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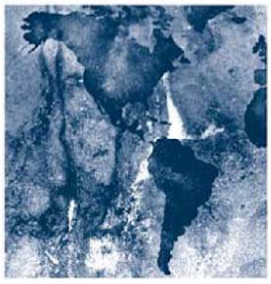
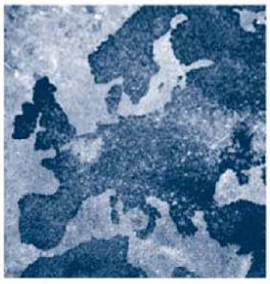
WORLD BANK

ENERGY EFFICIENCY STUDY IN LEBANON

FINAL REPORT
- December 2009 -





ECONOLER
INTERNATIONAL

ABBREVIATIONS AND ACRONYMS

ALI	Association of Lebanese Industrialists
ALMEE	Lebanese Association for Energy Saving & for Environment
CCGT	Combined Cycle Gas Turbine
CDM	Clean Development Mechanism
CFL	Compact Fluorescent Lamp
CRW	Combustible Renewables & Wastes
ECSWA	Economic and Social Commission for Western Asia
EDL	Électricité Du Liban
EDZ	Electricité de Zahlé
EE	Energy Efficiency
ESCO	Energy Services Companies
GDP	Gross Domestic Product
GEF	Global Environment Facility
GWh	Gigawatt Hour
HV	High Voltage
IEA	International Energy Agency
IRI	Industrial Research Institute
ISES	International Solar Energy Society
ktoe	Kilo Tons of Oil Equivalent
LAMP	Lebanese Action for the Management of Power Usage in Lighting
LCEC	Lebanese Center for Energy Conservation Project
LIBNOR	Lebanese Standards Institution
LSES	Lebanese Solar Energy Society
LV	Low Voltage
MEW	Ministry of Energy and Water
MSP	Mediterranean Solar Plan
MV	Medium Voltage
MW	Megawatt
OEA	Order of Engineers and Architects in Beirut
PPP	Purchasing Power Parity
RE	Renewable Energy
TEPS	Total Primary Energy Supply
TOE	Ton of Oil Equivalent
UNDP	United Nations Development Program

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EXECUTIVE SUMMARY

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. Energy efficiency (EE) is considered as a good alternative towards improving the current situation and reducing the energy losses. In 2006, the electricity consumption in Lebanon was estimated to be 13,200 GWh[1], of which approximately 61% was supplied by EDL, 34% through self-generation and the balance represented the suppressed demand. Hence, any action taken to reduce the country's energy consumption will improve the availability of electricity, reduce the need to import electricity and decrease self-generation.

The energy efficiency initiatives undertaken in Lebanon are diverse but need support for their implementation in the form of a global program covering all the sectors where the potential seems to be attractive. In spite of the lack of detailed data on the country's energy consumption preliminary energy efficiency evaluation was conducted in the attempt to develop an Action Plan for the Lebanese Government.

The actions summarized below have been identified based on available data and best practices in similar countries with comparable backgrounds. The actions have been ranked as short-, medium- and long-term priorities and presented according to the magnitude of expected savings.

The short term-priorities, with an implementation period of 5 years, include promoting the use of compact fluorescent lamps (CFLs) and solar water heaters (SWHs) in the residential sector. Their implementation would respectively result in a reduction of 187 MW and 39 MW for EDL that could reduce or eliminate the imports from Syria that totaled 200 MW in 2006.

The CFL Program could generate savings of about 239 GWh a year, which represents approximately USD 35 million in savings for EDL. The program will target the replacement of 3.5 millions lamps and provide incentives to households where they will be offered 1 lamp out of 3 free of charge and a subsidy of 50% of the cost of the 2 remaining CFLs. The investment for the implementation of the CFL Program is estimated at about USD 11 million.

The Solar Water Heater Program for residential sector could generate an annual savings of about 337 GWh, which represents about USD 49 million in savings for EDL. The Program will target the implementation of about 215 000 SWH units over a period of 5 years and provide about 20% of the cost of the heaters as an incentive. The total investment for the Program is estimated at USD 76 million.

The medium-term Action Plan includes programs with an implementation period of between 5 and 10 years. The first program will concern improving the energy efficiency in the industrial sector where the

[1] Electricity Sector Public Expenditure Review, World Bank, January 31,2008

electricity consumption in 2006 was about 60% of the country's overall consumption (26% of the total electricity produced by EDL and the remaining 34% produced by self-generation). In addition, the total oil consumption in the industrial sector is estimated at about 22.5% of the total country's consumption. The industrial sector therefore represents an important candidate for an energy efficiency program and energy savings. Unfortunately, no extensive data are available on the industry's specific energy end users and their technological levels. In spite of this fact,, the proposed program has been tailored based the sector's energy consumption, energy audits performed in the Lebanese industrial sector and the results of energy efficiency actions undertaken in the industrial sector over the last two decades[2] .

Based on our evaluation, the Energy Efficiency Program in the industrial sector could reduce the sector's electrical demand by about 16 MW, a total energy annual savings of USD 27 million represents around 35 KTOE. This would help the sector to generate about USD 18 million in savings on the end users' energy bills. The investment required for the implementation of the EE Program is estimated at USD 27 million.

The second medium-term program concerns street lighting, where the use of mercury lamps is estimated to be about 40% of the network. The objectives of the program will be to replace all mercury lamps with Sodium High Pressure lamps (SHP) and to introduce dimming and regulations systems to reduce the lighting intensity during the low traffic hours. These energy conservation measures will generate annual savings of about USD 6.5 million annually for EDL and reduce the energy bills of municipalities by USD 3 million, which could be used to finance municipal infrastructures and social programs. An estimated amount of USD 9.4 million is required for the implementation of the Street Lighting Program.

The long-term priorities include standards and labelling for appliances and thermal standards for new buildings. The Standards and Labelling Program will introduce an energy performance labelling scheme by setting up a certification process to determine the energy efficiency of appliances and displaying the information on the equipment on sale through a comparative labelling scheme. The cost of the implementation of the S&L Program is estimated at USD 7.7 million and it is expected the program will generate an average annual savings for consumers of around USD 6 million, which will translate to about USD 17.8 million in savings for EDL with a demand reduction of 19 MW. The program components focusing on refrigerators and air conditioning units will reduce the country's energy consumption by 582 KTOE annually.

The last proposed program in the Action Plan concerns the implementation of thermal standards. Based on the activities initiated 2005, the proposed Thermal Standards Program proposes a step-by-step path for the implementation of a nationwide program that would introduce the thermal standards as a mandatory requirement after an initial voluntary period of two years. With an estimated investment of USD 3.1 million, the project's long-term benefits are evaluated at 1,000 KTOE in annual

[2] IEA: Tracking Industrial Energy Efficiency and CO_2 Emissions

savings with reduced costs of about USD 14 million for EDL and a reduction in energy bills of 6.1 million for the end users.

The short-term Action Plan represents the “hanging fruit” that will help to not only reduce Lebanon's overall energy consumption and improve EDL's energy supply capacity, but to also improve the country’s energy efficiency with regards to the resources required, the benefits and implementation timeframe.

INTRODUCTION

Lebanon currently faces a serious energy challenge associated with fulfilling its social and economic development goals because of a lack of domestic energy resources, reduced generation capacities and the growing demand for energy. The current demand for electricity in the country is around 2,300 MW and EDL is incessantly struggling to ensure the continuous delivery of power with its maximum in the range of 1,500 MW.

The energy sector suffers from years of overall poor governance, weak management of the sector's agencies and high inefficiencies in its infrastructures including power plants and transmission and distribution networks. The reliance on costly imported fuel for power generation[3] despite long-standing plans to introduce natural gas remains one of the barriers with the increasing cost of fuel and relatively low electricity tariffs. In spite of the efforts, the electricity network does not represent a reliable source for the industrial and commercial sectors, where most end users have been compelled to install and use their own generation systems to overcome the electricity shortages and ensure the continuity of their operations. Efficiently using the available resources, reducing the overall losses and the effective use of energy appear to be adequate strategies to reduce the power shortages and help to improve the economic well being of not only the utility but the end users as well.

The purpose of this report is to assess the status of past and current energy efficiency initiatives in Lebanon and, in conjunction with key stakeholders, prepare an Energy Efficiency Action Plan, ensuring the Government's support in the implementation of this Action Plan in the near future.

The identified EE programs have been developed based on available data and information gathered during our one-week field mission and the best practices in similar countries with comparable backgrounds.

The savings and investments for each proposed program have been evaluated outlining the impacts of the expected emission reductions and of the expected primary energy savings. The major design phases of each program, their implementation, monitoring plans, and evaluation have been defined. Program financing sources have been recommended and enumerated for possible consideration during the development phase. The role of the various stakeholders has also been determined for each program with general recommendations and suggestions for the successful implementation of the programs.

[3] http://www.LCEC.org.lb/Files/ALI%20Survey%20Results%20Rev.%204-%20260207.pdf

1 ENERGY AND EE MARKET REVIEW

The electrification rate in Lebanon is about 99.9%, but this high rate is not reflected in the continuity of power supply and the services provided. The Lebanese electricity infrastructure has suffered significantly, mainly due to the conflict in 2006 and has not been rectified yet. The low quality of the country's electricity services as well as supply shortages and hazards have forced some consumers to meet their needs through other generation sources especially in the industrial sector where for each 1 MW supplied by EDL a 2 MW backup generator has been installed (ALI/LCEC report). Due to increasing oil prices, the energy sector constitutes a heavy burden on the country's economy and, because this situation persists, many consumers have considerably invested in backup generators, which have significantly affected the country's efficiency in terms of power generation.

1.1 PRIMARY ENERGY SUPPLY

Lebanon imports most of its petroleum products; this represented 97% of its primary energy needs in 2006. The country does not produce oil or coal and most of its energy needs are imported. Unfortunately, the cost of petroleum imports are continuously on the rise and the electricity sector's debt is getting larger and larger.

Renewable energy options are available including tides and waves, geothermal energy, solar energy, wind energy, hydropower, biomass and energy from non-separated waste; however these resources are not widely used. Altogether, hydro, combustion/renewable/waste (CRW) and geothermal/solar/wind power only represented 4% of the country's energy balance in 2006. Lebanon therefore has the potential for the implementation of more renewable energy technologies.

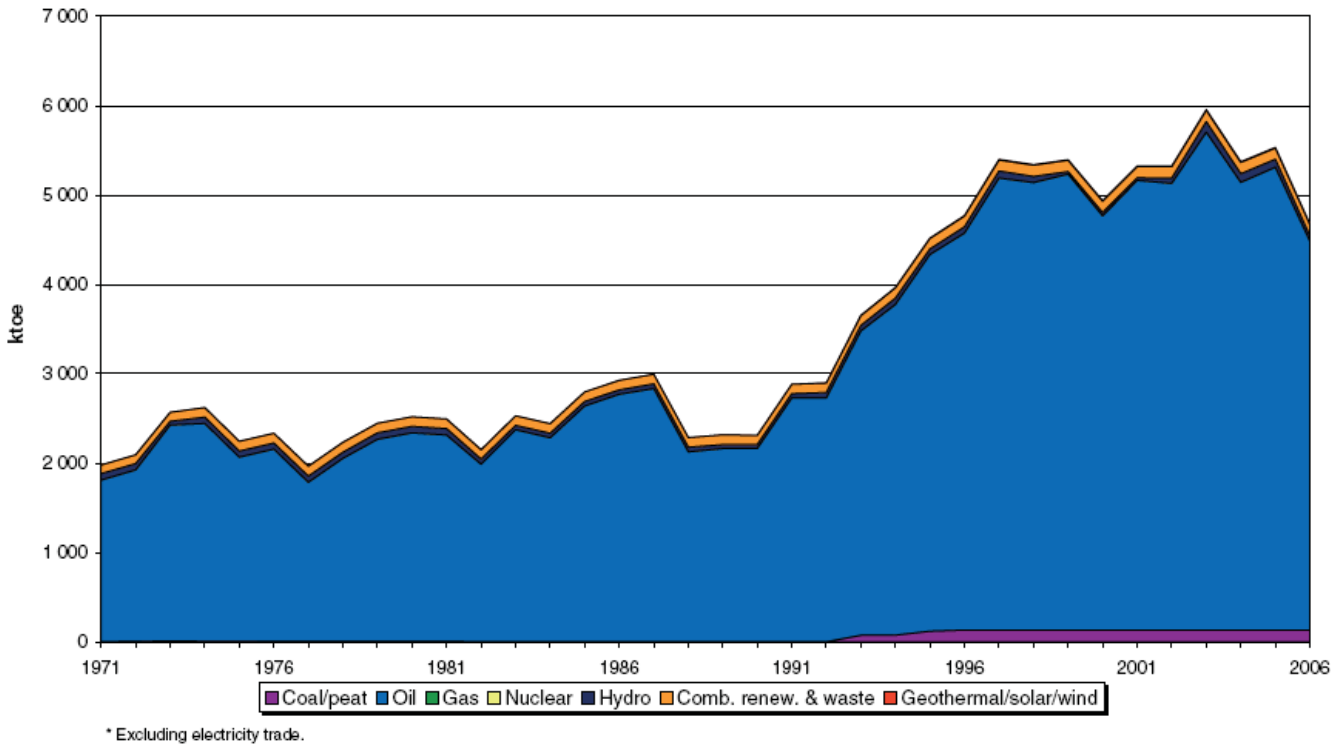


Figure 1: Total Primary Energy Supply[4]

In 2006, the Total Primary Energy Supply (TEPS)[5] was 4.76 million toe, of which local energy sources represented a mere 4%. The latest reported share includes hydropower: 60 ktoe (1.3% of the total supply), CRW[6]: 127 ktoe (2.7% of the total supply) and a tiny portion generated by solar energy: l8 ktoe (0.002% of the total supply)[7]. Imported petroleum products represent 91.44%[8] of the total energy supply and coal and peat imports represent around 3%. Oil represented 4.109 ktoe[9] in 2006, where gas/diesel accounted for 38.8%, residual fuel oil for 25% and gasoline for 29%.

As shown in Figure 1, from 1991 to 2005, the TEPS increased at a very high rate but, in 2006, the primary energy demand began to decrease. This was partially explained by the destruction of the electricity infrastructure caused by hostilities with Israel in July-August 2006.

As is the case in any developing country, Lebanon's electricity demand will keep increasing in the future and its electricity network will need to be upgraded accordingly.

[4] http://www.iea.org/textbase/stats/pdf_graphs/LBTPES.pdf
[5] Total Primary Energy Supply: Indigenous production + imports – exports – international marine bunkers ± stock changes
[6] Combustible renewables and waste – solid biomass and animal products, gas/liquids from biomass, industrial and municipal waste
[7] http://www.iea.org/Textbase/stats/balancetable.asp?COUNTRY_CODE=LB
[8] http://www.iea.org/Textbase/stats/balancetable.asp?COUNTRY_CODE=LB
[9] http://www.iea.org/Textbase/stats/balancetable.asp?COUNTRY_CODE=LB

The oil consumption of the EDL plants accounts for 76% of the total gas-oil and fuel oil consumption, which was equivalent to 213,000 tons in 2006[10]. The consumption of the power plants represents 47%[11] of the total imported primary energy while the transportation sector comes in second place with 33%. To compensate for EDL's power shortages, hundreds of generator sets were disseminated nation-wide to produce electricity mostly powered by diesel fuel. No official data on the consumption levels of those who use self-generation as an option is available.

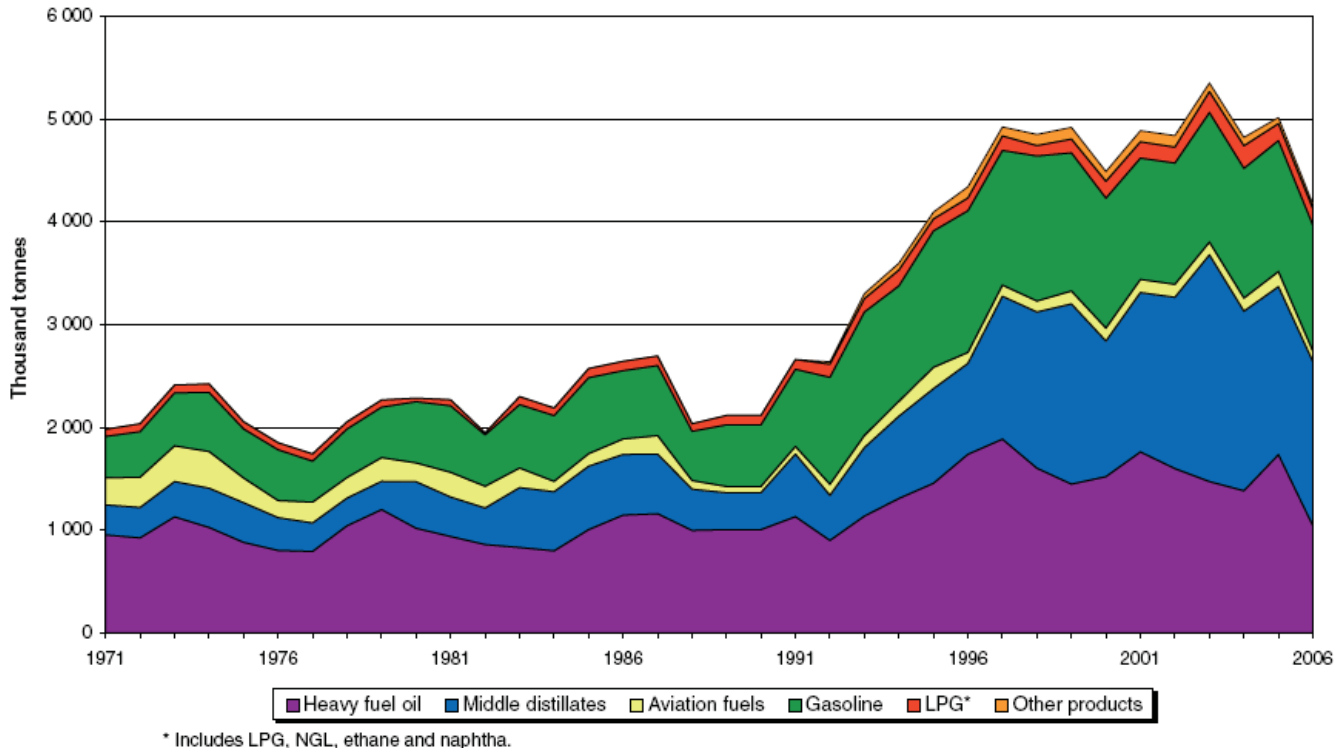


Figure 2: Consumption of Oil Products[12]

Over the last few years, the country's energy consumption was steady due to the on-going economic recession. Between 2005 and 2006, primary energy import decreased by around 20%, whereas the national energy bill increased by 19% (Figure 3). This growth in the energy bill was mainly due to the increase in oil prices that reached USD 2,500 million in 2006.

[10] http://www.almee.org/pdf/L'ENERGIE%20AU%20LIBAN%202006.pdf
[11] http://www.iea.org/Textbase/stats/balancetable.asp?COUNTRY_CODE=LB
[12] http://www.iea.org/textbase/stats/pdf_graphs/LBOIL.pdf

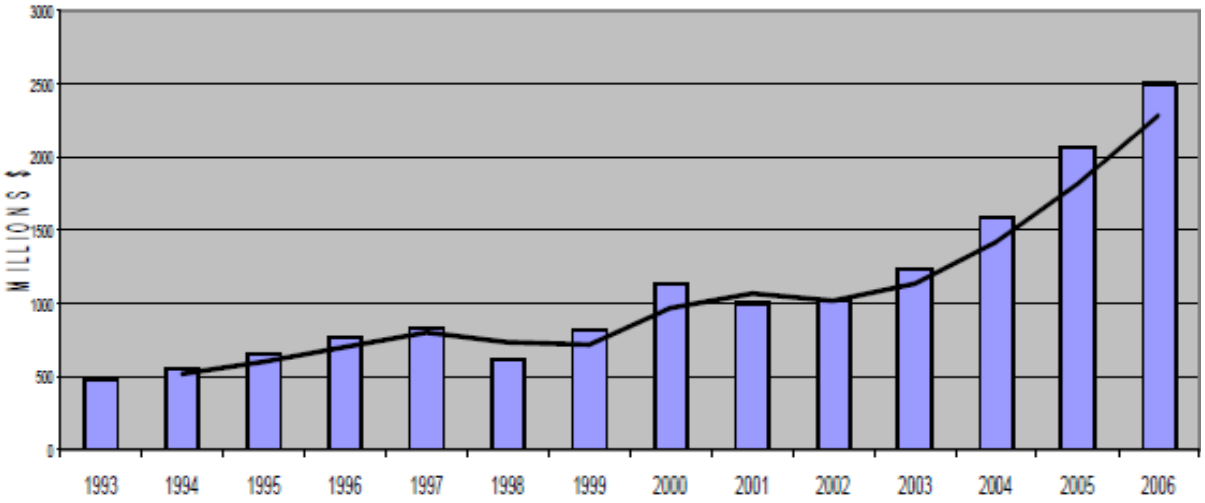


Figure 3: Energy Bills[13]

Table 3 shows the production (4%) and imports (96%) of the oil products that were consumed.

Table 1: Consumption of Oil Products[14]

1: Production				ktep	(%)
	HYDRO	GWh	695	60	
	CRW & solar			133	
Total 1				**193**	**4%**
2: Importation				ktep	
LGP		ktonne	161	182	
Gasoline		ktonne	1225	1310	
Gasoil	EDL	ktonne	1058		
	Market	ktonne	539		
	Total 2-1	ktonne	1596	1723	
Fuel oil	EDL	ktonne	957		
	Market	ktonne	83		
	Total 2-2	ktonne	1040	999	
Carbureacteur		ktonne	103	111	
Electricity		GWh	929	82	
Coal and peat		ktonne	200	132	
APP			44	42	
International Marine Bunkers				-16	
Total 2				**4565**	**96%**
Total 1&2				**4758**	

[13] http://www.almee.org/pdf/L'ENERGIE%20AU%20LIBAN%202006.pdf
[14] http://www.almee.org/pdf/L'ENERGIE%20AU%20LIBAN%202006.pdf and http://www.iea.org/Textbase/stats/balancetable.asp?COUNTRY_CODE=LB

Figure 4 presents the results of the survey conducted by ALI and LCEC[15] showing the oil consumption per sector in Lebanon.

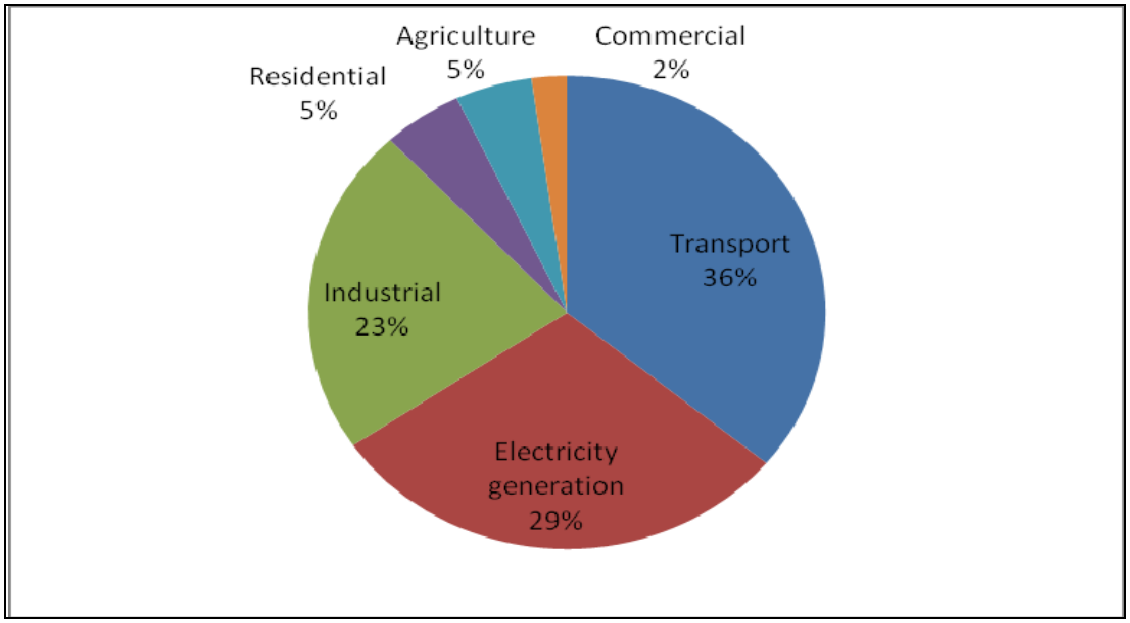


Figure 4: Consumption of Oil Products per Sector

As mentioned in the State of Energy in Lebanon Report, ‘’Lebanon is an energy intensive country, far more so than other neighbouring southern Mediterranean countries, with an energy intensity measured in 2006 at 0.24 toe/1000 USD 2000 (PPP). Its per capita primary energy supply is 1.17 toe/capita.’’[16]

1.2 ELECTRICITY SECTOR

1.2.1 Primary Energy Consumption

The power sector in Lebanon is dominated by Électricité Du Liban (EDL), which is the main governmental electricity provider in Lebanon. With seven power plants that currently operate on either gas-oil or fuel-oil, EDL's fuel consumption ranges between 30% and 35% of the total national imports, in terms of dollar values; this represented around USD 475 million in 2004 and around USD 900 million in 2006[17], . EDL is suffering from a lack of technical and managerial capacities and would require advanced systems to manage and monitor performance. Its financial situation is weak with an annual

[15] Understanding Energy Use in the Industrial Sector of Lebanon, Survey 2006, ALI/LCEC Report
[16] http://www.almee.org/pdf/state%20of%20the%20energy%20in%20Lebanon.pdf
[17] Financial and Engineering Support to EDL, Base Year Data Report, page 18, prepared by BCEOM

Deficit of close to USD 400 million and a rapidly deteriorating balance sheet showing retained losses of close to USD 1 billion[18].

1.2.2 Production Capacity

The electricity consumption in Lebanon was estimated at 8,684 GWh[19] in 2006, but this figure excluded self-generated electricity. An amount of 13,200 GWh[20] would be more realistic for the electricity consumption in 2006, from which about 61% was supplied by EDL, 34% through self-generation and the balance represented the suppressed demand.

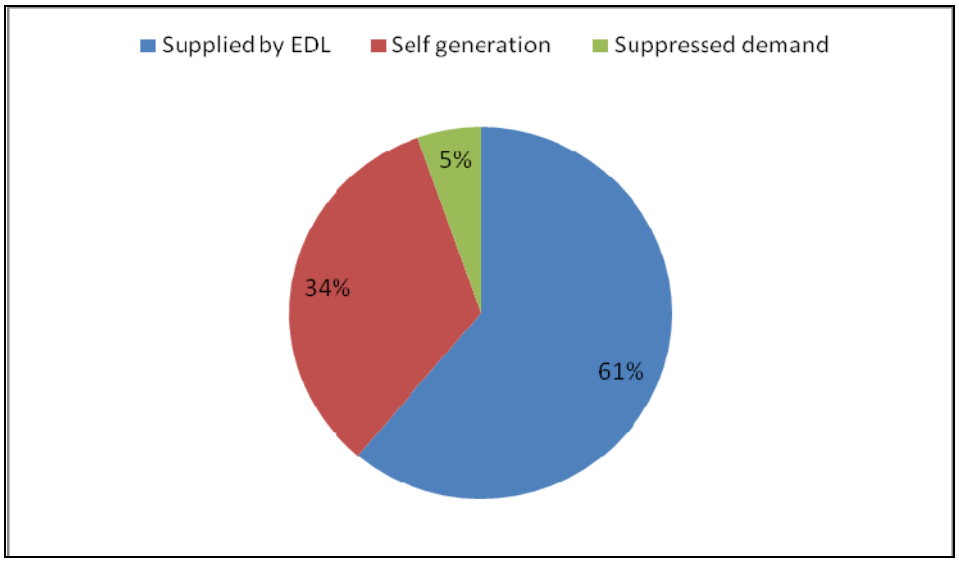


Figure 5: Electricity Production in 2006 (in GWh)

In numbers[21], 8,592 GWh were produced by oil, 695 GWh by hydropower plants and 929 GWh were imported. The technical losses represent about 15% of the total production. EDL's power generation plants are divided into two categories: thermal and hydraulic. There are seven thermal plants and three hydropower plants with a respective installed capacity of 2,038 MW[22] and 220.6 MW[23]. EDL's thermal plants are composed of steam turbine units with installed capacity of 1,300 MW and gas turbine units with an installed capacity of 738 MW[24]. The following Figure presents the percentage of installed capacity by plant category.

[18] Understanding Energy Use in the Industrial Sector of Lebanon- ALI/LCECP survey 2006, page 6
[19] http://www.iea.org/Textbase/stats/electricitydata.asp?COUNTRY_CODE=LB
[20] Electricity Sector Public Expenditure Review, World Bank, January 31,2008
[21] http://www.iea.org/Textbase/stats/electricitydata.asp?COUNTRY_CODE=LB
[22] http://www.edl.gov.lb/AboutEDL.htm#4
[23] idem
[24] http://www.EdL.gov.lb/AboutEDL.htm#3

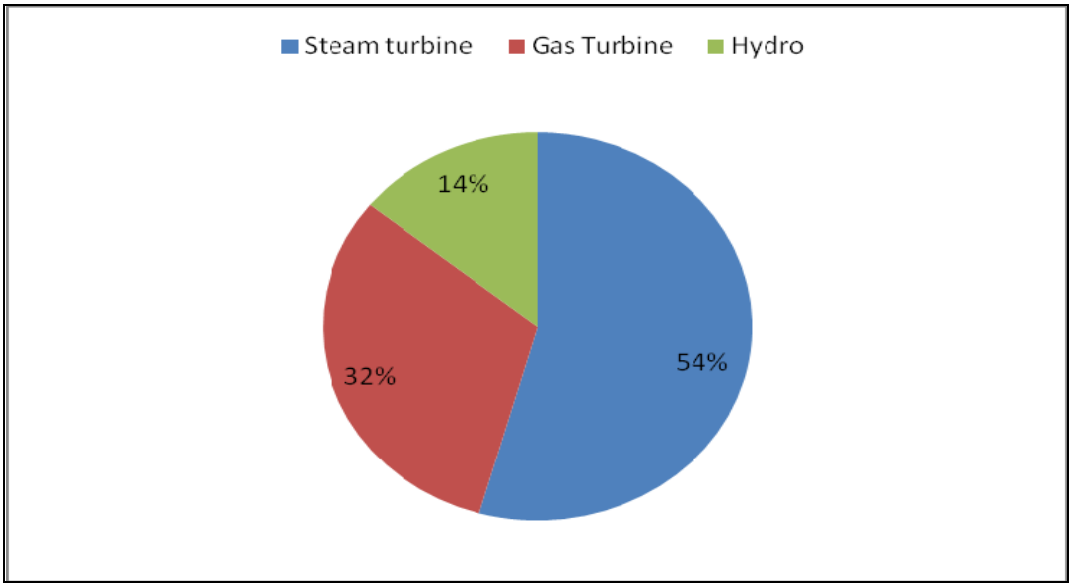


Figure 6: EDL's Installed Capacity by Plant Category

The installed capacity has risen in Lebanon since 1974 and most of the demand is met by EDL's thermal plants as shown in the figure below.

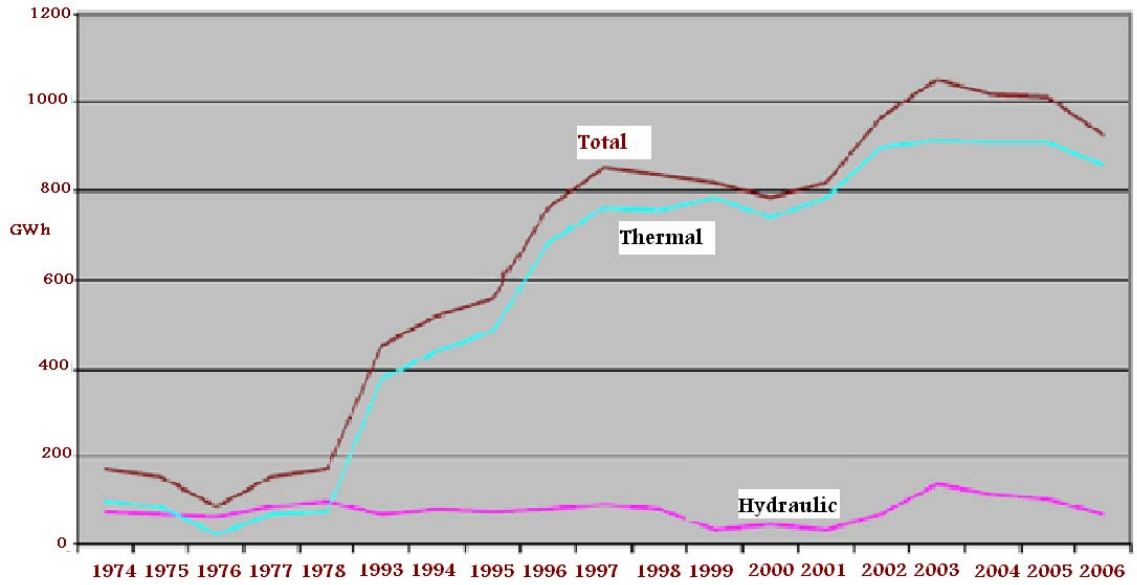


Figure 7: Evolution of the Electricity Production in Lebanon[25]

EDL's installed capacity is not sufficient to meet the demand of the entire country. Almost every day, EDL's electricity supply is cut and industries suffer from these frequent outages. As a result, about

[25] http://www.almee.org/pdf/L'ENERGIE%20AU%20LIBAN%202006.pdf

34% of the electricity is produced through self-generation. Besides increasing its supply capacities, EDL's grid requires improvements to regain the trust of its consumers trust Most of the population must pay at least an additional 25%[26] for self-generation to meet their needs every month. EDL's average electricity price is about 0.064 $/kWh and the cost of self-generation is estimated at 0.19$/kWh[27].

The difference between the peak demand (2,614 MW in 2006) and EDL's ability to meet this demand is compensated through self-generation, electricity imports from Syria and, from time to time, significant supply rationing. The current maximum import capacity from Syria is 300 MW. In 2006, EDL imported up to 200 MW at a price of approximately USD 0.12/ kWh.

1.2.3 Electrical Load Curve

The available EDL load curves for 2006 shows an evening peak load during the summer (June) and the winter (January). It is obvious that, with limited capacities, the load curves of EDL's electrical supply in June and in January do not reflect the real demand trends and cannot be used for any analysis. However, the country's demand curves can be used to compare loads between the wintertime and summertime. Based on the load curves illustrated in Figure 4, it is clear that maximum peak load occurs in the evening regardless the season, which is clearly linked to residential activities and demand. In the summer, the peak load during the day is most probably due to commercial activities and air conditioning during office hours since the demand load decreases at around 5 pm. The evening peak load occurs around 9 pm, which is mainly due to lighting and air conditioning, basically in the residential sector.

The analysis of the winter curve shows an evening peak load beginning at 5 pm and reaching its maximum at around 7 pm. The load is estimated to be the result lighting and most probably heating also, since the maximum load of 1845 MW in the winter exceeds the maximum load in the summer by approximately 114 MW.

