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Concrete analysis of energy facts in Lebanon with a perspective of promotion of renewable energy technologies

By

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April 2012

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www.almee.org

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PROLOGUE

In 2012, we have reached a turning point in our history. Climate change is already creating tangible effects, thereby exposing the limitations, costs and dangers of fossil and nuclear fuels. The next ten years will be decisive in our commitment to a sustainable or quite simply a viable future for human beings and ecosystems. For our energy systems, this means a rapid transition to efficient, renewable energy sources. This is already possible using current practices and technologies.

The Mediterranean region has an important role to play. It is one of the regions the most vulnerable to climate change while enjoying high sunshine levels. The Mediterranean Solar Plan (MSP), the DESERTEC industrial initiative (DII) or funds supporting sustainable energy such as the World Bank's "Clean Technology Fund (CTF)" show that this potential is recognised by politicians and economic and financial decision-makers.

We believe that these commendable intentions are attainable but require a participatory and proactive approach by the Mediterranean countries. These major projects must be integrated into the national sustainable energy strategies of the partner countries, rather than the opposite occurring. In other words, we would like to see national integrated solar plans (energy efficiency and renewable energy) in each Mediterranean country, supported by the MSP, DII and CTF (and others) [1].

Lebanon has a high solar and wind energy potential, technologies to tap these potentials are available and costs are rapidly decreasing. For instance, electricity and fossil energy (diesel) still heavily subsidized and renewable energy does not benefit from a stable long-term support.

The government adopted a "Policy Paper for the Electricity Sector, 2010" and a "National Energy Efficiency Action Plan, NEEAP, 2011". But several reforms are needed at the institutional, policy and legislative level.

This paper presents a concrete analysis of energy facts in Lebanon with a perspective of promotion of renewable energy technologies. The recommendations developed for an alternative energy efficiency policy will enable Lebanon to take control of its energy in the future while contributing to global efforts to cut greenhouse gas emissions.

We hope that this paper will provide material for thought and serve as a source of inspiration

NATIONAL ENERGY CONTEXT

Lebanon is a country largely devoid of fossil energy. Lebanon is not currently an oil or coal producer. Exploration has revealed the existence of oilfields in the Bekaa West plain as well as offshore along the North and West coast. The "Oil's Law" has been recently adopted by the parliament and a bill to open this market to the private sector in the form of DBOO (Design, Build, Own and Operate) or DBOT (Design - Build - Operate – Transfer) is currently under development.

The energy consumed is totally based on imported oil derivatives. Use of any form of RE is very limited in Lebanon. Electricity is supplied by "Electricité du Liban" (EDL), an autonomous state owned entity. EDL has the monopoly of production, transportation and distribution of electricity. In 2004 the installed capacity amounted to 2310 MW and 98% of the population was connected to the system. Work is in progress on the rehabilitation of the high voltage

transmission networks, which are currently planned for completion by the end of year 2012 (220 kV). There are very few concessions for the distribution of electricity, that date to more than 35 years ago and which represent a maximum of 5% of the total production and distribution volume, but no licenses at all. Losses, both technical and non-technical, are unusually high. Currently they represent 40% of electricity produced. This includes some 14% in technical losses and about 26% non technical losses (not billed). The principal objective of the distribution plan is to reduce these losses to a normal rate, but just now no tangible progress made. Electricity rationing still occurs (10 to 16h per day), in the regions outside Beirut (and 3 hours and more per day in Beirut). Because of this rationing, private illegal small electricity producers, spread all over the country, are producing and selling electricity without getting connected to the main grid but through independent cables tied on the electricity and telephone beams. A 6 to 8% growth in electricity demand is expected, which will require the simultaneous strengthening and extension of the network.

Lebanon has some waterways and suitable sites that have allowed the exploitation, at different levels, of several hydroelectric power plants (about fifteen with an aggregate nominal power of 280 MW). Lebanon was linked to Iraq and Saudi Arabia by pipelines running into two oil refineries (Tripoli in the North and Zahrani in the South on the Mediterranean Sea, actually not in operation).

For some years now, the Ministry of Energy and Water (MEW) has been importing the fuel allotted to “Electricité du Liban” (EDL) of which it is the supervising authority; EDL should pay the corresponding bill. Since the end of hostilities in 1990, the successive governments’ main priority has been the rehabilitation of the energy sector which suffered greatly during twenty years of war. Later, there was more focus on the sector’s growth to satisfy the increasing demand for energy and to ensure a secure and stable supply, a necessary condition for the economic development of the country. Two combined cycle power plants (900 MW) were constructed in 1998 and 2000 and Lebanon benefited from 24h per day electricity. Lebanon had signed an agreement to be part of the Arab Gasoduc (Egypt, Jordan, Syria, Lebanon, Turkey) and adopted the electricity law 462 (2002) aiming to open the electricity sector.

In 2003 The Minister of Energy and Water cancelled the partnership of Lebanon in the Arab Gasoduc (figure 1) and signed a contract with Syria to purchase the natural gas for the electricity plants. But Syria doesn’t have sufficient natural gas to export to Lebanon. The combined cycle thermal plants are filled with diesel increasing the electricity generation cost. The law 462 is just now not applicable.

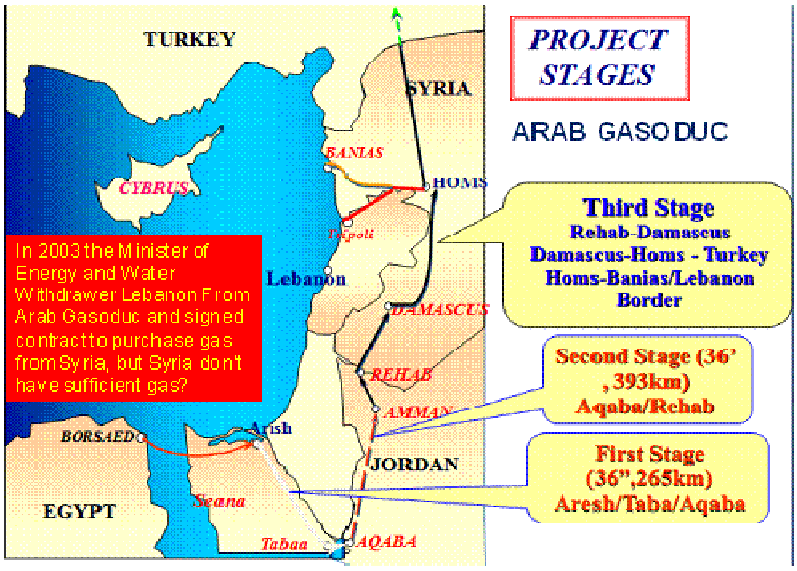


Figure 1: The Arab Gasoduc and the Lebonon-Syria Gasoduc networks

On the other hand, the policy of fixing energy rates based on relatively low prices policy, so-called ”social prices,” has inhibited the development of energy efficiency and encouraged

wasting of energy. Electric power billing for residential is done by parts of 100 kWh (from 0.023 C$/kWh to 13.3 C$/kWh); all the five parts are billed at prices still lower than the marginal cost of electric power generation and distribution (estimated at 27 cents$/kWh in 2011 and at 30 cents$/kWh in 2012).

