CORE
Metadata, citation and similar papers at core.ac.uk
Provided by e-Prints Soton

Draft Conference Paper Prepared for "Renewable Energy" Working Group
Global Network on Energy for Sustainable Development

A Sub-Regional Outlook of Renewable Energy Potential: The Case of Jordan, Syria and Lebanon

R. Chedid, N. Ghaddar, F. Chaaban, M. Fadel, T. Mezher, and F. Moukalled
Energy Research Group
American University of Beirut
P.O. Box 11-0236, Beirut 1107- 2020, Lebanon
Email: rchedid@aub.edu.lb

Abstract

This paper addresses the current status and the potentials of renewable energy applications in the selected Middle East countries; Jordan, Syria, and Lebanon. The energy and environmental situations within these primary target areas reflect many similarities and share serious common problems. These include an almost total dependence on imported oil products as the primary energy source, rapidly growing populations that are escalating the demand for energy, and only rudimentary efforts currently underway to mitigate the greenhouse and other adverse environmental effects of energy utilization. Lebanon is highly urbanized compared to Syria and Jordan with much smaller area and has not been fully engaged in pilot projects for use of renewable energy. Applications of solar energy in that region have been growing since 1970. Solar water heating with support of policies in Jordan has achieved measurable market penetration. Lebanon and Syria have not made reasonable progress in solar applications due to subsidized electricity supply to the end user. The technical and economic feasibility of wind energy utilization in Lebanon has not been yet fully explored, while it has advanced with two operating wind farms in Jordan, and one pilot wind farm in Syria. Similarly, the transfer of biomass technology has been successful in Jordan while it remains at the assessment level in Lebanon and Syria coupled with small pilot projects.

1. Introduction

The Arab countries (AC) are spread over a vast land extending from west Asia through North Africa. Many AC still have substantial proportion of their population live in rural and remote areas. In the ESCWA region, for instance, the high-income countries are 80% urbanized, with a large percentage of the population living in cities and towns. The rate of urbanization in the middle-income and low-income countries is 50% and 40%, respectively [1,2]. A common feature of rural areas in the AC is the limited access to: (1) appropriate electricity supplies (e.g. 15% of rural population in Morocco have access to electricity), (2) safe drinking water and sanitation (e.g. 2% of rural population in Jordan had access to sanitation in 1995), (3) education and basic health conditions, and (4) the harsh working conditions for women [1-5]. One of the factors that affect rural development in AC is the restricted and expensive supply of energy, a matter that asserts the importance of renewable energy development as an essential option for sustainable development in the region.

On the other hand, global environmental issues such as Climate Change still have low priorities compared to national economic development and growth in AC. Over 180 nations have already ratified the UNFCCC since it was adopted in the Rio Summit. Apart from Iraq and Palestinian Authority, all AC have signed the treaty on the convention and have been classified as Non-Annex I Parties [1].

This paper addresses the current status and the future potentials of renewable energy applications in selected Arab countries; Jordan, Syria, and Lebanon. The energy and environmental situations within these primary target areas reflect many similarities and share serious common problems. These include an almost total dependence on imported oil products as the primary energy source, rapidly growing populations that are escalating the demand for energy, and only rudimentary efforts currently underway to mitigate the greenhouse and other adverse environmental effects of energy utilization.

Jordan lies in the Middle East within latitude 29°11 and 33°22 north and longitude 34°59 and 39° east. The total area of the kingdom is 89,500 Km^2 (55900 $miles^2$). The climate is mostly arid desert with a rainy season in the west (November to April). At the end of 2002, the population of the kingdom was 5.329 million compared to 5.182 million at the end of 2001, i.e. a growth of about 2.8%. Eighty percent of the population occupies 20% of the total Kingdom area whereas the rest live in the remaining 80% of land. [3, 7]

The Syrian Arab Republic lies on the eastern coast of the Mediterranean Sea within latitude 32.3° and 37° north and longitude 36° and 42.4° east Greenwich. The total area of the Syrian Arab Republic is 185,517.971Km^2: 60,000 Km^2 is arable land whereas the rest consists of mountains (2500-1100m) and deserts. The climate is mostly desert hot with dry sunny summer days (June-August) and mild rainy winters (December to February) along the coast and cold weather with cold or sleet periodically in Damascus. The population of the Syrian Arab Republic in the middle of year 2002 was 17,130 thousand distributed as follows: urban population 40.2% and rural population 49.8%. [3, 7-9]

Lebanon is located on the eastern shores of the Mediterranean Sea between the North Latitudes 33° 03' 38'' and 34° 41' 35'' and East Longitudes 35° 06' 22'' and 36° 37' 22'' between Syria and Occupied Palestine. Lebanon covers an area of 10,452 $Km^{2.}$ Arable land in Lebanon constitutes 18.6 % of the total area. The climate in Lebanon is Mediterranean; mild to cool, wet winters with hot, dry summers. The Lebanese Mountains experience heavy winter snows. The population of Lebanon in July 2003 was 3,727 thousand with 90% residing in urban areas with Beirut housing nearly half of the country's population. [3, 9]

Table 1 shows the land total area, population, growth and rural distribution of Jordan, the Syrian Arab Republic, and Lebanon for the year 2002, while table 2 gives the GDP, GDP growth, and GDP per capita for the three countries for the year 2002. Table 3 shows the composition of the GDP according to the main economic sectors [3, 6-9].

