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Renewable Energy Resources in Lebanon : Practical Applications

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Abstract

Countries of the south generally have abundant renewable and nonrenewable energy resources. Lebanon is among the few countries that are not endowed with fossil fuels in the Middle East; accordingly, it is imperative that renewable energy (RE) be looked at as an alternative energy source. A review of the energy scene in Lebanon and available RE sources is presented. With the current status of technology and the available resources, the best renewable energy domain to focus on is the solar thermal water heating for residential houses.

Keywords : *solar thermal, resources, energy, water heating.*

1. Introduction:

Lebanon is located on the Eastern edge of the Mediterranean. The area is 10,452 km^2 while the population is around 4 million. Lebanon has $4010 per capita GNI but the national debt is around $30 billion. This high population density and relatively good standard of living, exerts significant environmental pressures on the land in addition to a large energy demand that has to be met. While Lebanon strives to meet the energy demand of its population, a different approach based on energy efficiency and renewable energy may be the solution. Lebanon is located in a relatively sunny area (2200 kWh/m^2.yr) and has other potential renewable energy (R.E.) sources, indicating that an investment in these technologies may offset the need to expand the power generation capacity.

2. The Energy Scene

The main electricity company in Lebanon, EDL, imports around $500 million worth of fuel each year to generate the electricity needed. This has resulted in $2.4 billion in debts. In addition, despite the large government investments in the power sector, demand still exceeds supply and Lebanon frequently goes through black out in peak demand times or has to resort to importing electricity from Syria. Official numbers [1] indicate that Lebanon has consumed 10.192 TWh in 2002. Table 1 shows the amounts of fuels imported to Lebanon to fulfill its various energy needs. The lack of local oil resources generates a heavy reliance on oil imports and results in a heavy drain (more than $1 Billion in 2001 [2]) of foreign currency from an already indebted economy.

Table 1: Oil imports to Lebanon

Oil imports (2002)	Thousand Tons
Oil	1230.1
Diesel	1688.3
Kerosene	132.8
Fuel-oil	1590.5
Butane gas	110.9

3. Overview of Potential Energy Sources

In considering the best R.E. alternative, it is important to consider all potential R.E. sources, their costs, market availability, suitability for the selected location, significance of the energy produced and return on investment.

Tides and Waves

Lebanon has 225 km of waterfront, which is relatively long compared to its area. However, the Mediterranean Sea is an almost closed sea with minimal variation in tides and relatively small waves for most of the year. These factors, in addition to immaturity of technology, makes tides ad waves unsuitable for consideration.

Geothermal Energy

Two tentative sites have been identified that may carry some economic value. The first is in the town of Sammaqiye near the Syrian border. This area belongs to the general District of Akkar, which used to be an active volcanic area a long time ago. This ancient activity is illustrated in the volcanic rock commonly found in the area. In the early 1970's a well was dug down to around 550 m and 70ºC hot water, rich in sulfur, erupted to a height of 30 m above ground. The second site is off the shore of Tyre in Southern Lebanon where thermal vents have been discovered covering an area of 800 m at a depth of 60m below sea level. The discoverer, Mohammad Sarji, has documented these vents on film.

Hydropower

Lebanon is famous for its waters in an otherwise water deficient region. Several hydropower plants have been installed and others are expected soon. However, the share of hydropower to the overall electricity generation is around 5% (Table 2).

Table 2 : Hydropower production in Lebanon

Production	2000	2001	2002
Thermal + Import	7392	9140	9514
Hydro	449	332	678
% Hydro of total	5.7	3.5	6.7

With the exception of the unusually 2002-2003 rainy season, this share is decreasing as Lebanon is getting less rain each year and more of the water is diverted for irrigation. New dams on major rivers may raise this percentage further [3], but of 21 planned dams costing $547 million only one is designed for electricity generation *(Table 3)* while others are designed for water flow control and providing fresh drinking water. Hydropower is definitely an economical alternative but not without some environmental concern.

