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POLICY AGENDA FOR ENHANCED RENEWABLE ENERGY (RE) AND HYBRID SYSTEM IMPLEMENTATION in LEBANON

i Current Situation Analysis

i.1. National Energy Policy

Lebanon is a country without fossil energy. Some prospecting revealed the existence of oil fields in western Beqa'a as well as offshore along the northern coast, but their exploitation, within the actual context of international oil market, is onerous and not very competitive.

On the other hand, Lebanon has some waterways and suitable sites that allowed it to place, at different levels, many hydraulic plants (about 15 with 280 MW rated power). Lebanon is in close proximity to oil producing states and maintains a privileged relationship with them. The country hosts pipelines from Iraq and Saudi Arabia and is home to two refineries (one in Tripoli, another in Zahrani in southern Lebanon), neither of which is currently operating. In the same context, we must stress that Lebanon is almost totally electrified and the electrification rate is one of the highest in the area (>95%).

The institutional entity in charge of the energy sector is the Ministry of Energy and Water (MEW), which issues import licenses for carbohydrates to private firms (22 companies), establishes fuel specifications, fixes their prices, controls their quality and provides stocking and distribution security.

For several years, the MEW has been importing the fuel allotted for Electricité du Liban (EDL), which MEW oversees. EDL is an autonomous office with a monopoly on power production, transportation and distribution.

The demonstrated priority of successive governments since the end of hostilities in 1990 has been rehabilitation of the energy sector, hard-hit by 15 years of war, then on expansion of the energy sector to satisfy the increasing energy demand (mean annual growth rate = 8% 1990-2004). A guaranteed secure and stable supply of energy is an essential condition for national economic growth. This necessary energy sector rehabilitation and expansion has cost more than 1.5 billion U.S dollars.

Moreover, the energy policy implemented used fixed rates based on relatively low prices (so-called" social prices"), which inhibited the expansion of energy saving programs and failed to discourage users from wasting energy.

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It should be stressed that EDL reports chronic financial losses (more than 5 billion USD at the end of 2005) due to non-technical losses estimated at 40%, payments arrears and a tariff policy that does not reflect the real production cost. (Electric power billing is done in bands of 100 kWh. The first three bands are billed at prices lower than the marginal cost of electric current production.)

The energy sector structure remains unchanged: almost 99% of our primary energy needs are imported. Most of these imports are oil by-products.

Renewables (solar, wind, biomass, hydraulic micro and tiny plants), despite favourable geographic and socio-economic potential, are still marginal (< 1%) in the global energy balance of our country.

Primary and final energy consumption are steady in the last years due to the on-going economic recession. Per capita, energy consumption (1340 koe/cap.year) is still lower than the world average (1500 koe/cap.year) and represents 1/5 of EU and 1/8 of USA and Canada.

Between 2003 and 2004, the energy bill increased by 32%. This increase was mainly due to the rise of oil price: it reached 1590 million USD. The taxes collected by the state on these imports amount to more than 350 million USD, but no royalty is directly assigned for processing of pollution caused by this energy combustion.

The final energy balance analysis shows that gasoline represents 38%, gas-oil 22% and electric power 18%, almost 80% of the total. This underscores the extent of the transportation sector role in the final energy consumption breakdown (45%)

While the use of gasoline is limited to transportation, gas-oil is more commonly used in industry, heating, and in hundreds of diesel generator sets disseminated nationwide for producing power to complement power produced by EDL. The analysis of the final electric power with regard to primary energy shows that heat power plants do not use more than 33% of the total energy and that the technical losses on high voltage and distribution networks are far from being negligible (estimated at 15%).

Electric power consumption amounted to 10,409 GWh in 2004, i.e. in decrease of 1.3% from 2003. It represents only 18% of the final energy despite an electrification rate of 98%.