[26] Electricity Sector Public Expenditure Review, World Bank, January 31, 2008
[27] Assumption: considering that the KWh produced by self-generation are equal to the KWh produced by gas turbines (0,19 $/kWh - source: LCEC)

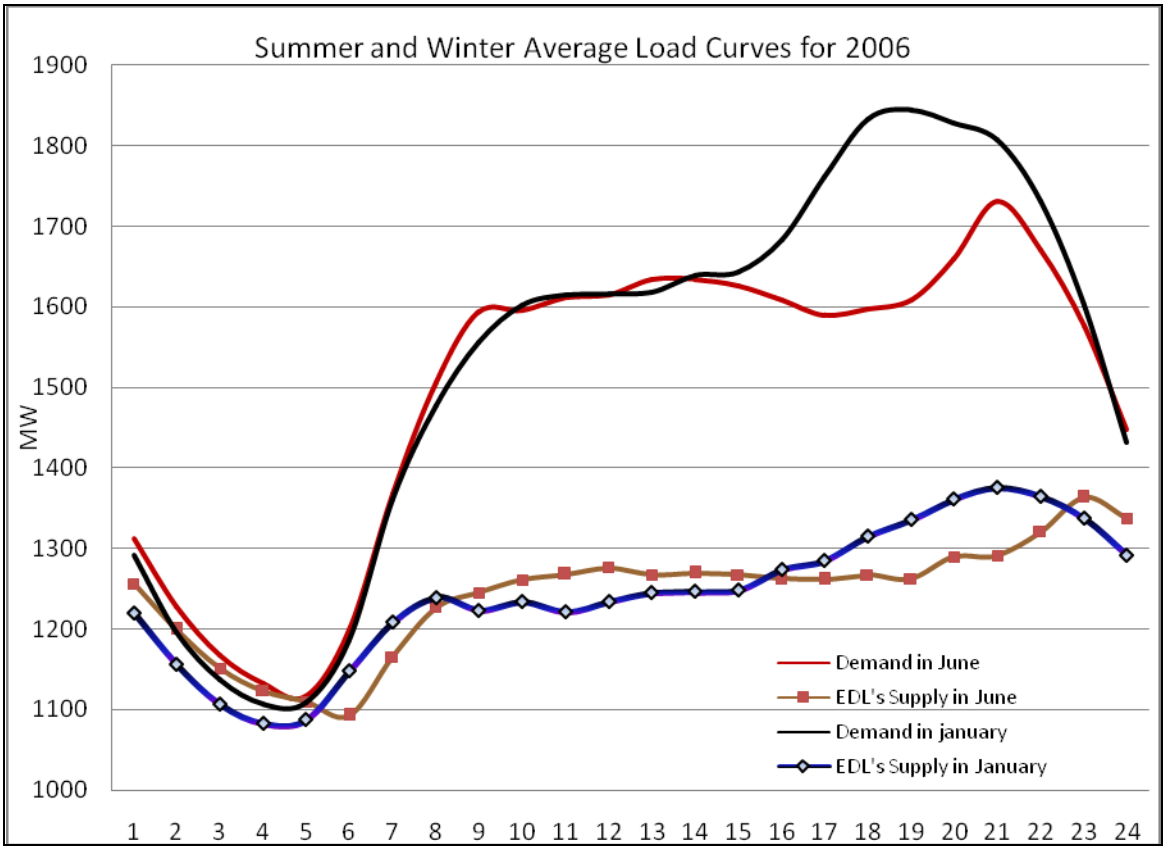


Figure 8: Demand and Supply Load Curves for January and June 2006

As for the electrical demand, the peak to off-peak ratio is approximately 167% and 155% respectively for January and June.

1.2.4 Electrical Energy Losses

Electricity losses are the losses resulting from the difference between the electricity produced and the power that is not paid for, which represents both technical and commercial losses as well. They represented about 60% from 1994 to 1996 and they decreased to 35% over the 2003 to 2005 period. These losses are a huge burden for the Government of Lebanon and especially for EDL, creating a serious threat to EDL's finances as mentioned in the EDL base year data report[28]. From 2002 to 2007, the technical losses were estimated at 15%, however the commercial losses significantly decreased during the same period. The commercial losses resulting from uncollectible energy bills and illegal connections were reported to be 18% in 2007. These commercial losses must be addressed in order to help improve EDL's revenues. The technical losses also need to be investigated since a percentage of 15% is considered high and an in-depth analysis should be conducted to determine ways to reduce this percentage.

[28] EDL, Energy EDL, Base Year Data Report, p. 75

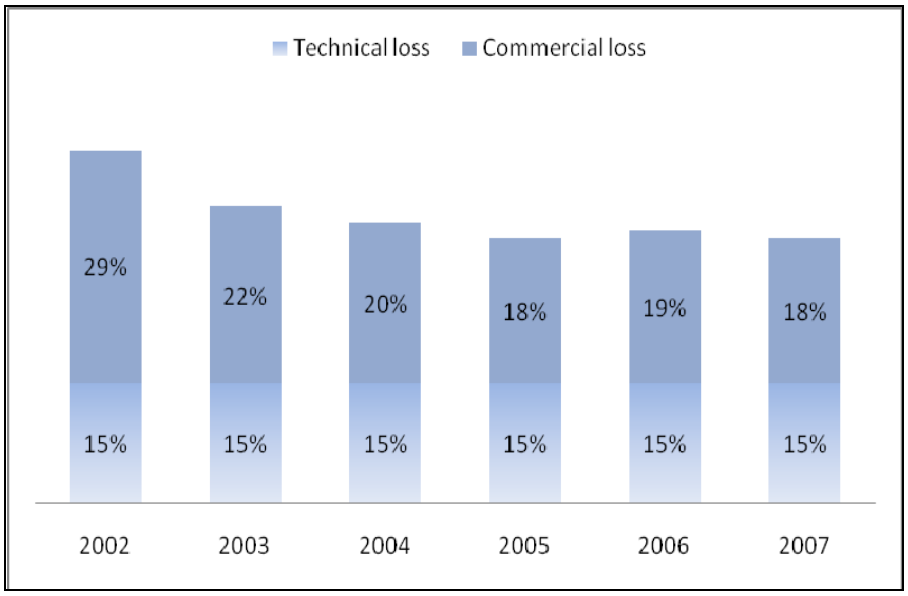


Figure 9: Electrical Energy Losses 2002-2007[29]

Appendix 2 presents information on the electricity demand and the evolution of electricity production in Lebanon.

1.2.5 Electricity Tariffs

Lebanon's electricity tariffs are high compared with regional standards and the quality of services provided, but they are considered too low to cover all EDL's costs. Most of Lebanon's electricity is generated by thermal plants and the tariff structure is based on the price of oil. EDL has three main tariff categories; high voltage (HV), medium voltage (MV) and low voltage (LV). The current tariff structure is presented in Appendix 1. The Ministry of Energy and Water (MEW) establishes and approves the electricity tariffs following EDL's recommendations. EDL has a total of 1,179,573 customers (12/12/2007). Two customers are supplied at the HV tariff, 3,114 at the MV tariff and the balance at the LV tariff.

The current tariff structure is based on an oil price of USD 25/barrel[30] and has not been adjusted to take into account the massive increase in international oil prices in recent years. According to the Electricity Sector Public Expenditure Review, the overall average tariff in 2006 based on the energy billed was USD 0.094/kWh. Compared to the electricity prices in the region, the Lebanese tariff level is in the upper bracket.

[29] EDL, Energy Management, Transmission Dept., Financial and Engineering Support Services to EDL, Base Year Data Report
[30] Source EDL, Sustainable Development Department, Report No. 41421-LB, page 25

Lebanon's electricity tariff is very similar to the tariffs in countries that are dependent on imported fuel for power generation such as Morocco and Jordan.

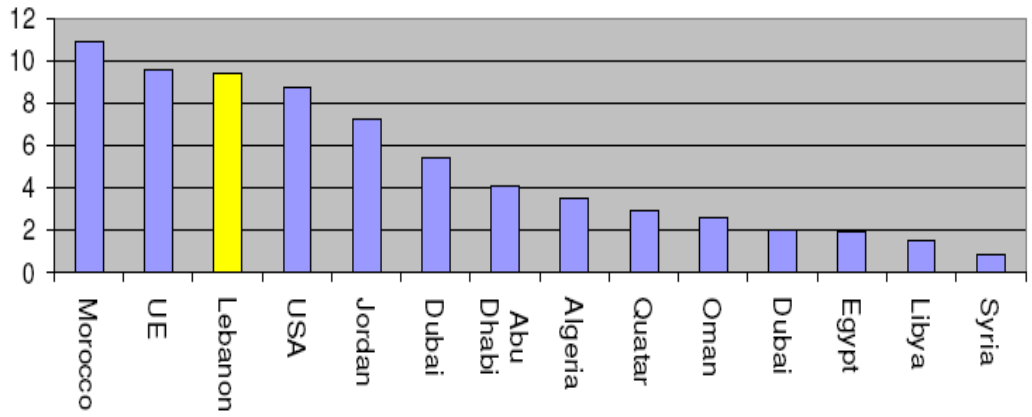


Figure 10: Regional Tariffs in US¢/kWh

For industrial users, the tariff structure actually encourages self-generation during peak periods. The average tariff for industrial consumers is USD 0.088 /kWh, but it jumps to USD 0.21/kWh at peak hours, which is close to the cost of self-generation.

For middle- and high-income residential consumers and large residential buildings equipped with generators to compensate for the unreliability of EDL's power supply, the running cost is competitive with the EDL tariff: for residential and commercial consumers, the tariff applied to each kWh consumed above the 500 kWh threshold is about USD 0.13 /kWh, which is close to the variable cost of a small diesel unit for self-generation. Details of electricity tariffs are presented in Appendix 1.

1.2.6 Electrical Consumption by 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%[31].

[31] Understanding Energy Use in the Industrial Sector of Lebanon, a Preliminary Analysis of the ALI/LCEC Survey results 2006

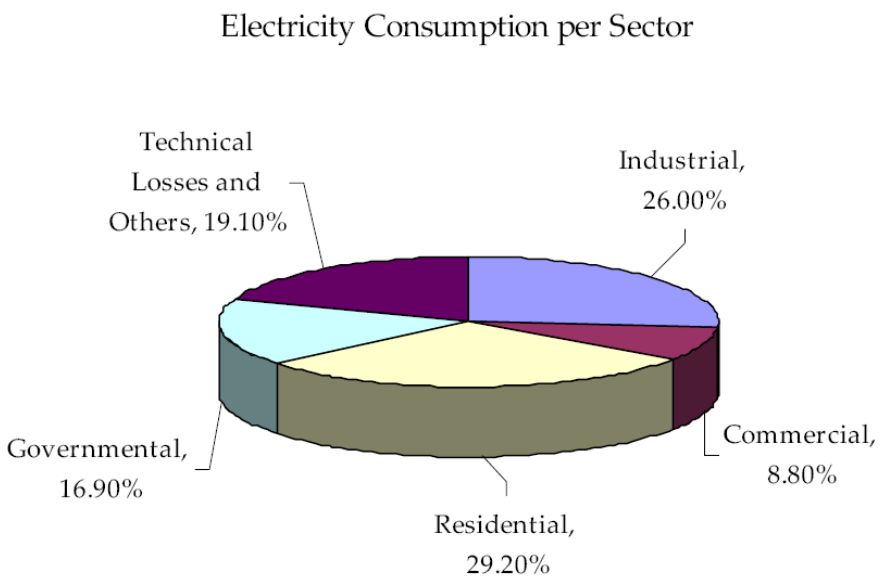


Figure 11: Electrical Consumption per Sector

According to the United Nations Framework Convention on Climate Change (UNFCCC), Lebanon's electricity consumption in the residential sector represents 30% of the country's total electrical energy consumption. Figure 8 presents the electrical energy consumption by end use in the residential sector.

The most recent data available on the electrical energy consumption per end use[32] in the residential and commercial sectors shows a relatively high consumption for 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 4.

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.

[32] http://www.lcecp.org.lb/Templates/InsideTemplate.aspx?PostingId=15

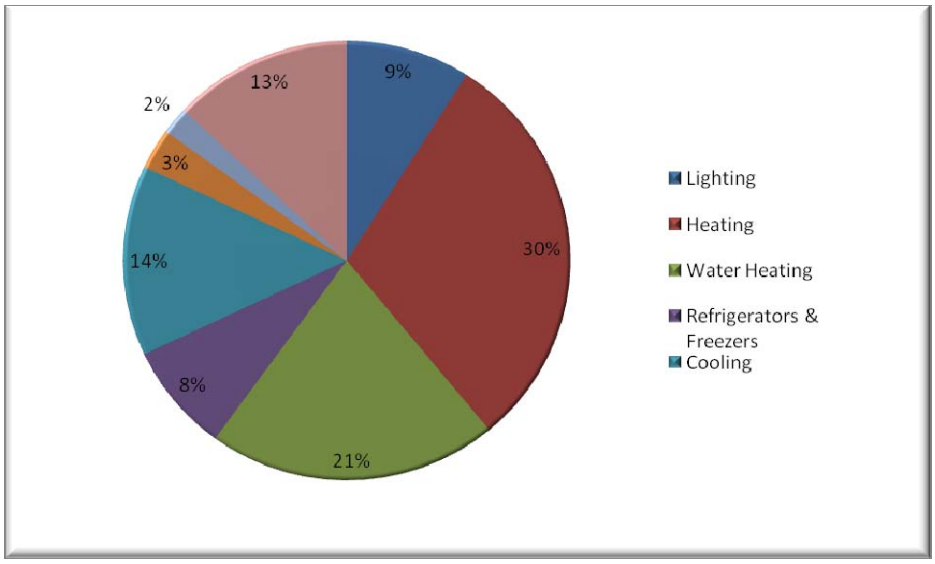


Figure 12: Electrical Consumption per End Use in the Commercial and Residential Sectors

1.2.7 Electricity Demand Forecast

EDL previously reported an estimated 4%-5% growth in the domestic demand for electricity for heating in Lebanon. As mentioned in the study on the electricity sector performed in January 2008 by the Sustainable Development Department, the total demand forecast for electricity will increase to 5.9% as of 2010 onward[33].

Three cases were analyzed in the study: a baseline case, a low case scenario and a high case scenario. The following figures show that the country's total electricity demand will reach about 4,000 MW and 21,000,000 MWh by 2015 for the baseline case. Based on this forecast, Lebanon (EDL and self-generation) would need to add 1,500 MW by 2015 to meet the total demand. Under the low case scenario, the additional capacity required would be about 700 MW and, in the high case scenario, 1,700 MW. These estimates were based on the GDP forecast for Lebanon provided by the World Bank. The following figures present the project's total electricity demand and consumption forecasts[34].

[33] Republic of Lebanon, Electricity Sector Public Expenditure Review, January 31, 2008
[34] The World Bank, Analysis 2007

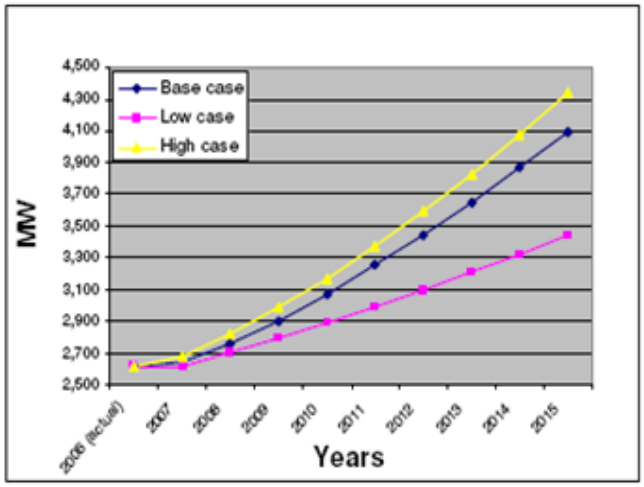


Figure 13: Total Electricity Demand Forecast

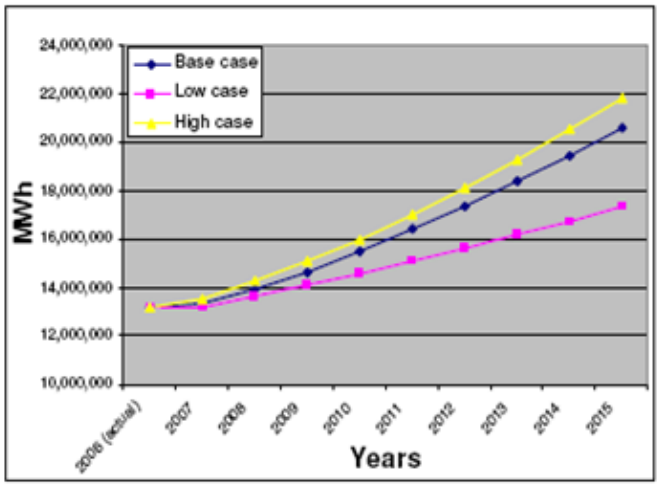


Figure 14: Total Electricity Consumption Forecast

Additional information about the main indicators of CO2 emissions, the summary of CO2 emitted by activity sector and the summary of GHG emissions in Lebanon are presented in Appendix 2.

1.3 EXISTING ENERGY EFFICIENCY PROGRAMS

This section includes a review of existing and ongoing energy efficiency projects and provides a picture of Lebanon's energy efficiency situation. The existing energy efficiency initiatives mainly concern energy audits, the labelling of refrigerators, thermal standards for new buildings, CFL and street lighting programs. The identified barriers have been listed to highlight the actions needed to ensure the continuity and effectiveness of the projects.

1.3.1 Energy Audits

Summary Description

Energy audits help to review the energy balance and define the potential for energy savings per sector. LCEC has supervised about 120 energy audits in various sectors. Detailed data for 58 completed audits was provided by LCEC and the sectors in which these audits were performed are listed in the following table. The data supplied by LCEC have been used to assess the potential for energy efficiency and EE technologies in the industrial sector.

Table 2: Energy Audits Performed per Sector[35]

Sector	Number of Energy Audits
Industry	17
Hotels	3
Hospitals	7
Pumping stations	3
Buildings and other	28

Impacts Forecast

An analysis of the energy audits demonstrates that thermal energy represents only 18% of the total energy billing, while electricity bills (EDL's and the cost of self-generation) represent 72%. Self-generated electricity represents 58% of the country's overall electricity consumption. This percentage is higher in the industrial sector, with 79%, which can be explained by the frequent shortages in EDL's electricity supply. During peak periods, industries also rely on self-generation since compared to EDL's peak period tariff, the cost of self-generated electricity is more advantageous.

The self-generated electricity consumed in hospitals and buildings respectively represents 33% and 44% of the total electricity consumption; this situation is also due to the frequent outages on the EDL grid. The following figure presents a breakdown of energy bills per sector.

[35] Source: LCEC

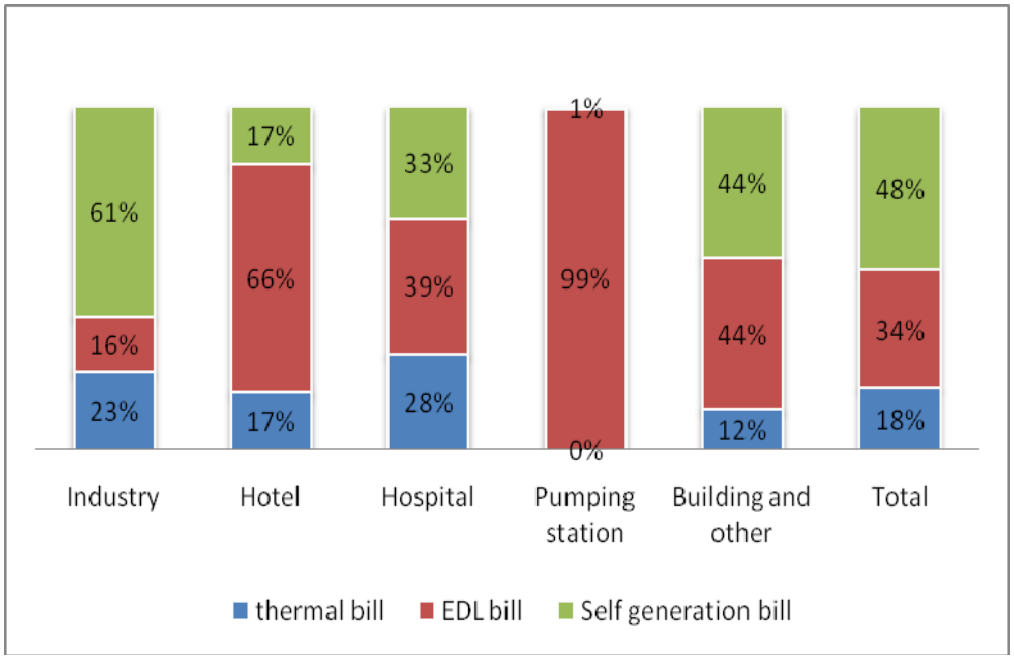


Figure 15: Energy Bills per Sector[36]

A compilation of the energy audits demonstrates that the energy savings potential differs depending on the various sectors and their operating and maintenance conditions. The payback periods also differ depending on the technology proposed, the hours of operation and electricity tariff. The following figure presents the payback periods of different energy conservation measures proposed following the completed energy audits.

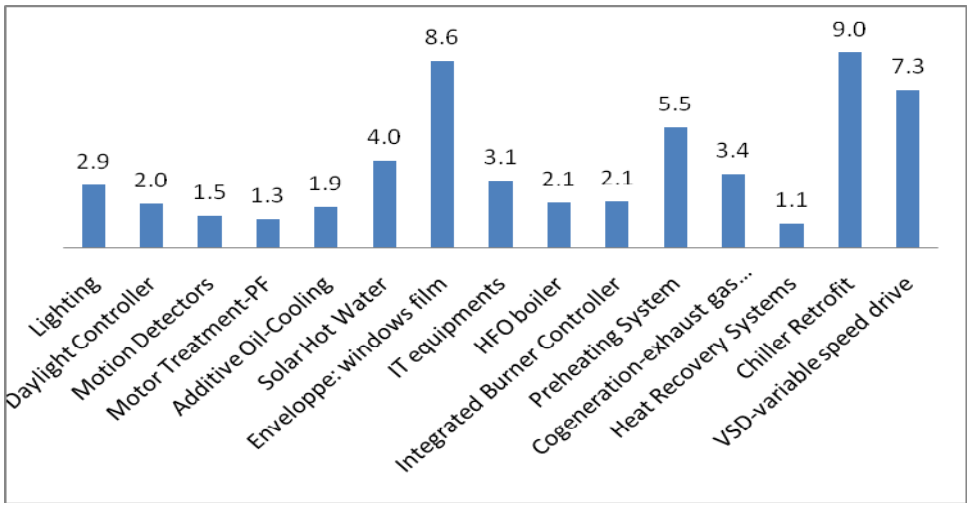


Figure 16: Payback Periods of Energy Conservation Measures[37]

[36] Source : LCEC

The least interesting technologies include variable speed drives, preheating systems, chiller retrofits, window films, and solar water heaters, which have an average payback period of about 4 years. This is far too long.

Most of the other technologies evaluated through the energy audits have interesting payback periods of less than 3 years.

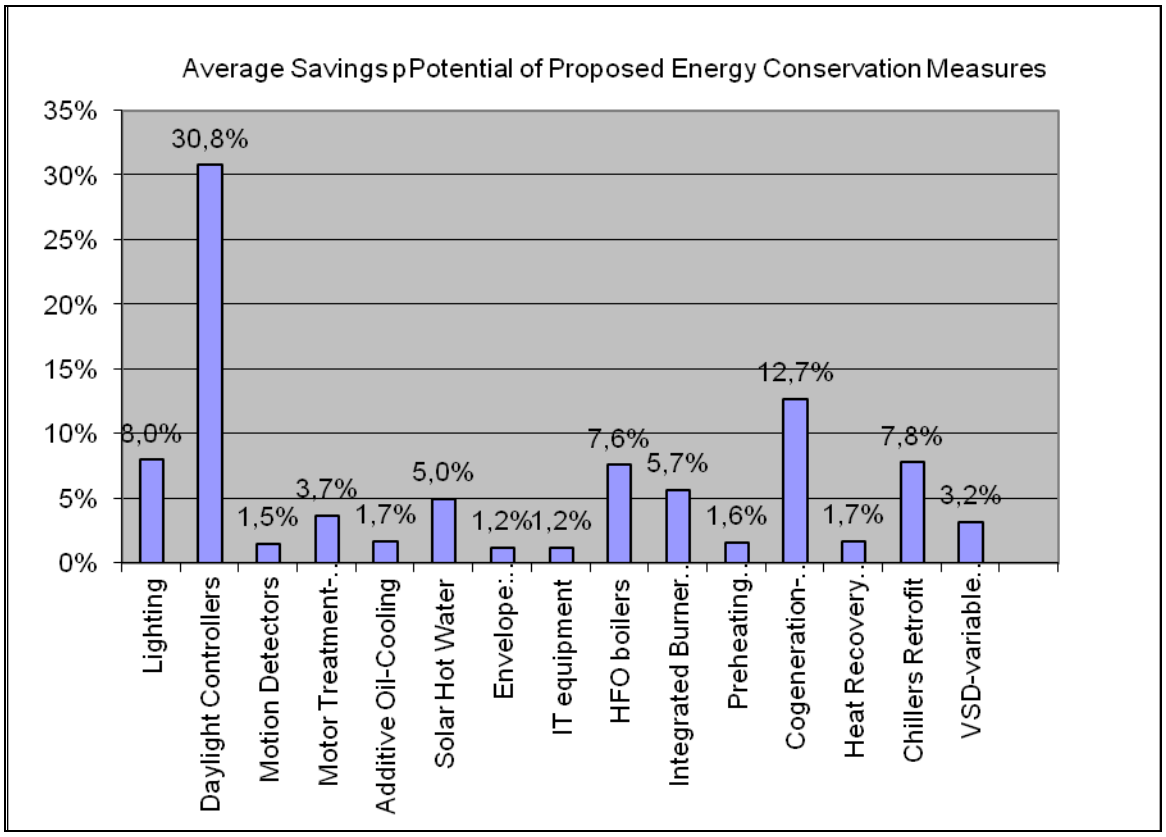


Figure 17: Savings Potential of Energy Conservation Measures

Identified Barriers

The main barriers encountered in the implementation of energy efficiency projects and energy audits, are listed below:

- The lack of a legal framework for energy auditing and energy consumption follow-ups.
- Consumers seek to invest in securing their energy supply rather than in energy efficiency. In Lebanon, this is due to EDL's frequent power outages.
- The lack of awareness and support on the part of professional associations.

[37] Source : data of LCEC

- Only a small number of energy efficiency measures are implemented in public institutions.
- The lack of fiscal and financial incentives to encourage consumers to invest in energy efficiency projects and the absence of ESCOs to propose performance contracting projects

1.3.2 Standards and Labelling

Summary Description

Since Energy Efficiency Standards and Labels for energy consuming equipment and household appliances represent a major part of LCEC's work, the project initiated several activities and defined the appliances to be subjected to energy efficiency standards under the project framework as follow:

- Solar water heaters;
- Compact Fluorescent Lamps (CFLs);
- Refrigerators;
- AC split units;
- Electric/Gas water heaters.

In accordance with the Government's policies to comply with International and European norms and standards, LCEC identified standards for the 5 household appliances and helped LIBNOR to officially adopt them on a voluntary basis. As of July 31st, 2008, all of the 5 sets of standards were announced in the official Gazette of the Lebanese Government. Official voluntary standards, as is well known in Lebanon, are usually treated by the Lebanese Government on a mandatory basis for application within Government facilities.

Regulation to adopt CFLs and the solar water heaters on a mandatory basis are currently in process and expected to be finalized by the Minister of Industry. LCEC conducted 4 focus group sessions with all the relevant stakeholders during which LCEC proposed a Minimum Energy Performance Standards and the adoption of a national comparative type label for refrigerators, A/C split units and compact fluorescent lamps.

The focus group session on solar water heaters concluded with 3 options in mind. The first one is a pass or fail of the standards along with quality certification similar to current European certification. A comparative type label as a second option can be chosen, if the performance classifications are ratified by the European Community at a later stage. An endorsement type label that passes the standards at a B standing limit regarded considered as 3rd option. A planned donation by Greece government will be supplying LCEC with 1 million dollars for testing equipment procurement to establish testing facilities for solar water heaters. LCEC is leaning towards implementing the testing facilities within the Institute through bilateral agreements. It is expected that through other donations he rest of the testing facilities for other appliances will be implemented within the same laboratory.

LCEC recruited an international expert in energy measurement, to perform the necessary tests at the Lematic labs (the sole refrigerator manufacturer in Lebanon). The objective is to guide Lematic through new design options and provide necessary support for labelling process.

LCEC will be assessing the enforcement requirements of the Labelling and the Standards Program to bring the enforcement capabilities up to the required level. LCEC will also be evaluating the need for a consumer information program to educate consumers on both the new Standards and on how to read and use the new labels.

The remaining challenging task is to implement the new Standards and Labelling Program jointly with the enforcement agencies and institutions.

More information on refrigerators, split system air conditioners and compact fluorescent lamps are presented in Appendix 3

1.3.3 Thermal Standards for Buildings

Summary Description

The Thermal Standards for New Buildings were developed through the project: “Capacity Building for the Adoption and Application of Thermal Standards for Buildings” funded by the Global Environment Facility and managed by the United Nations Development Programme (UNDP). The project was executed under the Lebanese General Directorate of Urban Planning, Ministry of Public Works and Transport.

The project falling under the Climate Change focal area targeted the establishment of Thermal Standards for new buildings and their adoption and application through the provision of capacity building and information dissemination. The Thermal Standards for new buildings has determined cost effective measures and recommendations for the thermal improvement of new buildings in Lebanon. An economic analysis of each improvement have been evaluated by calculating the direct payback period, the net present value of the investment and the savings generated for the different Lebanese climatic zones.

Forecast Impacts

The projected heating and cooling energy savings resulting from the application of the Thermal Standards for New Buildings vary between 10% in climatic zone 1 (coastal) up to r 50% for climatic zone 4 (high mountains).

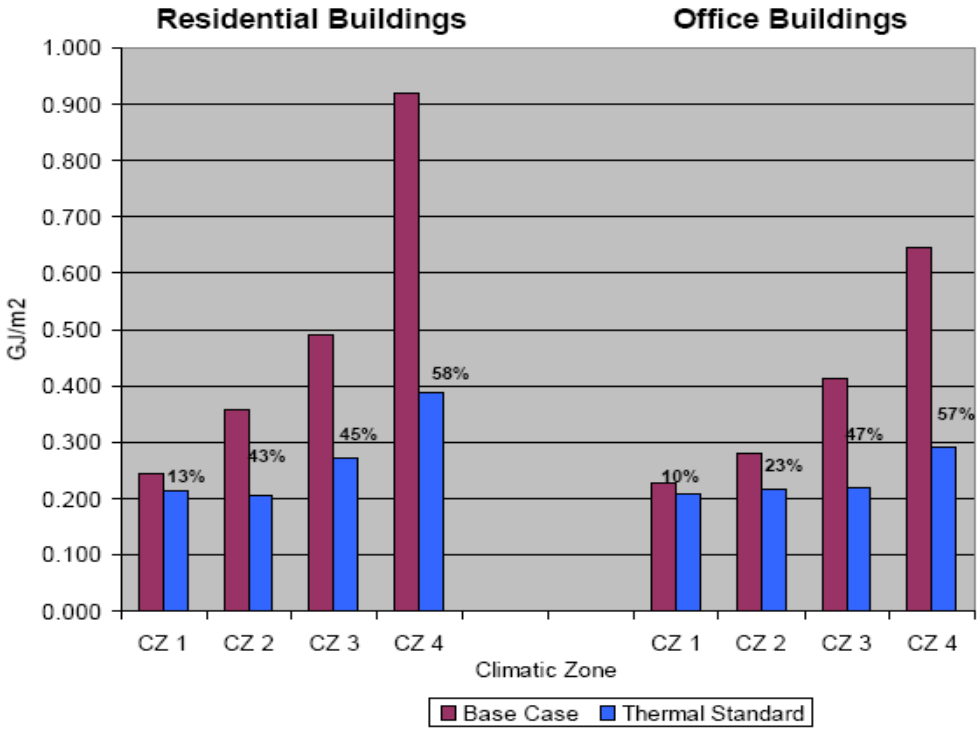


Figure 18: Energy Savings through Envelope Thermal Standards[38]

The incremental construction costs of measures with a positive net present value vary from no cost (where the savings on equipment are higher than the cost of envelope energy conservation measures) to more significant costs. The average cost for office buildings is estimated at around USD 7.85 /m2 whereas the cost for residential buildings is estimated at around USD 5.92 /m2.

The current positive net value obtained for all retained energy conservation measures translate into a payback period ranging from zero (immediate payback) to a maximum of 6 years. The average payback period for office buildings is estimated at around 5.2 years whereas, for residential buildings, it is estimated at around 0.9 years considering that comfort conditions are to be met for longer hours of operation.

Over a 20-year period, the projected national benefits resulting from the application of the Thermal Standards for New Buildings are estimated to 1.4 million Tons of Oil Equivalent (TOE) reducing emission by about 6 million tons of CO2. The savings estimated from the avoided energy will vary in magnitude depending on the price of fuel and diesel oil, with an average about USD 500 million.

[38] Source : Development of viable solutions for the thermal standard for building in Lebanon, Energy analysis and economic feasibility study

Identified Barriers

- Lack of a law defining the Thermal Standards application
- Lack of training and awareness programs for stakeholders
- Lack of demonstration projects
- Lack of institutional set-up and facilities for program implementation

1.3.4 Compact Fluorescent Lamps

Summary Description

In 2006, LCEC launched the Lebanese Action for the Management of Power Usage in Lighting (LAMP). The goal of LAMP is the adoption and development of energy conservation measures in lighting systems for all sectors in Lebanon with the final purpose of reducing energy use and minimizing the emission of pollutants. Lamp's role is to target the legal, technical and awareness aspects of lighting in Lebanon.

LCEC, in collaboration with “Electricité de Zahlé” (EDZ), has launched a pilot project on the installation of about 1,048 CFLs in the village of Niha. The contribution of LCEC was to purchase the CFLs whereas EDZ provided the technical team and the needed consumption data. This project seeks an average savings of 8.3% on each household's electricity bill (Dr. Houri’s report). Moreover, LCEC has launched another similar project in one area covered by “Electricité de Aley” (EDA).

Furthermore, a joint collaboration between Greece and Lebanon on sustainable development issues, specifically related to renewable energy and energy efficiency, will support the installation of more than 80,000 energy efficient lamps in residences and small institutions in the south of Lebanon.

These pilot projects prepared the ground towards the massive installation of CFLs nationwide, which falls under the umbrella of the Clean Development Mechanism (CDM). The Lebanese Center for Energy Conservation (LCEC) has succeeded in submitting and registering the first Project Identification Note (PIN) for the replacement of incandescent lamps with compact fluorescent lamps (CFLs) in the residential sector across Lebanon. The CDM project aims the replacement around 3 million lamps in all parts of the country, covering more than one million households.

The PIN was registered on April 22, 2009 with the Designated National Authority (DNA) of Lebanon based at the Ministry of Environment. Following the review of the PIN by the DNA, a letter was or is to be sent by the Minister of Environment to support project execution. With the complete cooperation of Electricité du Liban (EDL) and under the direct guidance of the Minister of Energy and Water, LCEC is keen to implement a successful project that can result in direct benefits for both Lebanese consumers and the national economy. By using the Clean Development Mechanism (CDM), Lebanon can also benefit from considerable carbon credit revenues.

Forecast Impact

The project will concentrate on replacing three 100-watt incandescent bulbs per household with 23-watt CFLs. The incandescent lamps will be disposed to prevent the reuse of this inefficient technology. An estimation of 715 GWh savings will result from the project up to 2012, corresponding to a reduction of 596,000 tCO2, equivalent to 596,000 CERs.

Identified Barriers

- Program implementation design not in place
- Initial investment financing scheme
- The quality of the electricity supply

1.3.5 Solar Water Heaters

Summary Description[39]

Lebanon is characterized by a high potential of solar energy with an overall daily average of 4.8 kWh/day and an yearly average of 3,000 hours of solar radiation. The country's residential hot water consumption is considered to be a major end user with an average annual consumption of 64.5 m3 per household, equivalent to 3,000 kWh.

The Lebanese Center for Energy Conservation (LCEC) has been playing, and still plays, an important role in the field of solar water heating in Lebanon. By the end of 2008, LCEC was able to install 2,310 square meters of solar collectors in the Lebanese territories; this was made possible through a donation from the Chinese Government to install 500 solar water heating units, as well as through a donation from the Swedish International Development Cooperation Agency (SIDA) to install 93 individual units and 11 collective systems. The two donations were managed by UNDP who assigned LCEC to supervise and direct the execution of the project.

In 2010, an additional area of around 2,500 square meters of solar collectors will installed through LCEC who will supervise the execution of two pilot projects. The first will consist in the installation of 600 solar water heaters provided by the Chinese Government, and the second will include the installation of 350 residential solar water heaters in a pilot project village that will be provided by the Greek Government.

In terms of quality control, solar thermal standards have been prepared and issued by LCEC and LIBNOR and efforts to adopt the standards on a mandatory basis are currently in process and expected to be finalized soon. In this regards, LCEC is working on establishing a comprehensive solar water heating testing facility in collaboration with the Greek Government who will supply the equipment to perform the tests under the supervision of concerned Lebanese parties.

[39] Source: assessment of energy and financial performance of a solar hot water system in a single family dwelling, 2009

LCEC has also conducted impressive awareness campaigns promoting solar energy applications that have proven to reach out to a major portion of the Lebanese population. In addition, a market assessment study was conducted to analyze the solar thermal market and its development throughout the years. In the same scope, a performance assessment campaign was initiated by LCEC to study the performance and feasibility of solar water heating applications in Lebanon. In this regards, a first financial assessment report was published by the Center with the results of a study conducted on a residence in South Lebanon, which can be generalized for typical residential applications in Lebanon.

The UNDP/UNEP/GEF project, the Global Solar Water Heating Market Transformation and Strengthening Initiative, will begin in early 2010 and end by the end of 2014, under the LCEC's umbrella. The scope of work aims to facilitate the installation of 190,000 m2 of new collectors over the duration of the project with an expected continuing growth reaching 1,050,000 m2 of total installed SWH systems by 2020.

Forecast Impacts[40]

An individual residential solar water heater would reduce a household's total annual energy consumption by around 42%. The implementation of 290,000 individual residential solar water heaters would reduce the electricity demand by about 100 MW, and the annual consumption by 876 GWh/year regardless of the grid's technical and commercial losses.