Table 1: Land area, population size, rural distribution and growth of Jordan, Syrian Arab Republic, and Lebanon in 2002.

Country	Area (Km^2)	Total Population (in thousands)	Percentage rural	Population growth *(annual)*
Jordan	89,500	5,239	20	2.8%
Syrian Arab Republic	185,517	17,130	49.2	3.1%
Lebanon	10,452	3,596	10%	1.8%

Table 2: GDP, GDP growth, and GDP per capita in Jordan, Syria, and Lebanon (2002)

Country	GDP *(billion US$)*	GDP (real growth rate)	GDP /capita
Jordan	9.295	3.5%	$1,797
Syrian Arab Republic	21.871	3.5%	$1067
Lebanon	17.293	1.5%	$3,800

Table 3: GDP composition by sector (2001)

Country	Agriculture	Industry	Services
Jordan	3.5%	27%	69.5%
Syrian Arab Republic	27%	23%	50%
Lebanon	12%	21%	67%

2. Renewable Energy Resources [1,3,4,7]

The Jordanian government works on implementing short and long term projects to exploit renewable energy resources, in particular oil shale, solar and wind energy, aiming at increasing the contribution of these resources to the total primary energy mix. The resources of hydro energy are very limited in Jordan. There is only one hydro plant for electric power generation with an annual capacity of 25 GWh at King Talal Dam. Solar energy is mainly used in Jordan for domestic solar water heating (about 30% of the houses in the country [3-4, 7].

Although the Syrian Arab Republic relies on locally produced traditional energy resources like oil and gas, other renewable resources exist such as wind and solar energy. There are hydro energy resources available on the Euphrates River with an annual production capacity of 1.4-2.1 TW, in addition to other stations and dams available. Other resources are considered for future electricity production such as oil shale that is found in the south and other regions. Estimates of the main biomass resources carried out by the author for the year 1999 show that there are about 577,365 tons of dry animal dung; 360,000 tons of dry chicken droppings; 230,000 tons of dry human waste; and 34,000 tons of dry kitchen residues available every year. The study of the author indicates that 357 million m^3 of biogas could be produced annually in Syria [3-4, 8].

In Lebanon, renewable energy available include resources such as solar, wind, hydro, and biomass resources, but still these resources are not widely used. Lebanon aims at maximizing its benefits from the existing water resources through studying the possibility of constructing dams along the Lebanese rivers in all the regions of Lebanon. The use of solar energy is still very limited, and apart from relatively modest hydroelectric resources and the import of 50-100 MW of electricity from the Syrian Arab Republic, all energy needs are met with imports of petroleum products. The use of biomass fuel in Lebanon is minor and was confined in 1994 inventory of the greenhouse gas emissions by sources and sinks to the use of 100,000 tons of wood, 1560 tons of charcoal and 180,000 tons of cooking coal [1, 3-4, 10]. A potential biomass energy source in Lebanon is methane from solid waste. Another source of biomass is agricultural waste that can be converted into electricity through gasification, biogas digestion or combustion processes. This source of energy is not exploited in Lebanon as agricultural wastes are typically burned. Limited applications have been initiated by non-governmental organizations (NGOs) by establishing biogas digesters for rural areas within the framework of community development projects financed by United Stated Agency for International Development (USAID), and have been operating efficiently [,11].

Table 4 summarizes the solar, wind and biomass energy resources in Jordan, Syria, and Lebanon; and table 5 gives information on installed and potential hydropower in the three selected countries.