In 2004, the rate of combined cycle of hydropower plants of Deir Ammar and Zahrani was in continuous decline. Hydropower production constituted only 11% of total power production. There are still some problems at the transportation and distribution levels that require the country to supply power for a part of North Lebanon and the Beqa'a from Syria. Lebanon imported 262 GWh from Syria in 2004, i.e. 2.5% of its global consumption through two 220 kV interconnection lines in the North and the East of the country.

The yearly consumption of electric power per capita was, in 2004, 2,600 KWh. This was 1/3 of the consumption of EU countries and 1/5 of USA and Canada.

The energy intensity rate of 0.6 TOE/1000USD is more than twice the rate in developed countries despite the weak consumption per capita and an industrial sector structure based on light industries with weak power content. This may be explained by the consumer behaviour, the decay of consumption equipment stock, the quality of transportation infrastructure and the lack of any policy of rational energy management at the national level. Moreover, in the last five years, the growth elasticity of the energy consumption ratio to the GDP remained near of 1.8.

Finally, the continuous growth of the energy import bill, is creating financial tensions

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increasingly more difficult to endure. This is mainly expressed in frequent disruptions of the energy domestic market, electric current rationing and frequent and anarchistic power cuts. These difficulties oblige the MEW to think about adopting policies of rational energy management and developing renewable energies as an alternative to the sole policy of supply management.

Nevertheless, these policies are still in the embryonic stage (cf. the table above for the evolution of the different structural and economic indicators of energy in Lebanon).

ii.Future Prospects

The situation described above is not going to improve. The reasons are the following:

ii.1. There no extension of electric power generation on way in the near future. The Ministry of Energy is planning to extend it. Between bidding, administrative delays, and implementation of the power plants and adequate grids attached to them, we will not have a new capacity before at least six years.

ii.2**.** In the next five years, the power generation capacity will decrease by 1,000 MW**,** as two old generation power plants will be out of operation (first the Jyeh power plant and then the Zouk power plant). During the council of ministers of August 7, 2006 the minister of EW received the power to conclude an agreement with an international consultant to open the gate of generation exploitation to build new power plants in Beddawi, Zahrani and elsewhere on private exploitation basis. In this meeting, he receives also the power to conclude an agreement with an international consultant to assess the option of keeping the power plants in Zouk and Jyeh in operation up to the construction of new more efficient power plants!

ii.3. The tensions in the oil market will continue for many reasons:

- The rate of growth of the two new economic giants, China and India, will increase their hunger for oil.
- Oil resources are declining everywhere. The OPEC countries and other oil producers are almost at the peak of their production capacity.
- The refining capacity in the world is limited. No major investments in this field have been made lately.
- The impact of the rise of oil prices was not big on the developed countries economies. They coped with it and benefited from this rise.

So it is urgent to find a solution. Among other topics relative to electric system set-up policy and strategy, we may consider to involve a large part of the private sector in calling on independent power producers.

We must have a **policy agenda for enhanced RE (Renewable Energy) and Hybrid System Implementation.**

1 – Improved Energy Infrastructure

What are the characteristics of the Renewable Energies?

- Renewable Energies have a satisfactory environmental balance (Waste, pollution).
- No carbon dioxide emissions (Greenhouse effect).
- No important and sustainable harmful effects.
- Renewable Energies do not constitute environmental risks (Explosion, radioactivity,…).

Renewable Energies are practically inexhaustible at the human scale of time: there are always available to the contrary of fossil and nuclear energies.

But they are far from offering only advantages:

- Renewable Energies are intermittent (Sun, rain, wind,…).
- Renewable Energies are unequally distributed on the surface of the earth.

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- Renewable Energies are diffuse in their volume or mass (Little concentration and intensity on a given point.

These characteristics pose problems relatively to their exploitation:

- A difficult collection: we are not able to concentrate and recover all these energies. If we were able to recover all the solar energy received by the Earth, we shall have at hand 15,000 times the produced energy in the whole world.
- A difficult storing: a part the stocked water in the dams, it is quite impossible or very expansive to stock other Renewable Energies.

In the other hand, the energy produced amounts of energy are usually little. Renewable Energies need a technological advance to increase their efficiency and supply a part of our energy needs.

