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Electric Energy Access in Jordan, Lebanon and Syria

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Abstract

This paper presents an overall energy profile and access in Jordan, Lebanon and Syria. The urbanization of the population has similar levels in Jordan and Lebanon at 80 and 90%, respectively, whereas Syria still has a 48 % rural population. All three economies rely on services in varying amounts the largest being in Jordan at 73% and the smallest is in Syria at 49%. On the energy scene Syria has enough fuel resources to cover its needs of oil and gas whereas nearly all energy needs in Lebanon and Jordan are met with imports of petroleum products. The electric energy consumption in all countries is dominated by the residential sector with layered tariffs trying to increase the access of electric energy to the poor. Whereas Jordan and Lebanon have a tariff structure to repay significant portion of the cost of production, Syria has a very high level of subsidy in the electric energy bill. Jordan has restructured and privatized the electricity sector by passing Law Number 64 in 2002, while in Syria no concrete plans to reform the electricity sector yet exist. Lebanon is somewhere in between where a law has been proposed by the government and is now awaiting discussion in the Parliament. Present access to electric energy seems satisfactory as high electrification levels have been achieved in the three countries and the bill for electric energy is a small percentage of household expenditure on average. The access of electric energy to the poor in terms of affordability is presented and discussed in a case study. The paper also presents energy consumption patterns in the three countries, the strategies and policies implemented in electric power sectors. Positive effects of the use of renewable energy in improving the access of energy in general are also noted.

Keywords: Energy access, Energy efficiency, Electric power sector, Electricity reform, Poverty assessment, Renewable energy

1. Introduction

Energy is the lifeblood of human societies and the fuel of their economies, which cooks the food we eat, heats and lights our schools and hospitals, powers our industries,

and keeps us warm or cool in our homes. The access to clean modern energy forms (e.g. electricity and gas) is critically important for our development and the eradication of poverty. The access to energy in general and electricity in particular has three basic elements, which are the electrification level, the affordability, and the availability of the supply resources. The energy sectors in Jordan, Lebanon and Syria (Syrian Arab Republic) provide vital support for economic and social development in the three countries and in general are dominated by fossil fuel resources. All countries have carried rural electrification projects that are providing electrification levels higher than 99.5% in all countries. However, there are still some communities that have no access to electric power, mainly in rural and remote regions. One impact of this is to hinder social and health services that may affect the possible development trends, especially for the poor, women and children of these regions. The energy and environmental situations within these 3 countries reflect some similarities and share serious common difficulties. These include an almost total dependence in Jordan and Lebanon on imported fuels as the primary energy source, high population growth rates especially in Syria and Jordan, escalating energy demand as the countries strive to develop their economies, and little priorities being given to environmental problems. The large population increases in these countries will put a continuous challenge to meet the associated increase of demand on electricity and sustain access. One way to tackle the access problem on the resource supply side is to raise the efficiencies with which this energy is being generated, delivered and consumed, which could play a vital role in reducing capital investments needed for expansion. Although this would help improve energy access by having a better utilization of resources, the access issue should also be directly tackled at the affordability level through proper legislation insuring the availability of energy at a fair especially price to the poor and less privileged.

2. General Country Profiles

In what follows is a brief highlight of the main population socioeconomic features of the three countries, which have some fair differences in terms of population structures and surface area as shown in Table 1. Jordan has a total area of 89,500 km^2, with a mostly arid desert climate and a rainy season in the west from November to April. At the end of 2002, the population of the kingdom was 5.12 million with a natural growth of about 2.4%, and with 80% of the population living in urban areas. The Syrian Arab Republic (Syria) lies on the eastern coast of the Mediterranean Sea with a total area of 185,518 km^2. Its 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 some rainfall in Damascus. The population of Syria in 2002 was around 17 millions with 2.4% natural growth rate, and at 48% has the highest rural population among the three countries. This relative balance in distribution is at least partially the result of steps taken in the past twenty years to develop services in the Syrian countryside and decrease emigration to cities. Lebanon is a mountainous country located on the eastern shores of the Mediterranean Sea covering an area of 10,452 km^2, with over half of this area being above 1,000 meters altitude. It has a Mediterranean climate having mild wet winters on the coast, heavy snows in the mountains, and with hot summers in general. The population of Lebanon in 2002 was 4.44 millions with 90% residing in urban areas with Beirut housing nearly half of the country's population.