Identified Barriers

- A majority of the buildings in Lebanon are not suitable for solar water heating applications due to the lack of space on the roof.
- The standards and labels are not mandatory, thus quality control is not ensured.
- The cost of SWHs is relatively high; a financing mechanism should therefore be instituted.
- No Research and Development departments are available in the field of solar thermal applications.
- There is no legal framework to organize sales activities and the installation of solar water heaters.

1.3.6 CEDRO Project

In partnership with the Ministry of Energy and Water, the Ministry of Finance and the Council for Development and Reconstruction, the United Nations Development Programme (UNDP) is currently managing the “Country Energy Efficiency and Renewable Energy Demonstration Project for the Recovery of Lebanon” (CEDRO). Created in October 2007, the project has a five-year mandate up to October 2012 and a budget of $9.73 million funded by the Lebanon Recovery Fund by means of a donation from Spain.

[40] Source: assessment of energy and financial performance of a solar hot water system in a single family dwelling, 2009

CEDRO was established to complement the national power sector's reform strategy and to support the greening of Lebanon's recovery, reconstruction and reform activities. To achieve this, the project intends to focus on activating end-use energy efficiency and renewable energy applications in public sector buildings and facilities across Lebanon.

More specifically, CEDRO's implication is divided into three levels:

- The first level involves the implementation of end-use energy efficiency and renewable energy demonstration projects in 180 public sector buildings and facilities across Lebanon;
- The second level involves technology transfer, which will enable other public sector buildings and facilities to become energy efficient; and
- The third level consists in supporting the formulation of a national sustainable energy strategy and Action Plan through a research and development program.

CEDRO has already identified, designed and signed the execution contracts for a first set of 30 renewable energy beneficiary public sites and is preparing an invitation to bid on 30 new sites.

1.3.7 Street Lighting

LCEC is currently working on one energy efficiency project for street lighting. This program includes the replacement of mercury lamps by sodium lamps. This program is not yet generalized for all municipalities due to the lack of funding.

1.3.8 Use of Natural Gas for Power Generation

A project is underway on replacing diesel oil by natural gas for the operations of the Beddawi combined cycle thermal plant. The gas pipeline between Lebanon and Syria has already been installed but is not yet operational. A study on this project has shown that a natural gas option would be beneficial to Lebanon and could result in considerable savings

2 LEGAL FRAMEWORK AND KEY EE PLAYERS

2.1 OVERVIEW OF EXISTING ENERGY LEGISLATION IN LEBANON

The management of the energy sector, Law 462/2002, is the main form of legislation on energy in Lebanon. The law defines the Government's role in the energy sector, documents production, transportation and energy distribution.

2.1.1 Production of Electricity by the Private Sector

The legislation sets the legal steps required to partially or completely privatize the management of the energy sector. Law 462 states that private electricity producers are only allowed to produce electricity for their own private use and cannot distribute electricity to others. Thus, legally, they are prohibited from selling electricity. Changes are needed in order to ensure the proper and legal implementation of renewable energy technologies and cogeneration. Power sector regulations require some changes in order to cope with actual situation in Lebanon and to open the way for the promotion of RE and the implementation of CHP to resolve some of the shortage issues in the country's electricity supply.

2.1.2 Renewable Energies

On June 16, 2004, the Council of Ministers adopted Decision N° 13 to reduce energy imports and develop local energy, including renewable energy resources.

In March 2006, the MEW's Investment Planning Program (IPP) submitted an energy law that established the objectives under which the energy sector would be operated and developed. The promotion of renewable energy resources[41] is among the energy policy's objectives.

2.1.3 Energy Conservation

A draft law on energy efficiency is under discussion within the MEW. This law defines an energy efficiency program and its management authority (LCEC). This program mainly contains the following actions:

- Mandatory and periodic energy audits to establish whether the total consumption exceeds 40 TOE. Mandatory energy audits for new projects where the consumption exceeds 40 TOE.
- Energy labelling of domestic appliances.
- Ministries and municipalities are required to implement their new projects according to the energy efficiency standards.
- Exoneration of customs duty and VAT for energy efficient equipment.

[41] Energy in Lebanon between reality and MYTH www.almee.org

According to the draft law, the energy experts authorized to carry out the audits should sign an energy agreement with MEW. In addition, a fine will be claimed for those who do not comply with this law.

2.1.4 The National Environment Fund

The National Environment Fund was created to support the activities of the Ministry of Environment. Its role and incomes are presented in Articles 9 and 10 of the Environment Protection Law (Law 444/2002) that sets the fundamental principles that would govern the use and management of the environment.

The role of this Fund is to[42]:

- Contribute to financing the measures to control the application of the Environment Protection Law.
- Propose terms for loans attribution.
- Support the progress of research and technological development in the environmental protection field.
- Support and encourage sustainable development projects aimed to protect the environment and combating desertification, deforestation, earth erosion and protect biodiversity.
- Support the initiatives and activities undertaken by associations and non-official organizations.
- Contribute to the protective activities that have an impact on the environment.
- Grant loans to projects where activities will be of benefit to the environment.

The incomes of the National Environment Fund consist in:

- Annual financial contribution determined in the general budget law.
- Fees for environment protection imposed under the Environment Protection Law.
- Subsidies, grants and donations even from public or private foreign and national entities to protect and develop the environment.
- Fines and damages paid by those responsible for polluting and for any damages to the natural environment.

The Fund's incomes should be deposited in a special account at the Bank of Lebanon, according to the Regulations of the Fund. The fund is not currently fully operational.

2.2 PRESENTATION OF MAIN EXISTING KEY PLAYERS

A brief presentation of the various existing stakeholders and key players identified during the mission who could be involved in the coming energy efficiency program and their role in the EE program implementation described below.

[42] http://www.moe.gov.lb/Corporate/The+ministry/Laws+and+Regulations/+قانون+رقم444.htm

2.2.1 Policy of Institutional Players

Presentation of LCEC

The Lebanese Center for Energy Conservation (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 financed 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, university and school students as well as 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, a 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[43] 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 man-made 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[44] is a Government department in charge of water and energy resources policy and management. It controls 21 Lebanese water authorities and the semi-autonomous public institutions in charge of providing drinking 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.

2.2.2 EE Services Providers (Technical Operators such as ESCOs)

The following table presents various private energy experts[45] in Lebanon that present a good potential to launch energy services activities and participate in EE project implementation as ESCOs.

[43] http://ec.europa.eu/environment/enlarg/med/pdf/lebanon_en.pdf
[44] http://www.zawya.com/cm/profile.cfm/cid1001326
[45] http://www.LCEC.org.lb/Templates/InsideTemplate.aspx?PostingId=54

Table 3: Energy Experts Companies from Lebanon

Company	Address	Email
APAVE Liban	Achrafieh, Sioufi, Rue Emile Lahoud, Beirut, Lebanon	apavelib@dm.net.lb
Beta Engineering	Badaro, Beirut, Lebanon	betaengi@inco.com.lb
Energy Efficiency Group (EEG)	Banking Center, 6th Floor, Dora, Lebanon	info@eegroup.com
Metacs	Achrafieh, Salim Bustros Street, Tabaris, Achrafieh Beirut, Lebanon	metacs@metacs.com
National Energy Consultants (NEC)	Rebeiz Building, Monot Street, Achrafieh Beirut, Lebanon	info@nec-group.com
SGS Liban	Tanios Saba Building, Ibrahim Bacha Street, Medawar Beirut, Lebanon	mireille.azar@sgs.com

The above listed companies are qualified to work with the UNDP-LCEC energy audit program. They have passed a pre-qualification procedure set by UNDP-LCEC and obliged to attend all trainings and workshops proposed by LCEC.

There are a number of ESCO projects implemented in Lebanon mostly by NEC (around 70 projects since 1996) and EEG, but not all could be considered Performance Contracting. The number is still limited due to the limited financial resources and the absence of legal framework organizing ESCO activities.

Most of the specialized energy firms perceive the proper financial mechanism as the big barrier. Following all the difficulties and unstable years Lebanon went through, companies have mostly cash flow problem. Besides, they are all short term oriented. If a proper financial mechanism is found whereby the client could access mid/long term financing scheme, or alternatively if ESCOs can get guarantees supporting their lending, then this would surely help push forward more the business.

A new initiative is underway with the Central Bank of Lebanon called NEEREA (the National Energy Efficiency and Renewable Energy Account), might bring a new support for ESCO business in short term.

ESCO could play an interesting role for promoting Energy Efficiency and projects implementation, however, financing mechanism need to be put in place to help projects realization.

Lebanese Center for Energy Conservation (LCEC)

Under the MEW, LCEC[46] provides free, practical advice to business and public sector organizations to help reduce energy use. The institution goal is to reduce GHG emissions in Lebanon by improving

[46] http://www.lcec.org.lb/

demand side energy efficiency through the creation of a multipurpose Lebanese Center for Energy Conservation.' LCEC will be assessing the enforcement requirements for the energy efficiency program to bring enforcement capabilities up to the required level. LCEC will also be evaluating the need for a consumer information program to educate consumers on the energy efficiency program. LCEC is seen as the qualified institution that will be in charge of applying and implementing the Government strategy on RE and EE. They can take in charge the development and management of EE and RE programs and Action Plans to reach the country's objectives.

Lebanese Association for Energy Saving & for Environment (ALMEE)

As the name suggests, the ALMEE[47] is devoted to energy saving and the environment for sustainable and harmonious development in Lebanon and in the Mediterranean region. ALMEE dedicates most of its time to global environment issues (Kyoto and Montreal Protocols). ALMEE is considered as an NGO and has been involved in many projects with international financial institutions in Lebanon especially before the creation of LCEC. The association could play an interesting role as advisor and programs promotion institution since its members are high level university professionals.

2.2.3 EE Financing Institutions

Kafalat is a Lebanese financial company with a public concern that assists small and medium sized enterprises (SMEs) to access commercial bank funding. Kafalat helps SMEs by providing loan guarantees based on business plans/feasibility studies that show the viability of proposed business activities. It processes guarantee applications for loans that are to be provided by Lebanese banks to SMEs operating throughout Lebanon. Kafalat targets SMEs and innovative start-ups that belong to one of the following economic sectors: Industry, Agriculture, Tourism, Traditional Crafts and High Technology. Kafalat's guaranteed loans benefit from interest rate subsidies. These subsidies have been set up to mitigate the crowding effect of the high interest rates in Lebanon that are induced by borrowing in the public sector. The interest rate subsidies are financed by the Lebanese Treasury and administered by the Central Bank of Lebanon.

Commercial Financial Institutions

Some banks are already involved in providing financing for SWH for some selected customers without any guarantee and in close collaboration with equipment providers. The banks could play an important role in EE and RE project financing if a complementary financing scheme and guarantee mechanism were put in place. They could promote EE and RE projects among clients with good credit worthiness records and provide alternative solutions such as mezzanine or equity financing.

More information on the Lebanese Standards Institution (LIBNOR), the Association of Lebanese Industrialists (ALI) and the Industrial Research Institute (IRI) are presented in Appendix 4.

[47] http://www.almee.org/

3 ACTION PLAN PROPOSALS

Based on the assessment of existing programs, the review of initiated actions related to energy efficiency, discussions with stakeholders and the analysis of information available during the execution of the mandate, several potential EE programs have been identified. The proposed portfolio of energy efficiency programs included in this Action Plan is recommended as a path to increase Lebanon's energy efficiency. Some initiatives are already completed or ongoing in Lebanon, however, reinforcement of the institutions, capacity building and financial and human resources are required to put in place a structured EE program. The proposed Action are divided into three part, short, medium and long term plan, where the short term includes actions with high savings potential and a relatively short time for implementation within a 5 years period. The medium action plan includes programs where the implementation period can reach up to 10 years and required more resources, preparation and planning and the long term plan more than 10 years program requiring an increased structure for follow up and relatively long period for implementation .

The short term plan concentrated mainly on the residential sector and includes CFL distributions and Solar Water Heating, while the medium term focused on energy efficiency improvement in the industrial and municipal sector. For the industrial sector, the proposal targets the development of an energy efficiency program to reduce energy consumption and energy bills and for municipalities the implementation of an efficient street lighting. The long term plan includes the implementation of standards and labeling (S&L) and thermal standards for new buildings. The outline of each program is presented in the following sections including specific activities required for their implementation. Section 4 will present additional programs and recommendations that could be implemented in the future. The following table summarizes the proposed actions and their impacts.

Table 4: Summary of proposed actions

	Proposed action Plan										
		Program period (PP)	Investment	Reduced power	Savings			CDM		NPV(0%)	
	Proposal	years	$M	MW	$M/PP	$M/year	ktoe/year	kTCO2	$M	Without CDM	With CDM
Short term	EEM1: CFL rogrram in the Residential Sector	5	11.0	187	104.7	34.9	199	598	5	94	99
	EEM2: SWH Program in the Residential Sector	5	76.2	38	159.2	48.2	275	908	7	83	90
	Total		**87.2**	**225**	**264**	**83**	**474**	**1506**	**12**	**177**	**189**
Medieum term	EEM3:Energy Efficiency in the industry	7	26.5	16	113	27	35	615	13	86	99
	MEE4: Lebanon Street Lighting Program	10	9.4	11	41.9	6.5	11	239	2	33	34
	Total		**35.9**	**27**	**154**	**33**	**46**	**854**	**15**	**119**	**134**
Long term	EEM5:Standards and Labeling	20	7.7	19	355.6	17.8	582	1975	0	348	348
	EEM6: Thermal Standard	20	3.1	11	280.4	14.0	1009	3735	0	277	277
	Total		**10.8**	**30**	**635.9**	**31.8**	**1592**	**5709**	**0**	**625**	**625**
TOTAL OF ENTIRE PROGRAMS			**134**	**282**	**1054**	**148**	**2112**	**8069**	**27**	**920**	**948**

3.1 SHORT-TERM ACTION PLAN

3.1.1 Compact Fluorescent Lamp Program

Key Program Parameters

The electricity consumption in Lebanon's residential sector is estimated at 30% of the country's total electricity consumption and lighting constituted about 9% or about 782 GWh supplied by EDL in 2006. The number of households connected to the EDL network was estimated at 1.14 million.

According to an LCEC study conducted in 2006, the total number of light bulbs used in Lebanon was estimated at 15.34 million and the total number of incandescent lamps in use was about 10.5 million. In the absence of a confirmed number of incandescent lamps, targeting the third of the announced number seems to be realistic. With a target of 3 lamps per household, replacing 3.5 million incandescent bulbs by CFLs would lead to a power reduction of at least 715 GWh.

The efforts in Lebanon to increase awareness about CFLs and the pilot project initiatives that have been undertaken have placed the CFL Program at the top of the priority list for the following reasons:

- It is a proven technology that has been successfully implemented in many countries around the world. A program of 1.7 million CFLs implemented in Mexico by the Comision Federal de Electricidad (CEF) reduced the country's demand by 78 MW and generated annual savings of 135 GWh. EVN, a state owned enterprise in Vietnam, implemented a pilot project introducing 1 million CFLs that generated 46 GWh in annual savings and a load reduction of about 30 MW. A year later, the CFLs purchased on the market reached 10.5 million units with a demand reduction of 280 MW and registered annual savings of 275 GWh. The Ceylon Electricity Board (CEB) in Sri Lanka implemented about 172 000 CFLs, which led to annual savings of 64 GWh and a load reduction of 46.7 MW.
- CFLs have a direct impact on the load curve and on the permanent load reduction during peak periods.
- They can result in a peak load reduction of about 187 MW.
- More electricity becomes available for other customers.
- The final end users' energy bills become lower. Massive participation in the program ensures the program's immediate positive impacts.
- Annual household savings can reach around USD 11.
- They also result in an annual reduction of electricity subsidies of about USD 26 per household.

The CFL initiative that is currently under development needs to be fine tuned with actual data and a wider coverage.

The feasibility phase of the project is ongoing, technical meetings are being held with international carbon facilities to assess the project's viability and to lay out its foundation, especially in terms of program implementation and its financial aspects.

The proposed program includes replacing traditional incandescent light bulbs with CFLs after an in depth assessment of the CFL Program's potential in Lebanon. The program not only involves switching to more energy efficient light bulbs but also collecting old energy consuming incandescent bulbs even if they are still in working order to prevent the potential reuse of this low efficiency technology. This effect, known as "leakage", could eliminate the possibility of claiming carbon emission reduction credits as a result of the project. To ensure that the incandescent light bulbs are disposed of after their replacement and not reused elsewhere, a strategic system to collect and recycle the old bulbs must be implemented with independent monitoring.

The suggested Action Plan recommends designing a roadmap to implement the CFL Program for the replacement of incandescent bulbs through effective distribution, exchange, recycling and quality control activities to be implemented by LCEC in collaboration with EDL.

We propose the following Action Plan for the program design and implementation.

Phase 1 - Program Design

The program design may include a broad marketing strategy, a baseline survey, an identification system for the CFL Program and a policy for the collection and disposal of old incandescent bulbs.

The proposed steps are the following:

Step 1: Home surveys on the electricity consumption in the residential sector. The proposed approach would not require many additional human resources on the part of EDL since its personnel currently visits households to read the meter indexes so the home surveys could be conducted and information could be provided through printed material when EDL staff perform their regular meter reading. This will, of course, add more time to thee meter reading but it would ensure comprehensive surveys and accurate data. The surveys could be focused on selected samples only, which would represent the main household categories and different regions of Lebanon.

Step 2: Develop a PIN and PDD for the CFL Program and have them approved by DOE.

Step 3: Develop specifications and labels for CFLs.

The CFLs used in the program must be affixed with an identification label that is unique and irremovable. This label will be used to identify all subsidized lamps that are part of the program. It will include the certification of the lamp's compliance with the Lebanese efficiency and quality standards. The label will be developed based on technical specifications that will be set by LIBNOR in compliance with international standards. When no technical specifications exist in a country, ELI standards are normally used. ELI, the Efficient Lighting Initiative, is a voluntary international program for the

certification of the quality and efficiency of lighting products. It is run by a non-profit organization, the ELI Quality Certification Institute, for the benefit of end users, policy makers, and lighting suppliers worldwide.

Step 4: Development of CFL tender documents.

Step 5: Implementation of a testing facility for CFL testing/certification: The Industrial Research Institute (IRI) will need to procure the necessary equipment for testing the CFLs and validating that they comply with LIBNOR standards.

Step 6: Lamp procurement by EDL: Selection of CFL suppliers and lamp procurement

Step 7: Distribution of the first free CFLs: In the program's first phase, it is recommended to distribute about 1.15 million out of 3.5 million CFLs free of charge (one free lamp per household) to reinforce the population's awareness and enrollment in the program. Distributing free CFLs will help households to not only to test the product and its impact, but also provide customers with certified high quality lamps, which will help them regain their trust in CFLs, which might have been lost as a result of the less expensive and low quality CFLs that are currently on the market. The free lamps could be distributed to the customers when they go to the EDL offices to pay their electricity bill. However, an incandescent lamp removed from their house would be requested in exchange for the customer to get the free CFL.

Step 8: Distribution of CFLs to provider networks/EDL offices: The high initial cost of CFLs is the major barrier for program implementation and increased participation. To overcome this barrier, the program should provide CFL subsidies and/or a financing mechanism in order to ensure the program's effectiveness.

The cost of high quality CFLs for end users is expected to be significantly lower if they are ordered in bulk as opposed to purchasing them in retail stores. However, compared to incandescent lamps, the price is still considered to be very high and incentives are needed to establish a price that will be attractive for consumers. Subsidizing CFL lamps is a solution that might be considered by EDL and the Government since the difference between the actual production cost of electricity and the tariff structure is considered a loss. EDL would benefit from reducing the deficit between its marginal cost and its electricity tariff. CFLs could be subsidized by up to 50% of their procurement cost. This will increase the rate of participation of households and encourage them to enroll in a program where the utility is helping its customers to reduce their energy costs.

Furthermore, spreading the acquisition cost of CFLs over a year with monthly installments would constitute an additional effective incentive for clients to enroll in the program. The payments are anticipated to be equal to or less than the energy cost savings generated by the CFLs.

The distribution of the CFLs could be in one of the following forms:

- Distribution of subsidized CFLs through EDL offices, where clients enrolled in the program could get up to 3 subsidized lamps, one of which would be free. They could pick them up at the EDL

offices when they go to pay their electricity bill. A record system should be established to keep track of the number of lamps sold per household. If a client should require more than 3 lamps, then the full price will charged and the client will have the option of paying for them through monthly installment.

- Distribution of CFLs through participating electrical equipment and commercial centers: In this case, participant providers would purchase the lamps from EDL and sell them to their customers at a fixed price. When paying their electricity bill, EDL customers would request to benefit from the CFL subsidy and EDL would confirm the subsidy for the number of authorized lamps on the customer's invoice or would provide them with a rebate voucher. Consumers can then go to any participant provider and buy the lamps at the subsidized price with proof of EDL's authorization or their rebate voucher. These bills or vouchers would have to be kept by the provider so that he can request being reimbursed by EDL for the subsidies.

A strategic system to collect and recycle incandescent bulbs must be created with independent monitoring to prevent the potential reuse of the low efficiency incandescent bulb technology.

Step 9: Marketing campaigns and distribution of information brochures: One of the main activities of the CFL Program is the marketing aspect that needs to focus on the following four major points: product, price, promotion and distribution. The output of this first marketing plan will be to identify the market barriers (price, quality, disposal, light output, etc.) as well as define the best channels for promoting the CFL Program. The strategies used to promote the program must be designed in accordance with Lebanon's national context. The type of programs offered and prevailing conditions on the targeted market should respect the country's national context. It should be noted that the fundamental objectives of the marketing strategy should be to have an effective impact on consumer behavior and to increase the consumers' participation rate in the program. The program should probably focus on informing consumers on the advantages and economic benefits of CFLs. Consumers have to understand that these lamps save a significant amount of energy and last longer than traditional incandescent light bulbs. In order to ensure the maximum impact of the marketing strategies with a reasonable budget, EDL and LCEC should study, along with marketing experts and their business partners, the attitudes, habits and motivation levels of their customers. Printed information such as flyers or advertising in newspapers, magazines, etc. are often the first alternatives considered to promote this type of program. A good strategy in this case would be to include information brochures with the electricity bills. This solution would involve EDL's participation and is economical, simple and effective and would reach the number of households targeted by the program. Moreover, since LCEC has already been mandated to develop communications tools, EDL would be in position to actively contribute to the production of attractive marketing materials. LCEC has already launched the CFL awareness campaign and will continue to follow up on the marketing needs of the CDM project.

Commercial campaigns on television, the radio and Internet would increase the impact of the marketing program but bear higher costs; however, broadcasting institutions belonging to the Government could transmit advertising at no fee. To reach more households, the private media could

also transmit advertising at a fee. Other possibilities such as door-to-door campaigns should also be considered, including the possibility of EDL personnel taking advantage of their visits to households for meter index reading and bill payment collection to carry out this type of door-to-door campaign.

Reaching customers through marketing is quite effective but, according to a study conducted in North America, messages printed on electricity bills and advertising mailings are the most commonly used marketing strategies. However, it has been observed that advertising on the radio, TV or in newspapers/magazines as well as reports on the latest developments in the field of energy efficiency and conservation and door-to-door campaigns substantially increase the rate of consumer participation.

A door-to-door approach would certainly require capacity building on program promotion techniques for EDL personnel.

Step 10: Apply a special tax on incandescent lamps; and, after five years, prohibit the sale of these lamps on the local market

It is proposed to apply a special tax on incandescent bulbs two years after the beginning of the CFL Program; this tax should be about 10% in the first year, 30% in the second year and 50% in the third. At end of the program, selling incandescent lamps should be prohibited on the local market.

Step 11: Program monitoring

CFL retailers will redeem the vouchers received in payment for subsidized CFLs on a monthly basis. EDL will use these vouchers to monitor sales and periodically inform stakeholders of the progress made.

In the case of the CFLs being distributed by EDL offices, a monthly report could be extracted from the billing system to determine the number of participating households and number of CFLs sold.

Step 12: Evaluating program results

M&E will consist in comparing at least one full month of electricity sales for selected domestic sectors before and after the program is implemented. This should also include energy consumption and load curve comparisons and cross checking them with the number of CFLs sold every month. The results will be disseminated to interested parties and information campaigns for the general public will be released under the auspices of the MEW and EDL.

Step 13: CFL recycling

EDL and LCEC, in collaboration with the Ministry of Environment, will investigate the best CFL recycling methodologies. Collected CFLs could be stored in a dedicated warehouse and then sent for recycling to the closest facilities in the region. Retailers and EDL should be required to ensure the collection process at their own expense as a condition of their participation in the program. The handling and recycling costs could be included in the CFL price. The Ministry of Environment should

be encouraged to develop a regulatory framework to ensure a long-term compliance with best environmental practices in the recycling of CFLs.

Phase 2 - Program Implementation

Implementing the CFL Program will consist in proceeding through a list of activities; the following identified actions are presented as a guideline.

INITIAL PHASE OF PROGRAM DESIGN

- Meeting with stakeholders
- Project planning
  - Defining key program parameters
  - Defining stakeholder roles and responsibilities
  - Defining eligible participants
  - Defining CFL technical specifications
  - Developing procurement procedures
  - Developing distribution mechanisms
  - Establishing a baseline
  - Designing an M&E plan
  - Planning and approving the Project Design Document

PROGRAM IMPLEMENTATION

- Tendering
  - Expression of interest publication
  - Tender document preparation
  - Tenders
  - Tender evaluations
  - Contract awarding
  - Procurement
  - CFL reception
- Marketing
  - Flyers: development and printing
  - Vouchers: development and printing, if need be
  - Voucher distribution, if need be
  - TV advertising
- Client monitoring
  - Residential sector data collection
  - Data analysis
  - Pre-implementation report
- CFL Distribution

- Distribution planning
- Regional distribution and logistics

MONITORING AND EVALUATION

- Residential sector data collection
- Data analysis
- Monthly post-implementation report

Basic Assumptions:

The following table presents the basic assumptions on savings and cost estimates.

Table 5: General Assumptions for the CFL Program

Assumptions for CFL program

	Values	Units
Householder number in Lebanon	1147921	
Average penetration (after five years)	3	lamps/householder
Power of Inc lamps will be replaced	100	W
CFL power	23	W
User factor	60%	
Hours operation	3.5	h/day
Technical loss in EDL gird	15%	
Cost of CFL purchased by EDL	4	$/lamp
Cost of CFL disturbed by program	2	$/lamp
Household annual savings	177	kWh
Household annual savings	11	$
Household pay back period	0.5	year
Reduced electricity subsidy	26	$/year/Household
CDM	8	$/tCO2
EDL's marginal cost	21	$Uscent/kWh
Current electric cost in residential sector	6.4	$Uscent/kWh
Thermal efficiency of EDL's power plant	35%	
GHG emission	0.833	KgCO2/kWh

Implementation Costs

The cost-benefit ratio of the program and the estimated CFL price charged by EDL to customers are presented in the cost and benefit sections. The penetration rate in Lebanon's 1,147,921 households is estimated at 3 CFLs per household after five years of program implementation. With an average quantity of three lamps per household, the total investment represents about USD 11million for the replacement of inefficient incandescent bulbs by CFLs over a five-year period. Considering all the

costs associated with the program, including the CFLs purchased from manufacturers, retailer services, marketing campaigns and the recycling of old incandescent bulbs, customers will be able to purchase high quality CFLs from retail stores that take part in the CFL Program at an estimated cost of USD 2.

The following table shows the detailed budget for the implementation of the CFL Program. This budget considers the cost of 1.5 million CFLs distributed free of charge to the consumers at USD 4 per unit and the subsidies estimated at USD 2 per unit, which will allow consumers to subsequently purchase the CFLs at a reduced price. The total cost of the program, including awareness campaigns and surveys, is estimated at USD 11million.

Table 6: Cost of the CFL Program

Program Components and Activities	Cost
CFL cost (first million lamps distributed free of charge) 1.15 million CFLs x 4$/CFL	USD 4.6 M
Subsidies (2.35 million lamps with subsidies) 2.35 million CFLs x 2$/CFL	USD 4.6 M
Surveys, data analysis and distribution of first free CFLs (by EDL personnel) 1$/household	USD 1.1 M
Testing facility equipment	USD 0.3 M
Awareness and training programs (2% of the project costs)	USD 0.4 M
Total	**USD 11 M**

Table 7: Role and responsibilities of the key players

Organization	Responsibilities
LECE /MEW	Executing Agency • Selects CFL Program • Liaises with different stakeholders • Supervises surveys and compiles results • Supports and facilitates CFL Program implementation • Promotes the CFL Program within government departments and agencies • Supports awareness campaigns • Disseminates information on CFL Program outputs and outcomes • Accounts for of CFL implementation
EDL	Implementing Agency • Conducts residential surveys • Selects and names program coordinator from EDL staff • Forms an Evaluation Committee • Prepares vouchers and sends them with monthly bills to EDL's domestic customers • Ensures that endorsement stickers are affixed to specifications compliant CFLs • Pays CFL participating retailers subsidies according to the number of returned vouchers • Contributes to the baseline domestic sector electricity consumption data, program monitoring and program evaluation • Coordinates CFL Program advertising and promotional campaigns
The Industrial Research Institute (IRI)	IRI will have on hand the required equipment to test imported or locally produced CFLs. IRI will certify the CFLs according to the standards defined by LIBNOR.
Participating Retailers	Express interest in the program by retailing specifications compliant CFLs to selected customers • Sign contracts with TAU • Proceed with CFL procurement implementation through a voucher system • Display CFL Program marketing and educational material in their retail outlets • Provide specific training to program related retail staff • Request subsidy reimbursement by EDL • Participate in used CFL waste management mechanism by installing containers in their retail outlets
The Lebanese Standards Institution (LIBNOR)	Will liaise between international and local standards. LIBNOR will closely collaborate with the MEW in the establishment of the standards.
The Ministry of Finance	Will establish the regulations and decrees required to finalize the legal framework in regards to an increased tax to be applied on incandescent lamps for three years prior to banning their distribution on the market. This will have to be approved by the Government.
International Consultant	Program Coordinator • Prepares and sends out requests for quotes • Proceeds with CFL suppliers selection and contracting • Proceeds with CFL participant retailers selection • Prepares endorsement stickers and manages their production • Designs and coordinates CFL Program advertising campaigns • Establishes baseline domestic sector electricity consumption data • Proceeds with program monitoring and evaluation • Proceeds with waste mechanism management • Manages program financing components • Periodically reports to stakeholders about program implementation, and advises on program adjustments when needed

Phase 3 - Program Financing

Most CFL Programs are financed and launched by utilities. The financing for the Lebanese CFL Program design, implementation and evaluation could be provided by EDL. This would include the costs of the internal resources required for program management, CFL distribution logistics, printing material and marketing. EDL will also finance the laboratory testing costs for the approval of the CFL's compliance under the program.

Funds for CFL recycling could be provided through a special levy to create a source of financing for this type of activity. For example, an incandescent recycling fund could be created based on a special levy on incandescent lamps or an extra amount (about USD 0.25) for recycling added to the cost of the CFLs.

The Government and EDL could also request a loan from an international financing institution like the WB to finance a portion or the totality of this activity.

Based on international experience, the CDM is an opportunity to sell carbon credits resulting from energy efficiency projects and is the main mechanism used to finance CFL Programs in developing countries. To be acceptable for registration under the Joint Implementation scheme, a CFL Program must be designed to respect all the provisions of an approved methodology issued by the CDM secretariat.

Phase 4 - Program Evaluation

The main actor in the CFL Program will be EDL that will play an important role in the implementation and evaluation phases of the program. In fact, EDL will be in charge of collecting pertinent information before and after the launch of the program and of the data analysis along with the support of national or international experts. The energy consumption of all participating consumers could be analyzed through EDL's billing system. Program monitoring could be performed through a random selection of a sample of customers to assess the impacts of the program on their energy bills and gather their feedback and opinions on the use of CFLs.

GHG reductions will be evaluated by way of an approved CDM methodology through a Project Design Document that will provide details about the monitoring activities.

However, the main indicator for program evaluation will reside in the energy consumption of EDL and its impacts on EDL’s load curve especially during the evening peak periods.

Savings Potential and payback Period

Energy Savings

Considering that 3.5 million CFLs will replace incandescent light bulbs over the 5-year program implementation period, the energy savings at the end of the program will reach up to 717 GWh of

electricity, reducing the primary energy consumption by about 177 ktoe and CO2 emissions by 597,000 tons.

The energy savings have been estimated taking into consideration the full completion of the CFL Program after a period of five years (replacing 100-watt incandescent lamps by 23-watt CFLs), with an end-user factor equal to 60% and a daily operation of about 3.5 hours/day. The CFL penetration rate as estimated is shown in the following table.

Table 8: Cumulative Penetration Rate of CFLs

Years	Penetration Rate %	Number of Installed CFL
2010	20%	690,000
2011	40%	1,380,000
2012	60%	2,070,000
2013	80%	2,760,000
2014	100%	3,440,000

Benefits

The benefits will result in savings on the utility bills based on a decrease in energy consumption. It is estimated that the net benefits will be USD 99.5 million at the end of the 5-year program. This estimate is based on EDL's current cost to produce electricity, which is USD 0.21/kWh and considering USD 8/tCO2. The following tables respectively present the costs and benefits of the proposed CFL programs in Lebanon and in the Beirut region exclusively.

Table 9: Benefits and Investments of the CFL Program for Lebanon

		2010	2011	2012	2013	2014	Total
Number of household		1,147,921	1,147,921	1,147,921	1,147,921	1,147,921	
Penetration rate of CFL lamps		20%	40%	60%	80%	100%	
Number of Inc lamps replaced (3 lamps/household)		688,753	1,377,505	2,066,258	2,755,010	3,443,763	
Installed power reduced (replacing three Inc lamps by 23 W CFL)	MW	53.0	106.1	159.1	212.1	265.2	
User factor	%	60%	60%	60%	60%	60%	
Technical loss	%	15%	15%	15%	15%	15%	
Peak demand reduced	MW	37	75	112	150	187	
Hours /day	h/day	3.5	3.5	3.5	3.5	3.5	
Hours /year	h/year	1278	1278	1278	1278	1278	
Energy savings	MWh	47,824	95,648	143,472	191,297	239,121	717,362
Primary energy savings	Toe	11,846	23,693	35,539	47,386	59,232	177,696
TCO2 reduction	tCO2/y	39,838	79,675	119,513	159,350	199,188	597,563
Savings	Million $	6.98	13.96	20.95	27.93	34.91	105
CDM	Million $	0.32	0.64	0.96	1.27	1.59	5
Total benefits	**Million $**	**7.3**	**14.6**	**21.9**	**29.2**	**36.5**	**109.5**
Number of lamps replaced		688,753	1,377,505	2,066,258	2,755,010	3,443,763	3,443,763
Free lamps		229,561	229,561	229,561	229,561	229,561	1,147,806
Lamp cost (1.15 million lamps distributed free)	Million $	0.9	0.9	0.9	0.9	0.9	4.6
Subsidies (2.35 million lamps with subsidies)	Million $	0.9	0.9	0.9	0.9	0.9	4.6
Survey and data analysis (1$/householder)	Million $	1.1					1.1
Testing facility equipment	Million $	0.3					0.3
Awareness and training programs (2%) (1st year 5%)	Million $	0.14	0.06	0.06	0.06	0.06	0.4
Investment	**Million $**	**3.4**	**1.9**	**1.9**	**1.9**	**1.9**	**11.0**
Net benefits	**Million $**	**3.9**	**12.7**	**20.0**	**27.3**	**34.6**	**98.5**

Payback Period

The payback period for end users is estimated at about 0.5 year considering an average of 3.5 hours of use per day and per lamp. The annual savings for each household is estimated at USD 11 with the current electricity tariff of USD 0.064/year. EDL's annual savings per household is around USD 26 considering a marginal cost of USD 0.21/kWh. EDL's payback period for subsidies is about 2.8 months.

3.1.2 Solar Water Heater Program in the Residential Sector

In Lebanon, solar energy is mainly used for sanitary water heating, the heating of swimming pools in tourist and leisure resorts as well as in some industrial processes where heat is required. Solar thermal applications were introduced in Lebanon more than 30 years ago. Solar water heaters (SWHs) have been mainly installed as collective systems and in the context of some individual pilot projects. Unfortunately, experience over the years created public defiance because of the lack of professionalism of distributors as well as the poor quality of the systems available. Associations, such as the Lebanese Solar Energy Society[48], do exist in Lebanon, however their activities are very limited and they do not play any significant role.

The majority of solar water heating system producers claims that their products comply with international standards. There are no Lebanese standards for SWHs and no labelling system certifying the quality of the products. In the summer of 2006, the MEW supervised the installation of 500 solar water heaters (with vacuum collectors) that were donated by the People's Republic of China. The MEW, in collaboration with LIBNOR, is attempting to put a SWH Standards and Labelling Program in place with an adequate certification process with IRI.