In 2009, electric consumption amounted to 15,000 GWh. From the 15,000 GWh, 12,000 GWh were distributed by EDL and 3,000 by the independent generator sets. The electric consumption represents only 18% of the final energy balance. The hydro-power (622 GWh in 2009) share was only 5%, and is in continuous decline compared to the thermal production.

In 2011, the national energy bill reached 5 billion US$, which represents more than 12.5 % of the GDP. In the resent years the national energy bill shows a steep increase which amounted in 8% during 2008-2009 and 51% in the years 2005-2009 [2]. The subsidies for electricity represented 17.5% of the government expenditures in 2011. In 2009 the total incomes of EDL was 390 M$, it represents around 3.75 C$/kWh produced. The subsidies are around 23 C$/kWh (figure 2).

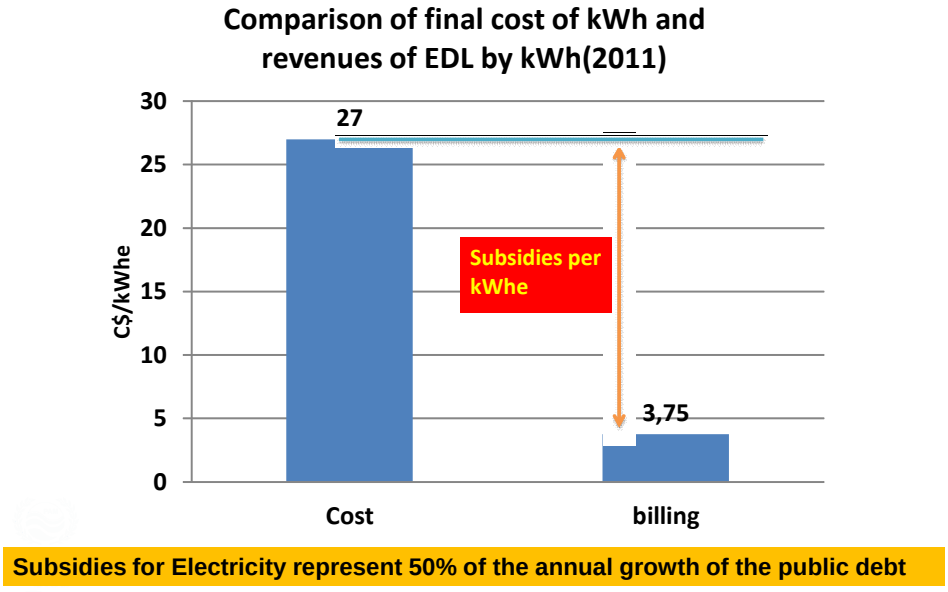


Figure 2: Comparison of final cost of kWh and revenues of EDL by kWh (2011)

Finally, the continuous growth of the energy import bill leads to financial pressures more and more difficult to bear and which result in, among other things, frequent disruption of domestic energy market, current rationing of power supply and frequent anarchic power cuts. This constrains the Lebanese government to consider the adoption of rational energy management policies and the development of renewable energies as an alternative to the policy of trying to manage only the supply. Nevertheless, the recommended policies remain at present time in **an embryonic state**.

In this context, it should be pointed out, that the GHG generation in Lebanon is 4.74 tCO2 per capita, that is more than the world average (4.22 tCO2 per capita), double of Southern Mediterranean countries (2.43 tCO2 per capita) and less than the half of the developed countries.

Some key indicators for Lebanon [3] follow are presented in table 1.

Primary Energy (kTOE)	6735
RES share (including hydro) in primary energy (%)	2.6
Primary energy per capita (TOE/c)	1.7
Energy intensity (TOE/1000$)	0.25
Energy independence (%)	3
Energy bill (Million $)	3134
Thermal electric generation (GWh)	10200
Hydro-electric generation (GWh)	622
Electric power import (GWh)	1115
Independent generator sets generation (GWh)	3000
Electric power consumption per capita (kWh/c)	3200
Electric power consumption by GDP (kWh/$)	0.6
Energy sector CO_2 production (Million ton CO_2)	18.8
Carbon intensity (kg CO2/$)	0.73
CO_2 production per capita (tCO2/c)	4.74

Table 1: Energy Indicators in Lebanon 2009 – Source ALMEE / RESSOL-MEDBUILD [3]

POLICY PAPER FOR ELECTRICITY SECTOR

Energy Strategy

At the beginning of 2010, the Lebanese Government adopted an objective of gradually increasing the share of renewable energies in the supply of primary energy from 2% in 2010 to 12% in 2020 as part of its energy plan. From the other side the Strategy assumes that energy efficiency will contribute to reduce the energy consumption by 5% in comparison to base case scenario (business As usual, BAU - trend or reference) by 2020. But in May 2012 no action plans and programmes have been undertaking to translate this strategy into effective projects.

Policy Paper for Electricity Sector

In 2010 and 2011 The Council of Ministers adopted the comprehensive reform plan submitted by the Energy and Water Minister regarding the electricity sector [4]. The "**electricity sector policy paper**" includes 10 related and comprehensive initiatives to cover the three main axes of the electricity sector, i.e. the infrastructure, sources and legal frameworks. The plan claims giving priority to the types of energy which cause the lowest damage to the environment, depending mainly on gas and renewable energy. It encompasses the setting up of liquefied natural gas (LNG) infrastructure and gas pipelines along the Lebanese coast. The plan established a legal framework for the transitional period and is aiming to create an energy sector with a **5,000 megawatt** capacity by the year 2015 (from which only new 120 MW from RE, figure 3).