Table 4: Renewable energy resources in Jordan, Syria, and Lebanon

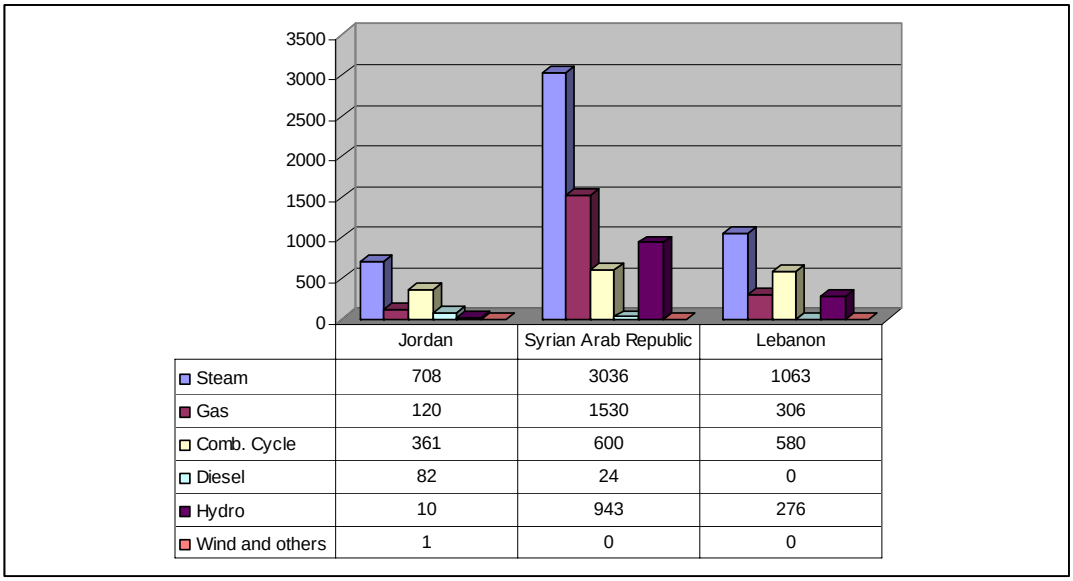
Country	Global solar radiation kWh/m^2/day	Direct normal solar radiation kWh/m^2/day	Wind energy m/s	Biomass and fuel wood (mtoe/year)
Jordan	5-8	5-7	5.5-10	0.74
Lebanon	4-6	4-6	3-5	0.59
Syrian Arab Republic	5-6	-	4.5-11	1.24

Table 5: Installed and potential hydropower in the selected countries

Country	Installed hydropower, MW	Potential hydropower, MW
Jordan	7	50
Lebanon	283.1	533
Syrian Arab Republic	1505	1236

3. Electricity Generation [3, 6]

Figure 1 shows the types of electricity generation systems (steam, gas, combined cycle, diesel, hydro, wind and others) in Jordan, Syria and Lebanon where the installed capacities are 1282 MW, 6133 MW, and 2,225 MW respectively for the year 1999. The thermal power plants utilizing steam turbines are still the predominant method in the three countries although the move towards combined cycle technology is clear.



	Jordan	Syrian Arab Republic	Lebanon
Steam	708	3036	1063
Gas	120	1530	306
Comb. Cycle	361	600	580
Diesel	82	24	0
Hydro	10	943	276
Wind and others	1	0	0

Figure 1: Types of generation in Jordan, Syria, and Lebanon (1999)

4. Energy consumption [3, 6-9]

In Jordan, primary energy demand reached about 5291 mtoe, reflecting a growth rate of (2.7%) compared to a growth rate of (5.6%) in 2001. The electric power sector is the highest consumer of primary energy taking up 36.8% of the total energy consumed during 2002 compared to (35.5%) during 2001. Table 6 shows the primary energy consumption in Jordan [3, 7].

Table 6: Annual primary energy consumption thousand tons oil-equivalent during 1997-2002 in Jordan

Year	Primary energy type				Total
	Crude oil and oil products	Natural gas (billion ft^3)	Renewable energy	Imported electricity	
1997	4385	10.7	65	N/A	4673
1998	4491	10.9	67	N/A	4784
1999	4471	10.8	68	N/A	7450
2000	4815	10.3	75	11	5114
2001	4803	9.9	76	65	5150
2002	4954	9.0	79	78	5299

In the Syrian Arab Republic, primary energy demand in 2002 was about 18 mtoe. Figure 2 shows the distribution of energy resource mix to satisfy the demand in 2002. Lebanon consumed around 4.2 mtoe in 1995 as primary energy distributed between oil products which are a major contributor to pollution and renewable forms of energy. Figure 3 shows the amounts of fuel imported to Lebanon in 1999 [3-4, 8].

Table 7 shows the total energy consumption and demand forecast in Jordan, Syrian Arab Republic, and Lebanon. The table illustrates the continuous increase in energy demand in the three countries and brings up the need to find ways to manage this increase.

