Association of Architects in Palestine
Engineering Association – Jerusalem Center

Palestinian Energy & Environment Research Center

# Integration of solar technologies into buildings in Mediterranean communities

# SOLAR-BUILD

## Market Analysis - Palestine

**Date: June 2007**

## Preface

Under the framework of Solar Build project "Integration of solar technologies into buildings in Mediterranean communities", EC-FP6-INCO-MPC/SSA, the Palestinian Energy & Environment Research Center (PEC) with collaboration of Association of Architects in Palestine prepared this document as a country report for Palestine, one of the activities of the project. The study handles the existing situation and the market of solar technologies needed to meet cooling, electricity and heat needs in buildings. The main purpose of this report is to the analyze the local conditions, current state and future market opportunities and threats in Palestine.

The report, prepared according to the predefined guidelines, provides detailed analysis of energy data with some information on building issues. It is stressed out that the required data be accessible through collaboration of both Energy and Architects institutions, in order that the final results have the architectural point of view.

# 1. INTRODUCTION

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 $34^o20'– 35^o30'$ E and $31^o10'– 32^o30$ N. It is comprised of two land areas; the West Bank 5879 $km^2$, and the Gaza Strip 365 $km^2$, a total area of about 6244 $km^2$, including the area of about 2000 $km^2$ for some 200 Israeli settlements.

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 West Bank. The climate of Palestine as a whole and of the West Bank in particular, is of the Mediterranean type, marked by a mild, rain winter and a prolonged dry and hot summer. The climatic conditions vary widely; the coastal climate in Gaza Strip is hot and humid during summer and mild during winter; the average daily mean temperature ranges from 25 $^0$C in summer to 13 $^0$C in winter. The climatic condition in the WB is characterized by hot humid summer and relatively heavy rains winter in the semi-coastal area of W.B, cold winter and mild summer weather in the highlands, and hot summer and warm winter in Jordan Valley. 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 - 17.8°C.

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 main demographic and energy indicators are presented in Table 1

**Table1: Socio-demographic and energy indicators**

| **Demographic Indicators (2004) ,** | |
|---|---|
| Population (m) | 3.7 |
| Population growth rate (%) | 3.7% |
| Active population (%) | 40.4% |
| Unemployment (%) | 26.8% |
| Average household size | 6.4 |
| Inflation (2004-2005) | 3.47 |
| **Energy Indicators (2004) ,** | |
| Gross Domestic Product (€/ head) | 890 |
| Total Primary Energy Supply (ktoe) | 1205 |
| Total Final Consumption of Energy (ktoe) | 1081 |
| Energy Intensity (toe/ 1000 $) [GIC/GDP] | 0.283 |
| Percentage of electrification of the country (%) | 97.7% |
| Total Final Consump/ capita (kg.oe/ inhabitant) | 292 |

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. The economic output of the WBG has increased substantially since 1990s, notwithstanding the temporary dip on 2000 on account of the current *Intifada*; since the beginning of the *Intifada* at the end of 2000, the Palestinian economy has gone into sever decline. 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 €. Figure 1 below illustrates the percentage contribution to GDP by economic activity.

