LEBANESE REPUBLIC
MINISTRY OF ENERGY AND WATER

THE SECOND NATIONAL ENERGY EFFICIENCY ACTION PLAN FOR THE REPUBLIC OF LEBANON

NEEAP 2016-2020

March 2016

LCEC
LEBANESE CENTER FOR ENERGY CONSERVATION
المركز اللبناني لحفظ الطاقة

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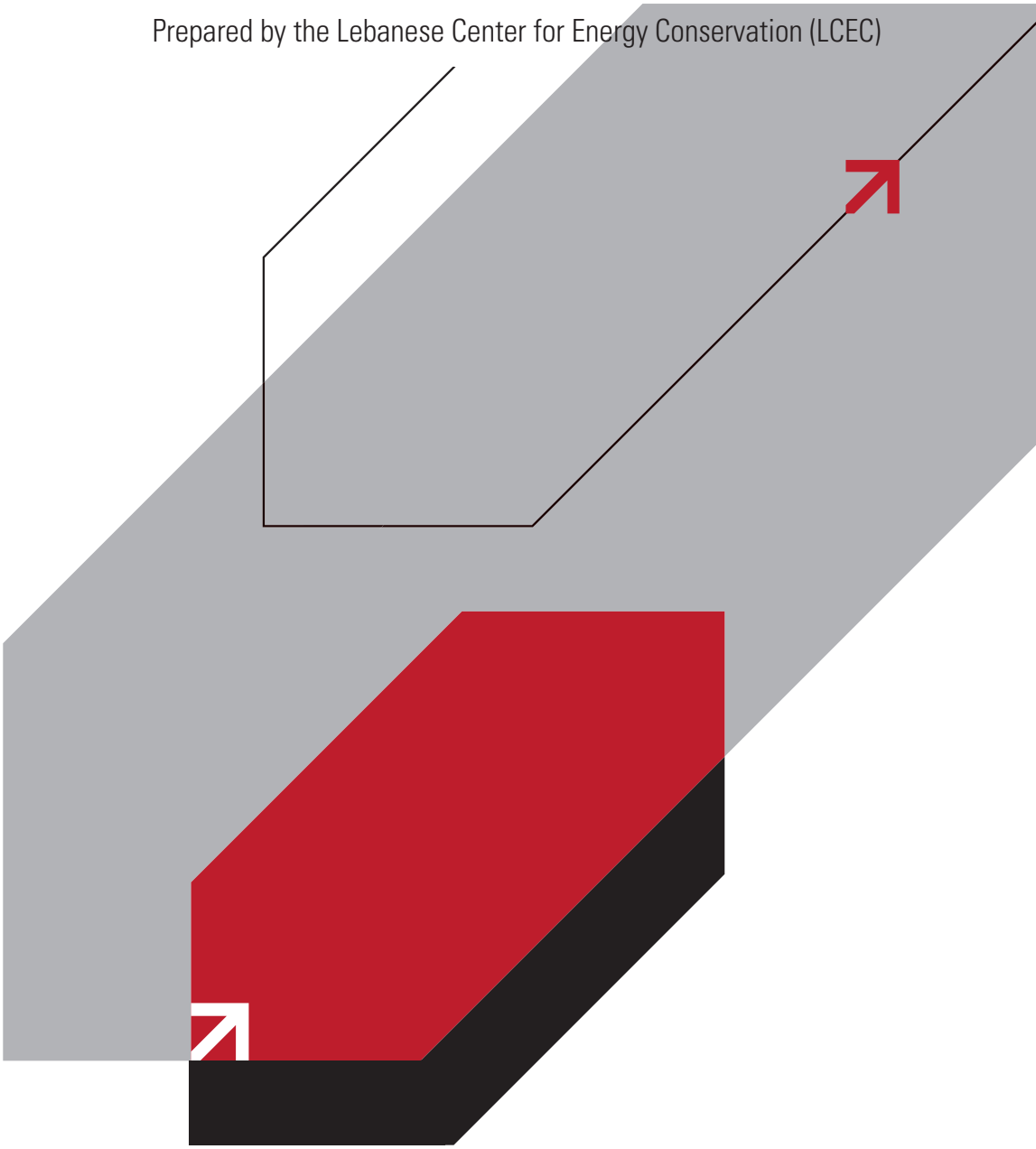
NEEAP 2016-2020

Prepared by the Lebanese Center for Energy Conservation (LCEC)



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Main Partners

Main Collaborators

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FOREWORD TO THE SECOND NEEAP FOR THE REPUBLIC OF LEBANON

Republic of Lebanon, Ministry of Energy and Water, The Minister

The energy efficiency market is growing at a steady pace in Lebanon. Tangible achievements have characterized this young market, and enormous efforts have been invested to actually reduce energy demand through energy efficiency measures. The year 2010 has definitely left its mark on this sector, being the year during which the first National Energy Efficiency Action Plan (NEEAP) for Lebanon was developed.

While the first NEEAP covered the period 2011-2015, this current NEEAP covers another five years from 2016 to 2020. Both documents have one thing in common: they are both built according to the guidelines of the European Union and the League of Arab States, making them solid references to initiate new projects and initiatives with our friends in the international community.

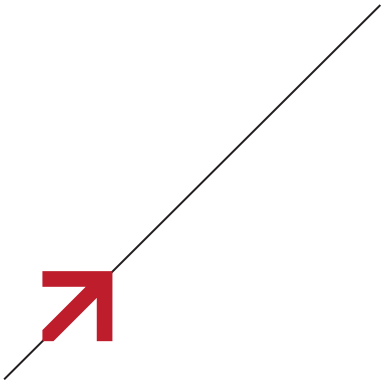
It is also a real pleasure to see that many of the initiatives mentioned in the first NEEAP have turned into actual projects. Yet, the real pride lies in the fact that the planning done in 2010 is now being reviewed and updated. This actual NEEAP 2016-2020 summarizes all the lessons learnt from the previous one, builds on the successes achieved, and proposes new tools to avoid the obstacles and bottlenecks.

It is true that the sustainable energy market in Lebanon faces uncertainties and challenges, but it is also true that this market offers huge opportunities for development. I personally believe that the implementation of the second NEEAP will represent not only a national platform for the development of energy efficiency in the country, but will also be the starting point for future projects in this vital and vibrant sector.

We should all focus on the fact that what our countries need most is an alignment of efforts between the public and private sectors. The Ministry of Energy and Water has invested a lot of efforts in order to develop the sustainable energy sector in Lebanon, and specifically energy efficiency measures. This second NEEAP is a call to the international community and friends of Lebanon to support making it a reality.

As this market is growing rapidly, our future decisions and actions should be based on more solid technical ground. I would like to thank all those who contributed in a positive way to making this second NEEAP a reality. The Ministry of Energy and Water looks forward to the fruitful implementation of the NEEAP, hoping that these actions would eventually lead to a prosperous and sustainable future for our country.

Arthur Nazarian
Minister of Energy and Water



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Contributors, Partners, and Support

The current version of the Second National Energy Efficiency Action Plan 2016-2020 (NEEAP) for the Republic of Lebanon is the result of many reviews and inputs by a large number of participants, including more than 100 national, regional, and international experts and consultants. The Lebanese Center for Energy Conservation (LCEC) is keen to thank all those who contributed to the development of this national document. The LCEC is thankful mostly to the Minister of Energy and Water H.E. Mr. Arthur Nazarian for all his support and encouragement.

This document couldn't have been achieved without the support of many partners and collaborators. In this regard, the LCEC would like to thank the EU-funded MED-ENEC project for its continuous support to the development of energy efficiency in Lebanon. LCEC is also keen to thank the Energy Department at the League of Arab States (LAS) and the Regional Center for Renewable Energy and Energy Efficiency (RCREEE) for their support and valuable advice.

The efforts of all our national partners are highly appreciated, especially the management and engineering teams at the national electric utility Electricité du Liban (EDL). EDL has a major role to play in the development of energy efficiency in the country.

The joint efforts of all the other national players have been a great support to LCEC, namely the Prime Minister's Office, the Ministry of Foreign Affairs, the Ministry of Industry, the Ministry of Environment, the Central Bank of Lebanon, the Order of Engineers and Architects in Beirut, the Industrial Research Institute, and LIBNOR. LCEC would also like to thank the UNDP CEDRO project for the continuous support in this sector. The role of universities and national NGO's is also crucial in the preparation of this document.

Special thanks to the European Union (EU) for all the support offered through the different initiatives and projects, namely MED-ENEC, MED-DESIRE, TAIEX program, and SISSAF.

LCEC team | March 2016 | Beirut, Lebanon

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LIST OF SYMBOLS & UNITS

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AC	Air Conditioner
AFD	Agence Française de Développement
CAS	Central Administration of Statistics
CoM	Council of Ministers
BdL	Central Bank of Lebanon
BU	Bottom-Up
CFL	Compact Fluorescent Lamp
EC	European Commission
EIB	European Investment Bank
EDL	Electricité du Liban
EPC	Energy Performance Contract
ESCO	Energy Services Companies
EU	European Union
GDP	Gross Domestic Product
GHG	Greenhouse Gases
IEA	International Energy Agency
IRI	Industrial Research Institute
IPMV	International Performance Measurement and Verification (IPMV) protocol
kWh_{FE}	Kilowatt hour Final Energy
LAS	League of Arab States
LBP	Lebanese Pound
LCEC	Lebanese Center for Energy Conservation
LED	Light Emitting Diode
LG	Liquid Gas

LIST OF SYMBOLS

LIBNOR	Lebanese Standards Institution
LPG	Liquid Petroleum Gas
MED-ENEC	Euro- Mediterranean Project on Energy Efficiency
MEPS	Minimum Energy Performance Standards
MoE	Ministry of Environment
MEW	Ministry of Energy and water
MoF	Ministry of Finance
MPW&T	Ministry of Public work and transport
NAMA	Nationally Appropriate Mitigation Action
NEEAP	National Energy Efficiency Action Plan
NEEREA	National Energy Efficiency and Renewable Energy Action
PC	Personal Computer
PV	Photovoltaic
P.S.	Private sector
SEAP	Sustainable Energy Action Plan
SME	Small and Medium Enterprise
SWH	Solar Water Heater
TD	Top-Down
TV	Television
UNDP	United Nations Development Program
USD	United States Dollars

LIST OF UNITS

A	Ampere
BTU	British Thermal Unit
G	Giga (1,000,000,000)
J	Joule
k	Kilo (1,000)
K	Kelvin
M	Mega (1,000,000)
t	Tonnes
T	Tera (1,000,000,000,000)
teCO2	Tonne of CO2 equivalent
toe	Tonne of oil equivalent

LIST OF UNITS

V	Volt
VA	Volt-Ampere
VAR	Volt-Ampere Reactive
W	Watt
Wh	Watthour

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INTRO/BACKGROUND

What is Lebanon's NEEAP?

The National Energy Efficiency Action Plan (NEEAP) is a national document that summarizes all the national efforts that are taking place in Lebanon and sets the road map to be followed by the country towards reaching its objectives in energy efficiency. The first National Energy Efficiency Action Plan (NEEAP) for Lebanon was developed in 2011 for the period 2011-2015. This current document presents the second NEEAP of Lebanon for the period 2016-2020.

The current NEEAP (2016-2020) includes a number of energy efficiency initiatives targeting the different sectors of the Lebanese economy. These initiatives are distributed along two major axes dedicated to primary energy savings and end-use measures. While the primary energy saving measures are in the generation, transmission, and distribution sectors of the Lebanese power network, the section on end-use measures deals with energy saving measures in the following major sectors: buildings; industry, SMEs, agriculture; mobility and transport; and public services and facilities. In addition, the section on end-use measures includes a crucial part on horizontal measures which have a cross-sectorial impact on the economy.

The NEEAP 2016-2020 is developed according to the format used by the European Union (EU). Accordingly, the NEEAP starts by the national baseline to be used as a reference against which actual savings are to be measured. The document also presents the national objectives to be reached by 2020, and the optimal way to be followed to reach these objectives. The importance of this document is that it sets the path towards the development of energy efficiency for years to come. The Second NEEAP also includes all the major players involved in the application of the different measures, including a budget estimate for the application of these measures.

The current document is developed by the Lebanese Center for Energy Conservation (LCEC) with the support and comments of many reviewers. LCEC has made its utmost efforts to have a comprehensive document that could be used as a reference document for the energy efficiency sector in Lebanon. LCEC is keen to keep updating this document as progress is made in the future.

All comments and suggestions are welcome at the following email address: energy@lcecp.org.lb

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THE VISION OF THE REPUBLIC OF LEBANON

CHAPTER 1 **THE VISION OF THE REPUBLIC OF LEBANON**

NATIONAL POLITICAL CONTEXT SURROUNDING THE SECOND NEEAP

Since 2009, the Lebanese Government has shown full support to the development of energy efficiency measures in Lebanon. This commitment by the Lebanese Government, and more specifically by the Ministry of Energy and Water, has increased over the years. Today, the Ministry of Energy and Water is more than ever dedicated to the development and application of energy efficiency measures in the country.

On 21 June 2010, the Lebanese Government adopted the Policy Paper for the Electricity Sector as a national strategy for Lebanon. The Policy Paper included ten initiatives, among which three initiatives were dedicated to energy efficiency and renewable energy. Based on the contents of the Policy Paper, the LCEC developed the first National Energy Efficiency Action Plan for Lebanon for the period 2011-2015. The Lebanese Government adopted the first NEEAP on 10 November 2011. The Ministry of Energy and Water is hereby adopting the second NEEAP for the Republic of Lebanon for the period 2016-2020 (NEEAP 2016-2020). The Ministry of Energy and Water is fully dedicated to implement this second NEEAP through the work of the Lebanese Center for Energy Conservation (LCEC).

This dedication will be translated in the investment of all needed efforts to transform all the proposed measures and instruments of the second NEEAP into realities. The commitment of the Ministry of Energy and Water to the implementation of this second NEEAP comes

from its strong belief that energy efficiency is a main key to successful energy policies in the future. In fact, energy efficiency could make a large contribution in the supply of affordable energy to companies and private consumers, while at the same time lowering the negative environmental impact of the Lebanese energy sector.

Lebanon's energy efficiency policy and strategy, developed in this document, are fully dynamic, updated on an ongoing basis and adapted to meet the latest challenges and opportunities both on a local and global scale.

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BACKGROUND & BASELINE

CHAPTER 2 **BACKGROUND AND BASELINE**

CURRENT GENERAL FRAMEWORK FOR INCREASING ENERGY EFFICIENCY

2.1 The 2010 Policy Paper for the Electricity Sector in Lebanon

In Lebanon, the average available production capacity in 2009 (including imports) was 1,500 MW while the average demand was around 2,000-2,100 MW. The instantaneous peak demand in the summer of 2009 was estimated at 2,450 MW. The total energy demand in 2009 was 15,000 GWh although the total produced energy (including imports) was 11,522 GWh. Thus, the electric energy deficit in Lebanon can be estimated at around 3,478 GWh.

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

To overcome all these problems, the Ministry of Energy and Water (MEW) of Lebanon developed a comprehensive energy policy (the Policy Paper for the Electricity Sector) that was approved by the Council of Ministers (CoM) on 21 June 2010. This policy paper establishes an overall structure for the energy sector in Lebanon. The Policy Paper includes ten initiatives, three of which are dedicated to energy efficiency and renewable energy.

In terms of conventional supply, the Policy Paper includes solutions for the identified problems in the electricity sector (generation, transmission, and distribution). At the generation side, the target is to reach "a total installed capacity of 4,000 MW by 2014 and 5,000 MW thereafter to meet a load of 2,500 MW (summer 2009), 500 MW of demand not currently supplied (i.e. self-generation), future demand corresponding to an annual load growth of 7%, and around 15% of peak load reserve". As per the Policy Paper, the proposed measures cost around 4,513 to 4,739 Million USD. The purpose of this current document is not conventional energy production, however this current NEEAP will be using the commitment of the Lebanese Government set in the Policy Paper as a baseline to calculate the planned savings in energy efficiency.

In other terms, in this current NEEAP, it is clearly assumed that the Lebanese Government will be implementing the initiatives of the Policy Paper in terms of conventional energy.

In this current NEEAP, it is clearly assumed that the annual load growth is 7%. It is also clearly assumed that the Lebanese Government will apply the Policy Paper in terms of conventional electricity production. All these assumptions will actually form the baseline against which the potential energy saving measures are to be compared.

IN FOCUS

THE POLICY PAPER FOR THE ELECTRICITY SECTOR

The Council of Ministers of Lebanon approved the Policy Paper for the Electricity Sector on 21 June 2010. The Policy Paper includes ten initiatives: infrastructure (generation, transmission, distribution); supply and demand (fuel sourcing, renewable energy, demand side management/ energy efficiency, tariffs); and legal framework (norms and standards, corporatization of EDL, legal status).


Policy Paper
for the Electricity Sector

Gebran Bassil
Ministry of Energy and Water

June 2010

At the transmission and distribution levels, the Policy Paper sets targets to reduce technical losses, to ensure adequate connections, and to complete and improve the systems infrastructure. The overall infrastructure improvement costs around 5,770 to 6,005 Million USD. The cost includes a three-phase strategy (short-term, mid-term and long-term targets).

Among many set objectives, the Policy Paper "commits to launching, supporting and reinforcing all public, private and individual initiatives to adopt the utilization of renewable energies to reach 12% of electric and thermal supply". The Policy Paper also commits to "control the energy demand growth in order to save a minimum of 5% of the total demand" (1). As mentioned earlier, three initiatives of the Policy Paper deal with energy efficiency and renewable energy. In terms of energy efficiency, the Policy Paper covers three main areas:

- The use of solar water heaters, compact fluorescent lamps, and energy efficient street lighting;
- The creation of a financing mechanism entitled NEEREA (National Energy Efficiency and Renewable Energy Action);
- The adoption of the Energy Conservation Law and the institutionalization of LCEC

The energy efficiency and renewable energy initiatives of the Policy Paper are the main milestones around which the first NEEAP of Lebanon was developed. It is worth noting that the first NEEAP included both energy efficiency and renewable energy measures. The next section will present Lebanon's NEEAP 2011-2015.

2.2 First National Energy Efficiency Action Plan for Lebanon- NEEAP 2011-2015 (2)

The first NEEAP for Lebanon was adopted by the Council of Ministers of Lebanon on 10 November 2011 (Decision No 26). It includes fourteen initiatives that tackle energy efficiency and renewable energy. The NEEAP 2011-2015 was prepared in conformance with the Arab Energy Efficiency guideline (based on the EU directive 2006/32/EC on energy end-use efficiency and energy service) and Lebanon was the first Arab country to officially adopt such plan. The initiatives are correlated and cross sectorial.

The 14 initiatives of the NEEAP are the following:

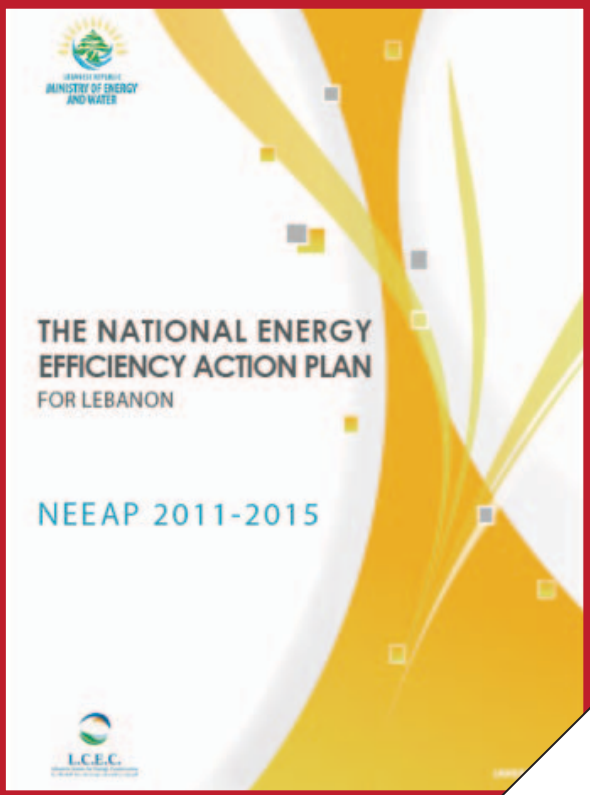
- Initiative 1: Towards Banning the Import of Incandescent Lamps to Lebanon;
- Initiative 2: Adoption of the Energy Conservation Law and Institutionalization of the Lebanese Center for Energy Conservation (LCEC) as the National Agency for Lebanon;
- Initiative 3: Promotion of Decentralized Power Generation by PV and Wind Applications in the Residential and Commercial Sectors;
- Initiative 4: Solar Water Heaters for Buildings and Institutions;
- Initiative 5: Design and implementation of a national strategy for efficient and economic public street Lighting in Lebanon;
- Initiative 6: Electricity Generation from Wind Power;
- Initiative 7: Electricity Generation from Solar Energy;

- Initiative 8: Hydro Power for Electricity Generation;
- Initiative 9: Geothermal, Waste to Energy, and Other Technologies;
- Initiative 10: Building Code for Lebanon;
- Initiative 11: Financing Mechanisms and Incentives;
- Initiative 12: Awareness and Capacity Building;
- Initiative 13: Paving the Way for Energy Audit and ESCO Business;
- Initiative 14: Promotion of Energy Efficient Equipment.

THE FIRST NEEAP 2011-2015 FOR THE REPUBLIC OF LEBANON

NEEAP 2011-2015 for Lebanon was adopted by the Council of Ministers on 10 November 2011.

It is the first officially adopted NEEAP in the Arab World.



IN FOCUS

As mentioned earlier, the NEEAP 2011-2015 is developed in accordance with the measures of the Policy Paper. During the period 2011-2015, the Ministry of Energy and Water, through the Lebanese Center for Energy Conservation (LCEC), invested all efforts to implement the fourteen initiatives of the NEEAP. While many initiatives have been actually implemented, the implementation of other initiatives witnessed some delays or obstacles. The implementation of the first NEEAP was evaluated in November 2014 in collaboration with the EU-funded MED-ENEC project.

Each of the 14 initiatives was evaluated individually to get a view on how much has been implemented over the past years. While the NEEAP 2011-2015 defines a number of "Milestones and Proposed Steps" for each of the 14 initiatives, only the most relevant milestones were used in the evaluation as indicators on the level of achievement of the initiative.

Each milestone was translated into a quantifiable target. In many cases, the milestones set in NEEAP 2011-2015 were of qualitative nature (e.g. "conduct a market survey") in which they were translated into quantifiable percentages of completion (0% to reflect "not reached"; 50% to reflect "partly completed"; and 100% to reflect "completely achieved"). With quantitative targets, the level of completion could be measured directly. Based on the target and the status quo, the percentage of completion was calculated. For instance, if the objective of measure is conduct 4 trainings, while actually only 3 took place, then a 75% completion is reported. This percentage is the ratio of achievement to target. Multiplied with the weighting factors of the milestone, the total score of each initiative was calculated. The results of the evaluation are shown below.

The evaluation exercise of the first NEEAP identified many gaps. For instance, a specifically defined overall target regarding energy efficiency was missing. This is not only relevant for completeness but can help monitoring the initiatives. Some measures are correlated, so progress is attributed to both measures, making evaluation difficult and incorrect. It is also worth noting that the first NEEAP included measures for energy efficiency and renewable energy.

Based on the evaluation exercise completed for the first NEEAP 2011-2015, the second NEEAP which is detailed in this current document takes into account the difficulties faced in the evaluation of the first one. Mainly, the current NEEAP 2016-2020 includes only measures regarding energy efficiency. Renewable energy measures will be detailed in a separate document called the National Renewable Energy Action Plan (NREAP) for Lebanon.

TABLE 1: RESULTS OF THE EVALUATION OF NEEAP 2011-2015		
Initiative	**Description**	**Percentage of completion**
1	Towards banning the import of incandescent lamps to Lebanon	45%
2	Adoption of Energy Conservation Law and institutionalization of LCEC as the energy agency	40%
3	Promotion of decentralized power generation by PV and wind applications	30%
4	Solar water heaters for buildings and institutions	53%
5	Design/Implementation of National Strategy for Efficient and Economic Public Street Lighting	60%
6	Electricity generation from wind power	23%
7	Electricity generation from solar energy	42%
8	Hydro power for electricity generation	34%
9	Geothermal, waste to energy, and other technologies	30%
10	Building code for Lebanon	0%
11	Financing mechanisms and incentives	80%
12	Awareness and capacity building	69%
13	Paving the way for energy audit and ESCO business	20%
14	Promotion of energy efficient equipment	8%

It is the NREAP document that will include several scenarios in achieving the set target of 12% of renewable energy by 2020. In addition, one of the main identified gaps in the NEEAP 2011-2015 was the lack of a clear baseline. This issue is the first to be tackled in the NEEAP 2016-2020: the next section describes the baseline calculations for the NEEAP 2016-2020.