Table 1: Main Population Indicators: Jordan, Syria, and Lebanon in 2002

Country	Total (Millions)	Percent Rural	Population Growth Rate
Jordan	5.12	20	2.4 %
Lebanon	4.44	10	1.5 %
Syria	17.13	48	2.4 %

Source: World Bank [24, 25, 26], [ESCWA, 5]

The main economic indicators and the primary sectors of the economy for the three countries are shown in Table 2. Jordan's economy achieved positive results in 2002 not seen in the past few years, despite the continuing negative effects of the regional and international situation. According to the available national statistics for year 2002, the gross domestic product was US$ 9.23 with an increase of 4.9% compared to 4.2% in 2001. The economic sectors contributing to the GDP are the industry (24.7 %), agriculture (2.1 %), monetary, insurance and other services (73.2 %). The economy in Syria mainly relies on oil production and the export of agricultural products such as cereals, cotton, and fruits, in addition to tourism. The gross domestic product for 2002 is estimated at US$ 17.9 billion with a growth rate of 3.5%. The main economic sectors contributing to the GDP are agriculture (23 %), industry (28 %), and services (49%) consisting of trade (16%), communication and transport (13 %), money and other services (20 %). It should be noted that Syria depends least on the services sector among the three countries, which through a central planning paradigm encouraged the development of agriculture and industry over the past 35 years. The Lebanese economy is an open economy where the services and banking sectors predominate (67 %), the industrial sector constitutes 21%, and the agricultural sector covers the 12 % remaining. In 2002, the GDP was US$ 17.6 billion, and the GDP real growth rate was 1.5%. In the past couple of years, the economy has been facing signs of sluggishness, where the country still awaits the adoption of privatization as means to reduce the heavy debt which estimated at US$ 25 billions.

Table 2: Main Economic Indicators in Jordan, Syria, and Lebanon (2002)

	Jordan	**Lebanon**	**Syria**
GDP (Billion US $)	9.23	17.6	17.9
GDP Growth Rate (%)	4.9	1.5	3.5
GDP /capita (US $)	1,830	3,954	1,045
PPP /capita (US $)	4,293	4,427	3,091
GDP Composition by Sector (%)			
- Agriculture	2.1	12	23
- Industry	24.7	21	28
- Services	73.2	67	49

Source: World Bank [24, 25, 26]

3. Poverty Overview

Social and poverty indicators of Lebanon, Syria, and Jordan are shown in Table 3. Poverty in Lebanon is integrally linked to disparities in economic diversity and activities, in human development levels, and in social structure and living conditions: about 6.3% of the population lives on less than $2/ day and about 18% on less than $3.3/ day, with the richest 14% receiving a 42.7% share of the income; illiteracy rates in the Bekaa valley

and the North are more than double those in Beirut, with illiteracy among women reaching 22.4% and 21.7%, respectively [NEHMEH, 18]. This correlates well with the low income percentages in the Bekaa and North, which are at 7.5% and 8.5%, respectively. The human poverty index for developing countries (HPI-1) measures the proportion of people below a threshold level of human development assumed to be living a long healthy life, having access to education, and a decent standard of living. Lebanon has a HPI-1 of 9.5% and ranks 14 out of 95 developing countries, whereas Jordan, the best performer among the Arab countries, ranks 7 out of 95 developing countries with an HPI-1 of 7.2%. Jordan also has a slightly better distribution of the income than in Lebanon where the poorest 20% of the population receive 7.6% of the income, while the richest 20% have a 44.4% share of the income. Syria has an HPI-1 of 13.7% and ranks 25 among the 95 developing countries, however, no data is available on the distribution of its income. One should note the large difference between the GDP and PPP (Table 2) perhaps due to large subsidies in energy and other basic commodities. Lebanon has the highest percentage of urban population, however all countries have developed poor neighborhoods that are densely populated. In addition, these countries host on their territories millions of Palestinian refugees, from the 1948 and 1967 Middle East wars, who still live in poorly managed camps located around major cities, which puts extreme pressure on the existing poor infrastructure and the environment in general.