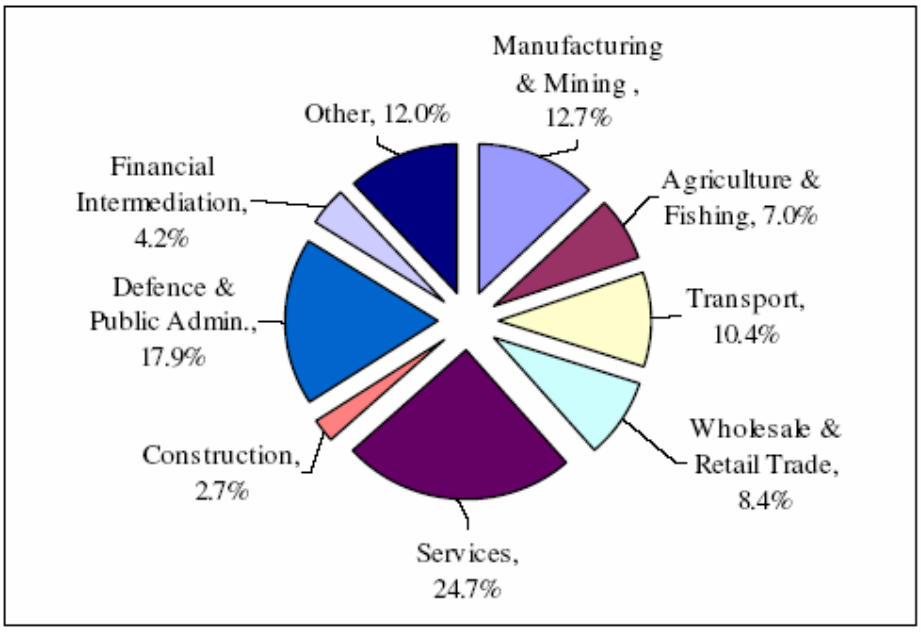



**Figure1: Percentage contribution to GDP by Economic Activity, 2005**

## 2. BUILDING AND ENERGY DATA

### 2.1 Building data

The building construction sector showed a rapid increase (as indicated by number of constructed buildings: offices and apartments) in the Palestinian territories between 1994 and 2000 with the establishment of the Palestinian Authority, then it slowed down after the start of the Intifada (up rising) 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. The pace of building 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 between 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 between 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 only: 83.6% in the West Bank and 88.6% in the Gaza Strip.

***Building permit procedures for private and public buildings***

Building permits 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' /projects' drawings are reviewed by the Engineering Association (EA) for approval. The application procedures to get a permit is almost standardized throughout the Palestinian Territories, main stages include:

1. Submitting proof of ownership to the municipality.
2. Verifying that all tax obligations have been fulfilled.
3. 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).
4. 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. Approval is issued by the EA and fees are paid if approved.
5. Submitting building/ project drawings to the Archeological and Health Departments for approval.
6. Submitting building/ project drawings to the municipality for approval. Building/ project documents and drawings are presented to the regulation committee at the municipalities, which will approve/ or reject the plans based on the regulations.
7. Paying processing fees in case of approval.

***Construction Materials & Local Market***

Building materials industry in Palestinian Areas still doesn't cover all the requirements of local Market and imports make up the balance. There is a limited types of building materials produced in West Bank and Gaza for example there is a lack in cement industry which forms a major part in building construction. The stone cutting industry in the West bank is the largest construction industry and has a great influence in gross domestic product.

Stone is used in construction mainly in the WB because it is readily available and cheaper than wood. It is estimated that there are 297 quarries and 5633 stone and marble cutting operations in West Bank and Gaza. Also climatic conditions make wood less desirable as the winter season is relatively short, and mild to hot weather prevails throughout most of the year. 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) and the list includes; lumber wood used to make doors, furniture and kitchens; steel, cement, aluminum profiles, glass, heavy equipment and machinery used in construction, and elevators. 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.

***Construction Techniques***

The types of buildings in West Bank and Gaza Strip are divided to Traditional and Contemporary buildings. The construction techniques used in traditional buildings depends on traditional materials which are with good thermal properties and the compositions of them in which the walls and the

slabs are thick; these properties gives the result of low thermal transmittance which means thermal comfort inside the buildings.
The construction techniques used in contemporary buildings depends on the new materials as stone and concrete and the compositions of them in which the walls and slabs thickness are small; these properties gives the result of high thermal transmittance which affects negatively the thermal comfort inside the buildings.
So, the techniques need the development process according to thermal behavior and thermal calculations.

***Architectural Styles***

**Analysis and Conclusions**

- New Building styles are not suitable to the Local, Social, Economic, Cultural and Climatic Conditions.
- Contemporary architecture has no special elements for energy saving or to reduce thermal loss.
- Some helping elements were done spontaneously or as tradition, such as balconies, colors, shading elements, openings, etc.
- Traditional architecture experience came through trial and error.

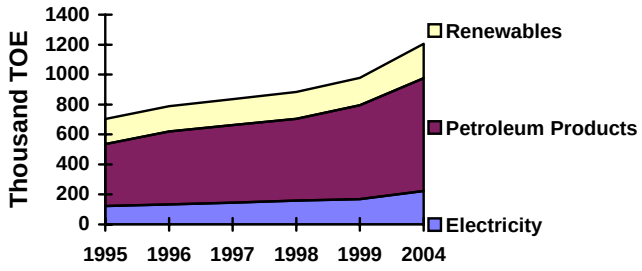
**Recommendations**

- *Orientation*, reduce heat loss in winter & heat gain in summer, natural lighting, ventilation and air circulation.
- *Architectural Elements*, openings and their sizes, glazing: single, double, triple and reflecting.
- Building Materials, new building and techniques for insulation. Exhibitions, public lectures and computer software.
- Awareness of the value of traditional Architecture.

