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ENERGY POLICY ASSESSMENT – LEBANON

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Contents

1. Overview

Lebanon has embarked on the path of sustainable energy since the commitment launched in Copenhagen in 2009 by the Lebanese Government to develop renewable energy (RE). That famous commitment, well defined in the 2010 Ministry of Energy and Water (MEW) policy paper for the electricity sector, has become a source of challenge and pride for the country, a real challenge to all concerned parties to reach the target by 2020 and a real pride because this commitment has boosted sustainable energy development in Lebanon to a high priority level.

The first RE power plant in Lebanon was installed back in 1924 using the hydroelectric power. The Bécharé Plant was built under the French mandate and it is still operational today - though partially.

2. Energy Situation

The average available electricity production capacity (including imports) was 1,500 megawatts (MW) while the average demand was 2,000 – 2,100 MW. The instantaneous peak demand in the summer of 2009 was estimated at 2,450 MW. The total energy demand in 2009 was 15,000 gigawatt-hours (GWh) although the total produced energy (including imports) was 11,522 GWh. Accordingly, the electric energy deficit in Lebanon was estimated to be 3,478 GWh. [1].

In Lebanon, electricity is basically generated from thermal and hydroelectric power plants. Approximately 7.5% of the total electricity production in 2009 was purchased from Syria (589 GWh) and Egypt (527 GWh) through regional interconnections. In addition to the deficit in electricity supply, the Lebanese electricity sector was facing several problems such as load shedding, technical losses and the aging of power plants. This situation resulted in technical and financial impacts on customers, the government and the entire economy. The Lebanese end-users were forced to rely on diesel generators to overcome the electricity shortages [2].

The country’s primary energy imports cover essentially the following types of oil products: liquid gas, gasoline, gas oil, fuel oil, kerosene and asphalt. Fuel oil is actually used by two main consumers, Electricité du Liban (EDL) and the local market. A considerable share of the fuel oil and gas oil imported goes to EDL, while another minor quantity goes to the local market (mainly used in industries). Liquid gas, gasoline, kerosene and asphalt go directly to the local market as shown in figure 1 [2].

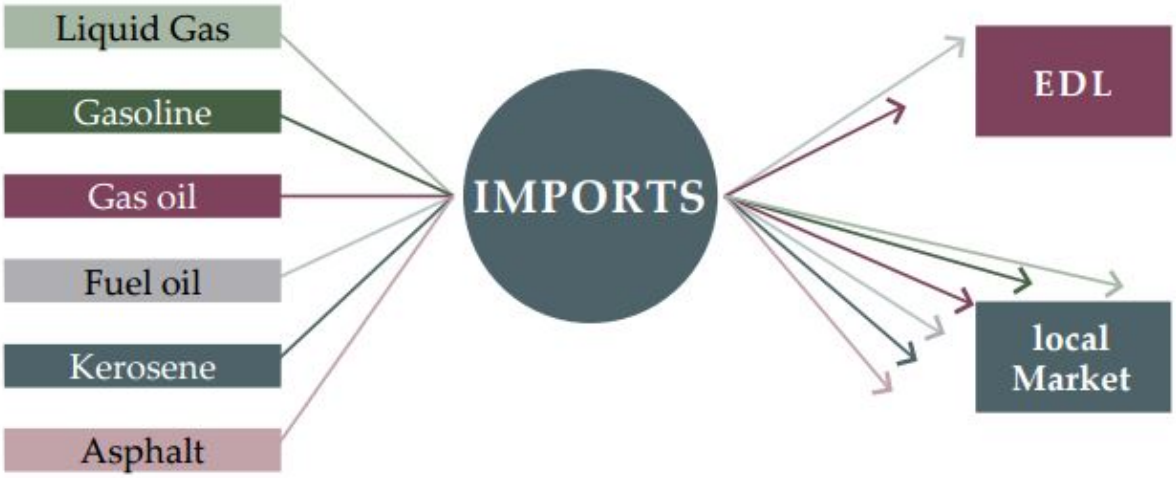

Figure 1: Flow of oil products in Lebanon market

Figure 2 shows the yearly distribution of oil imports as measured in toe. From this graph, it can be clearly seen that gasoline, gas oil and fuel oil have the major shares. The large quantity of gasoline is due to the large number of vehicles in Lebanon using this type of fuel. On the other hand, fuel oil and gas oil are the essential sources of the major power plants of the country.