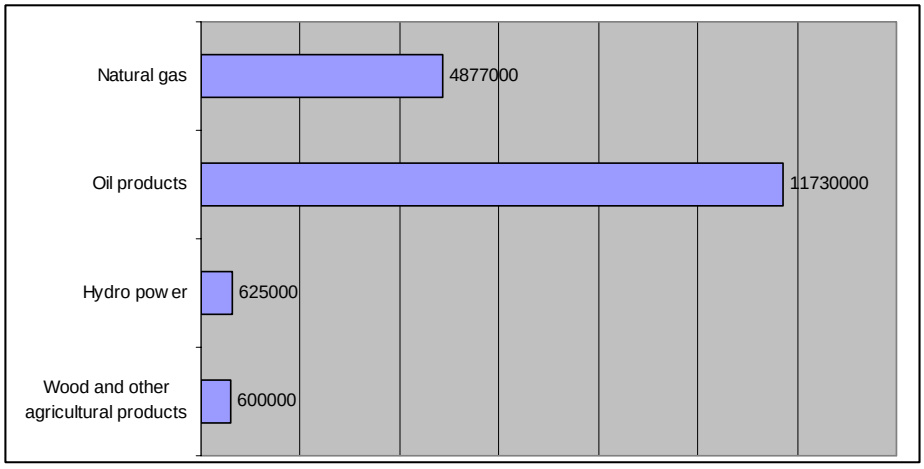


Figure 2: Primary energy demand during 2002 in TOE in the Arab Syrian Republic

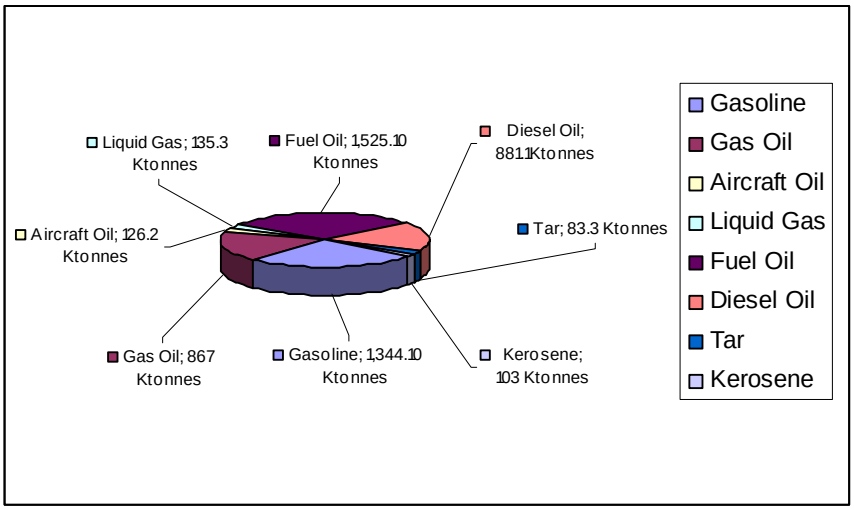


Figure 3: Fuel imports in Lebanon in 1999

Table 7: Total energy consumption and demand forecast in Jordan, Syrian Arab Republic, and Lebanon in GWh

Country	Energy consumption		Avg. growth rate (percent)	Project demand		
	1 995	2 000		2005	2010	2015
Jordan	4 778	5 810	5	7 596	8 849	10 159
Syrian Arab Republic	14 661	2 0580	9	32 843	44 366	59 372
Lebanon	5 484	8 630	13	10 284	12 512	14 087

5. Energy Status in Rural Areas

a. In Jordan, the percentage of rural population provided with electricity was 99.8 at the end of year 2002. The government works on providing the rest of the residential gatherings in the Jordanian countryside with electricity through the Rural Electrification Program. This project is financed via taxation of electricity bills. Also important to note that some residential areas in the kingdom were provided with electricity by solar cell systems with the help of the National Energy Research Center [1, 7].

b. In Syrian Arab Republic, there is a general orientation to develop the countryside socially and economically and decrease emigration to cities. A strategy was followed aiming at providing the Syrian remote and rural areas with electricity. The Ministry of Electricity is committed to provide villages and farms with light. Through the activities of the Energy Planning and Conservation Project, statistics have been collected to help develop rural areas and increase the utilization of sustainable energy systems. The main energy resources in rural areas are wind, solar and biomass resources in addition to liquefied gas and kerosene [1, 8].

c. In Lebanon, there are no special plans concerning supplying rural areas with energy as most of these areas have been electrified and have access to other commercial energy resources [1,9].

6. RE Technology Demonstration

a. Domestic Solar Water Heaters (DSWH): DSWH have been demonstrated with different penetration levels, types, capacities and fields of applications. For example, in Syria and Jordan, the installed DSWH are estimated to be around 15000-20000, and 200000 units respectively. Jordan has more than 25 manufacturers producing locally designed solar water heaters systems, while in Syria they are produced presently by more than 50 small private workshops with a total annual production capacity of about 150,000 m^2. In some cases inappropriate designs and/or manufacturing processes are used, resulting in systems with relatively low quality. In Lebanon, the installation rate of DSWH is increasing but has not reached the level that affects the energy utilization mode on the country level [1, 3-4, 7-9].

b. PV systems: PV technologies are not widely spread in AC due to many reasons including their high capital costs and the low level of awareness about their values. The total installed capacity of PV systems in all AC is estimated at 10MW spread in some countries including Egypt, Jordan, Syria, Palestine, Saudi Arabia, Tunisia, Morocco and Algeria. In Syria, the total capacity of demonstrated PV systems is around 80 kWp used for water pumping and in some pilot scientific cooperation projects for desalination as well as for supplying electricity to houses in certain villages. PV power is also demonstrated in Jordan for a total capacity of about 184 kWp. Demonstrated applications include emergency telephones, rail radio communication systems, relay stations for radio telephone communication, provision of minimal basic energy needs for remote communities, and water pumping in remote areas. In addition, 100 photovoltaic systems are used in remote areas throughout Jordan. [7].

c. Wind energy systems: Wind energy in some AC is in the stage of field applications where real contributions to national energy needs have already been made. Examples of serious developments can be found in Egypt, Jordan, Morocco, and Syria.