2.3 Baseline for NEEAP 2016-2020

2.3.1 Energy imports and trends

Lebanon relies essentially on oil importations as its main resource for energy production. An analysis of the oil imports to the country including amounts, flows, shares and trends is a major step to be able to set a clear baseline. At this stage, it is important to note that the next analysis is based on many data sources and analysis done by the LCEC team. LCEC considers all data presented in this sub-section as the closest to reality. LCEC is keen to tune this data whenever new data facts emerge.

The country's primary energy imports cover essentially the following types of oil products:

- Liquid Gas;
- Gasoline;
- Gas Oil;
- Fuel Oil;
- Kerosene;
- Asphalt.

Figure 1 Flow of oil products in the Lebanese Market

Oil consumption could be divided into two main consumers, Electricité du Liban (EDL) and the local market. Figure 1 explains the flow of the oil products into the Lebanese market.

A considerable share of the fuel oil imported by MEW goes to EDL, while another minor quantity goes to the local market (mainly used in industries). As for liquid gas, gasoline, kerosene and asphalt, their destination is the local market.

Figure 2 shows the evolution of the import of all oil products between 2001 and 2014 (measured in tonnes of oil and in tonnes of oil equivalent (toe)). While the curve in this figure shows an expected increasing trend, the sudden decrease in 2006 is due to the effects of the 2006 war.

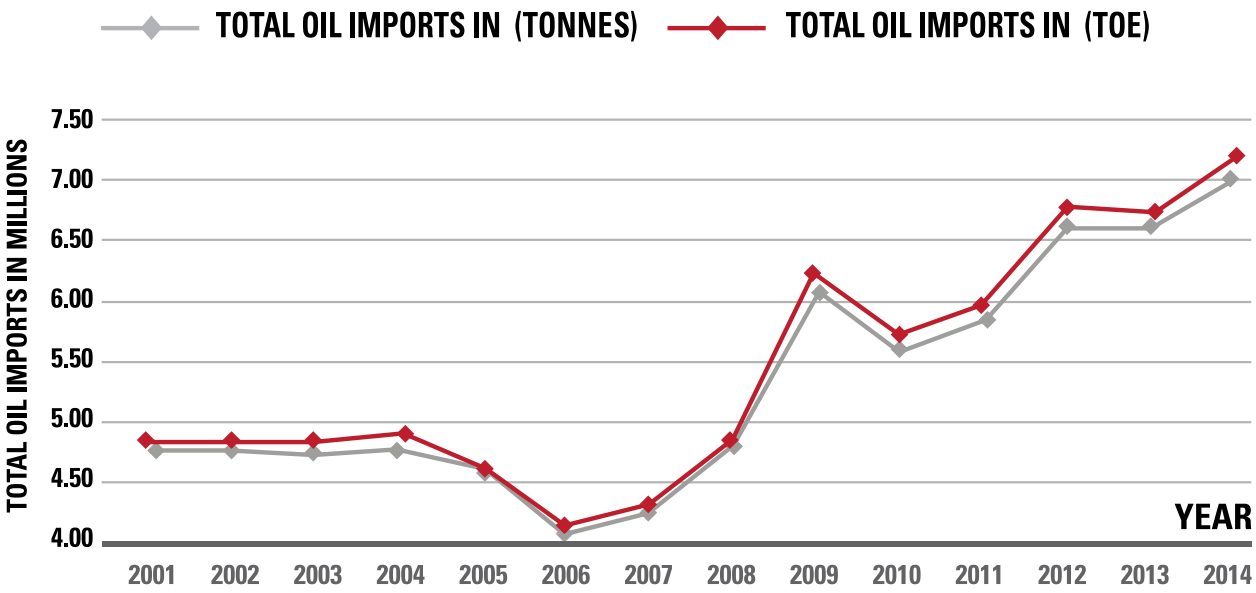


Figure 2 Total oil imports between 2001 and 2014

Figure 3 shows the yearly distribution of oil imports as measured in toe. From this graph, it can be clearly seen that the major shares are gasoline, gas oil, and fuel oil. The large quantity of gasoline is due to the large number of vehicles in Lebanon using this type of fuel. On the other hand, fuel oil and gas oil are the essential sources of the major power plants of the country.

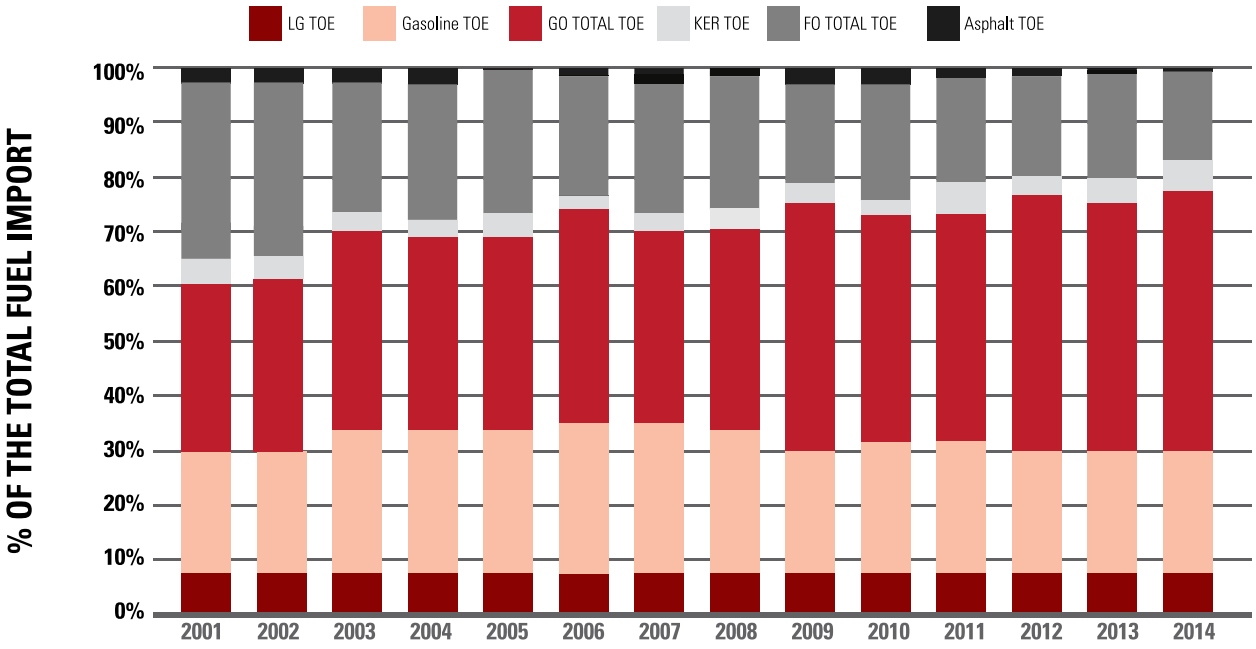


Figure 3 Shares of oil products imported between years 2001 and 2014

Picture 01 EDL has a major role to play in the development of energy efficiency

2.3.2 The baseline

The second NEEAP for the Republic of Lebanon takes the year 2010 as the base year. The choice of this year depends on the oil trends shown above and is done according to recommendations of the League of Arab States (LAS) for both the NEEAP and NREAP. During the base year, the total fuel imports amount to 5,768,269.94 toe consumed in the different sectors in Lebanon.

Other than the oil imports, the baseline includes all types of primary energy consumed in Lebanon. Accordingly, both electricity imports and the hydroelectric generation are to be included in the baseline. In 2010, imports from both Syria and Egypt amount to 1,248,871 MWh, whereas hydroelectricity produced by the different hydro power plants on the Lebanese territory amounts to 836,537 MWh. The International Energy Agency (IEA) conversion factors are used in the analysis (1 MWh of electricity is equivalent to 0.086 toe). For all hydroelectric power plants, a national conversion factor was calculated based on the fact that in 2010 the total amount of fuel used for thermal electricity generation (both by EDL and the private generators) was 2,982,295 toe generating 13,790,126 MWh of electricity. This leads to a conversion factor of 0.21626 toe/MWh or ktoe/GWh. Accordingly, the primary energy baseline for 2010 in Lebanon can be summarized as shown in Figure 4 (3).

As per Figure 4, the total consumption in 2010 amounts to 6,069,301 toe, out of which 96.8% were imported from outside Lebanon and the remaining (3.2%) were locally produced.

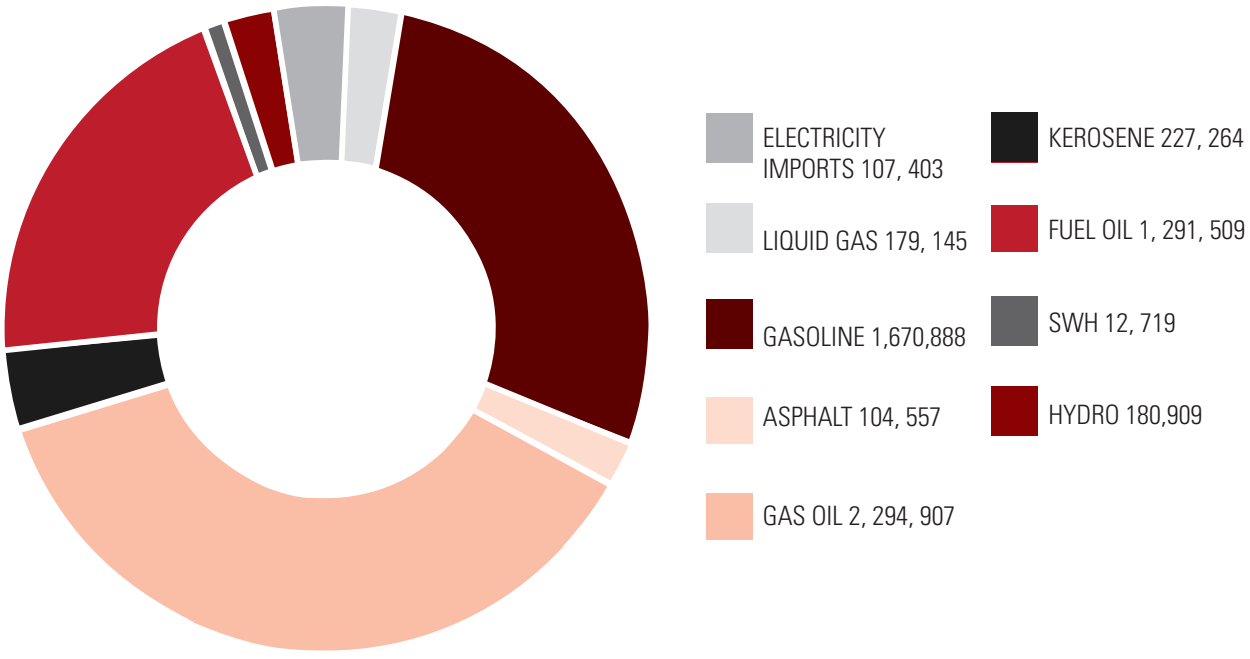


Figure 4 Primary Energy Mix in 2010 in Lebanon (toe)

2.3.3 Shares of the different sectors in the baseline

In order to calculate the shares of the different sectors of the Lebanese economy in terms of energy uses, it is important to note that the final use of some oil products such as gasoline, kerosene and asphalt is essentially for the transport sector. Other products like liquid gas are essentially used in the building sector for cooking or heating. Moreover, the data from MEW shows the quantities of gas oil and fuel oil that were consumed by EDL for electricity generation.

Furthermore, it is considered in the scope of this study (based on discussions with the representatives of the Ministry of Industry and other experts), that most of the fuel oil that is dedicated to the local market is actually consumed in the industrial sector.

Figure 5 below shows the quantities of energy (in toe) consumed in 2010 in each of the corresponding sectors of the economy. It is crucial to note that the main complication relies in the fact that imported gas oil is essentially used for heating purposes, private electricity generation and for transportation in diesel vehicles. At this stage, all these three sub-sectors are grouped as part of the category "Other".

The heating share was calculated based on the assumption that one third of the Lebanese households (as per (4)) use liquid gas cylinders for heating, and that the average consumption for heating is four 20 kg cylinders per year. This leads to 25,600 tonnes of liquid gas consumed yearly for heating in Lebanon. The remaining share of the total imported liquid gas is assumed to be used for cooking.

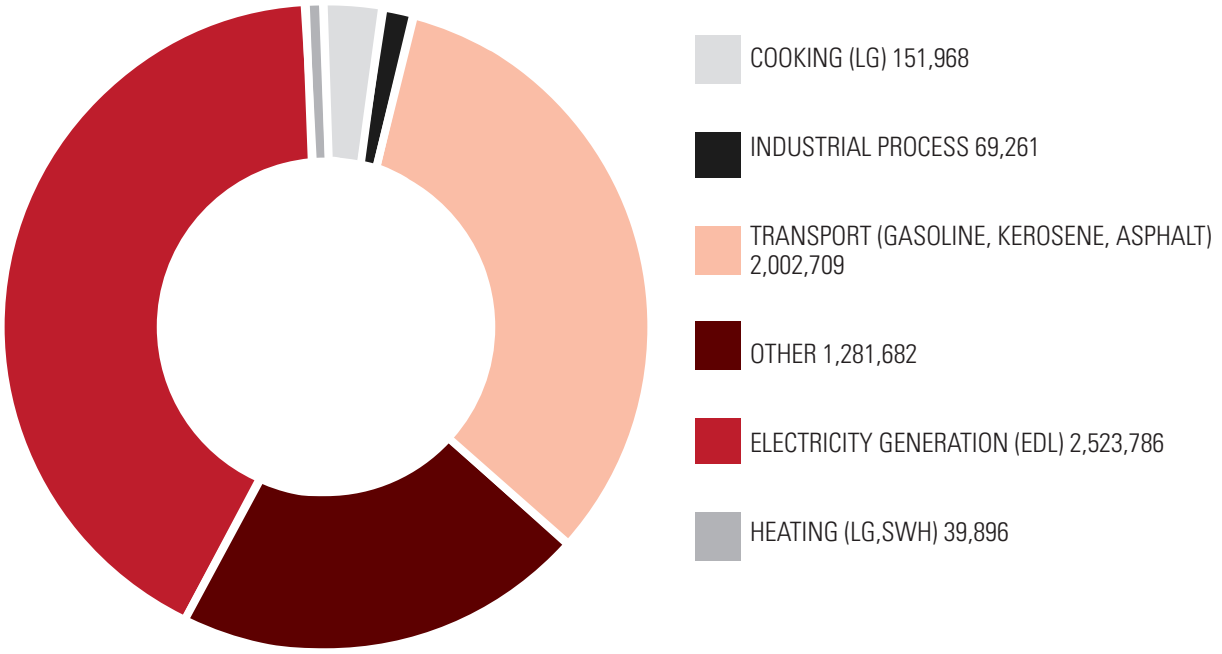


Figure 5 Distribution of the primary energy consumed in 2010 (toe)

In terms of percentages, and as shown in figure 6, the largest shares of consumption are for electricity generation and transportation.

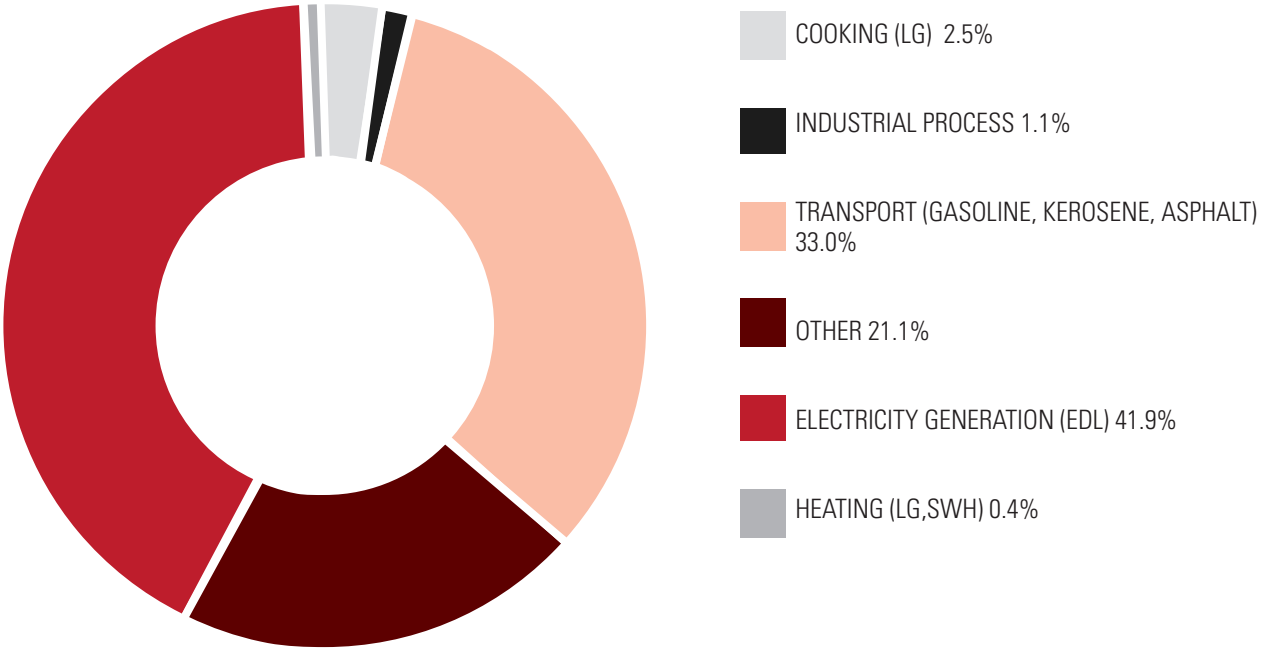


Figure 6 Percentages of the primary energy consumed (2010)

A set of assumptions are taken into consideration to explore even more the energy data of Lebanon:

- For three consecutive years (2009, 2010, and 2011), the Lebanese Government subsidized the prices of gas oil (usually dyed in red) used for heating purposes. This reduction was of 22.5 billion Lebanese Pounds (LBP) based on a 150 LBP reduction per liter of gas oil. The density of gas oil varies depending on the countries' specifications. Based on the EU directives 1998/69/EC and 1999/96/EC, this value varies between 833 and 837 kg/m^3, and accordingly, an average value of 835 kg/m^3 is considered. As a conclusion, it is estimated that in 2010, around 125,250 tonnes of gas oil were used for heating purposes;
- Green gas oil is used essentially for transportation purposes in diesel cars;
- The remaining quantity of red dyed gas oil is used for electricity generation in the private generators distributed in the country.

All these information lead to the following chart in figure 7 where finally electricity generation accounts for 53.9% of the total oil imports, transportation for 39.7%, heating for 2.8%, cooking for 2.5 % and industry consumes directly 1.1%.

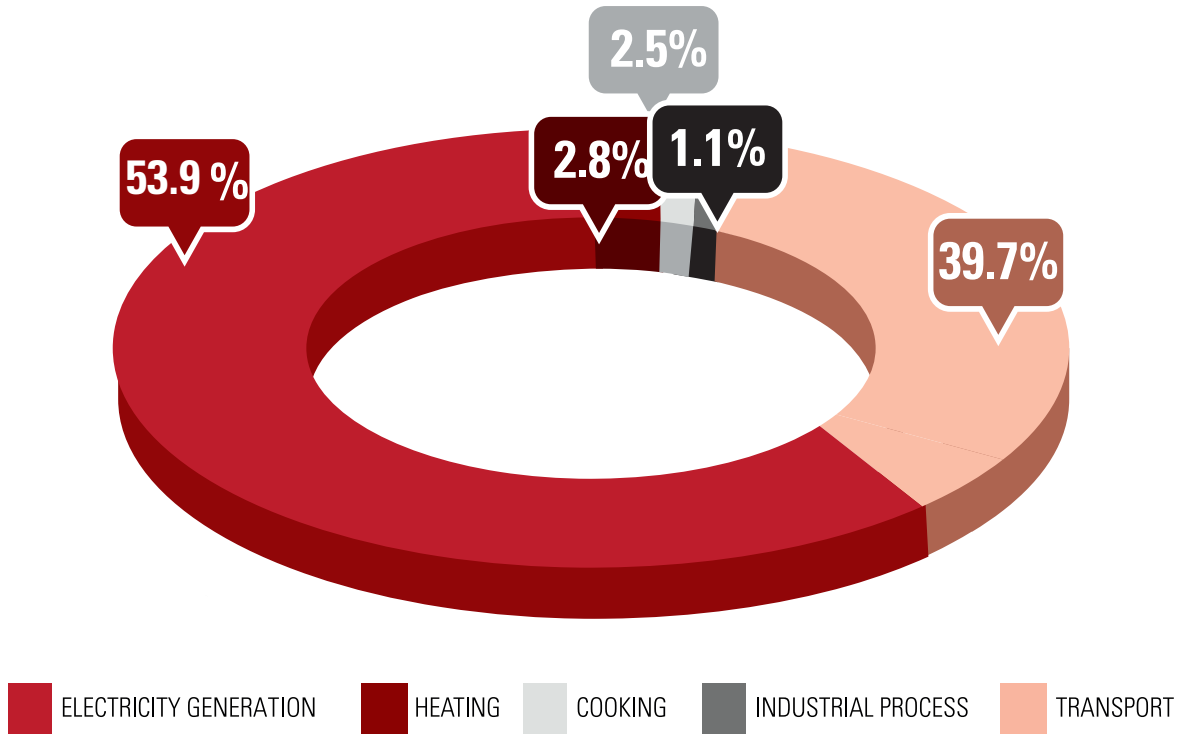


Figure 7 Approximated sectorial consumption of primary energy (2010)

MORE DETAILS ON THE SECTORIAL CONSUMPTION OF PRIMARY ENERGY 2010

To confirm the results of the previous chart, a comparative analysis on the quantity of gas oil that was considered for private generation of electricity in 2010 could be useful. The quantity of gas oil is assumed to be 732,862 tonnes or 877,679,042 liters based on a density of 0.835 kg/l. Based on a generic efficiency of diesel generators of 3.33 kWh/l, the consumed quantity of diesel would have generated 2,950 GWh from private electricity generation.

On the other hand, the total electricity generation by EDL in 2010 is around 12,089 GWh and the estimated demand was around 15,934 GWh, meaning that the electricity deficit is around 3,845 GWh. This deficit is partially covered by electricity generated from private sector generators (2,950 GWh), meaning that private generators are satisfying 77% of the blackouts. This percentage is based on the following:

- The load of the capital Beirut is around 450 MW;
- 3 hours of blackouts in Beirut are rarely covered by private generators;
- Not all of EDL subscribers are connected to private generators;
- Some private generators are turned off during the late night periods of blackouts.

IN FOCUS

The baseline being set, the following chapters will present the NEEAP as per the European Directives and Arab guidelines.

03

TARGETS & STRATEGIES

CHAPTER 3 **TARGETS AND STRATEGIES**

STRATEGIES FOR THE ACHIEVEMENT OF THE INDICATIVE ENERGY SAVINGS TARGETS

3.1 Key indicators

As per the "Arab Guideline for Improving Electricity Efficiency and Rationalizing its Consumption at the End Use", a NEEAP should include a number of key indicators to be detailed in the coming paragraphs. These indicators are detailed for the baseline year 2010 and the target year 2020. (5)

As defined by the Arab Guidelines, the key indicators should be referenced as shown below.

In the Lebanese case, the **target year 2020**, is chosen in harmony with the Lebanese government commitment.

Electric power intensity is calculated as an indicator of the quantity of electricity required to generate one unit of GDP. It is the gross annual electricity generation (15,039 GWh in 2010) divided over the GDP (as per the World Bank estimation of 38 billion USD in 2010). The electric power intensity for 2010 is therefore calculated as 0.396 GWh/GDP MUSD. Lebanon's low energy intensity can be explained by its diversified and low energy consumption industries and service-oriented economy.

As per the World Bank definition, "**Gross Domestic Product** GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products". It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. In this document, and per the World Bank, GDP in current USD for Lebanon in 2014 is around 47.73 billion USD whereas it was around 38 billion USD in 2010. (6)

The amount of **gross electricity generated** (in GWh) is the electricity generated by public or private power plants to feed the transmission and distribution grids, and for the power plants' own consumption. Regarding the Lebanese case, the gross electricity generated, detailed in the baseline section, is around 15,039 GWh.

Imported electric energy refers to the electric energy imported by EDL from Egypt and Syria or other countries as a result of the Pan-Arab interconnection grid and any possible future agreements. Imported electric energy amounted to 1,249 GWh in 2010 as per EDL (800 GWh imported from Syria and 449 GWh from Egypt).

Exported electric energy refers to the electric energy exported by EDL to other countries as a result of the Pan-Arab interconnection grid and any possible future agreements. No electricity is currently being exported from Lebanon.

Demand for electric power is at a constant growth in developing countries as a result of economic growth and population increase. Changes in the growth rate for demand for electric energy could indicate changes in the electricity consumption patterns of the country as a result of economic instability, energy efficiency or introduction of new energy sources. As per the Policy Paper of the Electricity Sector (1), the average growth rate is reported to be 7%.