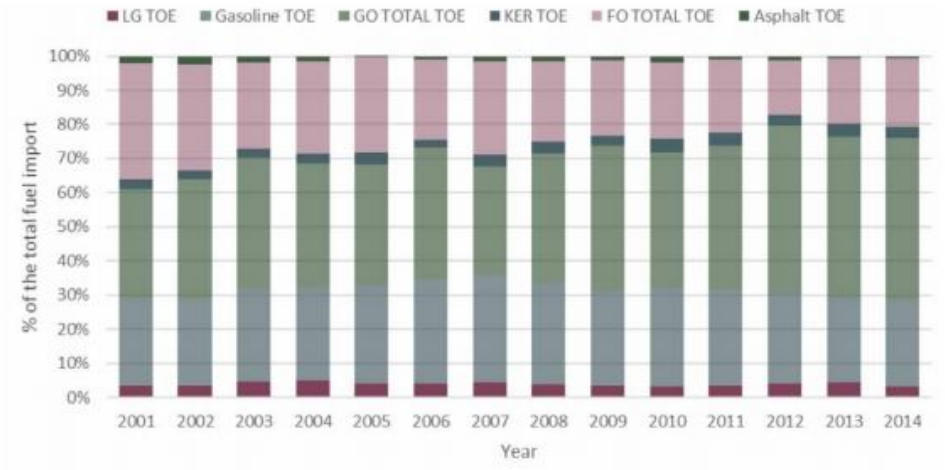

Figure 2: Shares of oil products imported between years 2001 and 2014

During the 2010 baseline year, the total fuel imports (liquid gas, gasoline, gas oil, fuel oil, kerosene and asphalt) amounted to approximately 5,768 ktoe (5,768,269.94 toe); these are consumed in different sectors in Lebanon.

On the other hand, electricity imports from both Syria and Egypt amounted to approximately 1,248,871 MWh (equivalent to 107,403 toe), whereas hydroelectricity produced by the different hydro power plants on the Lebanese territory amounted to approximately 836,537 MWh (equivalent to 180,909 toe). Furthermore, the amount of energy produced by solar water heaters installations amounted to approximately 12,719 toe [2].

Accordingly, the primary energy mix in Lebanon for the baseline year can be summarized as shown in Figure 3. As per Figure 5, the total consumption in 2010 amounts to 6,069,301 toe, out of which 96.8% were imported from outside Lebanon and the remaining (3.2% from hydro and SWH) was locally produced.