The stakeholders met during the assessment mission confirmed the demand for SWHs despite the current existing barriers. These barriers can be summarized as follows:

- The low quality of SWHs distributed on the Lebanese market.
- The lack of customer services and guarantees.
- The reluctance of end users to pay their bank loans when systems break down.
- The reluctance of bankers to finance SWHs without proof of a guarantee.
- The absence of national standards and labelling.
- Higher investment and payback periods for SWHs compared to conventional systems.
- The absence of incentives and a financing mechanism for SWHs.

The proposed program addresses these barriers in order to ensure the development of the SWH market and reduce the energy demand related to water heating.

The development of SWHs in Lebanon is considered a priority for the following reasons:

[48] http://lseslebanon.com/aboutus.asp

- There is a great solar radiation potential in Lebanon with an average of 5 (Kwh/m²/day) with a potential of 1.5 million[49] m2
- Solar thermal systems are proven technologies that have been successfully implemented in many countries around the world. Germany is considered as the world leader in solar installations with about 11 million square meters of solar collectors, followed by Greece with 3.8 million, Austria with 3.2 million and Italy with 1.6 million[50]. In the region, Palestine is considered as the leader with 1.6 million m2, followed by Jordan with 0.85 million, Egypt with 0.5 million, Syria with 0.2 million and Lebanon with 0.18 million[51].
- SWHs have a direct impact on the load curve and on the permanent load reduction.
- A SWH Program can result in a load reduction of around 39 MW.
- More electricity becomes available for other customers
- Annual household savings can reach around USD 100.
- Each installed system will generate a reduction in electricity subsidies of about USD 230 per household.

Phase 1 - Program Design and Development Costs

The implementation of this program includes the following steps for individual systems.

Step 1: Conduct a market study in the form of surveys on the development of SWHs in the residential sector in order to assess their real potential, to gather feedback from households on the technology and determine their interest in the technology and to identify development and implementation barriers. This step will be important as it will help to identify the real market barriers, to promote SWHs using a door-to-door program marketing approach and finally to design the program in such a way that the identified market barriers will be overcome. These surveys could be conducted by EDL personnel when they visit households to collect energy bill payments or to read the meters. A PIN and a PDD will be developed for the program in this step.

Step 2: Edit the standards and develop a labelling scheme for solar water heaters; LCEC has already proceeded with this step.

Step 3: Develop SWH technical specifications and guidelines for installers to guarantee the quality and proper installation of the equipment. Capacity building and training sessions for selected and certified installers should be put in place.

Step 4: Implementation of a testing facility.

Step 5: Implementation of a financing mechanism to help remove two major barriers for the consumers in terms of the high initial investment required for implementation and the relatively long payback period. The financing mechanism would provide the end users with financial incentives to

[49] Solar Water Heating in Lebanon: Current Status and FutureProspects, Dr. Ahmad Houri, Lebanese American University
[50] Solar Thermal Market in Europe, May 2009
[51] Framework Conditions for Solar Thermal Energy Use in the Southern Mediterranean Countries, December 2007

increase enrollment in the program. The first incentive would help to reduce the total investment cost through a grant based on the cost of the system and the second incentive would allow the end user to pay for the remaining investment through monthly installments over a 5-year period. The credit would be recovered through EDL's electricity bills.

Step 6: Reinforce the awareness campaign and put a training program in place on the standards and labels for various stakeholders and players on the SWH market; this training would include technical specifications and installation guidelines. Certified retailers will help to inform the end users about the benefits of SWHs and assist consumers in their applications for the new financing mechanism. LCEC is currently conducting awareness and capacity building activities.

Collective SWH systems can also be used in the tertiary sector; however, the SWH technology in the hotel sector shows very little potential. This is due to the generally very low room occupancy that did not exceed 22% in 2007. Consequently, collective SWHs will be integrated on the market without a specific program until the overall potential is confirmed in the upcoming years.

A demonstration period will be instituted for the SWH Program to establish the technical and financial structures before the program's final launch.

Following this demonstration period, the SWH market will have evolved and various players will be more familiar with the implementation methodology and procedures. The national market will be in a better position to pursue its development.

A legal framework should be developed based on the financial structure and program implementation specificities.

Phase 2 - Program Implementation

The Ministry of Energy and Water (MEW), through the LCEC, will be responsible for managing the program. A Program Management Unit (PMU) under LCEC will be created; this unit will be responsible for implementing the program, developing the required specifications for the SWH systems and defining a list of qualified installers and suppliers. This PMU will also coordinate the various key players and stakeholders and synchronize all their activities. The team will follow up on all surveys and studies that will be undertaken on SWH development in collaboration with national and international experts.

In the proposed implementation approach, equipment suppliers/installers will play an important role since they will ensure the main links between the consumers and EDL for the purchase and installation of the SWHs. Customers will ask their supplier for an estimate of the installation costs of the SWH based on the system that has been chosen and its installation specifications. This estimate will be accepted and signed by the customer and will then be submitted by the installer, through the PMU, to EDL requesting approval for system financing. After validating the file, EDL will authorize the bank to approve the supplier's credit and release it after the customer has accepted the installation terms. Once the SWH has been installed d, the supplier will request the related subsidy from LCEC. A

new amount covering the cost of the installed equipment will then be included on the customer's electricity bill and will be paid in monthly installments

The national banks are part of the main stakeholders in this proposed approach; their role will be to provide loans to SWH suppliers and recover the loans by way of EDL's customers' electricity bills.

Systems providers and maintenance firms could form associations to enroll in the program and provide comprehensive services to their clients.

The following figure shows how the different stakeholders in the SWH Program will interact.

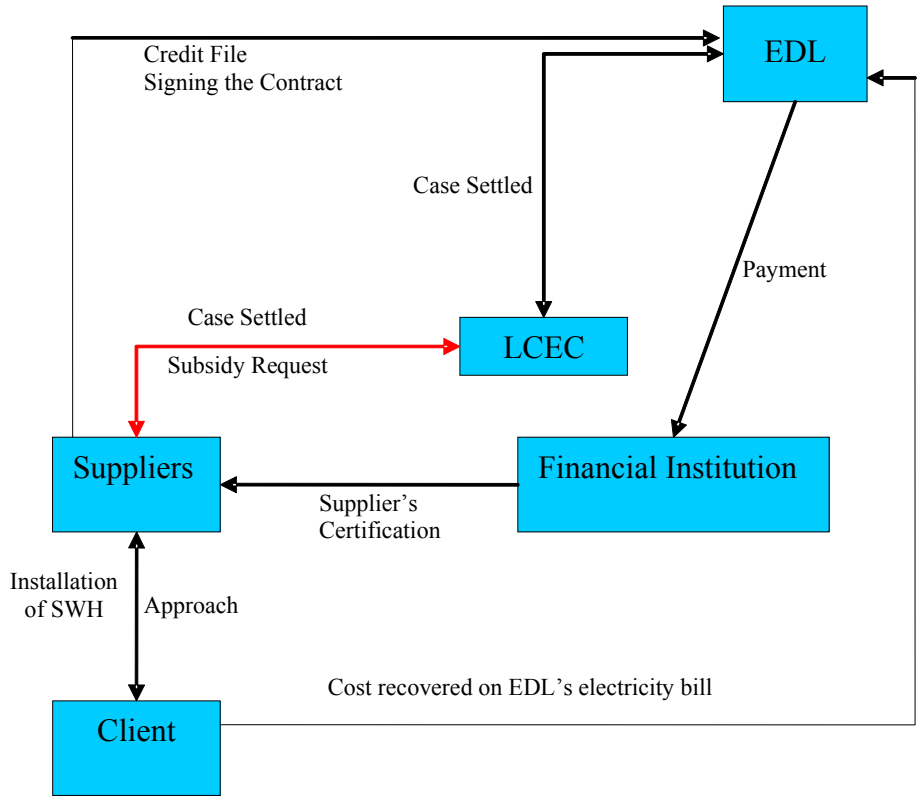


Figure 19: SWH Implementation

EDL will be the main key player in the recovery of SWH financing through its electricity bills. In addition, EDL will collaborate with LCEC in conducting a survey in the residential sector in order to define the real energy savings potential, the investments needed and the financing mechanism budget. This survey could be carried out by EDL staff.

The Industrial Research Institute (IRI) will need to be equipped with the required facilities to test and provide certification for all SWH systems distributed or manufactured on the Lebanese market. IRI will release certification for SWHs according to the local standards defined by LIBNOR.

The Lebanese Standards Institution, LIBNOR, will be in charge of transposing international standards into national standards. In addition, LIBNOR will be involved in the development of the technical specifications required for SWHs in collaboration with IRI and LCEC.

All suppliers will have to have their SWHs tested at IRI in order to be certified based on Lebanese specifications. The installation of each SWH should be executed by a certified installer.

A technical center could take charge of the training and capacity building for installers and system providers. Certified installers should follow specific training sessions to enable them provide adequate SWH services to their clients. Certification by the technical center should be a prerequisite to enroll in the program as SWH systems installers.

Table 10: Summary of the role and responsibilities of the key players

Organization	Responsibilities
LECE /MEW	Executing Agency • Program management • Liaises with different stakeholders • Supervises surveys and compiles results • Supports and facilitates SWH Program implementation • Promotes the SHW Program within government departments and agencies • Supports awareness campaigns • Disseminates information on SWH Program outputs and outcomes • Accounts for SWH implementation • Maintains a list of qualified system providers and installers • Pays subsidies to SWH providers
EDL	Implementing Agency • Conducts residential surveys • Authorizes bank credits to SWH providers • Prepares vouchers and sends them with monthly bills to EDL's domestic customers • Contributes to the baseline domestic sector electricity consumption data, program monitoring and program evaluation • Coordinates SWH Program advertising and promotional campaigns • Collects monthly installments from households through its electricity bills
The Industrial Research Institute (IRI)	IRI will test imported or locally produced SWHs and their compliance with the local standards. IRI will issue compliance certification on SWH systems based on the standards defined by LIBNOR.
Participating SWH suppliers/installers	Express interest in the program enrollment as suppliers/installers • Participate in the training and capacity building sessions offered within the program • Take charge of the household files presented to EDL for the purchase of SWHs and credit requests • Proceed with SWH installation • Display SWH Program marketing and educational material in their retail outlets • Request subsidy reimbursements from LCEC after the systems have been installed
The Lebanese Standards Institution (LIBNOR)	Will liaise between international and local standards. LIBNOR will closely collaborate with the MEW in the establishment of the SWH standards.
The Ministry of Finance	Will establish the regulations and decrees required to finalize the legal framework in regards to loan attribution, monthly installments and program stakeholders with specific responsibilities and roles.
Technical Center	Develop training programs for SWH distribution and implementation. • Provide training for SWH suppliers/installers • Issue certification for qualified SWH providers/installers
Local Banks	Ensure training to suppliers/installers on the submission of applications and credit requests • Provide credit to certified SWH providers/installers • Request payments from EDL for system installation
International Consultant	Program Coordinator • Design program and implementation procedures • Proceeds with the qualifications requirements and selection of SWH suppliers • Designs and coordinates SWH Program advertising campaigns • Establishes baseline domestic sector electricity consumption data • Proceeds with program monitoring and evaluation • Periodically reports to stakeholders about program implementation, and advises on program adjustments when needed

Basic Assumptions:

The following table presents the basic assumptions for savings and cost estimates.

Table 11 : General Assumptions for the SWH Program

Basic Assumptions for SWH Program

	Values	Units
Population in 2007	3,759,137	
Average ratio of population evolution	1.5%	/year
Average household occupation	4	p/family
Annual hot water consumption per person	13	m3/person kWh
Annual thermal consumption per person (Δ T= 40°C)	618	th/person/year
Households with electric heater	80%	
Performance of electric heaters	97%	
Market of solar water heaters (Independent house rate)	32.2%	
Penetration rate (five years after the launch of program)	80%	
Energy saving rate	42%	
Average household annual savings	1539	kWh
Average household annual savings	98	$
Average household payback period	9.7	year
Average reduced electricity subsidies	225	$/year/household
Current electricity tariff in the residential sector	6.4	$Uscent/kWh
EDL's marginal cost	21	$Uscent/kWh
Thermal efficiency of EDL's power plant	35%	
Technical loss of EDL grid	15%	
GHG	0.833	KgCO2/kWh
CDM	8	$/tcO2
Cost of SWH (average capacity 200 liters)	1,200	$/system

Implementation Costs

The detailed budget estimated for program implementation includes the subsidies, which represent 20% of the required investment, the cost of surveys, testing facility equipment and awareness and training programs. The following table shows the estimated costs of implementing the SWH Program over a period of five years.

This budget considers an amount of 51.4 million distributed as subsidies during the 5-year program duration without taking into account the dedicated SWH meters. The total cost of the program, including awareness campaigns, surveys, training, testing equipment and additional electrical meters is estimated at USD 76.2 million

Table 12: Implementation Costs of the SHW Program

Activity	Cost
Subsidies of 20% for an area of 430 000 m^2 of installed collectors	USD 51,500,000
Surveys and data analysis (EDL personnel) USD 1/household/year	USD 1,000,000
Testing facility equipment	USD 1,000,000
Marketing, awareness and training programs (0.5% of the project costs)	USD 1,300,000
Dedicated SWH meters	USD 21,400,000
Total	**USD 76,200,000**

Phase 3 - Program Financing

Using carbon finance to provide a portion of the subsidies for homeowners could be considered, especially under a program scheme that is part of the Clean Development Mechanism.

The Government could also request a loan from an international financing institution like the WB to finance a portion or the totality of the activities. The possibility of obtaining a grant from the Global Environment Facility (GEF) should also be explored to provide support for the initial design and development of the program.

Funds for program implementation could be provided through special taxes on all types of water heaters except SWHs, to create a source of financing to support the program's continuity.

On the other hand, the Kafalat Fund could be used to reduce the interest on the credits provided for SWH installation.

Since the SWH Program will generate significant benefits, the subsidy levels for the installation of SWHs could be increased to encourage enrollment in the program. This would improve the financial capacity of end users and reduce their reimbursement period.

In order to be approved as an emissions reduction project, appropriate documents are required for project development and registration.

Phase 4 - Program Evaluation

In order to evaluate the impacts of the SWH Program, it is recommended to implement separate electricity meters for SWH systems (if this has not already been done). These meters will provide two advantages; first, they will be useful in the utility's control on the demand of water heaters during peak periods (cut-off periods) and, secondly, they will allow evaluating the customers' energy consumption after the implementation of the SWH systems. Other advantages of separate metering are the possible introduction of a dedicated tariff system for SWHs, increased enrollment in the program and the promotion of the use of renewable energy.

Weather data, a peak demand analysis and energy consumption will also help to monitor the impacts of the SWH Program. The final methodology will be prepared during the program design phase in accordance with the stakeholder benefits and the utility's objectives.

Phase 5 – Savings Potential and Payback Period

Energy Savings

The proposed program related to individual solar water heaters is expected to reach 32% of the total households in Lebanon. The installed area of collectors is estimated at 430,000 m2 after a period of five years. The energy savings within these five years are estimated to be 1,115 GWh or 276 ktoe/year, and the total CO2 emission reductions are estimated at about 929,000 tons.

The estimated energy savings are based on the following assumptions:

- Independent dwellings only are being considered
- An average of four persons per family
- An annual hot water consumption estimated at 13 m3/per person
- SWH electricity consumption savings estimated at around 42%.

An estimated cumulative penetration rate of SWHs on the market is presented in the following table.

Table 13: Cumulative Penetration Rate of SWHs

Year	Penetration Rate (%)	Installed Collector Area (m^2)
2010	20%	100,000
2011	40%	200,000
2012	60%	312,000
2013	70%	370,000
2014	80%	430,000

Benefits

The estimated savings for the SWH Program will be mainly generated by the savings in the cost of electricity. Five years after program implementation, the net savings are estimated at USD 94.1 million. This estimate is based on EDL's current cost to produce electricity, which is 0.21/kWh, and a cost of USD 8/tCO2. The detailed estimates are presented in the following table.

Table 14: SWH Program Estimates

		2010	2011	2012	2013	2014	Total
Population		3,927,953	3,985,894	4,044,689	4,104,351	4,164,893	
Hot water consumption	m3	40,850,714	41,453,293	42,064,761	42,685,249	43,314,889	
Thermal energy needed	GWh	2,427	2,463	2,500	2,536	2,574	
Electrical energy consumption	GWh	2,944	2,988	3,032	3,076	3,122	
Average demand	MW	336	341	346	351	356	
SWH market	GWh	947	961	975	990	1,004	
Penetration rate	%	20%	40%	60%	70%	80%	
Energy savings	GWh	80	161	246	291	337	1,115
Reduced power	MW	9	18	28	33	39	
Primary energy savings	toe	19,709	39,999	60,883	72,078	83,590	276,260
TCO2 reduction	tCO2	66,277	134,510	204,741	242,388	281,101	929,017
Savings	Million $	12	24	36	42	49	162.8
CDM	Million $	0.53	1.08	1.64	1.94	2.25	7.4
Total	**Million $**	**12.1**	**24.7**	**37.5**	**44.4**	**51.5**	**170.3**
Number of installed systems		50,548	102,587	156,150	184,862	214,388	214,388
Number of new systems		50,548	52,039	53,563	28,712	29,525	
System cost	Million $	61	62	64	34	35	257.3
Subsidies (20%)	Million $	12	12	13	7	7	51.5
Market study and survey (1$/householder)	Million $	1					1.0
Testing facility (1million $)	Million $	1.0					1.0
Measurement and Verification (SWH dedicated meters)	Million $	5.1	5.2	5.4	2.9	3.0	21.4
Awareness and training programs (0.5%)	Million $	0.30	0.31	0.32	0.17	0.18	1.3
Investment	**Million $**	**19.5**	**18.0**	**18.5**	**9.9**	**10.2**	**76.2**
Net Savings	**Million $**	**-7.3**	**6.6**	**19.0**	**34.5**	**41.3**	**94.1**

Payback Period

With the current cost for electricity of USD 0.064/kWh, the payback period for end users is estimated at about 9.7 years considering an average savings of 42% on electricity bills. The annual savings for each household is around USD 100. EDL's annual savings per household is estimated at around USD 230 considering a marginal cost of USD 0.21/kWh. EDL's payback period for subsidies is about 1.1 year.

3.2 MEDIUM-TERM ACTION PLAN

3.2.1 Energy Efficiency Program in the Industrial Sector

The electrical consumption in the industrial sector represented around 26% of the overall electricity produced by EDL in 2006 (8,684 GWh)[52]. Self-generated electricity represented around 34% of the national consumption, the major part of which was consumed by the industrial sector. The installed power for self-generation in Lebanon's industrial sector represented about 257 MVA. In the country's total electrical consumption of 13,200 GWh in 2006, the industrial sector's consumption was about 60%. As far as oil consumption is concerned, the industrial sector's was estimated at about 22.5% of the country's overall oil consumption. The following figure shows the compilation of the results of 57 energy audits conducted by LCEC (in 17 industries, 3 hotels, 7 hospitals, 2 pumping stations and 28 buildings) illustrating the self-generation expenditures in different sectors.

[52] Source : Survey conducted by ALI and LCEC in 2006

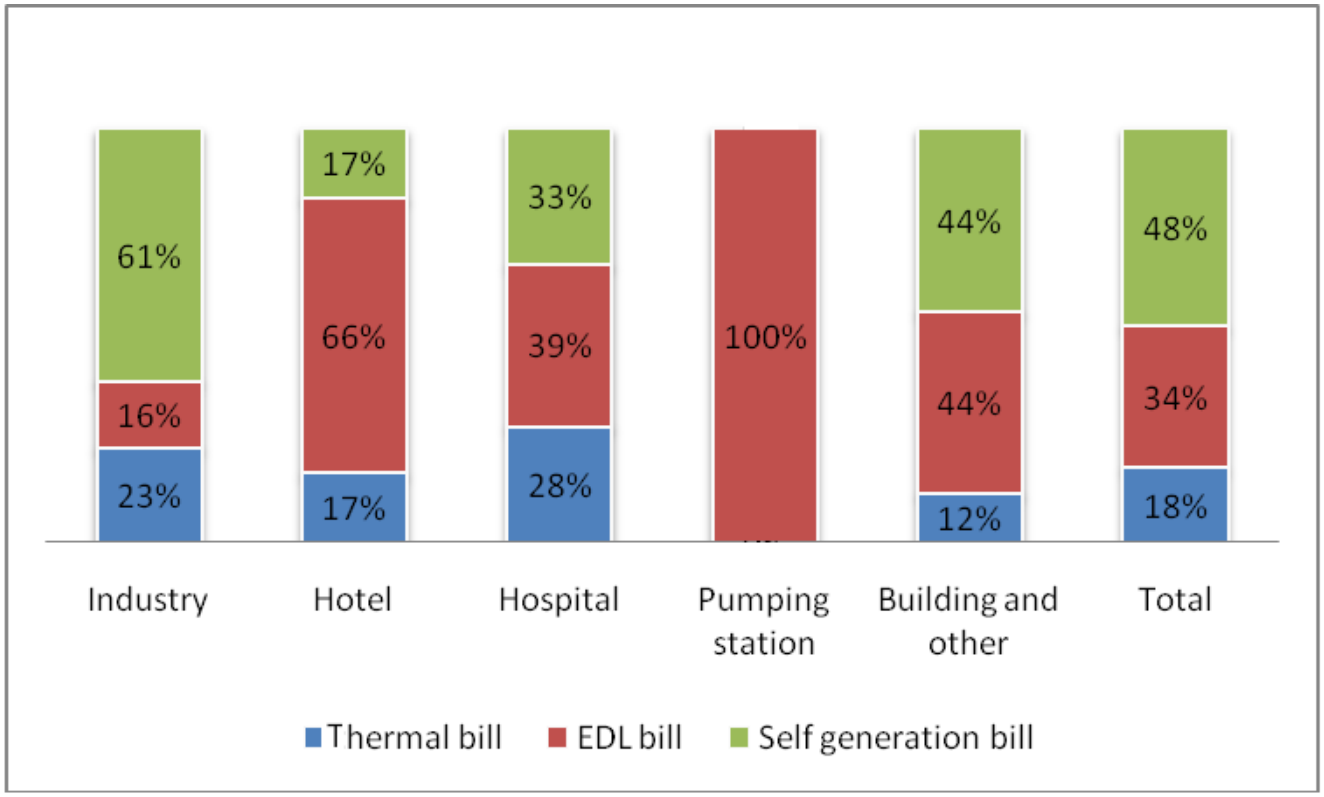


Figure 20: Bills per Energy Form[53]

The last updated data on the industrial sector were drawn from a survey conducted in 2006 by ALI and LCEC on 251 industries. The data analysis showed that 4.8% of the surveyed industries had energy consumption costs that represented more than 40% of their total production costs and about 20.8% of the industries incurred energy consumption costs representing more than 25% of their total production costs. Reducing the industry's energy bills will certainly help to reduce the sector's direct costs and increase the competitiveness of the products on the market.

The industrial sector, with 60% of the country's total electricity consumed and 22.5% of the total oil consumed, represents a significant energy efficiency potential, which identifies the sector as a priority for energy efficiency program development. Based on international experience, the estimated savings from the adoption of best practices commercial technologies in manufacturing industries is estimated to be between 18% and 26% resulting from final energy use[54].

Unfortunately, no extensive data are available to assess the detailed energy savings potential based on the sector and technologies used. No energy balance by end user is available or has been assessed in the industrial sector. The lack of detailed information on the energy consumption per sector and per energy type, the reduced number of energy audits conducted to evaluate the sector's

[53] Source: LCEC Energy Audits
[54] International Energy Agency (IEA),: Tracking Industrial Energy Efficiency and CO_2 Emissions, October 2007

potential and the unavailability of details on the technological levels of the sector constitute barriers to providing an Action Plan and precise targets for energy efficiency actions.

Nevertheless, this section presents the energy savings potential taking into consideration the sector's energy consumption and the results of energy efficiency actions undertaken in the industrial sector over the last two decades7.

In the industrial sector, energy consumption and energy balance are quite different from one sphere to another based on each sphere's activities and production. However, following a general assessment, the primary energy uses of the overall industrial sector are as follows:

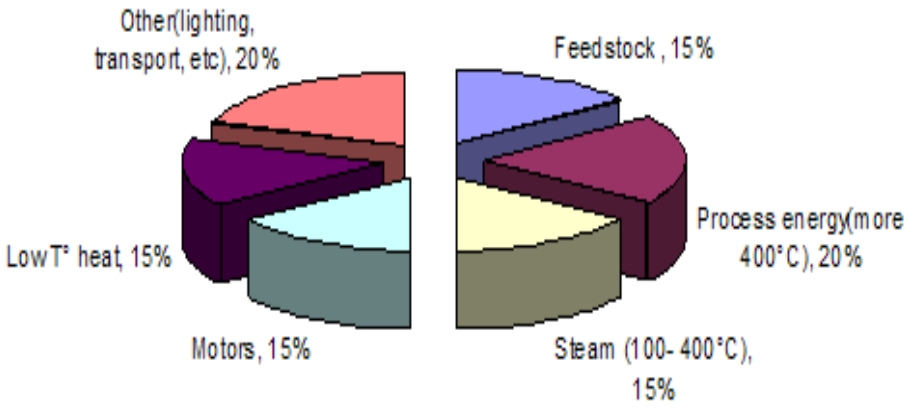


Figure 21: Primary Energy Uses in Industries[55]

The savings potential in the industrial sector was estimated based on a comparison of best averages from energy audits and world averages, or best practices and world averages. New technologies that are not yet widely applied in Lebanon were not taken into account in this estimate.

Based on international experience, the potential for energy savings by sector ranges between 9% and 33% as shown in the following table.

[55] International Energy Agency (IEA), Tracking Industrial Energy Efficiency and CO_2 Emissions, October 2007

Table 15: Energy Savings Potential by Industrial Sector

Energy Savings Potential by Industrial Sector	
	%
Chemicals / Petrochemicals	13-16%
Iron and steel	9-18%
Cement	28-33%
Pulp and paper	15-18%
Aluminum	6-8%
Other non-metallic minerals and non-ferrous metals	13-25%

On the other hand, a system/life cycle analysis shows an energy savings potential ranging between 2% and 40% as shown below:

Table 16: System/Life Cycle Improvement Potential in the Industrial Sector

Industrial Sector's Energy Savings Potential per System/Life Cycle Improvement (%)	
Motor systems	20 - 25%
Combined heat and power	3 - 4%
Steam systems	10 - 15%
Process integration	10 - 40%
Increased recycling	2 - 4%
Energy recovery	2 - 3%
Total Potential	**18 - 26%**

According to preliminary surveys in the Lebanese industrial sector, initial indicators suggest a high potential for energy savings, which could be more significant than the world average values. In fact, the majority of Lebanon's industries produce their electricity through self-generation, the performance of which is lower than combined heat and power (CHP) that provides a greater potential for energy and cost savings.

The energy audits conducted in 17 Lebanese industries show an average energy savings potential of 7% on the overall bills (electricity and thermal) and a payback period of about 3 years, which seems very low considering the international average. The energy savings potential by technology and the payback period of each technology are shown in the following figures.

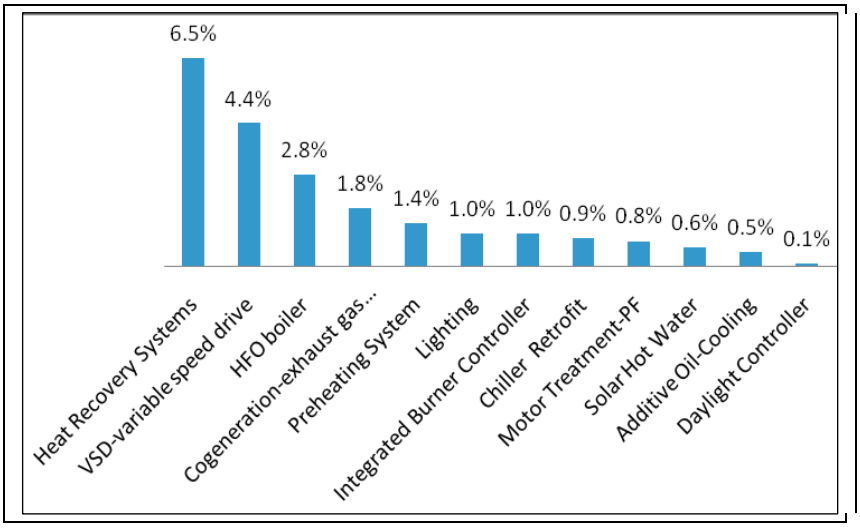


Figure 22: Energy Savings by Technology in Industrial Sector

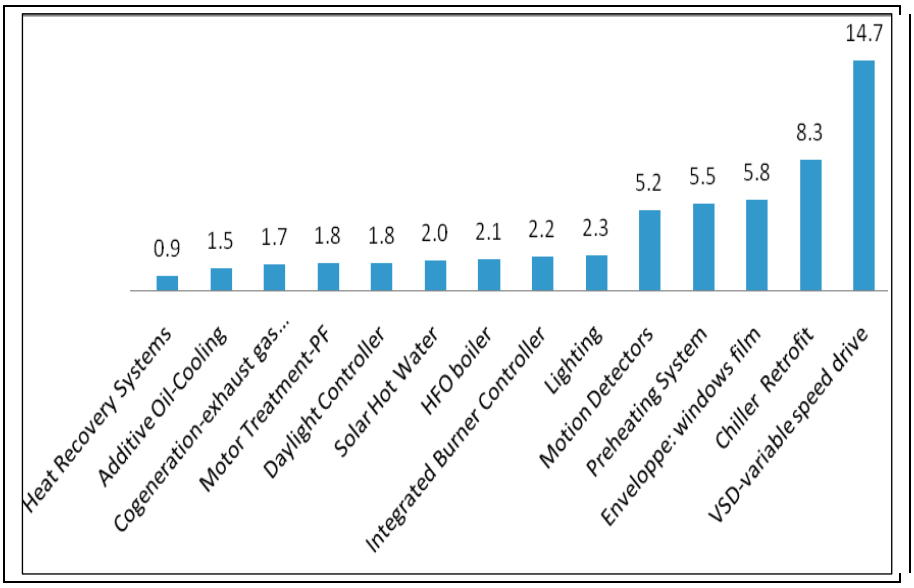


Figure 23: Payback Period of Each Technology

Phase 1 - Program Design and Development

The program targeting the industrial sector could be justified by its energy savings potential as well as the related GHG emission reductions. The objective of the Energy Efficiency Program in the Industrial Sector is to remove energy efficiency market barriers and focus on developing a financing mechanism that would allow the implementation of energy efficiency projects in the sector. The first step in a successful program can be initiated through a detailed market study targeting an analysis of the sector to assess its energy consumption and energy savings potential. The proposed Action Plan would allow

Lebanese manufacturers to become more competitive and help the establishment of a solid national policy regarding demand-side management and the reduction of GHG emissions.

The main objective of the program is to address the following issues for energy efficiency development:

- Gather comprehensive data on the sector's energy consumption and assess the energy savings potential and priorities for energy efficiency actions.
- Develop the energy efficiency market in the industrial sector by promoting energy service companies (ESCOs).
- Remove institutional barriers to implementing a legal framework adapted to the Lebanese context.
- Develop a financing mechanism for energy efficiency programs.

The Action Plan will include the following:

Component 1: Technical assistance and capacity building: This component includes the program design, program management and capacity building required for its implementation and execution. Capacity building will target potential ESCOs, financial institutions and participants in the industrial program. An awareness campaign on the importance of energy efficiency and project benefits will be a part of the capacity building component. The technical assistance component will include conducting surveys, data collection and analysis to assess the energy savings potential. TORs for ESCO certification will be developed and organizational operations will be established as well.

The capacity building training for financial institutions, insurance companies, energy efficiency experts and the country's technical centers will disseminate information on the energy savings potential for investors, customers and service providers. This training will help to define the role of each stakeholder and main player as well as the project outputs under Lebanon's global approach to energy efficiency. This component will be conducted by local and international experts.

Component 2: An energy efficiency fund will be created to support project implementation. This fund will be dedicated to the financing of energy efficiency projects in industries with attractive conditions for ESCOs and industrial clients. The fund will provide project financing up to 75% of the total project costs to a maximum of USD 200 000. No collateral will be requested for the credit allocated to these projects if the projects are carried out by ESCOs under a Performance Contracting scheme.

A guarantee fund for energy efficiency projects would be an alternative solution to help promote investments in the sector and encourage commercial financial institutions to participate in the market development. Kafalat can manage the fund and provide guarantees for loans and credits required for the implementation of EE projects up to a level of 70% of the total value of projects. This guarantee fund would be of great support towards ESCO development, providing the necessary financial resources for project implementation under a Performance Contracting scheme.

Under this component, undertaken energy efficiency projects will benefit from a 10% subsidy program to encourage project implementation up to a maximum amount of USD100 000.

Development Costs

The following table shows the estimated budget for program implementation. The program considered here includes the realization of 125 projects in the industrial sector representing about 20% of the number of industries that are members of the Lebanese Industrial Association, with a program timeframe of 7 years. The budget includes a 10% incentive for equipment procurement for the energy efficiency projects to be implemented. It also includes a provision for the establishment of an energy efficiency fund and the technical assistance and capacity building component. The program fund for the 125 energy efficiency projects is estimated at USD 4 million. The total budget for project implementation is estimated at USD 7.5 million.

Table 17: EE Program Costs in the Industrial Sector

Activity	Budget
10% subsidy (max USD 100,000/project)	USD 1.5 Million
Bank loans allocated to ESCOs (75% or up to USD 200,000)	USD 4 Million
Technical assistance and capacity building	USD 2, Million
Total Budget	**USD 7.5 Million**

The costs were assessed based on the investment required by 20% (or about 125 industries) of the 627 members of the Lebanese Industrial Association. The details of the assessment are presented in Appendix 5.

Phase 2 - Program Implementation and Monitoring Plan

The main stakeholders involved in this program are presented in the following section.

The Ministry of Energy and Water and the LCEC will be responsible for program management. A dedicated group under LCEC will be created with the objective of ensuring the coordination between the different players. This group will be in charge of managing the energy efficiency fund, developing specifications for ESCOs and EE organizations, identifying the barriers and proposing an Action Plan for the penetration of different technologies. Under LCEC and in collaboration with local and international experts, a task force will be created to identify the sector's technologies that show the best energy savings potential.

The fund will be managed by the Ministry of Finance in close collaboration with the Ministry of Energy and Water through LCEC. The fund will provide credits to ESCOs or to end users. Insurance companies will ensure the savings guaranteed by ESCOs.

Financial institutions, including banks, leasing and insurance companies, will be the main players in the financing of the energy efficiency projects. All these institutions will benefit from the capacity building component with the purpose of placing new energy efficient products on the market.

Energy experts, prospective ESCOs and technical centers represent the executive partners of the program. By mastering the appropriate methodologies for EE project development and implementation, they will monitor the risks associated with the EE projects and develop bankable documents for project financing.

The industrial sector will require specific training and awareness campaigns to increase its appreciation of the benefits of EE. The training, carried out by a dedicated task force, will include workshops for targeted groups promoting the benefits of the ESCO approach for EE project implementation.

Phase 3 - Program Financing

This program could have a demonstration period of up to 7 years that would help to overcome the barriers related to developing energy efficiency projects in the industrial sector. Over this seven-year period, skills on EE project implementation will be developed. The budget required for this EE program demonstration period could be funded by international financing institutions with the support of the CDM.

Kafalat could play a role in the EE fund by providing a reduced interest rate for the program.

In parallel, a local financing mechanism could be created to supply energy efficiency funds and to ensure the program's sustainability. These funds could be generated through taxes applied to high energy consuming or polluting equipment like electrical water heaters, low performance air conditioning units, incandescent lamps and vehicles used in the transportation sector, etc.

Phase 4 - Program Evaluation

The evaluation of this EE program will be conducted on a yearly basis. The data will be collected through a monitoring system that will be implemented for EE projects and implemented ESCO projects. A standard monitoring model will be defined through ESCO specification activities according to the International Performing Measurement and Verification Protocol (IPMVP) methodology.

Energy Savings

The potential annual energy savings that could be achieved through the implementation of the 125 projects are estimated at about 7,100 toe and the CO2 emission reductions would be about 123,000 tons.

Table 18: Estimated Energy Savings Generated by the 125 Projects over the 7-Year Program

	Investment	Reduced Power	Savings			CDM	
Program Savings	$M	MW	$M/PP	$M/year	ktoe/year	KTCO2	$M
Electrical savings	3.7	3.3	17.5	4.2	4.1	75.6	1.5
Thermal savings	1.6	0.0	5.0	1.2	3.0	47.4	1.1
TOTAL	**5.3**	**3.3**	**22.5**	**5.3**	**7.1**	**123.0**	**2.6**

The estimated savings for EDL and the industries are presented in the following table:

Table 19: Estimated Savings Generated by the 125 Projects for EDL and its Industrial Clients over the 7-Year Program

Program Savings			
Savings	EDL	Clients	Total
GWh	9	29	39
$ Million	1.1	3.6	4.8

However, the total potential savings of the entire sector is estimated at USD 27 million with reduced power of about 16 MW. The following table shows the savings potential in terms of electrical and thermal energy.