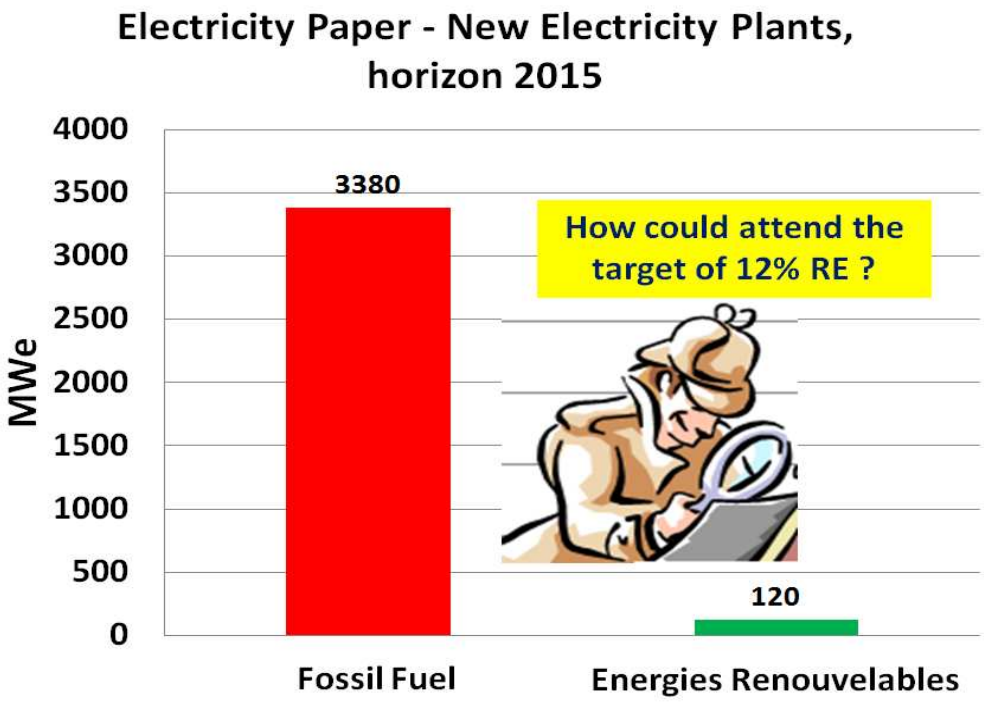


Figure 3: Electricity Paper new thermal and RE Electricity plants (2010-2015)

The plan's implementation requires funding of 6.8 billion USD by the state, the private sector and donor nations. It would lead to lowering the energy sector's losses sustained by the state treasury, as well as the economic costs sustained by citizens and business owners who use generators to tie them over during lengthy blackouts. The planed reform of electricity tariffs

still under required to insure the financial balance of electricity sector, and just now, no action has been undertaking to address this issue.

If we add the subsidies to electricity sector during the period 2010-2015 and the real cost of the LNG terminal and the NG infrastructure, and he appropriation cost of lands for NG storage, the expected impact of the implementation of the electricity plan on public debt (2010-2015) could rise to 25 Billion US$ (table 2).

Electricity Paper – Expected impact on public Debt (2010-2015)

	2010	2011	2012	2013	2014	2015
Subsidies to EDL	2 200 M$	2 500 M$	2700 M$	2 800 M$	3 000 M$	3 400 M$
New Elec. Plants		276 M$	306 M$	324 M$	253 M$	
Total	2 200 M$	2 776 M$	3 006 M$	3 124 M$	3 253 M$	3 400 M$
Total	**17 759 M$ of additional Debt**					
+ Private Sector for LPG maritime Terminal, Gasoduc infrastructure & 2500 MWe thermal plants without the cost of appropriation of lands						**7 300 M$**
Private Sector is heavily constrained by regulations that make impossible its participation						**Total 25 M$**

Table 2 : Expected Results and impact on public debt of the actual electricity Plan (horizon 2015)

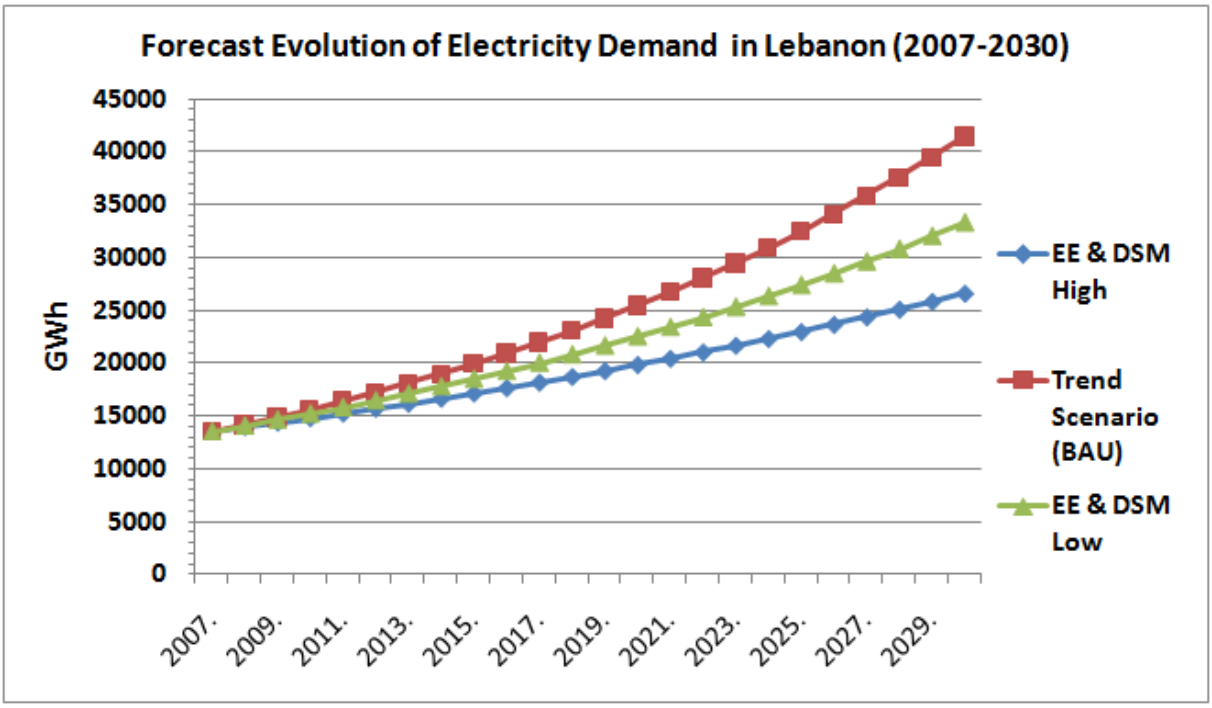
What it is the real mean of 12% RE?

The Policy Paper for Electricity Sector [4] commits to launching, supporting and reinforcing all public, private and individual initiative to adopt the utilisation of renewable energies to **reach 12% of electric and thermal supply**.

It seems that the objectives of 12% still not clear for policy makers (RE cover 12% of Primary Energy Needs or 12% of Electricity Production?) The difference is 8% of Primary energy.

