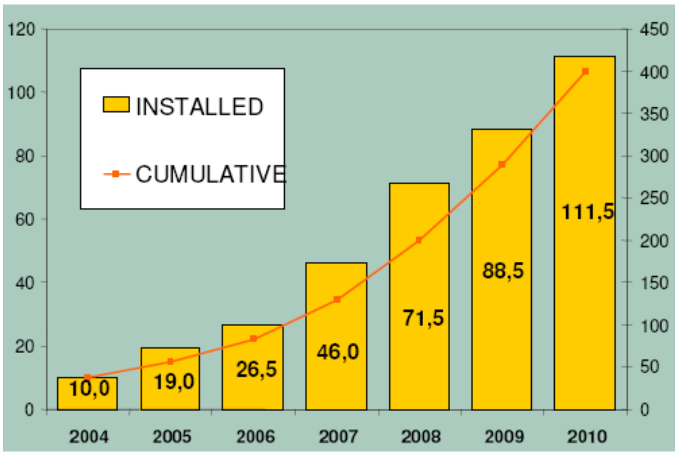


Figure 30. Expected trend of the PV market in Spain [source: IDAE]

3.3 Portugal

Up to 2002 there were 250,000m^2 installed solar collectors in Portugal. It is expected that with the policies the country is adapting, this will reach 1 million m^2 installed solar collectors in 2010. Most PV applications in the building sector are off-grid for domestic use, with a rising trend, as can be observed in Figure 31.

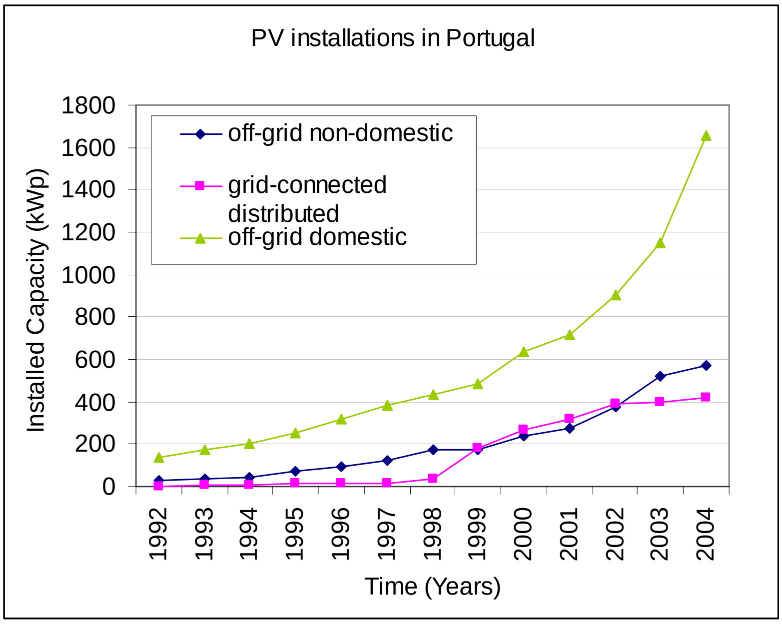


Figure 31. Cumulative installed PV power in Portugal by sub-market for the period 1992-2004 [adapted from data from the IEA Photovoltaic Power Systems Programme - http://www.iea-pvps.org/countries/portugal/index.htm]

3.4 Morocco

A typical solar collector can produce 50-70% of sanitary hot water needed for a typical family for the solar potential of Morocco. As can be observed in Figure 32, the solar thermal market in Morocco increases rapidly. In 1994 there were 3,460m^2 installed solar collectors and in 2006 they reached 30,000m^2. Most of solar collectors available in the market have an 8 year guarantee and a life period of 15-20 years.

Solar PV systems have been introduced by CDER since the late 1980s in the context of rural electrification and water pumping programs. Several programs have contributed to the PV electrification in Morocco. Today around 38,000 households have access to electricity thanks to PV systems. The total current installed PV capacity is estimated to be 9 MWp.

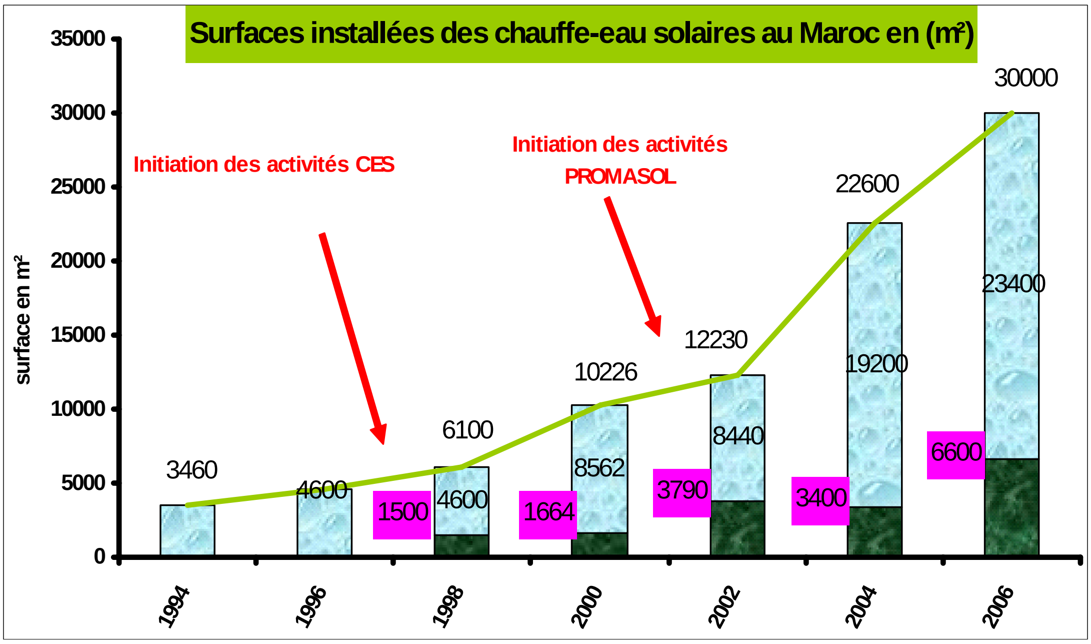


Figure 32. Installed surfaces of solar panels for sanitary hot water in Morocco from 1994 to 2006 [source: CDER]

3.5 Algeria

Solar energy has not penetrated so largely in the market yet, despite the high solar potential of the country. The majority of solar technologies equipment are imported, apart from some solar collectors for heating water, made by UDES (Unité de développement des Equipements solaires).

Regarding PV installations, thanks to the projects described in paragraph 4.5, Algeria already uses photovoltaic panels to electrify 18 scattered, off-grid villages in the Sahara, and 16 more are due to come on line by 2009.

3.6 Tunisia

The technology of active solar systems is today technically and commercially mature in Tunisia. In the past, active solar systems were considered not to be a profitable investment. Even with an initial 20% grand for domestic solar installations, the pay-off period was 13 years, when compared with heating with oil, more than 15 years when compared with natural gas and 6-7 years when compared with electrically heated water. For all consumers, the pay-off period should not surpass 4-5 years; thus the financial rationale has fundamentally not put forward the notion of solar power. For the service sector and especially for hotels, the need of sanitary hot water allows to profit from active solar systems. The energy prices make solar energy more favourable, especially for bungalow hotels. The pay-off period, with 20% grand from the State is 7-8 years when solar energy replaces diesel oil and 6 years when it replaces electricity. The pay-off period is much larger (15 years) when solar power replaces natural gas. Nevertheless, the pay-off period for such investments should not be more than 2-3 years, so that they can be attractive.

Although active solar systems had appeared in the Tunisian market since the 1980ies, with all these economic barriers, it had stayed an insignificant market. In 1994 only 330m^2 of solar collectors had been installed. In 1995 an ANME project, funded by GEF, managed to put the solar market to a raising trend. With a 35% grand from this GEF project, which started in 1997, the installed solar collectors raised to 50,000m^2 in 2000. In 2002 this grand was stopped, which caused a noticeable decline in the solar market. From the 17,000m^2 installed in 2001, it dropped to 7,000 in 2004. The absence of a “pullback strategy” and the cut of grants, combined with the low energy prices of the 2002-2003 period were fatal for the solar market, proving that a significant support, especially at the funding level of the solar systems was still necessary for assuring market durability.

The Ministry of Industry, the Ministry of Energy, the Ministry of Small and Medium Enterprises and the National Agency for Energy launched the program PROSOL, with the support of the program MEDREP of PNUE for setting more solid bases for the solar market. The supporting mechanisms developed for the program were the following:

- A credit mechanism for the buyers, on the acquisition of the solar thermal systems, with a 5 year duration
- A grant for each solar system buy from the Tunisian State, with supplements from MEDREC funding
- Improvement of the interest ratio of credits for the year 2005, with the intermediate funding from MEDREP.

Thanks to PROSOL the solar thermal market improved dramatically. From its first year (2005) 23,000m^2 solar collectors were sold, 35% more than during the GEF project. In 2006 35,000m^2 solar collectors were sold. At the end of 2006 the total operating active solar systems in Tunisia reached 130,000m^2 and today there are 13m^2 of solar collectors for every 1,000 inhabitants.

In Figure 33 the ups and downs of the thermal solar market in Tunisia can be seen for the period from 1985 to 2004.

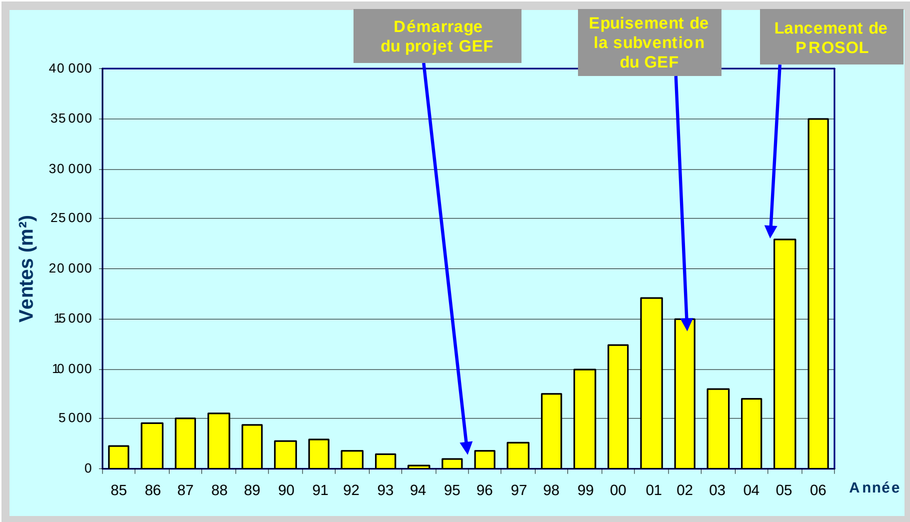


Figure 33. Active solar market evolution in Tunisia for the period 1985-2004 [source: ANME]

Regarding the PV sector, it dates from the late 1970ies in Tunisia, after the oil crisis, following, similarly to the active solar systems its ups and downs. The first period (end of 1970ies, mid of 1980ies) was the experimentation period, with the installation of the central PV station of 29kW capacity in Hammam Biadha in 1980. It covered the electric needs of the village Hammam Biadha, annually producing 15-20MWh. The end of 1980ies – beginning of 1990ies was characterised as the demonstration phase, marked with four "large" projects, three of which were not successful, due to maintenance, technical management of the equipment, suitability and dissemination. The last one, backed-up with German experience had positive effects. Mid 1990ies were characterised as a disseminating phase, where PVs were installed in 11,000 residencies and 200 schools, with a total installed capacity of 1,2MW. The different phases of PV applications in Tunisia can be seen in Figure 34.

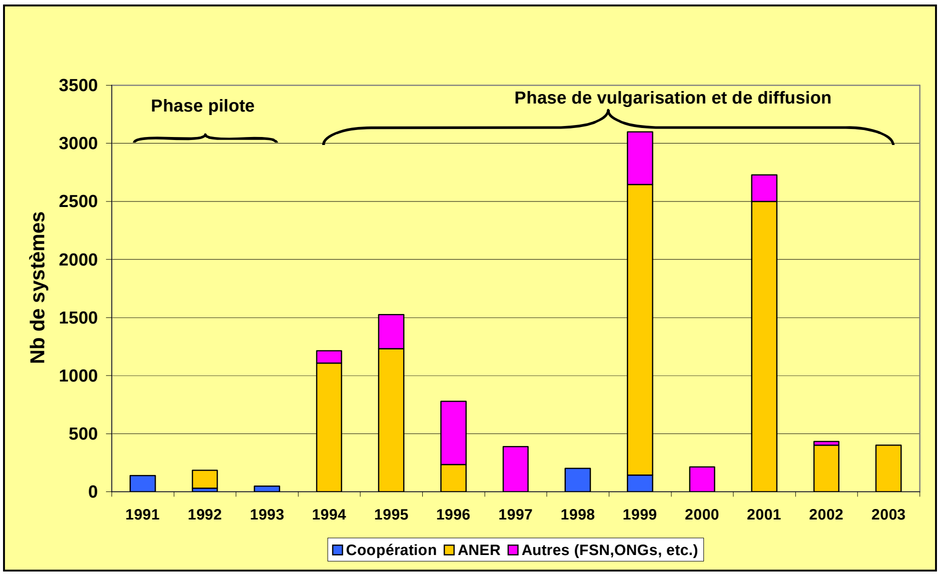


Figure 34. Evolution of the installed PV systems in Tunisia [Source: "Etude stratégique sur le développement des énergies renouvelables en Tunisie – Potentiels des ENR et impacts de leur développement". ALCO-AXENNE/ANME, 2003 – cited by ANME]

3.7 Italy

Italy is one of the least energy intensive countries in the world, but nevertheless has a complex system of energy policies and measures. One of the main reasons is the strong reliance on the import of energy carriers such as oil. Italy is estimated to be 80% reliant on imported energy sources from countries such as Libya and Algeria[4]. This high proportion of imported energy has forced energy prices higher than in other countries and has also driven development of alternative sources of energy.

Another reason for this complexity is the fact that many policies and measures are still (partly) implemented by regional and local governments. Energy responsibilities are shared between the state, the regions and local authorities. Climate change policy, renewable energy support and data collection is based on a localised approach, which results in great differences between the regions.