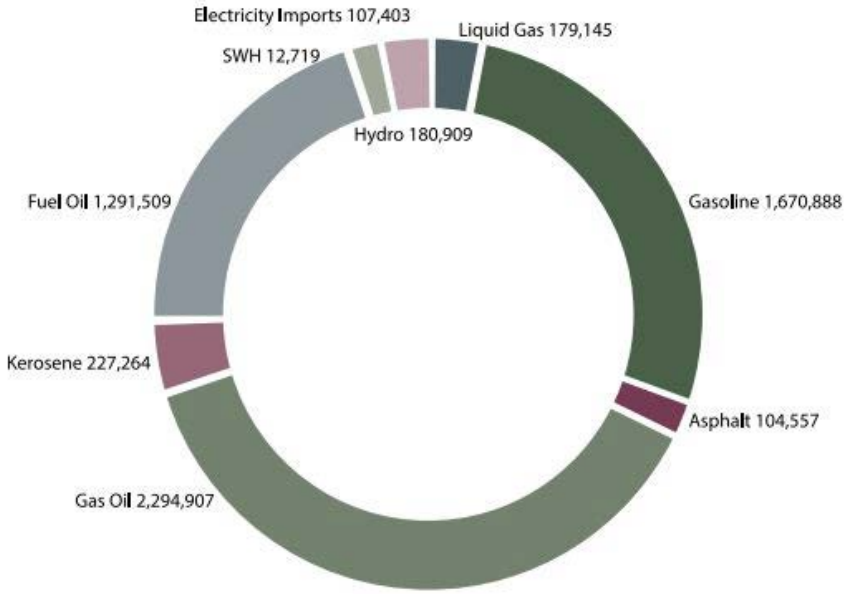

Figure 3: Primary energy mix in 2010 in Lebanon (toe)

Power outages are a daily occurrence in Lebanon. The demand for electricity exceeds the power supply capability of Electricité du Liban (EDL). The demand for electricity in Lebanon is likely to reach over 4,000 MW by 2015, which would correspond to a capacity increase of at least 1,500 MW. Since the realization of the two combined cycle power plants Zahrani & Beddawi (commissioned in 1998), no new power plant has been added to cover the electricity demand. Moreover, since 1996, the electricity tariffs in Lebanon have not been effectively adjusted to cover the cost of power generation. The overall average tariff for 2006, based on billed energy, was LBP 141/kWh ($c9.4/ kWh) and remains unchanged today. The current tariff is based on an outdated oil price of $25/barrel, meaning it has not been adjusted to take into consideration the increase in national oil prices and inflation since then. Consequently, the present selling tariff is too low to cover the electricity generation costs, which are currently at least $c19/kWh on average. [3].

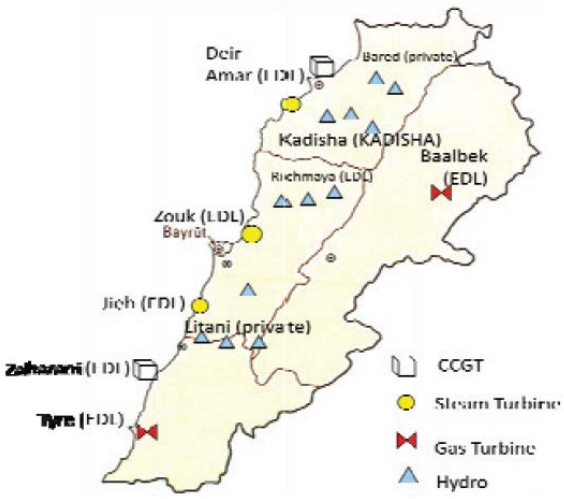

Figure 4: Power plants in Lebanon

Currently, power generation plants in Lebanon are divided into two categories: thermal and hydraulic. EDL operates 6 thermal power plants as follows:

- Two combined cycle gas turbine plants (CCGT), Deir-Ammar and Zahrani that are designed to operate using natural gas; these two plants are using gas oil/diesel instead [AZ OROM 2007]
- Two steam turbine plants, Zouk and Jieh, which operate using heavy fuel oil (HFO) [AZOROM 2007]
- Two open cycle gas turbine plants, Baalbek and Tyre, which are designed to operate using natural gas; they are using gas oil/diesel instead [AZ OROM 2007]

Furthermore, there is a steam turbine power plant, Al-hreesha, which is owned by Kadisha (Property Company of EDL) and uses HFO. The total installed capacity of these thermal power plants is 2038M W.

The hydraulic power plants are divided into Litani (public company), Al-Bared and Ibrahim (private companies) and Kadisha (property company of EDL) power plants. These hydro-power plants have a total installed capacity of 273.6 MW.

Figure 4 shows the evolution of electricity production according to the energy source between 1974 and 2010. It is noticed that hydraulic power plants have a small contribution to the total electrical production. Moreover, it could be noticed that both thermal and hydraulic power plants do not have fixed electrical production and change from one year to another [4].