Table 3: Poverty and Social Indicators in 2001

	Jordan	**Lebanon**	**Syria**
Poverty (% of population below $2/ day)	7.4	6.3	NA
Life expectancy at birth (years)	70.9	73.5	71.7
Infant mortality (per 1,000 live births)	25.0	26.0	23.0
Child malnutrition (% of children under 5)	5.0	3.0	7.0
Access to an improved water source (% of population)	96.0	100.0	80.0
Illiteracy (% of population age 15+)	9.1	13.5	17.1
Female Illiteracy (% of population age 15+)	14.1	19.0	25.8
Electricity Consumption per Capita (kWh)	1507	2152*	1528
Energy Consumption per Capita (kg of oil equivalent)	993*	1170*	1041*

Source: [UNDP, 21, 22, 23]; * Corrected

According to the 1997 Living Conditions Survey, pockets of poverty are expanding in the urban areas of the Governorate of Amman, lrbid and Zarqa while in more rural governorates of the south in Mafraq, Karak, Balqa and Ma'an, the incidence of poverty is higher. Over 400,000 people –about one Jordanian in ten- live in low-income urban areas consisting of 28 squatter settlements and 13 refugee camps. These areas are characterized by a housing occupancy that is about double the national average. Water and sewerage are inadequate and frequently unsafe, with narrow roads impeding access by ambulances, fire trucks, garbage collection and public transport vehicles. Physical infrastructure serving the rural poor is also deficient, though the dispersed nature of poverty makes it less apparent. This indicates that while poverty has to be addressed in the rural areas, there is an increasing demand for services and social assistance in urban areas. One should note that the social community in rural areas functions as "a safety net" that is missing in urban areas because families and communities are “broken up” [ESCWA, 6].

4. Energy Consumption Profile

Electricity production in Jordan, Lebanon and Syria is still predominantly based on thermal power plants, primarily using fuel and gas oil. Syria has a fair proportion of hydro-electric resources on the Euphrates. Lebanon has several small hydro electric facilities the bulk of which are on the Litani in the Bekaa valley. The tendency to move towards natural gas utilization is increasing due to the economic and environmental benefits of natural gas especially that gas networks are becoming increasingly available in Syria and Jordan. The installed capacities for the year 2001 in Jordan, Syria and Lebanon were 1657 MW, 6804 MW, and 2225 MW, respectively. The total energy consumption and forecast in Jordan, Syria, and Lebanon (Table 4) shows a continuous increase in energy demand in the three countries, which brings up the challenge to find ways to manage this increase.

Table 4: Electric Energy Demand and Forecast (GWh) in Jordan, Syria, and Lebanon

Country	1 995	2 000	2005	2010	2015
Jordan	4 778	5 810	7 596	8 849	10 159
Lebanon	5 484	8 630	10 284	12 512	14 087
Syria	14 661	2 0580	32 843	44 366	59 372

Source: ESCWA [8]

The Primary energy demand level in Jordan reached about 5.29 million TOE in 2002 representing a growth rate of 2.7% compared to 5.6% in 2001. The total primary energy consumption per capita was about 993 kg oil-equivalent (KOE) in 2002 compared to 994 kg in 2001 [ESCWA, 9]. Electric power consumption in Jordan was 6900 million kWh in 2002 compared to 6392 million kWh during 2001, i.e. an annual increase of (7.9%) compared to an increase of (4.2%) during 2001. Correspondingly, the average per capita electricity consumption reached 1585 kWh in 2002 compared to 1507 kWh in 2001. Fig. 1 shows the electric energy consumption in Jordan by sectors in 2001. In 2001, residential electricity consumption in Jordan was 2110 GWh which is 33% of the total electricity consumption in the kingdom [HARB 15].

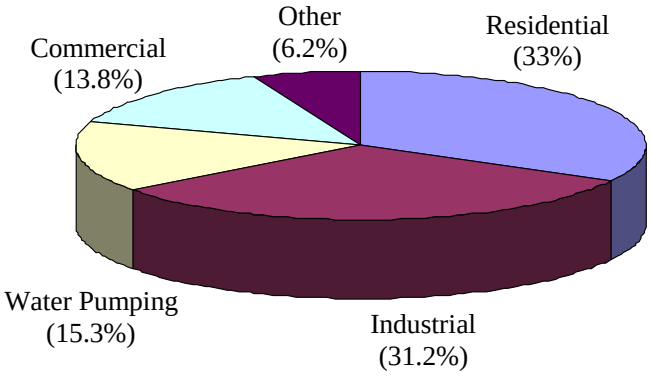

Fig. 1: Electricity consumption in Jordan by different sectors

In Syria the annual crude oil production rate was 26.7 million ton per year at end of 2001. At this rate of production the current known reserves are expected to last about 14 years. Furthermore, natural gas reserves are estimated at 371 billions m^3 and the annual