There is an Energy Authority that launched the self-production of energy with small size plants from renewable sources. The authority has passed measures to promote the self production of electric energy from small plants supplied by renewable energy sources with a power up to 20 kW. With these measures the authority implements the 2003 decree for the promotion and development of RES. The authority envisaged the possibility to sell to the local electric grid the energy output from renewable sources made with plants whose power is not superior to 20kW.

In this way the Ministry of Environment, Regional and Local Authorities have promoted many projects and actions for the RES development. The Regions and Municipalities, for this aim, have changed the building construction regulation to improve building efficiency and renewable energy sources.

The Decrees 192/05 and 311/06 define the obligation for new buildings to install solar technologies for electricity and thermal energy production in both residential and non residential applications. Consumers are more and more interested in buying technologically advanced systems and are more involved in the solar market.

PV technologies and plants are under development and many architects and engineers are involved in projects with challenging design integration.

In 2002 a study of the International Energy Agency - Photovoltaic Power Systems Programme (IEA-PVPS, Task 7) defined the potential power of the PV technologies integrated into the buildings. It estimated a roof area of about 763.53 km^2 (about 410km^2 for residential buildings and the rest in tertiary sector). The PV potential production integrated in buildings is about on 126 TWh/year (that is the 36% of the electric energy consumption for the 2006). Innovations in PV technologies are of the most important aspects for both the designers of the building and the technicians.

There is need to diffuse knowledge and technical information not only to technicians but also to users. That is why in the South of Italy, Sicily region has carried out an important project named SICENEA in which several workshops and training courses were organised to promote solar energy and energy efficiency in buildings and to

[4] EIA, 2000

contribute to Italy's targeted reduction of greenhouse gas emissions. The project carries out a proposal to create an Energy Service Office in all Sicily Province to promote solar projects in new and existing buildings and also the creation of small enterprises, so as to develop the market of solar technologies and to create new business energy companies.

3.8 Greece

There are two types of active solar systems most commonly used in Greece; the systems of natural circulation and the systems of forced circulation:

- The compact heaters or as they are also called, the integrated systems of collector-storage, which are constituted from one or more storage tanks and they are placed in an insulated jacket with their transparent side facing the sun.
- The thermosyphoning systems, which are based on the natural transfer for the water circulation in the collectors and the tank. The tank is placed on top of the collector. As the water heats up in the solar collector becomes lighter and rises up naturally towards the storage tank while the cooler water of the tank flows via the piping system towards the lower part of the collector generating in that way circulation in the whole system.

Thermal solar systems in Greece are applied in the following sectors:

- Domestic Hot Water Production
- Space heating and cooling
- Desalination
- Pool Heating

Regarding the use of solar systems, 99% of them are small scale systems for domestic hot water, 0.75% are large scale systems for hot water in the tertiary sector (hotels, hospitals and swimming pools) and 0.17 % (5,118 m^2) are large systems for hot water, air-conditioning and space heating in industry (*Ref. EBHE*).

About 20% of Hellenic households use thermosiphonic solar systems for the production of sanitary hot water. The great majority (more than 95%) of solar sanitary hot water systems installed in Greece regards compact thermosiphonic units, providing hot water to individual dwellings. A typical configuration of such system comprises a simple flat plate collector (single- or double-glazed) and a storage tank attached above the collector.

Further to the wide application for domestic use, the second larger customer of Solar Thermal Systems in Greece is hotels and hospitals. Over 100 hotel units have central thermal solar systems for sanitary hot water production, swimming pool heating and solar air-conditioning. The market rises up to 28,820 m^2 for the large solar systems and up to 35,000 m^2 for the thermosyphonic type solar systems. Both parts share a 2.2% of the total solar collector stock of the country. The average size of large solar system in hotels is 257 m^2, while the largest one is 2,783 m^2.

Among the operational systems of the Renewable Energy Sources, the active solar systems are the ones with the larger penetration in the market.

Table 7. Market size in terms of collector area (m^2) and capacity (kW_{th}) in Greece [source: European Solar Thermal Industry Federation (ESTIF)]

Market size in terms of collector area (m^2) in Greece							
In operation	Market (= newly installed)					Market Growth	Market Forecast
2006	2004	2005	2006			2006/2005	2007
Total Glazed m2	Total Glazed m2	Total Glazed m2	Total Glazed m2	Rate plate m2	Vacuum collectors m2	Total Glazed %	Total Glazed m2
3.287.200	215.000	220.500	240.000	235.200	4.800	9%	300.000
Market size in terms of capacity (kW_{th})[1] in Greece							
In operation	Market (= newly installed)					Market Growth	Market Forecast
2006	2004	2005	2006			2006/2005	2007
Total Glazed kW_{th}	Total Glazed kW_{th}	Total Glazed kW_{th}	Total Glazed kW_{th}	Rate plate kW_{th}	Vacuum collectors kW_{th}	Total Glazed %	Total Glazed kW_{th}
2.301.040	150.500	154.350	168.000	164.640	3.360	9%	210.000

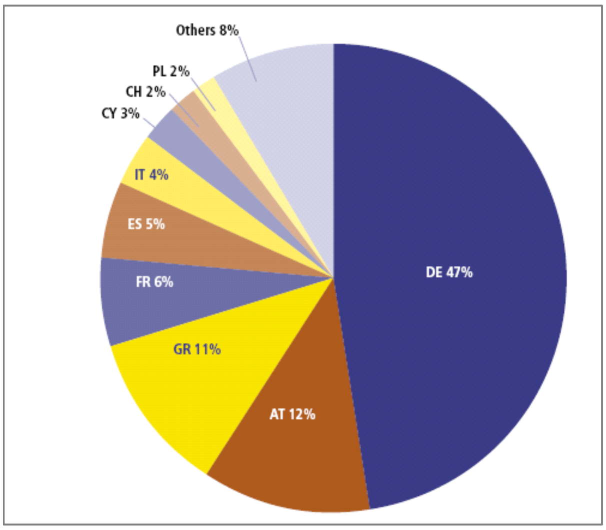


Figure 35. Solar Thermal Capacity in Operation [source: ESTIF 2005]

Regarding the use of solar energy for the production of electricity, it should be noted here, that the electricity demand rises significantly in Greece during summer, when solar radiation is at its peak, due to the use of air conditioning. The maximum electricity production that can be achieved from PVs in Greece coincides with the period when the electricity demand is at its highest (Figure 36). Thus, the use of PVs connected to the grid is capable of normalising the load picks and the total cost of electricity production (taking into consideration the high cost of producing electricity for load picks)[5].

Up to date the use of PVs in Greece has not been as large as for thermal solar systems. Most of the already installed PVs on buildings are isolated systems on summer houses, far away from the grid and not connected to it. Unfortunately, there is no statistical data about these installations.

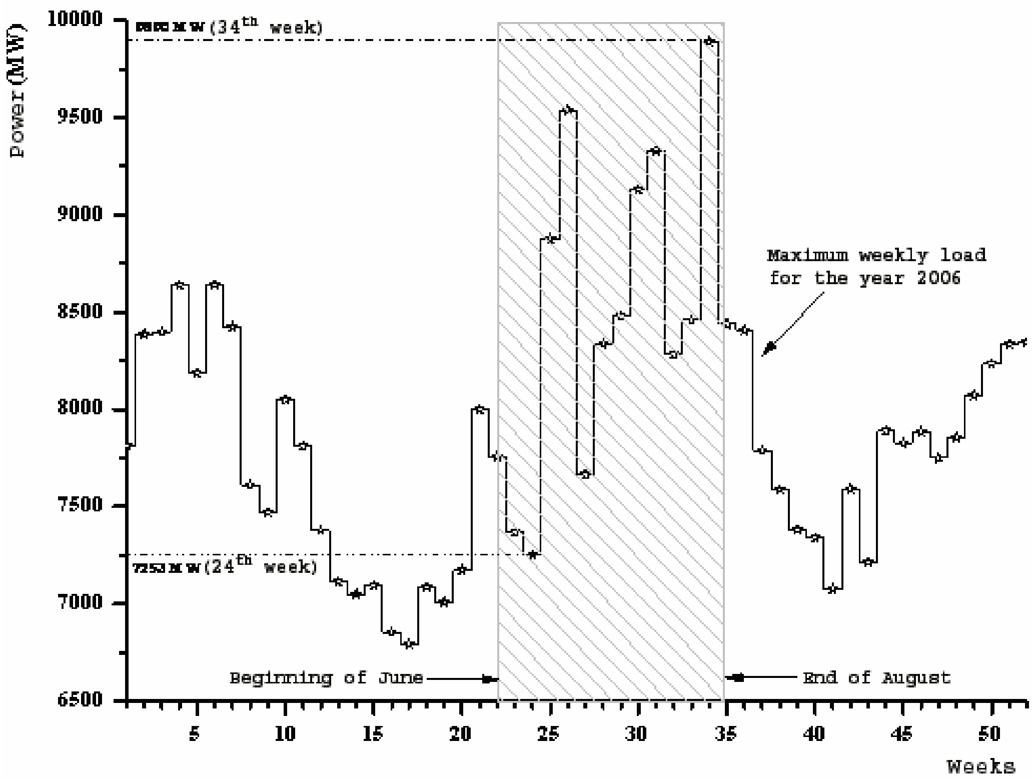


Figure 36. Maximum weekly electric load in Greece in 2006 [adapted from A. Kyritsis, 2008]

3.9 Lebanon

As is the case in Mediterranean Southern countries, the solar market opportunities are great in Lebanon. Thanks to its large solar potential, it is extremely favorable to use solar energy for all thermal applications. Although the solar market resumed its expansion when hostilities stopped, ten years later it is still considerably behind the countries of the region at the annual production level as well as at the existing installations. Currently there are 18 fitters operating in Lebanon. The current prices of collectors in Cyprus are near 105 $/m^2$. The FOB of imported collector is lower than the cost of local manufacturing highly penalised by the low manufactured quantities,

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5 A. Kyritsis (2008) *Optimum Design of High-Frequency Single-phase Inverter for the Connection of Low Power Photovoltaic Systems to the Low Voltage Grid.* PhD Dissertation, University of Patras, Patras, Greece.

but its price on the market is higher by 20 to 30%, taking into account transportation expenses and custom duties.

Currently, the installed capacity includes 87% of individual water heaters, mainly of "open circuit" type with generally a thermosyphon (more than 70%, the remainder being with a double circuit and pump operated) from which 40% are in collective buildings and the remainder are in individual houses. The installed solar collectors park, today, results in energy savings of the magnitude of 45 GWh and CO_2 emissions reduction equivalent to 38,000 tons.

Less than 8% are central installations (in buildings of the tertiary sector) with double circuit (primary and secondary) and operate with pumps. Guarantee of Solar Result (GSR), an idea introduced by the Energy Efficiency in Building Project (EEBP or PEEC), is not widely used in the country. In 2004, approximately 22,760 m^2 of collectors were installed, of which less than 12% were imported, an increase of 550% since 1994 when the total collectors installed did not exceed 4,300 m^2. Most of the installations are in urban areas. There are around twenty fitters operating currently in the local market, 50% of which are manufacturers and 30% importers.

Regarding photovoltaic applications in Lebanon, they are characterised by isolated, a few stand alone applications. These photovoltaic kits of unitary reduced power (few hundreds of Watts) are used in telephone, antenna and radar stations installed in rural areas on the top of the mountains. They are competitive with the diesel power generators and are more reliable.

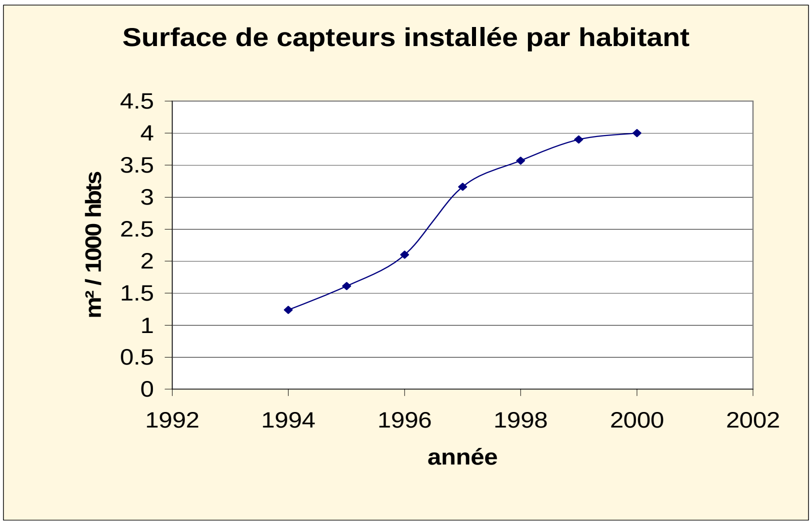

Figure 37. Surface of installed solar collectors per inhabitants in Lebanon [source: ALMEE]

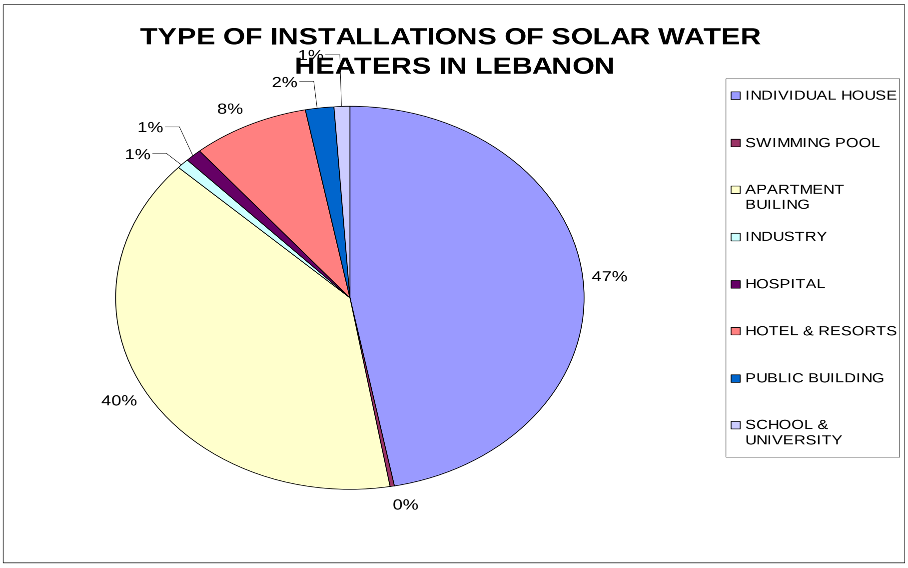

Figure 38. Type of installations of solar water heaters in Lebanon [source: ALMEE]