In Jordan, more than 12 demonstration projects totaling 1620 kW of wind turbines were implemented, tested and evaluated for (1) water pumping, and (2) electricity generation (a 320 kW grid connected Danish wind energy plant was installed in 1988 with annual energy production reached 0.75 million kWh. Also the Hofa wind farm consists of five 225kW turbines producing an average annual energy about 2.5 million kWh). Based on the promising results of those projects, the Ministry of Energy and Mineral Resources (MEMR) has issued the call for proposals for the development of a 75-90 MW wind IPP project, where two proposals are received and under evaluation. Wind Energy use for water pumping in Jordan utilizes locally manufactured mechanical windmills [7].

In Syria, A 150 kW grid connected wind turbine was set up in 1994 at the Qunetra south of Syria producing 300 MWh/year. There are also stand-alone wind systems installed in Syria for battery charging, water pumping and defrost (750 W to 50 kW) which are locally manufactured (since 1990) by private company (SAC) located at Adra, near Damascus. The wind generators are fully designed, manufactured and installed by this company. The total capacity production by the company is 600 kW [8].

*d. Biomass technology .*In Jordan, the biomass activities were limited to the construction of an experimental biogas digester in 1992 with a capacity of 16 cubic meters per day, where limited number of private firms built similar units. A techno-economic feasibility study for electric power generation from municipal solid waste was carried out in cooperation with the UNDP and GEF. Jordan has adopted a special program for Bio-energy by which pre-feasibility studies for the utilization of Municipal Solid Wastes for electricity generation have

been prepared since 1993 through cooperation with GEF. The outcome of these studies resulted in implementing the first biogas project in Jordan and in the region with a capacity of about (1) MW of electricity. This project is owned, operated and maintained by the Jordan Biogas Company (JBCO), and is going to be expanded up to (5) MW by the year 2005 [7].

In Lebanon and Syria, only theoretical assessment coupled with minor demonstration pilot projects have been carried out so far, although the potential for generating energy from biomass is great especially in Syria.

7. Policy and Planning Measures [1, 3, 4, 7]

During the past two decades, most of RE activities in Arab Countries were mainly linked to the R&D activities of the academic community in the countries, and were not considered as an integral element of national energy plans. In addition, limited strategies and policy issues were adopted to facilitate the dissemination of RE applications. Few countries like Egypt, Jordan and Syria have taken steps towards formulation of strategies, policies and plans for RE development.

a. In Jordan, the national strategy targets are: (1) the development of local energy resources and technologies to supply 28% of national primary energy by the year 2010, and (2) improvement of energy efficiency and promotion of energy conservation. In addition, the government adopted a number of policy issues to encourage RE development. Namely:

- Development and adoption of RE technologies relevant to Jordan's development needs particularly in remote areas.
- Upgrading R&D local capabilities.
- Increasing designs and production capabilities of RE equipment.
- Building testing facilities for RE equipment.

b. In Syria, the national strategy target is to save 5% of the country's total energy consumption around 2010 from solar and wind resources. To achieve this strategy the following measures have been considered:

- Coordination of national efforts towards the achievement of the strategy target for RE
- Support of RE market penetration
- Support of R&D, education and training in the field of RE.

The following recommendations and guidelines have been adopted for RE promotion. Mainly:

- To determine RE potential in Syria
- To direct research and development in the area of RE
- To diversify energy consumption through a better use of various energy resources.

c. In Lebanon, only policy guidelines encouraging R&D in the renewable energy field have been recorded, which can not constitute the necessary mechanism towards integration of RE within the overall national energy policies and plans.

8. Major Institutions Dealing with Renewable Energy Systems [1, 3, 7-8]

Only Jordan has established specialized RE institutions, while in Syria and Lebanon the RE activities are, mainly, undertaken by universities, research institutes, and in some cases, by departments within the competence of different ministries.

a. In Jordan, energy institutions were developed separately. Recognizing the importance of the energy sector in the economic and social development of the country, the government established the Ministry of Energy and Mineral Resources in 1984 to coordinate the activities in this sector and increase its efficiency.

b. In Syria, several energy organizations have specific responsibilities concerning energy and its utilization like the Ministry of Oil and Mineral Resources, Ministry of Electricity, Ministry of Irrigation, Ministry of Transport, and the National Center for Energy Research.

c. In Lebanon, several organizations are concerned with energy and its utilization like the Ministry of Electricity and Water Resources (MOHER), EDL, , Ministry of Transport, Ministry of the Environment, the Council for Development and Reconstruction (CDR), Energy Conservation Center (under development), and the National Council for Scientific Research (NCSR).