3. Renewable energy & energy efficiency potentials

Lebanon has a Mediterranean climate characterized by long, hot, dry summers and short, cool, rainy winters. Moreover, Lebanon is a mostly mountainous country, east and west, separated by the fertile Beqaa Valley and a narrow coastal strip of land fronts the Mediterranean Sea. This climate and its special nature give Lebanon high potentials in renewable energy resources as the following:

3.1. Solar energy

Its location on the World Solar belt as shown in Figure 5 in addition to its moderate climate, make Lebanon one of the most efficient places for using the solar photovoltaic energy (PV) and solar water heaters. Lebanon is characterized by a high potential of solar energy with an overall daily average of 4.8kWh/day and annual average of 3,000 hours of solar radiation

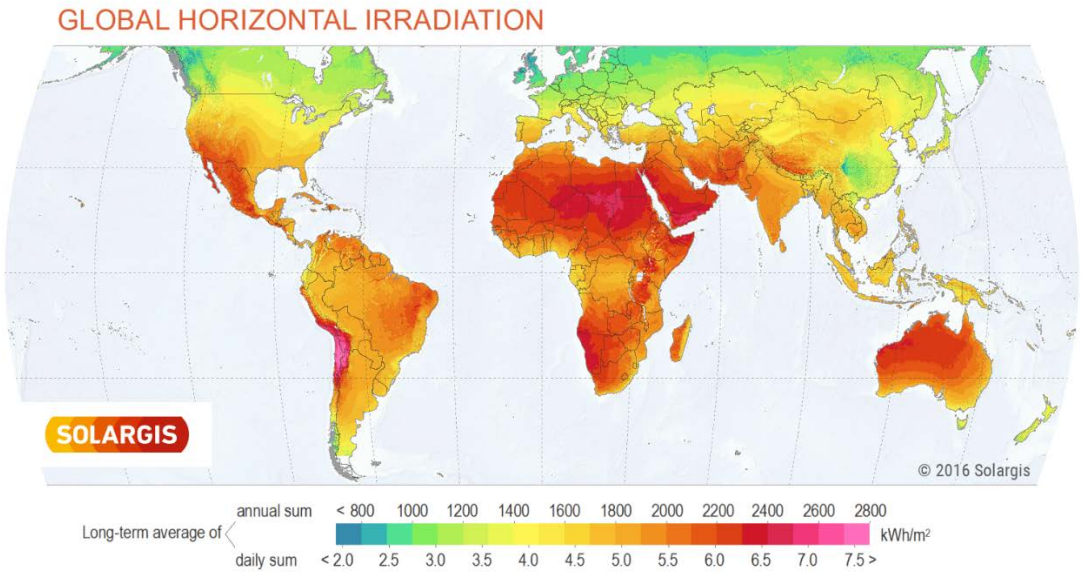

Figure 5 : World solar map [5]

Practically, all the Lebanese territories are suitable for solar PV power production and other solar energy uses and applications.

3.2. Wind energy

The pretty mountains and the nice shore of Lebanon have another advantage of the high wind speed. The United Nations Development Programme (the "Client") has requested that Garrad Hassan and Partners Ltd ("GH") provide consultancy services for the Republic of Lebanon ("Lebanon"). The Client has instructed GH to carry out mesoscale and microscale modelling for the entire Republic of Lebanon to produce a wind map with a resolution of 100 m. The results of this modelling work are reported in the National Wind Atlas for Lebanon.

GH has utilized the wind map derived here along with considerations of other constraints on wind power development to derive a figure for the potential installed wind capacity for Lebanon.

In order to calculate the potential wind power capacity, a number of high-level assumptions are required. The values that GH has assumed are considered to be reasonable universal assumptions and are listed hereunder:

- A wind speed of greater than 6.5 m/s at 80 m above ground level has been considered necessary for a viable wind farm;
- An installation density of 8 MW/km^2.

It must be noted that GH has pragmatically applied these assumptions in order to produce the value displayed below, however the actual value may vary due to a wide range of factors. Based on the described assumptions above the potential onshore wind power capacity of Lebanon is 6.1 GW.