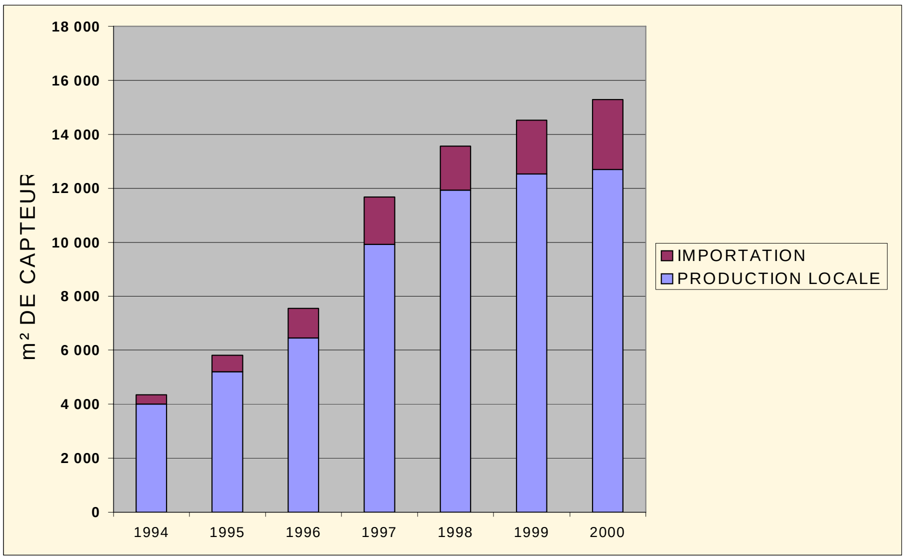

Figure 39. Surface of produced and imported solar collectors in Lebanon [source: ALMEE]

3.10 Palestine

Solar water heaters (SWH) are extensively used in the residential sector in Palestine (67.2% of households use solar family systems), whereas, it is limited in the service (hospitals, hotels, universities) and industrial sectors. The existing installed capacity in all sectors is about 1,500,000 m^2. This can produce about 940 GWh per year and saves about 85 M€ yearly for the national economy. The corresponding avoided emissions of CO_2 are evaluated to 650,000 tn per year or avoided 2.3 M€ damage. The market of SWH is about 13 M€ and can be doubled if proper policy with efficient financial scheme is adapted for the promotion and encouragement of the use of solar collective systems.

The most commonly used system is family system- thermosyphonic open circuit type. Solar heating is competitive with other means of heating and the system pay-back period is less than 2 years, when compared to that of electric systems. Use of collective systems is very limited and has to be introduced in an efficient way. The industry of solar water heaters in Palestine is small and needs to be developed and structured.

Passive solar heating is traditionally and widely used in Palestine, especially with regard to building orientation and window location. The national energy code for building has been set up. Serious attempts are being made to encourage the use of passive solar heating by the establishment of a comprehensive database of climatic conditions and zoning in Palestine, conducting of public awareness programs, and training of design engineers.

Regarding photovoltaic applications, in 1995 PEC had started with pilot projects for PV applications through clinic electrification program. In spite of the high cost of SHS at that time (>10 $/WP), applications were extended to electrify isolated schools, households, public establishments and publicity stations. More than 90 SHS were installed through two main projects: The Eldorado German Program for the promotion of PV technologies for public use in developing countries, and the Baden Wuerttemberg German PV revolving fund project for private use. Another important program is the GEF/ UNDP projects (implemented under supervision of PEA) for the electrification of a small boarder Bedouin community and lighting a bridge in Gaza.

3.11 Jordan

Despite the high solar potential of Jordan, solar energy technologies are not extensively used, except for solar water heaters (SWH), which are used for domestic water heating. It is an economically feasible technology to use, compared to all other conventional water heating systems. The SWH industry in the country is well developed. The market for Solar Water Heater has been rising around 60% in the year 2006 in comparison to year 2005, because of the increase in energy prices in Jordan, which is the main barrier to the market development. The Solar Water Heaters Market in Jordan is divided in the following sectors:

- Household Sector: is the main player in the market of solar water heating. About 14% of the houses in Jordan own solar family systems for water heating (source: national agenda 2006).

  According to the available figures from the Department of Statistics in 2004, the number of existing dwellings is 1,204 million. The total area of installed systems is about 896,740 m^2. An annual increase by 40,000 new dwellings per year is expected for the next 20 years.

- Hospitals: The total number of hospitals in Jordan is 91 with 8,982 beds. The total annual demand of hot water is 161,767 m^3 (1.5 m^3 monthly demand per bed). The estimated energy needs for hospitals in Jordan is about 25.7 × 103 GJ/year.

- Hotels: The total number of classified hotels in Jordan is 204 and 124 guest apartment and suites with 19,755 rooms and 37,613 beds in total. The estimated energy needs for hotels and guest apartments in Jordan is approximately 171 × 103 GJ/year.
- Universities, schools and sports facilities: Some schools and universities use solar heating systems. Unfortunately, detailed information is not available regarding the number of systems available in such facilities.

Photovoltaic applications are mostly used in communications systems in remote places. Many corporations have applied such systems in Jordan. In general they have attained an excellent degree of operational efficiency and reliability from both the technical and economic viewpoint. Their performance is comparable with, if not even better than, those powered by diesel generators.

4 Good practice examples in the region

4.1 Supporting Mechanisms and Success Stories from France

There are several supporting mechanisms that have developed in France, so as to encourage energy savings in buildings and RES installations. Regarding construction permits, since May 2007, an extra 20% coefficient of construction is applied, provided the construction has very high energy performance (THPE) and renewable energy installations are applied, with respect to THPE, ENR or BBC[6] labels for the new, public buildings and for the new, private buildings that consume 20% less energy, in relation to RT2005[7], encouraging the use of biomass, PVs, active solar systems and geothermal pumps. For the permit of the extension of existing buildings, insulation criteria and the use of the above mentioned RES are also put forward.

Regarding national policies, the perspective of the thermal regulation is to reduce building-produced CO_2 emissions by 4 until 2050, which is registered in law 2005-781. In 2003 the average annual energy consumption of the building sector was of the magnitude of 245kWh/m^2, while it was 372kWh/m^2 in 1973. With the assumption that the quantity of the emitted CO_2 is proportional to the consumed primary energy, buildings in France should consume less than 50kWh/m^2 for heating and cooling annually. For achieving this, the RT2005 has fixed, among others, a maximum annual energy consumption of 85kWh/m^2. The following RTs (thermal regulations) will have as target to improve the energy performance by 40% in 2020 and finally a reduction by 6 of the consumptions of 2050.

Since the end of 2006 a “diagnosis of energy performance” (DPE) is obligatory for any selling of existing buildings and since July 2007 it is obligatory for any type of rental contract. The DPE is a document which includes the quantified consumed or estimated energy for a standard use of the building. It is accompanied by recommendations for improving the energy performance of the building, including the replacement of equipment.

There are also five certificates for new buildings, concerning greater thermal performance than the one suggested by RT2005, which have the following labelling codes:

- Label HPE (high energy performance): 10% less energy consumed than in RT2005
- Label THPE (very high energy performance): 20% less energy consumed than in RT2005
- Label HPE ENR : HPE & biomass or heating network
- Label THPE ENR: 30% less energy consumed than in RT2005 & + (solar hot water and wood or heating network) or (solar hot water and heat) or PV or Heating Pump. Solar collectors should cover at least 50% of the SHW needs and the PVs should cover a production of 25 kWh/m^2

[6] These labels are explained below.
[7] RT2005: French Thermal Regulation of 2005

- Label BBC 2005 (label of Building with Lowest Consumption): consumption of the magnitude of 50 kWh/m^2 annually (modified according to climatic zone and altitude)

Financial incentives are given, among which:

- Tax credit; 40% for thermal insulation, appliances for regulating heating and 50% for RES technologies and heat pumps, contributing to energy decrease
- Subsidisation of pre-studies until 70% with upper limit 2,300€
- Subsidisation of studies until 50% in which regional funds could be added, reaching 70%
- Finally the subsidisation of the works can reach 350 €/m^2 with limit 40% of total cost for private, until 80% for local collectives

Regarding specific policies for active thermal systems, the “Plan Soleil” (Sun Plan) was launched at the end of 1990ies, after the revival of the solar market in France and as consequence of a large part of the existing installations, which did not work properly. The “Plan Soleil” mostly concerned quality measures. For ADEME to fund the installations, the following criteria were put forward:

- The materials used should be certified.
- The installer who made the works should belong to the network Qualisol, which is a charter of quality of good, professional practices.
- A contract of guarantee of the solar results (GRS) should be signed for installations greater than 50m^2, by all the actors of the installation of a central solar system; the engineers who make the studies, the installer, the salesperson of the equipment and the people in charge of the maintenance.

The mechanisms for supporting central solar systems are:

- Financing feasibility and financial study up to 70% by ADEME, with maximum 2,300€,
- Financing feasibility and financial study up to 50% by ADEME, with regional participation, making it 70%,
- Investment aid up to 350€ per m^2, which is limited to 40% of the total cost in the private sector and can become 80% in the case of public buildings.

Regarding photovoltaics, the development of the installed capacity in 2006 shows the success of a politic organised around state assistance and involving more instruments:

- A tariff system of support, since 2002, which was re-evaluated in 2006 for going from 15cts€/kWh to 30cts€/kWh for metropolitan France and 40cts€/kWh for its other territories. It reaches 55 cts€/kWh in case of panels integrated in buildings
- Tax exemptions of public projects
- The grants can also, under certain conditions, be vouchersafed by regional councils, municipalities and ADEME

It should be noted here that the market development is primarily oriented towards PVs integrated into buildings (BIPV). The installations and products are in accordance with the European and international quality norms (CEI). It is expected that a quality norm will be established for PV installation (Quali'PV), guarantying the professionals' qualifications, concerning electric and roof installations.

Finally, regarding the French industry of PVs, a factory is under construction in South Alps. It is expected to operate in 2008, with an annual production of 7,000 tonnes of high quality silicon for PV applications.

There are several examples of solar technology integrated in the building sector in France. In the instance of the 11th century historical monument in Alès, in the south of France, its arcades have been covered with 10kWp photovoltaic grid, consisted of 70 panels, of 46Wp each (Figure 40). The annual production at full capacity is about 6,000kWh.

a


b

Figure 40. The 11th century monument in Alès, South France, whose arcades have been covered with 10kWp PV panels [source: ADEME]

Another interesting project is the active solar installation in the public retirement home, in Oraison, on the Durance's bank. The installation is made of 120m^2 solar collectors, fully integrated in the roof structure, providing 55^{o}C sanitary hot water (Figure 41). The flat selective solar thermal collectors are connected to two hot water storage tanks of 4,000 litres each. They are oriented facing south with 30° inclination. This system produces from the sun more that half of the total hospital needs, and saves around 120,000kWh each year, i.e. 10TOE of gas and avoids 25tn of CO_2 emissions annually.

Figure 41. Solar panels integrated on the roof of the Oraison public retirement home [source: ADEME]

4.2 Supporting Mechanisms and Success Stories from Spain

The Renewable Energy Plan 2005-2010 brought in by the Electricity Sector Law in Spain, sets the objective to produce 12% of the energy of the country from RES. It also establishes the measures and incentives with which to achieve this objective, promotes increased competitiveness of regional economies, social cohesion and employment, using human and energy resources. It also allows the three solar sectors (photovoltaic, thermoelectric and solar thermal) to design long-term strategies. The developed mechanisms of supporting energy savings and RES applications in Spain are many, such as:

- The Technical Building Code which was approved by Royal Decree 314/2006. The Code is the regulatory framework establishing the demands to be met by buildings in relation to the basic security and habitability requirements set out in the Building Act (Ley de Ordenación de la Edificación, LOE).
- In order to encourage innovation and technological development, the Technical Building Code has adapted the most modern international approach in the field of building regulations; codes based on provisions, features or objectives.
- Thus, in a structured and hierarchical way, the Technical Code's project has established the demands that develop the law's objectives and its basic requirements based on the so-called Code Application Documents (DAC), drafted as technical rules. These include check-up methods or adaptable solutions, acknowledged as a means of satisfying the projects and work demands. Nevertheless, the DAC leaves the possibility of proposing other different means for its performance as an alternative to the already established ones.
- These DACs revise and update the existing technical regulations (for example, Basic Building Regulations) and also include areas not dealt with up to then, according to the existing technical Regulations.
- Among the seven DACs of the Technical Code is the DAC HE, whose basic requirement, "Energy saving", consists in achieving a rational use of the necessary energy to be used in buildings, thus reducing its consumption to sustainable limits and ensuring that a part of this consumption may come from renewable energy sources.
- The enforcement of this Code will take place the day after it is published in the Spanish Official Gazette (BOE); nevertheless, a transitional period of voluntary application is established. This period is not the same for all the Application Documents, and therefore, a term of 6 months has been established for the "Energy Saving" DAC HE. Thus it will be obligatory to meet the demands of this "Energy Saving" DAC HE.

The approval of new building regulations (CTE) in 2006 placed the solar photovoltaic energy sector in the building industry, opening new market and application opportunities. The modification of the IDAE aid lines in the same year improved the development of new projects.

Also, regarding photovoltaic applications, the following framework has been set:

- Law 54/1997, on the electricity sector
- Royal decree 661/2007
- Royal Decree 314/2006
- Royal Decree 1663/2000
- Resolution of 31 May 2001, Directorate General for Energy Policy and Mines

The first European large-scale solar thermal plan for the production of electricity is under development since the beginning of 2007 in Aldeire, Spain. The solar thermal power station AndaSol I has a rated output of 50 MW and can be operated for 6 hours out of a thermal storage during periods without sunshine. After the construction period the plant will produce approximately 179 GWh annually and provide electricity supply for up to 200,000 persons.[8] Also, integration of solar thermal systems and PVs have been put forward and Spain has to show some very interesting designs, of solar thermal systems being used as shading devices on façades (Figure 42) and photovoltaics being placed as new design elements on the top of roofs (Figure 43).