production was about 7 billions m^3 in 2001 [HAMZEH, 13]. Currently there is a need to import liquefied gas and diesel during dry and cold years since demand increases for agriculture and heating purposes. The primary energy demand in 2002 was about 17,832 thousands TOE, which gives an average per capita consumption of 1041 KOE. The per capita primary energy consumption in the residential sector has kept a fairly steady value of 870 KOE from 1998 to 2002, dipping slightly to 857 in 1999. In 2002, the total installed capacity of electric plants was about 7014 MW. Electric power demand has witnessed high increase rates during the past few years and in 2002, the yearly demand was 28.012 TWh. Studies indicate that strong measures should be taken to increase the efficiency of electric energy utilization, and thus it would be possible, by year 2020, to achieve a 10% decrease in demand [ESCWA, 4]. Figure 2 shows the electric energy consumption in Syria according to the different sectors in 2002 [ESCWA, 8] in which the residential sector consumption was 9668 GWH or 34.5%.

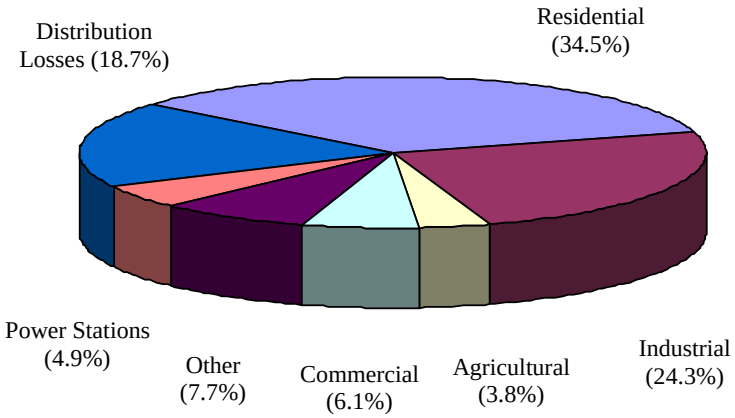

Fig. 2: Electricity consumption in Syria by different sectors

Nearly all energy needs in Lebanon are met with imports of petroleum products. The primary energy consumption in Lebanon in 2000 was 5.19 millions TOE. A large percentage of the primary energy consumed (48.2%) is to supply fuel-oil and gas-oil used almost exclusively by EDL for electricity generation, and the next largest fuel use is gasoline (27.1%) for road transportation, with LPG and kerosene used mainly in the domestic sector (4.8%) for cooking and heating, respectively. In 2001, the total electric energy generated was 9437 GWh and the per capita energy consumption was 2,152 kWh. The distribution of total electric power consumption per sector is shown in Fig. 3 where the residential sector has the highest contribution at 38.5%. Table 5 shows the electric energy production by various sources during 1996-2001 in GWh. The relative stagnation observed in the thermal production of electricity is mainly due to the inability to use the full potential of two combined cycle power station in Beddawi and Zahrani due to weakness in the transmission system which is still awaiting the completion of a 220kV super grid that was delayed by environmental concerns and pressures.

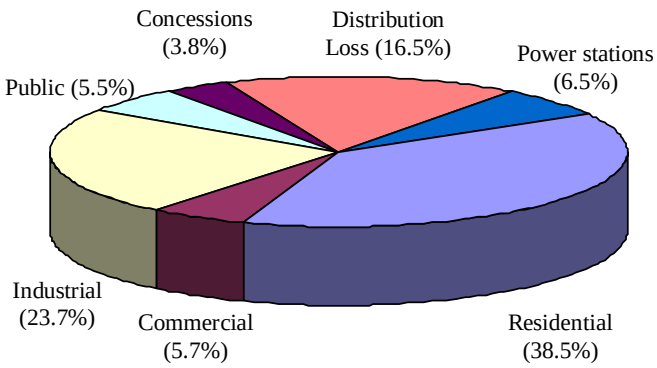

Fig. 3: Electric Energy Consumption in Lebanon by Sector.