Primary energy consumption at the national level, as calculated in the baseline section, is 6,069.031 ktoe. **The share of electric power in primary energy consumption** calculated also in the baseline section accounts for 53.9% in 2010.

The share of electricity consumption by sector in 2010 is estimated at 40% for the residential sector, 29% in the industrial sector, 18% in the tertiary and 13% in agriculture and fishing sectors. These shares would be adjusted once further information is available from EDL. (7)

The cost of producing one kWh is calculated as the total cost of generation by EDL (including operation and maintenance) in USD divided by the total electricity generation by EDL in kWh. The cost of producing one kWh in 2010 is 0.202 USD.

The **electrification rate** in Lebanon is the percentage of households with access to electricity. It is 100% in Lebanon in 2010. This indicator may decrease in relation to the access of refugee agglomerations to EDL electricity.

Based on the above, the table below shows the main key indicators for the baseline year 2010. In the next section, the national targets for 2020 will be presented. At this stage, it is crucial to note that LCEC will be conducting in 2016 a full review of the implemented energy efficiency measures between 2010 and 2015. This analysis will allow to have real values of an intermediate year (2015) between the baseline year 2010 and the target year 2020. Adding 2015 as an intermediate year would help in verifying the electric energy consumption and growth rate trends and in adjusting the national target for year 2020.

TABLE 2: KEY INDICATORS FOR THE BASELINE YEAR 2010			
N°	**Indicator**	**Unit**	**2010**
1	Electric power intensity	GWh/GDP (MUSD)	0.396
2	Gross Annual electricity Generation	GWh	15,039
3	Imported electric power	GWh	1,249
4	Exported electric power	GWh	0
5	Projected growth rate for demand for electric power	%	7%
6	Primary energy consumption at the national level	Mtoe	6.069
7	Share of electric power of primary energy consumption	%	53.9
8	The marginal cost of producing one kWh	USD/kWh	0.202
9	Electrification rate	%	100

3.2 National target

The best way to set a national target in the NEEAP is to identify the best way of monitoring the savings that could be achieved at the end of NEEAP's implementation period. The European Commission identified two different and complementary methodologies for evaluating the savings: the bottom-up (BU) approach and the top-down (TD) approach.

On one hand, the BU relies on the IPMV (International Protocol for Monitoring and Verification) principles, assesses the energy savings for each individual implementation, and sums them to cover the total number of measures covered by the policy/programme. Considering the difficulty and the cost of data gathering, some assumptions and simplifications are used. In case of major difficulties in collecting required data, default values could be used. Default values mean standard values in kWh/year for each individual implementation, based on studies (monitoring, surveys, market surveys, etc.).

On the other hand, the TD method relies on indicators (e.g. kWh/GDP), that are derived mostly from national statistical data. It uses existing statistical data and is easier to implement than BU method. The TD method includes all the policies covering the sector/equipment, and autonomous effects (e.g. technologies improvements not stimulated by specific policies) and structural effects (e.g. changes in activity, such as energy intensive industry moving out of one country) (8).

The Lebanese case shows clear lacks and/or updates in data regarding energy consumption in all sectors. This is a main constraint for using the TD approach. Besides, using the BU

approach pushes the data gathering forward which is a required action in the Lebanese case. In fact, each measure/initiative cited in this NEEAP includes a crucial milestone which is data gathering, allowing the foundation of an accurate database to prepare the third NEEAP in 2020.

Accordingly, the national target for 2020 will be actually the sum of all the potential savings in the different sectors of the economy. The energy efficient measures of the different sectors with their associated savings are detailed in the following chapter. It is noted that in case of lack of data, previous studies and assumptions were used to estimate the savings.

The sum of the overall estimated savings of the proposed measures over the 5 years of the second NEEAP's implementation are around 686.1 GWh for primary energy (including electricity generation, transmission and distribution) and 828.1 GWh for end-use energy (including building, industrial and public sectors). That would imply total savings of 1,514.2 GWh over the 5 years leading to average yearly savings of 302.9 GWh.

As reported earlier, the year 2010 is the baseline year. As per EDL, the electric energy demand in 2010 was estimated at 15,934 GWh, and the growth rate for demand for electric power is 7%. Then the expected demand in 2020 would be around 31,344 GWh. The total savings achieved by this NEEAP 2016-2020 constitutes around 4.83% of the total Lebanese electric power demand in 2020.

Considering the yearly growth (GWh) in the electric power and subtracting 302.9 GWh/year then dividing by the yearly demand, the new growth rate is then yearly calculated. The new growth rate varies between 5.64% (year 2016) and 5.96% (year 2020). An average value of the new growth rate in the electric power of 5.81% will be used in this document. The NEEAP 2016-2020 leads then to reducing the actual electric power growth rate by around 17%. Table 3 shows some of the projected key indicators in the year 2020 based on the new growth rate of 5.81% as a result of the NEEAP 2016-2020 implementation.

The projected GDP in 2020 is 71.7 billion USD in 2020 as per the International Monetary Fund's World Economic Outlook (WEO) Database, April 2015 edition.

TABLE 3: KEY INDICATORS FOR THE BASELINE YEAR 2010 AND THE TARGET YEAR 2020

N°	Indicator	Unit	2010	2020
1	Electric power intensity	GWh/GDP (MUSD)	0.396	N.A.
2	Gross annual electricity Generation	GWh	15,039	N.A.
3	Imported electric power	GWh	1,249	N.A.
4	Exported electric power	GWh	0	N.A.
5	Projected growth rate for demand for electric power	%	7%	5.81%
6	Primary energy consumption at the national level	Mtoe	6.069	N.A [1]
7	Share of electric power of primary energy consumption	%	53.9	N.A.
8	The marginal cost of producing one kWh	%	0.202	N.A.
9	Electrification rate	%	100	100

1

1 It is impossible to estimate especially that no effective measure was considered for the transport sector

04

SPECIFIC POLICY MEASURES FOR ENERGY EFFICIENCY

CHAPTER 4 **SPECIFIC POLICY MEASURES FOR ENERGY EFFICIENCY**

PRIMARY ENERGY SAVING MEASURES AND END-USE MEASURES

4.1 Structure harmonization with the European and Arab directives

As it is mentioned earlier, the Lebanese NEEAP 2011-2015 included 14 initiatives related to both energy efficiency and renewable energy. A comparison of the Lebanese NEEAP 2011-2015 with the European template for developing NEEAP and NREAP shows that out of the 14 initiatives of the Lebanese NEEAP, 7 measures relate to European NREAP, while 4 measures relate to European NEEAP.

In addition, the comparison shows that many measures recommended by the EU directives are not mentioned in the first NEEAP 2011-2015. These include measures related to primary energy savings and the industrial sector savings. In the EU NEEAP template, primary energy savings are treated separately from end-use ones; accordingly, the NEEAP 2016-2020 is divided into two chapters.

Moreover, the NEEAP 2016-2020 includes different types of measures regarding policies, regulations, action plans and implementation. Each measure is written in a tabulated form followed by a section explaining the savings calculation methodology. The tabulated form includes the measure's aim; its description; its estimated savings; input, output, and outcome indicators; funds for completion; and next steps.

The mentioned structure is also in accordance with the Arab guidelines for NEEAP as proposed by the League of Arab States (LAS). The "Arab Guideline for Improving Electricity Efficiency and Rationalizing its Consumption at the End-User" takes into consideration the economic viability of the proposed measures through using indicative targets and appropriate frameworks (financial, legal and institutional).

The guideline recommends tackling energy efficiency at the generation, transmission, distribution and end-use levels. It enforces the role of the public sector which is supposed to be exemplary. The guideline also solicits information availability and energy audit studies that should be accomplished by specialized ESCOs. Laws and regulations implementations are cited in article XIII as a must for enforcing energy efficiency measures.

In fact, the Arab guideline, which resonates with the EU directives, focuses on the following key points that are actually included in the Lebanese NEEAP 2016-2020:

- Definition of an overall target for the NEEAP and potential savings (GWh/year);
- Definition of the energy efficiency savings by sector;
- Cost analysis for each measure;
- Methodology of implementation;
- Methodology of monitoring;
- Definition of quantifiable, specific, achievable and time-bounded targets

All the above items shaped the development of the Lebanese NEEAP 2016-2020 as it is presented in the following sections. Section 4.2 here below will be detailing primary energy saving measures in the generation, transmission, and distribution sectors.

4.2 Measures for energy savings in the power sector

This section deals with energy saving measures at the primary energy sector and in particular the electricity sector in Lebanon. The proposed measures are based on the recommendations of the Policy Paper for the Electricity Sector. The most achievable measures were chosen and detailed. The calculation methodology in this section is based on the numbers of the Policy Paper regarding energy savings and implementation costs. This section includes five energy saving measures divided among three sub-sections: generation, transmission, and distribution.

The five measures presented in this chapter are heavily dependent on the implementation of the Policy Paper. It is worth noting that further analysis and details are needed to clarify all the aspects of these measures.

4.2.1 Energy saving measures in the generation side

The current NEEAP includes one energy saving measure in the generation side. The mentioned measure is in harmony with the measure proposed in the Policy Paper regarding the subject of upgrading Open-Cycle Gas Turbines (OCGT) to Combined-Cycle Gas Turbines (CCGT).

P 01	UPGRADING OCGT TO CCGT		
Description of the Measure	This measure aims at transforming the Open-Cycle Gas Turbine (OCGT) power plants into Combined-Cycle Gas Turbine (CCGT) power plants in Sour and Baalbeck.		
Type of measure	Implementation		
Sector	Power Sector		
Target Group	EDL generation sector: Baalbek and Tyr power plants		
Implementing Bodies	EDL, as per the Policy Paper for the Electricity Sector		
Start Date	2016	**End Date**	2020
Current Status and Plan for Implementation			
Gas Turbines are the most used technology in power plants all over the world. OCGT plants consist of a single compressor/ gas turbine that is connected to an electricity generator via a shaft. They are used to meet peak-load demand and offer moderate electrical efficiency of around 35%. CCGT plants have the same basic components as the OCGT plants but the heat from the gas turbine exhaust is used in a heat recovery steam generator (HRSG) to produce steam that drives a steam turbine and generates additional electric power. The CCGT electrical efficiency is estimated at around 50%. Further studies estimate that such efficiency will reach more than 64% in the near future. Moreover, CCGT plants offer a more flexible operation. They are designed to respond relatively quickly to changes in electricity demand and may be operated at 50% of the nominal capacity with a moderate reduction of electrical efficiency (50-52% at 50% load compared to 58–59% at full load). (9) Baalbeck and Tyr power plants were commissioned in 1996 and include two 35 MW OCGT each. In 2010, as per EDL, Baalbeck and Tyr power plants consumed 71,041 and 78,303 tonnes of Gas Oil respectively, to produce 237,050 and 248,171 MWh of net electricity at efficiencies of 28.5 % and 27 % and have relatively high CO2 emission factors (tCO2e/ MWh) of 0.901 and 0.948 respectively. The aim of this measure is to transform both power plants to CCGT power plants, therefore increasing their respective efficiencies to more than 45.4%, the efficiency of the typical CCGT plants in Lebanon (Dair Ammar (Beddawi) and Zahrani).			
Set Targets and Estimated Impact on Energy Saving			
N/A			
Yearly	72,738,150 kWh/year	**Altogether (2016-2020)**	254,583,525 kWh (considering 1.5 year for implementation)
Calculation Methodology	Such a measure will allow both power plants to produce more energy at lower costs, savings can be calculated using around 15% electrical output amelioration. Therefore, an amelioration of the efficiencies of Baalbeck and Tyr power plants would lead to an additional electricity production (savings) of 254,583,525 kWh.		
Data Needs/ Availability	- Yearly load demand curve - Electricity generation by both Baalbeck and Tyr power plants - Fuel consumption by both Baalbeck and Tyr power plants		

Monitoring Method/ Savings Measurement	- Input indicator(s): Fuel consumption per MWh generation - Outcome indicator(s): Additional electricity production of the power plants for the same fuel input due to the increase in efficiency
Monitoring/ Verification	- EDL to produce regular production and demand reports. - LCEC in charge of keeping track of all electricity indicators from EDL.
Next Steps After 2020	
Funding	
130 Million USD	Covered through the budget allocated to implement the Policy Paper for the Electricity Sector (1).

4.2.2 Energy Saving Measures in the Transmission Side

The section covers two measures proposed for the transmission network of EDL. While the first measure deals with the increase of the efficiency of transformers owned and operated by EDL in the transmission network, the second measure is about correcting power factor in order to reduce the reactive power of the system. The two measures are presented below.

P 02	**INCREASE OF THE EFFICIENCY OF EDL TRANSFORMERS**		
Description of the Measure	This measure aims at increasing the efficiency of all the transformers owned by EDL.		
Type of measure	Implementation		
Sector	Power Sector		
Target Group	EDL transmission sector		
Implementing Bodies	EDL, as per the Policy Paper for the Electricity Sector		
Start Date	2016	**End Date**	2020
Current Status and Plan for Implementation			
Step-up and step-down transformers are major components of the transmission sector. These components have usually high efficiencies (larger than 95%), however, new technologies showed that using high quality magnetic material and selected insulating substances and an ameliorated design allowing for a better cooling down, efficiency can be raised to around 99%. Moreover, lack of maintenance can affect these components drastically inducing high losses. This measure will focus on ameliorating the maintenance of transformers thus sustaining their efficiency at high levels all along while retrofitting old transformers by high efficiency new ones. (10)			

P 02	INCREASE OF THE EFFICIENCY OF EDL TRANSFORMERS		
Set Targets and Estimated Impact on Energy Saving			
N/A			
Yearly	5,397,912 kWh/year	**Altogether (2016-2020)**	18,892,692 kWh considering 1.5 years for implementation)
Calculation Methodology	It is very difficult to estimate the energy savings for such a measure, however we will only consider that only a 0.5% amelioration of the efficiency of the transformers is possible. Combining this assumption with the fact that the estimated total demand on the installed transformers by EDL is 1,540.5 MVA, we set the target for this measure to ameliorate the efficiency of 10% of all the transformers (a minimum of 11 transformers out of 115 transformers) including both maintenance and retrofitting.		
Data Needs/ Availability	- Yearly load on installed transformers (published on EDL website, timeline not clear) - Characteristics of the transformers (year of installation, old and new)		
Monitoring Method/ Savings Measurement	- Input indicator(s): Number of transformers and their corresponding year of installation, capacity, demand, no load and full load losses, and efficiency - Outcome indicator(s): Energy savings and resulting GHG emission savings achieved through the upgrade and maintenance of the transformers		
Monitoring/ Verification	- EDL to produce regular load and efficiency data of the installed transformers - LCEC in charge of keeping track of all electricity indicators from EDL		
Next Steps After 2020			
Funding			
20 Million USD	Covered through the budget allocated to implement the Policy Paper for the Electricity Sector.		

P 03	REDUCTION OF SYSTEM REACTIVE POWER		
Description of the Measure	This measure aims at implementing a power factor correction plan in order to "free" more "sellable" MVA capacity at the EDL power generation stations and to reduce the MVA load on the transmission and distribution grid points.		
Type of measure	Implementation		
Sector	Power Sector		
Target Group	EDL transmission sector		
Implementing Bodies	EDL		
Start Date	2016	**End Date**	2020

Current Status and Plan for Implementation			
In electrical networks, the power factor of an AC electrical power system is defined as the ratio of the real power flowing to the load to the apparent power in the circuit, and is a dimensionless number in the closed interval of -1 to 1. Adding power factor correction (in strategic locations) beyond what is strictly needed to meet the applicable reliability requirement of the grid has the potential to reduce transmission and distribution losses. High voltage reactive power compensation and harmonic filtering products help to improve performance of end user's installations through energy savings and better power quality (10).			
Set Targets and Estimated Impact on Energy Saving			
N/A			
Yearly	13,494,780 kWh/ year	**Altogether (2016-2020)**	47,231,730 kWh (considering 1.5 year for implementation)
Calculation Methodology	The demand on the transmission to distribution transformation points was estimated by EDL as being 1,540.5 MVA. Considering an amelioration of 1% of the power factor at this level, in case of 10% of this load will be reflected as 13,494,780 kWh/year savings.		
Data Needs/ Availability	-Data on reactive power on EDL transmission grid -Data on existing reactive power compensation on EDL transmission grid		
Monitoring Method/ Savings Measurement	Coordinate with EDL to identify hot spots for reactive power compensation and estimation of its savings. - Input indicator(s): Transmission grid power factor, type and location of power factor correction -Outcome indicator(s): Energy savings and resulting GHG emission savings achieved through the compensation of reactive power		
Monitoring/ Verification	- EDL to produce regular data on reactive power - LCEC in charge of keeping track of all electricity indicators from EDL		
Next Steps After 2020			
Funding			
500,000 USD	An estimation of the costs of the full study and analysis of the system. Funding not available		
22 Million USD	A rough estimation to be detailed in further documents. Funding not available		

4.2.3 Energy saving measures in the distribution side

The last two measures in this chapter deal with the electricity distribution sector. Whereas the first measure proposes changing the voltage level of the distribution system, the second measure covers automatic meter reading (AMR), leading to actual Demand Side Management (DSM) techniques.

P 04	MODIFICATION OF THE VOLTAGE LEVEL AT THE DISTRIBUTION SYSTEM		
Description of the Measure	This measure aims at changing the voltages used at the distribution level from both 11 kV and 15 kV to 20 kV.		
Type of measure	Implementation		
Sector	Power Sector		
Target Group	EDL transmission sector		
Implementing Bodies	EDL, Private Service Providers		
Start Date	2016	**End Date**	2020
Current Status and Plan for Implementation			
Currently, EDL's 20 kV distribution network only includes Downtown Beirut, Jounieh, and Beit El Dine, while the voltage levels for the rest of this network varies between either 11 kV or 15 kV. EDL has been planning to switch some of its substations to 20 kV and has already included the necessary components (dual rated voltage) to guarantee a smooth switch. This measure is seen as a key step in reducing the technical losses on the grid. The aim of this measure is to change the voltage level of 10 substations (equivalent to 30 MVA each) from 11 kV (5 substations) and 15 kV (5 substations) to 20 kV.			
Set Targets and Estimated Impact on Energy Saving			
N/A			
Yearly	104,408,250 kWh/year	**Altogether (2016-2020)**	365,428,875 kWh (considering 1.5 years for implementation)
Calculation Methodology	As a result of this measure, losses in these 10 substations would be reduced as follows: - In the case of the 15 kV substations the current will become I_20kV=I_15kV*15⁄20; hence the losses will become losses _20kV= losses _15kV* ((15)⁄20) ^2, leading to reduction of losses by a factor of 43.75%. Based on the international standard of 7% losses in distribution networks, the loss reduction for each of the substations would be around 919 kVA equivalent to 8,050,440 kWh/year. - Same calculation for the 11 kV substations shows a loss reduction by 69.75% equivalent to 1,464.75 kVA or 12,831,210 kWh/year		
Data Needs/ Availability	Detailed data on the pilot project of Beit El Dine substation		
Monitoring Method/ Savings Measurement	- Input indicator(s): Losses in the distribution grid - Output indicator(s): kWh/kVA consumed in each substation - Outcome indicator(s): Energy savings on the distribution grid; GHG emission savings		
Monitoring/ Verification	- EDL to produce regular data on technical and non-technical losses - LCEC in charge of keeping track of all electricity indicators from EDL		
Next Steps After 2020			
Funding			
1 Million USD	Based on the approximated budget indicated by the pilot project of Beit El Dine substation. Covered through the budget allocated to implement the Policy Paper for the Electricity Sector.		

P 05	INSTALLATION OF AUTOMATED METER READING (AMR)		
Description of the Measure	This measure aims at installing 22,000 Automatic Meter Reading (AMR)		
Type of measure	Implementation		
Sector	Power Sector		
Target Group	EDL Distribution sector		
Implementing Bodies	EDL, Private Service Providers		
Start Date	2016	**End Date**	2020
Current Status and Plan for Implementation			
Automatic Meter Reading or AMR allows consumers and utilities to have real time readings of the energy consumption allowing the consumers to adapt their electricity consumption and the utility to dispatch non-efficient power plants. Their installation will allow the estimation of all Demand Side Management (DSM) initiatives all along with possibilities for multiple tariff implementation.			
Set Targets and Estimated Impact on Energy Saving			
The estimated impact is related to the user behavior and to the load correction. Accurate readings and decreasing the commercial losses is the main impact of an AMR system. AMR system is a step towards smart grids where measurement and monitoring of the consumption at the distribution level are feasible.			
Yearly	N/A	**Altogether (2016-2020)**	N/A
Calculation Methodology	There is no direct impact for the installation of AMR on energy efficiency, however they will allow LCEC to estimate the impact of its DSM measures in reality. Moreover, it can serve as an awareness utensil allowing the consumers themselves to monitor their own consumption, especially if combined with a multiple tariff scheme.		
Data Needs/ Availability	- Individual energy consumption (real time) - Number and location of installed AMR		
Monitoring Method/ Savings Measurement	- Input indicator(s): Estimation of previous energy consumption - Outcome indicator(s): Energy consumption per type of consumers, hourly demand curves per type of consumers, hourly demand curves per region …		
Monitoring/ Verification	- EDL to produce regular data from the installed AMR - LCEC in charge of keeping track of all electricity indicators from EDL		
Next Steps After 2020			
Funding			
300 Million USD	A rough estimation to be detailed in further documents. To be covered as part of the Policy Paper for the Electricity Sector.		

05

HORIZONTAL END-USE MEASURES

CHAPTER 5 **HORIZONTAL END-USE MEASURES**

MEASURES WITH CROSS-SECTORIAL IMPACT

Whereas the previous chapter deals with measures proposed in the electricity supply side, this chapter details the possible measures and savings in the end-use sectors. End-use refers to the energy content of electricity and other fuels at the point of use by customers. This part is divided into five sections each dealing with a specific sector. The first section describes horizontal measures that are cross-sectorial and can be applied at different levels. The other four sections define the measures that can be applied in the building, industrial, transport and public sectors.

Besides the measure description, each section describes the calculation methodology used in estimating the savings along with the assumptions taken in case of lack of data. The major constraint that is faced during the development of this NEEAP for Lebanon is the lack of data. In fact, data collection is cited nearly in each measure. At its achievement, the second NEEAP will lead to having a baseline for each sector allowing then the development of the third NEEAP in a much more accurate way in the future.

This section includes five measures that affect all the consumption sectors (buildings, industrial, transport and public). Among them, developing minimum energy performance standard (MEPS), that once set, will allow energy savings in the buildings, industrial and public sectors.

5.1 Minimum energy performance standards

"Energy Efficient Home Appliances", a study done by Ipsos in 2007 for the UNDP, shows the distribution of the energy efficient equipment in the Lebanese Market. The study focuses on five main appliances: refrigerators, air conditioners, heating systems, water heaters and light bulbs. The study was based on surveys in the different Lebanese regions.

It concludes that only 7% out of 1,093 refrigerators surveyed in the Lebanese market contain energy efficiency marks and only 3% contain Energy Efficiency Labels (EU label-US Label or Australian Label). In addition, 20% of the household refrigerators belong to the ''24 cubic feet (680 liters)'' category; and 94% of the refrigerators in the Lebanese market are of freezer-up type.

42% of the Lebanese households have only one air conditioner (AC). The average number of air conditioners by household according to the fore-mentioned study is 2. The study shows also that 36% of the air conditioners in the households belong to the 9,000 BTU category.

The estimated total number of air conditioners in 2007 was 881,998. Out of which 98% are split units. All air conditioners have a dual function: AC cooling and heating.

On the other hand, electric heaters constitute around 67% of the heating systems used in the Lebanese market followed by gas heaters (27%). None of the Heating Systems contain Energy Efficiency Labels. Three main power rates are found (1,800 W, 1,200 W and 2,000 W) with percentages of 20%, 19% and 14% respectively. The total number of heating systems available at households is estimated at 1,223,555 units. The average number of heating systems per household is therefore 1.61. Fifty-eight percent of households have only one heating system. The estimated total number of electrical and gas heaters in Lebanon in 2007 is around 422,328 units.

83% of water heaters available in the market are electric devices. 31% of the water heaters available in the market have a volume of 80 liters, whereas 40% have a rated power of 1,200 W. The total number of water heaters available at households all over Lebanon was estimated at 953,284 where 83% of households have only one water heater.

Finally, light bulbs available in the market (in November-December 2006) are divided in two categories: 52% are incandescent lamps and 48% are compact fluorescent lamps (CFL) and energy efficient lamps. The highest percentage of all lamps have a rated power of 40 W (13%) followed by 100 W lamps (10%). The total number of bulbs and fixtures available in households is estimated at 15,339,465 lamps. The average number of bulbs per household is 18.23 units.

According to the situation detailed above, the following measure deals with setting Minimum Energy Performance Standard (MEPS) for certain appliances. The calculation methodology will follow later.