Figure 42. Solar thermal installation, acting as shading devices on the façade of the Poliesportiu Municipal del Guinardó Torrent d'En Melis, Barcelona [source: Agència d'Energia de Barcelona]

Figure 43. Roof of the Besós sewage treatment plant with 600kW photovoltaics in Barcelona [source: IDAE]

[8] W. Schiel (2007) *World's biggest solar power plant under construction in Spain*. Schlaich Bergermann und Partner; Stuttgart, Germany

4.3 Supporting Mechanisms and Success Stories from Portugal

Following the EU directive 2002/91/CE on “the energy performance of buildings” has caused the revision of the national regulations of Portugal. Two main codes have thus been created;

- the RCCTE DL80/2006 that concerns all household buildings and small service buildings, without air conditioning systems, or with air conditioning systems with output of less than 25kW. According to this regulation, it is obligatory to use thermal solar panels for heating sanitary hot water.
- the RSECE DL79/2006 that concerns large service buildings (greater than 1,000 or 500 m^2), small service buildings with air conditioning systems with output of more than 25kW and households with air conditioning systems with output of more than 25kW.

These codes are both for new buildings, for renovating and for extensions of existing buildings. In the following table, the dates from which the codes will start being put in practice are given for each type of building. In Figure 44 the energy certificate of buildings in shown, according to the new Portuguese codes.

The national solar thermal and PV policy is part of the general strategy and framework on Renewables established by the government. In 2005, the major change at the national energy policy level was the publication of a new government Cabinet Resolution (169/2005), which stressed the strategy for the country's sustainable development. Improving energy efficiency, reducing CO_2 emissions and increasing the use of renewable energy sources (RES) are some of the most significant objectives under this framework.

The government established ambitious goals for RES-E to be reached by 2010, allowing Portugal to be able to meet the targets agreed to under the 2001/77/CE Directive; 39 % of the gross electricity consumption from renewables by 2010. PV's contribution is set to increase from the current level of about 3 MW to 150 MW. The PV market development mechanisms are mainly based on a favourable feed-in tariff, together with a financial incentive system (PRIME, 2000- 2006), as well as other indirect market instruments (taxes)[9].

The main legal and incentive framework related to PV is:

- Decree-Law 312/2001 defining the conditions regulating the awarding and management of grid interconnection points for Independent Power Producers (IPP).
- Decree-Law 33-A/2005 establishing a range of favourable feed-in tariffs for RES electricity.
- Decree-Law 68/2002 regulating the delivery of electrical energy into the low-voltage grid (micro-generators, including PV).

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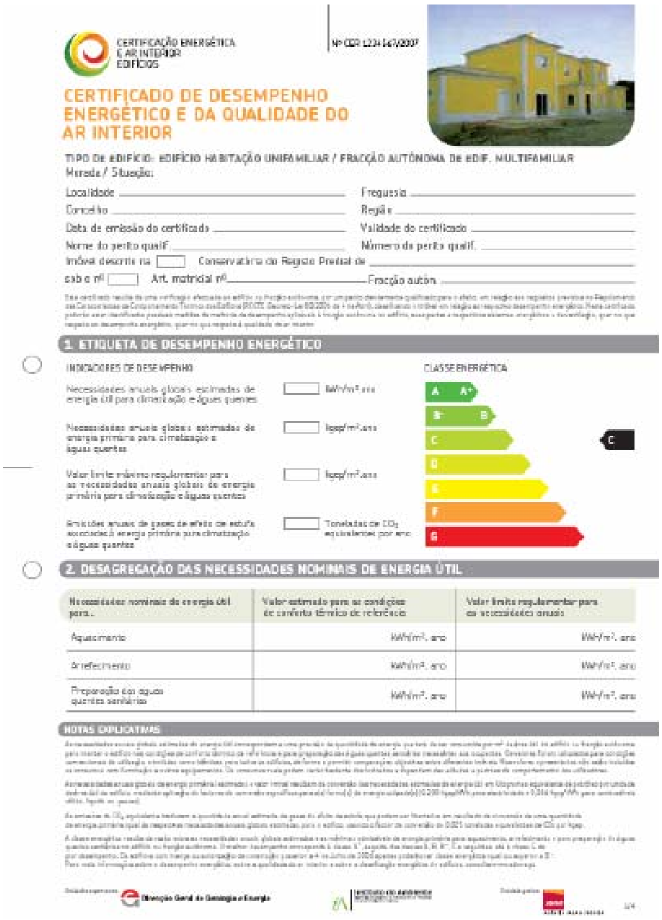
[9] P. Sassetti Paes, EDP S.A. (2006) Portugal: Photovoltaic Technology Status and Prospects. Available from: http://www.iea-pvps.org/ar05/prt.htm. [Accessed: 23rd January 2008]

- PRIME (Incentive Programme for the Modernisation of the Economy), which provides financial incentives, namely for energy efficiency and endogenous energies projects.

Table 8. Timetable of the start of application of the energy performance of buildings codes for different types of buildings in Portugal [source: ADENE]

Large Buildings (>1000m2) New	1ft July 2007		
Small Buildings (<1000m2) New		1ft July 2008	
Existing Buildings			1ft January 2009


CERTIFICAÇÃO ENERGÉTICA E AR INTERIOR EDIFÍCIOS

CERTIFICADO DE DESEMPENHO ENERGÉTICO E DA QUALIDADE DO AR INTERIOR

TIPO DE EDIFÍCIO: EDIFÍCIO HABITAÇÃO UNIFAMILIAR / FRACÇÃO AUTÓNOMA DE EDIF. MULTIFAMILIAR

Morada / Situação:

Localidade

Freguesia

Concelho

Região

Data de emissão do certificado

Validade do certificado

Nome do perito qualif.

Número do perito qualif.

Imóvel descrito na

Conservatória do Registo Predial de

Art. matricial nº

Fracção autón.

1. ETIQUETA DE DESEMPENHO ENERGÉTICO

INDICADORES DE DESEMPENHO

CLASSE ENERGÉTICA

A A+ B- B C D E F G

2. DESAGREGAÇÃO DAS NECESSIDADES NOMINAIS DE ENERGIA ÚTIL

NOTAS EXPLICATIVAS

Figure 44. Energy Classification and Certificate of Emissions of buildings in Portugal [source:ADENE]

Portugal has to show many success stories in the implementation of solar energy, such as the second largest photovoltaic system in Europe, the 11MWp photovoltaic field, which is located in Serpa Central (South Portugal), which consists of 52,000 PV panels. It can supply 8,000 people with electricity and was a 56,400,000€ investment in 2006. Apart from that, emphasis has been given on the integration of photovoltaics on the roofs and walls of buildings, as can be seen in the integration of PVs on the southern façade of the Solar XXI Building in the INETI Campus in Lisbon (Figure 45), where 96m^2 panels have been integrated on the façade, of 12kWp installed power, covering 30-50% of the electricity needs of the building. There is also a number of individual houses which can show the harmonic integration of solar thermal and photovoltaics on the building envelope (Figure 46).

Figure 45. Integration of photovoltaics on the southern façade of Solar XXI Building in the INETI Campus in Lisbon [source: ADENE]

Figure 46. Examples of solar heating and photovoltaic installations in individual houses in Portugal [source: ADENE]

4.4 Supporting Mechanisms and Success Stories from Morocco

The Energy Savings and RES legislation of Morocco established in 2007 previews among others, the following:

- Thermal regulation in buildings
- Labelling of appliances
- Fiscal and financial incentives

- Financial Funds for supporting programs for EE and RES
- Support of electricity auto-producers: limit at 50 MW, access in networks, feed in tariff exceeds 60% of public tariff (50 cents DH/kWh)

There is also other relevant legislation to energy saving, RES and environmental protection, such as:

- Law relative to electricity market liberalisation
- Law no 28-00 relative to waste management (2006)
- Law no 54-05 relative to management of public services (2006)
- Law for protection of the environment (2003)
- Law relative to the fighting of air pollution (2003)
- Law 10-95 concerning water (1995)

It is also expected to launch works of elaboration of Energy Efficiency Code in the Building Sector in the future.

The other available tools for the promotion of solar thermal systems are:

- Examples of energy savings and RES applications in the public sector, with the application of active solar systems in public buildings
- Quality of products and services through norms, certification and technical guidelines
- Financial and fiscal measures
- Energy tariffs policy (linkage with international markets)

Under this frame, the "Projet de Circulaire du Premier Ministre" promotes low electricity consumption lamps and Solar Water Heating in public buildings. The main axis of the energy efficiency program in buildings in Morocco include:

- Building thermal regulation: norms and technical guidelines
  - Concept plans (exploitation of bioclimatic potential)
  - Construction (improve insulation characteristics / use of the most appropriate materials)
  - Electromechanical systems for heating, ventilation, air conditioning
- Performance labelling of electrical appliances
- Implementation of 50 pilot projects (20 hospitals, 10 hotels, 5 collective buildings, 5 social buildings, 5 existing buildings, 5 national education buildings)
- Promotion activities

Up to 2012, the government of Morocco wishes to achieve the following in the energy conservation field:

- Diversification of energy supply sources
- Sustainable human development: general access to energy
- Decrease of energy service costs
- Optimisation of electricity load curve

- Decrease of the increase rate of GHG emissions (avoid 24 millions tonnes CO_2 until 2015 and preservation of natural resources, especially focusing on water and forests)

This can lead to economic development, with new investment opportunities; it has been estimated that these goals can mean investments of more than 4 billion Euros until 2020 and 23,000 new jobs.

Regarding photovoltaics, there have been many pilot projects initiatives. In the context of PERG (Rural Electrification Global Plan, launched by 1996), ONE (Office National d'Electricité/ National Electricity Company) had chosen to use the country's solar potential to electrify villages where the connection to the grid was prohibitively expensive. Other projects regarding PVs are:

- SAER, which was implemented in collaboration with the German Agency for Technical Cooperation (GTZ) and was initiated in the province of Kénitra (1989-1992). It was the detonator of PV solar kits demand for lighting and TV in rural areas. It allowed more than 400 households to be electrified with PVs.
- PPER was implemented in collaboration with French co-operation (1990-1994). PPER provided for the equipment, by RE in general and solar PV in particular, of 240 villages of three provinces: Azilal, Errachidia and Safi. The program equipped a total of 15,000 households. This was achieved with technical solutions based on RES; individual solar kits, collective solar (house of batteries refill) and micro-network (power generating units and MCH).
- VILLAGE POWER Programme: carried out within the framework of the Morocco-Spanish co-operation, this project concerned the equipment of 500 households. The equipment was provided in the form of donation, while installation and maintenance costs were charged to the users.
- PER/private sector (2001-2005): Within the framework of the efforts made by ONE in the field of decentralised rural electrification, a strategy based on an effective partnership with the private sector, the communities and villages associations was adopted. This approach is in conformity with the approach of the PERG which is based on the participation not only in the financial aspects but also in the implementation process.
- The Global Rural Electrification Program (PERG): based on the experience of previous programs, the national PERG was launched in 1996 to electrify rural households for which connection to the grid fell below 10,000 Dh. The use of individual PV kits was selected for villages where population is low and scattered, with the objective of electrifying 150,000 rural households and to reach total electrification rate of 98% by 2007. By the end of 2006, 37,489 households were supplied with electricity from PV systems.

4.5 Supporting Mechanisms and Success Stories from Algeria

The procedure for the construction permit for both public and private buildings does not include any regulations regarding the energy consumption of buildings in Algeria. The law no 99-09 of 1999, which is relative to energy, defines measures of "the rational use of energy, the development of RES and the reduction of the energy system impact to the environment". It defines an energy consumption model towards the use of natural gas for final, thermal uses and the use of electricity towards specific uses.

The National Energy Program (PNME) for the period 2006-2010 is the principle measure for the encouragement of RES, especially in the building sector. It focuses on active solar systems in the domestic sector and also in services. The financing of the projects defined in the PNME is assured from the National Foundation of Energy (FNME).

The national policy of Algeria for environmental protection is based on a legal framework, namely on laws 03/83 (related to environmental protection), 99-09 (related to energy), 01-20 (related to the sustainable development of the area) and 03/01 (related to the environmental protection in the frame of sustainable development). Regarding the promotion of RES, the National Assembly adopted in 2004 a relative law for the promotion of RES, in the frame of sustainable development. In addition, Algeria has engaged itself to cover 5% of its electric demand with RES, especially with solar power until 2010.

The existing solar installations in the country are mostly in the PV sector, which is the most developed RES sector in Algeria. The projects that operate up to date are:

- The electrification of 20 isolated villages in South Algeria, made by the National Society of Electricity and Gas (SONELGAZ).
- The electrification of approximately 1000 houses, in the frame of the development of the steppe regions, financed by the High Commission of Steppe Development (HCDS).

Figure 47. Batteries of PV systems in Gara Djebilet [source: APRUE]

Figure 48. Electrification of isolated villages in South Algeria [source: APRUE]

4.6 Supporting Mechanisms from Tunisia

The procedure for the construction permit for both public and private buildings is governed by the law 94-122 of 1994, where the different pieces composing the file of the building permit, the local and regional technical committees for licensing, as well as the obligatory participation of an architect are defined.

The law of 2/8/2004, regarding energy application, offers guidelines for energy application in the building sector. Nonetheless, it does not include the improvement of the thermal performance of buildings. A construction code and a thermal regulation code of buildings are under construction in the frame of the project GEF/PNUD.

For existing buildings there is no legal obligation for their energy performance. The works of thermal renovation are not eligible for financing. Thermal insulation materials have fiscal advantages, as foreseen from the energy application law. Nonetheless, the procedures for obtaining these advantages are too long, at a point that they are often given up by the thermal insulation companies.

Regarding PVs, they are favoured by the law no2005-82 for the production of electric energy from RES, supported by funding. The Directive no 2005-2234 fixed the primes for each investment.

4.7 Supporting Mechanisms and Success Stories from Italy

Building codes and building energy certification Codes for new buildings have been reinforced in Italy in 1975, 1982, 1989. In 1993 new standards (Decree 412/93) were set for new buildings and renovation works, to be enforced by local authorities. Sanctions are forecast in case of non compliance. Buildings after 1993 use 11% less energy than before 1978 and 5% less than between 1978 and 1989. The trend is to introduce provisions for energy saving/energy performance not only in new buildings but also in existing buildings when major renovation occurs. This tendency is fully in line with the content of the EPD and creates the legislative background for its application.

The most recent laws enforced to regulate the residential building construction sector were the Presidential Decree of 2001 No 308 "Unified text of laws and regulations for residential building construction" and its modifications through the Decree of 2002 "Modifications and integrations to DPR 6 June 2001". In particular, Art. 128 of the "unified text" deals with the building energy certification. It promotes a deep revision and innovation of the different Rules, Norms and Regulations at municipality level, also referring to the new regional urban and building laws.