Table 8 shows the major institutions involved with sustainable energy research and development in Jordan, the Syrian Arab Republic, and Lebanon.

Table 8. Major institutions involved with sustainable energy.

Country	Institution	Renewable energy field of activity
Jordan	1. The National Energy Research Center (NERC) 2. Ministry of Energy and Mineral Resources (MEMR) Renewable Energy Department 3. The Royal Scientific Society (RSS), Renewable Energy Research Center (RERC) 4. Private Industry	- NERC is responsible for RE development and field promotion of RE electricity generation with emphasis on wind generation - RERC/RSS performs R&D activities, demonstration, project, testing and certification, in addition to supporting local industries through the development of components and system designs.
Syrian Arab Republic	1. Ministry of Electricity (MOE) The Syrian Ministerial Cabinet Renewable Energy Office (REO) 2. Scientific Studies and Research Center (SSRC) 3. Ministry of Industry; Private industry 4. The Syrian Arab Organization for Standardization and Measurement	Coordinates RE activities REO coordinates plans and identifies implementation priorities • Develops analytical simulation models for RE systems and equipment standards • Manufactures DSWH and windmills • Develops standard specifications for RE equipment

Lebanon	1. Ministry of Energy and Water (MOEW), Electricité Du Liban (EDL) 2. National Council for Scientific Research (NCSR) 3. American University of Beirut (AUB) and other universities 4. Non-governmental organizations	• Plans studies on RE contribution to energy and coordinates efforts in RE field

9. Standards, Testing and Certification "ST&C" [1, 3, 4, 7]

a. In Syria, standards and codes of practice for DSWH components and systems have been developed and implemented since 1993. This task was the results of a joint effort between the "Syrian Arab Organization for Standardization and Metrology" and the " Renewable Energy Office".

The activities on testing and evaluation of RE equipment and systems have been carried out by several test stations and laboratories. These include an outdoor liquid flat-plate collector test facility in 1984, and an outdoor air collectors test facility in 1992, the Abou-Sorra PV test station, and the PV laboratory in Allepo which includes an indoor simulator for testing solar cells and modules prior to assembling and encapsulation.

b. In Jordan, the responsibility moved to the National Energy Research Center (NERC). At NERC, the focus was on the development of standards together with establishment of advanced testing and certification laboratories, as follows:

- Indoor-outdoor solar collector testing facility according to national and international standards.
- A solar water heater system testing facility which is capable of testing the performance of complete solar water systems according to ISO TC 180 SC4 standards.
- A hot water storage testing facility.
- A power electronics laboratory to simulate the performance of solar systems (5-10kW) and any wind energy system (up to 20kW)
- A PV outdoor testing facility
- A mechanical and electrical wind pump testing facilities.

c. On the other hand, Lebanon does not have field testing facilities but some indoor laboratory sets for testing and developing PV, DSWH and other renewable energy applications.

10. Training and Academic Activities in Renewable Energy [1, 3-4, 7-8]

a. In Jordan, research and development in the energy sector is aiming at achieving energy sustainability for future generations and using renewable energy resources in a reasonable way, in addition to protecting the environment from high pollution levels. Research and development concentrated on:

- Finding local energy substitutes like renewable energy and oil shale and studying the possibility of covering some of the kingdom's needs from these resources.
- Providing citizens with all types of energy required for social and economic development.

Energy sector institutions are acquiring the necessary technical expertise from Jordanian and non-Jordanian university graduates and professors, in addition to the many specialized laboratories in energy and related fields. There are also several training centers owned by

private companies where employees of these companies work on increasing and improving their technical skills and learning about the latest international advances in the energy sector.

b. In the Syrian Arab Republic, with the participation of a large number or engineers and people concerned, many training courses were given, in addition to other courses given to engineering offices and engineering university faculties. Some universities in the Syrian Arab Republic are specialized in the field of renewable energy and some give a diploma in renewable energy studies.

c. In Lebanon, major universities provide energy-related courses. Namely, courses in renewable energy, demand side management, energy efficiency, and energy planning and policy. Additionally, some private companies and NGOs in Lebanon are active in promoting renewable energy by occasionally organizing seminars, workshops and distributing newsletters on renewable energy, solar applications, environmental issues etc.

In a recent effort, a number of universities from Lebanon, Jordan and Syria have agreed to start collaboration on renewable energy and energy efficiency [7-8]. The purpose of such a consortium is to build training capacity at the universities and accelerate the development of strong energy efficiency and renewable energy technology initiatives. The initiatives target the: (i) development of a regional database for energy efficiency and renewable energy sources; (ii) Institutional strengthening and capacity building; and (iii) technology transfer, and its enhancement, and adaptation to regional needs. The universities plan to identify sources of funding that would allow the universities to move forward in providing educational, training and exchange programs on energy issues, advisory services, and contributions to national policy formation.