H 01	MINIMUM ENERGY PERFORMANCE STANDARD (MEPS)		
Description of the Measure	This measure aims at implementing MEPS and Labeling Program for at least 5 types of equipment (air conditioners, lamps, refrigerators, televisions, washing machines)		
Type of measure	Regulation		
Sector	Buildings, Industry, Public		
Target Group	Suppliers, consumers, manufacturers...		
Implementing Bodies	LIBNOR, Ministry of Industry, Ministry of Economy and Trade, Ministry of Energy and Water, IRI, LCEC		
Start Date	2016	**End Date**	2020

Current Status and Plan for Implementation

Minimum Energy Performance Standards or MEPS determine the minimum energy efficiency that products shall meet in order to be sold in the market. MEPS tend to protect the consumers from products that have low energy performance. MEPS can be applied to most technologies. However it should only be applied when there is certainty that alternatives are available and these alternatives are affordable to the consumers.

MEPS should be introduced for refrigerators, cooling, heating and water heating equipment, televisions, lights and electrical motors. MEPS will be later on extended for all equipment under the next NEEAP.

The first step would be to start with an Energy Consumption Labeling Ordinance that would open the way to implement MEPS in Lebanon. Labeling should be mandatory. The labeling program should start by adopting the EU-Label and Ecodesign directives for appliances, heating and water heating equipment, cooling, electrical motors, and lights. Then, and based on the market situation implement MEPS should be implemented in the Lebanese law based on the revised EU Directive on energy consumption labeling (2010/30/EC) and Ecodesign legislation (refer to the table 4 for the detailed directive number for the targeted equipment).

EU energy labeling advises the consumer on the energy efficiency and other functional performance qualities of models. Its aim is to rank all models of certain type of products with energy class range, from A to G (A being the most efficient and G the least efficient) or A+++ to D (class ranges change as equipment become more efficient). It thus "pulls" the market towards more efficient products by better informing consumers.

Eco design directive is also set by the EU, it regulates the energy consumption through the setting of minimum requirements for products. Contrary to labeling, this directive is not seen by the consumer because products on the market comply automatically with these requirements. Instead, it requires manufacturers to decrease the energy consumption of their products by establishing MEPS, therefore "pushing" the market away from the worst performing product.

The MEPS implementation procedure should include the following steps

- Establish the legal and regulatory frameworks
- Analyze and set standards:
  - Assess the energy performance of products currently sold in the market
  - Establish the technical feasibility and cost of each technology option that might improve a product's energy efficiency
  - Assess a national impact analysis
  - Determine the economic impact on consumers (purchasing+ operating cost)
  - Predict the impact on the manufacturers (if there are local ones)
- Select products and set priorities
- Develop a testing capability: define testing facilities needed and test procedures in order to have low-cost high quality tests
- Design and implement a labeling program

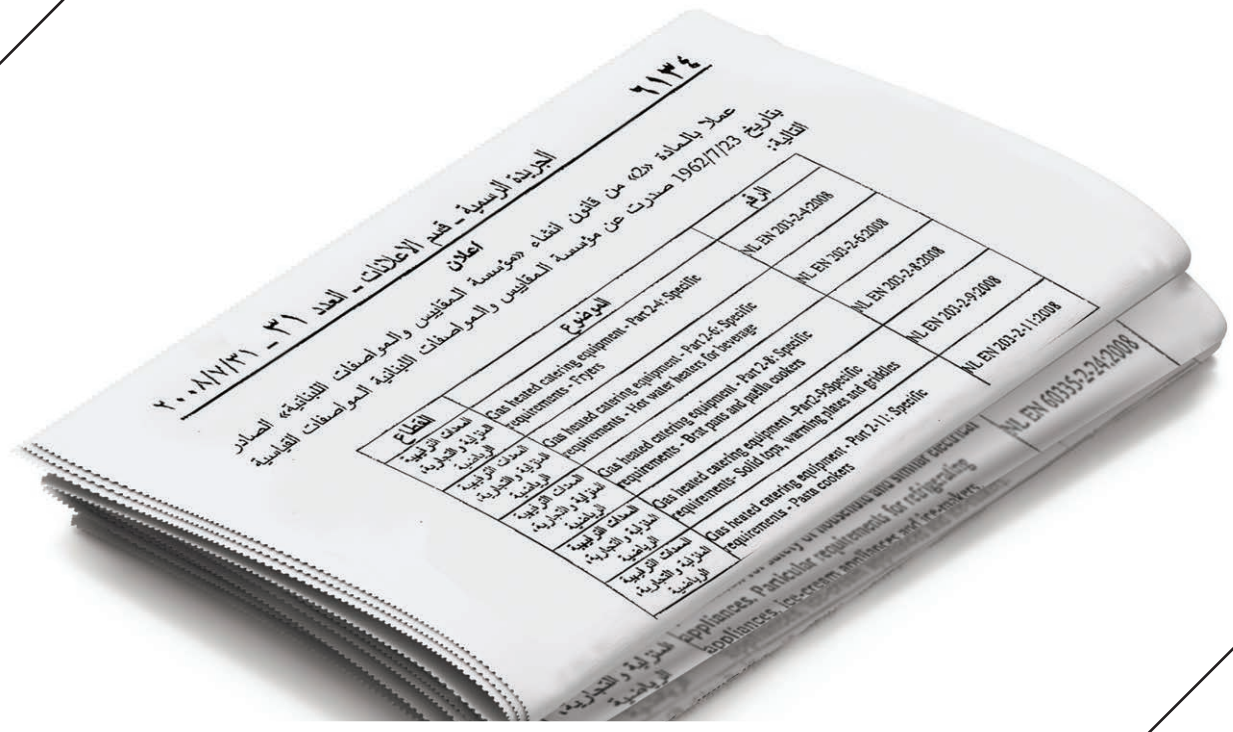
- Design and implement a communication campaign
- Establish a monitoring and verification scheme
- Insure program integrity
  - Establish fair, consistent, and practical criteria for certifying the energy efficiency of products
  - Establish sufficient penalties and adequate administrative processes for enforcement.
- Combine standards and labels with other policies (incentives, taxes...)(11)

Set Targets and Estimated Impact on Energy Saving

Electrical equipment account around 40% of the total energy consumption in buildings and industry (12). Most of these equipment are out of date and need to be replaced in the near future. In order to reduce the energy consumption resulting from purchasing inefficient equipment, MEPS and mandatory labeling are a must allowing for an adequate control of the market.

Yearly	10-129 kWh/ m^2.year	**Altogether (2016-2020)**	40-516 kWh/m^2 (considering 1 year of survey or fund raising is needed)
Calculation Methodology	See Below		
Data Needs/ Availability	- A survey to evaluate the availability, types, models, characteristics and energy efficiency of some electrical appliances (efficient and non-efficient) imported and locally manufactured. - Pricing comparison between energy efficient versus regular technologies in the market and assessment of the market impact on consumers, suppliers and manufacturers - Level of awareness of the public regarding efficient equipment - A survey to evaluate the availability of testing in Lebanon		
Monitoring Method/ Savings Measurement	- Input indicator(s): ▪ Current consumption of existing equipment ▪ Numbers and performance of equipment tested, labelled or sold - Output indicator(s): ▪ Level of obligation to use MEPS ▪ Mandatory or voluntary labeling could be set ▪ Amount of incentives pulling importers, manufacturers and consumers towards using labeled equipment ▪ Control procedure to be adopted by the Consumer Protection Service - Outcome indicator(s): The quantities of labeled products purchased and in use. This will be done by creating an automated system to monitor the market.		
Monitoring/ Verification	- The LCEC keeps record of data collected of existing equipment to calculate the actual consumption - Savings could be calculated based on the level of application adopted		
Next Steps After 2020	The next steps would be to set a mandatory national labeling system and ban the importation of non-efficient equipment		
Funding			
1 Million USD	An estimation of the costs of implementation of MEPS. Estimated at 250,000 $ per year over a period of 4 years. Funding not available.		

Picture 02 Energy labels in Lebanon: following the European model



Picture 03 Libnor: adoption of national standards for energy efficiency in appliances

The savings calculation methodology was based on the choice of typical equipment used in buildings. The chosen basic equipment to replace with more efficient ones are:

- Air Conditioners
- Lamps
- Refrigerators
- Televisions
- Washing machines
- Vacuum cleaners
- Computers

Table 4 shows the directives used to calculate the energy savings for the above cited equipment. Basically, the EU labeling data were used. Ecodesign requirement were used when an energy labeling was missing for certain equipment (e.g. Computers). When calculating energy savings due to computers replacement, specifications of several manufacturers were studied. The consumption per desktop can vary between 60 and 250 W depending on the processor type, screen width and several other parameters. For savings calculation an average value of 150 W was considered.

TABLE 4: DIRECTIVES/REGULATIONS

		Ecodesign	Energy Labeling
Air conditioners	Air conditioners and comfort fans	(EU) No 206/2012	EU No 626/2011
Boilers	Hot-water boilers	92/42/EEC	
Circulators	Circulators and glandless circulators integrated in products	(EC) No 641/2009	
Computers	Computers and computer servers	EU No 617/2013	
Dishwashers	Household dishwashers	(EU) No 1016/2010	(EU) No 1059/2010
Electric motors	Electric motors	(EC) No 640/2009	
Fans	Fans driven by motors	(EU) No 327/2011	
Lamps (directional and LED)	Directional lamps, light emitting diode lamps and related equipment	(EU) No 1194/2012	(EU) No 874/2012

Lamps (household)	Non-directional household lamps	(EC) No 244/2009	(EU) No 874/2012
	(including amendment on ultraviolet radiation)	(EC) No 859/2009	
Lamps (fluorescent)	Fluorescent lamps without integrated ballast, for high intensity discharge lamps and for ballasts and luminaries able to operate such lamps (including amendment)	(EC) No 245/2009 (EU) No 347/2010	(EU) No 874/2012
Power supplies	External power supplies	(EC) No 278/2009	
Refrigerating appliances	Household refrigerating appliances	(EC) No 643/2009	(EC) No 1060/2010
Set-top boxes	Simple set-top boxes	(EC) No 107/2009	
Standby and off mode	Electric power consumption standby and off mode of electrical and electronic household and office equipment	(EC) No 1275/2008	
Television	Television	(EC) No 642/2009	(EU) No 1062/2010
Tumble dryers	Household tumble dryers	(EU) No 932/2012	(EU) No 392/2012
Vacuum Cleaners	Vacuum Cleaners	(EU) No 666/2013	(EU) No 665/2013
Washer-driers	Household combined washer-driers	-	96/60/EC
Washing machines	Household washing machines	(EU) No 1015/2010	(EU) No 1061/2010
Water pumps	Water pumps	(EU) No 547/2012	

The baseline chosen for savings calculation is the lowest class of each equipment (usually G is the least efficient). The maximum savings (129 kWh/m^2.year) consists of energy savings due to setting the minimum energy performance standard at the highest class (Most efficient usually A+++). Whereas the minimum performance (10 kWh/m^2.year) is found by setting the minimum energy performance level at the second least efficient class (means moving only one class upward).

Depending on equipment type, the energy consumed by each equipment was calculated based on the EU labeling methodology mentioned in the directive. Several assumptions were taken such as the number of equipment in an apartment of 100 m^2:

- Electrical consumption due to heating and cooling was calculated based on the heating and cooling demand for Beirut calculated in details in the ''LCEC Guidelines on preparing technical proposals for non-certified High Performance Buildings-2014'' (13).
- One Refrigerator
- One Television
- Need of light is around 450 lumen/m^2
- One Washing machine
- One Vacuum cleaner
- One Desktop

The operating time for some equipment were chosen based on EU labelling recommendations such as 24 hours per day for refrigerators, 4 hours for televisions, 8 hours per day for desktops.

The least efficient class as defined by the European regulations differ from equipment to another. The consumption of the least efficient class of each equipment considered for this measure are shown in Annex II. Annex II details also energy savings when replacing an old equipment (the least efficient) with a new one (A+++ for maximum savings and F for minimum savings).

5.2 Financing mechanism

It is undisputable that financing mechanisms are an extremely effective way to boost energy efficiency, renewable energy, and green buildings in a country. Fortunately, Lebanon is characterized by one of the best financing mechanisms in the region: NEEREA is the National Energy Efficiency and Renewable Energy Action, a highly efficient financing mechanism developed by the Central Bank of Lebanon (BDL) back in November 2010.

The concept of having a national action called "NEEREA" was developed in the National Energy Efficiency Action Plan (NEEAP) for Lebanon for the years 2011-2015. NEEREA is one of the fourteen initiatives of the first NEEAP for Lebanon. It is worth noting that the Council of Ministers (CoM) of Lebanon approved the NEEAP 2011-2015 on 10 November 2011 (Decision No. 26).

On 25 November 2010, the Central Bank of Lebanon issued Circular No. 236 setting the conditions of application for "green loans" under the NEEREA financing mechanism. NEEREA is dedicated to support the financing of new and existing environmental projects, including energy efficiency (EE), renewable energy (RE), and green buildings implementations. NEEREA allows private sector entities (individuals, SMEs, or corporate bodies) to apply for subsidized loans for any type of EE and/or RE projects. Loans are available to all subsidized (industrial, agricultural, tourism, information technology, and research) and non-subsidized sectors (residential, commercial, non-profit organizations). NEEREA finances new environmentally friendly projects as well as enhancing the conditions of existing projects to become environmentally sound.

The characteristics of NEEREA are various; starting from the fact that loans amount can be as low as 2,000 USD and as high as a ceiling of 20 million USD. The interest rate of NEEREA is low, typically 1.075%, and reaching as low as 0.3%. The repayment period for existing projects is up to 10 years (with additional 2 years grace period), while the repayment period for new project is 14 years (including 4 years grace period).

Another extremely important characteristic of NEEREA is that green loans are provided through any of the Lebanese commercial banks to directly reach the end user. Till date, more than 17 Lebanese banks are involved in the NEEREA mechanism. Still, the most important aspect of NEEREA is that it is a fully national mechanism, meaning that the incentives of NEEREA are based on incentives created and offered by the Central Bank of Lebanon (BDL).

During its start-up phase between 2011 and 2014, NEEREA benefitted from a generous grant offered by the European Union (EU) of 15 million euros to smal and medium entreprises (SME's). The EU has in fact contributed to NEEREA by offering a grant over a share of the investment done by beneficiaries. The grant is equivalent to 15% of the green loan amount for nonsubsidized sectors and 5% for subsidized sectors, with a ceiling not exceeding 750,000 USD of grant money. Funds are allocated to the project after LCEC reviews and approves the technical study proposed. The grant money allocated would be only disbursed upon final execution and after technical validation by LCEC. Till date, most of the EU grant money has been allocated by the BDL given the fast-growing use of NEEREA loans by beneficiaries.

It is also important to note that the EU support to the BDL includes two major support tools: a small part of the EU grant is dedicated to finance the technical unit of the LCEC. Another part is dedicated to launch a nationwide marketing campaign to promote the use of green loans in the country. LCEC works as the technical arm of BDL in the review of NEEREA loan requests.

MORE DETAILS ON HOW DO BDL INCENTIVES WORK

NEEREA gave a huge push to the development of energy efficiency and renewable energy markets in Lebanon. Following the launching of Circular No. 236 on 25 November 2010, BDL has issued several circulars to develop NEEREA and give it the right boost. As per Circular 236, Lebanese commercial banks can free some of their required reserves at the Central Bank of Lebanon to finance NEEREA projects. The banks can be granted with 150 percent from the balances of the loans to finance these projects. The net interests calculated for these loans should not exceed 3 percent minus 50 percent of the return for one year (3%-50%TB), calculated every year starting from the date on which the loan is put into execution. However, the final interest rate can differ from one commercial bank to another depending on fees and insurance.

Circulars 313, 318 and 346 dated January 2013, February 2013 and November 2013 respectively specify that commercial banks will receive 150 percent of the value of granted loans in Lebanese pounds from BDL to finance ecofriendly energy projects, whose value exceed 30 million Lebanese pounds and do not benefit from an interest rate subsidy, be it from subsidized or non-subsidized sectors. In this case, the net interest rate for these loans should not exceed 3.75 percent minus 50 percent of the return of the Lebanese Treasury Bills (3.75%-50%TB) for one year. Circulars 313, 318 and 346 were issued after NEEREA reached the ceiling of credits granted by BDL Circular No. 236.

The amended circulars indicate that the loans to be provided under the circular 346 have to be earmarked to finance new projects or the development of existing ones. The loan could not be used to refinance existing projects, repay loans, finance partnership, or fund the operating capital of a company. BDL indicates that the Lebanese commercial banks would not benefit from reductions in the obligatory reserve requirements if they abide by Circular No. 236.

IN FOCUS

Till mid-2015, more than 225 NEEREA loans have been approved by the Central Bank of Lebanon (BDL) based on the technical review of LCEC. The total amount of these loans exceeds 240 Million USD. The BDL has a ceiling of 1 Billion USD for subsidized loans, including NEEREA loans.

The following proposed measure builds on the existing NEEREA mechanism by extending its action till 2020. The measure also includes the new credit line facility signed between the European Investment Bank (EIB) and the Agence Française de Développpement (AFD) on one side and the Lebanese Government on the other side.

H 02	NATIONAL FINANCING MECHANISMS AND INCENTIVES		
Description of the Measure	This measure aims at boosting and sustaining the operation of the NEEREA financing mechanism in order to help promote and implement energy efficient measures in the building, industrial, and agricultural sectors.		
Type of measure	Financing Mechanism		
Sector	Buildings, Industry and Agriculture		
Target Group	ESCO, Private Sector		
Implementing Bodies	BDL, LCEC		
Start Date	2016	**End Date**	2020

Current Status and Plan for Implementation

The National Energy Efficiency and Renewable Energy Action (NEEREA) is an ongoing financing mechanism that was initiated by the Central Bank of Lebanon (BDL) in collaboration with the Ministry of Energy and Water (MEW), the Ministry of Finance (MOF) and the Lebanese Center for Energy Conservation (LCEC).

NEEREA's goal will always be to finance private projects where energy efficiency is the key. These projects may vary from existing buildings, new buildings, industrial projects or agricultural ones. It offers soft loans with a grace period and very low interest rate.

After submitting the project (financial and technical documents are required) to a commercial bank, the project is reviewed by BDL and forwarded to the LCEC for technical review. BDL examines LCEC's recommendations and comments and gives the final approval (14). The overall procedure can be found on lcec.org.lb (15). Since its creation back in 2012, more than 225 loans were till this date approved by NEEREA for a total amount of 240 Million USD.

The impact is indirect through the applied measures: energy savings for projects implemented between 2012 and 2015 are about 43 GWh leading to an emission reduction of about 84,000 tonnes of CO2 and an actual saving of 27 million USD. All EE technologies are covered like LED lighting, improving building's envelope, certified buildings, biomass systems, PV systems and SWHs.

This current measure aims to provide funds for promotion and implementation of energy efficiency (EE) measures through NEEREA and other types of incentives and grants for the period 2016-2020. Actually, NEEREA has proved its success as a financing mechanism. The current available fund for NEEREA is around 400 Million USD. NEEREA will be boosted by a new credit line by EIB and AFD with a total value of 80 Million Euros.

NEEREA will be also promoted for the small and medium industrialists in rural areas. The industrialist that will benefit from NEEREA should be legal (at least should have the Industrial Certificate)

Set Targets and Estimated Impact on Energy Saving

By end of year 2020, around 300 projects related to EE should be financed thanks to national financing mechanisms (existing and new buildings). Their environmental impact could be measured by the effect of each EE measure implemented.

The EE measures should be classified as follows :

- EE measures in existing facilities (buildings, industry and agriculture)
- EE measures in new facilities (buildings, industry and agriculture)
- EE measures in certified Buildings (LEED, BREAM and HQE)

Yearly	12,300,000 kWh/ year	**Altogether (2016-2020)**	49,200,000 kWh/year
Calculation Methodology	The sum of estimated savings (post-evaluation) for each individual measure/project as presented in the technical documents studied by the LCEC NEEREA unit.		
Data Needs/ Availability	- Available Funds - Current state and energy consumption of projects - Types of buildings, industries and agricultures to be targeted		
Monitoring Method/ Savings Measurement	- Input indicator(s): ▪ Number of projects (2016-2020) ▪ Measures implemented in each project - Outcome indicator(s): ▪ Energy savings by measure (Lighting, envelope, heating, cooling, equipment…) ▪ Total energy savings		
Monitoring/ Verification	- LCEC and BDL keep record of each project - LCEC team does continuous site inspection		
Next Steps After 2020	The next step would be to expand the role of the national financing mechanism to fund projects in other sectors such as the transportation sector.		
Funding			
500 Million USD	An estimation of the NEEREA loans over a period of 5 years. Around 100 Million USD per year by the national subsidy program of BDL.		
80 Million Euros	A new credit line proposed by EIB (50 Million Euros) and AFD (30 Million Euros).		
5 Million Euros	Technical assistance by the EU to support the BDL in the EIB/AFD credit line.		

NEW CREDIT LINE BY EIB AND AFD

An 80 Million Euros global loan is provided by EIB (50 Million Euros) and AFD (30 Million Euros) to support small-scale investments in energy efficiency (EE) and renewable energy (RE) by private companies in Lebanon, with particular focus on SMEs. The Central Bank of Lebanon (BDL) will be the project promoter on behalf of the Lebanese Government, making loans available to financial intermediaries. The loan agreements have been signed between EIB and AFD on one side, and the Lebanese Government on the other. Till mid-2015, this global loan didn't get yet the approval of the Lebanese Parliament. A technical assistance component will accompany this initiative.

IN FOCUS

5.3 Awareness raising campaigns and capacity building

This section contains two measures proposed under "Awareness Raising Campaigns and Capacity Building" activities. While the first measure deals with the overall activities related to this issue, the second measure is more focused on the development of ESCO business. Both measures refer to Initiative 12 of the First NEEAP 2011-2015 for Lebanon. In fact, initiative 12 focused on the necessity of "raising awareness and building the capacity of all stakeholders working in the energy efficiency and renewable energy sectors". The initiative also focused on "analyzing and disseminating good practices, creating skills and experience in energy efficient technologies, as well as strengthening existing ones".

During the period 2011-2015, LCEC has conducted many awareness campaigns to educate people about energy conservation, to promote the use of renewable energy and to facilitate individual project financing. These campaigns include magazine articles, brochures, newsletters, TV spots, incentives and events. LCEC estimates that capacity building activities reached easily more than 7,000 Lebanese professionals. Awareness raising campaigns reached a large part of the Lebanese population.

The success of all these campaigns and activities lays in the large number of partnerships created in this regard, whether with local, regional, or international players. A large number of trainings have been conducted. For instance, a recent training is entitled ''ESCOs for Management and Business Developers'' with the purpose to promote ESCO business in Lebanon. The training was conducted thanks to the support of the EU-funded MED-ENEC[2] project.

Picture 04 EU-funded MED-DESIRE raising awareness for thousands of Lebanese citizens

2

2 Energy Efficiency in the Construction Sector in the Mediterranean

PARTNERSHIPS THAT MAKE A DIFFERENCE

The impact of capacity building activities and awareness raising campaigns could be multiplied through alignment of efforts. In this regard, most of the activities of the LCEC are done in partnership with many entities. Definitely, the role of the Ministry for Energy and Water (MEW) is crucial in awareness raising activities, the MEW being the central public organization in charge of the energy sector in Lebanon. The Central Bank of Lebanon (BDL) is also playing a major role through the momentum created by the NEEREA financing mechanism.

The following national entities are also heavily involved in awareness raising and capacity building activities: the European Union (EU), the United Nations Development Programme in Lebanon (UNDP), Electricité Du Liban (EDL), the Industrial Research Institute (IRI), the Lebanese Standards Institution LIBNOR, the Order of Engineers and Architects in Beirut, and the Economic and Social Commission for Western Asia (ESCWA).

In addition, the following national players are also supportive in many awareness raising activities: the Ministry of Finance, the Ministry of Environment, the Ministry of Industry, the Council for Development and Reconstruction (CDR), the Lebanese Solar Energy Society (LSES), the Lebanon Green Buildings Council (LGBC), the United Nations Interim Force in Lebanon (UNIFIL), the United Nations Environment Programme (UNEP), and the World Bank.

Other regional and international players have also very positive roles to play, namely: the International Renewable Energy Agency (IRENA), the Energy Department at the League of Arab States (LAS), the Regional Center for Renewable Energy and Energy Efficiency (RCREEE), the Mediterranean Solar Plan (MSP), the World Energy Council (WEC), and the Energy Charter.

Finally, the efforts being invested by the European Union (EU) through its different projects and initiatives are really impressive. The EU has pushed a lot towards raising awareness and building the capacities of Lebanese professionals through the following projects and tools: TAIEX, MED-ENEC, CES-MED, SISSAF, MED-SOLAR, MED-DESIRE, SHAAMS, FOSTEr-in-MED, GR.ENE.CO, EDILE, and SUDEP.

IN FOCUS

In addition to all the national and international players, a lot of efforts need to be invested with universities, schools, and technical vocational schools. In this regard, the LCEC is currently working with the Directorate General of Technical and Vocational Education and more closely with the Ecole Des Arts Et Metiers - Dekwaneh on modifying the curriculum to include courses related to energy efficiency and renewable energy. The LCEC has also been continuously giving awareness raising presentations and lectures to school children and university students throughout Lebanon.