In October 2005 the Decrees No 192 and No 311 in 2006 were issued for the application of the Directive 92/2002/CE on the efficiency in the building sector. They defined the standards and the rule for the new and refurbishment building construction for the energy certification in buildings.

These laws updated not only the mandatory energy efficiency requirements for the shell of new residential and non-residential buildings, but also revised completely the methodological approach with the introduction of rules and calculation methods to determine the seasonal energy consumption. The decrees 192/2005 and 311/2006 set the criteria for the design and maintenance of buildings. It is expected that emissions of CO_2 will reduce by 10% in the new residential buildings.

In 2001, legislation was established via two Bills, setting quantitative targets for electric and gas distribution companies (Ministry for Productive Activity issued, together with the Ministry for Environment, the Decrees "about the national quantitative targets for energy savings and RES development" and "about national quantitative targets for the improvement of the energy efficiency of final end uses"). Within these decrees, the National Authority for Energy and Gas (AEEG) was appointed for the definition of reference technical norms and the preparation of specific guidelines for the design, delivering and evaluation of possible actions.

Starting in 1998, several fiscal measures were introduced to support energy saving intervention such as:

- Law No. 449/97 allowed a fiscal reduction of 41% of the cost (VAT included) related to building restructuring - including renewable energy sources - carried out during 1998 and 1999. The reduction applies only to building owners and is due on personal income tax (IRPEF), divided into five to ten annual rates. The reduction is applicable for costs limited to 77,468.53 € per building unit per person per year.
- In December 1999 law No 488 was published, encompassing mainly a new round of fiscal incentives (-36% on expenses in this round) for energy savings maintenance and renovation activities in buildings carried out in the year 2000, with a maximum of 77,468.53 €. The incentive can be applied also to the purchase of a building that has been refurbished by a firm. In addition, a reduced VAT (10%) is applicable for the material used and the maintenance activities. The fiscal incentive has been reduced due to the contemporary introduction of the VAT reduction (-10%).

- The possibility of 55% deduction for energy saving purposes related to upgrading the performance of buildings or elements of the buildings foreseen in the Decree 311/06. The same Law prolonged also the reduction of VAT to 10%.

These laws were not specifically designed for energy saving purposes only, but also to support the construction sector and for the reduction of the black market in restructuring; however, for a higher quality of the material and qualified manpower used they increase also the potential for thermal efficiency of buildings.

Starting in 2005 the Ministry delle Attività Produttive promoted the first action to support the PV plants grid connected named “Conto Energia”. The goal is to install 3,000MW PV until 2016, 1,200 MW of which use these incentives.

The most active regions in the solar market are Emilia Romagna, Lazio, Liguria Lombardia, Sicilia, Campania that start with voluntary proposals to upgrade public buildings, particularly schools, or challenge for passive houses or solar buildings. The Municipalities of Rome, Asti have also carried out in an Altener program a European Solar Exhibition project. In this project several solar residential buildings were designed as in Saline- Ostia-Rome, or in Asti (Figure 49). Today, some winner projects are in construction phase.

The Municipality of Sperlonga near Latina, Central Italy, with the Ministry of cultural Heritage the Architects Association and the ATER (social housing Body) promoted a challenge for innovative solar buildings in a site near the sea. The winner was a project of residential building with 24 dwellings. The building is in “A” class due to the high performance of material and design (Figure 50). In Figure 51a the cost benefit of investment can be seen and in Figure 51b the energy gained from the solar panels.

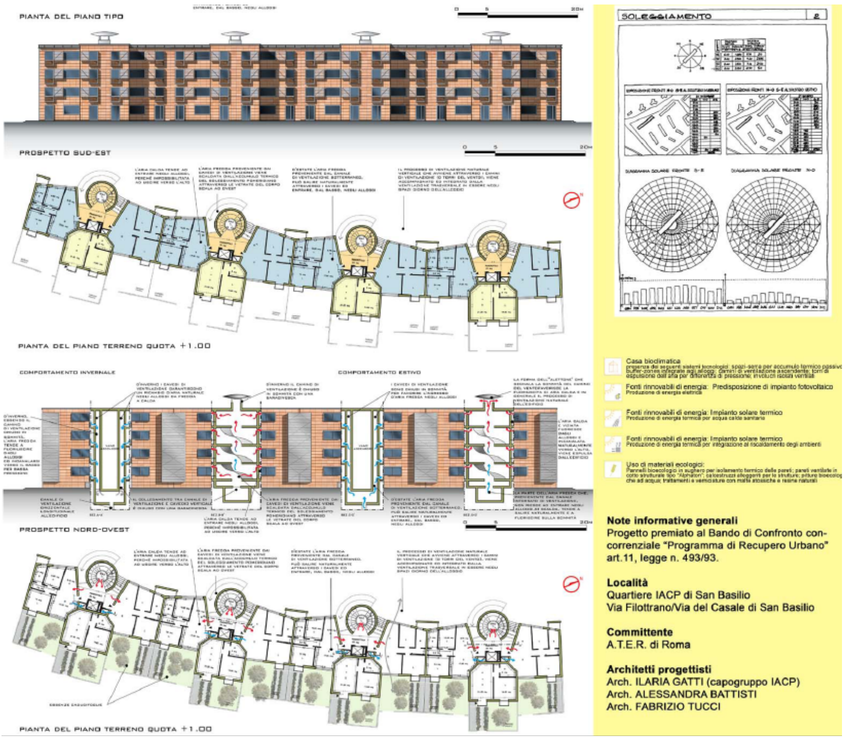


Figure 49. Winner project for 56 dwellings in bioclimatic solar buildings in Italy in the European Solar Exhibition, performed under the Altener 2002 program [source: ENEA]

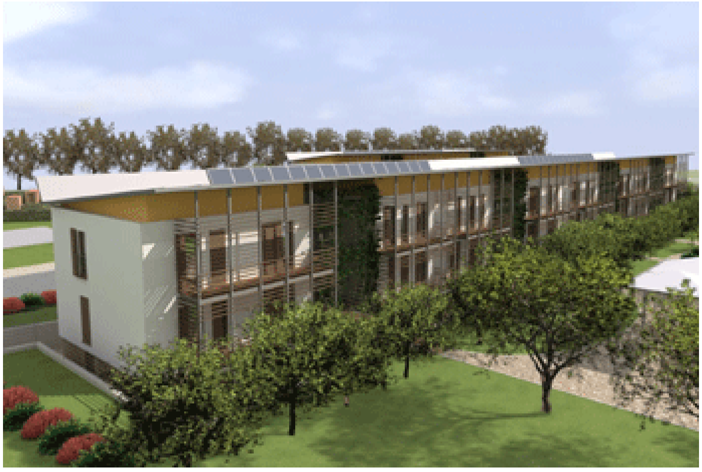
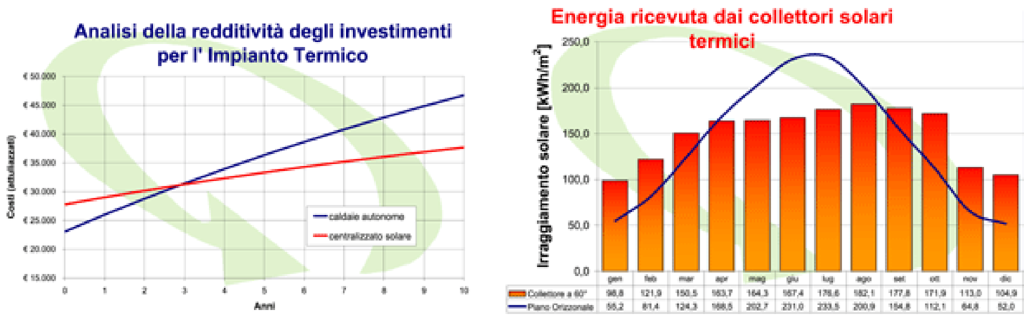


Figure 50. The Light House building in Sperlonga [source: ENEA]



a b

Figure 51. (a) Cost benefit of the investment and (b) Monthly energy from the solar panels in the Light House building in Sperlonga [source: ENEA]

4.8 Supporting Mechanisms and Success Stories from Greece

The application of active solar systems in Greece[10] started in mid 70's. The use of electric heaters in almost every Greek household, in combination with the oil crisis, and the rising price of electricity during this period, provided the background for the solar market to develop (EBHE – the Greek Solar Industry Association - was created in 1978). The advertising campaigns of large firms and relevant regulations helped in the initial phase of the establishment of the solar market.

Regarding building permits, they are issued by the Local Planning Departments which operate under the auspices of each Prefecture. A building file containing a complete package of the architectural and structural drawings as well as the studies for thermal insulation and electrical-mechanical systems, is submitted to the Planning Department of the area. The compliance with the building Regulations is controlled and the building permit is issued. A final control, in the construction phase, is

[10] "Collection of statistical data on Solar Energy Applications in Greece", C.R.E.S - Department of Energy Information Systems, European Commission – EUROSTAT 2001

conducted by the Local Planning Department in order to provide the required certificates for the connection of the building to the electricity grid.

Technical regulations for the building sector are specified in the 'General Building Code', which defines maximum allowed building factors, site coverage factors and building volume coefficients, in relation to the size of plots and by specific area (for building permits), both for new buildings and for extensions to existing structures.

The 'Regulation for Thermal Insulation' imposed in 1979, sets limitations to heat losses (by setting limits to k values) of the building envelope, varying by climate zone and F/V ratios. By amendment of the General Building Code, since 2000, incentives are provided for the application of passive solar systems onto the building shell. Such incentives foresee exclusion of the area of the energy systems within the building factors and volume coefficients. Moreover, in the General Construction Code (1985), an exception was provided to the limitations posed with respect to the maximum allowable height of buildings, in case a solar water-heating installation was included.

Following official adoption of the Action Plan "Energy 2001" by the Hellenic Government, significant tax incentives for (domestic) RES installations and systems were introduced by Law 2364/1995; up to 75% of the total cost for the purchase and installation of domestic RES appliances and systems can now be deducted from the taxable income of natural persons. It is estimated that the tax deduction of Law 2364/1995 can reduce the cost of domestic RES systems (e.g. of solar heaters) by up to 30%.

"Energy 2001" was further reinforced by the enactment of M.D. 21475/98, which incorporated the provisions of Council Directive 93/76/EC (EU Save Directive) for the stabilisation of CO_2 emissions and the efficient use of energy in buildings.

Concerning the incorporation of RES systems in buildings, the M.D. 21475/98 specifically refers to:

- active solar systems (ASS), such as hot water solar heaters and photovoltaic modules
- other (non-specified) RES systems, which may convert renewables to electricity or thermal energy.

In the frame of the implementation of the *'Energy Performance Building Directive 2002/91 of the EC and the Council*', the 'Regulation for Thermal Insulation' is going to be replaced by the new 'Regulation on Energy Efficiency of Buildings' which sets as obligatory the energy design of all buildings, specific energy consumption limits (per climate zone), materials properties and performance and calculation methodologies for H/C/L.

Apart from regulations, for the dissemination and the further promotion of the solar thermal systems in Greece, a considerable number of activities have already taken place, such as mass media campaigns, advertising, implementation of workshops business oriented, web and journal publications, technical brochures productions, etc. The support of the state to the solar industry has been decisive for the development of solar thermal industry in Greece and its applications in the domestic sector. In 1984-1986 the Hellenic State supported a successful advertising campaign. This campaign, combined with the introduction of the VAT process in the Hellenic taxation system (due to the consumers' expectations this change created a major increase in the durable product market), by the end of 1986 boosted the annual sales of glazed solar collectors up to 185,000 m^2. Low interest loans and tax credits were also available during this period. Another campaign in two phases over the period 1994-1995 was co-financed by EU OPET Programme and manufacturers and included a TV campaign and direct mailing through the bills of the Public Power Corporation (PPC). This Campaign was collaboration between CRES, EBHE and PPC, with encouraging results. A parallel series of promotional and raising awareness activities funded by the European Commission, have been carried out during the last 15 years, mainly through the THERMIE and ALTENER programmes, focusing both on the demand and the supply side.

Since 1987 the market's growth rate has stabilised mainly because:

- The financial constraints slowed down the rate of construction of new buildings
- The oil price started going down as the oil crisis ended
- The electricity tariffs remained low resulting in the decrease of the competitiveness of solar systems.

Trying to support the application of central solar systems in the tertiary and the industrial sector, which is still low, the Operational Programme for Energy (1996-2000) supported a significant number of solar systems in Hotels and Industry by financing up to 50% of the capital cost.

The most important reasons of the success of Solar Thermal Systems in Greece are summarised below:

- High solar radiation, climatic conditions and morphology of the country
- Successful marketing campaigns
- Legislative support and incentives at early stage
- Broad dissemination of the technology (advertisements, information brochures, demonstration projects, etc.)
- Public acceptance
- Continuous effort from the manufacturers for better and cheaper products
- Easy access of solar thermal products.

According to the experience gained all these years through the campaigns and promotional actions for Solar Thermal Technologies, a general Strengths, Weaknesses, Opportunities and Threats Analysis (SWOT) concerning the Hellenic Market is presented:

Table 9. SWOT Analysis of the Hellenic Solar Collectors Market [source: CRES]

strengths	• mature technology • economically reasonable • comfort for the consumer

weaknesses	• need to train the plumbers or other installation personnel • inadequate international labelling • integration of STT in the architecture • low advertising budget • low environmental awareness in some regions
opportunities	• high energy cost • on time penetration in new developing markets • STTs usually have positive social acceptance and more comfort for the consumer • EU environmental policy and subsidy Programmes • ,joint ventures with new trade partners)
threats	• seasonality • competition from countries with low labour cost • discredit due to bad previous examples • environmental sensitivity of the consumers

Regarding the use of solar energy for producing electricity, the Law 3468 of June 2006 has set the tariffs for buying/selling electricity produced from PVs and other RES systems, which has given an impulse to large, connected to the grid, PV installations. Also the Directive 129 of the Public Power Corporation of Greece (PPC) is expected in due time, which sets the guidelines for the connection of sparse electricity production systems to the grid.

Apart from that, a factory of producing crystalline silicon solar wafers, cells and modules, of total power 60 MW is expected to start operating within 2008 in the industrial zone of Patras, in Peloponnesus, Southern Greece, which is also expected to bust up the market of photovoltaics in the country.