Table 20: Estimated Energy Savings for the Entire Industrial Sector over the 7-Year Program

	Investment	Reduced Power	Savings			CDM	
Industry Savings	$M	MW	$M/PP	$M/year	ktoe/year	KTCO2	$M
Electrical Savings	19	16.3	88	21	20	378	8
Thermal Savings	8		25	6	15	237	6
TOTAL	**27**	**16**	**113**	**27**	**35**	**615**	**13**

The estimated savings for EDL and the industries for the entire industrial sector are presented in the following table:

Table 21: Estimated Savings for EDL and its Industrial Clients for the Entire Industrial Sector over the 7-Year Program

Entire Industry Savings			
Savings	EDL	Clients	Total
GWh	47	146	193
$ Million	5.7	18.2	23.9

The energy savings potential in the industrial sector has been estimated based on the IEA assessment of the potential of EE projects based on the Lebanese industrial sector's energy consumption combined with the energy savings potential determined through the 17 energy audits conducted by LCEC. The following table presents the estimated energy savings potential per type of EE technology.

Table 22: Estimated Energy Savings per Technology in the Entire Industrial Sector over the 7-Year program

Industry EE Proposals										
		Investment	Reduced power	Savings			CDM		NPV(0%)	
Proposal	Program Period (PP)	$M	MW	$M/PP	$M/year	kTOE/year	KTCO2	$M	Without CDM	With CDM
EEM 1: Boiler Efficiency Improvement (combustion and insulation)	7	3.9		7.9	1.8	5.0	79.1	1.9	4.1	5.9
EEM 2: Heat Recovery systems	7	1.0		4.9	1.1	3.1	49	1.2	3.9	5.0
EEM 3: High Efficient Motors	7	6.1	3.6	17.9	4.6	4.5	65	1.5	11.7	13.3
EEM 4: Cogeneration - Exhaust Gas	7	2.1		9.3	2.2	5.8	92	2.2	7.1	9.3
EEM 5: Preheating Systems	7	0.4		1.1	0.2	0.7	10	0.2	0.7	0.9
EEM 6: Improvement of Lighting Systems	7	0.9	0.3	1.8	0.4	0.4	6	0.2	0.9	1.1
EEM 7: Solar Water Heaters	7	0.4		1.8	0.4	0.4	7	0.2	1.4	1.6
EEM 8: Improvement of Cooling Systems	7	8.1	10.9	59.5	13.9	13.6	216	5	51.4	56.5
EEM 9: Motors- PF Improvement	7	3.5	1.5	8.4	2.0	1.9	91	0.7	4.9	5.6
TOTAL	**7**	**27**	**16**	**113**	**27**	**35**	**615**	**13**	**86**	**99.2**

The Energy Efficiency Program in the Industrial Sector will generate monetary savings on both electricity and fuel bills. EDL will also incur savings resulting from the reduction in subsidies for energy saving equipment. The net present value (NPV) with a CDM contribution is estimated at USD 100 million at the end of the 7-year program and, without a CDM contribution, at USD 86 million. This estimate is based on EDL's marginal cost for electricity production, which is USD 0.21/kWh, and considering the sale of reduced CO2 emissions of USD 8/tCO2.

Appendix 5 includes the details of the estimates for each proposal.

3.2.2 Energy Efficiency in the Street Lighting

Street lighting represents heavy costs for municipalities where the costs are not only related to the municipal energy consumption, but also to the operation and maintenance of equipment. Many countries in the world have developed and implemented street lighting programs to reduce their electricity bills. In County Cork in Ireland, the street lighting program savings are estimated at about € 1 million, which represents about 30% of the area's total electricity bill. In Bulgaria, Silistra's municipal street lighting program consisted in replacing mercury lamps with High Pressure Sodium (HPS) lamps, which represented about 65% of the city's network and including an automatic control system. The savings generated were about 59% of the city's electricity bills with a payback period of around 2.5 years. The energy efficiency project for street lighting launched in Kutums, Latvia, contributed to reducing the lighting consumption to 30% of the energy consumed before the project was implemented.

The savings potential varies according to the lighting network's state, existing lamp types and operation and maintenance practices. However, 30% in savings is considered to be an achievable potential in the street lighting sector when replacing mercury lamps with HPS lamps is considered.

The major identified barrier for such programs is the availability of funds for project implementation since municipalities generally have limited financing resources to consider an energy efficiency project as a priority. In fact, municipalities have no means to finance EE projects with their budgets. In some countries, this barrier is resolved through credits lines, ESCO projects and leasing contracts. Moreover, carbon transactions represent an additional possible financing source.

In Lebanon, the efforts in regards to energy conservation in street lighting have not led to concrete projects, with the exception of CEDRO[56]. This project's mandate is to install photovoltaic lighting on 22 lamps. The existing external lighting system in the Jbeil port area comprises 12 6m-high wooden light poles with 250W High Pressure Sodium (HPS) lamps.

With the lack of detailed information on the street lighting in Lebanon, the energy consumption in the Lebanese lighting sector has been estimated based on Tunisia's database, taking into account the difference in population density as an adjustment factor. The energy consumption in the lighting sector is estimated at 66 GWh, which represents about 0.5% of Lebanon's electricity consumption in 2006. In Tunisia, this ratio is 3%, a difference that can be justified by the more significant amount of vertical structures in Lebanon. The total number of street lights in Lebanon is approximately 67,000 units, among which 40% are mercury lamps[57].

The total annual subsidies for electricity consumption in the street lighting sector is estimated at USD 9.7 million, considering a marginal production cost of USD 0.21/kWh. Any savings in street lighting will

[56] Project Presentation: http://www.undp.org.lb/ProjectFactSheet/projectDetail.cfm?projectId=56
[57] Assumption drawn from the information in a Khobary (National energy consultants) presentation on the street lighting project.

not only reduce municipal electricity bills but also reduce the need of the Government's financial support to the energy sector.

Program Design

The proposed program includes two components as follows:

Component 1: Replacement of existing mercury lamps by HPS lamps in the case of about 18 000 units. The average energy savings is estimated at 56% of the consumption of mercury lamps. The replacement of all of the street lamps in Lebanon is planned over a period of five years after the launch of the program.

Component 2: Implementation and dissemination of Automatic Voltage Regulators (AVRs) in the street lighting network, reducing the energy consumption by an average of 35%. AVRs are electronic devices that can be installed on part of a network or on individual lamps. AVRs play two roles. The first consists in regulating the voltage and providing lamps with steady voltage eliminating network fluctuations, which represents an average savings of 10%. The second consists in reducing the lighting level during low traffic hours, which can be easily programmed, based on the needs and selected hours. The implementation of this component on the entire network is expected to be completed over a period of 10 years.

The implementation of this program will certainly require training on the use of AVRs for the technical personnel of municipalities or sub-contractors/firms responsible for the maintenance of street lighting.

On the legal side, the Government might prohibit the use of mercury lamps in new street lights and on the existing network once all the lamps have been replaced at the end of the 5-year program. AVRs could be required for all new lighting projects; with recommendations on their installation during the refurbishment of existing street lamps.

The general assumptions in the program estimates are shown in the following table.

Table 23: General Assumptions for Street Lighting Program

Assumptions for Street Lighting Program

	Values	Units
Population in 2007	3759137	
Population's yearly evolution	1.5%	
Country area	10452	Km2
Density	359.7	R/km2
Overall electrical consumption in 2006	13200	GWh
Street Lighting Consumption	66.4	GWh
Installed Mercury Lamp	40%	
Number of existing mercury lamps	18090	Lamps
Mercury lamp efficiency	60	lm/W
Sodium lamp efficiency	135	lm/W
Energy savings of mercury lamp	56%	
Energy savings rate of voltage regulator	35%	
Operation hours	4175	h/year
Current electricity tariff	6.4	$UScent
EDL's marginal cost	21	$UScent
Thermal efficiency of EDL's power plant	35%	
Technical loss of EDL grid	15%	
GHG	0.833	KgCO2/kWh
CDM	8	$/tcO2
Voltage regulator system	0.315	$/kWh saving
HPS fixture cost	100	$/lamp

Implementation Costs

The budget required for this program is estimated at USD 9.4 million. The cost of the replacement of mercury lamps by HPS lamps is estimated at 1.8 million, whereas the automatic voltage regulators will require an investment of about 7.6 million.

Current situation		**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
Population		3,927,953	3,985,894	4,044,689	4,104,351	4,164,893	4,226,328	4,288,670	4,351,931	4,416,126	4,481,267	
Lighting consumption	GWh	69	70	71	72	74	75	76	77	78	79	
Mercury lighting consumption	GWh	28	28	29	29	29	30	30	31	31	32	
SPH lighting consumption	GWh	42	42	43	43	44	45	45	46	47	47	
Mercury power	MW	7	7	7	7	7	7	7	7	7	8	
SHP power	MW	10	10	10	10	11	11	11	11	11	11	
Total lighting power	MW	17	17	17	17	18	18	18	18	19	19	
ECM1: Replacement Mercury lamp by HPS												Total
Penetration rate		20%	40%	60%	80%	100%	100%	100%	100%	100%	100%	
Reduced Power demand	MW	0.87	1.76	2.68	3.63	4.61	4.67	4.74	4.81	4.88	4.96	5.0
Investment	Million$	0.4	0.4	0.4	0.4	0.4	0	0	0	0	0	**1.8**
ECM2: Voltage regulators												Total
Penetration rate	%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	
Reduced Power demand	MW	0.65	1.24	1.78	2.26	2.68	3.26	3.86	4.48	5.11	5.77	5.8
Investment	Million$	0.9	0.8	0.7	0.6	0.5	0.8	0.8	0.8	0.8	0.9	**7.6**
Balance ECM1+ECM2												Total
Reduced Power demand	MW	1.52	3.01	4.47	5.89	7.29	7.94	8.61	9.29	10.00	10.72	10.72
Investment	Million$/year	1.21	1.14	1.07	0.99	0.91	0.77	0.79	0.81	0.83	0.86	**9.4**
Total of saving	Million$/year	**0.9**	**1.8**	**2.7**	**3.6**	**4.4**	**4.8**	**5.2**	**5.7**	**6.1**	**6.5**	**41.9**

Program Implementation

This program will be implemented in close collaboration with the MEW through LCEC, the Ministry of Interior and Municipalities, EDL, technical centers, IRI and LIBNOR.

LCEC will be responsible for project management, the development of technical specifications for the proposed equipment within the program framework in collaboration with LIBNOR, IRI and EDL. LCEC will take part in coordinating the activities of the main stakeholders, following up and analyzing the results as well as the establishment of requirements to take advantage of possible financing and incentives.

The Minister of Interior and Municipalities will be responsible for carrying out the program and the implementation of decisions such as prohibiting the use of mercury lamps and the mandatory use of AVRs in all new street lighting projects.

EDL will assist in commissioning and surveying as well as in verifying the savings.

The involvement of LIBNOR and IRI in the project will include defining the technical specifications for the required equipment and certifying the compliance of equipment with the Lebanese standards.

The technical centre will train municipal O&M staff, equipment suppliers and installers on the installation and maintenance of new equipment, especially AVRs.

The Resources Centre for Local Development[58] could play a major role in strengthening partnerships between local authorities and increasing the cooperation between partners. It can be involved in project follow-up, ensuring the dissemination of information and exchanging on experience with the international partners.

Program Financing

The program financing should be provided by the Government that could request a loan from an international financing institution like the WB to finance a portion or the totality of the activities.

The CDM is an additional mechanism that could be used to finance the Street Lighting Program. To be acceptable for registration under the Joint Implementation scheme, the program must be designed to respect all the provisions of an approved methodology issued by the CDM secretariat.

On the other hand, buyer credits could be a good way to finance projects and provide funds for equipment procurement. Buyer credits could represent up to 50% based on negotiations between suppliers and the Government

[58] http://www.localiban.org/spip.php?rubrique469

The ESCO concept would be another opportunity for project implementation; however, changes in the legal framework would be required to include the specificities of Performance Contracting in the tendering process.

Program Evaluation

The evaluation of the energy savings will be conducted by LCEC in collaboration with EDL and also through ESCO projects. The energy bills of selected street lighting networks will be used to establish a savings-by-consumption comparison before and after project implementation. A baseline will be defined for each of the projects before program implementation and adjustments will be made when necessary to take reporting period conditions into account.

Energy Savings and Payback Period

The energy savings of the program's first component (replacement of mercury lamps with SHP lamps) are estimated at around 56%, while those associated with AVRs represent about 35%.[59] The energy savings over the 10-year program represent about 45% of the electricity consumption of street lighting, generating a reduction of about 286 GWh, which is equivalent to 70 500 toe. Moreover, this program will reduce the country's overall peak load by about 11 MW at the end of program implementation.

The energy savings for each program component are as follows.

Table 24: Energy Savings for Each Component

		ECM 1	ECM 2	Total
Power reduction	MW	5.0	5.8	10.7
Energy savings	MWh/PD	157,094	129,838	286,932
	MWh/y	20,693	24,071	44,765
	toe	38,600	31,903	70,503
	toe/year	5,085	5,915	10,999
	Million$/year for EDL	3.0	3.5	6.5
	Million$/year for Govt.	1.3	1.5	2.9
	Million$/PP	22.94	18.96	41.89
GHG reduction	tCO2	130,859	108,155	239,014
	tCO2/year	17,238	20,051	37,289
	Million$/year	1.0	0.9	1.9
Total savings	Million$/year	24.0	19.8	43.8
Investment	**Million$/year**	**1.8**	**7.6**	**9.4**

The payback period is estimated to be around 1.5 years; the NPV (10 years) is about USD 34 million.

[59] http://www.cdmtunisia.tn/pdf/NIP_CPSCJ.pdf

Benefits

The program's total savings will be USD 42 million, of which USD 2 million will be generated by CO2 transactions. The following table presents an impact simulation of the program.

Table 25: Program Impact Simulation

Current situation		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Population		3,927,953	3,985,894	4,044,689	4,104,351	4,164,893	4,226,328	4,288,670	4,351,931	4,416,126	4,481,267
Lighting consumption	GWh	69	70	71	72	74	75	76	77	78	79
Mercury lighting consumption	GWh	28	28	29	29	29	30	30	31	31	32
SPH lighting consumption	GWh	42	42	43	43	44	45	45	46	47	47
Mercury power	MW	7	7	7	7	7	7	7	7	7	8
SHP power	MW	10	10	10	10	11	11	11	11	11	11
Total lighting power	MW	17	17	17	17	18	18	18	18	19	19
ECM1: Replacement Mercury lamp by HPS											
Penetration rate		20%	40%	60%	80%	100%	100%	100%	100%	100%	100%
Reduced Power demand	MW	0.87	1.76	2.68	3.63	4.61	4.67	4.74	4.81	4.88	4.96
Energy savings	MWh/y	3,628	7,362	11,206	15,162	19,233	19,516	19,804	20,096	20,393	20,693
	$/year	529,641	1,074,906	1,636,143	2,213,703	2,807,946	2,849,366	2,891,396	2,934,046	2,977,326	3,021,244
	toe/y	891	1,809	2,754	3,726	4,726	4,795	4,866	4,938	5,011	5,085
GHG reduction	tCO2/y	3,022	6,133	9,335	12,630	16,021	16,257	16,497	16,740	16,987	17,238
	$/year	24,175	49,063	74,680	101,042	128,165	130,056	131,974	133,921	135,897	137,901
Cumulative SPH Lamps changed	units	3,618	7,236	10,854	14,472	18,090	18,090	18,090	18,090	18,090	18,090
Investment	Million$	0.4	0.4	0.4	0.4	0.4	0	0	0	0	0
ECM2: Voltage regulators											
Penetration rate	%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Reduced Power demand	MW	0.65	1.24	1.78	2.26	2.68	3.26	3.86	4.48	5.11	5.77
Energy savings	MWh/y	2,707	5,192	7,441	9,443	11,186	13,621	16,126	18,701	21,349	24,071
	$/year	395,283	757,967	1,086,351	1,378,681	1,633,151	1,988,690	2,354,362	2,730,389	3,116,997	3,514,417
	toe/y	665	1,276	1,828	2,320	2,749	3,347	3,962	4,595	5,246	5,915
GHG reduction	tCO2/y	2,255	4,325	6,198	7,866	9,318	11,346	13,433	15,578	17,784	20,051
	$/year	18,042	34,597	49,585	62,928	74,543	90,771	107,462	124,625	142,272	160,411
Investment	Million$	0.9	0.8	0.7	0.6	0.5	0.8	0.8	0.8	0.8	0.9
Balance ECM1+ECM2											
Reduced Power demand	MW	1.52	3.01	4.47	5.89	7.29	7.94	8.61	9.29	10.00	10.72
Energy savings	MWh/y	6,335	12,554	18,647	24,605	30,418	33,137	35,930	38,798	41,742	44,765
	Million$/year	0.92	1.83	2.72	3.59	4.44	4.84	5.25	5.66	6.09	6.54
	toe/y	1,557	3,085	4,582	6,046	7,474	8,142	8,828	9,533	10,257	10,999
GHG reduction	tCO2/y	5,277	10,457	15,533	20,496	25,339	27,603	29,930	32,318	34,771	37,289
	$/year	0.04	0.08	0.12	0.16	0.20	0.22	0.24	0.26	0.28	0.30
Investment	Million$/year	1.21	1.14	1.07	0.99	0.91	0.77	0.79	0.81	0.83	0.86
Total Savings	Million$/year	**0.9**	**1.8**	**2.7**	**3.6**	**4.4**	**4.8**	**5.2**	**5.7**	**6.1**	**6.5**
Net Savings	Million$/y	**-0.3**	**0.7**	**1.7**	**2.6**	**3.5**	**4.1**	**4.5**	**4.9**	**5.3**	**5.7**

3.3 LONG-TERM ACTION PLAN

3.3.1 Standards (MEPS) and labelling program

Minimum Energy Performance Standards (MEPS) and the labelling of equipment to inform consumers about their energy usage characteristics are two different but complementary policies. When introduced simultaneously, they are referred to as Standards and Labelling (S&L). MEPS includes testing standards to establish the energy consumption of equipment under normalized conditions and a regulation that defines the minimum energy efficiency characteristics that a product must meet to be introduced and/or sold on the market. Some MEPS programs are introduced first as pilot projects then as a voluntary scheme before becoming mandatory. However, it should be noted that voluntary schemes are generally less effective and usually result in a limited impact on the market and it should be considered as a transition period only toward a mandatory scheme.

Labelling is another regulatory tool that stipulates that energy performance labels must be affixed to products sold on a market to provide consumers with the necessary information to allow them to make informed purchasing decisions. Labelling regulations are often used as a complement to MEPS but can also be implemented as a stand-alone program. Generally, energy efficiency labelling schemes are categorized under two broad categories: endorsement labels and comparative labels. Endorsement labels are mostly introduced as voluntary as they help the consumer to differentiate between efficient and inefficient products on the market. They try to move the customer towards the higher efficiency products present on the market and can be considered as a seal of approval from Government agencies or from an international institution or local institutions. The comparative labels, as the name implies, allow the consumer to compare the relative efficiency of different products and is affixed to all appliances sold on a market. Comparative labelling schemes can be introduced as a voluntary or as a mandatory regulation.

International experience in the implementation of S&L Programs for appliances and other equipment has demonstrated its value as one of the most effective energy efficiency policies when implemented under an effective legal framework. Several S&L Programs are documented in literature such as the one introduced in Thailand in the nineties. In this country, the implementation of S&L activities was able to shift the range of products of manufacturers, importers and distributors as well as the perception and willingness of the general population to buy energy efficiency products[60]. The Tunisian experience with refrigerator labelling also demonstrated the potential of this regulatory policy to cause a rapid market shift to more efficient products. Other studies relate the EU experience and results after the first few years of S&L implementation. One of these studies drew conclusions on the comparative advantage of S&L as compared to other policy options by stating the following: “In the case of the

[60] How Energy Labelling affected production decisions of appliance manufacturer in Thailand, IIEC 2004.

European Union, minimum efficiency standards yield the largest energy savings at the lowest implementation cost"[61]

This is why MEPS and labelling are proposed as high priority programs for Lebanon's energy efficiency Action Plan. The new regulations will result in higher efficiency products on the market and the increased energy efficiency of the targeted appliances will then generate savings from the moment they are purchased throughout the equipment's lifetime, which will result in significant cumulative savings.

The implementation of MEPS and labelling can be achieved with a reasonable initial investment and the economic returns are generally very good because of the medium= and long-term impacts the policies can achieve by triggering and supporting a market transformation.

The Lebanese Government has already shown interest in implementing these policies and has initiated work on five appliances. In line with the Government's policy to implement Standards and Labelling that are in harmony with regional and international practices, the first MEPS and S&L initiatives were based on the existing European EE Standards and Labelling schemes. The five appliances targeted by this initial effort included solar water heaters (SWH), gas/electric water heaters, refrigerators; air conditioner (AC) split units, and compact fluorescent lamps (CFL). Energy efficiency classes to be used on the labels were determined for each of these appliances.

The LCEC then prepared three prototype labels for refrigerators, split unit air conditioners and CFLs. In addition, it defined six energy labels for different refrigerator categories.

It is recommended to implement a program including both an MEPS component and a comparative labelling component. The comparative label for solar water heaters (SWH) will be adopted later when the EU will have ratified its own. MEPS and a comparative type label are proposed for adoption for refrigerators, A/C units and CFLs. The microeconomic impacts of each energy classification for these products have been examined based on a study conducted by an LCEC consultant.

There are currently no testing facilities in Lebanon and this will have to be addressed in the future. They will either have to be built or agreements with neighboring country testing laboratories will have to be reached.

The proposed S&L Program ultimately aims at introducing an energy performance labelling scheme and an MEPS regulation. The program will include a testing procedure to determine the energy performance of appliances/equipment and a comparative label that will be affixed on appliances and equipment sold on the market. This labelling scheme will help consumers select and purchase more efficient appliances. The scheme will be initially implemented on a voluntary basis by enrolling some manufacturers and distributors. This initial voluntary period is recommended since there are no testing facilities in Lebanon and the necessary regulatory framework or institutional capacity for enforcement

[61] European Union efforts to promote more efficient appliances, Paolo Bertoldi, Randall Bowie, European Commission, Directorate General for Energy

are non existent in the country as well. A voluntary period for the introduction of the labelling activity will allow the LCEC to put in place several of the key program components without putting too much of a burden in terms of finances and resources on the Government. The MEPS component, which usually has little effect when implemented as voluntary, will have to move rapidly towards becoming mandatory but should also include a transition period of at least two years to allow manufacturers and importers to adjust their product range to comply with the new requirements.

The program will recommend adopting the technical criteria and label designs of the Tunisian Energy Labelling Scheme. The Tunisian scheme shares several components with the European Union except that the Tunisian labels are bilingual (French and Arabic) and the energy efficiency scale in Tunisia is offset by one grade as compared to the scale in the EU. For instance, a B classification for refrigerators in Tunisia is equivalent to a C classification in the EU. This difference in scale reflects the difference in the energy efficiency levels established in Tunisia compared to in the EU. The objective in Tunisia was to avoid having several categories of higher efficiency equipment that would not be represented on the market. For instance, if an S&L Program is introduced with a scaling system of A++, A+, A,B,C etc. and no equipment is available in the best 4 or 5 categories initially, the purpose of the labelling system would be defeated and consumers would not appreciate the value added of the labels if all the products on the market seem to be on the lower efficiency side of the scale. The offset in classes was designed in such a way that it would be easy for European manufacturers to transpose the equipment performance testing into the Tunisian scale and vice versa. Other characteristics of the Tunisian scheme, such as the color bar coding and a numbered scale rather than a letter-based scale, were adopted to fit the Maghreb culture.

The draft legislation framework that includes provisions in regards to the Government's power to label appliances or equipment has not yet been approved. Here again, a voluntary period will make the approval process easier by reducing potential barriers and any lobbying on the part of some stakeholders. The voluntary period will serve as a demonstration period as well as a learning experience for the LCEC, which will result in increased institutional capacities to design and implement S&L schemes for other equipment and products. It would subsequently be followed by the mandatory introduction of the program. The following section covers the design, implementation, financing as well as the evaluation of the S&L Programs.

Phase 1- Program Design

The first phase covers the program design and includes various activities to develop and then implement the regulatory framework, the testing procedures, the labelling and the communication activities. Based on the efforts that have already been exerted by the LCEC to design the energy labels and determine the different energy classifications, the following activities will need to be implemented for each appliance.

Table 26: Activities to be implemented

Step	Description
1	Stakeholder information meetings
2	Market research • Manufacturer surveys • Retailer surveys • Importer surveys • Household surveys
3	Energy saving potential and prioritization
4	Test the labels
5	Finalize the label design options
6	Regulatory framework preparation and enactment • Framework law • Decree for each appliance/equipment MEPS • Decree for the labelling for each appliance/equipment
7	Establish the timeline for the voluntary and mandatory periods
8	Testing standards review, modification and adoption
9	Testing procedures development
10	Testing facilities implementation or agreements with laboratories abroad
11	Preparation of a communications plan and budget
12	Preparation of communication materials
13	Preparation of a training program for sales personnel
14	Deliver the training program for sales personnel
15	Determine the support activities required for manufacturers
16	Enforcement plan
17	Set up an advisory group to regularly revise the standards

Step 1: Stakeholders Information Meetings

Stakeholder group meetings should include manufacturers, retailers and importers. The purpose of the meetings is to create a communication channel between the LCEC and the stakeholders and to inform the stakeholders of the upcoming legislation. The meetings will provide an opportunity to discuss the implementation plan and process for the labelling activity and for the MEPS levels and timeline for enforcement. The stakeholders' comments would be collected during these meetings and reviewed by the program design team to determine how the program can be adjusted to reflect field and market realities. These stakeholders will be the primary communication channel with the market actors during the program's preparatory and implementation phases. It is therefore important to ensure that the stakeholders show an interest in the program and support it. Focus group sessions have already been conducted by the LCEC with all interested stakeholders to discuss the proposed MEPS and label classifications. The LCEC should pursue these meetings regularly as the program develops.

Step 2: Market Research

Market research should be conducted with the largest manufacturers, retailers and importers on the market to determine the sales volume per year of each appliance or piece of equipment that will be included in the program. The energy efficiency characteristics of the equipment sold in Lebanon should also be reviewed to determine a baseline and to provide an important insight towards determining the MEPS levels and labelling classifications. Surveys should also be conducted in a significant number (200-400) of households to determine their energy efficiency perceptions, their willingness to pay for energy efficient appliances, their purchasing habits and main decision criteria when they are considering buying their household appliances. An analysis of the surveys as well as other sources of information will be used to prepare a communication campaign for the program. The LCEC has already conducted an initial market survey as well as a socio-economic survey, but further surveys are still required to know more about the market characteristics of each product that will be included in the program.

A technical analysis should then be performed to assess the current efficiency levels of appliances on the market and compare them with the levels found on the international and regional markets. This information will provide important input for discussions with manufacturers and importers on the levels of MEPS that will be proposed on the market.

Step 3: Energy Saving Potential and Prioritization

Based on the results of the market surveys, the potential for energy savings associated with the S&L Program can be refined and confirmed. A priority should be set for the design and implementation phases. In the current context of Lebanon and considering the preliminary work already performed by the LCEC, it is recommended to pursue the work on the three targeted priority products and then to develop S&L schemes for additional products based on their potential for energy savings and the economics associated with the introduction of higher efficiency equipment.

Refrigerators are a natural target due to their relatively high potential for energy savings and the extensive experience accumulated around the world on this type of equipment. Furthermore, refrigerators are appliances with a high saturation point on the market and this implies that a large quantity of units is sold every year. Sub-regions including Egypt, Syria and Jordan have already implemented or considered implementing labelling schemes for those appliances. If Lebanon does not rapidly implement a similar program, there is a risk that suppliers of low efficiency equipment will target the Lebanese market to sell their low efficiency and low quality products.

Air conditioners are also a priority appliance in the country as the Lebanese living standards increases and the price of split room air conditioners decreases simultaneously. This has resulted in a rapid increase in the sale and penetration of this type of equipment, which in turn creates an increase in the utility's peak demand in the summer. Lebanese households also purchase a large quantity of reverse A/C systems that can be used for cooling in the summer as well as for heating in the wintertime.

These types of units result in a shift in the country's energy source from traditional fossil fuels to electricity for heating purposes, which also increases the electricity grid's peak demand during the winter season. These 2-in-1 reverse A/C units are generally less expensive than separate A/C units and heating systems and this is one of the reasons why households decide to buy them. Using electricity for heating does not make a lot of sense in a country where most fossil fuel resources to produce electricity must be imported and then converted to electricity in relatively low-efficiency plants when compared to the efficiency that can be achieved through the use of standard or high-efficiency condensing residential boilers or furnaces.

A third household priority is CFL lamps as these types of lamps have a significant energy saving potential due to their higher efficiency as compared to incandescent bulbs, which they are replacing in residential households.

Step 4: Test the Labels and Step 5: Finalize the Label Design Options

It is recommended to test the labels with consumer groups to ensure that the message they convey will be well understood and interpreted by the population. A label that works in one country may not work as well in another due to cultural differences so it is important to thoroughly test them before launching a large-scale promotional campaign featuring the label and/or the program logo. The design of the labels should be presented to stakeholders for their comments and to discuss the rules and procedures related to affixing them to the products. Simple issues like having to open the packaging of all imported products to affix an energy label on them can add a large burden to importers and distributors and should be carefully thought out to avoid drawbacks and negative reactions on the part of stakeholders. Once the comments are collected, the label design and procedures can be finalized. It is recommended to copyright the final design to protect the trademark/label from abuse.

Step 6: Regulatory Framework Preparation and Enactment

A regulatory framework should be prepared and enacted to provide the legal grounds for program implementation. The national EE Law must include sufficient provisions to allow the Government to establish the MEPS and labelling program. A series or decrees should then be prepared to define the rules and procedures for the MEPS or labelling program for each appliance or piece of equipment. Alternatively, LIBNOR could be responsible for specifying the Minimum Energy Performance Standards for Lebanon and the scale for the label classifications. A decree could then be prepared and enacted stipulating that the MEPS must be adhered to in the production, import and sale of equipment in Lebanon. In a number of countries, the MEPS and labelling schemes are defined in individual regulatory documents. It is recommended that the regulations related to the country's MEPS and labelling scheme include provisions to set penalty levels in the case of non compliance and also include a provision to allow governmental bodies to inspect manufacturer, importer and retailer facilities.

It is recommended that the Lebanese program be under the jurisdiction of the Ministry of Environment and Water (MEW) and directly supervised by the LCEC. The LCEC is expected to be the entity in charge of issuing the label classification authorization to manufacturers and importers upon the recommendation of the test reports issued by IRI or other accredited testing laboratories.

Step 7: Establish the Timeline for the Voluntary and Mandatory Periods

The LCEC should establish a timeline for the introduction of each appliance/equipment label and the MEPS, at first, for a voluntary period and, then, for the launch of the mandatory period.

The MEPS program must be first launched on a voluntary basis for a period of at least two years. This period is required to allow manufacturers and distributors to adapt their production or their import policies to the upcoming mandatory standards. This voluntary period must be discussed with the main manufacturers on the market to ensure that the timeline set for the introduction of the scheme is realistic for them.

The MEPS levels can then be set for a period of about three years. This period will allow manufacturers to recoup the investment required to comply with the new MEPS levels and to improve their product lines. Again, this period where the MEPS will be kept unchanged after the initial introduction of the regulations should be discussed with the manufacturers who will be the main actors affected by these changes on the market.

The labelling component will be more flexible as its implementation will not cause any major disruption on the market. The main issues to be taken into account by the LCEC when selecting the duration of the voluntary period are the constraints related to enforcing the labels. The LCEC and other government agencies must have the required resources and training to rapidly start the enforcement activities. One of the main flaws of S&L Programs is the lack of enforcement, which quickly and often results in a lack of confidence on the part of stakeholders, the dissemination of false label or false information on the labels.

Step 8: Testing Standards Review, Modification and Adoption

Testing standards for each appliance must be prepared. The relevant international standards have already been identified and announced in the country's official Gazette. The most effective approach in this instance is to transpose applicable international or regional standards to avoid the duplication of testing procedures and the proliferation of trade barriers. Each country that adopts a testing standard that differs from recognized international standards is adding an additional burden to the manufacturing industry and importers by making the mandatory testing of equipment based on non-uniform testing procedures. Lebanon has adopted a policy to harmonize its testing procedures with the European Community's procedures.

Step 9: Testing Procedures Development

In parallel with the adoption of testing standards, the LCEC should establish procedures that manufacturers and importers must follow in order to have their equipment tested prior to their introduction on the market.

The procedures must state how many units of the same model should be tested (usually, only one is sufficient), how the sample to test should be selected and which entity will be responsible for contracting and paying the laboratory for the testing. The Industrial Research Institute (IRI) is the entity that will be performing and supervising the tests in Lebanon.

It is recommended that manufacturers and importers be responsible for having one sample of each model on the market tested and that the official test results be submitted to the LCEC for approval. The LCEC will also incorporate this information in the market follow-up database that will be used to track the market's progress over time. Furthermore, manufacturers and importers should provide a declaration that the model used for testing is a regular production model and that it was not improved for the sole purpose of getting a better grade during testing. The necessary institutional framework must be put in place to perform and review the test results, provide the official approval to the industry and indicate the approved energy class on a specific label. The LCEC will be assessing the enforcement requirements for the labelling and the standards program so that enforcement capacities are at the required level.

Step 10: Testing Facilities

Ideally, in a program without financial constraints, a testing facility must be built for each appliance. However, the investment for this type of infrastructure could rapidly become the largest portion of the program design costs especially if multiple appliance or equipment testing facilities have to be built. To resolve this issue, several countries accept tests performed by internationally recognized laboratories using the same testing standards as the approved Lebanese standards. As Lebanon does not currently have the infrastructure for testing any type of appliance or equipment, it would be advisable to start the program by negotiating agreements with other national laboratories such as the labs in Jordan, Egypt or Tunisia. The budget presented on Table 27 below proposes two options for the program design phase. Activity 10a is the option to negotiate agreements with foreign laboratories while option 10b provides a budget for the implementation of national laboratories. The two options can be combined if the final decision is to build only some of the required laboratories. If Lebanon decides to go ahead with the construction of its own infrastructure, this would provide greater flexibility for the scheduling of testing of local manufacturers' products while agreements with foreign laboratories would be more subject to delays in the execution of tests. If the construction of laboratories is decided upon, it will be important to perform revenue and cost of operations analysis for the laboratories to ensure that the number of tests conducted each year will be sufficient to cover the operating costs of the labs. It may not be that feasible in a country the size of Lebanon so the decision to build should be taken only after an in-depth analysis of the benefits and drawbacks.

Step 11: Preparation of a Communications Plan and Budget

A comprehensive communications plan must be prepared including a mass media campaign to support the introduction of the labels. MEPS do not require such large media support since their introduction is mainly a matter of informing manufacturers, importers and retailers about the new regulations. As far as the MEPS are concerned, meetings with and mailings to those particular stakeholders will be more appropriate than a media campaign.

The new labelling scheme should be presented at trade fairs where homeowners are known to shop for appliances and energy consuming products. The scheme should be promoted at the country's events focused on energy efficiency. The communications plan should be developed by a local consultant, preferably with the supervision or input from an experienced international consultant specialized in MEPS and labelling. A budget should also be established at this point for the campaign implementation.

Step 12: Preparation of Communication Materials

To support the label communications plan, the production of a flyer explaining the labels is essential. A repertory of all the products offered on the market and their efficiency levels should be made publicly available to inform consumers about the different equipment categories, their energy efficiency levels (grade or kWh) and cost effectiveness (savings over the life span of a product compared to the product's initial additional cost). The label itself should be used to convey information about the energy consumption of appliances to the customer. Collaborative labelling advertising with Lebanon producers and retailers should also be considered as it would be profitable for both parties.

Different types of marketing materials should be prepared for consumers including flyers, pamphlets and bill inserts (if EDL takes part in the promotional scheme) to increase their awareness and knowledge about energy efficient appliances. The material should also present the benefits associated with higher efficiency products. These materials should be prepared before the public launch of the labelling program. Households must be informed of the new regulations and the benefits of choosing energy efficient appliances. Point-of-Sale promotional materials should also be produced and distributed to retailers so they can display them in their stores. These types of materials include posters, stands and promotional displays.

It is recommended to prepare and conduct a market test through a small-scale pilot project on some selected points-of-sales to measure consumer reactions to the promotional materials and their understanding of the label before launching the full-scale program.

Step 13: Preparation of a training program for sales personnel and Step 14: Deliver the training program

The support of retailers is essential to promote the labels and to make sure that consumers are well informed and guided about appliances. The enhanced awareness and knowledge of the management

and staff of retailers on the energy efficiency of the appliances they sell as well as sales rationales are also important factors in the success of a labelling program. A retailer manual and a training program for sales personnel should be developed and implemented. Several training sessions should be planned and conducted at the main retailer facilities to train their personnel on the best way to inform their customers about the labels.