## 2.2 Energy data

The Palestinian energy sector is in an unusual position; 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 facing 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 by 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, an increase of. The indigenous production (renewable) contributed 19% of TPES, while the remains were imports from Israel. Energy supply and share of fuels in TPES are illustrated in Figs. 2 and 3 respectively



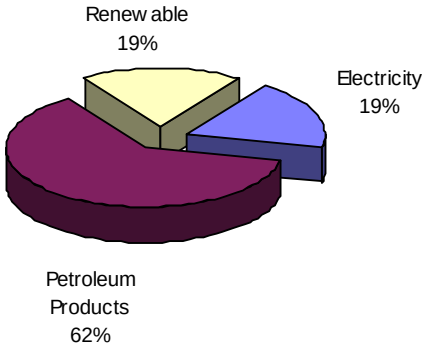




**Figure 2: Total primary energy supply by fuel and sector** **Figure3: Energy share by fuel type, 2004**

The total final energy consumption (TFEC) by fuel type and sector for the year 2004 is presented in figure 4

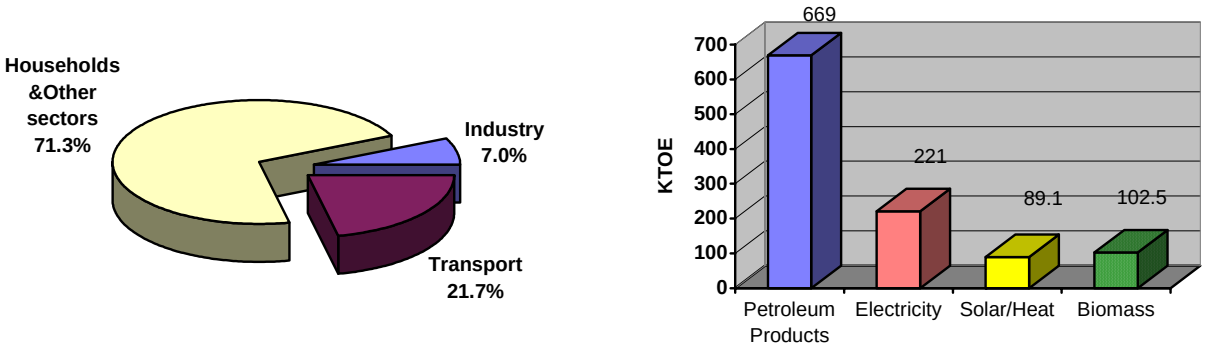



**Figure 4: Total final energy consumption by fuel and sector**

It is worth to mention that residential sector contributes to larger part of increase in the total final energy consumption due to the large expanding of the housing sector.

## 2.3 Institutions

The national institutions active in energy are:

***1. Palestinian Energy Authority (PEA), www.pea-pal.tripod.com.:***

Established to administer and develop the electricity sector in West Bank and Gaza Strip. Its main functions include the management of generation, transmission, wholesale and electricity import and export, as well as establishing utilities for electricity distribution and setting tariffs. The PEA mandate includes formulation a national- long term strategy for development of energy sector in

Palestine and supervision the implementation actions towards development of renewable energy resources and rational use of energy.

***2. Palestinian Energy & Environment Research Center (PEC), www.perc.ps:***

It is a national R&D institution responsible for programming and coordination of energy efficiency and renewable energy issues.
PEC has been allocated as the focal point for all actions related to renewable energy and energy efficiency in Palestine. Its main functions include conducting studies and researches related to energy and its influence on the local environment in Palestine that provides the National Authority, decision-makers and interested parties with information needed for the development of energy and environment, as well as development and implementation of national programs for energy conservation, rational use of energy, and renewable energy.

***3. Energy Research Centre (ERC), www.najah.edu:***

It is followed to An-Najah National University. This research centre is concerned with, research, development, system design, feasibility studies and training in all conventional and renewable energy fields, energy management and energy conservation.

In early 2000 the scope of the centre was expanded to encompass the impacts of energy on global environment, health and social development.

Other institutions related to building sector are:

- ***Ministry of Local Government (MLG)*:** responsible for providing all services to local authorities and councils, including building licensing, town planning, zoning, and local elections.

- ***Higher Planning Council (HPC)*:** the entity is chaired by MoLG and consists of 15 members from other ministries. Its scope of work includes; approving outline plans (Master plans), approving detailed plans (where they were not approved by the District Committee), dealing with building permit appeals, determining planning boundaries, and approving bylaws.