11. Poverty Alleviation

Population growth and poor economic performance in both developed and underdeveloped countries has increase poverty and environmental degradation s in these countries. Despite soaring global wealth, now estimated at $24 trillion annually, some 1.2 billion people across the world live on less than $1 a day—a condition classified as "extreme poverty" and characterized by hunger, illiteracy, vulnerability, sickness and premature death. Half the world lives on $2 a day or less [12].

Ending poverty has been an international aim since 1960. After significant advances between 1970 and 1990, the rate of poverty reduction in the 1990s fell to only one third of the pace required to meet the United Nations' commitment to halve poverty levels by 2015.

Although affluence consumes energy and produces waste at far higher rates, the effects of poverty also destroy the environment. Global attention has consequently focused on the complex relationship between environmental degradation, poverty and sustainability. Understanding it may be the key to ending poverty and closing the gap between more and less affluent, as well as meeting the objective of sustainable development.

Population pressures are increasing in many poor and ecologically fragile zones in urban as well as rural areas. Fertility in many of these places is already high, and more people are being driven to them by a shortage of land for subsistence farming, by economic policies encouraging large holdings, intensive agriculture and cash crops, and by poverty and high population densities elsewhere. Poor people depend heavily on natural resources for direct income and their poverty offers them few choices.

Table 9 shows poverty and social indicators in Lebanon, Syria, and Jordan. Percent poverty in these countries range between 25 and 30 percent of the population with an

average annual population increase between 1.4 and 3 percent. Even though Lebanon has a higher percentage of population living in urban areas, all countries have developed poor neighborhoods that are heavily dense. In addition, these entire countries host on their territories millions of Palestinian refugees that live in poorly managed camps that are located around major cities. This will put extreme pressure on the already poor existing infrastructure and in turn on the environment. Other indicators in the table show that the living conditions in these countries are not that bad.

All three countries should come up with development policies that will reverse the population migration from rural to urban areas, sustain good economic growth, and reduce negative environmental impact. This should result in poverty reduction. Comparing these three countries to Africa, almost more than 95 percent of the population in both urban and rural areas has access to electricity. In Lebanon, the cost of electricity is much higher than in both Syria and Jordan. Therefore, renewable Energy and Energy efficiency are important factors that will contribute to reduction of the energy bill and conserve natural resources. In addition, it will create a new renewable energy industry in rural areas that will help in their economic development. Jordan is more advanced in development its renewable energy industry than Syria. Lebanon is still lacking behind. The previous section did discuss the status of renewable energy in each of the three countries. There is an urgent need for entrepreneurial policies that will encourage the investments of the private sector in renewable energy and energy efficiency with the help of the public sector and civil societies. This can only be done if it is only complimented with good financial policies and economic instruments. More studies are needed to determine the correct development path of using renewable energy and energy efficiency in order to alleviate poverty in both rural and urban areas in Lebanon, Syria, and Jordan.

Table 9. Poverty and Social Indicators

Country	Lebanon	Syria	Jordan
Average annual growth, 1996-02			
Population (%)	1.4	2.5	3
Labor force (%)	2.6	4	4
Most recent estimate (latest year available, 1996-02)			
Poverty (% of population below national poverty line)	28	25	30
Urban population (% of total population)	90	52	79
Life expectancy at birth (years)	71	70	72
Infant mortality (per 1,000 live births)	26	23	25
Child malnutrition (% of children under 5)	3	N/A	5
Access to an improved water source (% of population)	100	80	96
Illiteracy (% of population age 15+)	13	24	9
Gross primary enrollment (% of school-age population)	99	109	101
Male	101	113	101
Female	97	105	N/A

Sources: World Bank (www.worldbank.org) and USDS (www.usds.gov).

11. Conclusion

The profile of renewable energy sources and the extent of their use in the three Arab States of Lebanon, Syria, and Jordan are presented. Renewable energy programs grow only when supported by sound energy policies that promote sustainable energy practices. The assessment of renewable energy sources in the Arab States confirms that these sources have the potential to provide much of the energy needs. To develop this potential, countries would have to commit to the development and implementation of renewable energy

technologies and energy conservation. Governmental, educational, and professional bodies should play a greater coordinated role in developing various combinations of renewable technologies consistent with the characteristics of the different countries and for dissemination of these appropriate options.

12. Acknowledgement

This work was supported by the Global Network on Energy for Sustainable Development (GNESD) for the project on: “Identifying of the Contribution and Barriers of Renewable Energy Technologies (RETs) to Poverty Alleviation in Jordan – Lebanon – Syria, 1250001-5 RETs Theme.