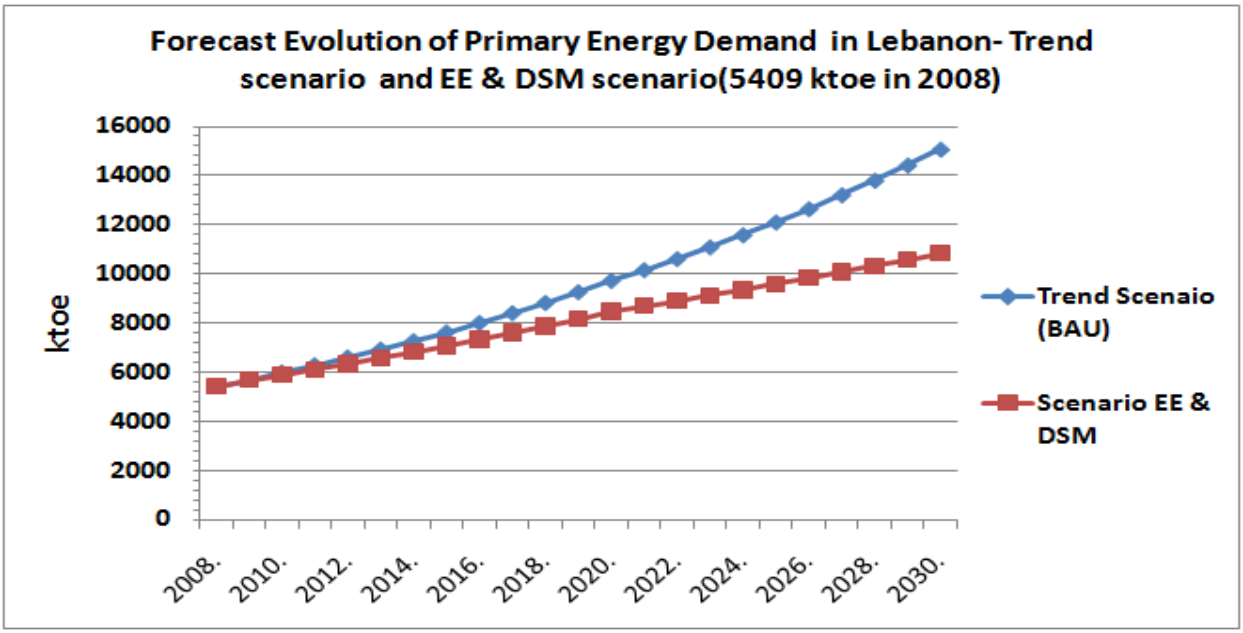
Taking into account several factors relating to the present economic climate, reducing the primary energy consumption (car penetration rate already high, high performance of new cars) and electricity consumption (introduction of less consuming equipment), the needs for primary energy for the 2020 horizon will be **8.4 Mtoe** (including electricity generation of 22,500 GWh - i.e. 36 times the actual hydro-electricity production in 2009). Twelve per cent of primary energy is equivalent to **1,000 ktoe** to be produced from Renewable Energy.

Figures 4 and 5 show the forecast evolution of electricity demand and primary energy demand in Lebanon (2007-230) for “Trend Scenario” (BAU) and for EE&RE scenarios based on the implementation of Energy Efficiency measures and Renewable Energy at low and large scales.



(Source : Adel Mourtada – Plan Bleu [5])

Figure 4: Forecast Evolution of Electricity Demand in Lebanon for different scenarios (2007-2030)



(Source : Adel Mourtada – Plan Bleu [5])

Figure 4: Forecast Evolution of Primary Energy Demand in Lebanon for different scenarios (2007-2030)

National Energy Efficiency Action Plan

The National Energy Efficiency Action Plan for Lebanon NEEAP 2011-2015 has been adopted by the Government (November 2011) [5].

The NEEAP is planned for the upcoming years 2011-2015. It includes 14 independent but correlated activities. Even the activities are described but the financial means for their achievement are not identified. More no program for implementation, no indicators for follow up and no methodology of evaluation are indicated. Unfortunately the proposed NEEAP is not sufficient to achieve the objective of 12% RE by 2020.

Revision and adaptation of the National Energy Efficiency Action Plan (NEEAP) should be realised with clear evaluation of demand, potential cost, benefice and impacts of each initiative. Complementary measures with adapted mechanisms for implementation and relevant indicators for progress evaluation should be also designed.

PILLARS OF A SUSTAINABLE ENERGY POLICY

Trends

Lebanon has an interesting technical and financial potential capable of launching and supporting ambitious projects in the energy and environment domains. The banking sector is economically powerful with significant financial reserves and the moment could be opportune for financing energy efficiency, renewable energy and Environmental projects.

The country receives a lot of small bilateral cooperation with European countries. Lebanon positively considers the Mediterranean Solar Plan project envisaged by European partners. Lebanon presented a portfolio of several projects for this initiative. This indisputably reinforces the wishes to enhance cooperation with neighbouring countries on the north side of the Mediterranean Sea and, more generally, with EU member states.

Solar potential

Lebanon is geographically well situated to try with solar energy an original formula of sustainable development:

- a sunny period of 3,000 hours yearly
- a yearly average solar radiation of 2,200 kWh/m²
- a daily global sunny period of 4.8 kWh/m².

In Figure 5 the global solar radiation, from North to South and from East to West for a yearly period are presented. The slight variation of monthly averages between these zones is pointed out. On the other hand, seasonal variability remains high, with a variation factor of more than 3 between December and July. These values are related to the only available measurements in three stations in Lebanon for the period 1968-1990 (Table 3).

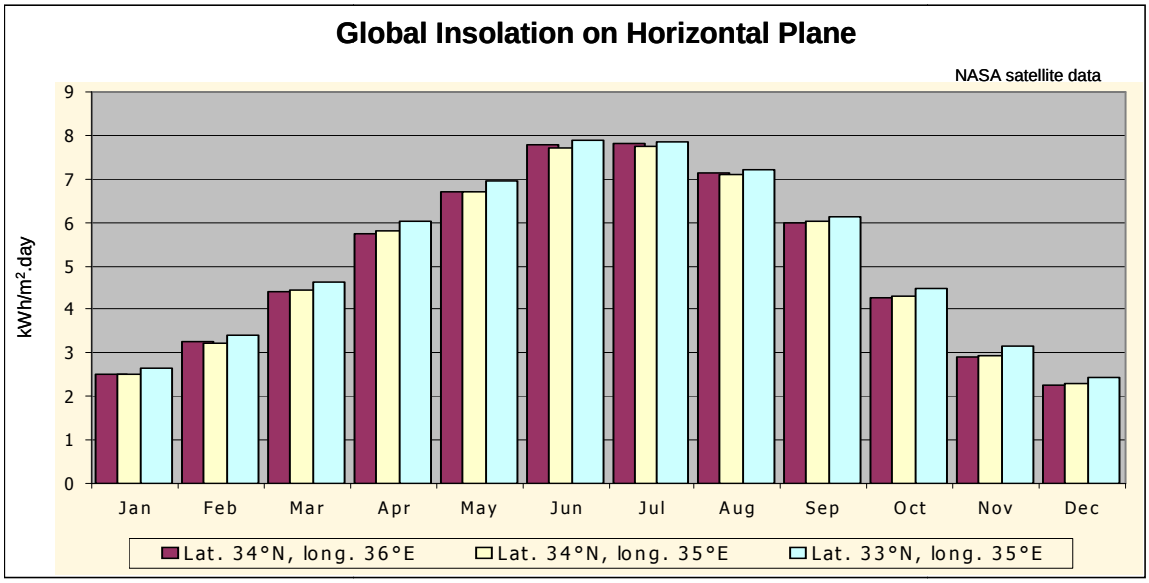


Figure 5: Average daily radiation per month in Lebanon (kWh/m^2.day) – Source ALMEE

It is worthwhile to point out, in this framework, that the Directorate General of the weather forecast as well as some universities are equipped with a network of meteorological stations allowing measurements of the solar radiation for hourly periods in many sites of the country. However, there is no analysis of such data.