- ***Engineers Association:*** responsible for Upgrading the Engineers' professional and scientific level through stimulation and support for engineering research. Participate in planning and developing engineering, industrial, and vocational education and training programs, and work towards improving workers proficiency in the field of engineering.

## 3. OVERVIEW OF SUPPORTING POLICIES, TARGETS, SUPPORT MECHANISMS AND THE ROLE OF THE MAIN PLAYERS

### 3.1 Legislative framework:

A clear comprehensive and general energy policy at a national level is being developed. This late is due to the continuous Israeli occupation, weak and fragmented institutional framework and the incomplete framework of the Palestinian State. It is envisaged that all energy institutions be gathered in a representative council of energy and the national energy plan and strategy be

developed to include policy on financial aspects and resources, policy on establishing priorities in energy, policy with regard to scientific collaboration at the national or international levels, and policy on the relation between energy institutions and the local industries.

The Palestinian Energy and Environment Research Center (PEC) has recently joined the Palestinian Energy Authority (PEA). In accordance with the policy of PEA, PEC is active in the fields of Renewable Energy (RE), Rational Use of Energy (RUE) and Energy Efficiency (EE) and is appointed as the national center for coordination and the focal point for all these subjects in Palestine. Under the new reforms, PEC as a national Research and Technology Development center (RTD) will function under the umbrella of the PEA and supervision of its Chairman.

Both the PEA and the PEC are committed to formulating and implementing a long- term national strategy for developing renewable energy resources and increasing energy efficiency in Palestine. These two goals are important for their crucial effects on the general economy, the environment, and the energy security of the country.

## 3.2 Policy and National targets

Huge efforts are being made for maximum and efficient utilization of renewable resources especially solar for power production, water heating and photovoltaic applications, wind for grid-off electricity production and water pumping, and biogas industry. A national master plan for development of renewable energy and energy efficiency has been set up. The plan aims at raising contribution of renewable energy in the energy balance sheet, and improving the energy efficiency especially in buildings. The policy of RE focuses on utilization solar energy for power production (CSP, PV) and utilization of energy from solid waste.

The key components of the plan are:

- Adaptation and implementation of national regulations and energy norms for RE&EE that facilitate investment in RE & EE technologies and leads to less energy bill and environment protection.
- Development and implementation of national programs and projects for best utilization of RE and energy conservation in residential, commercial and industrial sectors.
- Upgrading of the local market for clean and efficient technology through evaluation of the technology available and identification of standards and key factors for improving the level of quality.
- Awareness dissemination, know-how transfer and upgrading of technical capacities for the new and efficient technologies.
- Provision of suitable scientific and technological research & testing facilities that support researches and investment in clean and efficient technologies.
- Contribution to the regional efforts and global initiatives (CDM, GEF, etc) of the climate change.

## 3.3 Financial instruments

Unfortunately, neither specific financial scheme nor incentives/ subsidies is adopted at a national level for development and investment in solar technologies. This is due to the limited financial resources and tight budget of the PNA, and absence of private sector involvement due to high political risk for investment. Instability of the political situation negatively affects the interest of foreign investors to invest in Palestinian Territories. Some and inadequate financial supports are

received from the med-euro partnership and EC energy programs. This support is only specified for feasibility studies, seminars, and pilot projects.

## 4. CURRENT STATUS OF SOLAR ENERGY TECHNOLOGY APPLICATIONS

Palestine is one of the countries that posses a high potential solar energy (5.46 kWh/ $m^2$.day) which make it qualified to be feasible for all types of solar energy applications such as solar thermal energy and photovoltaic electrification..

### SOLAR THERMAL APPLICATIONS

***Solar Water Heating:*** Solar water heaters (SWH) are extensively used in the residential sector (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 totalled about 1,500,000 $m^2$. This can produce about 940 GWh per year and saves about 85 M€ yearly to the national economy. The corresponding avoided emissions of $CO_2$ are evaluated at 650,000 ton per year or avoided damage 2.3 M€. The market of SWH is about 13 M€ and can be doubled if proper policy with efficient financial scheme is adapted for promotion and encouragement the use of solar collective systems. The most commonly used system is family system- thermosyphonic open circuit type. The 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. Industry of solar water heaters in Palestine is a small and simple industry and needs to be developed and structured.

***Space Heating:*** 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. Active solar heating seems not applicable since solar insolation is low in winter with only few hours of sunlight. Serious attempts are being made to encourage the use of passive solar heating by establishment of a comprehensive database of climatic conditions and zoning in Palestine, conducting of public awareness programs, and training of design engineers.