Source: [EDL, 11]

Table 5: Electric Energy Demand (GWh) in Lebanon: 1996-2001

Year / Energy Source	1996[a]	1997[a]	1998[a]	1999[a]	2000[*]	2001[b]
Thermal	6171	7618	7555	7858	7850	7841
Hydraulic	799	902	785	332	333	333
Imported from Syria	684	608	654	650	800	1263
Total	7654	9128	8994	8840	8983	9437

Sources: (a) [BDL, 2]; * Estimated; (b) [IEA, 16]

5. Electric Energy Access Profile

The rural electrification project (REP) implemented in Jordan has electrified 99.8% of the counryside in 999 rural villages inhabited by 1,863,000 people. It was financed by adding 2 fils/ kWh on electricity bills of all consumers. Work is ongoing to provide the rest of the Jordanian countryside with electricity. 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. There is a PV village electrification system in remote areas with peak capacities varying from 1 kW to 4.5 kW. Water pumps for Bedouins with capacities varying between 1.4 to 6.3 kW per system have been installed [UNDP, 20].

Table 6: Electricity Tariff (cents/ kWh)* for Residential Consumers

Block Number	**Amount**	**Tariff**
First block	1 - 160 kWh	4.3
Second block	161 - 300 kWh	7.7
Third block	301 - 500 kWh	9.0
Fourth block	above 500 kWh	11.2

* (Calculated at JD 1 = $1.4)

The electricity tariff is constructed to present a low cost to the poor as shown by the tariff of the first block for low income costumers, which is at about half of the cost of production. The range stretches from 4.5 cents to 11.2 cents/ kWh. Other energy forms (i.e., LPG cans) are also widely used in the household sector primarily for cooking and water heating, which are made available in rural areas through a good road network. This is now curbing the use of inefficient biomass stoves, which have negative health effects primarily on housewives and children.

In Syria, there is a general active orientation to develop the countryside socially and economically and decrease emigration to cities, which is reflected in the fact that Syria has the largest rural population among the three countries. A strategy was followed to provide rural areas with electricity reflected in the general increase in the electrification level from 88.2 % in 1997 to 99.5 % in 2002. The main energy resources in rural areas are electricity mainly for lighting, liquefied gas for cooking, and kerosene for water and space heating, in addition to fuel oil which is used for space and water heating. Some families use wood and other biomass products. No solar heaters are domestically used in rural areas due to their relatively high prices. The electric energy requirement of the rural population in the residential sector in Syria is about 564 kWh per annum 70 % of goes to lighting, refrigeration and TV. Table 7 gives the average electricity tariff and the life line tariff up to year 2002. The electricity tariff in Syria is heavily subsidized and is far below those of Jordan and Lebanon. Apparently Syria is subsidizing electricity as a means of making it accessible to rural areas and can afford to do this, for the moment, as it produces its own needs of fuel.

Table 7: Electricity Tariff in Syrian Arab Republic

Indicators	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Average tariff (cents/ kWh)	1.426	1.396	1.367	1.340	1.314	1.673
Lifeline tariff (cents/ kWh)	1.064	1.042	1.02	1.00	0.980	0.962
Lowest tariff class (kWh)	50	50	50	50	50	50

The monthly average expenditure per household is $344 of which only about $6.5 is the expenditure on electricity. This level of subsidy in electric energy and other essential needs is also clearly reflected in the large difference between the GDP and PPP per capita which are at $1224 and $3620, respectively. An Energy Planning and Conservation Project now under way and statistics on renewable energy resources are being collected to help develop wind, solar and biomass resources in addition to increase the utilization of sustainable energy systems. The sizes of the projects involved are still fairly small. For example, a PV pumping system of 3.25 kW is currently used to pump 120 m^3/day of water at 43 m head in Dummar near Damascus. Village electrification using PV cells was demonstrated in 1994 in two villages totaling a peak capacity of 6.35 kW. Additionally, a PV home electrification system of 35 kW peak capacity is used to supply 44 houses in Zarzita near Aleppo and individual stand-alone PV systems are used to supply electricity to 65 houses in certain villages in Aleppo was successfully demonstrated [HAMZEH, 14].

In Lebanon, there are no special plans concerning supplying rural areas with energy as most of these areas have been electrified and also have access to other commercial energy resources, primarily diesel fuel for heating and LPG for cooking. However, the energy bill has become a considerable burden on the economy both at the national and

household levels. Many of the poor in slum-like refugee camps are not paying for their electricity bills thus presenting a burden on the already difficult financial status of EDL which the government seeks to privatize. Non-technical losses, as they are officially called, or plainly thefts, still account to about 23% of electric energy consumed. The figure used to be higher but efforts by EDL to curb it are paying off. At the household level the burden is due to a large use of energy hungry appliances making electricity consumption in the residential sector around 38.5% of total electric energy supplied. The analysis of the electricity structure and consumption for both residential and commercial sectors is based on a study done in 1998 for Lebanon [UNDP, 19]. From this analysis 80% of the total electricity consumption in these sectors is due to electric space heating 31%, electric domestic hot water systems 22%, air conditioning A/C 13%, lighting 8.5% and refrigeration 6%. The high energy cost in the country is putting a burden on low income families that sometimes rely on electricity theft to supply their needs. The tariff currently used by EDL for residential consumers is shown in Table 8. In addition to this layered tariff structure, there is a rehabilitation charge of about $6.7 and a fixed connection charge that ranges from $3 to $20 per month depends on the size the circuit breaker.