Figure 52. Examples of solar heating installations in Greece [source: CRES]

Figure 53. The 22kWp PV installation on the roof and wall of the laboratory of PV technology in CRES [source: CRES]

4.9 Supporting Mechanisms and Success Stories from Lebanon

“The Guarantee of solar results (GSR)” notion which was introduced lately in Lebanon thanks to the French GEF-ALMEE “Energy Efficiency Project in the Construction in Lebanon”, analysed below, is a first step to the development of the solar market in the country. The installations of the Zouk project (mentioned below) are recorded up since nearly one year and the results so far are very satisfactory. More than 80% of the installed solar systems are locally manufactured by about 10 Lebanese industrials. Most of them are members of the “Lebanese Association of Solar Industrials” (ALIS).The average price of an installed Domestic Solar Water Heater (DSWH) system is 260 €/m² of solar collector. This price has been decreasing continuously for the past 5 years. Despite the high price for the Middle East region, the cost of DSWH is competitive relatively to the electricity produced hot water, as electricity is the main source of DHW in 70% of Lebanese houses. The feasibility of Solar Water Heaters against Conventional Energy Sources is shown in Table 10. Finally, the environmental impact for using fossil energies is far from being negligible, and the 100,000 m^2 of solar collectors in service actually avoid emission of 35,000 tons of CO_2 each year.

Table 10. Solar water heaters versus conventional energy sources – payback period [source: ALMEE]

Conventional Energy Source	Solar Water Heater payback period
Electricity Heater (Efficiency =90%)	2.1 years
Diesel Oil (Efficiency =59%)	2.8 years
LPG (Efficiency =70%)	4.0 years

The findings of the GEF project mentioned above, regarding the situation in Lebanon can be summarised as:

- Fast development and demand of the construction
- Insufficient electric power production in a sector showing a deficit with tariffs greatly subsidised

- Primary energy almost completely imported from oil derivatives.

With five pilot operations, the project had objectives to show the technical and economical feasibility of energy improvement for collective housing. The project also aimed, while using results of the operations, at adopting new energy efficiency policies in the housing sector by launching public awareness and capacity building campaigns. The project was proposed by the "Lebanese Association for Energy Efficiency and Environment" (ALMEE) following a cooperation work with the ADEME.

The first demo operation concerned a housing project in Zouk Mosbeh. The promoter "Elissar Contracting and Engineering" built 64 apartments totalling 3,900 m^2 and some offices and shops. Two types of improvements were introduced in the program: solar water heaters and low consumption lamps.

The energy efficiency of buildings included an adapted design of buildings (roof and partitioning insulation, plastering, tightness of openings to prevent infiltration, controlled mechanical ventilation, double glazing, etc). The demo operation included a follow-up mechanism and survey nearby of the users in order to evaluate improvements introduced.

4.10 Supporting Mechanisms and Success Stories from Palestine

Building permits in Palestine for both private and public buildings are issued by the Municipalities or, in some cases, by the District Offices at the Ministry of Local Government (MoLG). The permits are issued against a fee collected by municipalities or the Ministry of Finance in case permits are issued by MoLG. In issuing permits, municipalities depend almost entirely on zoning according to the approved town plan (known as the Master Plan), before they issue the permits. Buildings' drawings are reviewed by the Engineering Association (EA) for approval. The application procedures to get a permit is almost standardised throughout the Palestinian Territories and their main stages include:

- Submitting proof of ownership to the municipality.
- Verifying that all tax obligations have been fulfilled.
- Issuing the "site map" that indicates road lines, plot boundaries in the vicinity of the site and the zoning & building regulations in the specific site (this is usually specified by the planning departments at municipalities).
- Submitting building/ project drawings to the EA to ensure the project is in compliance with:

  a) building standards; architectural, civil, mechanical and electrical

  b) site map regulations.

Regarding the type of construction in Palestine, it is very much limited to the availability of materials in the local market. Stone constructions are common in the West Bank. Wood is not used due to cost and climatic conditions. Variety of cement blocks (solid, hollow concrete) used for walls and slabs are locally produced from local materials. All other materials are purchased from Israel or imported from other countries (except aggregate and stone) including lumber wood steel, cement, aluminum profiles, glass. As a result of the present difficult situation Israel Preventing the supply of basic construction materials and do not allow their entry to the Palestinian area through their control of the borders checkpoints.

The types of buildings in West Bank and Gaza Strip are divided into traditional and contemporary buildings. The construction techniques used in traditional buildings depend on traditional materials and are characterized by thick walls and slabs with high thermal capacity and low U-value, allowing for optimum thermal comfort. The construction techniques used in contemporary buildings depend on the new materials (stone and concrete) and their composition. Walls' and slabs' thickness are small, allowing for smaller thermal mass and larger thermal exchanges with the surroundings, negatively affecting thermal comfort and energy needed for heating/cooling.

PEC (the Palestinian Energy & Environment Research Centre) was involved in several studies related to solar water heaters, one of which is the Beir Zeit University. Central solar water heating had been installed as Palestinian pilot installation for studying the tele-monitoring protocol. This solar system covers the demand of hot water needed for the cafeteria of the University. It is a recently installed system (year 2000), with a collector area of 148 m², a 15 m^3 storage tanks (5 × 3,000 liters) and an external heat exchanger. The collectors are installed on the flat roof of the cafeteria as shown below. The system is perfectly working and covers the required hot water for the cafeteria in summer time.

Figure 54. Central solar thermal system in Beir Zeit University, in the Palestinian Authority [source: PEC]

Another successful application is the solar collective system in Jericho Governmental Hospital which covers the needs of hot water for cleaning, washing and the patients needs (55 beds). The system is a closed loop type with tilt angle 43° and consists of 69 solar panels with total area around 100 m² (Figure 55). The ambient temperature in Jericho city reaches 43°C in summer, which makes this kind of systems to be feasible.

Figure 55. Central solar thermal system in Jericho hospital, in the Palestinian Authority [source: PEC]

The total installed PV capacity in Palestine is about 50 kWP, categorised as follows:

- Rural clinics – 12 systems (7.37 kWP)
- Rural schools – 21 systems (13.44 kWP)
- Bedouin tents – 24 systems (5 kWP)
- Rural households – 22 systems (6.6 kWP)
- Isolated village – 1 central system (5.5 kWP)
- Bedouin community- hybrid PV-wind system (4 kWP)
- Street lighting/ Gaza - (2.2 kWP)
- Agricultural farms – (2.44 k WP)
- Water pumping – 1 system (0.4 kWP)
- Others (security check point, animal zoo, mosques, governmental offices) – 6 systems (1 kWP).


a


b

Figure 56. (a) PV for lighting for Beduins and (b) PV installed in School [source: PEC]

4.11 Supporting Mechanisms and Success Stories from Jordan

Building permit procedures for private and public buildings usually goes into several phases in Jordan. First is the design phase, usually made by an architect practice. The practice submits the blue print of the building which includes: civil and structural work, electrical and mechanical works, and of course architectural designs to the Jordan Engineers Association.

The Jordan Engineer Association revises the design and supervises the work made by Architect Practices. Unfortunately this supervision does not emphasise on checking the Energy Efficiency measures in the building or renewable energy applications even though it is mentioned in the Jordanian "Codes of Buildings". Usually the Jordanian Engineer Association revises the design structure and mechanical and electrical works.

The involvement of Jordan in Renewable Energy and Energy Efficiency goes back to the early 1980ies. Unfortunately this early interest and knowledge was not accompanied by solid policy framework and market driven tools. Serious steps did not start until recent years. The increase of the oil price, along with the long work of NERC to pass an energy efficiency law, compelled the Ministry of Energy and Mineral Resources (MEMR) of Jordan (the legitimate entity that is in charge of defining policy, fixing energy tariffs and regulating activities linked to energy) to issue "The National Energy Efficiency Strategy" in September 2004 which was approved by the prime minister. The strategy has focused on the following policies to achieve its goals:

- Tariff policy
- Legislations
- Taxation policies
- Technical standards
- Thermal insulation
- Building codes
- Customs Duties
- Traffic Congestion

In 2004 the Government of Jordan developed an integrated and comprehensive Energy Master Plan for the development of the energy sector over the next 20 years. Under the Energy Master Plan the proportion of energy from renewable resources will increase in order to reach 3% of Jordan's primary energy demand. A number of studies are underway to remove barriers to the exploitation of renewable energy, particularly wind, solar, biomass and also to prepare a draft for Renewable Energy Law.

The Ministry of Environment, which is in charge of designing environmental policies, has a strong trend in increasing environmental standards in order to meet USA or EU requirements. New standard for ambient air quality have been established recently (1140/2006). Maximum limits for air pollutants emitted from stationary sources, written in 1999 (JS1189/1999), have recetly been revised. A draft is under analysis.

Jordan has to show many interesting solar thermal applications, such as:

- Jordanian solar house: The Royal Scientific Society (RSS) and the Kuwait Institute for Scientific Research performed a joint project to study the possibilities of solar heating and cooling in buildings, where solar heating should have first priority in Jordan. To meet the objectives of this project, a house was designed and built at an RSS location. Both passive and active design criteria were considered. The house faces south, with large windows and insulated walls.
- Coral Beach Hotel solar water heating system in Aqaba: The aim of this project was to evaluate the possibility of using large solar water heating systems for industrial applications. For this purpose, a large solar water heating system was installed as a pre-heater to the existing conventional (boiler) heating system in 1987. The total collecting area installed was 180 m^2 (90 flat plate collectors, 2 m^2 each), with a hot water storage tank of 12 m^3 and the necessary piping and control devices (Figure 57).

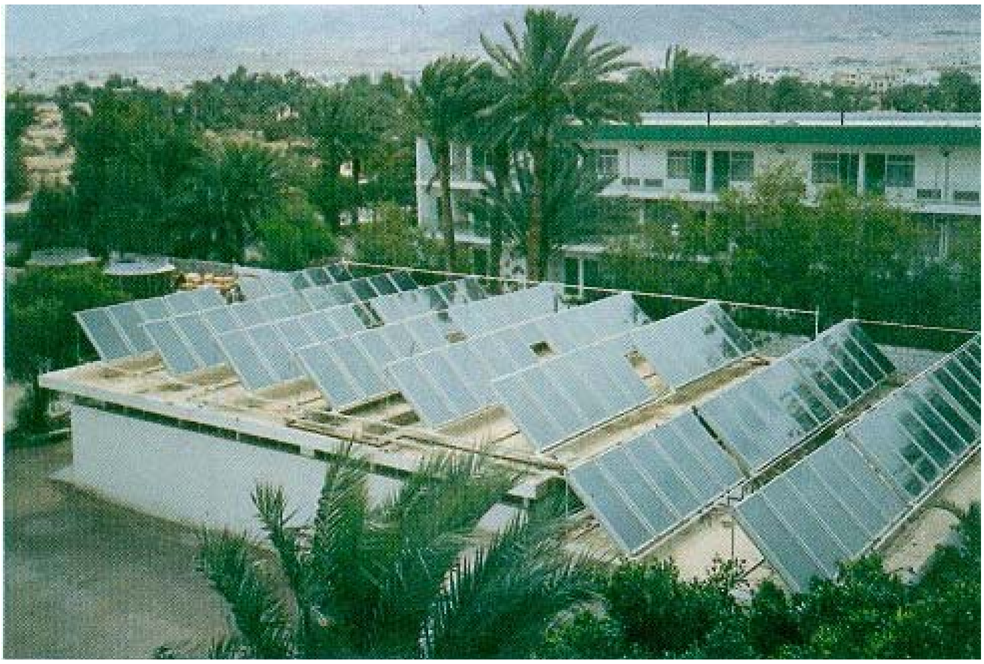


Figure 57. Solar collectors of the Coral Beach Hotel in Aqaba [source: NERC]

Photovoltaic applications have also been very successful in Jordan. In 1995, 5 stand alone PV systems were designed and erected by RSS-RERC in the southern part of Jordan, in five remote villages: Rahmeh, Beer Mathkour, Qater, Rajef and Greegra. The main object of this project, financed by Telecommunications Corporation, is to supply electric power to telephone lines which will be used by the inhabitants of these villages. Other PV applications have also involved:

- Photovoltaic water pumping systems: such as the Umari photovoltaic water pumping system in the Umari well, which is 180 km east of Amman. It was installed in June 1985, designed to supply the Bedouins and their herds with an average daily yield of 40 m^3 water. The system is still operating without any problems. The Al Shomari photovoltaic water pumping system is part of the joint project between Jordan – Royal Scientific Society and Egypt – the Academy of Scientific Research and Technology. To optimise such PV water pumping systems and their components, a project between the RSS and the Higher Council for Science and Technology (HCST) was carried out. This project aims at developing, manufacturing and testing a microprocessor control unit that connects, according to solar radiation intensity, one or two submersible pumps to a PV generator. Preliminary tests showed that use of such a unit will result in 19% increment in the daily pumped water quantity.
- Photovoltaic power supply for remote schools: In 1993, 6 identical stand-alone PV systems were designed and installed in the southern part of Jordan in five remote villages namely, Beer Mathkour, Finan, Titen, Al-Minfur and Wadi Rum (Figure 58). The main objective of this project, financed by the Ministry of Education, is to supply electric power to schools and the teachers' residences.