EU TAIEX

TAIEX is the Technical Assistance and Information Exchange instrument of the European Commission. TAIEX supports public administrations with regard to the approximation, application and enforcement of EU legislation as well as facilitating the sharing of EU best practices. TAIEX deals with issues at short notice in three ways: workshops, expert missions and study visits (55).

Lebanon has benefited from this instrument through different TAIEX exchanges with the participation of 120 energy experts. Lebanon is planning to continue benefiting from this instrument to help achieve the targets of this NEEAP.

IN FOCUS

The following measure aims at focusing on the needed awareness raising and capacity building activities that need to accompany all the other initiatives to take place in Lebanon. The ultimate goal would be to create a new culture of sustainability among the Lebanese population on one side, and to create a new generation of professionals knowledgeable in the energy efficiency sector.

MED-DESIRE PROJECT

The MED-DESIRE project, MEDiterranean DEvelopment of Support schemes for solar Initiatives and Renewable Energies, is a project co-funded by the European Union through the ENPI CBC MED Programme 2007-2013. This project of 35-months consists of nine partners from five countries including LCEC.

The project aims at spreading energy efficiency, and in particular, solar energy across the Mediterranean area through the definition of innovative financial schemes and market stimulation tools. The project includes the proposal of standards for Photovoltaic systems and Solar Water Heaters to the LIBNOR National Solar Energy Committee, the feasibility study for a solar PV testing facility at the IRI, study tour to Italian solar testing laboratories, training on solar testing and certification, training of trainers (teachers from public vocational schools) with an aim to ameliorate the quality of installations and equipment.

In order to facilitate the implementation of energy efficiency and renewable energy at the local level, the project also includes the development of a local solar thermal ordinance within the Union of Municipalities of Tyre and the development of a financing mechanism dedicated to municipalities as well as training of municipal staff, local urban planning department officials and financing institutions. Finally, to boost the market demand on renewable energy and energy efficiency, an awareness raising campaign is integrated within the project, it includes a TV spot, a radio spot, awareness raising brochures, and several awareness raising events for citizens of different ages (in collaboration with the Scout du Liban, Radio One Lebanon, Donner Sans Compter , several schools and universities and all lebanese media platforms).

IN FOCUS

Picture 05 The "human factor": building a culture of sustainability

H 03	AWARENESS RAISING CAMPAIGNS AND CAPACITY BUILDING		
Description of the Measure	This measure aims at raising awareness about energy efficiency among the general public as well as to build the capacities of professionals working in the sector		
Type of measure	Campaign		
Sector	Building, industry, agriculture, public		
Target Group	General public, energy managers, ESCOs, building designers and contractors, schools, universities, decision makers.		
Implementing Bodies	Ministry of Education and Higher Education, Universities, Ministry of Finance, NGOs, LCEC		
Start Date	2017	**End Date**	2020

Current Status and Plan for Implementation

H 03 a: Awareness campaigns shall be targeting all the Lebanese society segments. This measure includes several milestones based on the targeted segment.

1. Schools/Scouts

- First of all, Schools and scouts are the key for training children on energy efficient behaviors. At least twenty information campaigns (posters, brochures, lectures and educational books) shall be focusing on how to improve energy efficiency and how to adapt their daily behavior based on that.
- Modifying school curriculum especially technical schools and institutes to include energy efficiency courses such as efficient heating and cooling, heat recovery, efficient buildings...
- Integrating Green Diploma such as ProGreen program initiated by AUB, LAU and AUC, and the RE masters at the Lebanese university with ESIB/USJ collaboration, Schneider University
- Promoting online student training programs
- Establishing a yearly student competition for students' projects on energy efficiency, with 3 monetary awards
- Integrating Research and Development activities through financial incentives to work on three topical subjects

2. General Public

- Publishing and distributing various information publications and guides (posters, brochures, TV/radio spots, seminars,...) on EE behavior and investment
- Organizing green procurement and green behavior events especially in public buildings (2 lectures per year)
- Active participation in the Arab Energy Efficiency Day and exchange of experience with other Arab states

H 03 b: Capacity Building events shall be targeting the professionals working in the field. This measure includes several activities.

3. Installers

- Organizing continuous training sessions for installers of energy efficiency solutions, building constructers (Frame installation, pipes insulation, infiltration...)
- Installing a certification system for contractors in the building and the industrial sectors
- Installing a certification system for Operation and Maintenance works
- Establishing periodic examination and certification for the professionals that complete the LCEC paths in the Schneider Energy University

The awareness campaigns and capacity building should target also the small and medium industrialists in rural areas.

Set Targets and Estimated Impact on Energy Saving			
N/A			
Yearly	N/A	**Altogether (2016-2020)**	N/A
Calculation Methodology	N/A		
Data Needs/ Availability	- Targeted group - Source of funds - Type of campaign - Assessment of impact post-implementation		
Monitoring Method/ Savings Measurement:	- Input indicator(s): ▪ Number of campaigns (lectures, TV spots, and others) and people reached ▪ Evaluation questionnaire for small-scale events ▪ Yearly survey on the public perception on energy efficiency ▪ Modified curriculum ▪ Number of trainings and trained professionals - Outcome indicator(s): Public awareness and number of trained technicians		
Monitoring/ Verification	LCEC keeps record of each event (awareness campaign and capacity building)		
Next Steps After 2020			
Funding			
50,000 USD per year	Available contributions by different funding windows (like WEC, MED-DESIRE project, cooperation with MED-ENEC, League of Arab States, etc.).		
	EU-funded TAIEX events		
600,000 USD	Funding needed during the period 2017-2020 to complete all actions. Estimated budget at around 150,000 USD per year		
100,000 Euros	Available by EU (year 1 only)		
100,000 USD	Not available		

ENERGY UNIVERSITY BY SCHNEIDER ELECTRIC

Energy University is a FREE, online, educational resource, offering more than 200 vendor-neutral courses on energy efficiency and data center topics to help the user identify, implement, and monitor efficiency improvements within his organization.

The student can select one of the two certification opportunities: Data Center Associate and Professional Energy Manager (PEM). Schneider Electric University offers the training and skills needed to build and expand career options.

LCEC and Schneider Electric collaborated in 2012 on the development of three paths related to energy efficiency, based on the existing Energy University courses: LCEC Common Language (10 courses), LCEC Energy Fundamentals (33 courses) and LCEC In Depth Energy (63 courses). The Objective of this collaboration is to set a minimum level for the technical know-how in the Lebanese energy market.

The Energy University could be accessed through MyEnergyUniversity.com with the keycode 39401P for the LCEC referral.

H 04	ESCO'S BUSINESS DEVELOPMENT		
Description of the Measure	This measure aims at setting the legislative framework for the Energy Service Companies (ESCOs).		
Type of measure	Regulation		
Sector	Building, industry, agriculture, public		
Target Group	Building companies, design firms, entities dealing with manufacturing and installation of efficient technologies		
Implementing Bodies	Ministry of Finance, MEW, Banking Sector, LCEC		
Start Date	2017	**End Date**	2020
Current Status and Plan for Implementation			
An ESCO is an energy service company specialized in energy efficiency improvement services. LCEC launched in 2014 an application for ESCO's evaluation, once identified, any beneficiary can contact directly a specialized ESCO to conduct energy audit, implement energy conservation measures and monitor energy savings according to a certain standardized energy performance contract. This action predicts drafting and/or amending the legislative and normative framework in place to promote the development of ESCOs. This initiative should be accompanied by the awareness campaign targeting the potential recipients of energy services, and by the training of potential providers of energy services. The direct targets of this initiative would be: 1. the adoption of the qualification system being set by the LCEC 2. the organization of 4 training seminars and day events per year for ESCOs 3. the promotion of the adoption of ISO 50,001 4. the establishment of a certification systems for energy auditors 5. the drafting of the energy performance contract (contract template; additional necessary acts) *As per the EU commission definition, an Energy Performance Contracting (EPC) is a form of 'creative financing' for capital improvement which allows funding energy upgrades from cost reductions. Under an EPC arrangement an external organisation (ESCO) implements a project to deliver energy efficiency, or a renewable energy project, and uses the stream of income from the cost savings, or the renewable energy produced, to repay the costs of the project, including the costs of the investment. Essentially, the ESCO will not receive its payment unless the project delivers energy savings as expected. Two types of contracting exist, guaranteed savings and shared savings. (16)* 6. the development of a legal framework to organize the market. It would be critical for setting a procedure for the energy services market to guarantee energy savings through the conclusion of energy performance contracts.			
Set Targets and Estimated Impact on Energy Saving			
N/A			
Yearly	N/A	**Altogether (2016-2020)**	N/A
Calculation Methodology	N/A		
Data Needs/ Availability	- Targeted group - Source of funds and bank guarantees - Type of trainings		

Monitoring Method/ Savings Measurement	- Input indicator(s): Number of trainings, number of projects concluded, number of EPC and amount of savings achieved by type of measures… - Output indicator(s): ▪Setting the energy performance contract ▪Adopting a legal framework for organizing the market ▪Establishing the certification system for ESCOs and auditors ▪Number of ESCOs established - Outcome indicato(s): Energy savings can be measured and monitored if EPCs are concluded and established with certain entities, buildings or facilities.
Monitoring/ Verification	LCEC keeps record of each event and of the monitored savings.
Next Steps After 2020	The next step would be to extend the trainings to cover all energy efficiency measures in all sectors.
Funding	
800,000 USD	Estimated at around 200,000 USD per year for a period of 4 years. Budget not available.

REGIONAL CENTER FOR RENEWABLE ENERGY AND ENERGY EFFICIENCY (RCREEE)

The Regional Center for Renewable Energy and Energy Efficiency (RCREEE) is an independent not-for-profit regional organization which aims to enable and increase the adoption of renewable energy and energy efficiency practices in the Arab region.

RCREEE teams with regional governments and global organizations to initiate and lead clean energy policy dialogues, strategies, technologies and capacity development in order to increase Arab states' share of tomorrow's energy. LCEC is a Board of Trustees and founding member of RCREEE, they work in close collaboration on several axis such as capacity building and regional projects.

RCREEE provides support and technical assistance to its member states "through unifying and integrating technical standards and frameworks." A unified RCREEE certification scheme, framework law and EPC could be of key importance in the development of a healthy market for ESCO's.

IN FOCUS

5.4 Adoption of the Energy Conservation Law

The second initiative of the first NEEAP aimed at ''the adoption of an Energy Conservation Law for Lebanon, including the institutionalization of the Lebanese Center for Energy Conservation (LCEC) as the national energy agency for Lebanon". The law is supposed to offer a legal framework for the following subjects: energy audits, energy efficiency standards and labels, financial incentives for energy efficiency appliances, and net-metering and the LCEC's national role.

The draft of the ''Energy Conservation Law'' was approved by the Ministry of Energy and Water and was sent to the Council of Ministers but still not amended. Currently, the draft law needs to be updated to cope with the changes that took place in the country. The draft law was returned to the Ministry of Energy and Water in November 2015. Since LCEC is already now an active institution, the proposed name of the law will be reduced to "Energy Conservation Law". The LCEC is currently working on a new Framework Law that covers developments and achievements in the topics of energy efficiency, renewable energies, green buildings and the efficiency in the connection to the electricity grid. This Framework law will include the NEEAP and the NREAP as the main policies to be implemented. These action plans' (for EE and RE) implementation is the responsibility of the LCEC under the patronage of the Ministry of Energy and Water.

H 05	ADOPTION OF THE ENERGY CONSERVATION LAW		
Description of the Measure	This measure aims at creating a political momentum towards the development of this law towards a more comprehensive framework law as per the recommendations of LAS and towards having a smooth adoption by the Lebanese Parliament.		
Type of measure	Regulation		
Sector	Building, industry, agriculture, public		
Target Group	Decision makers		
Implementing Bodies	Council of Ministers, parliament, parliamentary committee on Energy, Ministry of Energy and Water, LCEC		
Start Date	2016	**End Date**	2018
Current Status and Plan for Implementation			
The Energy Conservation Law was approved by the Council of Ministers. The law regulates the framework of energy efficiency topics in Lebanon: - Projects consuming energy (> 400 toe equivalent to 4,640 MWh or 2,500 KVA) have to obtain license from LCEC regarding their compliance with policies and measures for energy conservation and efficiency - Mandatory audits for institutions consuming more than 400 toe (2,500 KVA) - Mandatory certification for ESCO - Mandatory audits for public buildings - Incentives for green buildings - Energy consumption labeling ordinance (appliances, electrical motors, lights…) - Banning import of non-efficient appliances and equipment - Incentives for importing efficient equipment - Incentives on importing efficient low consuming vehicles			
Set Targets and Estimated Impact on Energy Saving			
N/A			
Yearly	N/A	**Altogether (2016-2020)**	N/A
Calculation Methodology	N/A		
Data Needs/ Availability	N/A		
Monitoring Method/ Savings Measurement	Law adoption		
Monitoring/ Verification	Law adoption		
Next Steps After 2020	The next step would be to extend the mandatory energy audits to all building types and sectors		
Funding			
225,000 USD	Estimated at around 75,000 USD per year for three years (2016, 2017, and 2018). Budget to be made available by MEW.		

06

END-USE MEASURES IN THE BUILDING SECTOR

CHAPTER 6 **END-USE MEASURES IN THE BUILDING SECTOR**

The Lebanese building stock is very diverse where the share of new buildings increased exponentially in the last 10 years while old buildings still lack proper maintenance and renovation. The building stock in Lebanon is highly dependent on the political and the security situations.

Census of buildings and dwellings and establishments 2004 performed by CAS in 2005 showed that the number of buildings in Lebanon is 480,515 whereas the number of dwellings is around 1,377,445 (4).

In fact, a report published by MoE based on data collected by CAS between 1996 -1998 showed that in Beirut 40% of the existing buildings were constructed before 1950 whereas in the suburbs of Beirut 30% of the buildings were constructed between 1951 and 1970. The new construction shares decreased during the war between 1971 and 1990 and then peaked in the nineties where the country was being reconstructed after the war (17).

In addition, the Central Bank of Lebanon (18) has been publishing the number of buildings constructed each year based on the construction permits registered.

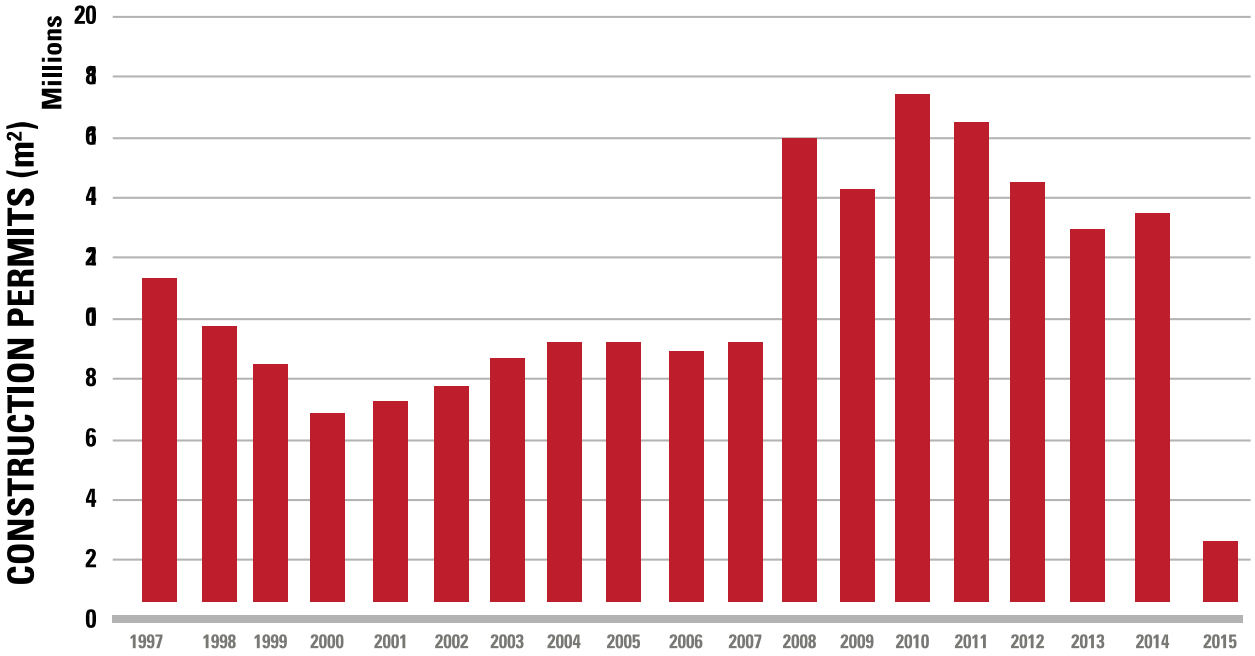


Figure 8 Construction permits between 1997 and first quarter of 2015

Lebanon's real estate sector has developed during the period 2007-2010. In fact, the country's favorable investment climate coupled with financial market crashes in around the world at that time resulted in an upsurge in Foreign Direct Investment (FDI) inflows which translated to a booming real estate sector (19). However, since the beginning of 2011, the property market witnessed a slowdown affected by the political instability and the regional conflicts.

The fore-mentioned (17) study classifies the Lebanese buildings into residential (63%), non-residential (11%), mixed and other. Mixed buildings represent 20% of all buildings and may include industrial establishments. Residential buildings constitute 83% of total construction permits followed by commercial buildings (8%), public buildings (5%), and economic sector buildings (4%) (19).

The share of the energy consumption of the residential sector alone in reference to the total final energy was estimated to be around 24% in 2010 (7). This share would be much higher if all buildings are counted including public and industrial buildings (not facilities).

Thus, the improvement of the building sector would achieve considerable savings in the energy consumption. This section proposes eight measures that can be applied in the building sector. These measures are distributed between regulations, action plans and implementation. They tackle all types of buildings including residential, tertiary, public and industrial buildings.

6.1 Double wall ordinance

This is definitely the most important measure to increase the efficient use of energy inside buildings. The potential energy savings could be very impressive.

B 01	DOUBLE WALL ORDINANCE		
Description of the Measure	This measure aims at: - Setting the Double Wall Ordinance that improves a building's envelope performance - Implementing the ordinance in 100 buildings (total area 100,000 m^2).		
Type of measure	Regulation, implementation		
Sector	Building		
Target Group	Developers, landlords, architects, construction companies		
Implementing Bodies	Ministry of Public Works and Transport / Higher Council for Urban Planning, Order of Engineers and Architects in Beirut, Order of Engineers and Architects in Tripoli, Lebanon Green Building Council, LCEC		
Start Date	2017	**End Date**	2020

B 01	DOUBLE WALL ORDINANCE

Current Status and Plan for Implementation

Thermal Insulation Ordinance enforces minimum requirements in terms of the energy quality of cladding. The actual Lebanese concrete recipe contains sand (1500 kg/m^3), cement (2000 kg/m^3), gravel (1800 kg/m^3) and Asphalt (1700 kg/m^3). One m^3 of concrete is formed by mixing 800 l of gravel, 400 l of sand, 7 bags of cement (50 kg), 300 l of water and 100 kg of steel. Thus the overall density of the Lebanese concrete is 2500 kg/m^3.

The Overall U-value of an exterior hollow concrete block (a wall composed of 15 cm/ 2500 kg/m^3 Lebanese concrete and 2.5 cm of plaster from internal and extern side) is 2.76 W/m^2.K.

This measure aims at setting the double wall as an ordinance. Double wall insulation as stated in the Lebanese building code is optional. In case of double wall, outer walls areas are not accounted within the rate of investment and the factor of public investment. The non-counted outer walls include insulation thickness, if any, and parts of the columns within the exterior walls and ranging in thickness between twenty-two centimeters / 22 cm / and thirty-five centimeters / 35 cm /. It is required that the separation between the two walls should not be less than 3 cm (three centimeters) and the outer wall thickness not less than ten centimeters (10 cm).

The aim of this measure is to make the double wall configuration mandatory in the new buildings in Lebanon. Considering the double wall composition as follows: air, plaster, 10 cm concrete, 5 cm insulation air cavity, 15 cm concrete, 2 cm plaster and air; the overall U-value is 1.57 W/m^2.K.

The thickness can be reduced to 2 cm (two centimeters) for buildings licensed before the issuance of the NEEAP 2016-2020. It will also require that cavity between the double-wall includes heat-insulating material in case the property is built at an altitude of more than 700 m above sea level.

If the conditions above are fulfilled, the glazing used in windows and outer doors must be of double glazing type and the buildings must be subject to a mandatory technical audit to ensure adequate installation and public safety requirements.

Set Targets and Estimated Impact on Energy Saving

The building sector accounts for roughly one quarter of the Lebanese energy consumption. The double wall measure could save around 43 % of a building consumption for cooling and heating.

Yearly	66.44 kWh/m^2.year	**Altogether (2016-2020)**	26,577,440 kWh (considering 1 year of implementation, survey or fund raising is needed)
Calculation Methodology	SEE BELOW		
Data Needs/ Availability	- The current state of the building sector (building types, numbers in each region…) - The overall heat transfer coefficient of the actual wall types used in the different Lebanese regions and different building types - Choose 100 buildings (new and existing) and apply the thermal insulation ordinance		
Monitoring Method/ Savings Measurement	- Input indicator(s): Percentage (number) of buildings complying with the thermal insulation ordinance - Output indicator(s): Saving opportunities defined by auditors and implementation of this measure - Outcome indicator(s): Energy savings and resulting GHG emission savings achieved		
Monitoring/ Verification	- The LCEC is in charge of site visits and checks - The LCEC keeps records of data collected in Residential, tertiary and mixed buildings		

Next Steps After 2020	The next steps would be to: - Get the building code through the law-making process by lobbying and creating buy-in from relevant stakeholders - Coordinate with the institutions in charge of construction and occupancy permitting to have a lever for enforcement
Funding	
300,000 USD	For the ordinance establishment. Budget not available.
8 Million USD	For the implementation of the ordinance in 100 buildings. Budget not available.

A simplified calculation methodology is used to estimate the savings in two parts: cooling and heating.

In terms of cooling, overall heat losses for a building include heat losses due to transmission (conduction, convection and radiation) through walls, windows, doors floors and more, heat losses caused by ventilation and heat losses caused by infiltration.

The transmission losses for each building's component (roof, walls, exposed floors, glazing, fenestration, beams, and columns) are identified by the U-values. The building's cooling (Q) demand due to transmission losses can be calculated using the equation 1.

$Q\_cooling = U.A.\Delta T.t$ (1)

Where U is the component's overall heat transfer coefficient ($W/m^2.K$), A is the component's area in square meters (m^2), ΔT is the difference between inside and outside temperature (K), and t is the duration for which cooling demand is calculated. Note: For calculating U-value, refer to Thermal Standard for Buildings in Lebanon (20).

The sum of all components arising from the above formula is the total cooling demand of the building. This total cooling demand is then multiplied by the total number of buildings to obtain the total cooling demand of all new houses in a specific year.

Having the cooling demand of all new houses before and after implementation of the thermal insulation, the energy savings is equal to the difference between these two values.

Referring to Equation 1, energy needed for cooling is directly proportional to the U-value (assuming that no other improvement was done). Considering only walls improvement, the single wall has a U-Value of 2.76 $W/m^2.K$ and the double wall's U-value is 1.57 $W/m^2.K$, the energy savings resulting from replacing a single wall with a double is about 43 %.

Picture 06 Building envelope is crucial in energy saving

Picture 07 Smart architecture: more savings in energy

The EU-funded MED-ENEC project has conducted a study in July 2013 on "A Roadmap for developing Energy Indicators for Buildings in Lebanon". The average energy consumption for cooling in buildings (all types included) is about 150 kWh_{FE}/m^2.year for the coastal zone. This value varies from 97 kWh_{FE} /m^2.year for seasonal residences to 259 kWh_{FE} /m^2.year for retail and varies also depending on the climatic zone (21).

Installing double wall could save around 64.5 kWh/m^2.year. Considering that Measure B 01 is to be implemented in 100 buildings of 1,000 m^2 each, the savings in final energy consumption are around 6,450 MWh_{FE}/year or 6,450 kWh_{FE}/m^2.year per building in the coastal zone. This value should be divided into fossil fuel and electricity consumption.

As for heating, the same equation (1) and calculation methodology could be used for calculating the heating demand.

The MED-ENEC study cited above shows that the average energy consumption for heating in buildings (all types included) is about 4.52 kWh_{FE}/m^2.year for the coastal zone. Using Heating degree days, the average energy consumption for heating could be found for the inland-plateau zone (all types of buildings included) as around 17 kWh_{FE}/m^2.year. Considering that Measure B 01 is to be implemented in 100 buildings of 1,000 m^2 each in the coastal zone, the savings in final energy consumed for heating are around 194 MWh_{FE}/year or 194 kWh_{FE}/m^2.year. Note that the energy consumed for heating in the coastal zone is negligible compared to that consumed for cooling.