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Abde	2044	3089	3875	6095	6464	7344	7035	6822	5312	3588	2734	2115	**4715**
Ksara	2518	3625	4943	6214	7702	8840	8758	7949	6762	4849	3424	3507	**5683**
Beirut	2308	3191	4380	5496	6461	7208	7018	6424	5380	4247	3004	2317	**4793**

Table 3: Global radiation in Wh/m^2.day- 3 years means 1968-1990 (Source: Lebanese climatic Atlas).

Wind potential

The National Wind Atlas of Lebanon prepared by Garrad Hassan for the United Nations Development Program (UNDP) - CEDRO Project (25th January 2011) [6] estimates a high potential onshore wind power capacity for Lebanon (figure 6).

There is considerable uncertainty in all the displayed wind mapping results. Without higher quality measured data it is not possible to meaningfully define the bounds of uncertainty in the maps produced.

The wind atlas for Lebanon should be redeveloped according to international methodology and basing on effective measures of wind speed at 80m level.

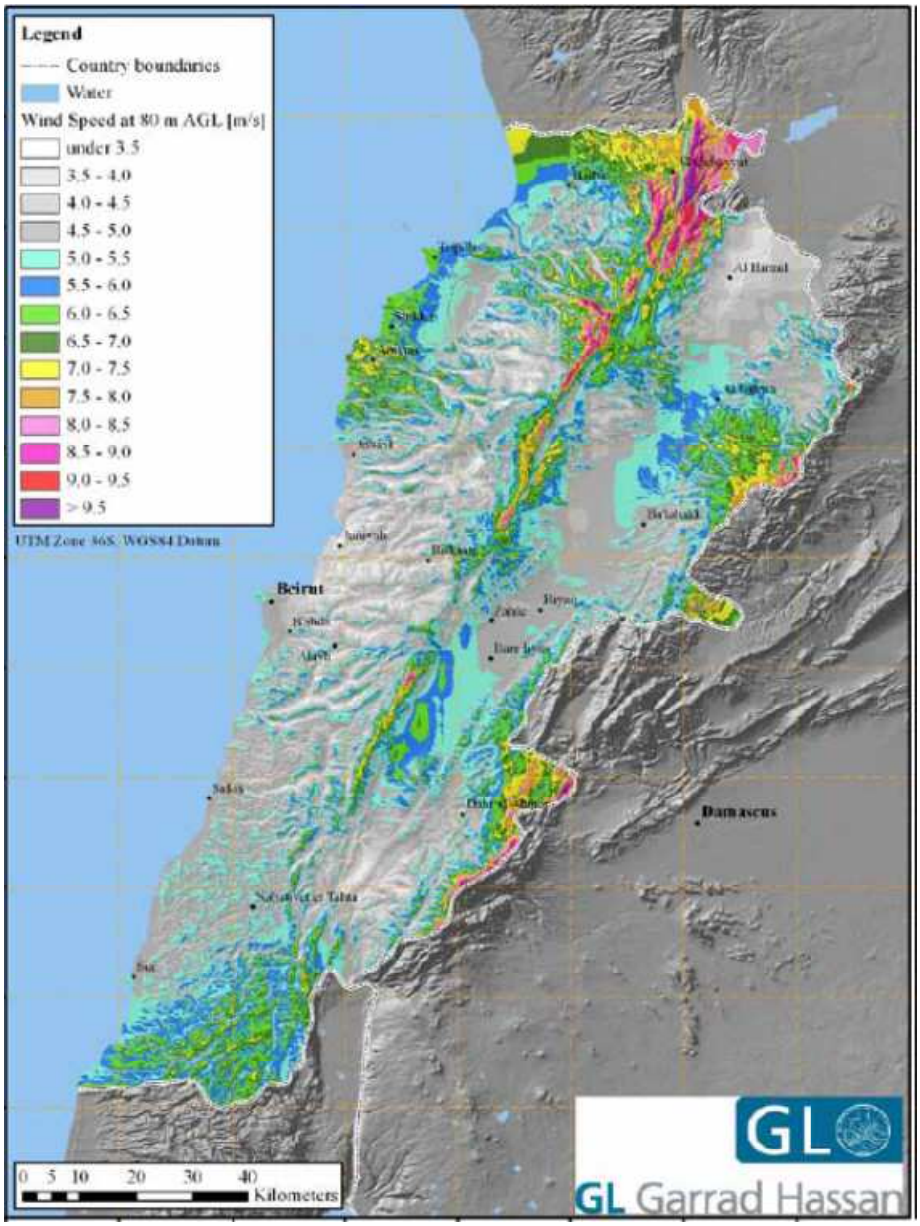


Figure 7: Central estimate wind map of the Republic of Lebanon at 80 m above ground (source: Lebanon Wind atlas)

Development in Lebanon of Renewable energies

In this context, the arguments in favour of the development in Lebanon of renewable energies seem obvious and can be summarized as follow:

- Energy bill control and balance of payments improvement.
- Reduction of the conventional energy system emissions to the local and global environment: SOx, NOx, CO2, etc…
- Reduction of the impact of future world energy pressures on national economy.
- Technical innovation promotion and technological progress dissemination, bypassing some development stages.
- Reduction of investments for expanding the conventional energy production system.

- Optimization of economic costs, favourable to a sustained growth and rapid improvement of the country incomes.
- Reduction of risks linked to uncertainties in the world energy situation.

Barriers to EE & RE Strategy Implementation

Policies and Institutional Barriers

- The absence of effective policies, legislations and regulations,
- Lack of favorable import for RE&EE products and components as well as conducive policies to promote RE&EE developments;
- Limited scope for R&D institutions to interface with international bodies and to share expertise already existing within the sector;
- Private Sector is heavily constrained by regulations.

Policies and Legislations: These are the conditions that greatly affect capacity building actions for they can be the real barriers. They include regulations and standards that preclude new technologies, maintain distorting market interventions such as subsidies for polluting industries, and regulated markets that create disincentives for new technologies, planning system issues, etc.

Regulatory measures are requested to stimulate market opportunities and support the introduction of innovative methodologies, attractive schemes, investment capital, and flexible financial mechanisms.

Economic Barriers

- High subsidies on electricity (that make the payback period of RE applications so high for end users).
- No preference taxation for RE&EE equipment.
- RE&EE industry has no incentives to react to market demand.
- No efficient incentives to promote RE&EE investment in electricity sector: wind, CSP, PV, biogas, etc..
- Unavailability of financial mechanisms and instruments encouraging RE&EE manufacturing.
- The high cost of capital, and lack of access to capital & financial institutions (for high investments).

Technical Barriers

Immaturity of Technology: This may take several forms; the simplest is where potential purchasers are ignorant of new technology capabilities. They may also be faced with multiple and conflicting information and have limited ability/time to absorb it, and choose a known option in preference to new alternatives.

Adequacy of Resources: The transfer of new technologies requires the existence of supporting infrastructure. For example, testing laboratories, skilled labour for regular maintenance, and availability of local manufacturing facilities to support minor modifications and spare parts are all important elements for a successful technology transfer process.

Social Barriers

- Lack of Information about technologies.

- Electricity has been available cheaply - no need to explore other options.
- Lack of mainstream marketing of RE&EE options.
- Lack of priority for national R&D programs.
- Lack of training & education at university and professional or vocational level .
- Eroded consumer trust.
- Domestic expertise is not sufficiently considered.