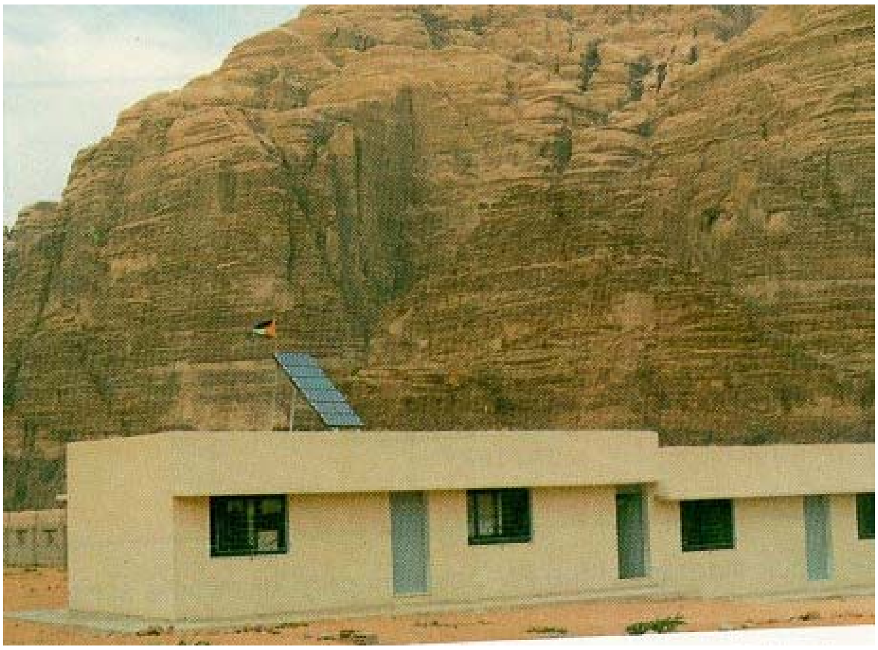


Figure 58. DC-decentralised PV system at Wadi Rum School [source: NERC]

- Photovoltaic power supply for remote police stations: In 1991 the Royal Scientific Society (RSS) and the Public Security Department undertook, a joint project to use PV technology, instead of using diesel generators. The PV system, which was installed in January 1992 to electrify the Al-Salamani police station displayed good performance and high reliability through the two-year period of continuous tests.
- Photovoltaic generators for the Non-Directional Radiobeacon (NDB) systems: In 1988 the Civil Aviation Department, in cooperation with the Royal Scientific Society (RSS) set up two identical PV-powered non-directional radiobeacon (NDB) systems in two remote villages, namely Al-Reesheh and Rahmeh, which are located in the southern part of Jordan at a distance of about 80 and 50 km respectively from Aqaba airport. The main purpose of these systems is to identify these sites to the planes flying to Aqaba airport.

5 Tackling hurdles

5.1 France

Despite the hopeful, recent evolution in France, it is possible to improve certain aspects for supporting the solar market. A certain number of difficulties should be overcome in the recent future:

- The funding system is synonymous to long delays of payment, as it is applied after the annual revenue declaration.
- The territorial regulation can, in certain conditions, be an obstacle to the development, as certain authorities may be negative towards RES, due to "aesthetical norms".
- The administrative procedures are quite strong and need certain improvements. Four permits are needed at least to make a project, which can take from 4 to 12 months for a small installation and from 1 to 2 years for important installations, as the procedures become stricter.

5.2 Spain

Thanks to the implementation of the new codes discussed in paragraph 4.2 Spain enjoys the dynamic development of solar market, in both thermal and pv applications.

Regarding solar thermal applications, the main problems that Spain still faces are:

- Inadequate return of the investment if financial aids are not provided
- Lack of promotion to potential users
- The lack of promotion of these technologies to Town Halls for the dissemination of solar thermal energy.

Regarding PV applications, the main problems that Spain faces are:

- Inadequate return of the investment
- Lack of incentives and initiatives for innovative plants
- Limitation on current premiums and tariffs until they reach 135MW
- Administrative formalities are disproportionate and non-uniform throughout the country.

5.3 Portugal

In Portugal the barriers of the solar market can be summarised as following:

- The construction industry is too much conservative to apply any new technologies

- There is disinterest and lack of education among the majority of architects for solar energy applications
- Legislation does not help in encouraging the application of RES projects, as it is disperse and contradictory (Figure 59).

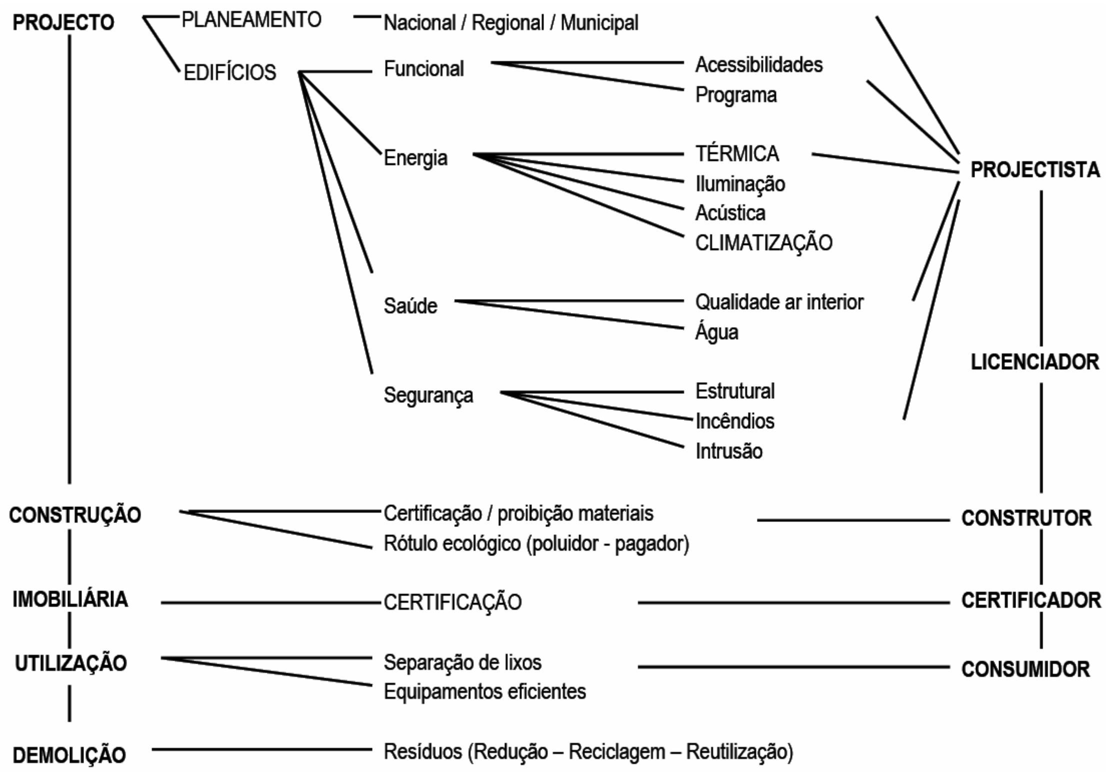


Figure 59. Schematic representation of the disperse and contradictory legislation in Portugal [source: ADENE]

5.4 Morocco

In Morocco, there are barriers in the solar market development, due to policy, technology, as well as fiscal barriers.

- Policy barriers;
  - Not strong integration of RES in energy and development policies
  - Not fair fiscal conditions
- Technical barriers;
  - Limited quality approach
  - Not enough information
  - Not capitalisation of training
  - Not sufficient R&D
- Fiscal barriers;
  - Inadequate configuration of usual financing
  - Increased commercial tax credits

- Not adapted retail financing local tools
- External costs not taken into account.

5.5 Algeria

The main constrains that oppose to the development of solar technologies in Algeria are relative to financial aspects. The prices of the equipment are very high and the pay back period is generally very long. This is due to the relatively low energy prices (especially that of natural gas) and also due to the importation of most of the equipment employed in solar technologies. Also, the absence of developed local industries in the domain of solar technologies makes the cost of the investment very high, limiting the diffusion and the integration of RES into buildings.

5.6 Tunisia

The principle obstacle for the solar market in Tunisia is the price of solar collectors, which reaches 1,000 dinars for a 200 litres capacity. The conventional water heating systems (natural gas, crude oil, electricity) have an investment cost of 200 to 350 dinars. The solar market is thus double blocked; at both investment and pay back level.

Similarly, the main blocking factor for the development of the PV market in Tunisia is financial. It has been estimated that PVs will become competitive in Tunisia around 2025, thanks to the projected decrease of PV prices.

Even with the financial assistance of PROSOL II (the continuation of PROSOL in the residential sector), the credit rates might be too high for consumers to buy solar installations.

5.7 Italy

The main barriers in Italy that limit the development of the building integrated solar technologies are:

- Economical barriers: In Italy the investment costs are higher compared to other EU Countries because of the poor diffusion of these technologies. Also final end users with low energy consumption consider RES not a priority, as the payback period is long.
- Information barriers: There is lack of environmental awareness and energy information for the public. Few people know the potential possibility on the use of renewable sources to upgrade the environment and their comfort.

- Administrative barriers: These kinds of barriers are bureaucratic procedures. They involve the Department of the Energy Authority, Municipalities, and some times the Ministry too. To change the regulations and the legislation so as to simplify the procedures is not simple, as legislation revision is needed to promote new rules and more friendly procedures.
- Visual impact barriers: In Italy the cultural Heritage in the city, the historical town, the conservation of historical landscape are great resources but also strong barriers in the RES implementation in the building sector, due to aesthetics conservation.
- Infrastructural barriers: The national electric grid needs upgrading in order to promote and apply PV installations.

5.8 Greece

Since 1987, the thermal solar market has decreased principally due to:

- oil prices decrease after the end of the oil crisis
- reduced electricity tariffs, influenced by governmental social policy, have decreased the competitiveness of solar systems
- financial constraints slowed down the rate of new buildings construction
- removal of all existing incentives and the lack of support of solar systems in the future
- limited budget was available for promotion campaigns and development because the manufacturers suffered from sales decrease and lack of funds
- Among the major barriers for innovative solar thermal applications to enter energy markets is the lack of rational marketing planning and sufficient marketing activities. Consequently there is a need for a reliable marketing strategy, planned and adapted to different types of markets.

Regarding the photovoltaic installations, the main problems that they face are:

- The existing regulations and legislation to attain a licence for a PV plan make the procedures quite bureaucratic. Many ministries and regulating bodies get involved, such as the Regulation Authority for Energy (RAE), Regional Government, Prefecture Council, Regional Department of the Ministry of Environment and Land Planning, Regional Forestry Department of the Ministry of Agriculture, Directorate of Planning and Development, the Ministry of Development, Public Power Corporation, and many others. This makes the process unattractive to investors and the licensing procedure a very time consuming process.
- The history of the PV technology in Greece is not as large as for solar thermal systems. Most people are not familiar with this technology or they confuse it with the well known solar thermal systems.

- Apart from that, the lack of rational marketing planning mentioned above, as well as the reduced electricity tariffs and oil price are factors with negative effect not only on solar thermal systems but also on PVs.

5.9 Lebanon

However and in spite of all its advantages, thermal solar energy in Lebanon is not developed enough compared to other countries of the region. Several barriers prevent the establishment of a favorable dynamic natural market to be expanded:

- The policy of the energy rates that do not reflect the real cost, thus electric heaters develop at the expense of solar heaters
- The absence of a political will in favor of solar energy that can converge the national and macro-economic interests toward those of the consumer and the end user
- An insufficient interest on the environmental impact and of the public health due atmospheric pollution
- The relatively high price of the DSWH (about 1,500 € for a complete DSWH of 3 m² - 200 liters)
- The quality of water is generally hard and calcareous which leads to a fast deterioration of the DSWH (water tank collectors, heat exchangers), dragging an appreciable reduction of the output and the life of the DSWH system.
- A flagrant lack of sensitization, public awareness and information.

Thermal solar energy remains marginal in the Lebanese energy balance representing less than 1%, which makes some few KTOE out of a potential market estimated to be more than 1000 KTOE.

Regarding photovoltaic applications, the installed photovoltaic power does not exceed several KWs in Lebanon, due to several barriers such as:

- Lebanon is 98% electrified and isolated sites are rare.
- EDL still have the monopoly of production and distribution of electricity.
- The electricity actual tariffs did not change for the past 10 years and do not reflect the real costs of production and distribution.

These barriers are still the major problems for the development of the standalone or grid connected photovoltaic systems which inhibit the demand and explains the absence of this market (no manufacturers or suppliers of equipment and related services). The few existing installations referred to in paragraph 3.9, encounter problems such as:

- Lack of spare parts,
- High cost of batteries,
- Lack of qualified labor.

5.10 Palestine

Successful use of active and passive solar design principles and integration of PVs in architectural design, urban planning, and building construction is still very limited; there is lack of awareness, capabilities among architects, engineers and planners in such related issues, in addition to the lack of clearly defined polices and strategies that aim at promoting solar and ecological design principles, using environmentally compatible forms of energy, and integrating solar technologies and systems in design, planning and construction. Other obstacles include:

- Lack of incentives & proper financing schemes that encourage investment in large installations, especially under critical economic situation and low income of end user.
- Lack of information and technical handbook/ software's for sizing, design, installations of collective systems.
- Lack of regulations & provisions to implement standards and to mandatory solar installations in new buildings.
- Lack of qualified testing & certification facilities
- Lack of awareness, pilot projects and expertise especially for the new applications of solar (water distillation, concentrated power, solar cooling).
- Limited area available for collective installations especially in complex buildings, hotels, hospitals.
- Absence of private sector involvement, governmental initiatives, and financial resources for development RE market.
- Unstructured framework of the local solar industry and inefficient industrial processing.

5.11 Jordan

Barriers in Jordan could be classified according to different factors such as:

- Policy barriers: Absence of regulations, rules and energy provisions to control the quality and the effectiveness of the locally manufactured, imported or used equipment. Only two local manufacturers produce collectors in accordance with the Royal Scientific Society's designs, while others do not follow any regulations.
- Technical barriers: Absence of professional calculation tools or technical handbooks for design and sizing of large solar systems. Exiguity of professional qualifications and technical skills particularly for the new efficient designs. Absence of compulsory testing regulations that forces the manufacturers and importers to test their collectors, although a national testing facility to test solar collectors exist at the Royal Scientific Society. High cost of high specification materials/component such as double-glazing, selective coating material, sheet

metal, pipes. This results in hindering the development of designs and quality. Water contamination or calcification, water freezing in the pipes of collectors in cold regions add up to the technical problems.

- Market barriers: Lack of incentives & financing offers. The majority of manufacturers are located in Amman (the capital) which makes it difficult and more expensive for people living in other cities to install solar collectors and have periodic maintenance.
- Social barriers: Recently, most of the buildings are multi-floor within small floor area. The floor area is usually used for many purposes such as water tanks, dishes etc, therefore, there is not enough space for installing solar water heating systems for all residences.

6 Recommended next steps

6.1 France

The next steps for energy savings and the integration of solar technology in France would be the following:

- It is necessary to involve more actors of the sector, from the producers to the constructors for developing and promoting products and efficient practices.
- Administrative procedures should be simplified to make it more attractive for investors to make RES projects.
- Even if solar energy is one of the RES that is very well-accepted to the greater public, its acceptance should be upgraded. This is the reason why areas like PACA and Languedoc Roussillon have started calls to projects, insisting on the aspect of example and visibility, so as to reinforce the public opinion and education on the subject.