Renewable Energies require high investments which make their economic balance unfavorable relatively to other energies, actually cheaper.

This economic competitiveness is particularly difficult to reach as long as the externalities or the indirect costs linked to the impacts on the environment from conventional energies are not taken in account (Air pollution, waste stocking, oil slicks, health…)

Nevertheless Renewable Energies lend themselves fairly to distributed power generation and to hybrid installation. We must stress here that in the case of connection to the grid, the primary investment can be cut as the grid will be used as stocking.

1.1 Solar Energy

Solar Energy could be used in three ways: produce sanitary hot water through individual; systems or collective systems; produce power by concentrating solar energy by adequate equipment to produce high temperature (400 – 1500 ^{o}C) as a part from a larger system including boilers operating on fuel and/or gas turbines; produce power from photovoltaic systems .

1.1.1 Solar water heating

Solar energy could be used in sanitary water heating, air conditioning, swimming pools heating in tourism and leisure resorts as well as in some industrial processes where heat is needed.

Solar water heaters became more and more a part of the Lebanese panorama. It began in the late 70's. It suffered in the beginning from the fact that many of the persons on the market lack professionalism. That created defiance in the public. But little by little these non professional actors were eliminated by the market rules. The profession is more regulated, especially that a great part of the production is local.

There were many pilot projects both collective and individual. They were the object of some communications in specialized publication and seminars. They were the occasion to create the Lebanese Association of Solar Energy Industrialists.

The majority of solar water heating systems producers says they are applying foreign standards because up to now there are no Lebanese standards in this sector. Furthermore there is no any kind of labeling for quality insurance. But the MEW (Ministry of Energy and Water) which was supervising the installation of 500 solar water heaters granted by the People's Republic of China, is pushing on this way and promised to ask LIBNOR to activate the editing of standards for solar water heaters and to charge the Industrial Research Institute (IRI) to issue the adequate label after the protocol definition.

1.1.2 Solar Super heater as part of classical steam or combined cycle power plants

This use has not yet been considered in the Lebanese strategy. The prerequisite for such a use is a survey of solar energy received in the Lebanese territory. The purpose of this survey is to draw a solar atlas of Lebanon. This atlas will allow to

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identify sites where such energy could be used taking in consideration the constraints for the choice of power plants sites.

1.1.3 Photovoltaic Power

This is a typical power production for an IPP. The system can be a stand alone system backed by battery bank or grid connected where the grid becomes a kind of storage device avoiding the cost of a battery bank and its maintenance. This latter solution will lower the initial investment.

The owner of a grid connected PV system can often sell as well as buy electricity. This because electricity generated by the PV system can be used on site or fed through a meter into the utility grid. When a home or business requires more electricity than the PV array is generating (e.g. in the evening), the need is automatically met by utility power. When that home or business requires less electricity than the PV array is generating, the excess can often be fed (or sold) back to the utility through net metering. At the end of the month or on the period of billing, a credit for electricity sold is deducted from charges for electricity purchase. In another system of power accounting, the period is a year long if the peak in power consumption is seasonal: if the PV system generates more electricity than the house uses and sends the excess into the utility grid, in summer; in winter, the house uses more electricity than the PV system produces and draws some power from the grid.

Here, we see the interest of establishing a solar atlas. It will allow the identification of all possible sites where it will be the most efficient to install PV systems taking in consideration that the electricity national grid covers almost 98% of the territory.

1.2 **Wind Power**

Wind power has been used for over 6000 years, first for powering boats, windmills and wind pumps, and now for generating electricity. The equipment ranges from small water pumps and chargers (used to charge batteries at remote locations) to large multi-megawatt wind turbine in wind farms that supply power to the electricity grid.

Wind power equipment has been developed to provide a large range of power outputs, from under 100W up to 3MW. The reliability of wind turbines is > 97%. Modern machines are designed to have a useful life of about 25 years. When used for electricity, turbines can generate either direct or alternative current. The flexibility of design of individual turbine components means that machines can be used in areas with high, medium or low wind speed from mountain to locations out to sea.