To illustrate the sensitivity of this capacity to the key inputs, if GH considers the perturbation analysis described in Section 5.4, the impact of reducing all wind speeds by 10 % would result in a potential wind power capacity of 2.5 GW. If all wind speeds were increased by 10 %, the potential capacity would be 12.0 GW. Furthermore, if the maximum slope constant is altered to be 8 degrees, the potential capacity would be reduced to 3.8 GW. If this reduced maximum slope is combined with the minus 10 % perturbation case, the resulting potential capacity is reduced to 1.5GW [6].

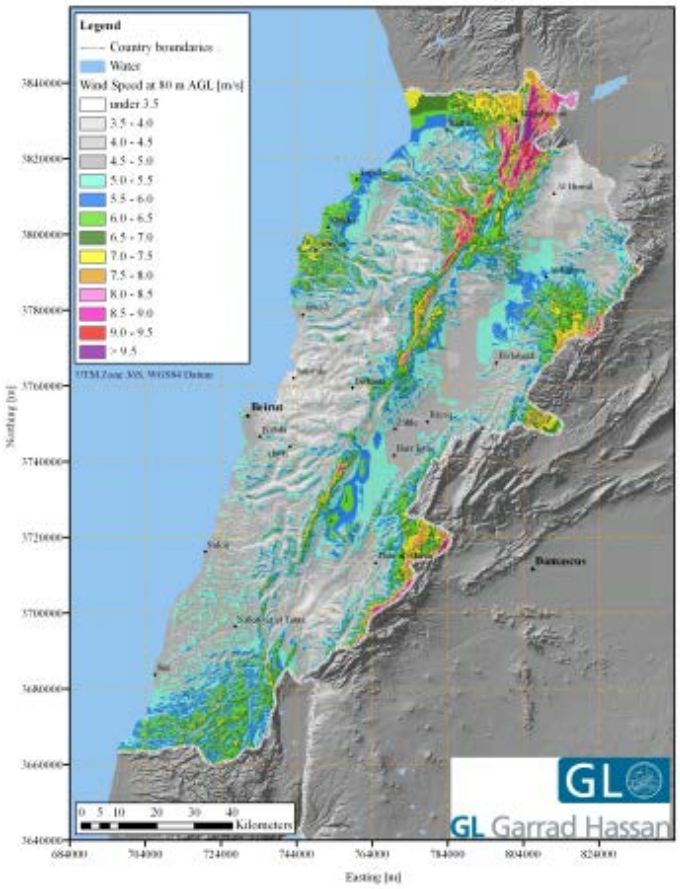

Figure 6: Wind map for Lebanon at 80m

3.3. Hydropower

In Lebanon, hydropower capacity is approximately 282 MW, representing 8.7% of total nationally produced power in Lebanon. This exchange focuses on hydropower prospects in Lebanon and identifies its importance to the future of Lebanon's security of supply.

Figure 7: Lebanon River Map

The Lebanese Government plans to use further potential sources for electricity generation, anywhere they are technically and economically feasible, particularly focusing on renewable energy sources. The potential of generating micro-to-small hydropower from non-river based water sources, is mainly [3]:

3.3.1. Irrigational channels and conveyers

The primary function of this source is irrigation, which needs to be maintained at the required minimum pressure and flow. The production of electricity is only ranked second and must not undermine the primary function in any way. The hydropower plant has to be designed in a way to make optimum use of available head and flow at different irrigation regimes.

3.3.2. Wastewater treatment plants inlet and outfall pipes

There are two possibilities for using the hydropower potential in such systems:

- Install a turbine at the inlet of the wastewater treatment plant, using untreated wastewater.
- Use the potential of treated wastewater before it is returned into the receiving water.

3.3.3. Thermal power plants' outfall pipes

Large thermal power plants require significant amounts of cooling water. Cooling water is normally taken from the sea, pumped to a heat exchanger and returned via the outfall pipes to the sea. The available hydropower potential depends on the specific situation / topography at the respective thermal power plant. For example, a turbine can be installed at the outlet of the discharge cooling water system at a thermal power plant.