6.2 Spain

So as to achieve the goals of solar penetration in Spain, as referred in paragraph 3.2, it is necessary to:

- Maintain the premiums established in the Royal Decree 436/2004
- Provide public support to investments through Regional and State budgets (348 m € during 2005-2010)
- Support the implementation of solar municipal bylaws promoting solar technologies in the Town Halls (period 2005-2010)
- Modify the limit for premiums from 150MW to 400MW
- Give support to innovation plants (period 2005-2010)
- Coordinate the Autonomous Regions, regarding energy saving and solar applications on buildings (period 2005-2010)
- Promote training campaigns addressed to citizens (period 2005-2010)

6.3 Portugal

Similarly, in Portugal it is necessary to:

- Adapt legislation with “eco-logy” as guidance (Figure 60).
- Promote governmental policies with significant increment on supporting funds on investigation and implementation of energy efficiency.

- The future building code should be less prescriptive and more based on performance (Report of OA –Portuguese architectural association on proposal of new building code).
- Formation of Technicians should be made (ADENE with several institutions forming specialists and OA is giving Energy Efficiency formation Module compulsory for future architects).
- Dissemination both by ADENE and OA (media –television, internet, etc.)

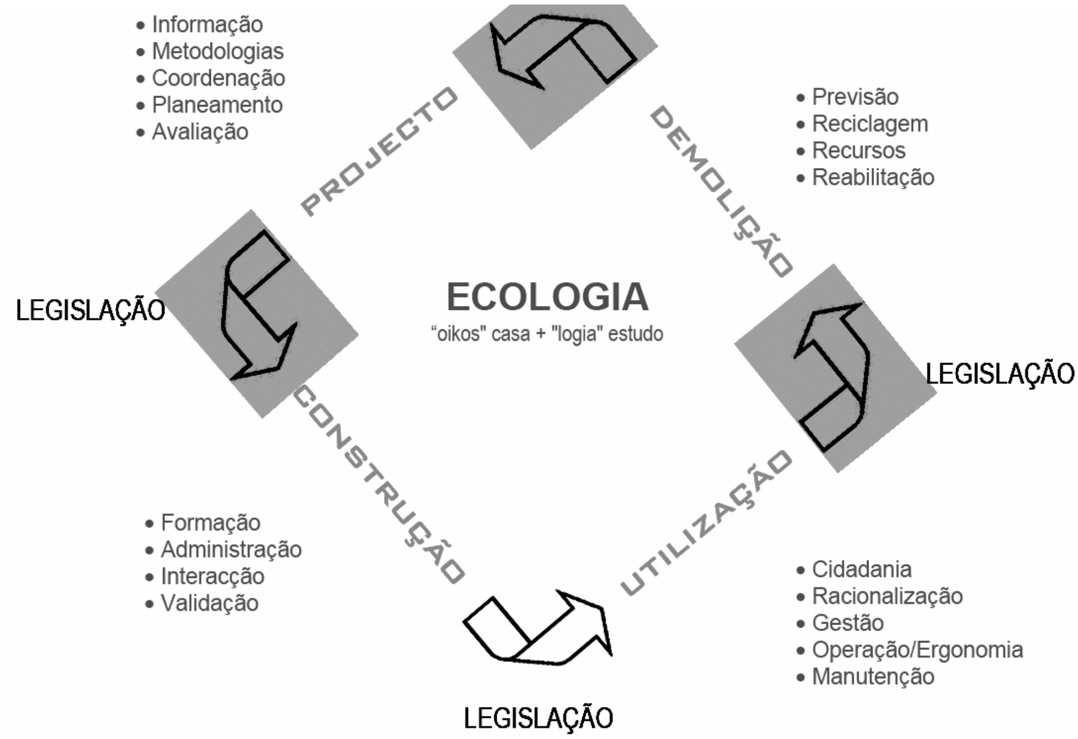


Figure 60. Adapt legislation with "eco-logy" as guidance [source: ADENE]

6.4 Morocco

It is important to encourage and consult players in Morocco for the best practice of solar systems and also for a rational use of energy and of innovative technologies.

From a legislative point of view, it is important to integrate energy saving measures in the building codes, as well as solar applications.

6.5 Algeria

For achieving its goals to generate 5% of its energy in 2010 from RES, Algeria has to put forward significant solar thermal installations. Legislation should be adapted, so so as encourage both thermal and electric solar installations. In this frame, the Entreprise Nationale des Industries Electroniques (ENIE) develops a solar cell that allows the fabrication solar cells and the encapsulation of PV panels.

Finally, the Programme National de Maîtrise de l'Energie (PNME 2006-2010) allows boosting up the field of sanitary hot water from the sun through project with investment aids. The aim of these projects is the diffusion of sanitary hot water from the sun systems in the residential and services sector, by encouraging the creation of a local market for the production of such systems.

6.6 Tunisia

Taking into consideration the effects of the program PROSOL and considering its continuation in the future for the boost-up of the solar market in Tunisia, it is expected that 222,000m^2 solar collectors will be installed in the period 2005-2011, encouraging business development in the RES sector.

Table 11. Development scenarios of the solar market in Tunisia, according to the projections of the program PROSOL (m^2/an) [source: ANME]

Année	2005	2006	2007	2008	2009	2010	2011	Total periode 2005-2011
Nombre de m2 projetés dans le cadre du projet PROSOL	22 000	25 000	28 000	31 000	35 000	38 000	43 000	222 000

6.7 Italy

To change the building regulations and simplify the procedures for the installation of solar systems in Italy, it is necessary to:

- promote training courses for all technicians
- disseminate Best Practice in public buildings
- research and innovate to upgrade the competition of the actors in the market.

Regarding the solar thermal market itself, it has been found out that[11]:

- Collectors' cost is the main parameter for the feasibility of a new installation
- the role of public funding is almost necessary for the development of the solar thermal market, to be competitive with other technologies and reach interesting economic parameter, acceptable also for economic and financial institutions. The 30% value (the usual funding for ST installation in Italy) provides significant reduction in all the financial indexes
- the price of conventional energy can modify the economic considerations: even if they have just a little range, this can be sufficient in some border cases

[11] L. Colasuonno, M. Motta. ST-ESCOs Market Analysis: Italy. Development of pilot Solar Thermal Energy Service Companies (ST-ESCOs) with high replication potential. Project no. EIE/04/059/S07.38622 "ST-ESCOs" Available from : www.stescos.org [Accessed 24.12.2007]

- the substitution of non methane fossil fuels can provide a cost effective investment; solar thermal applications in building renovation projects can have significant results

6.8 Greece

In order to achieve further penetration of solar thermal and photovoltraic applications in the industrial and building sector Hellenic key players have to:

- Further advertise the products.
- Raise environmental awareness.
- Improve installation and product quality
- Implement promotion campaigns to engineers, architects, installers
- Implement promotion campaigns for large systems
- Further penetrate solar systems in the public sector
- Continue subsidisation and incentives
- Introduce green taxes
- Simplify the bureaucratic process for the licensing of such systems

Solar industry represents a well-developed manufacturing sector in Greece. The Hellenic Solar Industry Association counts 18 members, which represent the larger manufacturers. Besides, about 50 smaller enterprises are active at a local or regional level. Greece is the largest exporter of solar systems in Europe. The production of the sector covers about 30% of the European market.

For a more marketing oriented development of solar thermal technologies, according to the relevant campaigns-actions, the role of the level of public awareness of environmental problems, the support of solar thermal energy by governments and the development of creative marketing strategies by market actors are critical.

6.9 Lebanon

So as to achieve a sustainable solar market, Lebanon could take the following steps:

- For economic barriers: Energy rates should reflect the direct cost of energy and they should also include pollution cost linked to conventional energy. Fiscal incentives should also be provided.
- Institutional barriers: Adoption of rational energy policies and management programs seeking durable development

- Social barriers: Dissemination, education, promotion of solar technology to the wide public, sensitization towards environmental problems
- Technical barriers: Apply standards, labelling, guarantee of the solar results and technical training. Promote water heaters with primary and secondary circuits and use water softeners, so as to prolong the life of solar collectors.

Especially for photovoltaics, an attractive feed in tariff of regulation and a long period guarantee are needed. As this technology is in big progress, the prices for the installations are getting lower and lower and the solar energy data seem very attractive. Thus, it should be expected that such installations are applied in Lebanon, according to the following scenario:

Table 12. Expected installed PVs connected to the grid in 2010 and 2020 in Lebanon [source: ALMEE]

Year	2010	2020
PV in KW	10	1,000
Power generation in GWh	0.021	2.1

6.10 Palestine

The plans in Palestine for the promotion of solar energy applications are summarised below:

- Creation of a national fund with participation of the government, private sector and external financial aid for supporting development actions of RE and EE.
- Imposition of standards, regulations and certifications for improvement the level of market quality.
- Development of governmental policies, regulations, provisions and incentives to encourage use and investment in solar thermal technologies. The incentives to local industry could be duty license reduction & VAT exemption for raw material/ equipment, and to the end users building tax/ license reduction.
- Establishment of national unity for solar technologies manufacturers & suppliers.
- Establishment of national solar technology supporting unit (testing/research labs).
- Installation of solar collective systems in the residential, commercial, industrial and service sectors (such as health, education, tourism and sport) by the government initiatives of legislative measures to mandate SWH in new housing, hospitals and hotels.
- Introduction of new applications of solar thermal energy (solar cooling and heating, solar concentrated power) and new generation of efficient collectors (concentrators, evacuated tubes, etc).
- Use of collective solar water heating systems in complex buildings, and service sector (health, tourism, education).
- Rural electrification by PV.

6.11 Jordan

Renewable energy is considered the largest domestic energy source together with oil. Technical and market potential exists to increase significantly the contribution of renewable energy sources in Jordan's energy balance, resulting in employment and economic benefits. However, the contribution of such resources in the national energy mix is still minor. For the long-term future, ensuring the security of energy supplies is a highly important issue, but this is regarded as of minor importance when compared to the more immediate social and economic problems that Jordan is facing. Efforts have been made to promote the use of renewable energy, such as wind, solar and biomass, but these are not likely to make more than marginal contributions to the national energy balance for the next 15 years, unless attitudes change and energy unit prices rise significantly. This is because harnessing renewable energy has in general been more expensive per unit of energy than that obtained from conventional energy sources, despite the fact that it is environmentally beneficial. Up to date renewable energy provides approximately 1% of the total primary energy demand in Jordan.

Nevertheless, one main result of the EE Strategy that is expected in the very next future is the implementation of the Energy Efficiency Fund, which could grant studies and audits, training, awareness campaigns, and pilot projects.

Recently, the fossil fuel price was increased for more than 100% when compared with the fuel prices before three years. This rapid increase of fuel price is a good opportunity of using the solar thermal technology such as SWH in domestic hot water as well as in space heating. The penetration of solar thermal technology to the market can be achieved by the following:

- Modifying the existing solar system through transfer of EU technological know-how.
- Enhancement of awareness of using the solar systems.
- Incentives for using the solar systems, such as decreasing the taxes and customs on imported solar system and on the materials that are used in local manufacturing of the solar systems.
- The Jordan Engineers Association should educate architects and designers to take into consideration the implementation of energy efficiency measures and renewable energy.
- The Municipality of Amman and other municipalities should increase their supervision on the implementation of the Jordanian Building Codes.

7 Conclusions

It has been shown in this guide that, although the solar potential in the countries around the Mediterranean is of similar magnitude, that the tendency of energy consumption is to increase and that most of the building stock is residencies, the solar market has not developed similarly in each country. The building sector is responsible for large amounts of energy consumption, varying from 17% in Morocco to 46% in France of the total energy consumed within the country. Sanitary hot water, space heating and electricity are of the main energy consumptions of the building sector. All three can be covered with mature and already commercially available solar technologies; sanitary hot water with solar collectors, space heating with solar thermal “combi” systems (space cooling with solar active cooling technologies) and electricity with photovoltaics.

Wars and social instability have been a major factor for delaying the evolution of solar applications, as in the cases of Palestine and Lebanon. Low energy prices from conventional fuels on the other hand and the lack of local industry have been restrictive factors for the massive use of solar active systems and PVs. In cases where solar technology has been encouraged and promoted by the state, financial incentives have encouraged the public to invest on solar applications. Standards and labelling that ensure the quality of the product, as well as qualified installers and engineers, have made people trust this technology and use it widely.

Although the market is not uniform in the Mediterranean region, it is obvious that some common activities are necessary to transform the market from a niche to a commodity one. These activities could support the sustainable penetration according also to the European Commission's White Paper. These activities can be grouped as following:

- Central policy for the promotion of RES in the building sector through simplification of the bureaucratic procedure, tax exemption and financial incentives
- Motivation of the population (image campaigns to raise public awareness, information on the economic benefits associated with solar applications, increase of environmental awareness, subsidy programs as incentives to install a solar plant, aesthetic acceptance of the integration of RES on the building envelope of existing buildings, even of monumental character, as in the example of France, Figure 40, page 43)
- Technical development of the product (increase of the reliability, introduce standards and labelling where not available, definition of technical solutions to specific local problems such as water quality, adaptation to household technology –e.g. hot water supply, integration in the building - e.g. in the roof or façade, development of innovative applications - e.g. solar cooling, desalination, cost reduction)
- Distribution and sales (creative marketing strategies, inclusion in the product range of heating traders - wholesale, retail -, building distribution networks,

training of personnel in distribution and sales, development of local industries where raw material can be found, distribution networks among the countries)

- Architects, engineers, craftsmen and consumers information (concepts and new aesthetics for the architects, education of engineers on detailing installation issues, perception and marketing by craftsmen, technical training of craftsmen, information material available to craftsmen for consumer consulting)
- Integration of both solar thermal and photovoltaic technologies in demonstration projects of public character and in architecture competitions.
- Other activities (acceptance by decision makers of the building sector -architects, house technology planners, engineers etc).

This booklet, funded by the EUROPEAN COMMISSION, 6th Framework Programme on Research, Technological Development and Demonstration (FP6-2002-INCO-MPC/SSA-2), provides information on the solar energy market and practices in 11 countries around the Mediterranean area (France, Spain, Portugal, Morocco, Algeria, Tunisia, Italy, Greece, Lebanon, Palestine and Jordan), with emphasis on the integration of solar systems (both thermal and photovoltaic) on the building envelope.

Integration of PV panels on the façade of an 11th century monument in Alès, South France

Integration of PV and thermal solar systems on the building envelope of the bioclimatic building of CRES in Pikermi, Greece

Use of thermal solar systems as external shading devices on the façade of the Poliesportiu Municipal del Guinardó Torrent d'En Melis, Barcelona, Spain

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