Within the design parameters necessary for conditions at any individual site, the size of turbine required will depend on the type of application

One of the applications is a large-scale, grid connected electricity generation: a number of large turbines grouped together on one site to form a wind farm, either on-or off shore. The output of each individual turbine is aggregated at a central point before it is fed through a power line to the point where it connects with the national grid passing through a transformer to match the voltage to that of the grid.

Another application is a small-scale, grid connected electricity generation. This application is typical in remote areas where electricity grid can not accommodate a large amount of generation.

Wind turbines could be a designed for stand alone generation. They may be as small as a charger used to charge batteries for telecommunication equipment in remote areas or megawatt-sized turbines used for powering a desalination plant. The use of solitary wind pumps feeding water to salt marches in Enfeh shore was a familiar sight up to 20 years ago.

Wind power is very suitable for incorporation into hybrid systems. These offer flexibility, because they can provide power even if wind is not blowing. Wind-diesel combinations are common, but more recent developments include wind-PV units,

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a hybrid option for power generation from 100% renewable sources.

Up to now, we missed a wind atlas of Lebanon. Now a contract was awarded by the MEW to establish a wind atlas of Lebanon (July 2006). A preliminary academic study by the LAU showed that there are three sites suitable for wind farms in Lebanon: Akkar, Dahr el-Baidar and Marjayoun. Maybe once established and with the technological progress we can identify more sites or some sites for the installation of hybrid systems.

Due to the low production cost of kWh from wind (.05 € for wind kWh, while it is .04 € for LPG kWh and .03€ for nuclear kWh). We see here in this application an opportunity for investment for IPP.

1.3 Hydro Power

From the sixties, no major hydro-electric power plant has been implemented.

In 1999, a decennial program from 2000 to 2009 from MEW previewed the construction of 15 dams and 6 artificial lakes with no mention to exploit any power production project.

In May 2005, MEW prepared a table of potential hydro-electric power estimated to 206 MW. The sites are owned mostly by private sector (potential 175 MW from 206 MW).

Many experts think that the potential hydro-electric power is far more than 206 MW.

The evolution of hydro-electric power in Lebanon requires the processing of some new barriers:

- The irregularity of annual rainfalls all long the year which affects the level in the rivers, especially those on the western part of Mount Lebanon: high in spring, medium in winter and low in summer and autumn. Low water in the hot seasons, combined with the increase of needs to drinking water and irrigation, may not allow to supply enough electric power.
- The environmental impact especially on the wild life.
- The problems of the inherited rights on the water, creating a lot of legal, organizational, administrative and financial complications.
- The increase in the exploitation costs due to precaution measures necessary for the environment conservation

Nevertheless, as we consider that hydraulic resources are the principal public wealth of Lebanon, we should profit from these resources to a maximum. What is required is to combine hydro-electric power projects with drinking water and irrigation projects in a way to profit from the abundant flow to produce electric power and, during the low water, to give the priority to drinking water and irrigation and to use the surplus, if there is any, to produce electric power.

The projects mentioned in the MEW table include plants going from 4 to 40 MW. It neglects all the potential of the installation of mini and micro hydro-electric plants. A survey should be implemented on all the Lebanese territory to identify all the sites where this kind of plants can be installed. This survey can be implemented jointly by MEW, local authorities, private sector and NGO's. It should also study the possibility of hybrid systems on those sites: solar-hydro, wind-hydro.

1.4. Bioenergy

the definition of bioenergy is the industrial and social use of the available biomass everywhere on earth but in deserts or the extremely cold areas.

Biofuel is extracted from agricultural material, animal stool, solid waste and sewage. To give an idea of the potential bioenergy, we quote that to produce 100 liters of biogas, we need ½ kg of wood, 1kg of dry cow manure and 200g of coal. That is why there is a tendency to use these wastes and left behind to produce a renewable energy environment friendly which participates in energy consumption covering.