3.3.4. Potable water distribution networks

The primary function of these systems is to supply potable water to the consumers at a specified supply pressure. Where there is a need for pressure reduction, the excess pressure can be used to drive a hydroelectric system. There are different possibilities to produce electricity within drinking water systems. One concept is to install a turbine at the entrance of the reservoir or the storage tank at the water distributing station. Another option is to install it within the supply networks. In that case, normally a certain residual pressure - as required for the distribution network - has to be maintained.

3.4. Bio energy

Lebanon has a relatively abundant availability of bioenergy resources as approximately one third of the country's land is arable, with the most fertile areas being located along the coastal strip and in the Beqaa valley [7].

Potential resource for energy production have been identified and fully characterized. These streams have been grouped according their source of origin in:

- Forestry
- Wood and paper industries
- Agriculture
- Energy crops
- Food processing industry
- Municipal solid waste and non-hazardous industrial waste

3.5. Energy efficiency

In Lebanon, the existing energy efficiency initiatives mainly concern energy audits, the labelling of refrigerators, thermal standards for new buildings, compact fluorescent lamps (CFL) and street lighting programs [8].

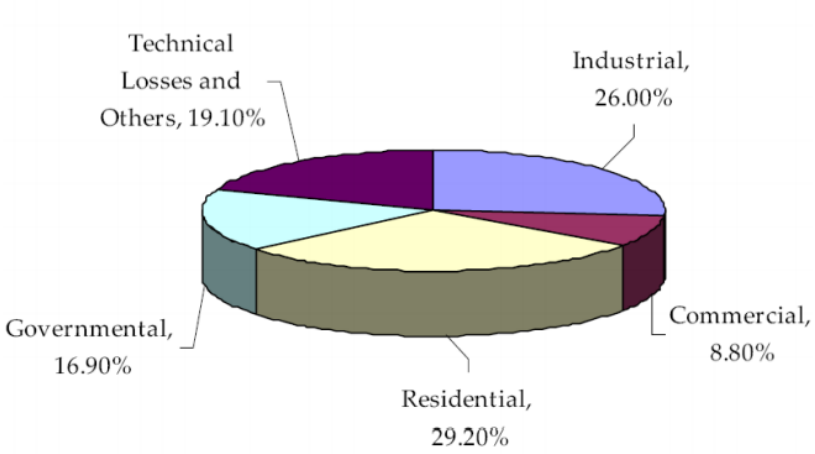

Figure 8: Electrical consumption per sector

The breakdown of the electricity generated by EDL by sector is presented in the following figure, where the residential sector takes the lead with 29.2%, followed by the industrial sector with 26%, the commercial sector with 8.8%, the government sector with 16.1% and the technical losses and others, which represent about 19.1% as shown in figure 8.

The most recent data available on the electrical energy consumption per end use in the residential and commercial sectors show a relatively high consumption of heating, which reflects the increased demand for electricity during the winter when compared to the demand in the summer as reflected in the load curves in Figure 9.

Unfortunately, the lack of comprehensive data on the total energy consumption per end use constitutes a significant barrier for a sector analysis. Without detailed information on the energy consumption per sector, the potential for possible energy efficiency programs and their impacts on the load curves cannot be assessed.