MED-ENEC

MED-ENEC, or Energy Efficiency in the Construction Sector in the Mediterranean, is a regional project funded by the European Union. It aims at increasing the use of energy efficiency measures and renewable energy systems in buildings in southern and eastern Mediterranean countries. MED-ENEC's main objectives are to improve framework conditions, develop business and technology cooperation, build institutional capacities and offer technical training, support awareness campaigns, initiate and promote success stories through pilot projects, intensify networking among actors.

LCEC cooperates actively with the MED-ENEC project as the national focal point for Lebanon. MED ENEC, conducted an evaluation of the first Lebanese NEEAP, setting a methodology for evaluation based on concrete indicators and milestones to measure progress. LCEC and MED-ENEC organized a national workshop gathering all the main players of the energy sector to present the results of the evaluation of the first NEEAP in November 2014. MED-ENEC has an important role in implementing the second NEEAP.

6.2 Testing facility for building construction material

Measure B 01 dealing with the thermal ordinance for buildings implies indirectly a high performance of the buildings material used. LIBNOR has issued several standards for thermal insulation, concrete and calculation methodology of building components and elements. These standards are cited below in table 5 and they are not mandatory.

TABLE 5: STANDARDS FOR BUILDING COMPONENTS

Standard	Title	Mandatory	Publication Year
NL 13162	Thermal insulation products for buildings - Factory made mineral wool (MW) products - Specification	NO	2009
NL 13163	Thermal insulation products for buildings - Factory made products of expanded polystyrene (EPS) - Specification	NO	2009
NL 13164	Thermal insulation products for buildings - Factory made products of extruded polystyrene foam (XPS) - Specification	NO	2009
NL 13165	Thermal insulation products for buildings - Factory made rigid polyurethane foam (PUR) products - Specification	NO	2009
NL 13166	Thermal insulation products for buildings - Factory made products of phenolic foam (PF) - Specification	NO	2009
NL 13786	Thermal performance of building components - Dynamic thermal characteristics - Calculation methods	NO	2006
NL 13789	Thermal performance of buildings - Transmission heat loss coefficient - Calculation method	NO	2005
NL 14063	Thermal insulation products for buildings - In-situ formed expanded clay lightweight aggregate products - Part 1: Specification for the loose-fill products before installation	NO	2009
NL 14316	Thermal insulating products for buildings - In-situ thermal insulation formed from expanded perlite (EP) products - Part 2: Specification for the installed products	NO	2009
NL 14317	Thermal insulation products for buildings - In-situ thermal insulation formed from exfoliated vermiculite (EV) products - Part 1: Specification for bonded and loose-fill products before installation	NO	2009
NL 6946	Building components and building elements-Thermal resistance thermal transmittance: Calculation method	NO	2006
NL 10211	Thermal bridges in building construction - Heat flows and surface temperatures - Part 1: General calculation methods	NO	2006
NL 14782	Thermal bridges in building construction - Linear thermal transmittance - Simplified methods and default values	NO	2005

NL 823	Thermal insulating products for building applications - Determination of length and width	NO	2003
NL 68	Guide to the thermal insulation and summer comfort of buildings in Lebanon	NO	1999

In addition to the fore-mentioned standards, further Lebanese standards deal with the concrete, glass, and insulation properties.

This next measure aims at installing a testing facility able as a first step to test the thermal properties of the building components. It will lead to the calculation of the overall heat transfer coefficient (transmission coefficient) of the materials allowing then to classify the buildings components in the Lebanese market. This step will organize the market of building components locally manufactured and imported. Having a testing facility that is operational or identified goes in parallel to the procedure of having the current standards mandatory at LIBNOR and developing standards for new components.

The testing facility will allow the certification of the components as per the Lebanese standards and open the door for Research and development (R&D) of new efficient material, especially the locally manufactured ones.

B02	**TESTING FACILITY FOR BUILDING COMPONENTS**		
Description of the Measure	This measure aims at installing a testing facility able to test the thermal properties of building components.		
Type of measure	Implementation		
Sector	Building		
Target Group	Developers, architects, designers, construction companies		
Implementing Bodies	IRI, Lebanese University, Order of Engineers and Architects in Beirut, Order of Engineers and Architects in Tripoli, LIBNOR, LCEC		
Start Date	2016	**End Date**	2020
Current Status and Plan for Implementation			
Steps for implementing this measure are : - Install or identify a testing facility for building components - Test local and imported components - Establish a list of building components properties (Conductivity, U-Value…) and prices and integrate in a national database - Start by imposing mandatory Lebanese standards for certain types of components - Issue new Lebanese standards for building components			

B02	TESTING FACILITY FOR BUILDING COMPONENTS		
Set Targets and Estimated Impact on Energy Saving			
N/A			
Yearly	N/A	**Altogether (2016-2020)**	N/A
Calculation Methodology	N/A		
Data Needs/ Availability	- Current properties of the locally manufactured building components - Current list of prices of the local and imported building components		
Monitoring Method/ Savings Measurement	- Input indicator(s): List of currently used building components with their properties and prices - Output indicator(s): ▪ Testing facility implemented ▪ Listed material tested - Outcome indicator(s): ▪ At least 5 mandatory standards imposed among the existing ones ▪ At least 2 new standards developed		
Monitoring/ Verification	The LCEC will be in charge of keeping records of the following steps: - Establish the procedure test for each type of building components - Install or identify the testing facility - Test the properties of the most used building components (Concrete, Rockwool, …) - Test the properties of assembled components (double wall, insulating material…) - Overview the existing Lebanese standards - Impose mandatory standards - Create a national database for building components		
Next Steps After 2020	Make the standardization procedure a continuous process for building components		
Funding			
700,000 USD	Funding not available		

6.3 Building Code

There is a huge need to update the building code of Lebanon towards having a sustainable building code. Currently, several parties are working on including green buildings items in the construction law. The purpose of the next measure is to align all efforts in order to update the national building code.

SISSAF

The EU-Funded project "Support Programme for Infrastructure Sector Strategies and Alternative Financing (SISSAF) "represents an ambitious effort to tackle some critical aspects of the situation in Lebanon directly linked to the economic, social stability and sustainable growth of this geographic area. The project provides technical assistance & training support to two line Ministries (Ministry of Energy and Water, and Ministry of Public works & Transport).

SISSAF has two main streams of activities. The first is the establishment of mechanisms for development and implementation of national policies complementing national & international resources. The second stream is towards assistance in the implementation of strategically important projects in the three sectors.

In the Energy Sector, SISSAF assists the MEW in the development of green building standards, the coordination of priority projects, an awareness campaign in energy efficiency & renewable energy, the implementation of new power plants as well as the Energy Sector donors' coordination.

IN FOCUS

B 03	**BUILDING CODE**		
Description of the Measure	This measure aims at improving the energy efficiency standard of new buildings.		
Type of measure	Regulation		
Sector	Building		
Target Group	Developers, landlords, architects, construction companies		
Implementing Bodies	Ministry of Public Works and Transport / Higher Council for Urban Planning, Order of Engineers and Architects in Beirut, Order of Engineers and Architects in Tripoli, Lebanon Green Building Council, LCEC		
Start Date	2017	**End Date**	2020
Current Status and Plan for Implementation			
The development of the code itself is ongoing and shall be enhanced through this NEEAP measure by: - Reinforcing initiative number 10 in the first NEEAP, stressing its continued importance for energy efficiency in Lebanon - Fostering the technical development of the code - Offering incentives for compliance (e.g. access to subsidized loans, increased rate of investment as suggested in the Green Building Law [3] etc.)			

3

3 Regulation: Following Prime Minister Najib Mikati's proposal to increase building taxes through the increase of the rate of investment, and by consequence building areas ("Mikati Floor"), a Green Building Law was proposed by the Higher Council for Urban Planning, including green building criteria as key conditions to increase this rate of investment (an additional floor for large buildings or an increased footprint for buildings less than 4-stories high). This proposal was turned down by the parliament and will need to be revised.

B 03	BUILDING CODE		
Current Status and Plan for Implementation			
- Make estimation of building's energy use obligatory for developers - Installation or upgrade of weather stations in each climatic zone with regular publishing of weather information - Setting clear responsibilities for the development process as well as for enforcement, monitoring and verification and regular update of the code			
Set Targets and Estimated Impact on Energy Saving			
The building sector accounts for one quarter of the Lebanese energy consumption. The building stock has large improvement potential regarding energy efficiency and small measures such as insulation could have a large impact.			
Yearly	N/A	**Altogether (2016-2020)**	N/A
Calculation Methodology	N/A		
Data Needs/ Availability	- Total final energy consumption residential sector - Total final energy consumption per tertiary building category - Definition of reference buildings / developing a building typology for Lebanon - Improve building stock knowledge by identifying size of building stock: Residential and tertiary floor area and tertiary buildings furthermore separated by tertiary building category - Up-to-date hourly climatic data - Energy demand (based on historic data and/or calculations) - Final energy consumption by energy carrier in the residential sector - Final energy consumption by energy carrier in the tertiary sector and furthermore separated by tertiary building category - Final energy consumption per energy use and building category - Primary energy factors		
Monitoring Method/ Savings Measurement	- Input indicator(s): Once the building code is in place, monitor the percentage of new buildings complying with the code and their performance - Outcome indicator(s): With calculation of energy use of the buildings obligatory in the permitting process, overall energy consumption of buildings can be calculated and compared to historic data		
Monitoring/ Verification	Follow a roadmap for a systematic data collection. The roadmap developed in the MED-ENEC project 2013 "A Roadmap for developing Energy Indicators for Buildings in Lebanon" can be used as a blueprint		
Next Steps After 2020	- Get the building code through the law-making process by lobbying and creating buy-in from relevant stakeholders - Coordinate with the institutions in charge of construction and occupancy permitting to have a lever for enforcement		
Funding			
600,000 USD	Estimated at 150,000 USD per year over 4 years. Budget not available		

6.4 Use of Efficient Equipment

B 04	USE OF EFFICIENT EQUIPMENT		
Description of the Measure	This measure aims at using energy efficient equipment in 200 buildings of 1000 m^2 each (Total area tackled around 200,000 m^2) (Residential and non-residential except for public buildings). Energy efficient equipment in public buildings are covered under "Pu 02 Green procurement for new and existing public buildings" and not included in this measure.		
Type of measure	Implementation		
Sector	Building, industry, trade and commerce		
Target Group	Consumers, energy auditors, retailers		
Implementing Bodies	Ministry of Energy and Water, Ministry of Finance, Central Bank of Lebanon, Syndicate of Importers of Electrical Equipment & Electronics, LCEC.		
Start Date	2016	**End Date**	2020
Current Status and Plan for Implementation			
Set Targets and Estimated Impact on Energy Saving			
N/A			
Yearly	10-129 kWh/.m^2.year	**Altogether (2016-2020)**	8,000,000-103,200,000 kWh (considering 1 year of survey and fund raising is needed)
Calculation Methodology	See calculation methodology for H 01: Minimum Energy Performance Standards (MEPS), considering this measure applied in a total building area of 200,000 m^2.		
Data Needs/ Availability	- Number and type of equipment replaced in old buildings - Number and type of equipment installed in new buildings - Energy consumption of each equipment (efficient and non-efficient)		
Monitoring Method/ Savings Measurement	Using the data collected the energy savings due to energy efficient equipment could be calculated **E_equipment ((kWh)/year)=E_equipment (kW)*time ((hours)/day)* (days/year)** This equation could be used for both old and new equipment. When replacing an equipment A with an equipment B, the Energy savings would be (EA-EB) in kWh/year (E stands for energy consumed). The aim of this measure would be to replace equipment in 200 buildings of all types (total area to be tackled is around 200,000 m^2). - Input indicator(s): ▪ Percentage (number) of new equipment complying with the measure ▪ Energy class of each equipment installed or replaced ▪ Area tackled, number of buildings, type of buildings - Outcome indicator(s): Savings in energy consumption and GHG reduction		

B 04	USE OF EFFICIENT EQUIPMENT
Monitoring/ Verification	The LCEC is in charge of site checks and in keeping records of each building tackled through this measure.
Next Steps After 2020	Carry out a national scrapping program for old equipment with a higher degree of reach and support.
Funding	
1 Million USD	Budget not available

6.5 Energy Performance Certificate for Buildings

B05	ENERGY PERFORMANCE CERTIFICATE FOR BUILDINGS		
Description of the Measure	This measure aims at establishing a system of certification and labeling of the energy performance of buildings and setting minimum energy performance requirements. The measure also includes the labeling of an occupied area of 200,000 m^2.		
Type of measure	Regulation		
Sector	Building, industry, public		
Target Group	Consumers, energy auditors, developers, real estate companies		
Implementing Bodies	Ministry of Energy and Water, Order of Architects and Engineers, LGBC,LCEC		
Start Date	2016	**End Date**	2020
Current Status and Plan for Implementation			

This initiative is based on the recommendations of the Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the Energy Performance of Buildings.

Minimum energy performance requirements should be developed based on surveys to set the actual energy performance levels of Lebanese buildings (residential/non-residential and new/existing). The surveys should be able to show buildings energy consumption regarding heating, cooling, ventilation, hot water and lighting.

Minimum energy performance requirements should take into consideration the annual energy consumption for residential and non-residential buildings and the percentage of energy from renewable sources in the total energy consumption. Surveys are essential to set the actual level of energy performance of Lebanese buildings.

After setting a minimum energy performance and a label for the energy performance levels for each type of buildings, a methodology for calculating the energy performance should be developed. Its method for application on both new and existing buildings should be clear.

A template of Energy Performance Certificate will be developed. It should include the annual energy consumption, recommendations for the cost-optimal or cost-effective improvement of the energy performance of a building or building unit. These recommendations should be technically feasible in new buildings (envelope, equipment...) and existing buildings (renovation techniques...).

This measure should also specify the qualifications of certifying bodies (auditors, consultants…) and inspection templates and methods.

Set Targets and Estimated Impact on Energy Saving			
The impact should be calculated based on the expected reduction of consumption between actual buildings and minimum expected level of performance. This measure is tackling 200,000 m^2 of occupied area.			
Yearly	22-144 kWh/m^2.year	**Altogether (2016-2020)**	17,600,000-115,200,000 kWh (considering 1 year for funds raising)
Calculation Methodology	See Below		
Data Needs/ Availability	- Building types in Lebanon - Construction materials market in Lebanon - Equipment types and their consumptions		
Monitoring Method/ Savings Measurement	- Input indicator(s): Data of 200 buildings of 1,000 m^2 each or a total area of 200,000 m^2 - Output indicator(s): ▪ Using the data collected to develop a tool generating load curves including heating, cooling, ventilation, domestic hot water, lighting and other equipment for each type of buildings ▪ Load curves of each consumption station are the basis of the tool ▪ Load curves of all devices will be assembled to generate the elementary load curve of the building ▪ The assembly of the buildings load curves generates the load curve of the neighborhood or geographic area chosen - Outcome indicator(s): Generate a performance table for each type of building (kWh/m^2.year) and calculate the final energy savings and GHG reduction		
Monitoring/ Verification	The LCEC is in charge of: - Technical inspection - Monitoring the percentage of new buildings labeled - Monitoring the percentage of existing buildings labeled		
Next Steps After 2020	Make this measure obligatory in all types of buildings especially upon sale of building or building unit.		
Funding			
1 Million USD	Budget not available		

The simplified calculation methodology of the above measure is to propose a reduction of consumption for each type of buildings, thus calculate expected savings: Considering that the Lebanese buildings fall in the category (class) G on the French scale, the target would be to set a minimum performance level and calculate the savings compared to the chosen baseline.

In fact the French classification of the buildings performance is detailed as follows:

TABLE 6: FRENCH CLASSIFICATION OF BUILDINGS PERFORMANCE

Consumption in primary energy (kWh/m².year)	Class
<15	A++
15-50	A
51-90	B
91-150	C
151-230	D
231-330	E
331-450	F
>451	G

Note that this consumption is a primary energy consumption and it includes heating, cooling, ventilation, domestic hot water and lighting. As mentioned before, the NEEAP 2016-2020 includes final energy consumption in each of its measures. Thus the final energy equivalent of the primary energy in the table above is listed in table 7.

TABLE 7: EQUIVALENT CONSUMPTION IN FINAL ENERGY

Consumption (kWh/m².year)	Class
<5.8	A++
5.8 - 19.4	A
19.8 - 34.9	B
35.3 - 58.1	C
58.5 - 89.1	D
89.5 - 127.9	E
128.3 - 174.4	F
>174.8	G

This measure could adopt F as the current Lebanese Baseline considering that the average of final energy consumption is around 150 kWh/m^2.year.Thus, savings will depend on the new minimum performance level chosen. Table 8 shows the expected savings if each of the levels above F were adopted as the minimum performance level for buildings.

TABLE 8: FRENCH CLASSIFICATION OF BUILDINGS PERFORMANCE

Savings (kWh/m^2.year)	Class
>144.2	F --> A++
130.6-144.2	F --> A
115.1-130.2	F --> B
91.9-114.7	F --> C
60.9-91.5	F --> D
22.5-60.5	F --> E

6.6 Energy audits for public buildings

B 06	ENERGY AUDITS FOR PUBLIC BUILDINGS		
Description of the Measure	This measure aims at performing energy audits for 200 public buildings including all types of usage: hospitals, schools, administrations…		
Type of measure	Action Plan		
Sector	Building, public		
Target Group	Auditors, consultants, public facilities (municipalities, ministries…)		
Implementing Bodies	ESCO, Auditors, LCEC		
Start Date	2017	**End Date**	2020
Current Status and Plan for Implementation			
Article 19 of the Energy Conservation Law states that all public buildings should be audited. This measure aims at auditing 200 public buildings. The selection should include different buildings sizes, different regions, different usage type (ministries, municipalities…) An energy audit is a systematic method for obtaining sufficient information about the existing energy consumption profile of a building or group of buildings in order to determine and quantify the opportunities for energy savings and record the results in a report. This measure will be performed by certified auditors and consultants. It will be the base for setting a baseline and reference value of public building consumption. <u>For accomplishing this measure, the following steps should be ensured:</u> - Set a uniform methodology for auditing to be used by the different auditors - Set a uniform template for results presentation - Define the qualifications of the auditing bodies - The audits will lead to proposing measures			

B 06	ENERGY AUDITS FOR PUBLIC BUILDINGS		
Set Targets and Estimated Impact on Energy Saving			
The public building sector should give the example regarding the reduction in the energy consumption. Auditing public buildings was mentioned in the Energy Conservation Law. The impact here is indirect, and it shall be calculated in the implementation phase after auditing.			
Yearly	N/A	**Altogether (2016-2020)**	N/A
Calculation Methodology	N/A		
Data Needs/ Availability	- Total energy consumption for every building - Keep track of which companies undertook the audits and what the outcomes were (baselines, savings potential, possibly obligatory reporting for all certified auditors back to LCEC) - Keep track of actions through regular short progress reports from the industries (e.g. every 4 years)		
Monitoring Method/ Savings Measurement	- Input indicator(s): Number of public buildings audited and number of public buildings that are obliged (fall under Energy Conservation Law). - Output indicator(s): Saving opportunities defined by auditors and implementation of these by the buildings - Outcome indicator(s): Energy savings and resulting GHG emission savings achieved through efficiency programmes defined by auditor		
Monitoring/ Verification	- LCEC in charge of keeping track of all buildings that fall under regulation and their energy consumption annually. - Public buildings obliged to report energy consumption and efficiency actions to LCEC - LCEC to report on buildings actions and savings every 4 years		
Next Steps After 2020	- Energy audits applied to all the public buildings - Proposed energy efficiency measures implemented - Awareness campaign conducted to change users' behavior and achieve no-cost savings		
Funding			
2 Million USD	Budget not available		

6.7 Implementing measures in selected public buildings

B 07	IMPLEMENTING MEASURES IN SELECTED PUBLIC BUILDINGS		
Description of the Measure	This measure aims at implementing energy efficiency measures in selected public buildings.		
Type of measure	Implementation		
Sector	Building, public		
Target Group	Energy auditors, consultants, public facilities (municipalities, ministries…)		
Implementing Bodies	Energy auditors, ministries in charge of the audited buildings, directors for the audited buildings, LCEC		
Start Date	2017	**End Date**	2020
Current Status and Plan for Implementation			
The audits applied on public buildings in lead to proposed energy efficiency measures. These measures may include: - High performance double flow ventilation with heat recovery - Use of energy efficient equipment based on MEPS developed in measure H 01 for heating, cooling and ventilation equipment - Use of renewable energy for hot water and electricity generation - Improvement of the building envelope (U-value, infiltration, insulation, glazing, fenestration…) - Use of green lighting and install dimmers and motion sensors on lights where possible to control electricity use - Behavioral change and awareness			
Set Targets and Estimated Impact on Energy Saving			
The public building sector should give the example regarding the reduction in the energy consumption. The impact here is direct but shall be calculated depending on the type of measure implemented.			
Yearly	N/A	**Altogether (2016-2020)**	N/A
Calculation Methodology	N/A		
Data Needs/ Availability	- Energy consumption by usage (heating, cooling, ventilation, lighting, equipment…) - Choice of measures to be implemented		
Monitoring Method/ Savings Measurement	- Input indicator(s): Results of the audits and energy bills before and after implementation of the energy efficiency measures - Output indicator(s): Implemented measures (lighting, envelope improvement, efficient equipment…) - Outcome indicator(s): Savings achieved per measure and total savings achieved		
Monitoring/ Verification	- LCEC continuous checks and inspections - Public buildings to update the LCEC on energy consumption		
Next Steps After 2020	The next step would be to implement energy efficiency measures in all the public buildings.		
Funding			
20 Million USD	Funding potential by the World Bank		

6.8 Pilot project

B 08	PILOT PROJECT		
Description of the Measure	This measure aims at building an exemplary green building (LCEC new premises).		
Type of measure	Implementation		
Sector	Building		
Target Group	Energy auditors, consultants, contractors, LCEC		
Implementing Bodies	LCEC		
Start Date	2016	**End Date**	2020
Current Status and Plan for Implementation			
The building should include all possible energy efficient measures where the building energy consumption should be lower than 35 kWh/m^2.year which corresponds to Class B proposed in measure B 05. Factors to be considered are: - Building envelope - Ventilation and tightness - Efficient equipment - Efficient lighting - Water pipes and air ducts insulation - Building Management System (BMS) - Use of renewable energy sources			
Set Targets and Estimated Impact on Energy Saving			
The pilot project should be energy efficient and should present a high energy performance level where its annual consumption should be less than 35 kWh/m^2. The estimated savings compared to an actual building would be around 115 kWh/m^2.year considering that an average consumption of a current building is 150 kW/m^2.year.			
Yearly	115 kWh/m^2.year	**Altogether (2016-2020)**	345,000 kWh
Calculation Methodology	The total savings in kWh are dependent on the occupied area of the selected building, for this measure, 1000 m^2 are considered.		
Data Needs/ Availability	- Building type, orientation, envelope, occupancy, neighborhood, occupied space - Energy consumption by usage (heating, cooling, ventilation, lighting, equipment…)		
Monitoring Method/ Savings Measurement	- Input indicator(s): Check data needs above - Output indicator(s): Building construction - Outcome indicator(s): Final energy consumption		
Monitoring/ Verification	- LCEC will be supervising each phase of the building construction - LCEC will be checking the monthly data of energy consumption after occupancy		
Next Steps After 2020	The next step would be to communicate savings and promote similar projects.		
Funding			
1 Million USD	Available through the LCEC budget		
2 Million USD	For fund raising		

6.9 Capacity building for refurbishment

B 09	CAPACITY BUILDING FOR REFURBISHMENT		
Description of the Measure	This measure aims at training and educating workers on the best ways of renovating a building going green.		
Type of measure	Capacity Building		
Sector	Building		
Target Group	Energy auditors, consultants, contractors		
Implementing Bodies	Order of Engineers and Architects of Beirut, Order of Engineers and Architects of Tripoli, Ministry of Public Works and Transport / Higher Council for Urban Planning, LCEC		
Start Date	2016	**End Date**	2020
Current Status and Plan for Implementation			
Based on the national building stock based, as appropriate on statistical sampling, this measure aims to teach the ESCOs and the energy efficiency consultants the methodology for building renovation: - How to do energy audits and how to use the resulting data - Categorize the cost-effective approaches to renovations relevant to the building type and climatic zone - Identify policies and measures to stimulate cost-effective deep renovations of buildings, including staged deep renovations - How to guide investment decisions of individuals, the construction industry and financial institutions			
Set Targets and Estimated Impact on Energy Saving			
This measure does not have a direct impact on building sector energy savings. However, its impact is shown in the renovation of the existing building going towards higher energy performance levels.			
Yearly	N/A	**Altogether (2016-2020)**	N/A
Calculation Methodology	N/A		
Data Needs/ Availability	Current knowledge and application of energy auditors, consultants and contractors in renovation.		
Monitoring Method/ Savings Measurement	- Input indicator(s): Current state of the renovation in the Lebanese building sector, existing policies, contractors knowledge. - Output indicator(s): ▪ Define policies and procedures for efficient buildings' refurbishment ▪ Include the policies and the procedures in ESCOs' scope of work ▪ Organize 10 sets of trainings and workshops to introduce the refurbishment procedure and requirements. - Outcome indicator(s): Energy savings due to an efficient refurbishment of the existing Lebanese buildings, thus reduction of GHG emissions.		
Monitoring/ Verification	- LCEC will be in charge of setting the procedures with both the Orders of Engineers and Architects and the Higher Council for Urban Planning - LCEC will be organizing the trainings and the workshops		
Next Steps After 2020	The next step would be to impose mandatory refurbishment of the Lebanese buildings older than 30 years.		
Funding			
600,000 USD	Estimated at 150,000 USD per year over 4 years. Budget not available		

Picture 08 Renovation of existing buildings could lead to considerable energy saving

Picture 09 Energy performance certificates: measuring the "health" of a building

07

END-USE MEASURES IN INDUSTRY & AGRICULTURE

CHAPTER 07 END-USE MEASURES IN THE INDUSTRY, SME'S AND AGRICULTURE

This section of the NEEAP 2016-2020 covers the industrial and agricultural sectors. While two measures are proposed for the industrial sector, only one measure is proposed for the agriculture sector. The three measures are listed here below:

- I 01: Mandatory Energy Audits in the Industrial Sector
- I 02: Energy Efficiency Measures in the Industrial Sector
- I 03: Energy Efficient Measures in the Agriculture Sector

7.1 Industrial sector

The following paragraphs will offer a general overview of the Lebanese industrial sector before presenting the two proposed energy saving measures.