Table 3 : Dams initiated in 2002 and future Hydropower dams

Planned dams	Area	Water Capacity (m^3)	Use	Electricity production	Cost (million $)
Shabrouh	Kesrwan	8 million	Drinking water	N/A	48
Qaisamani	Baabda	0.55 million	Drinking water	N/A	8
Yamouneh	Baalback	1.5 million	Drinking water/ tourism	N/A	6
Jannah	Byblos	30	Drinking/power	40-100 MW	60

Biomass

Although Lebanon has little forest cover, it has significant other sources of biomass, namely municipal solid waste (MSW). If burnt, the 400 tons of MSW produced on a daily basis could provide 30% of the electricity needs, however, due to lack of emission controls and a strong resistance from locals and NGO's this alternative is not being considered. As a matter of fact, In a country like Lebanon with little natural resources, MSW is far more valuable if the raw material is recovered and recycled. Glass, paper, aluminum and some types of plastics are examples of material that can be completely recycled locally. Biogas generation from sewer and farm waste decomposition has the potential of offsetting 2.8% of the electric needs. Some plans are currently under way for large-scale utilization of biogas on a dairy farm.

Wind

There is significant evidence to support the presence of strong sustained winds in various areas in Lebanon, specifically the north. This evidence is mainly based on the tree deformation index, which suggests speeds of 7-8 m/sec to be present in selected sites. With the absence of a Wind map for Lebanon, attempts at measuring the wind have been done on small scale and by individuals or small organizations. With wind energy growing more competitive every day, wind turbine installation preceded by a good wind-monitoring plan seems to be the future. However with the strongly regulated electricity generation and distribution system existing in Lebanon, and due to the monopoly of one company on electricity (EDL), it is up to the government to promote and install wind farms and connect them to the grid. A regulatory change could open up the market for entrepreneurs fairly rapidly; especially that electricity generation in Lebanon is relatively expensive.

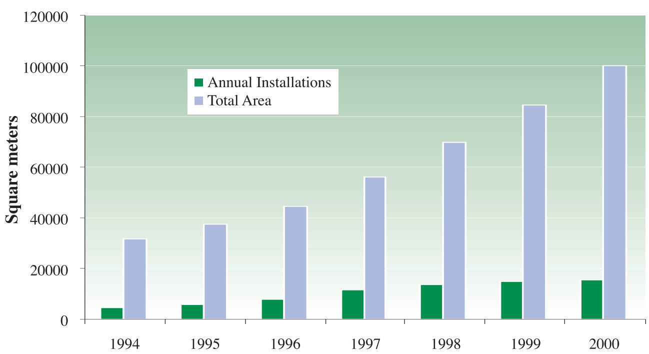
Solar PV

With the majority of towns and villages connected to the electric grid, solar PV in its current status is not economical and cannot compete with electricity supplied with the traditional oil-based methods. An exception exists for isolated remote applications such as transmission and relay towers.

Solar Thermal

Due to its abundant solar resources and the maturity of the solar thermal industry, Lebanon stands to benefit greatly from the utilization of solar water heating. Plans for the implementation of solar thermal collectors (STC) have been thoroughly studied [4 , 5, 6]. However, local acceptance has neither been due to published research nor due to government support. It has been simply a case of observed saving and simplicity of use. Figure 1 shows the increasing use of SHW systems. It shows a healthy upward trend.

Fig 1: Annual Installations of SHW systems in Lebanon



However, when the percentage annual increase is analyzed *(figure 2)*, it is seen that with the economic hardships that people are going through due to a faltering economy, the percentage increase is going down. This is despite the fact that the market is nowhere near saturation yet. Profiling SHW systems users showed that the wealthier portion of the society is the one utilizing these energy saving systems [7]. They are yet to be common among the more impoverished classes who need it most.

Despite the above analysis, the market is still expected to grow and according to LSES [8], *figure 3* is suggested to show the future market of SHW systems. Any effort by the government or local NGO's will greatly and rapidly enhance the use of these systems.

System effectiveness has spurred an active import trade in various brands of solar thermal collectors. With the absence of quality standards, customers were going after the best name or the cheapest product. Products are imported from various countries near (Cyprus) and far (Australia). While this attitude had several problems, it aided in initiating a local industry providing a competitive price. Since the manufacturing procedure does not require advanced technology, several manufacturers have gone into the market but again no standards are being applied so the product marketability is based on word of mouth and previous experiences with the product. All of the systems currently produced in Lebanon depend on the simple open cycle system. Ample sunlight is making up for any minor inefficiency that may exist in the systems.