Public Awareness: Lack of awareness is a major barrier hindering the widespread of cost-effective new technologies. Awareness about the benefits that new technologies offer as well as the provision of alternatives is very important for facilitating acceptance of new technological options. Cultural and societal barriers are also important and need to be addressed.

Capacity Buildings and awareness programmes are needed

Market and financial Barriers

- Most RE&EE companies are small size with limited financial capacities.
- Low competitiveness due to fossil fuels and electricity prices.
- No taxes reduction for RE&EE projects and importing.

Availability of Funding: New technologies are generally cost-intensive, and potential investors may lack the financial resources required to bear the upfront cost.

The new financial mechanisms of Banque du Liban (BDL), Kafalat and Private Banks for Green Projects need further adaptation. The amount of offered investment facilities is still very low in comparison to the expected need of capital finance.

Commerciality and Competitiveness: This constitutes one of the main barriers of accelerating the technology transfer process. New technologies should be able to compete technically and cost-wise with existing and well- established products. Commerciality and competitiveness is influenced by the monopoly powers that can introduce incentives to innovate and erect barriers.

SUSTAINABLE AND COMPETITIVE RENEWABLE ENERGY IN LEBANON

How to develop and implement EE & RE Strategy

The analysis of the local situation revealed that the most important policy option is a to develop a clear energy Renewable Energy and Energy Efficiency strategy (based on the assessment of energy needs and the RE and EE potential) with all the stakeholders (bottom-up and top-down), then develop (or update) and enforce related laws and regulations followed by: (i) the development of suitable market based programs, (ii) creation of a favour climate for the engagement of the private sector in projects related to RE Technologies (Wind, PV, CSP, etc.) (iii) Supporting national programmes of technology transfer, education, training and research development, (iv) benefit from the European Initiatives (MSP, DESERTEC, Clean Technology Fund, Transgreen/MedGrid, etc.) and programmes of international donor agencies (MEDREG, EIB/EBRD, etc.,). The constraints facing technology

transfer are divided into legislative, economic, social, technological, marketing and infrastructure.

We recommend strongly defining a new energy policy according to a more comprehensive **Lebanon's energy strategy that implies the development and implementation of** wide-ranging energy management programmes based on:

- an in-depth analysis of the cultural and social context and the development of an "energy saving" culture;
- a detailed evaluation of demand based on sector and type of use (for example in buildings: lighting, heating, cooling, SWH, etc.), reduction of waste and optimal satisfaction of needs (technological and economical);
- supplying Low Consumption (LC) products, equipment, buildings, vehicles and services;
- Putting in place appropriate financing systems. These programmes should be based on sectoral energy efficiency action plans, including standards & labels (S&L), tax incentives, national ("Energy and Environment") and local energy management agencies.

Lebanon 2020 objectives: a scenario of transition and a break with the past

Supplying sustainable and competitive renewable energy (RE) should be primordial to Lebanon's new energy policy. The following steps should be implemented to achieve this objective:

- evaluating the technico-economic potential of RE;
- analysing the constraints and solutions to overcome obstacles to the development of RE;
- developing an offering of high-quality equipment and services;
- support financing and tariff measures.

Clear Lebanon 2020 objectives should be defined. We recommend the adoption of the targets bellow:

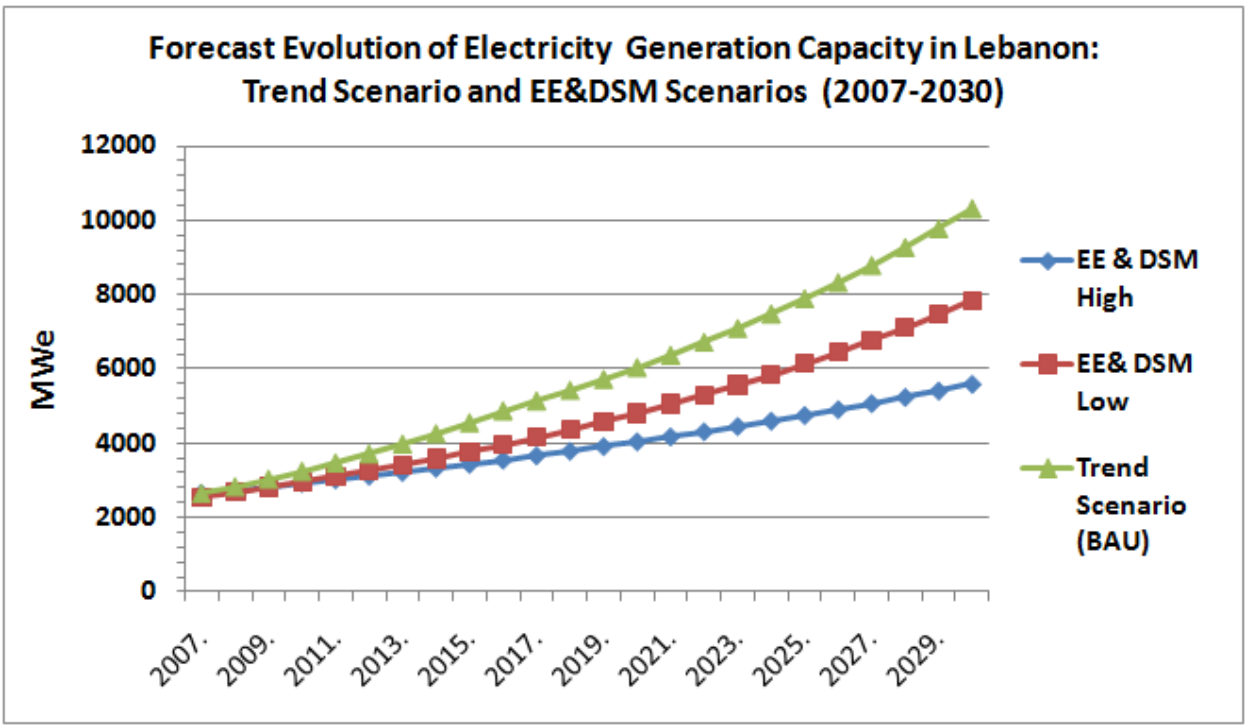
- Reduction in consumption in comparison with the trend scenario (BAU) of 16% and energy intensity of 15%;
- Renewable energies cover 12% of energy needs (gross primary energy consumption) and 20% of electricity consumption (in GWh);
- Dependency on energy imports reduced from 98% to 88%;
- 28% reduction (compared with the trend scenario) in polluting emissions, in particular CO2, as a result of energy and reforestation objectives.
- Elimination of subsidies on Electricity tariffs and fossil fuels prices – Synergy with Mediterranean projects (DESERTEC, MSP, etc.) should be developed.