The last report published by the Ministry of Industry regarding the industrial sector dates back to 2010. The report is entitled "The Lebanese Industrial Sector: Facts and Findings-2007" and it covers all industrial plants operating in the different Lebanese regions. The report provides data regarding the performance, capacities, problems and needs of the surveyed industries. Most of the data and information used in this section of the NEEAP 2016-2020 are based on the mentioned study. In addition, other data included in this section of the NEEAP is based on direct contact and meetings with the Director General and the technical teams of the Ministry of Industry.

The Lebanese industrial sector is made of 4,033 factories employing five workers or more, having a power subscription higher than 10 kVA (50A/220V), and having an operating area of more than 100 m^2. These industrial facilities are distributed over 22 industrial sectors. 65% of all industrial facilities are in the food, furniture, minerals and metals sectors. The food and beverage sector is the largest contributor (25.7%) to the industrial production. The average built area of all industries is 2,877 m^2 and the average operating area for 62% of the industries is 364 m^2. The operating area ranges from a simple open storage to a highly sophisticated laboratory, hence, the comparison between sectors or factories could be biased by the complexity and cost of the built operation area. It is important to note that 99.2% of Lebanese industries have less than 250 employees. Thirty-two large enterprises exist, which employ 16.5% of the industry's workforce (22).

For the purpose of this report, it is estimated that the energy demand of all industries in terms of electricity, diesel/gas oil, residual fuel oil, LPG and coal bituminous would be 1,603 ktoe in 2015. It is worth noting that in 1994, the Lebanese industry reached about 970 ktoe of end-use energy consumption.

Some additional info regarding the industrial sector would give a better picture of the energy situation: the industrial sector contributed to 10.76% and 11.2% of the GDP of Lebanon in 2012 and 2013 respectively. The industrial sector consumed 20% of the final energy consumption in 2006. In 2009, the final energy intensity of the industrial sector was 2,910 tCO_{2e}/toe (23). The share of the final energy consumption of the industrial sector registered around 14% in 2010. In 2013, the cement sector produced 5,830,616 tons (around 417,785.61 toe), taking into consideration that 1 ton of Portland cement consumes 833.3 kWh (24).

It is important to note that the Ministry of Industry recently adopted the decision 7/1 entitled "the permanent statistical framework for industries". Each industry willing to obtain a certificate or an industrial statement is required to fill information regarding employees, production, fuel and electrical consumption. The aim of this study is the gathering of information and indicators of the industrial sector state in Lebanon at different levels, which will permit to set clear industrial action plans to develop the sector.

Under the supervision of the Ministry of Energy and Water and the LCEC, around 128 energy audits were undertaken by Energy Service Companies (ESCOs) between 2006 and 2010. The audits covered facilities from the industrial, commercial and services sectors. 22% of the total energy audits belong to the industrial sector. The distribution of energy consumption in the industrial sector shows that generators present the highest energy cost (61%), followed by thermal energy (23%), and followed by EDL electricity (16%) (Figure 9).

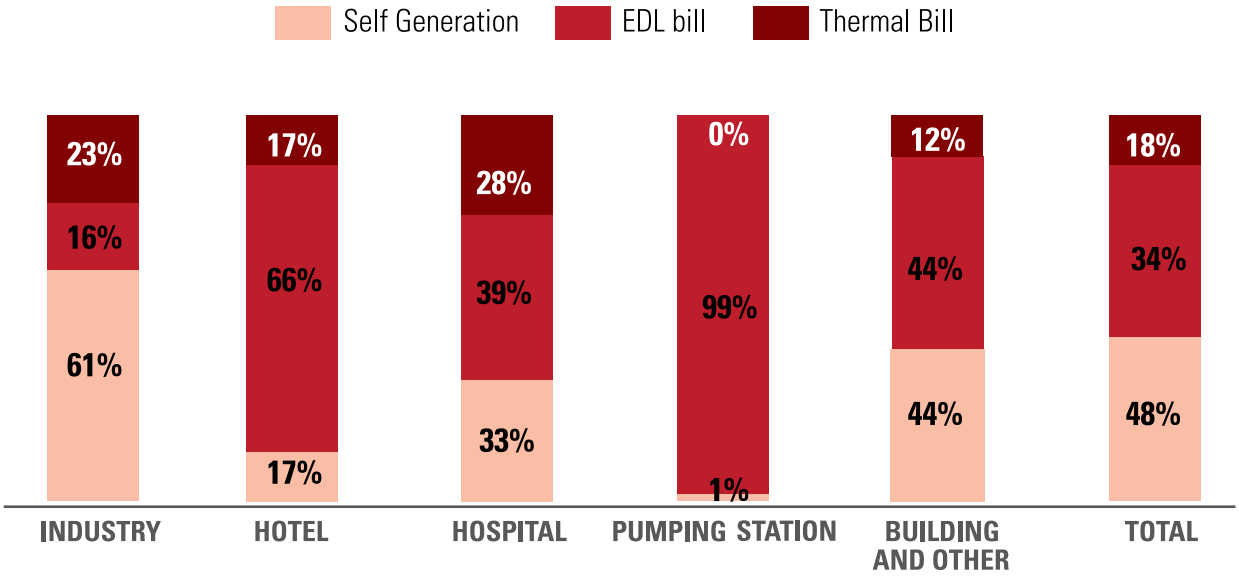


Figure 9 Share in energy bill per sector (25)

More specifically, the electrical energy breakdown consists of successively: motors 57%, cooling, air conditioning and others 29%; lighting 7% and boilers 6% as shown in figure 10.

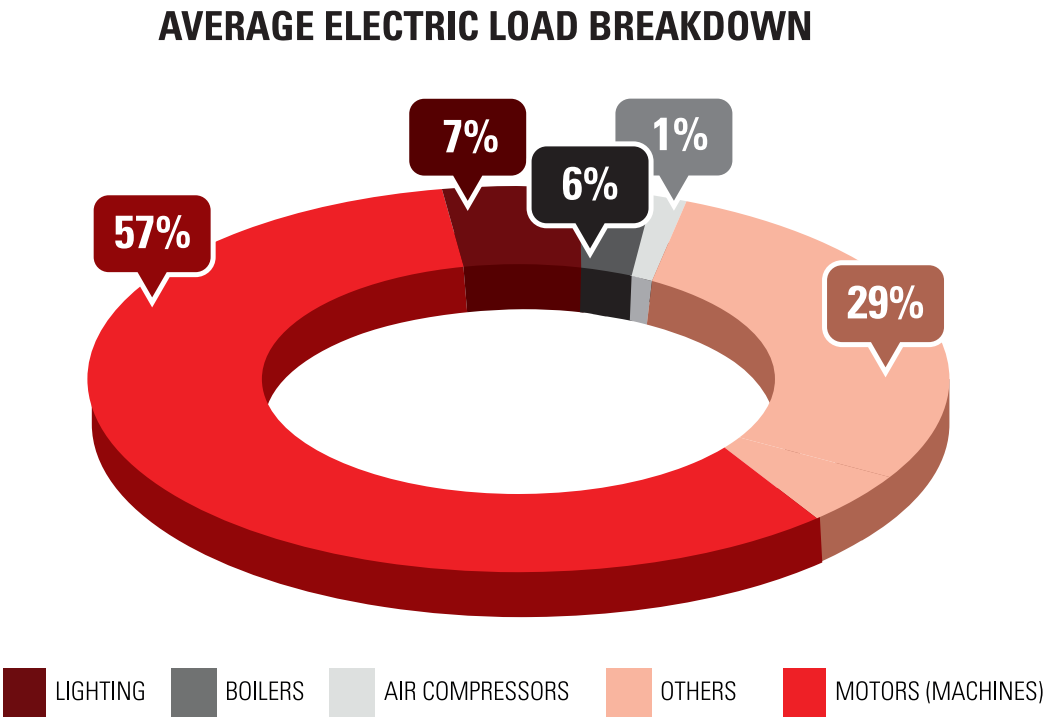


Figure 10 Electric Load Distribution in the industrial sector (25)

Based on all of the above, the current NEEAP 2016-2020 proposes two energy saving measures in the industrial sector. The first measure targeting the industrial sector aims at forcing large existing facilities to perform regular energy audits as a first step towards implementing energy efficiency measures.

By conducting regular and periodic energy audits, the level of awareness of the management of large industrial facilities will be increasing. Accordingly, facility managers will be implementing "no-cost" or "low-cost" measures in the facilities. In addition, a behavioral change in consuming energy will be taking place. The current NEEAP 2016-2020 estimates that the simple act of conducting energy audits will lead to an overall energy saving of 5% of the facilities' total energy consumption due to the reasons mentioned earlier. This is clearly indicated in initiative I 01.

I 01	**MANDATORY ENERGY AUDITS**		
Description of the Measure	The draft Energy Conservation Law imposes mandatory audits for institutions consuming more than 400 toe (2,500 kVA). This measure aims at obliging these industries (existing and new) to conduct regular energy audits. This measure offers also incentives for 800 industries to perform the energy audits, among them 36 existing industries consuming more than 400 toe.		
Type of Measure	Regulation, incentives, implementation		
Sector	Industry		
Target Group	Large energy consuming industrial facilities, ESCO, energy auditors, LCEC, MOI, MOF.		
Implementing Bodies	Ministry of Industry, with support from LCEC		
Start Date	2017	**End Date**	2018
Current Status and Plan for Implementation			
Energy audit means a systematic procedure with the purpose of obtaining an adequate knowledge of the existing energy consumption profile of a building or group of buildings and/or an industrial operation, identifying and quantifying cost-effective energy savings opportunities, and reporting the findings. (25)			
Set Targets and Estimated Impact on Energy Saving			
Mandatory energy audit is a first step to track energy consumption and benchmark industries. When defining potentials for possible energy efficient use, this will lead to energy savings at later stages. However, by conducting regular energy audits, industrial facilities could save up to 5% of the total energy consumption due to the application of "no cost/low cost" measures and through some behavioral changes.			
Yearly	21,030,000 kWh/year	**Altogether (2016-2020)**	84,120,000 kWh

I 01	MANDATORY ENERGY AUDITS
Calculation Methodology	- Concerning mandatory energy audits, industries to fall under this measure could be defined on the basis of their energy consumption: greater than 4,562 MWh per year (equivalent to 400 toe per year). As per MOI, industries consuming more than 400 toe are 36 industries. They are obliged to undertake energy audits as well as new industrial facilities. - As for Incentives for conducting energy audits: the first 800 industries willing to conduct energy audits benefit from 50% of the amount needed. As an average, a complete energy audit costs around 10,000 $. The total grant would be around 2 million USD and each industry will benefit from 5,000 $ - This measure should be combined with awareness campaigns in the industrial sector especially in rural areas. The savings are calculated based on the assumption of 5% due to audit. The overall consumption of the industrial sector is calculated in details in the measure below I 02.
Data Needs/ Availability	- Total energy consumption for every Industry (collaborate with EDL and fuel suppliers, ESCOs and industries) to track the performance of industrial enterprises - Keep track of which companies undertook the audits and what the outcomes were (savings potential, obligatory reporting for all Energy Service Companies back to LCEC) - Keep track of actions through regular short progress reports from the industries (e.g. every 4 years) - Certified energy auditor will require numerous data from the enterprises directly (and potentially also gather some of the data)
Monitoring Method/ Savings Measurement	- Input indicator(s): Number of companies audited vs. number of companies that are obliged (fall under defined threshold) = equal rate of each - Output indicator(s): Reports on the energy consumption of total audited industries by sector/ size... and analyses of the results to obtain a baseline consumption data to proceed with energy saving measures. - Outcome indicator(s): Potential savings in energy consumption thus potential reduction of GHG emissions
Monitoring/ Verification	- LCEC in charge of keeping track of all industries that fall under regulation and their energy consumption annually. - Industry obliged to report energy consumption and efficiency actions to LCEC
Next Steps After 2020	The next step would be to make the auditing process continuous for all industries.
Funding	
25 Million USD	Budget not available.

ENERGY AUDIT PROCEDURES AND REQUIREMENTS

An energy audit is an in-depth analysis of the energy consumption inside a given facility resulting in the evaluation of the efficiency of most systems that use energy. The energy auditor starts at the utility meters, locating all energy sources coming into a facility. The auditor then identifies energy streams for each type of energy sources, quantifies those energy streams into discrete functions, evaluates the efficiency of each of those functions, and identifies energy and cost savings opportunities. The results of an energy audit study are compiled in an energy audit report.

More specifically, an energy audit quantifies energy use through a detailed review and analysis of equipment, systems, operational characteristics, and on-site measurements and testing and suggests measures to reduce the energy consumption. Standard energy engineering calculations are used to analyze efficiencies and calculate energy and cost savings based on improvements and changes to each system. The standard audit also includes an economic analysis of recommended Energy Conservation Measures (ECM).

The Energy Audit is undertaken following a well-structured path summarized as follows:

1. Walk Through Audit or Preliminary Audit: the first phase consists of site examination to be audited including its equipment and energy consumption... to become familiar with the industry operation and to identify areas of energy waste or inefficiency and potentials for energy efficient implementation measures.
2. In Depth or Detailed Energy Audit:
   - Data collection and documentation: gathering all historical databases from energy bills for the last 2-3 years.
   - Gathering all facility layout, description, load data, operational hours
   - Perform a full load inventory on all electrical loads: (lighting to HVAC, motors, resistive equipment…)
   - Perform actual and historical measurement (data logging) on all important electrical loads and distribution panels
   - Build an energy simulation of the facility using energy analysis software. This modeling allows having a detailed load and cost breakdown along with an in depth study on the consumption of the facility
   - Energy data analysis: energy consumption patterns and measurements are analyzed. Utility bills are examined and baseline year consumption for electricity, fuel sources and water is established.
   - Development of the list of potential energy conservation measures: All the previous steps are documented in a comprehensive energy audit report and selected. Detailed description of energy conservation measures (ECM) and scenarios are suggested. The report mentions the economic assessment for every ECM by calculating its initial cost, the potential savings and the simple payback period and the environmental impact (GHG emissions reduction)
   - Preparation of the list of contactors or Energy Service Companies for the ECM implementation.
   - Measurement, verification and follow up impacts and effectiveness of implemented ECM options/ scenarios are measured and evaluated in terms of efficiency improvement, consumption levels and decreasing energy costs.

Picture 12 A solid energy audit relies on the use of accurate testing equipment

Picture 13 Energy savings start with energy measurements

Picture 14 Industries offer large opportunities in energy saving

I 02	IMPLEMENTING ENERGY EFFICIENCY MEASURES IN 20% OF THE LEBANESE INDUSTRIES		
Description of the Measure	This measure aims at implementing energy efficient measures ''EEM'' in 800 industries and to consider the compliance of equipment before giving industrial permits. Incentives for implementing the suggested seven EEM's (they can be implemented through NEEREA projects).		
Type of Measure	Implementation		
Sector	Industry		
Target Group	20% of the industries, around 800 industries		
Implementing Bodies	Ministry of Industry, with support from LCEC		
Start Date	2017	**End Date**	2020
Current Status and Plan for Implementation			
This measure tackles 20% of the 4,033 Lebanese industries employing five workers or more, having a power subsription higher than 10kVA (50A/220V), and having an operating area of more than 100 m^2. Reduction of energy consumption through the implementation of 7 energy efficient measures related to the industrial process **EEM1**: High Efficiency Motors **EEM2:** Motors-Power Factor Improvement **EEM3:** Boiler Efficiency Improvement **EEM4:** Heat Recovery Systems **EEM5:** Cogeneration- Exhaust Gas **EEM6:** Preheating Systems **EEM7:** Improvement of Cooling Systems			
Set Targets and Estimated Impact on Energy Saving			
The implementation of 7 energy efficient measures (directly related to the industrial process) in 20% of industrial establishments will lead to a reduction of 105.14 GWh/year.			
Yearly	105,140,000 kWh/ year	**Altogether (2016-2020)**	525,690,000 kWh (Cumulative savings based on EEM implementation in 200 industries per year)
Calculation Methodology	- Based on surveys currently conducted by the LCEC, the total electricity consumption of the industrial sector is 4,201 GWh per year in Lebanon. The electrical consumption of large industries is around 3,850 MWh/year whereas it is around 650 MWh/year for small industries. Considering 500 large industries and 3,500 medium ones, the average electrical consumption of the Lebanese industries is around 4,201 GWh/year. - The total thermal energy consumption in the Lebanese industries was found to be around 4,210 GWh, where the large industries consume around 4,360 MWh/year and medium ones consume 580 MWh/year.		

Calculation Methodology	- The energy consumption ratio (RO) is represented here below: ▪The heating system accounts for 30% (0.3) of the total energy consumption ▪The cooling system accounts for 2 % (0.02) of the total energy consumption ▪The motors account for 15% (0.15) of the total energy consumption Based on previous experiences, the energy saving ratio in the industrial sector vary between 15% and 30%. Considering a saving ratio of 25% and tackling 20% of the fore-mentioned Lebanese industries, the average savings per year is then calculated. Savings=(Electrical conumption+Thermal consumption)*0.25*0.2 Savings=(4,201+4,210)*0.25*0.2=421 GWh/year Considering a penetration rate of 200 industries per year during four years, the cumulative savings are then found to be around 525.69 GWh.
Data Needs/ Availability	- Energy audits of industries - Measurement of energy consumption after the implementation of EEMs - Keep track of which companies undertook energy efficient measures and what the outcomes were (energy savings, possibly obligatory reporting for all Energy Service Companies back to LCEC) - Keep track of actions (other energy conservation measures) through regular short progress reports from the industries - Certified energy auditor will require numerous data from the industries directly for studies, statistics, action plans...
Monitoring Method/ Savings Measurement	- Input indicator(s): Number of industries that undertook EEMs through incentives and number of industries having energy consumption more than 400 toe that are obliged to reduce their energy consumption (data can be gathered from energy audits). - Output indicator(s): Implementation reports on the energy conservation measures in around 20% of the industries - Outcome indicator(s): Energy saved and emissions reduction
Monitoring/ Verification	- The ministry of industry and LCEC in charge of keeping track of all industries that fall under regulation and that undertook EEMs through incentives. - Industry obliged to report efficiency actions to LCEC
Next Steps After 2020	The next step would be to tackle the remaining 80% of the Lebanese industries.
Funding	
95- 190 Million USD	Budget depending on the measures implemented and the amount of savings achieved. Budget not available.

7.2 Energy Saving Measures in the Agriculture Sector

Agriculture is the third most important sector in Lebanon after the tertiary and the industrial sectors; it contributes to 7% of the GDP of the country (27). The agricultural production breaks down into vegetable production and animal production. Crop production accounts for around 71% of the total agricultural production. 29% of them are vegetables or cash crop production as per the Agricultural Census (28).The main agricultural products are citrus, grapes, tomatoes, apples, vegetables, potatoes, olives, tobacco, sheep and goats. The Agricultural Census reports in 2010 that:

- an increase of 35% in the number of farm holders working in agriculture to reach 165 thousand agricultural holders;
- an increase of 155% in the area of irrigated lands to 112 thousand hectares of 230 thousand hectares of cultivated lands;
- the fragmentation of agricultural lands in such a manner that 75% of farming units do not exceed 1 hectare and represent 20% of the total cultivated area.

The estimated total water consumption for irrigation is 1,050 Mm^3/year. Increasing water scarcity and agriculture intensification leads to more demand for the geographical location. Nevertheless, Lebanon's diversified climate and its production show an asset if only the country makes rational use of its natural resources, especially water, overcomes the obstacles limiting its competitiveness, and preserves the environment (29).

This section of the NEEAP proposes one measure in the agriculture sector that is related to water pumping. With more than 17,000 wells in the agriculture regions, more than 17,000 pumping stations are used to increase the water supply, especially in dry seasons where surface water is not available.

A study of the FAO shows that irrigating 1 hectar of land requires 8,575 m^3/year of groundwater. The volume of water is not easy to assess since it depends on the irrigation method and types of crops and soil. Lebanon is known for the law-use efficiency in irrigation systems and thus, it weakens its hydrological sustainability and affects its food production. The water is extracted from the earth depth where it is pumped through pipes to irrigate the cultivation. Different types of pumps exists, depending on areas of use, water quantity and quality extraction needs. Centrifugal pumps are the most common pumps used in irrigation systems.

Rational use of the water resource increases the water sustainability and the yield of production for farmers. Different water irrigation technologies exist and can help improving water management and energy efficiency at the same time. Installing drip irrigation, variable speed drives (VSD), energy efficient water pumps are examples of good practices and present potential water and energy savings. Traditionally, electric motors have operated at a fixed speed regardless the amount of water needed for extraction. By installing a VSD, which is an energy efficient electronic device, the motor speeds down to match the actual demand of water flow required for the pump, which can reduce energy consumption.

Accordingly, a VSD is installed when:

- Various flow rates are required in irrigation zones;
- Depth of water level varies from start of irrigation season to end of season;
- Pressure to inlet of current pump varies;
- Reduce flow to prevent over pumping on wells with slow recharge and dynamic water drawdown during pumping.

The following measure I 03 encourages the use of VSD in irrigation as a solution to reduce consumed energy.

I 03	**INSTALLING 100 VARIABLE SPEED DRIVES (VSD) ON IRRIGATION PUMPS**		
Description of the Measure	This measure is specific to the agriculture sector. It aims at installing variable speed drives (VSD) on 100 irrigation pumps.		
Type of Measure	Implementation		
Sector	Agriculture		
Target Group	Farmers using pumps for irrigation		
Implementing Bodies	Ministry of Agriculture, with support from LCEC		
Start Date	2016	**End Date**	2020
Current Status and Plan for Implementation			
VSDs will allow farmers to save energy and money when using irrigation pumps and will lead to a rational use of water resources and reduction of pressure on groundwater. (27)			
Set Targets and Estimated Impact on Energy Saving			
Average savings potential is 50 % on a pump overall consumption. This measure will target 100 irrigation pumps in several agricultural Lebanese regions.			

I 03	INSTALLING 100 VARIABLE SPEED DRIVES (VSD) ON IRRIGATION PUMPS		
Yearly	147,000 kWh/year	**Altogether (2016-2020)**	441,000 kWh (considering 2 years of implementation and funds raising are needed)
Calculation Methodology	Pumps targeted are defined based on their energy consumption, 30 hp or 22 kW and above (see calculation methodology below). The final energy savings is calculated assuming that all pumps are 30 hp.		
Data Needs/ Availability	- Types of pumps available in different regions in Lebanon, pumps size and average needed volume of water to irrigate lands in dry seasons. - Total energy consumption of pumps (survey with farmers and measurements) to set a baseline energy consumption based on needs of water extraction		
Monitoring Method/ Savings Measurement	- Input indicator(s): 100 VSD installed and number of pumps with potentials for energy savings - Output indicator(s): ▪ Current consumption of irrigation pumps to be modified ▪ Number, size and type (hp/kW) of pumps modified - Outcome indicator(s): Energy savings and resulting GHG emission savings achieved through implementing VSDs on irrigation pumps		
Monitoring/ Verification	- LCEC in charge of keeping track of all farms that undertook the implementation and their energy consumption annually - LCEC with collaboration with contractors/consultants implementing VSD pumping to report the project results		
Next Steps After 2020	The next step would be to tackle all the irrigation pumps in the Lebanese agriculture sector		
Funding			
600,000 USD	Budget not available		

Different VSD energy savings calculators are available online. The parameters that affect the most the pump efficiency are the following: pump speed, operation hours of the pump, efficiency of the VSD, and input voltage. To calculate the energy savings, refer to the affinity law: when the speed decreases, the load on the pumps decreases and savings increase. For instance, at 50% speed, the load would be 12% of the full load and the power saved is 87%. As an average, the installation of a VSD can save 50% on the energy cost and consumption.