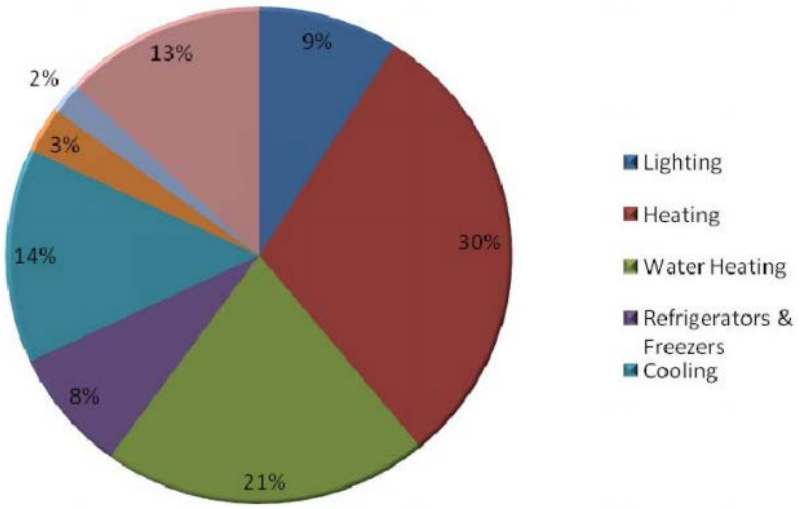

Figure 9: Electrical consumption per end use in the commercial and residential sectors

4. Policies and strategies:

In Lebanon, electricity is basically generated from thermal and hydroelectric power plants. Approximately 7.5% of the total electricity production in 2009 was purchased from Syria (589 GWh) and Egypt (527 GWh) through regional interconnections. In addition to the deficit in electricity supply, the Lebanese electricity sector was facing several problems such as load shedding, technical losses and the aging of power plants. This situation resulted in technical and financial impacts on customers, the government and the entire economy. The Lebanese end-users were forced to rely on diesel generators to overcome the electricity shortages.

To overcome all these problems, MEW published a comprehensive energy policy (the 2010 Policy Paper for the Electricity Sector) that was approved by the Council of Ministers (COM) on June 21, 2010. In addition to proposing a strategic solution to the electricity sector in Lebanon, the policy paper also built on the 12% commitment of RE to propose some future milestones. The year 2010 is then considered the turning point in the development of the electricity sector and, more specifically, RE in Lebanon. [2].

The policy paper for the electricity sector covers all the aspects of the energy sector in Lebanon and includes 10 initiatives, 3 of which are dedicated to EE and RE grouped as follows: infrastructure (generation, transmission and distribution), supply and demand (fuel sourcing, RE, demand side management/EE and tariffs) and legal framework [norms and standards, corporatization of Electricité du Liban (EDL) and legal status].

In terms of RE, the policy paper focused on the development of hydropower, wind energy, solar photovoltaic (PV) applications, solar water heaters and waste-to-energy. The policy paper for the electricity sector has set the strategic path for the development of RE in Lebanon

4.1. Policy of Institutional Key Players

The Lebanese Center for Energy Conservation (LCEC):

LCEC is the national energy agency in charge of energy efficiency and renewable energy (EE and RE) matters in Lebanon. LCEC has succeeded in establishing itself as a focal point for energy conservation issues within the Lebanese Ministry of Energy and Water (MEW).

LCEC has been in operation since 2002 and more actively, since 2005, on a project basis finance by the Global Environment Facility (GEF) and the Ministry of Energy Water (MEW) in addition to other bilateral donors and under the management of UNDP.

LCEC developed energy efficiency standards and labels for some household appliances (in cooperation with Libnor and IRI), helped in the creation and support of Energy Services Companies (ESCOs) which were able to conduct LCEC-funded energy audits for companies and institutions. As a matter of fact, LCEC supervised more than 100 audits for major sites like the Beirut International Airport, Casino du Liban and Hôtel Dieu de France. LCEC also helped in the installation of solar panels donated by different international funds.

On the communications front, LCEC launched a multitude of awareness campaigns, namely "some turn-offs do save", "don't burn your money to heat water, solar energy is for free" and "save the energy and keep the light"; in addition to tactical campaigns targeting industries, universities, school students, and many others.

LCEC established successful partnerships with MEW, Electricité du Liban (EDL) and local power companies, the Industrial Research Institute (IRI), the Council for Development and Reconstruction (CDR) and the Order of Engineers and Architects in Beirut (OEA). Lately, LCEC and Kafalat signed a cooperation agreement to provide interest rate subsidies for energy efficiency projects.