The sources of biomass are:

1. The dry biomass from wood, remains of industrial wood, forest remains, agricultural and human

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waste where the energy is extracted by combustion.

2. The wet biomass from sewage, domestic animal remains that could be transformed chemically in gas suitable for clean combustion.

All organic material can be fermented, preferably by anaerobic process. This includes liquid waste, solid industrial and domestic waste, manure and urine from bovine and ovine farms and poultries and sewage. In waste-to-energy facilities, all this waste produces biogas which will be used as fuel in power plants or in cogeneration plants.

In Lebanon, some parts of the coast have been used as landfills as well as some valleys or some unused lands like Naameh landfill. These landfills became full more quickly than previewed. They are a threat for the environment and for underground waters.

The yearly production of solid waste is near 1,424,000 metric tons. The potential calorific energy is almost 317MTOE. The amount of clean methane extracted is 100,000 metric tons that have a potential calorific energy of 120MTOE.

No major technical problems constitute a barrier to establish facilities for waste management and processing. This should be studied case by case. The implementation of waste management nationwide will be approached in the second part.

2 Legal and Administrative Framework

2.1 Law N°262/2002

In 2002, the electricity law N°262, was issued. It defines, among other things, the roles of the government, the entities in the sector, and that of the private sector, the structure of the sector and creates an independent regulator agency and the principles of regulation.

This law sets the rules, principles and framework governing the electricity sector as well as the rules governing the total or partial transferof the sector of the sector or of its management to the private sector.

It sets the principles of independence of the production, the transmission and distribution activities. It sets also the incorporation of privatized companies and the privatization procedures, especially, the licenses.

It defines the MEW's powers. The ministry sets the general policy of the electricity sector. It proposes the overall policy for the regulation of the electric power production, transmission and distribution services and oversees the implementation. It also proposes draft laws and decrees governing the electricity sector. It proposes the designation of the members of the Regulation authority.

The Regulation Authority has among its duties and powers:

- promote investment in the electricity sector

- ensure and encourage competition and transparency in the sector

-determine the ceiling of the production, tariffs applied on the various services of the electricity transmission and distribution, subscription fees, etc.

-set technical and environmental standards and rules governing the verification of compliance with these standards.

- determine the rules and standards of the licenses and authorizations.

-issue, renew, suspend, amend and cancel licenses and authorizations.

-ensure that all holders of licenses and authorizations equally benefit from the transmission equipment.

Up to now, no application decrees or by-laws were issued of the above law. But the Council of Ministers took on June 16/2004 the decision N°13, in order to reduce the importation of energy, for developing local energy including renewable energies. In April 6/2006, the Council of Ministers organized by his decision N°58 the generation license issuance to IPPs.

2.2. Proposed draft energy law

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In March 2006, the Investment Planning Program (IPP) MSC Energy in the MEW submitted a Draft Energy Law.

This draft sets out the objectives under which the energy sector shall be operated and developed and the instruments to be applied and measures to be taken for putting the objectives into practice including the suitable legal, regulatory, and institutional energy sector frameworks.

In this draft law, we will be concerned by what is relating to renewable energies.

Among the objectives of the energy policy: use and promotion of renewable energy sources. The promotion of the renewable energy sources shall be integrated into the general national energy policy.

A law on renewable energy creating the legal framework for the elaboration and enforcement of a national policy on promotion of renewable sources shall be ratified.

The MEW shall enact regulations on specific measures and support schemes to promote the use of renewable energy sources.

The MEW shall propose the regulations on power generation under special regime using renewable sources and cogeneration of heat and power.

The regulations shall indicate: the sources of energy, their duration, financial mechanisms and forms of promotion (financial, incentives, guaranteed prices, reserve supply of electricity, priority of dispatch and priority of access to the electricity network).

2.3. Renewable energy law

In order to promote the development and utilization of renewable energy, improve the energy structure, diversify energy supplies, safeguard energy security, protect the environment and sustain development of the society and the economy.