Implementation of EE & DSM Measures and Programmes

According to the electricity company's projections (trend scenario), Lebanon needed to significantly increase its total generation capacity in future years. The installed capacity of 2,350 MW (including 10% of hydropower plants) in 2010 (but only 1500 MW are operational) need to be increased to 6,000 MW in 2020 (plants relying on heavy fuel, diesel and imported gas) to meet the increased demand in the absence of a demand management policy (the most cost-efficient way of satisfying growing needs). However, a combination of increased

production equipment imports and fuel imports has a very unfavorable impact on the country's investment capacity and balance of payments.

The implementation of EE&DSM measures and programmes could reduce the need of generation capacity to 4000 MW by 2020. Figure 8 shows the inmpact of EE and Demand Side Management (DSM) scenarios on the forecast evolution of Electricity Generation Capacity in Lebanon.



(Source: Adel Mourtada – Plan Bleu [5])

Figure 8: Forecast evolution of Electricity Generation Capacity in Lebanon – Trend scenario and EE&DSM scenarios.

Feed-in tariffs and grid connection

Feed-in tariff and easy grid connection should be implemented.

A feed-in tariff (FiT, feed-in law, advanced renewable tariff or renewable energy payments) is a policy mechanism designed to encourage the adoption of renewable energy sources and to help accelerate the move toward grid parity. FiTs typically include three key provisions:

- guaranteed grid access
- long-term contracts for the electricity produced
- purchase prices that are methodologically based on the cost of renewable energy generation and tend towards grid parity[dubious – discuss].

Under a feed-in tariff, eligible renewable electricity generators (which can include homeowners and businesses) are paid a premium price for any renewable electricity they produce. Typically regional or national electric grid utilities are obligated to take the electricity and pay them.

Different tariff rates are typically set for different renewable energy technologies, linked to the cost of resource development in each case. The cost-based prices therefore enable a

diversity of projects (wind, solar, etc.) to be developed while investors can obtain a reasonable return on renewable energy investments. This principle was first explained in Germany's 2000 RES Act.

The electricity grid in Lebanon should be redesigned according international standards to permit the connexion of PV systems and Wind systems.

A grid-connected PV system essentially comprises the following components: PV modules/array (multiple PV modules connected in series or parallel with mounting frame), PV array combiner/junction box (with protective equipment), direct current (DC) cabling, DC main disconnect/isolator switch, inverters, AC cabling, meter cupboard with power distribution system, supply and feed meter, and electricity connection. The integration of PV systems to electricity networks is covered at the top level in the standard which groups the issues into two main categories: safety and power quality. DC injection and radio frequency suppression are also important topics.

Evaluation of the technico-economic potential of RE in Lebanon (2011-2020)

The potential of electricity generation from RE and the investment needs (period 2011-2020) are estimated in table 4.

Technology	Installed capacity	Share of production in Primary Energy needs in 2020 (%)	Investment needs in M€	Electricity production costs (in €cents/kWh)
Existing Hydropower	235 MW	1.54	0	3
Small sized hydropower	60 MW	0.92	86.9	4
Wind power	250 MW	1.71	235.5	6
PV plants	67 MW	0.50	193.5	24.5
CSP* (Concentred Solar Power)	600 MW	5.30	1521.7	17.3
Biogas	35 MW	0.60	76.0	5
Total	**1247 MW**	**10,57**	**2113.6**	

Source : Adel Mourtada – WWF Lebanon Fact Sheet [8]
*CSP : Concentred solar power plants without storage system

Table 4: Potential of generation electricity from RE and investments needs (2011-2020)

The potential of thermal solar water heaters and the investment needs are estimated in table 5:

Technology	Installed capacity	Share of production in Primary Energy needs in 2020 (%)	Investment needs in €
Installed solar water	350 000 m^2	0.44	0

heaters in 2010			
New solar water heaters by 2020	1 000 000 m^2	1.26	300
Total	**1 350 000 m^2**	**1.70**	**216.4**

Source: ALMEE / RESSOL MEDBUILD [3]

Table 4: Potential of thermal solar water heaters and investments needs (2011-2020)

The potential of biomass is still not important and it is not considered in the RE plan.

The total capital investment need for RE is 2330 M€ by 2020 (equivalent to one year subsidies to electricity sector). The share of RE in Primary energy needs in 2020 is estimated up to 12% (electricity + thermal).

A EuroMed model partnership

This balanced mix of energy efficiency and renewable energy projects, including decentralised and centralised, small and large scale projects will benefit the country's inhabitants and companies. To ensure the relevance of "Lebanon 2020" in an international context linked to major projects, grid connections and major project objectives should be drawn up not only for 2020, but also for 2030, 2040 and 2050 [9] since the networks and major solar and renewable installations are planned on a long term basis.

Lebanon could share this plan with the neighbouring countries, IRENA, the MSP and DESERTEC in order to identify areas of common interest. Cooperation with neighbouring countries would facilitate the planning of the grid and electricity production. Within the framework of the MSP, some major projects were intended, at least partially, for the export of electricity via Syria and Jordan. This concerned mainly CSP plants during the day (600 MW in 2020). Best practices from neighbouring countries (example Tunisia for SWH) could help Lebanon to group together small projects, in particular those covering individual and collective SWH projects for the residential and service sectors and biomass in order to make them more interesting for large banks and investors.

The government must also carry out a prior regional strategic Environmental Impact Assessment (EIA), in order to gain a clearer understanding of the combined impact of the various projects. In practice, the government should decide to go even further and optimise the selection of sites suitable for large solar and wind power stations, while facilitating the work of industrialists, by designating Renewable Energy Development Zones (REDZ). Planning in Lebanon should take account of climate conditions (sun, wind, biomass, etc.) and the strategic EIA, including any human presence in the region, biodiversity, the fertility of the land, cooling water resources for solar thermal plants, the presence or absence of electricity grids and infrastructures, the closeness of centres of consumption, etc.

CONCLUSION

- Lebanon is very dependent on fossil energy imports. It imports about 98% of its primary energy, and most of the electricity is produced with heavy oil and diesel oil. Despite 3000 hours of sunshine per year and an average annual solar flow of 4.8 kWh/m²/day it only has 1% renewable energy, and that is mainly from hydropower.
- The power sector in Lebanon is suffering from inefficiencies and cuts.

- Electricity subsidies are a heavy burden on the public budget (17% of government expenditures in 2007). In addition, more than 20% of electricity bills are not collected.
- Growing energy consumption and growing energy prices are increasing this financial pressure.
- The electricity Law No 462 (year 2002) for the privatisation of Electricity Sector and the Establishment of a Regulation Authority still not enforced.
- At the government level there are no ministries that deal with renewable energy or energy efficiency. There is no official renewable energy or energy efficiency agency either. There are several sustainable energy experts and active NGOs in the country.
- Lebanese banks do have sufficient financial resources and are looking for interesting investments.

This International and Mediterranean context should be favourable to start a discussion on renewable energy and energy efficiency and work on increasing the share of renewable energy in the Lebanese energy mix. There are some barriers hindering the uptake:

- energy tariffs do not reflect the real cost of energy, especially electricity,
- absence of capacity at the political level and of political decisions in favour of renewable energy and energy efficiency,
- no adequate consideration of negative energy externalities,
- lack of capacity/awareness at various levels to promote sustainable energy options,
- no effective legislation,
- the actual electricity plan 2010-2014 is not in line with Lebanon government target to source 12 percent of all energy needs of the country from renewable by 2020.