13. References

1. R. Chedid, F. Chaaban, “Renewable Energy Development in Arab Countries: *A Regional Perspective”. Journal of Applied Energy,* Volume 74, Issues 1-2 , January-February 2003 , Pages 211-220*, 2003.*
2. A. Hegazi, Renewable Energy: An Option for Sustainable Development in the Arab States. A paper presented at the Middle East and North Africa International Energy Congress. Cairo, Feb. 16-18, 1999.
3. H. Al-Khatib, Renewable Energy in the Arab World. Oil and Arab Cooperation. Vol. 24, Issue 85, 1998.
4. Survey of Economic and Social Developments in the ESCWA Region 1998-1999. ESCWA Distr.
5. Regional Renewable Energy Profile, prepared by the Energy Issues Section, ESCWA, 2001
6. ESCWA, Regional Approach for Disseminating Renewable Energy Technologies, Part I: The Regional Renewable Energy Profile, 2001
7. F. Abdulla, M. Widyan, Z. Al-Ghazawi, S. Kiwan, H. Abu-Qdais, M. Hayajneh, A. Harb, M. Al-Nimr, Status of Jordan Renewable Energy Sector: Problems, Needs and Challenges. Presented at the Regional Collaboration Workshop on Energy Efficiency and Renewable Energy Technology, April 26-30, 2004.
8. A. Hamzeh, “Overview of the Syrian energy profile; Presented at the Regional Collaboration Workshop on Energy Efficiency and Renewable Energy Technology, April 26-30, 2004.
9. M. El-Fadel, R. Chedid, M. Zeinati, W. Hmaidan, Mitigating energy-related GHG emissions through renewable energy. Renewable Energy 28 (2003) 1257–1276.
10. Lebanon. Technical annex to Lebanon’s first national communication. Ministry of Environment and UNDP (United Nations Development Programme), Beirut, Lebanon. 1999.
11. ESCWA, Economic and Social Commission for Western Asia. 1998. Regional programme for the development of new and renewable energy resources: assessment and prospects. United Nations, New York. (E/ESCWA/ENR/1997/14).
12. The World Bank. 2000. *World Development Report 2000/2001: Attacking Poverty.* New York: Oxford University Press.

A sub-regional outlook of renewable energy potential: the case of Jordan, Syria, and Lebanon. Draft conference paper prepared for Renewable energy working group global network on energy for sustainable development. [2] Kamel Araj. Jordans nuclear power program. First Arab conference on the prospects of nuclear power for electricity generation and seawater desalination. Tunsia, June 23-26, 2010. [3] Annual report of National Electric Power Company, 2010. Better yet, Jordan has enormous potential for renewable energy, especially in solar photovoltaics (PV) and wind. In this study, I evaluate Jordanâ€™s readiness to implement renewable energy, analyze a case study of the Zaâ€™atari refugee camp (which recently transitioned to running entirely on solar energy), and make basic projections on potential job creation and water conservation by switching from coal and natural gas to PV and wind.Â The issues at hand in Jordan today Environmentalism of renewable energy Economics of renewable energy III. Methodology IV. Analysis: RE Progress V. Case Study: Zaâ€™atari VI. Analysis: Basic Projections Job creation Water conservation VII. Draft Conference Paper Prepared for â€œRenewable Energyâ€ Working Group Global Network on Energy for Sustainable Development. A Sub-Regional Outlook of Renewable Energy Potential: The Case of Jordan, Syria and Lebanon. R. Chedid, N. Ghaddar, F. Chaaban, M. Fadel, T. Mezher, and F. Moukalled Energy Research Group. American University of Beirut P.O. Box 11-0236, Beirut 1107- 2020, Lebanon. Email: rchedid@aub.edu.lb. Abstract. This paper addresses the current status and the potentials of renewable energy applications in the selected Middle East countries; Jordan, Syria, and Lebanon. The energy and e... Renewable Energy Outlook: Lebanon, prepared in collaboration with the Ministry of Energy and Water (MEW) and the Lebanese Center for Energy Conservation (LCEC), identifies key challenges as the country pursues environmentally and economically sustainable power and heat. The report highlights the policy, regulatory, financial and capacity-building actions needed to meet or surpass current targets.Â These action plans build on the high availability of renewable energy sources and the potential for the deployment of renewable energy and energy efficiency measures to satisfy 12% of primary energy consumption for both electricity generation and heating purposes by 2020. Part Two: Jordan. Jordanâ€™s economy was weakly integrated with Syriaâ€™s before the war.Â Jordan has been an importer of energy and is working to change that with major investments. These are aimed at tapping its large underground oil shale reserves and developing renewable energy sources. The World Energy Council estimates that it has the fifth largest oil shale reserves. Jordan recently awarded a Saudi oil company the rights to explore some of those reserves.Â These are just a few of the many renewable energy projects underway. Therefore, it is heavily dependent on its Middle Eastern neighbours for meeting domestic energy needs. It previously relied on Egypt and the Arab Gas Pipeline for most of its energy needs.