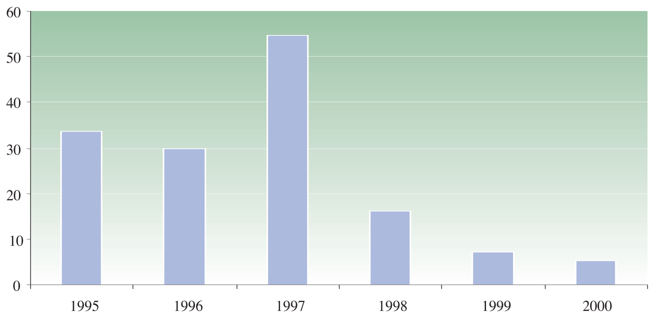


Fig 2 : Year on year percentage increase in SHW systems installed

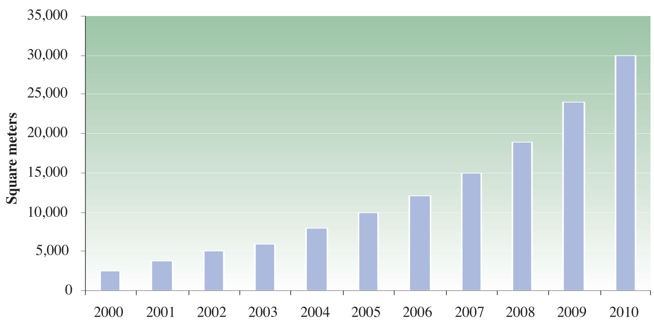


Fig 3 : predictions for SHW systems installations (LSES 2003)

The available systems on the market today are open and closed cycle. The closed cycle systems are more expensive especially that they are imported. However, they are expected to have a longer lifetime since well water is commonly used in Lebanon. This water tends to be rich in calcium carbonate and other salts that may form solid crystals inside the system. A typical installed system (4 m^2, 200L) could cost anywhere from \$700-\$1500 depending on type and manufacturer. Vacuum systems are new in the market and are significantly more expensive. These systems are being marketed for industrial applications. Lebanon's residents generally reside in multi-floor apartments and space is at a premium in the cities, even roof space. This means that space may be a limiting factor in SHW system installations. With minor behavioral modifications and sharing of hot water resources among the building residents, vacuum collectors could prove more successful in harnessing the power of the sun to provide hot water for city residents since they provide more hot water per unit area.

The extent of the success of SHW systems is a direct function of government regulation. *Table 4* compares the situation in Lebanon to similar neighboring countries where SHW systems have been very successful. This is because of regulation forcing housing developers to install these systems on all new houses and providing incentives for residents of older houses to install SHW systems.

Table 4 : SHW systems installed in representative countries

	Lebanon (2000)	Greece (1994)	Cyprus (1994)
Total (x106 m^2)	0.1	2	560
Per person (m^2)	0.025	0.20	0.85

A quick cost analysis indicates that the average payback period of the installed system under local conditions to replace electric heaters is 3-4 years. A 4m^2 system can fully provide the hot water needs for a family of five for six months of the year with minor water use adjustments. It can significantly reduce the electric bills in the remaining months. It is this visible savings that is motivating people to purchase SHW systems.

Social and environmental benefits are abound. SHW systems work quietly, use a renewable energy source, reduce the electricity bill for the consumer and save the country millions of dollars in avoided new power plant costs. They have a long lifetime (usually 20 years) and are reliable. They provide jobs and income for a highly unemployed population. They also help in reducing the health bill by reducing the pollutants that would have been generated by power plants. Increased awareness about the environment and renewable energy may creep in through the intent of citizens to save money. Since most residents today rely on electric heaters for water, 60-80% of the residential electricity used may be saved by the adoption of SHW systems.

It remains to be said that without government subsides, these systems will not be able to compete with diesel water heating used in large establishments and factories. Adoption of laws similar to those implemented in neighboring countries could give the industry a large boost.

4. Conclusions

Despite the clear advantage and emphasis given in this paper on the use of solar water heating as a best renewable energy alternative for Lebanon, it is not intended to minimize the importance of other systems. This paper merely addresses the urgency of applying the most cost effective system that would require minimal initial investment and life style changes. The experiences gained from neighboring countries only serve to support the need to promote solar hot water (SHW) systems. Environment often conflicts with human requirements and the need for extra cash. In the case of SHW, environmental protection and the use of renewable energy is able to provide residents with their needs in an economical way. This is illustrated in the fact that despite the lack of government subsidy, SHW systems sales are increasing resulting in job creation and emerging industries. A simple decrease in the Value Added Tax could result in further increase in the rate of adoption of such systems. SHW systems are bound to reach some saturation point in the future resulting in a relatively constant amount of sales per year. That is why it is important to plan ahead and prepare to use other, and perhaps more expensive, renewable sources of energy.

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