While this component is important, it should be mentioned that maintaining the level of awareness of sales personnel is sometimes a difficult task due to a high turnover in this particular environment. The program should reach a balance between the cost required to conduct regular training of sales personnel and the benefits expected as a result of this activity.

Step 15: Create Support for Manufacturers

Some of the smaller manufacturers should be provided with technical support to help them better understand the benefits of the new standards and how their company can adjust to the new regulations. This type of activity will be helpful in ensuring compliance to the standards. Some countries offer the support of international experts to selected manufacturers to provide them with the basics of improved appliance design. Larger manufacturers usually do not require support as they have the engineering capacities and international alliances that provide them with access to the technical expertise they require. Some manufacturers are reluctant to any kind of change and must be supported by providing them with the rationale they need to secure their higher management's approval to design and produce more efficient equipment.

Unfortunately, some equipment manufacturers never adapt to new regulations. This is often observed in older factories where the owners are phasing out of a business where their production equipment is outdated and their overall organization is not up to the task of maintaining profitability in a more and more competitive environment. Sometimes these manufacturers lobby and use public media pressure to try to curb the Government's intentions by threatening to lay people off or to close a plant that has been in operation for years. In these cases, the Government has little choice but to accept the fact that some factories will not survive and to maintain a strict policy to retain the timeline and objectives of the S&L Program as planned.

Step 16: Enforcement Plan

An enforcement plan should be prepared to determine how the program integrity's will be maintained once it has become mandatory. Regular visits to manufacturers and retailers should be common practice to ensure that the standards and labelling are enforced. The equipment testing program should be monitored by the LCEC and appliances that are deemed to be out of spec compared to their initial design and performance should be tested. The Ministry of Commerce should be responsible for store inspections, manufacturing plant inspections, importer offices and storage centers. Working in close collaboration with the customs agency is essential to control the import of appliances. A training program for customs officers should be prepared to inform them on the importance of monitoring all

imported products to ensure that they meet the new standards and labelling requirements. Each model of appliances introduced on the market will need to be formally tested to ensure that it complies with the new standards. The laboratory testing should also record the main characteristics of any tested product (compressor type, heat exchanger size, etc.) to ensure that, in future product inspection at point of sales, it will be easy to compare the product offered in sales with the actual product previously tested and found on the market.

Any manufacturer or importer found to be in default of the law by either producing or importing a product that differs from the initially laboratory-tested product and for which an approval was sought should be prosecuted. A database listing all approved products should be developed; this database should be easily accessible and the ideal way to publish it would be on the Web. A copy of all tests performed by laboratories should be obtained and kept in the LCEC's records. The regulations should also require that manufacturers and importers keep a record of all the design and production characteristics of their products for a certain period of time (5-7 years).

Step 17: Set Up an Advisory Group to Regularly Revise the Standards

A technical advisory group will have to be formed to regularly revise the MEPS levels and the energy efficiency scales used on labels. It is fundamental to be continuously aware of the regional and international improvements on Standards and Labelling as technologies are constantly changing. Participating in regional and international events will help to keep up to date on the latest advances in labelling and MEPS in the sub-regions. The Standards and Labelling should not be modified too often; this would destabilize manufacturers, retailers and importers. The advisory group should recommend and deliver an updated version of the standards every two to three years.

Program Design and Development Costs

The following table shows the budget components that should be considered for the design and development of the Standards and Labelling program for the three targeted priority products.

Table 27: Standards and Labelling Budget

Activity Number	Activity Description	Funds for Consultants or Equipment for 3 years (US$)	Governmental Bodies (Days of Work)
1	Stakeholders group	$ 30,000	50
2	Market research	$ 85,000	80
3	Potential and prioritization	$ 45,000	45
4 and 5	Design and produce labels	$ 30,000	40
6	Law and regulations	$ 85,000	85
7	Timeline establishment		15
8	Prepare test standards	$ 55,000	60
9	Testing procedures		20
10a	Agreements with foreign laboratories		40
10b	Testing facilities construction ➢ Refrigerators ➢ A/C ➢ CFLs	 $ 250 000 $ 650 000 $ 150 000	 50 65 30
11	Communications plan	$ 40,000	35
12	Communication materials production	$ 80,000	40
13 and 14	Training program preparation and initial delivery	$ 45,000	50
15	Support program for manufacturers	$ 75,000	120-
16	Enforcement plan	$ 160,000	450
17	Advisory group to revise the standards	$ 25,000	35
	Project management and implementation support	$ 105,000	150
Total (Without the construction of laboratories)		$ 860,000	**1 185**
Total (With the construction of laboratories)		$ 1 910 000	1 300

Phase 2 - Program Implementation

After completion of the program design and preparatory work, the S&L Program will be ready for implementation. It is usually recommended to start such programs with a small-scale activity to refine the program process, procedures and tools before launching a national communication campaign for its promotion.

Activity 1 – Work Plan and Assigning Responsibilities

The first activity in the implementation of a Standards and Labelling Program is to finalize the implementation plan and then assign roles and responsibilities. The work plan should include all activities required for the day-to-day operations and management of the Standards and Labelling Program, including the supervision of the testing process, the compliance verification process and the program monitoring and evaluation activities. In parallel with the day-to-day operations and management of the program, the LCEC should plan on activities for future energy label classifications and MEPS updates.

Activity 2 – Program Management

The MEW will be responsible for overseeing the program's implementation and coordinating the efforts of the various ministries and bodies participating in program delivery. This would include maintaining the detailed work plan up to date and supervising its implementation, contracting the international and local consultants required for the various steps, finalizing administrative agreements with local or foreign laboratories and holding regular meetings with the various bodies taking part in the implementation of the project to review the details of the program, the problems encountered in the program's operations and the modifications required to the program's process.

Activity 3 – Laboratory Test Supervision and Approval

All the appliances on the market will have to be monitored in a testing laboratory. The tests will be performed either by national laboratories (if they are built) or in foreign laboratories after agreements have been reached. The Industrial Research Institute (IRI) will receive and review the test results and will be responsible for determining the proper energy classification for each appliance. The certification will be ultimately approved by the MEW based on IRI recommendations. The MEW can then either issue a formal certificate or simply a letter of approval as preferred by the program manager. Once an appliance is approved, the MEW will authorize the manufacturer to affix the energy efficiency category label on the product.

A database of the test results should be constituted to follow up on the evolution of the market and to provide a reference for customs officials and enforcement officers when verifying the compliance of various stakeholders to the program requirements.

Activity 4 – Communications Campaign

A communications campaign should be launched. The main cost associated with the campaign will be related to the media used for publicity and the handling and shipping of brochures and point-of-sales material to participating manufacturers and retailers. The budget for the campaign could vary widely according to the type of media that the program will be using for promotional purposes. Television and radio campaigns are rather expensive and their cost often depends on whether the Government has access or not to “free” air time on national broadcasting stations. Other media can include newspapers and specialized journals. Some field activities to cover trade fairs and public assembly meetings could also be incorporated in the activities.

Activity 5 – Program Enforcement

This activity is normally only required after an S&L Program's voluntary period and once it has become mandatory. However, in some countries in the past, some type of enforcement was required even during the voluntary labelling period because some market actors where using false statements and, in some cases, false labels on the equipment sold on the market. In cases such as these, the government has no choice but to maintain the voluntary program's integrity by rapidly initiating enforcement activities.

The MEW will be in charge of the enforcement of the MEPS and Standards and Labelling regulations. This will include planning all the enforcement activities including visits to manufacturer, importer and retailer facilities to ensure that they comply with all the requirements. The visits to manufacturers and importers could be to verify the range of products put on the market and to confirm that each product has been tested by an approved laboratory. These visits could also serve to ensure that a product's design was not altered and that the energy efficiency performance of the currently sold appliance is in conformity with the initial testing performed in the lab.

The MEW will also be responsible for determining if additional tests of the product samples are required to ensure that they comply with the standards or to verify that the appliances sold on the market are still in compliance with the initial approval received for those particular products. The costs for additional testing should be supported by the Government unless the manufacturer, importer or retailer has been found in an illegal position. This is usually a limiting factor in the effectiveness of enforcement procedures since each test is relatively expensive and Government budgets for this kind of enforcement activity are often limited and are often appropriated to products that can affect the health or safety of the population.

The MEW will receive and analyze any complaints from various stakeholders and take action if the complaints are based on the evidence that a market actor is not following the rules of the program and the regulatory requirements.

The MEW will prosecute any organization that does not comply with the regulations.

Activity 6 – Meetings with Stakeholders

Various stakeholders will take part in the implementation of the program, including manufacturers, retailers and importers. Manufacturers should adapt their production practices to meet the MEPS and should have their products tested and affix labels to their products according to their assigned energy classes. Retailers should change their product lines and offer higher efficiency equipment to follow the market trend; they should also ensure that energy labels are affixed to all the products in their showrooms. They should also plan and implement capacity building activities for their sales personnel so that they are able to provide more detailed information to their customers regarding the characteristics of their energy efficient appliances. Importers will gradually change their product lines and import more energy efficient models.

All these changes on the market will need to be closely coordinated by the MEW and the stakeholders and meetings should be scheduled regularly to exchange on the practical considerations of the program. It is recommended that these meetings be held on a quarterly basis in the first year and then at a lower frequency once the program is running smoothly.

Activity 7 – Market Research

Market research efforts should take place at regular intervals to follow up on the evolution of the market. These market research activities should provide updated information about the overall sales and the efficiency of each category of appliance or equipment on the market. This information will provide the necessary data to assess the impacts of the program. The review and analysis of the evolution of the efficiency of equipment sold on the market should be based on laboratory test results submitted to the IRI. The market research activities should also include in-depth interviews with stakeholders to learn more about the sales volume of the various categories of equipment and the market trends observed by manufacturers, importers and retailers.

A system could be established to track results using a software that is readily available on the market like the PAM model from CLASP or using a model developed for the specific characteristics of the Lebanese market.

Activity 8 – Program Follow-Up

The MEW should conduct follow-ups of the program and reports should be issued at regular intervals to the higher levels of Government to summarize the results of the policies implemented. The laboratory testing and market research data will be combined to evaluate the impacts of the program and disseminate the results. Program tracking is an important aspect of any S&L Program and the information gathered will be helpful to policy makers in their future decision making concerning expanding the Lebanese S&L Program to other appliances and equipment.

Program Implementation Costs

The following table shows the budget components that should be considered for the implementation of the Standards and Labelling Program for the three targeted priority products.

Table 28: Implementation Costs for the S&L Program

Activity Number	Activity Description	Funds for Consultants or Equipment (USD per year)	Governmental Bodies (Days of Work per year)
1	Work plan and management	$ 15,000	25
2	Program management		80
3	Laboratory tests supervision and approval		40
4	Communications campaign	$ 200,000	50
5	Enforcement activities	$ 60,000	150
6	Meetings with stakeholders	$4 000	12
7	Market research	$ 45,000	45
GRAND TOTAL		$ 324,000	**402**

Phase 3 - Program Evaluation

If required by the Government, a formal program evaluation could be conducted every two years to assess the process, market transformation and then the impacts of the program. This type of evaluation is normally performed by an independent specialist and is used to evaluate the overall program delivery, the market evolution and the quantitative savings. This external evaluation will provide a more accurate vision of the program's effects on the market than would an internal follow-up performed by the program management team. The evaluation will also provide an insight on aspects of the program process that need to be improved.

An evaluation of a Standards and Labelling Program should be based on primary research tools including stakeholders and homeowners surveys. The quantity of all product models sold on the market and their associated efficiency should be reviewed and compared against a baseline that was established prior to program implementation. The evaluation should take program free riders into consideration as well as interactive effects such as the cross-effects of the heat rejected by appliances and equipment on the energy consumed to heat houses or buildings.

As a rule, an independent international/national contractor should conduct the evaluation.

The GHG reductions should also be evaluated. If the program is partially financed by CDM carbon finance, the process for the evaluation of the GHG reductions and their impact should be more formal

and should be approved prior to the launch of the program through a project design document that will provide details on the monitoring activities.

One of the most important indicators of the effectiveness of a program is the analysis of the average performance of the equipment sold each year on the market. This information is generally obtained through market studies and a review of laboratory tests. An investigation on the share of high efficiency equipment in stores is another indicator that is useful in determining to what extent the implementation process has been effective.

A realistic timeframe would be to plan an external program evaluation every two years. As the main purpose of this program is to effect a market transformation, it is important that the period of time between evaluations not be too lengthy since market effects are quite difficult to document after a span of more than two years. If the period of time between each evaluation is too long, the workload becomes higher and the accuracy of the evaluation process decreases.

Program Financing

Most of the financing for the S&L Program design, implementation and evaluation should be provided by the Government. This includes the costs and resources for program management, laboratory testing supervision, the enforcement process and a large portion of the communications campaigns. Some of the advertising and marketing efforts to promote the label will be provided by manufacturers or retailers either through a collaborative promotional agreement with the Ministry or based on their own budget and private communication campaigns. Manufacturers and retailers will probably include a higher proportion of energy efficient appliances in their communications campaigns to position their products as top-of-the-line on the market. The laboratory testing costs for the approval of a new product under the program should be supported by the market stakeholders including manufacturers and importers.

Funds for program implementation could be provided by the National Treasury (generated by the income taxes of the general population, the commercial sector and industries) or through a special levy to create a source of financing for this type of activity. For example, a green fund could be created based on a special levy on petroleum products or on the import of luxury energy-consuming equipment.

The Government could also request a loan from an international financing institution like the WB to finance a portion or the totality of those activities. The possibility of obtaining a grant from the Global Environment Facility (GEF) should also be explored to provide support for the initial design and development of the program.

The funds required to purchase higher efficiency equipment will be provided by homeowners since they will be the ones to ultimately buy the energy efficient appliances and to benefit from the energy savings. The cost of the energy efficient equipment will, of course, be higher than the cost of normal

appliances but the incremental cost will be recovered through the energy savings generated over the lifetime of the appliances.

Using carbon finance to provide a portion of the financing for homeowners could be considered, especially under a program scheme that is part of the Clean Development Mechanism. This should be considered only to support the voluntary purchase of equipment that is at the higher end of the efficiency scale since simple compliance with the MEPS will not be considered an incremental activity.

Energy Savings Potential and Payback Period

The energy savings potential in Lebanon was estimated based on a study recently completed in Jordan[62]. The calculations were performed with a proprietary tool developed by Econoler that is used to estimate the potential of S&L strategies on a market. The model is based on the premise of the quantities of each given appliance sold on the market and the percentage of appliances sold in each class of energy efficiency. The baseline model evolved over time to take into account the natural tendencies demonstrated by markets to move toward higher efficiency equipment even in the absence of an S&L Program, where, obviously, the transformation evolves at a much slower pace.. The model was adapted to reflect the Lebanese context by adjusting some parameters related to the country's population and living standards. Very little information exists about the true characteristics of the Lebanese market, including the number of appliances sold every year and their efficiency levels. The figures presented in this section should therefore be considered as an initial estimate of the market potential and they will need to be refined during the detailed program design based on market research data. Table 29 provides data on refrigerators and on air conditioners – two of the priority appliances in the Lebanon program. The table also provides the potential of two other products (freezers and washing machines), which are often the next in line for implementation in several countries. The potential of CFLs has not been evaluated in the table because the effects of an S&L Program on this type of product are more difficult to quantify. On the short term, a labelling program does not necessarily generate large savings associated with the introduction of CFLs on a market since, as is often the case, the savings associated with CFLs are significant even if low-quality CFLs are purchased and used. However, adding CFLs to the list of priority products covered by the Lebanese S&L scheme could help the penetration of higher efficiency lamps on the market especially in view of the fact that CFLs are increasingly being promoted in Lebanon. Marketing efforts can modify the purchasing habits of households and the increased use of CFLs – and therefore the market shift – is a direct result of marketing campaigns and not because more energy efficient CFLs have been introduced on the Lebanese market. One of the main characteristics of CFLs that generates savings is their long life span, which is a parameter that is not always included in labelling and standard programs.

The evaluation of the potential was based on a 3-year intensive implementation program supported by a communications campaign to initiate a market transformation. Table 29 provides the expected

[62] Jordan market study and GEF project proposal, 2008

results during the 3 years of implementation as well as the expected market effect over year 4 to 10, which represents the long-term shift on the market achieved through the initial communications efforts and the lasting effects of the labelling scheme. The project and post-project periods will cover a total of 20 years.

In the table, the savings in GWh from year 1 to 3 were calculated based on the number of improved appliances introduced on the market during this initial 3-year period and their cumulative savings over their life cycle (with a life expectancy estimated at 14 years). The post-project period will begin immediately after the 3-year implementation period and the savings calculations take the impacts generated by the market transformation into consideration. The total number of units introduced on the market during the post-project period (up to 2020) was multiplied by an average unitary savings representing the gradual shift from appliances with a low-efficiency baseline to appliances with a higher efficiency level as a result of the program. The table also provides the unitary energy consumption baseline and unitary energy consumption for the first year of the program. The unitary savings will increase gradually as more and more appliances and products on the market belong to the more energy efficiency classes. The energy savings are cumulative. Every year, new energy efficient products will be introduced on the market and will add their effect to the savings of products that have been introduced in the previous years.

Table 29: Cumulative Delivered Energy Savings (GWh)

	Number of Appliances (2010)	Unitary Energy Consumption Baseline (kWh/unit)	Unitary Energy Consumption - Year 1 (kWh/unit)*	Program (Equipment Sold from Year 1 to 3) Cumulative Life Cycle Savings	Market Effects (Equipment Sold from Year 4 to 10) Cumulative Life Cycle Savings
Appliance				GWh	GWh
Refrigerators-freezers	54000	353	335	87	867
Air conditioners	1000	3119	2963	31	1030
Sub total	**55000**	**-**	**-**	**118**	**1897**
Stand-alone freezers	5000	369	351	9	95
Washing machines	43000	227	216	45	571
Total	**103000**	**-**	**-**	**173**	**2,564**
Total				**2,737**	

* The unitary energy consumption in the program scenario becomes lower from year to year due to a higher penetration of efficient appliances.

The cumulative energy savings do not consider the technical losses of EDL and are thus conservative.

Program Benefits for Consumers

The following table provides an estimate of the utility bill savings for homeowners. The energy costs were based on average selling rate for households of USD 0.21/kWh.

Table 30: Utility Bill Savings (USD Million)

Appliance	Project	Post-Project
	USD Million	USD Million
Refrigerators-freezers	24	98
Air conditioners	9	117
Sub-Total	**33**	**215**
Stand-alone freezers	2	11
Washing machines	12	65
Total	**47**	**290**
Grand Total	**337**	

Payback Period

The average payback period on equipment is approximately seven years. However, it is often very difficult to determine the payback period of products in the context of an S&L Program because the incremental cost of a more energy efficient product is often based on other factors such as its brand and size as opposed to its energy efficiency. Several studies have shown little or no relation between the final cost of an appliance on the market and its efficiency, at least for the more popular models. Nevertheless, the general rule is that minimum standards should always be set at such a level that the equipment's additional cost will be recovered by savings over the equipment's lifetime. Program designers often perform cost effectiveness studies based on an estimate of the manufacturer's production cost to increase the efficiency of a product on the market and the effect it should have on the product's retail price using an average margin. In the real world, the popularity of the brand will be one of the factors that cause the retail price of a product to vary so the theoretical calculations of a product's cost are not always reflected on the market properly.

3.3.2 Thermal Standards for new Buildings

In 2005, the Government of Lebanon initiated a project towards developing thermal standards for new buildings. The project was funded by the Global Environment Facility (GEF) and managed by the United Nations Development Programme (UNDP). Econoler's resources took part in this project and provided support to finalize documents that were drafted by other parties. As part of this project, a climatic region guide, thermal standards, an information dissemination manual and a compliance checking software were developed. The software component was developed by the University of Beirut and the testing was performed and recommendations were proposed by Econoler resources. The project was managed by the Lebanese Directorate General of Urban Planning and the Ministry of Public Works and Transport. The main objective of the thermal standards for new buildings was to determine minimum requirements for insulation, fenestration and shading devices in order to improve the thermal performance of building envelopes. This, in turn, would improve the thermal comfort in

buildings, generate medium- and long-term monetary savings for building owners and help the country reduce its dependency on imported fuel for building space heating and cooling.

Almost 5 years after the release of the thermal standards document and analysis, the standards have unfortunately not yet been established as a mandatory requirement for the construction sector. A lack of resources and the conflict of July 2006 were the major causes for this delay.

The present Action Plan builds upon the 2005 activities and recommends a step-by-step process for the implementation of a nationwide program that would introduce the thermal standards as mandatory after an initial voluntary period of two years.

Program Description

The thermal standards requirements for new buildings were determined for typical buildings in the residential and the office building sector. The building envelope improvements considered in the standards include the thermal insulation of walls, roofs and floors, higher efficiency windows and external shading devices to reduce the heat gains in the summer.

The minimum requirements in the standards were selected so that they would be cost effective for homeowners. The criterion used in the selection of each measure was that it would result in the highest net present value for building owners over its life cycle. The energy savings calculations were performed using the DOE2.1D simulation software while the life cycle cost analysis was produced on spreadsheet. The standards provide recommendations that are specific to each type of building and for different climatic regions in Lebanon. The requirements of the thermal standards for new buildings are applicable to both residential and non-residential buildings. They define two alternative paths for promoters and designers through which compliance with the standards could be demonstrated – a prescriptive path and a performance path. The prescriptive path is based on the use of simple equations and tabulated reference values and, as such, requires a limited amount of effort to demonstrate compliance; however, it provides little flexibility for designers. On the other hand, the performance path is based on hourly computer energy simulations and, as such, requires more effort to demonstrate compliance but allows greater design flexibility. Some of the main characteristics of the two paths are described below.

Prescriptive Path

The maximum thermal transmittance levels and characteristics of individual building envelope components or of overall building envelopes (two acceptable approaches) are defined. The thermal standards also dictate a maximum exposure to solar radiation, expressed as a maximum effective fenestration ratio. This ratio integrates specific characteristics including window size, orientation and shading devices as well as the type of windows and their reflectivity characteristics.

Performance Path

The performance path is based on a computer run of a building model to calculate its annual thermal energy requirements in kilowatt-hours (kWh). Both cooling and heating energy are considered in the model and its proposed energy consumption should be lower than the annual thermal energy allowed for a reference building meeting the prescriptive path requirement.

The following sections present the recommended program components including the design phase, the implementation phase and the evaluation phase.

Phase 1 - Program Design and Development

The design and development of the thermal standards program includes the steps shown in the following table.

Table 31: Program Design and Development Steps

Step	Description
1	Creation of stakeholder groups
2	Finalization of the timeline for voluntary and then mandatory schedules
3	Revision of the draft standards issued in 2005
4	Organization of a public review process
5	Implementation of a pilot project
6	Developing a communications plan
7	Developing training material
8	Delivering training sessions
9	Launching the voluntary standards
10	Preparing the regulatory framework
11	Developing procedures and tools for the mandatory standards
12	Launching the mandatory standards

Step 1: Creation of Stakeholder Groups

Before introducing the thermal performance standards, several stakeholder groups should be created to establish formal communication channels with architect associations, engineering associations, contractors as well as building promoters and owners. These stakeholder groups will provide a forum to discuss the issues associated with the implementation of the thermal standards and will also provide an opportunity to collect comments from professionals and the construction community. These groups will hold regular meetings to discuss the application of the thermal standards, training requirements for professionals and construction workers as well as awareness-raising and information dissemination issues. All these elements are required to support the voluntary and then the mandatory introduction of the standards. The stakeholder groups will constitute the primary communications channel for the different categories of market actors during the preparation and implementation phases of the program.

Step 2: Finalization of the Timeline for Voluntary and then Mandatory Schedules

If the Government's objective is to rapidly implement the thermal standards prepared in 2005, they could be approved without modifications. However, we recommend that the original document be updated before being launched as mandatory. Using the existing standards would, of course, make things move faster but the building construction requirements will be rather conservative since the economic studies were based on the energy and construction costs of 2005. The price of fossil fuel has almost tripled since then and this alone justifies an update of the standards. A revision process will result in thermal standards that are more in line with the realities of 2010 and beyond, but will require approximately one year. In addition, a significant budget and a pool of human resources will be required.

Based on the 2005 technical analysis on the energy savings associated with different thicknesses of insulation and various improvements to window characteristics, an update of the economic analysis for each measure based on the life cycle of a building's components. The results could be reviewed by a technical committee to determine the most appropriate performance levels for each thermal standards component. The criterion used in 2005 to determine the standard stringency level was the maximization of the net present value for building owners. With the current price of fossil fuel, this criterion should be modified as it would result in very short payback periods and standards requirements that would be too low. It is recommended to change the criterion to one that will set a maximum acceptable payback period for building owners.

Step 3: Revision of the Draft Standards Issued in 2005

A revision of the 2005 voluntary thermal standards is strongly recommended because the requirements were based on a cost-benefit analysis at a time when fossil fuel was selling at USD 25 per barrel. The barrel price has almost tripled since then so a revision of the cost-benefit analysis will likely result in more aggressive standards requirements. To manage the revision process, a technical committee should be formed to coordinate all the activities required to update the documents.

Some of the work performed in 2005 can still be considered valid. For instance, the computer simulations on different types of buildings and different levels of thermal improvements could be kept and used as a basis for the standards revision. Also, the different climatic zones were defined and included in the 2005 thermal standards and they are considered to be valid and can be kept unchanged. The regional climatic report at the time recommended four climatic environments: coastal, western mid-mountains, inland plateau and high mountains.

Step 4: Organization of a Public Review Process

A public review process should take place before launching the voluntary and the mandatory standards. All stakeholders that will be affected by the thermal standards should be invited to review and comment on the draft document and submit their questions and comments to the technical committee. It is important that architects, engineers and practitioners be included in the process, either

as individuals or through their respective association. Representatives from the largest Lebanese towns, the standardization organization of Lebanon, the building research association of Lebanon and the urban development authority should also be represented in the review process. This public review will help to improve the standards and take into consideration the views and reactions of the community to the draft document. Their comments and recommendations will ultimately provide the needed input to improve the thermal standards and ensure their acceptance by market stakeholders.

Step 5: Implementation of a Pilot Project

The voluntary period will provide an opportunity to gather and review comments from the community about the standards and their application. However, we recommend implementing a number of a pilot project before launching them as mandatory. The pilot project should be implemented in about ten selected residential and non-residential buildings. These buildings should be selected by the LCEC amongst promoters who are interested in taking part in the pilot project. If some kind of subsidy program could be put in place to cover a portion of the incremental costs of the design and construction of more efficient buildings, this would definitively help to recruit participants for this activity. Similar pilot projects were recently implemented in Tunisia before the enactment of the country's thermal standards for residential buildings. During the demonstration pilot project, the design team of the promoters will be assisted by a team of national or international experts in a review of the design of the buildings and in proposing the integration of improved thermal envelope characteristics and components. The results of these projects should serve as a learning experience for LCEC and the participating promoters and professionals. They will also be useful in the creation of case studies on the pilot project and about the generated energy savings and the economic interest in designing more energy efficient buildings. The case studies should be in the form of fact sheets that can be used later on for the dissemination of information to other promoters and building design professionals. The pilot project should be implemented over a period of a year and a half to two years and should include various types of buildings to better evaluate the issues associated with the implementation of the thermal standards in different types of construction and in different regions.

The energy savings calculations for various improvements to the thermal envelope of buildings could be performed using an hourly simulation software (similar to the software DOE used in 2005) or, if the budget is limited, by simplified tools like the RETSCREEN software or though simple engineering formulas based on degree-day calculations. The former provides a more realistic modeling of the relationship between the solar heat gains and a building envelope as well as the infiltration of heat gains and losses of a building's envelope. It will provide a more accurate evaluation of the energy savings for each measure implemented. The simplified approach will provide less accurate results but will be faster and will require less technical and financial resources. Whatever approach is retained, the pilot project will allow confirming the avoided energy that could result from the implementation of building thermal standards based on an appropriate measurement and verification protocol. The pilot project will also be useful in revising the expected program costs/benefits and the program's economic analysis.

Step 6: Developing a Communications Plan

The implementation plan for the thermal standards should include a comprehensive communication plan to disseminate information to all market actors involved in building design and construction. A large-scale promotional campaign should support the introduction of the new thermal standards. Promotional documents including booklets, fact sheets, circulars and the documentation developed as part of the 2005 GEF project should be used to provide information on the thermal standards requirements and on the ways to comply with the standards. These publications would provide information on the standards implementation process in general, the requirements of the thermal standards and the compliance forms and tools used to have a building design accepted by the authorities. In the future mandatory phase, specific documents should also describe the approval process for new buildings.

Ensuring that information on the thermal standards is widely disseminated is among the important activities that will ensure future compliance to the standards. The groups and media that could be targeted will include: professional societies, trade associations, building owner associations, banker associations, engineering associations, architect associations, universities, as well as specialized engineering, architecture and construction magazines. The most important stakeholder groups to inform include architects, engineers, building promoters and construction companies. The educational system can also contribute to this information dissemination and training by including a course for students in school curriculums that describes the thermal standards and their application.

The publication of examples of building calculations and case studies could also be used to support the dissemination of information and knowledge about the standards. This kind of material could be a powerful educational tool and should provide step-by-step information on how to comply with the standards and how compliance can be demonstrated for any new building. A document was issued in 2005 that provided examples of thermal standards applications and could be used as a draft for the production of such publications.

Step 7: Developing Training Material and Step 8: Delivering Training Sessions

Training is an essential component that will ensure the success of the thermal standards. The necessary knowledge and skills to apply the standards must be built amongst professionals and construction specialists in order for the standards to be successful. Training material should be developed to disseminate thermal standards requirements and to provide a detailed explanation of the two acceptable compliance paths. The capacity building activities should ideally begin during the thermal standards development phase with a more general module describing their overall structure and main characteristics. Over time, the training sessions offered should be more specific to discuss and address the practical issues encountered and the application of the standards. Different modules will be necessary to address the specific interest and needs of the various stakeholders involved. For instance, the module designed for construction professionals like architects and engineers will be somewhat different from the modules developed for promoters and for contractors. As far as

contractors are concerned, different modules will be necessary to address their specific specialties. For instance, a module can focus on insulation materials and techniques while another module could deal with window and door characteristics.

Government employees involved in the standards application and the compliance verification process will also need to be trained. These include ministry representatives, building inspectors, municipal specialists responsible for the approval of plans and drawings, etc. A compliance verification process should be established. This will ensure the uniform application of the thermal standards for new buildings. Compliance verification agents will need training and easy to follow checklists to verify if the thermal standards have been applied properly. They will also need to be trained on the procedures to follow to handle building designs that are not in compliance or on-going construction activities. Training material for compliance verification agents must be developed to explain the process. The training module should also cover the internal checking procedure for compliance including communication channels and documents, the information flow between promoters, professionals and construction specialists and the government bodies.

Trainers should be selected and should follow train-the-trainer sessions to ensure that the individuals delivering the courses are knowledgeable and comfortable with all the aspects and implementation procedures of the thermal standards.

A well developed and implemented training program will be one of the cornerstones to the successful implementation of the building code.

Step 9: Launching the Voluntary Standards

The thermal standards will be first launched on a voluntary basis and eventually become mandatory. The voluntary period was to be initially implemented with awareness and capacity building activities to help the community understand and apply the standards. After which, they were expected to become mandatory after the voluntary period of 1-2 years. This approach is still valid and we recommend maintaining this timeline as the building community will need time to adapt their business practices to the new standards.

Step 10: Preparing the Regulatory Framework

The transition from voluntary to mandatory thermal standards for new buildings will require the preparation and the adoption of an appropriate judicial framework. Ideally, there should be a provision in the national EE Law allowing the Government to have the legal power to publish and enforce the thermal standards for new buildings and, in the future, for major renovations. The thermal standards can then be promulgated by decree as a legal document. The regulations must include a provision to allow the Government to inspect new buildings and to enforce and apply penalties to companies that do not comply with the regulations.

Step 11: Developing Procedures and Tools for the Mandatory Standards

Another important aspect in the preparation of a mandatory thermal standards program is the development of compliance forms as well as software and procedures that would be used by the organizations involved in the construction market to demonstrate to the authorities each building's compliance to the thermal standards. Forms for checking compliance should be prepared and filled in by building promoters and designers The forms could be complemented by a compliance software that will make it easy for building promoters/designers to check whether their building complies with the standards or not. The forms should be easy to use and brief to avoid creating an additional administrative burden in the construction process. In developing the forms, it is important to understand how the people who will fill them out work and think. A form structured as a checklist might be a useful model to consider. Some form designs were included in the 2005 project and it is recommended that this material be used to create the final forms used for the large-scale program. The pilot project could be the perfect opportunity to test the forms in a real project context. The compliance software developed by the American University of Beirut in 2005 could also be reviewed and updated and included as a tool for compliance checking.

Step 12: Launching the Mandatory Standards

The mandatory stage should be announced and publicized well before its implementation to inform all construction sector stakeholders. A period of time between the voluntary launch and mandatory launch is essential to allow promoters, construction companies, engineers and architects to adapt their design processes and approaches to these new building standards requirements.

Phase 2 – Program Implementation

During this phase, Government employees will review drawings, specifications and submission forms filled in by building professionals and will issue an approval for construction. The following table summarizes the steps in the implementation process.

Table 32: Program Implementation Steps

Step	Description
1	Processing of requests for approval, issuing certificates and enforcement
2	Communications campaign
3	Program follow-up and energy savings calculation
4	Creation of a permanent technical committee

Step 1 – Processing Requests for Approval, Issuing Certificates and Enforcement

These activities will be conducted by individuals working in the Urban Planning Departments of ministries, counties or municipalities as applicable. These individuals will receive training on how to

manage the approval process and how to apply the enforcement procedures during the preparation phase prior to the standards mandatory application.

Field visits should be conducted to ensure that buildings are actually constructed with the thermal characteristics that were submitted in the request for approval. Promoters who are to not comply with the thermal standards requirements should be notified of the default and construction work should be stopped until the faulty elements are corrected.

Enforcement is one of the key elements that will ensure the success of the thermal standards as this activity will guarantee their consistent application on the market. The Government must demonstrate a strong political will and should make all the necessary decisions and take the actions needed to ensure that the efficient enforcement process is effective for the policy to succeed. In the absence of a strong standards enforcement procedure as of their initial introduction, the building community will probably not fully adhere to the thermal standards requirements.

Step 2 – Communication campaign need to be put in place centralized on program benefit and needs for application.

Step 3 - Program Follow-Up and Energy Savings Calculations

Program follow-up is an important activity that will provide feedback to the policy makers on the current status of the building standards and their implementation. An evaluation of the program impacts based on forms submitted to the Government and to regional and municipal authorities will serve as the main input for the preparation of a program follow-up dashboard.

To calculate savings associated with the standards, program managers will need to gather information about the total square meters of buildings that have gone through the approval process. A program database should be set up to store all the relevant information about each building that was built according to the standards requirements. The square meters of all new buildings should be classified by type of building and by climate zone to be able to prepare statistics that can be analyzed from different perspectives. The total quantity of square meters would then be multiplied by an index of energy savings by square meter that would be derived from the 2005 background study on the energy impacts of the program. This index will vary by building type and by region to provide the most accurate evaluation of the impacts of the thermal standards on the market.

The approach proposed above will be sufficient to estimate the program savings based on the minimum requirements of the thermal standards. However, the data will not be sufficient to quantify the industry's additional efforts that go beyond the minimum requirements. This exercise will result in a conservative estimate of the program's impacts on the market.

Step 3: Creation of a Permanent Technical Committee

The construction sector is in constant evolution. Consequently, regular thermal standards updates will be required to keep them relevant and adapted to market realities. The main actors taking part in this update process could be professionals from a building research association, consultants and academics. Economic analyses will need to be conducted to analyze new technologies and materials and to determine more stringent requirements for insulation and fenestration as the cost of energy rises. A Thermal Standards Revision Committee should be set up to ensure that the standards are revised on a continuous basis. This Committee should develop a revision plan with goals, detailed activities and schedules. It should establish priorities for thermal standards improvements and/or extensions, conduct analyses as needed, incorporate feedback and comments and issue periodic updates and clarification for the introduction of the standards.

Phase 3 - Independent Program Evaluation

In order to review the process, the market impacts and energy impacts of the thermal standards during their mandatory phase, it is recommended that an independent program evaluation be conducted every two years. This evaluation should review the process followed to have a building approved as well as the verification and enforcement processes to identify any area that needs improvement. The estimate of savings generated during the program follow-up activities could be replaced by a more formal impact evaluation using either computer simulations of building models or a direct measurement of the program's effects on a sample of buildings.

As mentioned above, it is suggested that the independent evaluation be conducted every two years. As this program aims towards a market transformation, it is important that there not be any lengthy delays between evaluations to avoid losing important information about the market trends and the effectiveness of the standards. If the period of time between two evaluations is too long, the workload will be higher in the end and the data collection will be more complex because the required information will begin to scatter or will simply be lost.