***Success stories***

PEC was involved in several studies related to solar water heaters. One of which is the Beir Zeit University collective solar water heating that had been selected as the 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 $m^2$, a 15 $m^3$ storage tanks (5 x 3000 liters) and an external heat exchanger, the collectors are installed on the flat roof of the cafeteria as shown below.

**Figure 5: Collective Solar system at Beir Zeit University**

The system was perfectly working and was covering the required hot water for the cafeteria in summer time.
The objectives of the tele-monitoring were measuring the performance by measuring the useful energy supplied by the solar system, qualifying the performance by comparing the real and the estimated performance, and ensuring the performance by detecting and analyzing incidents that reduce system performance. This type of tele-monitoring is also indispensable for proposing a guaranteed solar results (GSR) contract.

The second system is the solar collective system at 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, the ambient temperature at Jericho city at summer time reaches 43˚C which makes this kind of systems to be feasible, a photo for the system is shown below.

**Figure 6: Collective Solar system at Jericho hospital**

## PHOTOVOLTAIC APPLICATIONS

In 1995 PEC had started with pilot projects for PV applications through its 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: Eldorado German Program for promotion of PV technologies for public use in developing countries, and Baden Wuerttemberg German PV revolving fund project for private use. Another important program is the GEF/ UNDP projects (implemented under supervision of PEA) for electrification of a small boarder Bedouin community and lighting a bridge in Gaza.

The total installed capacity is about 50 kWP, catagorized as follows:

- Rural clinics – 12 systems (7.37 kWP)
- Rural schools – 21 systems (13.44 kWP)
- Bedouin tents – 24 systems (5 k WP)
- 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 k WP).

**Figure 7: PV water pumping system, Yanoon village**

**Figure 8: PV system, rural clinic- Kufor Thulth village**

**Figure 9: PV lighting Bedouin system**

**Figure 10: School PV system**

***LESSONS LEARNED***

1. PV is an easily penetrating technology in the Palestinian market.
   Indicators: increasing demand on SHS by different categories of users even connected people to the grid.
2. PV electrification by SHS can be a short and mid-term solution for specific political conditions.
   Indicators: settling of several families threatened from land confiscation and people eviction.
3. Maintenance of storage battery is a dominant factor for sustainability of the system.

Indicators: Several SHS became out of work due to failure of batteries resulted from ignoring maintenance, low quality of batteries or bad management of connected loads.

4. The technology is still expensive and subsidies are essential for success of PV implementation, especially in most cases the system capacity should be > 400 $W_P$.
   Indicators: high potential of interested people but low acceptance of the system due to the high cost.

***Hybrid Solar-Wind Power System for Village Electrification*:** This small scale project started in 1999 was implemented by UNDP through the Palestinian Agriculture Relief Committee (PARCS) – a Palestinian NGO. The project targets a small, 100 person Bedouin community located in the southern area of the West Bank. It aimed at assisting this community in building and operating a solar - wind hybrid power system to meet the community needs. The project also incorporated energy efficiency awareness and it includes efforts to share this idea with other nearby communities.

## 5. BARRIERS IMPEDING BUILDING INTEGRATED SOLAR TECHNOLOGIES

Successful utilization of active and passive solar design principles in architectural design, urban planning, and building construction is still very limited; there is lack of enough awareness, capabilities among architects, engineers and planners in such related issues, this is 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.

Planning and design concepts usually did not take into account energy use and consumption; town plans (what is know as Master Plans) is more or less a land use plans that regulate land development is a specific land area; there is little awareness of how solar energy can be integrated with urban design, layout and structures in away that minimize energy consumption and use passive solar energy in heating, cooling and lightning. Other obstacles include:

- Lack of incentives & proper financing schemes that encourage investment in big 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.

# 6. FUTURE OPPORTUNITIES AND PLANS, MOST PROMISING MARKET NICHES

***Plans:***

- 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).
- Creation of a national fund with participation of the government, private sector and external financial aid for supporting development actions of RE and EE.
- 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.
- Imposition of standards, regulations and certifications for improvement the level of market quality.
- Establishment of national solar technology supporting unit (testing/research labs).
- Mobilization 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.

***Market trends and potential:***

- Mobilization use of collective solar water heating systems in complex buildings, and service sector (health, tourism, education).
- Introduction of new technologies for solar cooling, desalination.
- Utilization of solar thermal (CSP) for power and water production.
- Rural electrification by PV.

The potential for solar thermal (water heating) is about 1,630,000 $m^2$ .

The potential for solar photovoltaic is about 600 $kW_P$ .