Table 8: Tariff currently used by EDL for residential consumers

Consumption fraction (kWh)	0-100	101-300	301-400	401-500	>500
Tariff (cents/ kWh)	2.33	3.67	5.33	8	13.3

6. Case Study

The results of a case study on the affordability of electric energy are provided in Table 9, which calculates the electricity expenditure per household in the three countries and compare it with the average household expenditure. The electricity expenditure is calculated based on the average household electricity consumption from the total consumption in the household or residential sector and the total number of households. The average household expenditure is calculated from basic GDP data and the contribution of the household sector to the GDP. Syria has the lowest household electricity expenditure at $6.5 per month reflecting the high level of subsidy in its tariff structure even at the higher layers. Lebanon has the most expensive bill at $21.7 per month, which still looks affordable when compared with the average household expenditure of $ 1476. Table 10 shows similar results calculated for poor household with an in come of less than $2 per day, which constitute 6.3 and 7.2 % of households in Lebanon and Jordan, respectively. The electricity utilization was assumed to be 50% of the average consumption given in Table 9 and was found to be in line with an estimation based on appliance enumeration approach. In Jordan the monthly bill for the poor is about $5.2, which represents 1.7% of the $300 income of a poor household, whereas in Lebanon it represents about 5% of the household income, which is fairly significant for this level of low income. The tariff structure seems to be well balanced on average, but the addition of fixed charges of about $8 per month creates distortion in the pricing mechanism and presents a heavy burden on a bill with relatively low energy (kWh) usage. For comparison one should note the equivalent price for electricity for the poor in Jordan and Lebanon which can be derived from the given result as $0.043/ kWh and $0.92/ kWh, respectively. It is estimated that the cost of 1 kWh delivered is approximately $0.075/ kWh, which shows that the poor in Lebanon would be paying

higher than the production cost whereas in Jordan he or she would be somewhat subsidized.

Table 9: Affordability Case Study in 2001 for Average Household

	Jordan	Lebanon	Syria
Total Electric Energy (GWh)	7548	9437	26712
Number of Households	855,000	877,000	2,860,000
Household Electric Energy Share (%)	33	38.5	34.5
Household Expenditure ($)	652	1476	344
Household Electric Energy Use (kWh)	243	345	269
Household Electric Energy Expenditure ($)	13.5	23.5	6.5
Electricity Expenditure (%)	2.0	1.5	1.8
Equivalent Price of Electricity ($/ kWh)	0.055	0.068	0.023

Table 10: Affordability Case Study in 2001 for Poor Household

	Jordan	Lebanon	Syria
Household Expenditure ($)	330	330	195
Household Electric Energy Use (kWh)	121	173	134
Household Electric Energy Expenditure ($)	5.2	15.8	3.1
Electricity Expenditure (%)	1.6	4.8	1.6
Equivalent Price of Electricity ($/ kWh)	0.043	0.092	0.023

7. Reforms and Policies in the Electricity Sector

The government in Jordan has restructured and privatized the electricity sector by passing law (No. 64) in 2002. The National Electric Power Company (NEPCO) retained transmission and dispatching, while generation (CEGCO) and distribution (JEPCO, IDECO, and EDCO) were unbundled into separate companies. The objectives are to activate market forces, attract domestic, Arab and foreign investment and strengthen the local capital market by directing private savings into long term investments [ABDULLA ET AL, 1]. Development in the electricity sector concentrate on planning to cover local demand of electrical energy through long term contracts, installation of new generation plants, and implementation of strategic projects like the Arab electric interconnection project and the oil and gas pipelines, while taking into consideration the growth in population and the growth rates in the different sectors of the national economy. At present, the electricity tariff is based on economic yet observes a social dimension by providing a low tariff (31 fils/ kWh) for the first 160 kWh for household use. A similarly low tariff (38 fils/ kWh) is also available for small industries. The actual cost of production is estimated to be in the region of 60 fils/ kWh (9 cents/ kWh), which is essentially the tariff in the 3rd block and the tariff practiced for commercial customers and hotels.