LCEC is the official representative of Lebanon in the Mediterranean Association of the National Agencies for Energy Conservation (MEDENER). It is also a founding member representing Lebanon in the Regional Center for Energy Conservation and Renewable Energy (RCREEE). LCEC is the national focal point for different EU-funded projects like MED-ENEC and MED-EMIP. LCEC is building a solid platform to become the national counterpart for the upcoming Mediterranean Solar Plan (MSP).
The role of LCEC is growing with extended responsibilities for energy audits, financial incentive schemes, standards and labelling, promoting the use of renewable energy, national energy database and the promotion of the Clean Development Mechanism (CDM) for carbon off-sets.

Électricité Du Liban (EDL):

EDL produces, transmits and distributes electricity through seven thermal power plants and three hydraulic power plants. It is a public establishment with an industrial and commercial vocation. Its role would be to help in the implementation of all EE programs. EDL will guarantee the recovery of credit through its electricity bills. EDL will collaborate with LCEC in conducting

various surveys. Those surveys will be performed by EDL personnel when collecting the payments of electricity bills.

Ministry of Environment (MoE)

The MoE was established in 1993 (Law 216/93) and reformed late in 2005 (Law 690/2005) to empower its mandate to preserve the environment and strengthen decentralization. Its general duties are to formulate general environmental policies and to propose measures for its implementation in coordination with various concerned government administrations, to protect the natural and manmade environments in the interests of public health and welfare and to fight pollution by taking preventive and remedial actions. The MoE's role would be to set the emission reductions objectives by promoting efficient technologies and supporting EE project financing through the Environment Fund.

Ministry of Energy and Water (MEW)

MEW is a governmental department in charge of water and energy resources policy and management. It controls 21 Lebanese water authorities and semi-autonomous public institutions in charge of providing potable water. In May 2000, a government decree merged the authorities into four larger public establishments. The MEW, through the Energy Department and LECEP, drives all activities related to RE and EE project implementation and awareness campaigns.

4.2. Renewable energy strategy

The government of Lebanon aims to have 12% of its total energy needs from renewable energy sources (RES) by 2020. This means roughly, the production of 1800 GWh of electricity coming from renewable energy sources by 2020 - if this entire objective is met through electricity-supplying sources only [1].

In terms of set numbers, our main target is to implement RE projects that would actually produce approximately 767 kilotons of oil equivalent (ktoe) in 2020, equivalent to 12% of the projected total electricity and heating demand in Lebanon during that year. MEW is aware that this target is challenging, but we are also confident that aligning the efforts of all national players and international allies would lead to achieving this target.

Three main paths need to be developed in order to reach this 12% target. Wind energy for electricity production would represent one major milestone with a projected share of 2.06% of the total Lebanese demand for energy in 2020. Solar energy-including solar photovoltaic (PV) concentrated solar power (CSP) and solar water heaters-would be another important milestone with around 4.20%. Furthermore, benefitting from hydro resources for electricity production would be essential with a percentage of around 3.24%. Finally, biomass would cover around 2.50% [2].

4.3. What has been achieved

What has been archived can be summarized in the table below:

Year	2010 (Base Line)	2015	2020
Total heating and electricity demand	3,438 (Actual)	4,822 (Actual)	6,389 (Foreseen)
Total national renewable energy production (in ktoe)	193.72 (Actual)	239.2 (Actual)	767 (Set Target)
Share of renewable energy production of the total energy production (%)	5.63% (Actual)	5.12% (Actual)	12% (Set Target)

4.4. Identified barriers

In spite of the efforts to improve the situation in the energy sector in Lebanon, the sector is still suffering from a lack of generation capacities and shortages in the delivery of electricity.

The main barriers encountered in improving the energy status in Lebanon are listed below:

- Lack of regulations and standards that controls the renewable energy such as feed-in tariff and net metering in addition to the standards that control the renewable energy and energy efficiency system components and their specifications.
- The electricity grid infrastructure & the availability of a grid that renders some Renewable Energy projects unfeasible.
- The registered/not registers investors who invested in power generation companies and are resisting and opposing improvements to retain their own interests and businesses.
- Lack of money and funds for such projects.
- Lack of data for the end users which leads to making a lot of the assumptions.

References

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