Renewable energy is referred to non-fossil energy of solar, wind, water energy, biomass, geothermal and sea energy.

The government encourages and supports various types of grid-connected renewable power generation. It supports also the construction of independent power systems in areas not covered by the grid. It encourages the use of solar energy utilization systems of solar water heating, heating and cooling as well as photovoltaic systems, etc.

The grid power price of renewable energy power generation projects shall be determined in the principle of being economic, reasonable and beneficial to the development and utilization of renewable energy.

Grid connections expenses for the renewable power may be included in the transmission cost and retrieved from the selling price.

Financial institutions may offer preferential loan with financial interest subsidy to renewable energy development and utilization projects. The government grants tax benefit to these projects.

3 Energy pricing and funding schemes

To achieve the objectives of the policy of the implementation of RE and hybrid system, it is necessary to attract the private sector and even individuals to engage themselves in the adventure of the renewable energies and enhance the economy and the environment of the country. Only a favorable energy pricing and funding schemes can do that job.

As we saw in the second part, the administrative and legal framework previewed the great lines of these schemes, at least the principles of these schemes. It is obvious that everywhere most of the new energy technologies which were introduced into the market received support in different ways for the process of market penetration. Support schemes for market introduction are common instruments.

We can consider the following support mechanisms once the administrative and legal framework in place :

3.1 Investment subsidies can support the installation of plants. They are generally not related to production and therefore considered as economically inefficient.

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This can be achieved by the Lebanese banking system to IPPs who comply with a book of conditions enacted by the regulatory authority, once designated. Lebanon can also try to have loans from international institutions like the World Bank or some programs from the EU like the program MEDA. In this field some NGOs can be of great help.

3.2 Feed-in tariffs: this model guarantees a long term minimum price for electricity produced from renewable sources and obliges system operators to purchase it. Applied in some countries in the EU, it shows good results. Here the price is dictated and it is left to the market to supply the quantity.

3.3 Certificates trading model: producers of electricity from renewables receive a total payment consisting of the market price for their electricity supplemented by the market price for the green certificate which is thought to be produced simultaneously with the electricity. Thus, the price of the green certificate should represent the additional cost costs of producing renewable electricity compared to conventional sources. Green certificates could also be traded on international market, especially with the countries if annex 1 of the Kyoto Protocol.

3.4 Quota system: under this system, governments set quotas per source and set the requirements to meet this quota. A variety of market actors can be obliged (producers, suppliers, consumers, ..). that is to say that the quantity is dictated and it is left to the market to determine the price.

3.5 Net metering: this serve as an important incentive for consumer investment in renewable energy generation. It enables customers to use their own generation to offset their consumption over a billing period by allowing their electric meters to turn backwards when they generate electricity in excess of their demand. Without net metering, a second mater is usually used installed to measure the electricity that flows back to the provider, with the provider purchasing the power at a rate much lower than the retail price.

Net metering is a low-cost, easily administrated method of encouraging customer investment in renewable energy technologies. It increases the value of the electricity produced by renewable generation. It allows the customer to bank their energy and use it at a different time than it is produced giving him more flexibility and maximizing the value of its production. Providers may also benefit from net metering because when customers are providing electricity during peak periods, the system load factor is improved.

3.6 Tax benefits

The government should grant tax benefits to energy production from renewables either by abolishing or decreasing them. The same thing should be applied for VAT on renewable equipment or raw material used in the renewable industries.

3. Conclusion

The implementation of this policy agenda for enhanced renewable energy and hybrid systems is only a part of the electricity sector solution. It should be a part of a global strategy in the sector.

This agenda should be in discussion in the spheres of decision in the electricity sector. Once discussed, it should lead to prepare and ratify the suitable legal and administrative acts to the framework favorable to renewable energy sources.

Adopting this agenda in concomitance with other measures such as the shift to natural gas in Combined Cycle power plants (actual and future), adopting energy conservation program on both the supply and demand side and adopting a new policy for tariffs reflecting the true cost of electricity production is in keeping with general pattern of the sustainable development of the country.

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