In Syria, current plans aim at increasing the efficiency of energy production by increasing the contribution of natural gas in electricity generation to 51.5% in 2002, and by expanding the use of the more efficient combined cycle technology in generation plants. The production and utilization of energy resources play an important role in the economy as 75% of export revenues come from the export of oil products. With the large population growth and the increase in the standard of living in cities and rural areas and

the industrial development, there is a growing demand on energy resources requiring larger investments, thus presenting an increased burden on the national economy. Due to the limitation in energy and financial resources available, there is a strong urge to increase the utilization efficiency both at the end-use and supply sides and diversification of energy resources. The increase in efficiency and the diversification (e.g. use of solar water heaters) will have a net effect of having more electric energy available for wider a section of the population. To that extent, electric energy demand forecasts have been done until 2020 with plans to increase the utilization efficiency at the consumer level aiming to decrease the electric energy consumption by about 10%. It is worthwhile to note that there are still no concrete plans to reform the electricity sector in Syria, which will most likely remain under government ownership for the next 10 years [ESCWA, 4].

In Lebanon, the rehabilitation program permitted the restoration of a supply capacity of around 1800 MW primarily limited by the 150/66 kV transmission and distribution system while the generating capacity is about 2300 MW. So even though the electrification level is nearly 100%, the Lebanese electric power system still suffers in peak demand periods from fairly rigorous load sheds with poor areas suffering most. The existing infrastructure is being further expanded to face the continuous increase in demand by building a 220 kV super grid, reinforcing the distribution network, providing new generating capacity, and by implementing administrative reforms and improving technical assistance. EDL has been regaining control over its operations and steps are being taken to address billing and collection weaknesses as well as curbing non-technical losses. The EDL system is now interconnected with the Syrian system through two 220/ 400 kV overhead lines with an overall capacity of 400MW. In an effort to improve the fuel availability at the combined cycle (CC) Beddawi power plant (415 MW) in the north of Lebanon, a 45 km gas pipeline with a supply capacity of 1.5 million m^3 per day is about to be completed (GASYLE-I). In the second phase of this project the second CC power plant at Zahrani (415 MW) will be connected to the Jordan-Egypt-Syria gas pipeline in 2005. The contribution of renewable energy to the Lebanese energy needs comes mainly from hydropower, with a minor contribution from wood, charcoal and solar energy for the production of hot water. Solar water heating has so far had limited usage in the residential sector and is much lower than the levels found in Jordan or Syria, but the trend is picking up [ESCWA, 9].

To encourage greater private sector participation in the economy, the Government with support from the World Bank initiated the Power Sector Restructuring and Transmission Expansion Project which calls for the implementation of a set of sector-wide structuring and reform actions designed to introduce competition and private sector participation in utility operations and to reorganize EDL. To that end, a draft law to privatize generation and distribution but keep transmission under EDL control was prepared by the government and is currently awaiting discussion in the Lebanese Parliament.

An Energy Conservation Center in Lebanon is under development at present as a cooperation effort between UNDP and the Ministry of Energy Its main objective is to identify the major barriers preventing the widespread implementation of both renewable energy and energy efficient measures. It will help the Lebanese government in adopting policies and measures to achieve energy conservation targets and in promoting energy

efficiency and enhancing public awareness. Also a Lebanese Thermal Building Standard is being developed to set requirements to minimize the use of energy in new buildings while maintaining comfort and productivity of the occupants [MPW, 17], which would promote a more efficient utilization of electric energy and extend the access associated to available electricity resources.

8. Research and Development in Energy

Research and development in the energy sector should aim to achieve energy supply sustainability for future generations and protect the environment. Research and development should focus on finding local energy sources like wind and solar in Jordan and Syria who have large uninhabited land areas suitable for such developments. Hydro-electric resources in Syria and Lebanon, and to a lesser extent in Jordan, have a potential of supplying a fair proportion of the electric energy required in the future. All this would require additional investment that can only be supplied by giving the private sector confidence through proper legislation. The implementation of strategic projects like the electric interconnection project [BADAWI, 7] and the oil and gas pipelines has the potential to increase the energy access as it will be made available at lower prices through long-term contracts. However such interconnection should be made operational through treaties among the various countries to set the stage for an efficient exchange of energy.