Costs and Resources for the Thermal Standards for New Buildings

The following table shows the estimated costs and resources required for the implementation of a voluntary and then a mandatory thermal standards program.

Table 33: Budget for the Thermal Standards Program Development

Activity	Consultants or Direct Costs (1 year development) (USD)	Government or Municipal Resources (in man-days)
1 – Creation of stakeholders groups	USD 2,000	15
2 – Finalization of the timeline		20
3 – Revision of the 2005 draft standards	USD 80,000	60
4 - Public review process	USD 45,000	30
5- Pilot project (with subsidies to 10 participants)	USD 350,000	80
6 – Development of the communication plans and materials	USD 50,000	40
7- Developing the training material	USD 20,000	20
8 – Delivering the training sessions	USD 15,000	15
9- Launching the voluntary standards	USD 4,000	25
10 – Preparing the regulatory framework	USD 25,000	40
11- Preparing the procedures and tools	USD 18,000	30
12- Launching the mandatory standards	USD 4,000	25
Total	**USD 613,000**	**235**

Table 34: Budget for the Thermal Standards Program Implementation

Activity	Consultants or Direct Costs (1 year development) (USD/year)	Government or Municipal Resources (man-days/year)
1- Processing requests for approval	USD 20,000	500
2- Communications Campaign	USD 60,000	60
3- Program follow-up and energy savings calculations	USD 30,000	35
4- Permanent Technical Committee	USD 20,000	40
Total	**USD 130,000**	**575**

The estimated cost of the development of a thermal standards program represents USD 613,000 and 235 man-days of work and the cost of a program's implementation phase represents USD 130,000/year and 575 man-days per year.

Energy Savings Potential

In 2005, energy saving calculations and an Economic analysis were performed to select cost effective minimum requirement levels to be incorporated into the thermal standards for buildings in Lebanon. The estimate of energy savings related to the thermal standards was calculated using the DOE-2.1E software using parametric runs. A parametric run allows to rapidly performing several energy savings calculations for the same building by varying the values or characteristics of a single parameter. For instance, a parametric run could explore the impacts of various thicknesses of wall, roof or slab

insulation while others could be used to analyze the energy savings associated with different types of windows and shading devices. The results of these computer simulations were then fed into an economic analysis model and the most appropriate level of stringency was selected based on the economic results of the various energy conservation measures considered.

The savings calculations for the various model buildings simulated were extrapolated to the overall market by using available Government projections about the country's population growth and the number of buildings to be constructed during the program period. The following table shows the total number of square meters of residential and non-residential buildings that will be constructed in compliance with the standards.

Table 35: Residential Building Areas that will comply with the Standards

Year	Housing number (units)	Housing total area (m2)
2010	15,648	2,190,788
2011	15,600	2,184,019
2012	15,441	2,161,705
2013	15,398	2,155,746
2014	15,447	2,162,598
2015	15,062	2,108,687
2016	14,849	2,078,897
2017	14,848	2,078,699
2018	14,717	2,060,363
2019	14,722	2,061,130
2020	14,549	2,036,791
2021	14,424	2,019,407
2022	14,440	2,021,612
2023	14,359	2,010,290
2024	14,336	2,007,031
2025	14,153	1,981,354
2026	14,013	1,961,849
2027	14,026	1,963,599
2028	13,965	1,955,089
2029	14,004	1,960,563
Total (2010 to 2029 - 20 years)	**294,002**	**41,160,216**

Table 36: Forecast of Building Construction Areas that will Comply with the Standards

Year	Economic growth	Working offices	New offices rate	New offices Annual	Total number of offices	Empty offices	Area (m^2) of office complying with the thermal standard				Year
							Zone 1	Zone 2	Zone 3	Zone 4	
	(%)	(units)	(%)	(units)	(units)	(units)	15%	40%	20%	25%	
1996	-	188,162	0	0	301,853	113,691	0	0	0	0	**1996**
1997	4.0	195,688	2	3,763	305,616	109,928	9,031	24,083	12,042	15,052	**1997**
1998	2.2	199,993	1.1	2,153	307,769	107,775	5,167	13,779	6,890	8,612	**1998**
1999	1.2	202,393	0.6	1,200	308,969	106,575	2,880	7,680	3,840	4,800	**1999**
2000	0.4	203,203	0.2	405	309,374	106,170	972	2,592	1,296	1,620	**2000**
2001	0.0	203,203	0	0	309,374	106,170	0	0	0	0	**2001**
2002	0.0	203,203	0	0	309,374	106,170	0	0	0	0	**2002**
2003	0.0	203,203	0	0	309,374	106,170	0	0	0	0	**2003**
2004	1.0	205,235	0	0	309,374	104,138	0	0	0	0	**2004**
2005	1.0	207,287	0	0	309,374	102,086	0	0	0	0	**2005**
2006	1.0	209,360	0	0	309,374	100,013	0	0	0	0	**2006**
2007	1.0	211,454	0	0	309,374	97,919	0	0	0	0	**2007**
2008	1.0	213,569	0	0	309,374	95,804	0	0	0	0	**2008**
2009	3.0	219,976	0	0	309,374	89,397	0	0	0	0	**2009**
2010	3.0	226,575	0	0	309,374	82,798	0	0	0	0	**2010**
2011	3.0	233,372	0	0	309,374	76,001	0	0	0	0	**2011**
2012	3.0	240,373	0	0	309,374	69,000	0	0	0	0	**2012**
2013	3.0	247,584	0	0	309,374	61,789	0	0	0	0	**2013**
2014	3.0	255,012	1.5	3,714	313,087	58,075	8,914	23,770	11,885	14,856	**2014**
2015	3.0	262,662	1.5	3,825	316,913	54,250	9,180	24,480	12,240	15,300	**2015**
2016	3.0	270,542	1.5	3,940	320,852	50,310	9,456	25,216	12,608	15,760	**2016**
2017	3.0	278,658	1.5	4,058	324,911	46,252	9,739	25,971	12,986	16,232	**2017**
2018	3.0	287,018	1.5	4,180	329,090	42,072	10,032	26,752	13,376	16,720	**2018**
2019	3.0	295,629	1.5	4,305	333,396	37,767	10,332	27,552	13,776	17,220	**2019**
2020	3.0	304,498	1.5	4,434	337,830	33,333	10,642	28,378	14,189	17,736	**2020**
2021	3.0	313,633	1.5	4,567	342,398	28,766	10,961	29,229	14,614	18,268	**2021**
2022	3.0	323,042	1.5	4,704	347,102	24,062	11,290	30,106	15,053	18,816	**2022**
2023	3.0	332,733	3.0	4,846	351,948	24,062	11,630	31,014	15,507	19,384	**2023**
2024	3.0	342,715	3.0	4,846	351,948	24,062	11,630	31,014	15,507	19,384	**2023**
2025	3.0	352,996	3.0	4,846	351,948	24,062	11,630	31,014	15,507	19,384	**2023**
2026	3.0	363,586	3.0	4,846	351,948	24,062	11,630	31,014	15,507	19,384	**2023**
2027	3.0	374,494	3.0	4,846	351,948	24,062	11,630	31,014	15,507	19,384	**2023**
2028	3.0	385,729	3.0	4,846	351,948	24,062	11,630	31,014	15,507	19,384	**2023**
2029	3.0	397,301	3.0	4,846	351,948	24,062	11,630	31,014	15,507	19,384	**2023**
Total (2008 to 2027 - 20 years)				**69,478**			**148,696**	**396,524**	**198,262**	**247,828**	
							991,310				

The benefits of implementing thermal standards were outlined in the “Energy Analysis and Economic Feasibility Study for the Thermal Standards for New Buildings in Lebanon” conducted in 2005. In this report, the residential and office building sectors were studied in detail. The energy savings were calculated for the buildings to be constructed in compliance with the standards. Savings calculations were performed for buildings located in four climatic regions in Lebanon including the coastal, western mid-mountains, inland plateau and high mountains areas. The effects of the thermal standards on the energy consumption of the buildings varied widely according to their location. One analysis compared two different types of residential buildings. A similar analysis was conducted on non-residential buildings. The Model 1 building was built according to the minimum thermal standards whereas the Model 2 building was a more advanced and energy efficient design. The following tables show the comparative results of the net present value of both models of buildings for different climatic regions

Table 37: Savings for Residential Buildings

	Savings (USD)			
	1 - Coastal	**2 - Western Mid-Mountains**	**3 - Inland Plateau**	**4 - High Mountains**
Model 1 Walls: Single, non insulated, U=3.432 W/m2C Roof: Insulated 6 cm. EPS, U=0.524 W/m2C Windows: Single reflective, SC=0.45, U=5.490 W/m2C Overhang: PF = 0.40 for E,W,S side	**USD 26,124**	**USD 13,871**	**USD 16,098**	**USD 3,482**
Model 2 Walls: Double, insulated 6 cm EPS, U=0.500 W/m2C Roof: Insulated, 6 cm EPS, U=0.524 W/m2C Windows: Single reflective, SC=0.45%, U=5.490 W/m2C Overhang: PF = 0.40 for E,W,S side	**USD 25,695**	**USD 11,007**	**USD 31,497**	**USD 16,855**

Table 38: Savings for Office Buildings

	Savings (USD)			
	1 - Coastal	**2 - Western Mid-Mountains**	**3 - Inland Plateau**	**4 - High Mountains**
Model 1 Walls: Single, non insulated, U=3.432 W/m2C Roof: Insulated 6 cm. EPS, U=0.524 W/m2C Windows: Single reflective, SC=0.45, U=5.490 W/m2C Overhang: PF = 0.40 for E,W,S side	**USD 9,942**	**USD 9,069**	**USD 14,392**	**USD 340**
Model 2 Walls: Double, insulated 6 cm EPS, U=0.500 W/m2C Roof: Insulated, 6 cm EPS, U=0.524 W/m2C Windows: Single reflective, SC=0.45%, U=5.490 W/m2C Overhang: PF = 0.40 for E,W,S side	**USD 9,026**	**USD11,004**	**USD 22,470**	**USD 17,364**

The savings in GWh for the Lebanese residential and office sector were established and are shown in the following table.

Table 39: Estimate of Energy Savings (GWh)

Category	Energy Savings (GWh)
Residential	8,931
Office (non-residential)	1,156
Total	10,088

These energy savings were estimated for a 20-year period (2010-2029) and included the total area of buildings that that are expected to be built and that will comply with the new thermal standards. The analysis at the time considered a fossil fuel price of USD 25 per barrel of crude oil. In this report, the models were subjected to parametric runs once again; this time based on a crude oil price of 50 USD and 75 USD per barrel to show the sensitivity of the savings to the energy price. We found that variations in the cost of fuel do not drastically alter the savings associated with the thermal standards since the incremental savings associated with additional insulation decrease rapidly when the insulation thickness is increased. On the other hand, the cost of insulation increases steadily based on its level of thickness. The sensitivity analysis performed shows that the variations in the price of fossil fuel do not have any effect on the thickness of insulation recommended in the thermal standards. However, the higher fuel price had a significant effect on the payback period of each measure, which was significantly reduced. Therefore, the interest in implementing the recommendations of the thermal standards is more attractive to customers with the current costs of fossil fuel.

The savings in Tables 37 and 38 do not include the electricity transmission and distribution losses. Additional savings will be generated for buildings with electrical heating and for buildings with electrically powered cooling systems. The tables should therefore be considered as conservative estimates. These savings include only cost effective measures for building owners. The very large potential associated with this policy highlights the importance of considering the thermal standards for Lebanon as a priority. They will significantly help to reduce Lebanon's dependency on imported fossil fuel.

Payback Period

Each minimum requirement of the thermal standards was selected to obtain the maximum net present value for the building owner. For instance, the residential requirement for wall insulation was selected after comparing the results of adding 2 cm, 4 cm, 6 cm and 8 cm of polysterene insulation. As far as Beirut is concerned, the 6 cm option provided the maximum net present value for a residence that is heated and cooled and will result in a total gain of 4958 USD over the insulation's life cycle. Similar calculations were performed in various regions and for buildings that were only heated and others that were both heated and cooled. In Beirut and in 2005, the range of the payback period for homeowners varied between 0.5 and 3,5 years depending of the measure considered. This was at a fuel price of 25 USD per barrel. With today's energy prices, several measures now have a payback period of less than one year and a significant number of measures have between a one- and two-year payback period.

Program Financing

The financing for the design, development and implementation of the thermal standards should be provided by the Government. The funding will need to cover the management activities, the standards revision process, the public review, the communications campaign and the capacity building program for market actors. The cost of the building approval process and the enforcement procedures will be shared between the Lebanese Directorate General of Urban Planning and the Ministry of Public Works and Transport, regional authorities and municipalities. The various units responsible for building approval and standards enforcement will be the same who normally supervise and approve construction plans submitted by promoters.

Funds for these activities can be sourced from the National Treasury (normal income taxes or fiscal tools from the central Government) or through a special levy to create a source of financing to support the introduction of the policy. Examples of such financing include the creation of a green fund based on a levy on the sale of petroleum products, or could be a fee charged on the import of equipment known for their high energy consumption and mainly owned by high revenue households. For example, in Tunisia, a special environmental fund was created through a levy applied on the purchase of air conditioning equipment and imported cars.

The Government can also consider a loan from the World Bank (WB) in the financing plan for these activities. This possibility can be explored together with the possibility of GEF funding, keeping in mind that the proposed project should include components that were not covered in the previous GEF project.

In addition to funding provided by the Government, it is important to acknowledge the voluntary contribution of several market stakeholders. For instance, the construction community could provide feedback during the public review process or could take part in the Technical Committee put in place to provide guidance and make decisions during the review process. The professionals and construction community should also enroll in capacity building activities and should pay for their human resources' time that will be dedicated to training.

Capacity building activities can be offered free of charge to the market if the activities are entirely financed by the Government or can be offered at a reduced cost if the Government chooses to only pay for a portion of the training. This can be a way of reducing the program implementation costs.

It is important to note that, after the introduction of the thermal standards as a mandatory requirement for new buildings, the largest portion of the funds needed to cover the incremental construction costs will be financed by promoters and building owners. Thus, the largest portion of the funds required for the implementation of the thermal standards will be absorbed by the market actors who will ultimately benefit from the cost effective measures included in the standards.

3.4 OTHER RECOMMENDATIONS

The detailed EE programs proposed in this report represent the best actions to be undertaken with regards to the available information and data and the actual situation of the Lebanese energy market.

This section outlines the complementary tasks required for the successful implementation of the proposed EE programs. It also discusses institutional, regulatory and technical capacity building.

3.4.1 Legal Framework Development

To ensure the success of the proposed programs, a legal framework should be developed. Up to now, there are no regulations related to energy management in Lebanon. A draft law on energy management has been submitted to the Government for approval. However, additional legislation is required to take into consideration the Lebanese context and the different barriers for EE program implementation. This legislation should cover the following issues:

- Establishing the appropriate legislation to enforce the technical specifications for new buildings and thermal standards implementation.
- Incorporate an EE fund to Kafalat, which will provide subsidies for industrial sector EE projects.
- Organize professional energy efficiency accreditation and define terms of reference for energy auditing.
- Define ESCO activities by establishing ESCO project implementation procedures and the role of each stakeholder involved in project implementation.
- Define the conditions for S&L implementation for energy efficient appliances and the energy consumption levels of prohibited appliances.
- Define the pre-consultancy conditions and processes for large energy consumption projects.
- Define certification conditions for manufacturers and installers for the SWH Program.
- Define the list of energy efficient appliances exonerated from VAT and customs fees.
- Define street lighting technical specifications to encourage municipalities to consider the energy saving components of new street lighting.
- Install SWHs on a mandatory basis in hospitals and Government buildings if their profitability is confirmed.

The development of this legal framework and of the technical specifications will require an overall budget of about USD 600,000; where about USD 200,000 will be used for the organization of seminars and marketing campaigns.

3.4.2 Nomination of Energy Managers in Government Buildings

In order to closely track the energy consumption in Government buildings and to improve their efficiency, it is recommended to designate Energy Managers in Government buildings. The mandate of these Officers would be to track and analyze the energy consumption of the buildings and to

prepare monthly reports for LCEC. These reports will provide the data needed to analyze and identify all energy consumption anomalies. This information will also contribute to creating an energy consumption database on the Government sector for LCEC. The database will help to define the energy savings potential and to establish a benchmarking tool to compare energy consumption and define objectives to be targeted for buildings.

This action will require an investment in energy training estimated at USD 0.8 million calculated on the basis of training sessions in each semester for a period of three years. The expected savings are estimated at 2% of the sector's energy consumption, or about 27 kteo/year, resulting in an emissions reduction of 102,000 tCO2/year.

3.4.3 Development of a Database on Energy Consumption

One of the barriers facing EE program development in Lebanon is the unavailability of information on energy consumption by sector, sub-sector and by energy type. Without the appropriate set of data on energy consumption and demand profiles, energy efficiency program could not be developed and appropriate targets and objectives could not be defined.

Consequently, it is highly recommended to carry out a detailed energy consumption assessment on different market sectors in order to collect information defining the country's energy consumption structure and energy indicators by sector.

3.4.4 Development of the Use of Natural Gas

Lebanon is currently connected to a natural gas network via a pipeline from Syria that is intended to supply the Beddawi power plant. The feasibility study for this project demonstrated that, once the pipeline becomes operational, the substantial gain is estimated to represent USD 172 million.

Upon the pipeline's commissioning, it is recommended to establish a strategy to connect industrial zones and to promote the use of natural gas in the residential and tertiary sectors as well.

The development of the use of natural gas would lead to savings on energy bills and also to a net reduction in GHG emissions.

The use of natural gas in Lebanon will open the doors to developing other EE technologies such as natural gas air conditioning and cogeneration, which have proven to be highly successful and justified in other countries where the use of natural gas has been developed.

3.4.5 LCEC Capacity Building

The draft law on energy efficiency assigns an important role to LCEC as being in charge of law enforcement and the implementation of EE programs. To achieve its mission, it is recommended that LCEC undergo capacity building activities, which will include the following:

- Recruitment of qualified resources and a network of international and national experts to assist LCEC in EE program implementation. For comparison purposes, the Tunisian National Energy Agency has 130 employees and 50% of them are professionals (engineers and managers), whereas LCEC has only 8 full-time employees.
- The creation of task forces for the development of technologies with justified energy savings potential.
- Energy audit development, a measurement campaign, EE project implementation and the signature of contracts with consumers.

CONCLUSION

Energy security and environmental constraints are a challenge for the social and economic development of Lebanon. Energy efficiency is considered as a priority to address the country's increased needs for energy and to reduce the need for Government subsidies in the energy sector.

CFLs and SWHs for the residential sector are part of the short-term Action Plan and are considered to be an immediate solution for the improvement of the energy efficiency conditions in Lebanon and the improvement of EDL's current situation in regards to its peak load periods. The estimated demand reduction of 226 MW within the 5year program with an investment of USD 87 million represents a very attractive opportunity for EDL with a ratio of USD 0.38 million per MW. The annual savings generated by the implementation of the short-term Action Plan are estimated at USD 84 million, which represents the difference between EDL's production cost and selling cost of the saved electricity. In addition, the benefits for residential end users are significant; participating households in both programs will save about USD 112 annually. The environmental benefits are significant as well; the Action Plan will reduce the country's energy consumption by about 480 ktoe, representing about 1527 ktCO2 in reduced emissions.

The medium-term Action Plan proposes programs that require a relatively long implementation period. Energy efficiency in the industrial sector and efficient street lighting will generate a demand reduction of 27 MW within the 10 years of the program implementation period with an investment of USD 36 million. The savings generated annually are estimated at USD 33 million, reducing the country's primary energy use by about 46 ktoe, which represents about 854 ktCO2. The implementation of the medium-term Action Plan will require that a complete and detailed study be conducted to assess the energy consumption and technologies used in the industrial sector, which will constitute a database to evaluate the potential energy savings in the sector and to adjust the program accordingly. As far as the Street Lighting Program is concerned, information about the number of fixtures by lamp type, their power and the various metering points will have to be gathered in order to update the proposal and the savings potential.

The long-term proposed actions, with an implementation timeframe of up to 20 years, are related to a market transformation where the benefits expected are on the long term. The Thermal Standards for New Buildings and the Standards and Labelling of appliances will require putting dedicated structures in place for implementation and follow-up, and this will require time, efforts and appropriately skilled resources.

With a significant savings potential of about 1592 ktoe per year, the long-term Action Plan will only require an investment of about 11 million. In spite of the fact that the reduction in electricity demand will not be very great over the long implementation period at only 30 MW, the energy savings will be very significant and are estimated at 12,450 GWh.

It is recommended to begin with the short-term Action Plan, however the other proposed plans could be started, especially in the case where related actions have already been initiated, to ensure their continuity and the effective development of the proposed programs.

APPENDIXES

APPENDIX 1 EDL TARIFS

The conversion of the Lebanese pound (LBP) to USD is based on the exchange rate of June 4, 2009: 1 LBP = 0.000666223 USD[63]. The following tables show three tariff categories.

1. High Voltage Category (HV)		
Category	**Existing Tariff**	
	Lebanese Pound	**USD**
Kadisha concession		
Demand charge (LBP/KVA.month)	-	-
(Energy charge (LBP/kWh)	62	0.041306
Other HV subscriber (Sibline)(Special EDL- (Siblinecontract)		
Demand charge (LBP/KVA.month)	800	0.532978
(Energy charge (LBP/kWh	90	0.05996

[63] http://www.xe.net/ucc/convert.cgi

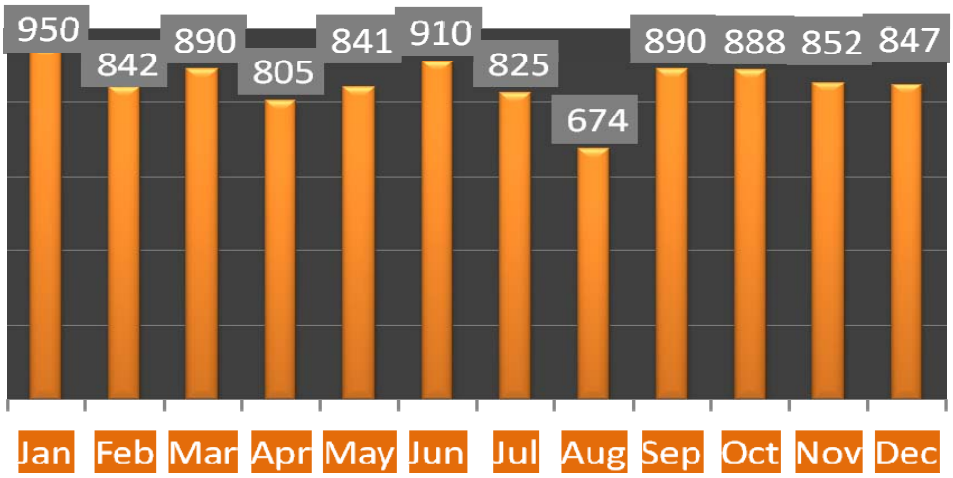
2. Medium Voltage Category (MV)			
Category		**Existing Tariff**	
		Lebanese Pound	**USD**
Concessions			
Demand charge (LBP/KVA.month)		-	
Energy charge (LBP/kWh)		75	0.049967
		Zahle) concession (50	
General MV Tariff S ≥ 100 KVA			
(not including public establishments and administrations)			
The transformer belongs to the subscriber			
Demand charge (LBP/KVA.month)		600	0.399734
Energy charge (LBP/kWh)	Peak	320	0.213191
	Day	112	0.074617
	Night	80	0.053298
Rehabilitation charge (LBP/KVA.month)		200	0.133245
The transformer belongs to EDL			
Demand charge (LBP/KVA.month)		1200	0.799468
Energy charge (LBP/kWh)	Peak	320	0.213191
	Day	112	0.074617
	Night	80	0.053298
Rehabilitation charge (LBP/KVA.month)		200	0.133245
General MV tariff S < 100 KVA (and public establishments and administrations)			
The transformer belongs to the subscriber/ to EDL			
Demand charge (LBP/KVA.month)		600/1200	
Energy charge (LBP/kWh)		)140 lighting) or (130(motors	
Rehabilitation charge (LBP/KVA.month)		200	0.133245

3. Low Voltage Category (LV)

Category	Existing Tariff	
	Lebanese Pound	USD
Social tariff		
Up to 3 KVA and less than 300 kWh per month		
Demand charge (LBP/KVA.month)	1200	0.799468
Energy charge LBP/kWh 1° block (100 kWh)	35	0.023318
(block (200 kWh)2°	55	0.036642
(Rehabilitation charge (LBP/month)	5000	3.331115
LV general tariff		
From more than 3 KVA to 9.9 KVA		
Demand charge (LBP/KVA.month)	1200	0.799468
Energy charge LBP/kWh 1° block (100 kWh)	35	0.023318
block 200 kWh 2°	55	0.036642
block 100 kWh 3°	80	0.053298
block100 kWh 4°	120	0.079947
block beyond 5°	200	0.133245
Rehabilitation charge (LBP/month)	5000	3.331115
General tariff above 10 KVA		
Demand charge (LBP/KVA.month)	1200	0.799468
Energy charge LBP/kWh 1° block (100 kWh)	35	0.023318
block 200 kWh 2°	55	0.036642
block 100 kWh 3°	80	0.053298
block 100 kWh 4°	120	0.079947
block beyond 5°	200	0.133245
Rehabilitation charge (LBP/month)	10000	6.66223

3. Low Voltage Category (LV)		
Category	**Existing Tariff**	
	Lebanese Pound	**USD**
Rates 115 and 140		
Rate 115 - up to 9.9 KVA		
Demand charge (LBP/KVA.month)	1200	0.799468
Energy charge (LBP/kWh)	115	0.076616
Rehabilitation charge (LBP/month)	5000	3.331115
Rate 115 - above 10 KVA		
Demand charge (LBP/KVA.month)	1200	0.799468
Energy charge (LBP/kWh)	115	0.076616
Rehabilitation charge (LBP/month)	10000	6.66223
Rate 140 - up to 9.9 KVA		
Demand charge (LBP/KVA.month)	1200	0.799468
Energy charge (LBP/kWh)	140	0.093271
Rehabilitation charge (LBP/month)	5000	3.331115
Rate 140 - above 10 KVA		
Demand charge (LBP/KVA.month)	1200	0.799468
Energy charge (LBP/kWh)	140	0.093271
Rehabilitation charge (LBP/month)	10000	6.66223

APPENDIX 2: ADDITIONAL ENERGY DATA



EDL's Monthly Production and Purchased (GWh)

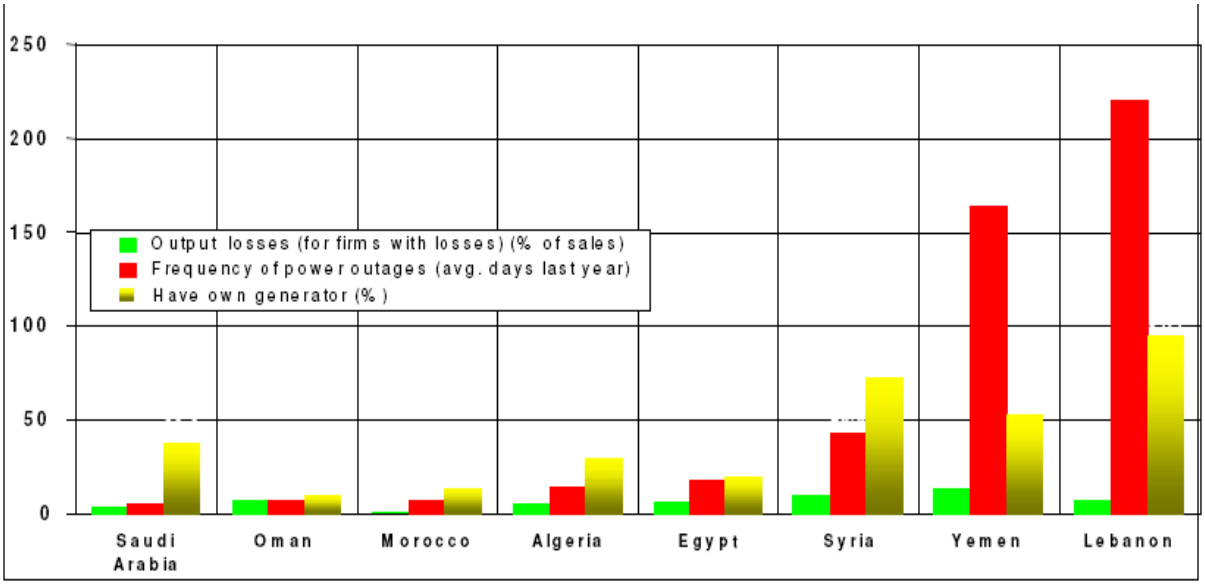
Performance Indices of EDL's Power Plants

According to Financial and Engineering Support Services Report to EDL[64], the average value of the overall availability of each power plant was between 44% and 77%, this is far below normally acceptable values. Benchmark values of a Combined Cycle Gas Turbine (CCGT) plant would be around 90% for normal operations while the values of an older conventional plant would be approximately 85%.

EDL's installed capacity is not able to meet all the demand and the power stations are always solicited at their highest capacity, which causes tremendous constraints on their effective operation. Preventive maintenance is frequently skipped due to circumstances and unplanned outages often occur because of this lack of maintenance. The outage rate for a power plant should not exceed 15%; according to international best practices the rate should be less than 10%. Currently, EDL's exceeds 25% on average because the utility cannot carry out normally planned preventive maintenance because of its system's demand.

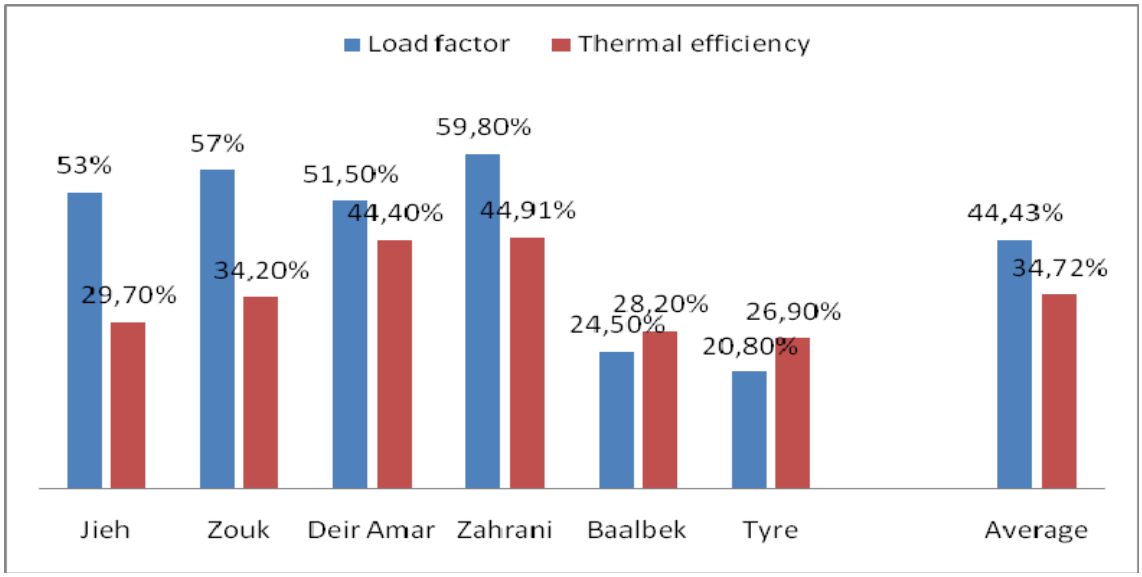
As shown in Figure 26, the number of average days where power outages occur is higher in Lebanon than in countries in the Middle East and the North Africa (MNA) Region. Yemen comes in second with around 60 days less than Lebanon and Syria has outages on over 150 days less than Lebanon. This graph shows that Lebanon's electricity grid is in very poor shape.

[64] Financial and Engineering Support Services to EDL, base year data report draft



Comparison of Power Performance Indices in the MENA Region[65]

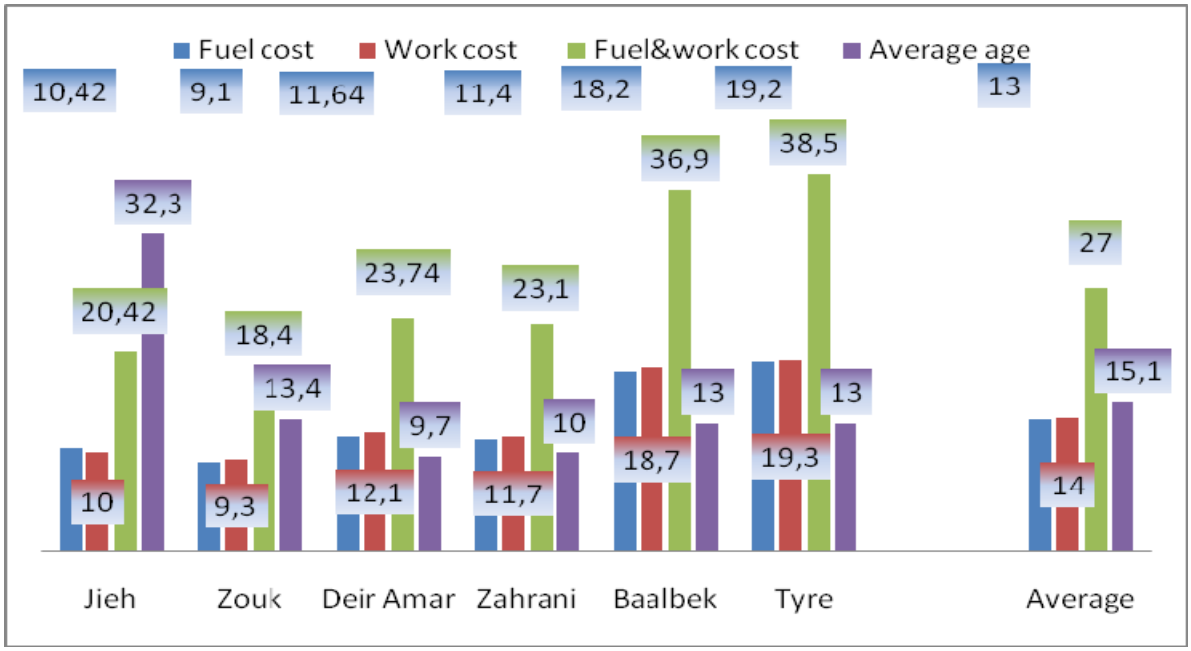
The following figure presents the load factor and the efficiency of EDL's 6 power stations. The average efficiency of the power plants is 34.72%; their thermal efficiency fluctuates between 44.91% and 26.90%. This is very low compared to the CCGT[66] average efficiency. There is a significant lack in thermal efficiency, which increases production costs. To remedy this situation, according to the report mentioned previously, each plant should have its own benchmark or target to properly assess potential improvements. Another concern in regards to plant efficiency is the age of the thermal plants, which varies between 32.3 and 9.7 years; Zouk Power Station is the largest and oldest one. Load factors are low considering the shortfall in overall generation capacity. The average load factor is about 44.43%; it ranges from 22.9% for Baalbek Station to 59.8% for Zahrani.



[65] Sustainable development department, Report n° 41421-LB page 21
[66] EDL, Energy Management, Transmission Dept, Financial and Engineering Support Services to EDL, base year data report

Thermal Efficiency and Load Factor of Each Power Plant in 2006[67]

The next figure shows the fuel and operating costs of each EDL thermal plant, the costs depend on the plant's thermal efficiency, its age and the type of energy used. The fuel costs represent 50% of the total operating costs. The average operating cost for EDL's 6 power stations is USD 0.13/kWh according to the Financial and Engineering Support Services Report to EDL[68].



Fuel and Operating Costs of EDL's Power Plants ($/kWh) and the Average Age of Each Plant[69]

Lebanon ratified the UNFCCC in 1994 and the Kyoto Protocol in May 2006. The Designated National Authority is currently being established at the Ministry of Environment.