Activities and results:
Civil society is well organised in Lebanon, with dynamic NGOs, such as the ALMEE, LSES, LGBC, LCEC, Green Line, IndyAct, etc., and also skilled and organised professionals bodies (Order of Architects and Engineers, ASHRAE, etc.). WWF (an international NGO with high experience and skills) is wondering to work with most of them to achieve activities related to Mediterranean Solar (hot) Spot programme.

In Lebanon ALMEE and NGOs should:

- Act for the development of a comprehensive RE&EE Strategy.
- Focus on capacity building and awareness on RE, EE and energy subsidies.
- Improve the technical and scientific infrastructure for EE & RE research development (see annex)
- Work with stakeholders to develop mechanisms for RE & EE incentives and to phase out electricity subsidies [10].
- Work with stakeholders to review the electricity plan 2010-2014 for more RE in the electricity mix.
- Work with civil society stakeholders to campaign for a more sustainable energy mix and RE and EE targets,
- Work with stakeholders to campaign for a favourable legislative framework for RE.
- Document with partners positive experiences in the world and in the region, focussing on solutions that are applicable to Lebanon.
- Use these to inform and capacitate Lebanese society at different levels from active civil society to more passive government officials.
- Experiment with a RE subsidy scheme in a showcase project with public and private partners.
- Document the socioeconomic and environmental impact of large expected RE projects and get feedback from civil society regarding these projects.

RECOMMENDATIONS

- Sustainable energy requires the right energy context & strong national **energy policy & reforms** and the right international support.
- Overall energy **reforms rely on** strategy, institution and regulation (balanced prices & direct subsidies) to reach economic fundamentals and social balance.
- **Focus on EE (regulation)** to limit impact of demand increase.
- **Ownership** and national & regional institution/capacity building are key (Med best practices).
- Financial support dispersed and little adapted to small and medium EE & RE projects: need for a Med EE & RE Fund.

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WWF for a living planet	This paper is based on the Lebanon Fact Sheet prepared with the support of (WWF) Panda (NGO) in the frame of the Mediterranean Solar (hot) Spot – Preparation Phase.
	The research leading to these results has received funding from the European Community's Seventh Framework Programme FP7/2007-2013 under grant agreement no 245583.

Annex

RESSOL-MEDBUILD PROJECT
WORKSHOP ON SOLAR ENERGY IN LEBANON: RESEARCH TRENDS
WORKSHOP'S RECOMMENDATIONS

By the end of the workshop on "Solar Energy in Lebanon" held in October 8, 2010 within the frame of the European project RESSOL-MEDBUID, the scientific committee has established the recommendations stated in this document.

Recommendations are given to encourage the establishment of fruitful activities to be done within the domain of solar energy exploitation in Lebanon and in the region. Some of the following recommendations could also be considered as a global subject for launching research works. Three categories of recommendations are given. The first one concern human resources, the second category is on technical resources and the third one is related to legislative and administrative aspects.

1- Increase Human Resources to be involved in solar energy projects:
   a. Implement short term training programs
   b. Establish educational scientific programs at all levels: technical, undergraduate and graduate
   c. Integrate within these programs the legislative and the administrative aspects related to the implementation of solar energy projects
   d. Encourage the establishment of multidisciplinary research teams

2- Improve the technical and scientific infrastructure:
   a. Generate technical and scientific guides for projects implementation in the Lebanese and the regional area.
   b. Complete the existing Solar Maps of Lebanon and the region
   c. Establish an update process for the completed solar maps
   d. Adapt when necessary the international standards related to solar energy production and distribution
   e. Study the process of technical adaptation of the electrical distribution network for future grid connectivity

3- Create a legislative support for facilitating the implementation of solar energy generation and distribution.
   a. Establishment on the national basis a legislative committee for this purpose
   b. Members of the legislative committee to be from the public and private sectors of legislation, science, industry, economy and administration
   c. Provide the appropriate scientific and technical support to the legislative committee

The following items are major necessities for making the above recommendations feasible and fruitful:
   a. Establish a cooperation between private and public sectors
   b. Benefit from the expertise of international institutions that have proved their skills through the establishment of important solar energy projects
   c. Benefit from the financial support of international programs

Call For Papers

International Conference on Renewable Energies for Developing Countries

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Conference Venue

Science, art, culture & entertainment give an insight into the social life of the capital of Lebanon. Beirut is a melting pot of several cultures. Arabic traditions, oriental and western influences offer a perfect blend of a specific society in the world. Art has formed an integral part of Beirut's history. Older universities in the Middle East region were established in Beirut. This wonderful city will be the conference venue.

Conference Objectives

Some developing countries are actually active in the domain of exploiting renewable energies. They are doing efforts in order to progress towards a green future. They tend to be in conformity with international requirements to protect the environment. Also, some projects are implemented in these countries in order to reduce their external energy dependence. Although the willingness for introducing renewable energies is apparent, there are still important economical constraints preventing them from investing in this hot area.

National strategies in these countries need to be enforced with more appropriate technical solutions and more accurate data acquisition of resources. A common vision among national stakeholders in the domain of renewable energies should be considered. Laws and regulatory issues need to be more adapted. The conference aim is to benefit from international experience and discuss innovative scientific solutions adapted to the developing countries situations. Researchers from local and foreign universities will suggest during this conference solutions for specific problems. Professionals will find the opportunity to know about the most efficient way for investing in renewable energies in these countries. Case Studies on successful solutions and on supporting programs will be presented. The adaptation of laws and regulations will be discussed for an easy penetration of renewable energies in developing countries.

Conference Topics

1. Renewable Energy resources in developing countries (wind, solar, biomass, hydraulic, geothermal, waves, tidal...)
2. Technologies related to Renewable Energy sources in developing countries (state of the art, technological solutions, successful applications, lowered barriers...)
3. Energy saving and energy efficiency measures (energy conversion, power electronic conversion and compensation, energy storage, energy efficient buildings...)
4. Energy management (simulation software, smart buildings, smart grids...)
5. Policy, regulations and laws related to an effective penetration of Renewable Energies in developing countries (solutions, incentive measures, successful examples, investment and financial mechanisms, released constraints...)
6. Capacity and institutional building for the specific needs of Renewable Energy penetration in developing countries (knowledge transfer, development of institutional structures...)
7. Educational and research programs in the domain of Renewable Energies (technical, undergraduate, master, higher education, research...)
8. Regional & International supporting programs for renewable energies penetration in developing countries (CTF, UFM, EC-Paving the Way for the MSP, MEDGRID, DESERTEC, RESSOL, CLEAN ENERTEC, ALGUE...)

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Important dates

Deadline for full paper submission: June 30, 2012.
Notification of acceptance: October 6, 2012.

Deadline for submission of camera ready accepted papers: October 27, 2012.
Conference dates: November 28 – 29, 2012.

ESCWA Joint event date (www.escwa.un.org): November 27, 2012