Improving energy access through renewable energy need not be far fetched and high-tech as has been demonstrated by the use of domestic solar water heaters (DSWH) in Jordan and to a lesser extent in Syria. For example, in Jordan and Syria, the installed DSWH are estimated to be 200,000 and 20,000 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 [ESCWA, 10]. The electric energy saved by one unit, as compared to using electric heaters, is estimated at 2000 kWh/ year [UNDP, 19]. Therefore for Jordan these DSWH are replacing about 400 GWh of electricity, which for Lebanon would represent about 120% of its hydroelectric energy generated in 2001. Using a load factor of 62% typical of the region, this energy represents a reduction in the peak demand by about 73.5 MW, which for peaking capacity ($350/ kW) would cost approximately $25.7 millions, not including fuel. This compares very favorably with the cost of 200,000 DSWH units which would be about $16 millions! There would be enough money to provide financial incentives to customers to build DSWH, which for the existing generation capacity would free an equivalent amount of electric power for other usage and hence help improve access in the overall balance.

PV technologies are not widely spread in Arabic countries (AC) due to many reasons including their high capital costs and the low level of awareness about their value. 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 peak capacity of demonstrated PV systems is around 80 kW used for water pumping and in some pilot scientific cooperation projects

for desalination as well as for supplying electricity to houses in remote villages. PV power is also demonstrated in Jordan for a peak capacity of about 184 kW [CHEDID & CHAABAN, 3]. 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 [EL-FADEL ET AL, 12].

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 water pumping, and electricity generation. A 320 kW grid connected Danish wind energy plant was installed in 1988 with annual energy production of about 0.75 GWh. Also the Hofa wind farm consists of five 225kW turbines producing an average annual energy about 2.5 GWh. 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 [ABDULLA ET AL, 1]. In Syria, A 150 kW grid connected wind turbine was set up in 1994 at Quneitra south of Syria producing 0.300 GWh per year. There are also stand-alone wind systems installed in Syria for battery charging, water pumping and defrosting (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 per year [HAMZEH, 14].

Biomass activities in Jordan 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 that produced 5.4 GWh of electricity in 2002, which is equivalent to 1770 tons of Diesel fuel estimated to cost JD 247,660. 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 [ESCWA, 10]. 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.

9. Concluding Remarks

Jordan and Lebanon rely heavily on imported oil products to develop their economies, whereas Syria is endowed with a fair amount of fuel oil and natural gas to meet its needs for development. Although there are differences in the per capita energy

consumption of electric energy, but such differences are not radical and are in general well correlated with the per capita gross national product. All countries have carried rural electrification projects that are providing electrification levels higher than 99.5%. Electricity tariffs in all countries are currently based on economic and social considerations, with a fixed connection charge in Lebanon to cover rehabilitation and capacity charge to some extent. Electricity reform acts have been implemented or are being studied; Jordan has unbundled its generation and distribution functions but real trading and competition does not yet exists on the system, while Lebanon is moving towards privatization with the help of studies financed by the World Bank and the UNDP. The present access to electric energy seems satisfactory as high electrification levels have been achieved in the three countries and the bill for electric energy is a small percentage of household expenditure on average. Jordan appears to have a good tariff structure in terms of energy access to the poor as it conserves the small percentage without being overly subsidizing in the global utilization picture. The challenge to energy access in the future is likely to come from failing to meet the rapid increase in electric energy demand, which may increase the likelihood of load shedding. Affordability of electric energy by the poor should be properly addressed through an appropriate tariff study prior to the implementation of the draft law to reform the electricity sector in Lebanon. On the supply side the trend is to move towards more utilization of natural gas as it becomes more available through the Egypt-Jordan-Syria pipeline due for completion in 2005. Consequently, more power generation will be taken from combined cycle rather than steam due to the availability of natural gas and the higher efficiency of CC technology. The electric power interconnection project between Egypt, Jordan, Syria, Iraq, Turkey and Lebanon, is an effective means of increasing the efficiency and reliability of the electric supply system at lower level of investment to help sustain the access to electric energy. Energy efficiency and conservation measures are being legislated for and implemented on the demand side to make better utilization of existing resources and improve access. The development of renewable energy resources for domestic solar water heaters (DSWH) in Jordan is noteworthy as 25% of households are equipped with DSWH and to a lesser extent in Syria. There is tremendous expertise and know how in Egypt and Jordan in the field of renewable energy which should be disseminated to other AC in order to focus on how to reduce the huge investments needed in the energy sector to improve sustainability in energy utilization and development.

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