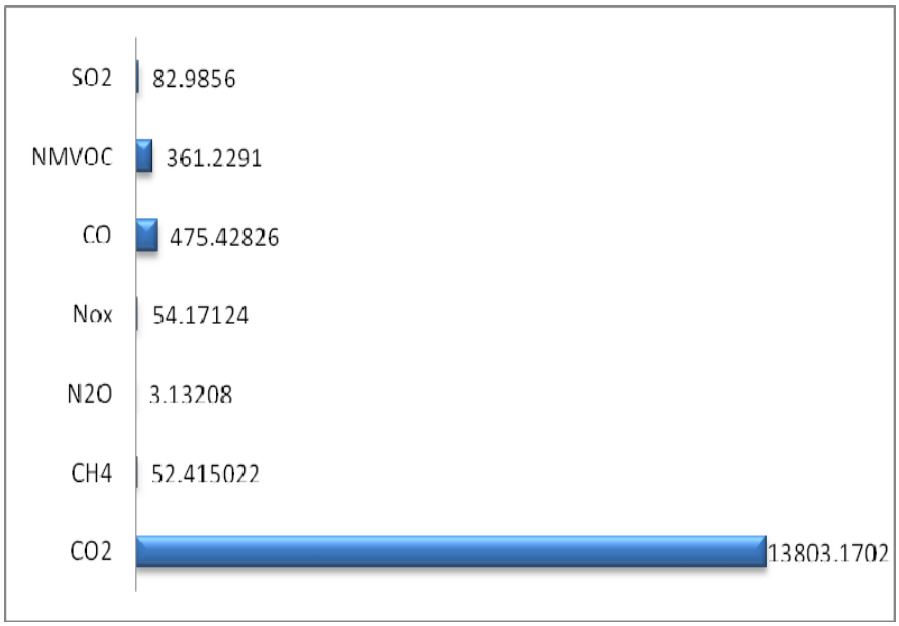
The following table presents the principal indicators of CO2 emissions in 2006.

Principal Indicators of CO_2 Emissions[70]

CO_2/TPES (tCO_2/toe)	2.8
CO_2/Population (tCO_2/capita)	3.29
CO_2/GDP(kg CO_2/thousand USD 2000 PPP)	0.67

[67] EDL, Energy Management, Transmission Dept, Financial and engineering support to EDL, base year data report
[68] Financial and Engineering Support Services to EDL, base year data report draft
[69] Sustainable development department, Report n° 41421-LB page 21
[70] http://www.iea.org/Textbase/stats/indicators.asp?COUNTRY_CODE=LB

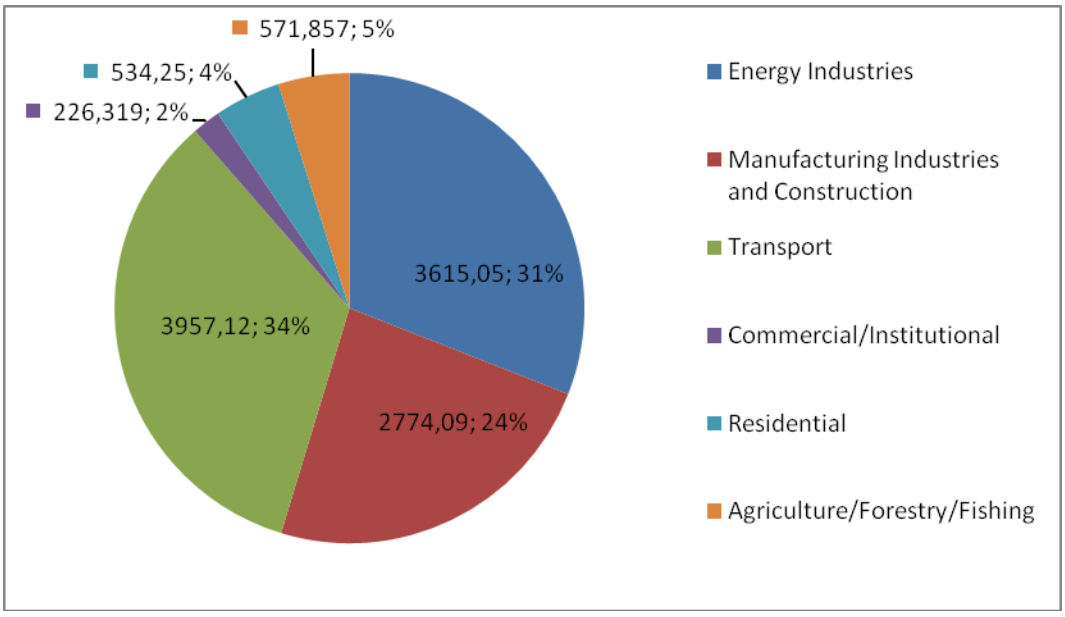
An updated GHG emissions inventory financed by the GEF, shows that carbon dioxide produces most GHG; it represents around 93% of the overall GHG emissions.



Summary of GHG Emission Inventories in Gg (1994)[71]

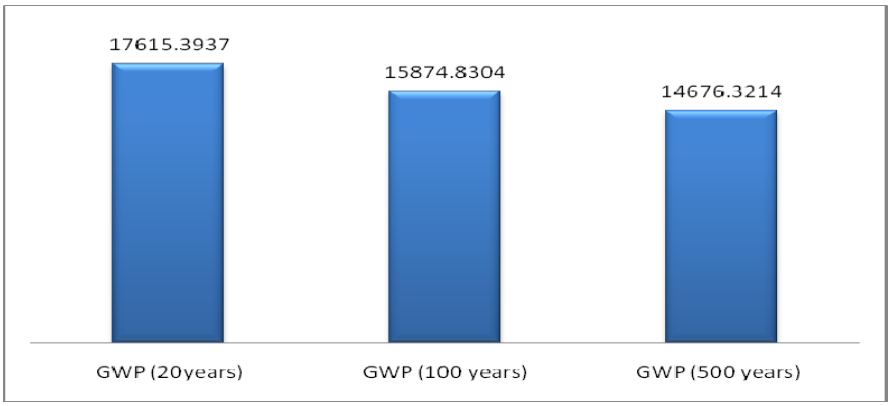
In 1994, the overall CO2 generated in Lebanon was 11,678.694 Gg. The Lebanese electricity sector is one of the main sources of GHG emissions. It is considered as the largest CO2 contributor after the transport sector; in 1994, it represented 3,615.05 Gg of CO2, which is equivalent to 31% of the total CO2 emissions in Lebanon. The energy sector produced this amount of CO2 through the electric utility and private generation. The transport sector emitted 33% and 24% was produced by manufacturing industries and construction.

[71] http://www.moe.gov.lb/pdf/Climate%20Change/Lebanon's%20First%20National%20Communication-Summary%20Report/chapter2.pdf



Summary of CO2 Emitted by Activity Sector (in Gg)

In 1999, the gross CO2 emissions were 16,699.432 Gg, of which energy consumption represented 89%; this represented an increase of about 4% from the figures in 1994. The total global warming potential estimated for Lebanon over the next 20 years is about 18,000 Gg CO2 eq as shown in Figure 21, and it is expected to decrease over the next 100 and 500 years.



Total Global Warming Potential in Lebanon, Gg[72]

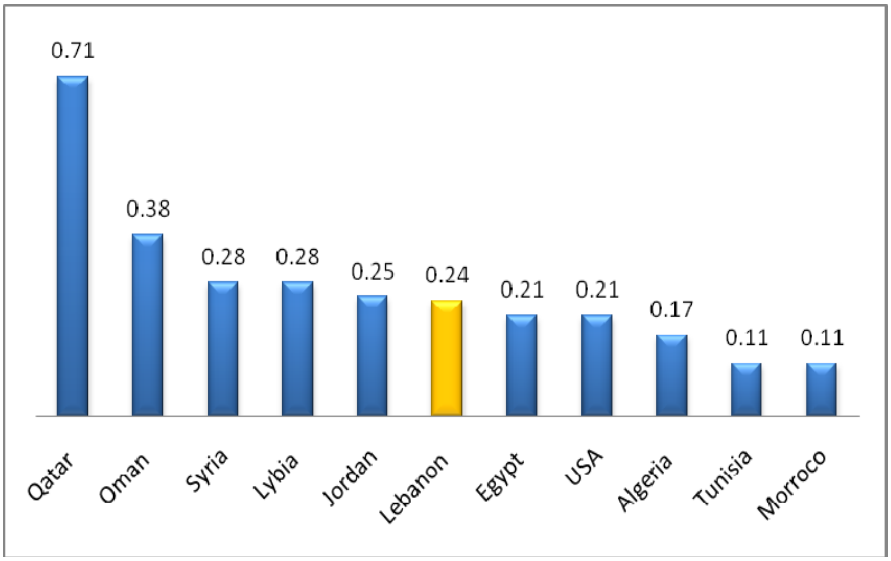
The various indices that characterize the energy consumed and the GHG emitted in Lebanon and other countries are presented in the following figures.

The background of these ratios confirms that the energy intensity began to decline from the year 1992 until 2006, while the primary energy consumption per capita did not cease to increase from 1992

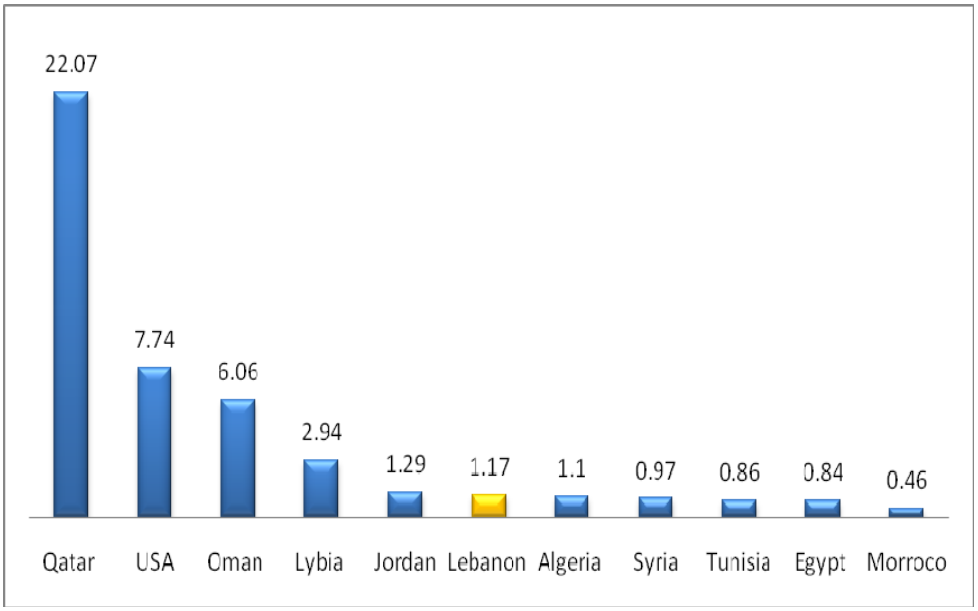
[72] http://www.moe.gov.lb/pdf/Climate%20Change/Lebanon's%20First%20National%20Communication-Summary%20Report/chapter2.pdf

(0.78toe/capita) to 2006[73] . The various ratios related to energy consumption and emitted GHG for Lebanon and for other countries are compared.

For Lebanon, the energy intensity measured in 2006 was 0.24 TOE/1000 USD 2000 (PPP), and the per capita primary energy supply was 1.17 toe/capita. These values were almost similar to Jordan's indices, which was in the same situation as Lebanon, and they increased compared to the Tunisian values, where several energy efficiency programs had been implemented.

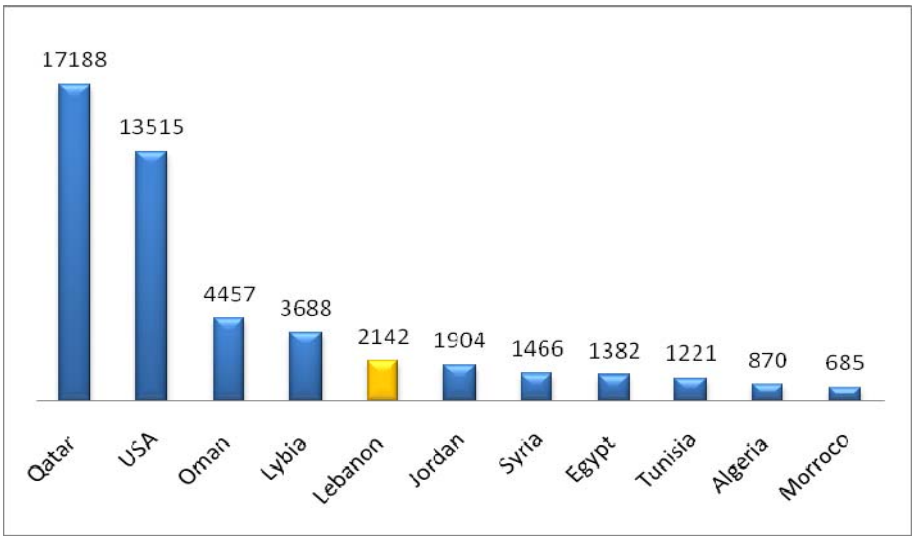


Energy Intensity TEPS/GDP Toe/Thousand USD 2000 PPP (2006)[74]



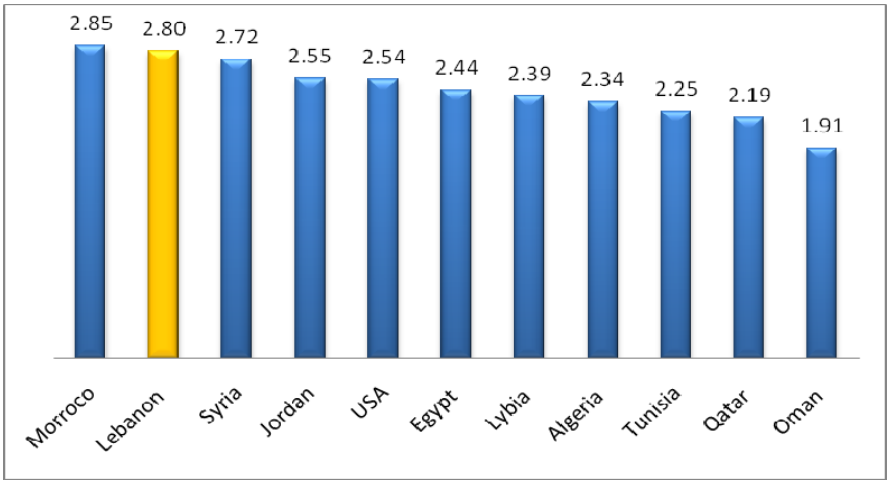
Primary Energy Supply per Capita TOE/Capita (2006)[75]

[73] www.almee.org.lb (state of energy in Lebanon report)
[74] Source: available data on www.iea.org



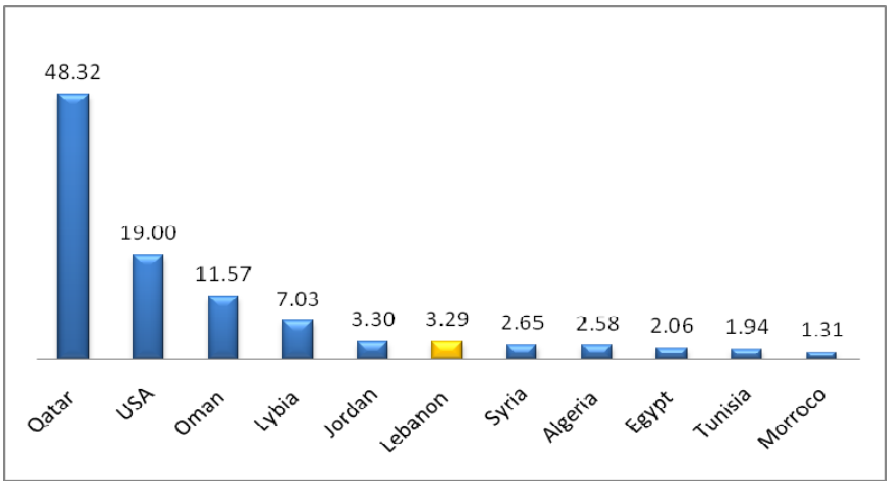
Electricity Consumption per Capita kWh/Capita (2006)[76]

Despite the fact that Lebanon and Jordan use fuel to produce electricity, Lebanon's CO2 value emitted per TEPS (2.8 tCO2/toe) was higher than Jordan's (2.55 tCO2). This value remained high in comparison with Tunisia (2.25 tCO2/toe) and Algeria (2.34 tCO2/toe) where natural gas is mainly used to produce electricity.



Electricity Consumption per Capita tCO2/toe (2006)[77]

[75] Source: available data on www.iea.org
[76] Source: available data on www.iea.org
[77] Source: available data on www.iea.org



Electricity Consumption per Capita tCO2/Capita (2006)[78]

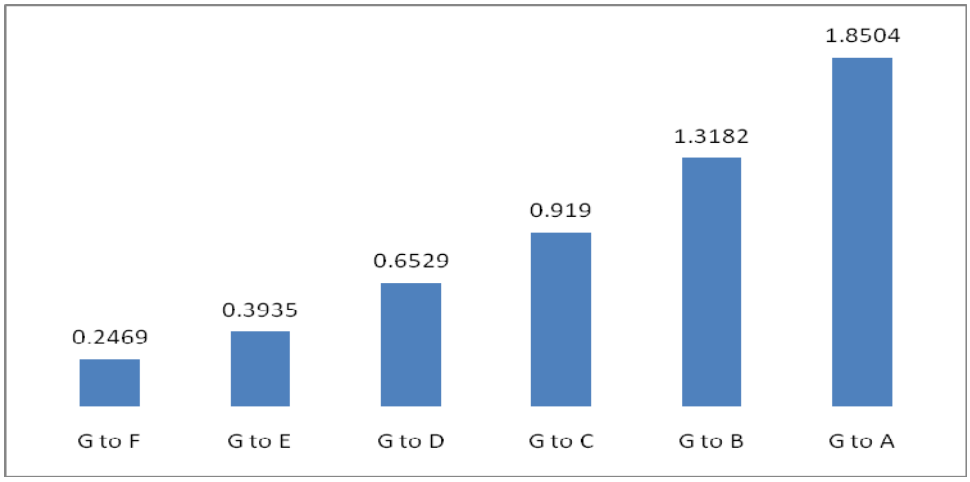
[78] Source: available data on www.iea.org

APPENDIX 3: LABELLING

The three label models cover refrigerators, split system air conditioners and compact fluorescent lamps. The refrigerator label was designed similarly to the Tunisian refrigerator label, which was adapted from the EU energy label. Currently, LCEC has defined six energy classes for refrigerators. Unfortunately, they are not being applied because the draft law, including refrigerator labelling, has not yet been approved. Furthermore, the implementation plan has not yet been well defined and no implementation methodology for the labelling program is in effect. Testing facilities for appliances do not exist as yet and must be operational before program execution. A strategy for labelling organization and incorporation with stakeholders and market players has not been established. Procedures for certification, approval and control must be defined and a dedicated team and a structure for program execution need to be established.

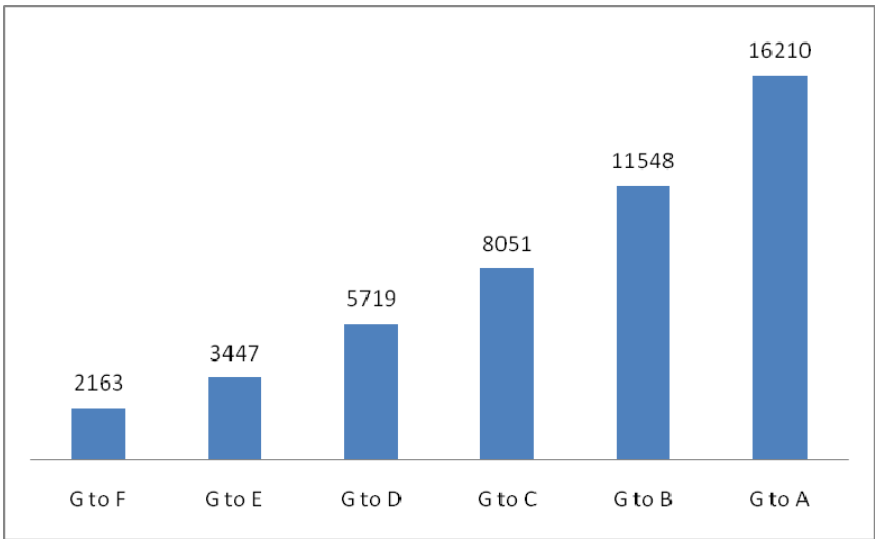
Forecast Impacts

The forecast load reduction and energy savings, in the case where 35,000 Class G refrigerators would be replaced by a higher class, are presented in the following two figures.



Forecast Load Reduction for the Labelling Project (MW)[79]

[79] Source : data of LCEC



Forecast Energy Savings for the Labelling Project (MWh)[80]

Identified Barriers

- The draft law that includes an article about the refrigerator labels has not yet been approved
- Lack of testing facilities needed to approve the appliances for labelling
- Lack of detailed program for implementation
- Lack of structure to ensure coordination between all stakeholders
- Lack of resources at LCEC for program development
- Lack of institutional setup and facilities for program implementation

[80] Source : data of LCEC

APPENDIX 4: OTHER EE ACTORS

Lebanese Standards Institution (LIBNOR)

LIBNOR[81] is a public institution attached to the Ministry of Industry. It was established by a law dated 23/7/1962 as the sole authority to issue, publish and amend Lebanese standards and to give the right to use the Lebanese Conformity Mark (NL Mark) that indicates the conformity of certified products and goods to national standards. LIBNOR has a key role in developing, through standardization, the quality of industrial products to be competitive on the domestic and international market and at the same time to protect consumers from unsafe products. LIBNOR aims to cooperate with international and regional standardization organizations and increase its participation in their activities, in order to highlight and reflect the needs and specificities of the Lebanese industry in terms of international and regional standards.

Association of Lebanese Industrialists (ALI)

ALI[82] is a Lebanese economic organization founded in 1943, grouping industrialists from all over Lebanon. ALI advocates a policy of balanced industrial development for all Lebanese regions. The Association seeks to create and maintain an environment which is favorable to industrial investment, growth and development. Considering that industries in Lebanon, except for cigarette manufacturing, are purely private, the Association's role becomes even more significant to promote EE and RE programs.

Industrial Research Institute IRI

IRI[83] is a Lebanon institution for studies, industrial research and scientific testing and analysis. IRI is a non-profit institution, declared as public utility by D/L No.10059. dated 17 August 1955, linked to the Ministry of Industry by Law No. 642/1997, with administrative and financial autonomy.

The possible role of this Institute will be to include testing facilities for all equipment related to standards and labelling and other related products which need certification and validation. The Institute has been involved in the thermal standards for new buildings and is keen to operate and take charge of the testing facilities.

Lebanon Producers

The main role of producers in the standards and labelling program is to have their appliances tested by an independent certified laboratory to verify their compliance to the standards. They have to submit a copy of the test report for verification. Once an appliance is certified, they have to apply an energy efficiency label on each appliance. This label will provide the appliance's performance and its

[81] http://www.libnor.org
[82] http://www.ali.org.lb/
[83] http://www.iri.org.lb/

category. Manufacturers will have to adapt to the rising demand for more efficient appliances by changing and improving their range of products on the market.

Lebanon Importers

This category includes all the stakeholders related to imports. The main role of importers in the standards and labelling program is to ensure that all imported appliances be tested by an independent laboratory which is certified by the Ministry of Energy and Water. A test report must be submitted for verification. All additional information about the imported appliances must hand out to facilitate their identification. Each appliance must include a label indicating the appliance's energy efficiency category. Importers will have to change their way of planning imports by incorporating an amount of time for foreign producers to have their appliances tested and certified.

Lebanon Distributors

This category includes all the stakeholders who sell appliances on the Lebanese market. Distributors have two main roles. They have to make sure the appliance label is well displayed and that the appliance data sheet is easily accessible to the consumers.

The role of the main key players is outlined in each EE program Action Plan.

APPENDIX 5: INDUSTRY SAVINGS AND INVESTMENT ASSESMENT

Industry EE Proposals										
		Investment	Reduced power	Savings			CDM		NPV(0%)	
Proposal	Program Period (PP)	$M	MW	$M/PP	$M/year	kTOE/year	KTCO2	$M	Without CDM	With CDM
EEM 1: Boiler Efficiency Improvement (combustion and insulation)	7	3.9		7.9	1.8	5.0	79.1	1.9	4.1	5.9
EEM 2: Heat Recovery systems	7	1.0		4.9	1.1	3.1	49	1.2	3.9	5.0
EEM 3: High Efficient Motors	7	6.1	3.6	17.9	4.6	4.5	65	1.5	11.7	13.3
EEM 4: Cogeneration - Exhaust Gas	7	2.1		9.3	2.2	5.8	92	2.2	7.1	9.3
EEM 5: Preheating Systems	7	0.4		1.1	0.2	0.7	10	0.2	0.7	0.9
EEM 6: Improvement of Lighting Systems	7	0.9	0.3	1.8	0.4	0.4	6	0.2	0.9	1.1
EEM 7: Solar Water Heaters	7	0.4		1.8	0.4	0.4	7	0.2	1.4	1.6
EEM 8: Improvement of Cooling Systems	7	8.1	10.9	59.5	13.9	13.6	216	5	51.4	56.5
EEM 9: Motors- PF Improvement	7	3.5	1.5	8.4	2.0	1.9	91	0.7	4.9	5.6
TOTAL	**7**	**27**	**16**	**113**	**27**	**35**	**615**	**13**	**86**	**99.2**

EEM 1: Boiler Efficiency Improvements (combustion and insulation)		2010	2011	2012	2013	2014	2015	2016	Total
Penetration rate	%	10%	20%	40%	60%	70%	80%	85%	7 years
Final energy savings	TOE	585	1,171	2,342	3,513	4,098	4,684	4,976	21,369
Investment per year	$M	0.46	0.46	0.91	0.91	0.46	0.46	0.23	3.9
Cumulative savings	TOE	585	1756	4098	7611	11709	16393	21369	
Primary energy savings	TOE	585	1171	2342	3513	4098	4684	4976	21,369
Savings	$M	0.22	0.43	0.87	1.30	1.52	1.74	1.85	8
TCO2 savings	TCO2	2166	4332	8665	12997	15163	17330	18413	79,067
TCO2 cumulative savings	TCO2	2,166	6,499	15,163	28,161	43,324	60,654	79,067	
Total CDM contribution	$M	0.02	0.1	0.1	0.2	0.3	0.5	0.6	2
Benefits without CDM contribution	$M	-0.24	-0.02	-0.04	0.39	1.07	1.28	1.62	
Benefits with CDM contribution	$M	-0.22	0.03	0.08	0.62	1.41	1.77	2.25	

NPV	4.1	
NPV with CDM contribution	5.9	
Savings	EDL/year	Client/year
GWh		
$ Million		1.85

EEM 2: Heat Recovery Systems		2010	2011	2012	2013	2014	2015	2016	Total
Penetration rate	%	10%	20%	40%	60%	70%	80%	85%	7 years
Final energy savings	TOE	361	721	1,442	2,163	2,524	2,884	3,064	13,159
Investment per year	$M	0.12	0.12	0.24	0.24	0.12	0.12	0.06	1.0
Cumulative savings	TOE	361	1082	2524	4687	7210	10095	13159	
Primary energy savings	TOE	361	721	1442	2163	2524	2884	3064	13,159
Savings	$M	0.13	0.27	0.54	0.80	0.94	1.07	1.14	5
TCO2 savings	TCO2	1334	2668	5336	8004	9337	10671	11338	48,688
TCO2 cumulative savings	TCO2	1,334	4,002	9,337	17,341	26,679	37,350	48,688	
Total CDM contribution	$M	0.0	0.0	0.1	0.1	0.2	0.3	0.4	1
Benefits without CDM contribution	$M	0.0	0.1	0.3	0.6	0.8	1.0	1.1	
Benefits with CDM contribution	$M	0.0	0.2	0.4	0.7	1.0	1.2	1.5	

NPV	3.9
NPV with CDM contribution	5.0

Savings	EDL/year	Client/year
GWh		
$ Million		1.14

EEM 3: High Efficiency Motors		2010	2011	2012	2013	2014	2015	2016	Total
Penetration rate	%	10%	20%	30%	40%	60%	70%	80%	7 years
Final energy savings	TOE	341	681	1,022	1,362	2,043	2,384	2,724	10,557
Investment per year	$M	0.20	0.40	0.59	0.79	1.19	1.39	1.58	6.1
Cumulative savings	TOE	341	1022	2043	3406	5449	7833	10557	
Primary energy savings	TOE	566	1131	1697	2263	3394	3960	4526	17,538
Electrical savings	$M	0.58	1.15	1.73	2.31	3.46	4.04	4.62	
Power savings	MW	0.45	0.90	1.36	1.81	2.71	3.17	3.62	
Power savings	$M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total savings	$M	0.58	1.15	1.73	2.31	3.46	4.04	4.62	17.88
TCO2 savings	TCO2	2093	4186	6280	8373	12559	14652	16746	64,889
TCO2 cumulative savings	TCO2	2,093	6,280	12,559	20,932	33,491	48,144	64,889	
Total CDM contribution	$M	0.0	0.1	0.1	0.2	0.3	0.4	0.5	2
Benefits without CDM contribution	$M	0.4	0.8	1.1	1.5	2.3	2.7	3.0	
Benefits with CDM contribution	$M	0.4	0.8	1.2	1.7	2.5	3.0	3.6	

NPV	11.7
NPV with CDM contribution	13.3

Savings	EDL/year	Client/year
GWh	10.2	31.7
$ Million	1.2	2.8

EEM 4: Cogeneration - exhaust gas		2010	2011	2012	2013	2014	2015	2016	Total
Penetration rate	%	10%	20%	40%	60%	70%	80%	85%	7 years
Final energy savings	TOE	411	822	1,643	2,465	2,876	3,287	3,492	14,996
Investment per year	$M	0.43	0.23	0.46	0.46	0.23	0.23	0.11	2.1
Cumulative savings	TOE	411	1233	2876	5341	8217	11504	14996	
Primary energy savings	TOE	682	1365	2730	4095	4777	5460	5801	24,911
Savings	$M	0.25	0.51	1.01	1.52	1.77	2.03	2.15	9
TCO2 savings	TCO2	2525	5050	10101	15151	17677	20202	21464	92,171
TCO2 cumulative savings	TCO2	2,525	7,576	17,677	32,828	50,505	70,706	92,171	
Total CDM contribution	$M	0.0	0.1	0.1	0.3	0.4	0.6	0.7	2
Benefits without CDM contribution	$M	-0.2	0.3	0.6	1.1	1.5	1.8	2.0	
Benefits with CDM contribution	$M	-0.2	0.3	0.7	1.3	2.0	2.4	2.8	

NPV	7.1
NPV with CDM contribution	9.3

Savings	EDL/year	Client/year
GWh		
$ Million		2.2

EEM 5: Preheating Systems		2010	2011	2012	2013	2014	2015	2016	Total
Penetration rate	%	10%	20%	40%	60%	70%	80%	85%	7 years
Final energy savings	TOE	78	155	311	466	544	621	660	2,834
Investment per year	$M	0.16	0.03	0.05	0.05	0.03	0.03	0.01	0.4
Cumulative savings	TOE	78	233	544	1009	1553	2174	2834	
Primary energy savings	TOE	78	155	311	466	544	621	660	2,834
Savings	$M	0.03	0.06	0.12	0.17	0.20	0.23	0.25	1.1
TCO2 savings	TCO2	287	575	1149	1724	2011	2298	2442	10,487
TCO2 cumulative savings	TCO2	287	862	2,011	3,735	5,746	8,045	10,487	
Total CDM contribution	$M	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2
Benefits without CDM contribution	$M	-0.1	0.0	0.1	0.1	0.2	0.2	0.2	
Benefits with CDM contribution	$M	-0.1	0.0	0.1	0.2	0.2	0.3	0.3	

NPV	0.7	
NPV with CDM contribution	0.9	

Savings	EDL/year	Client/year
GWh		
$ Million		0.25

EEM 6: Improvement of Lighting Systems		2010	2011	2012	2013	2014	2015	2016	Total
Penetration rate	%	20%	40%	50%	60%	70%	80%	85%	7 years
Final energy savings	TOE	52	104	129	155	181	207	220	1,048
Investment per year	$M	0.20	0.20	0.10	0.10	0.10	0.10	0.05	0.9
Cumulative savings	TOE	52	155	285	440	621	828	1048	
Primary energy savings	TOE	86	172	215	258	301	344	365	1,741
Electrical savings	$M	0.09	0.18	0.22	0.26	0.31	0.35	0.37	1.8
Power savings	MW	0.07	0.14	0.17	0.21	0.24	0.27	0.29	1.4
Power savings	$M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Total savings	$M	0.09	0.18	0.22	0.26	0.31	0.35	0.37	1.78
TCO2 savings	TCO2	318	636	795	955	1114	1273	1352	6,443
TCO2 cumulative savings	TCO2	318	955	1,750	2,704	3,818	5,091	6,443	
Total CDM contribution	$M	0.0025	0.0076	0.0140	0.0216	0.0305	0.0407	0.0515	0.17
Benefits without CDM contribution	$M	-0.1	0.0	0.1	0.2	0.2	0.2	0.3	
Benefits with CDM contribution	$M	-0.1	0.0	0.1	0.2	0.2	0.3	0.4	

NPV	0.9
NPV with CDM contribution	1.1

Savings	EDL/year	Client/year
GWh	0.8	2.6
$ Million	0.1	0.2

EEM 7: Solar Water Heaters		2010	2011	2012	2013	2014	2015	2016	Total
Penetration rate	%	10%	20%	40%	60%	70%	80%	85%	7 years
Final energy savings	TOE	30	59	119	178	207	237	252	1,081
Investment per year	$M	0.10	0.05	0.09	0.09	0.05	0.05	0.02	0.4
Cumulative savings	TOE	30	89	207	385	593	830	1081	
Primary energy savings	TOE	49	98	197	295	345	394	418	1,796
Savings	$M	0.05	0.10	0.20	0.30	0.35	0.40	0.43	1.8
TCO2 savings	TCO2	182	364	728	1093	1275	1457	1548	6,647
TCO2 cumulative savings	TCO2	182	546	1,275	2,367	3,642	5,099	6,647	
Total CDM contribution	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2
Benefits without CDM contribution	$M	-0.1	0.1	0.1	0.2	0.3	0.4	0.4	
Benefits with CDM contribution	$M	0.0	0.1	0.1	0.2	0.3	0.4	0.5	

NPV	1.4
NPV with CDM contribution	1.6

Savings	EDL/year	Client/year
GWh	0.9	2.9
$ Million	0.1	0.3

EEM 8: Improvement of Cooling Systems		2010	2011	2012	2013	2014	2015	2016	Total
Penetration rate	%	10%	20%	40%	60%	70%	80%	85%	7 years
Final energy savings	TOE	963	1,925	3,851	5,776	6,739	7,701	8,183	35,137
Installed thermal power	KW fg	3,195	6,391	12,781	19,172	22,367	25,562	27,160	
Investment per year	$M	0.96	0.96	1.92	1.92	0.96	0.96	0.48	8.1
Cumulative savings	TOE	963	2888	6739	12514	19253	26954	35137	
Primary energy savings	TOE	1599	3198	6397	9595	11194	12793	13593	58,368
Electrical savings	$M	1.63	3.26	6.52	9.78	11.42	13.05	13.86	60
Power savings	MW	1.28	2.56	5.11	7.67	8.95	10.22	10.86	47
Power savings	$M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total savings	$M	1.63	3.26	6.52	9.78	11.42	13.05	13.86	60
TCO2 savings	TCO2	5917	11834	23667	35501	41417	47334	50293	215,963
TCO2 cumulative savings	TCO2	5,917	17,750	41,417	76,918	118,336	165,670	215,963	
Total CDM contribution	$M	0.0	0.1	0.3	0.6	0.9	1.3	1.7	5
Benefits without CDM contribution	$M	0.7	2.3	4.6	7.9	10.5	12.1	13.4	
Benefits with CDM contribution	$M	0.7	2.4	4.9	8.5	11.4	13.4	15.1	

NPV	51.4
NPV with CDM contribution	56.5

Savings	EDL/year	Client/year
GWh	30.6	95.2
$ Million	3.7	8.3

EEM 9: Motors- PF Improvement		2010	2011	2012	2013	2014	2015	2016	Total
Penetration rate	%	10%	20%	40%	60%	70%	80%	85%	7 years
Final energy savings	TOE	136	272	545	817	954	1,090	1,158	4,972
Investment per year	$M	0.42	0.42	0.83	0.83	0.42	0.42	0.21	4
Cumulative savings	TOE	136	409	954	1771	2724	3814	4972	14,780
Primary energy savings	TOE	226	453	905	1358	1584	1810	1923	8,260
Electrical savings	$M	0.23	0.46	0.92	1.38	1.62	1.85	1.96	8
Power savings	MW	0.18	0.36	0.72	1.09	1.27	1.45	1.54	7
Power savings	$M	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Total savings	$M	0.23	0.46	0.92	1.38	1.62	1.85	1.96	8.42
TCO2 savings	TCO2	837	1675	3349	5024	5861	6698	7117	30,561
TCO2 cumulative savings	TCO2	837	2,512	5,861	10,885	16,746	23,444	30,561	90,845
Total CDM contribution	$M	0.0	0.0	0.0	0.1	0.1	0.2	0.2	1
Benefits without CDM contribution	$M	-0.2	0.0	0.1	0.6	1.2	1.4	1.8	
Benefits with CDM contribution	$M	-0.2	0.1	0.1	0.6	1.3	1.6	2.0	

NPV	4.9
NPV with CDM contribution	5.6

Savings	EDL/year	Client/year
GWh	4.3	13.5
$ Million	0.5	1.2

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