The farms are unevenly distributed in the country. In 2005, the average farm size was at 12,484 m^2 (30), with the highest number registered in the Bekaa Valley and Anti-Lebanon mountains (26,622 m^2) and the lowest in Mount Lebanon (6,058 m^2). Assuming that a VSD costs 5,000 USD including site measurements and installation, the total cost of a VSD would be 500,000 USD. Based on those indicators, the measure of installing 100 VSDs in irrigated lands is illustrated in Figure 11.

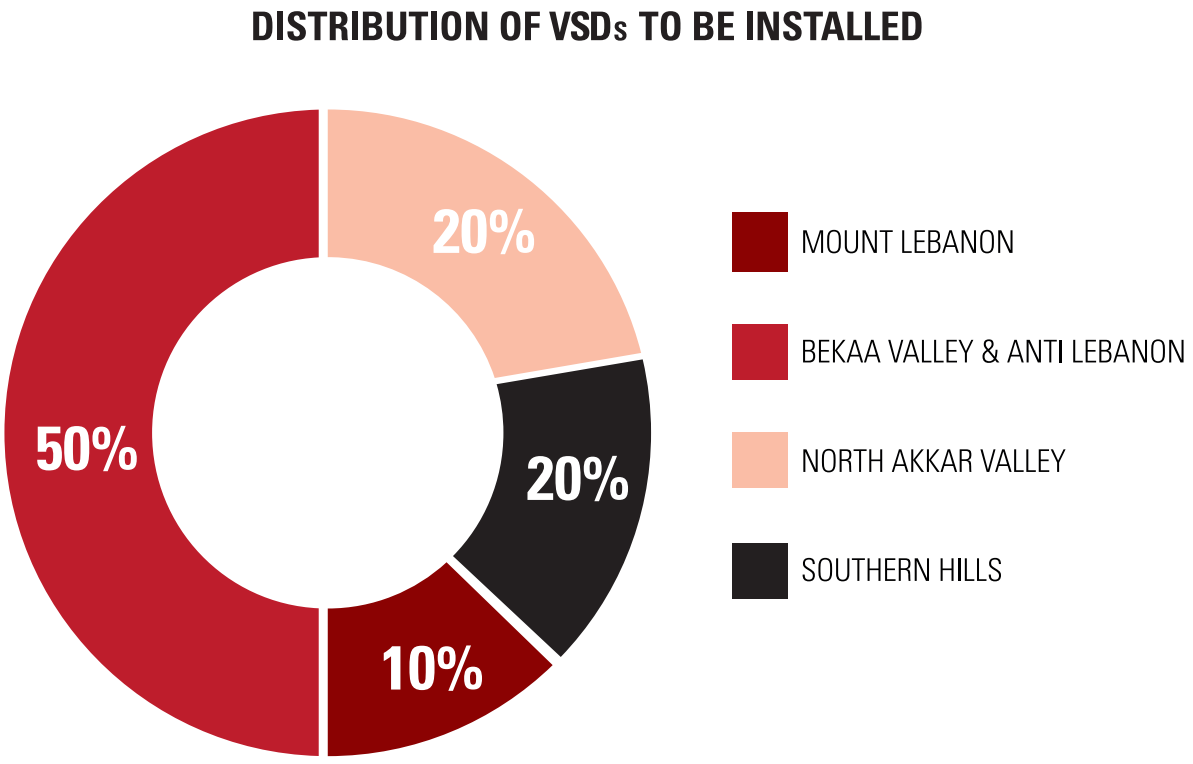


Figure 11 VSDs to be installed in the different Lebanese regions

Assuming that the water consumption per day of one farm of 12,484 m^2 is 68 m^3 based on a total water consumed for irrigation of 1050 Mm^3/year and assuming also that the energy needed to lift 1 m^3 of groundwater with vertical distance of 100 m is 0.36 kWh (31). Thus, the energy used would be 24.5 kWh/day in each farm. Due to the uneven distribution of precipitation in space and over time and which occurs during a short period (80 days and 10 hours a day during 6 days), the dry season is considered to expand over 285 days (32).

If we consider that the irrigation period from groundwater is 120 days, then the volume pumped per year would be 8,160 m^3/farm and the energy consumed to lift this volume would be 2,940 kWh/year. Over 100 farms, the energy used is 294,000 kWh/year. If we install 100 VSD on pumps, the savings would be around 50%, thus 147,000 kWh/year.

MEASURES IN MOBILITY & TRANSPORT

CHAPTER 8 **MEASURES IN MOBILITY AND TRANSPORT**

The transportation sector in Lebanon is a major energy consumer. The transportation sector is part of the responsibilities of the Ministry of Public Works and Transportation. Lebanon lacks a clear vision and strategy for the transportation sector. In addition, there is a clear lack of data regarding this vital sector. This section of the second NEEAP will present an overview of the transportation sector and the potential areas of energy saving. This section will not include any calculation for energy saving in the transportation sector. It is also important to note that the potential energy savings in this sector will not be part of the NEEAP national target.

The purpose of including the transportation sector in this NEEAP is to initiate a national momentum to start discussing a potential strategy for the country. This section will cover three main titles:

- Current situation of the Lebanese transportation sector;
- Existing policies and measures;
- Different studies on improving the Lebanese transportation sector;
- Possible savings in the transportation sector.

8.1 Current Situation of the Lebanese Transportation Sector

In terms of infrastructure, the transportation sector is made of the air transportation, maritime transportation, and land transportation.

a. Air Transportation

The Beirut Rafic Hariri International Airport is located at 9 kilometers from the center of Beirut. It is considered as the main headquarter of the Lebanese aviation company MEA (Middle East Airlines). The airport was renovated in the nineties. In 2013, the airport received around 6,248,744 passengers.

b. Maritime Transportation

Maritime transport in Lebanon is the most important mode for external trade. There are four main ports in Lebanon:

- Port of Beirut: Located in the capital city Beirut, the Port of Beirut is the main port in Lebanon and is one of the largest ports on the Eastern Mediterranean. The port consists of a total area of 1.2 million m^2
- Port of Tripoli: The Port of Tripoli has an approximate area of 3 million m^2. It receives approximately 450 ships every year, averaging around 37 ships per month.
- Port of Sidon: The port of Sidon is an ancient port, mainly used as a fishing port and for accommodating small freighters. About 200 ships enter the port of Sidon each year from Europe, Africa and Arab countries
- Port of Tyre: The Port of Tyre is a small harbor that is located in south Lebanon. In this port, the breakwater protects the Marina harboring fishing boats and some private pleasure crafts or sailing boats, but does not extend sufficiently to shelter vessels berthing at the main harbor (33)

c. Land Transportation

Lebanon had about 22,000 km of roads in 2001 of which 30% are classified and fall under the authority of the MPW&T, while the remaining 70% (about 15,400 km) are non-classified roads governed by municipalities (34).

The share of road transport in Lebanon reached 28.7% of total primary energy and about 42% of final energy in 2008, compared to about 27% and 40% for the year 2009 according to International Energy Agency (35). The oil consumption of the road transport sector constituted more than 60% of the total oil consumption, 99.2% of which is gasoline.

Table 9 shows that the energy consumed by the road transport did not record major changes from 2000 to 2010.

TABLE 9: PERCENTAGE OF ENERGY CONSUMPTION IN THE LEBANESE ROAD TRANSPORT SECTOR OF THE TOTAL PRIMARY ENERGY (36)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
%	28	24	25	26	26	27	28	25	28	27	27

Lebanese road transport sector consumes energy (in terms of percentage of the total energy consumption of the country) double the world average. The passenger transport sector presents a high energy demand per capita, higher than the world average. An average Lebanese consumes about 2.7 times more than the world average and 2.3 times more than a citizen in the Arab world (Figure 12).

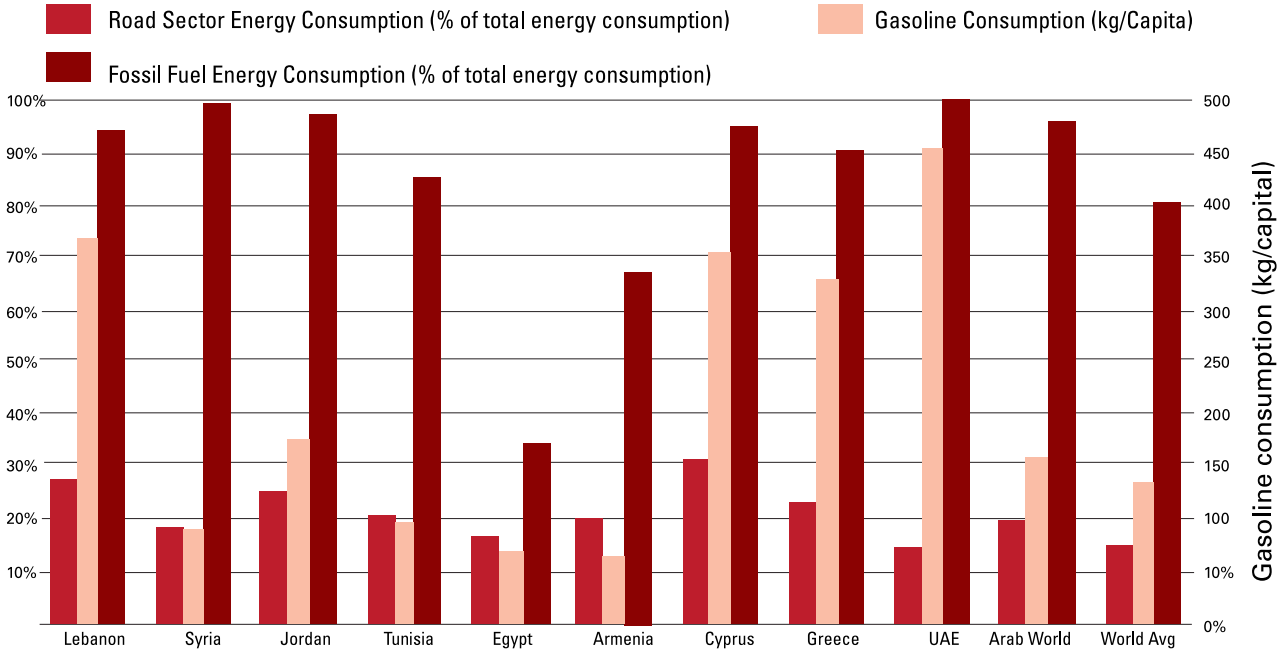


Figure 12 Energy consumption indicators (37)

Mobility demand has experienced a real explosion since 1990, particularly in Greater Beirut Area (GBA), and the trend is strongly upward over the decade to come. This growth is mainly attributed to the rise of daily passenger trips and the increase of car ownership.

The Lebanese car fleet counted around 1.55 million vehicles in 2007. Private passenger cars constitute around 80% of this car fleet (38). That implies a rate of ownership of 3 cars per person.

Mansour and Al showed in (39) that the 2012 vehicle fleet database presents a total of 1.58 million registered vehicles: 85% passenger cars, 0.9% buses, 8.9% trucks and 5.2% motorcycles whereas table 10 shows the Lebanese vehicle fleet composition in 2007.

TABLE 10: THE LEBANESE VEHICLE FLEET COMPOSITION IN 2007	
Passenger cars	1,247,572
Red plate cars	47,707
Heavy duty vehicles	183,428
2/3-wheelers	70,699
Agriculture vehicles	210
Total	**1,549,616**

The average age of the Lebanese car fleet is 13 years. Figure 13 shows the age distribution of the Lebanese car fleet. It is shown that 71% of the cars have more than 10 years. 60% of the cars have engine displacements exceeding 2.0 liters, while only 8% have engines less than 1.4.

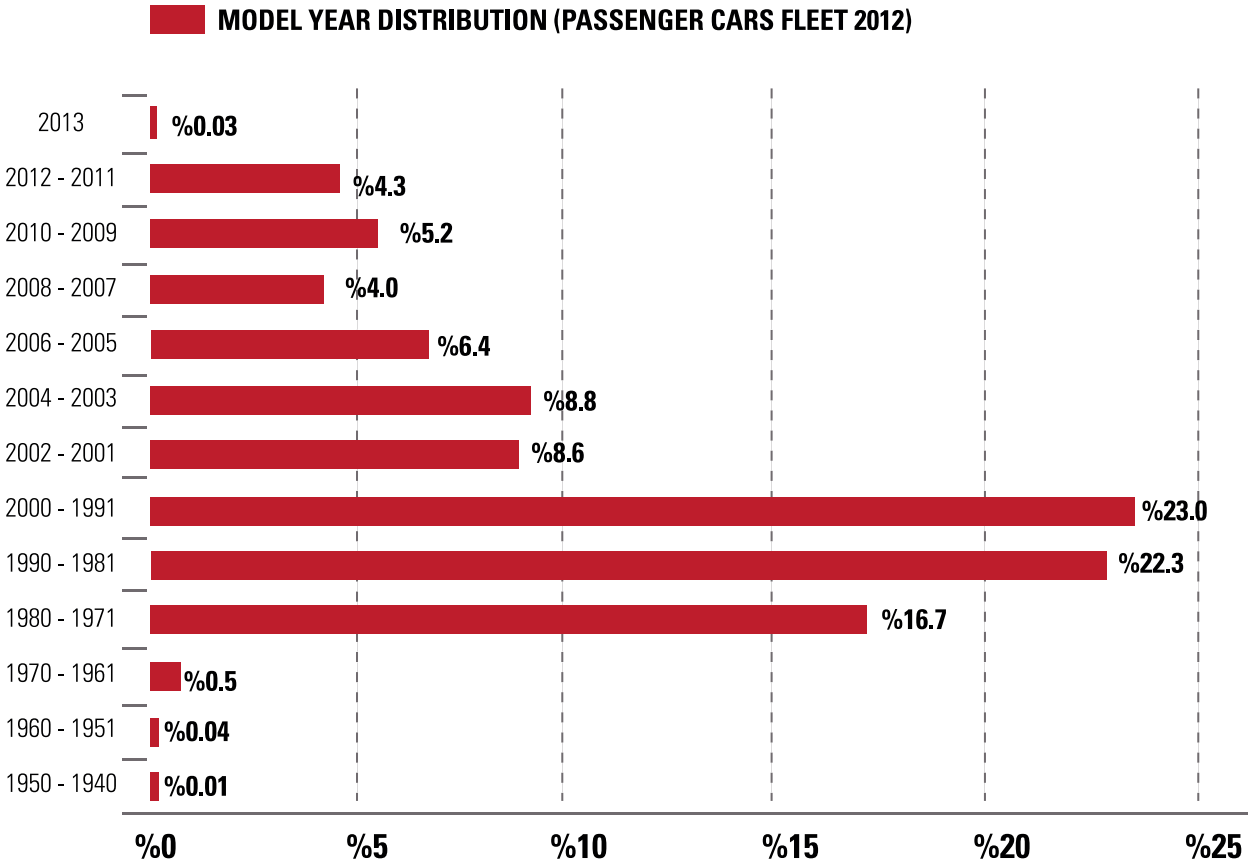


Figure 13 Age distribution of the Lebanese car fleet (39)

Public transport in Lebanon is made from private and public buses, vans and taxis.

TABLE 11: PUBLIC TRANSPORT IN LEBANON IN 2007 (40)	
Public Collective Transport (Buses)	3.2 million passengers per year, 61,360 bus trips per year
Private Collective Transport (Buses)- Lebanese Commuting Company	13 lines, 52,385 bus trips per year
Number of Licensed Taxis	33,500
Number of Licensed Vans	4,000
Number of Red Plates - Buses (25-55 passengers)	2,236
Number of Red Plates - Trucks	14,000

The driving conditions in Lebanon make the transport sector a large energy consuming sector. In fact, the main cause of high energy consumption is the traffic congestion.

Based on collected data from on-road measurements in Greater Beirut area, through GPS survey with different drivers as stated in the Technology Need Assessment for climate change study done by MoE in 2012, the GBA driving conditions in 2011 are characterized by the fact that 50% of total trips have a total distance lower than 5 km and 75% lower than 12 km, with an average trip distance of 9.6 km. 25% of stops are below 2 seconds and 75% below 10 seconds. Stop time corresponds to more than 15% of travel time. This conducts to high congestion rate and considerable rate of stop times. Besides, the acceleration rates are significant at very low speed implying inefficient operation of the engine thus higher fuel consumption and pollutants' emissions. Passenger's transport energy intensity was estimated in 2007 at 3.08 MJ/passenger-kilometer (38).

Lebanon does not have an internal flight movement, maritime and air transport are not present in the action proposed for reducing energy consumption in the transport sector. Land transport is the main consumer of energy. The next section will detail the existing measures for decreasing energy consumption and the planned ones to be implemented.

8.2 Existing policies and measures

The Ministry of Environment (MoE) in Lebanon, in collaboration with UNDP, has cited the existing measures and has proposed new ones in the study called Technology Needs Assessment for Climate Change - 2012.

TABLE 12: EXISTING RULES AND POLICIES FOR THE TRANSPORT SECTOR IN LEBANON

Rules/Policies/Regulations	Description
Decree No. 124/2003	Specifications of motorcycles and engines, and allowed time to drive, applied in all areas of Lebanon.
Decree No. 8243/2003	Mandatory annual vehicle inspection.
Decree No. 11244/2003	Set up of the Traffic Management Organization (TMO) which has yet to carry out a technical traffic management role rather than just an administrative one.

Decree No. 7858/2002	- Incentives to renew the fleet such as exempting new cars, 5 years old cars, public transport cars, and buses of no more than 24 passengers from import tax, registration, and inspection fees. - Compensate owners of private cars, public transport cars, and buses which would convert to gasoline engines with amounts ranging from 1,000,000 to 13,000,000 L.L depending on the year of manufacture. - Ban the use of private and public cars of diesel engines starting from 15/6/2002. - Ban the use of private and public transport autobuses of diesel engines starting from 15/7/2002. - Ban the use of public buses of 16 to 24 passengers of diesel engines starting from 31/10/2002. - Designate the port of Beirut and Tripoli for collecting the replaced engines until they are exported outside Lebanon.
Decree No. 8442/2002	Specifications of fuel motor vehicle; diesel oil and gasoline 92, 95 and 98 octane.
Law 341 (6/08/2001)	The law lays the legal framework for reducing air pollution from the transport sector and encouraging the use of cleaner sources of fuel. Specifically, the law bans the import of minivans operating on diesel engines, as well as old and new diesel engines for private passenger cars and minivans. The law empowered the GoL to retrieve 10,000 public license plates operating on diesel.
Council of Ministers decision 9, on 5/4/2000	The decision calls for the reform and reorganization of the Land Public Transport Sector in Lebanon and the reduction of the number of public transport vehicles from 39,761 to 27,061 vehicles.
Decree 6603 (4/4/1995)	It defines standards for operating diesel trucks and buses, as well as the implementation of a monitoring plan and permissible levels of exhaust fumes and exhaust quality (particularly for CO, NOx, hydrocarbons and total suspended pariculate).

8.3 Different studies on improving the Lebanese transportation sector

Numerous studies deal with the different aspects of the Lebanese transportation sector. This section will limit the discussion to some studies including the highlighting of possible solutions and measures.

The Ministry of Environment and UNDP Lebanon have developed three Nationally Appropriate Migration Actions (NAMA's) factsheets for the transportation sector. These factsheets are detailed as below:

1. Advanced powertrains for passenger cars / fuel efficiency, where advanced technologies classified as passive (indirect impact on reducing fuel consumption, like reducing the vehicle weight) and active systems (direct impact on consumption reduction like engine idle stop/start systems and automated manual transmissions) are shown (41).

This factsheet also showed the effect of the proposed technologies on a vehicle fuel consumption (see table 13).

TABLE 13: COSTS OF TECHNOLOGIES USED IN FUEL EFFICIENT GASOLINE VEHICLES

Technology	Fuel savings	Additional Cost USD/car
Continuous variable transmission	7%	150-200
Dual clutch transmission (DSG)		5,500
6-Speed automatic transmission	4-5%	100-500
Gasoline direct injection	3-4%	125-175
Lightweight material	4-8%	200-500
Engine downsizing + turbo charging	10-15%	up to 150% of the baseline gasoline engine

2. Advanced powertrains for passenger cars / hybrid vehicles. A hybrid electric vehicle (HEV) has a flexibility offered by the electric motor that implies a more efficient engine operation. At low demand, the motor drives the vehicle using battery power. The internal combustion engine engages when needed to drive the wheels or recharge the battery. At full acceleration, the battery adds power; when the vehicle idles, the internal combustion engine shuts off (41).

HEVs finds a solution to every source of energy losses:

- Engine stop to prevent from idling
- Brake energy recovery to prevent losing kinetic energy of the vehicle while braking
- Engine downsizing and electric boosting during acceleration
- Management of engine operating points
- Electric drive mode

10-30% of fuel consumption can be saved with such technologies relative to that of comparable gasoline powered vehicles.

3. Public transport / Bus Rapid Transit (BRT) with dedicated lanes. As defined in the NAMA factsheet, "BRT system is a high-capacity transport system with dedicated lanes for bus transit. It consists of a systematic combination of infrastructure (busways, stations, terminals) with organized operations and intelligent technologies to provide a higher quality experience than possible with traditional bus operation.

> Main services enhancements are increasing the average velocity and ensuring matching the scheduled timetables". BRT system allows to reduce total vehicle mileage, congestion, energy consumption, incident and emissions while increasing road capacity. (42)

On the other hand, the ESCWA proposed some solutions for the Lebanese transport sector in the study entitled "Environmental and Economic Command Vehicles: a Practical Solution to Reduce Fuel Consumption and Environmental Pollution in Lebanon 2013". According to the study, infrastructure development (roads, bridges, tunnels, car parkings and bus stations) is an essential and urgent need especially in the Greater Beirut.

The study proposes the following measures in order to improve the energy efficiency in the transport sector.

- Ensure incentives for the purchase of high-tech car
- Apply Decree 6603/1995 regarding the operating standards of buses and trucks working on diesel and monitor the GHG emissions
- Issue and impose tough measures on imported used cars
- Modify car taxes and car registration fees to be in line with the environment
- Mechanical inspection and use of incentives
- Restructure and improve the organization of traffic management
- Create a transport fund and strengthen the partnership between the private and public sectors in order to reduce the financial burden of the transport sector on the general budget
- Ease traffic in cities by reducing trucks entry, control operations of loading and unloading, and prevent the construction of the stores in the ground floors and under-floor buildings
- Prevent private vehicles in the center commercial area by narrowing passages and creating parking coupled with financial taxes makes use in the commercial center of the region more expensive (as opposed to securing an effective alternative transport)
- Train drivers subject to tests and motivate to promote eco-driving

- Apply traditional improvements to traffic / deciding new traffic law/ tightening driver's licence delivery procedure
- Adopt a tax system and impose duties on fuel coupled with the deployment of awareness with regard to sustainable transport
- Reduce the average number of car trips and duration through the adoption of decentralization in public, academic and medical institutions, optimization of logistical and simplification of administrative transactions
- Promote group transport by electric rails (Metro / Tramway) for the long term
- Develop legislative reforms with respect to the laws of urban planning, taxes and fees and traffic.

Picture 15 The transportation sector in Lebanon: a need for renovation

8.4 Possible savings in the transportation sector

The International Energy Agency has published several studies regarding improving energy efficiency in the transport sector. The following table shows the possible savings in fuel consumption for some measures that can be applied to the Lebanese case (43).

TABLE 14: RECOMMENDED MEASURES FOR THE TRANSPORT SECTOR

Increasing the use of public transport	Reduce the prices of public transport tickets Free public transport Increase public transport services during off-peak hours Increase public transport services in peak hours Availability of public transport 24h/day
Increasing collective trips	Designate emergency carpool lanes along all motorways, designate park-and-ride lots, develop a programme to inform public and match riders
Increasing work from home	
Compressed work week	Programme with employer participation and public information campaigns
Driving ban	Odd/even licence plate scheme 1 in 10 days based on licence plate with police enforcement and signage
Speed limits	reduce highway speed limits to 90 km/hr. Provide police enforcement or speed cameras, appropriate information and signage
Eco-driving	intensive public information programme

Picture 16 An old railway station in Lebanon

Picture 17 Public transport is essential in sustainable transportation

END-USE MEASURES IN THE PUBLIC SECTOR

CHAPTER 9 **END-USE MEASURES IN THE PUBLIC SECTOR**

This chapter targets the areas of contribution of the Lebanese public sector in the conservation of energy. It aims at defining the measures that need to be undertaken to increase energy efficiency in the Lebanese public sector.

The definition of the Lebanese public sector used throughout this chapter includes the following: governmental buildings, municipal buildings, Lebanese Armed Forces buildings, Lebanese Security Forces buildings, public hospitals, public schools and streets. These will be referred to as "public bodies" or "public entities" in this document.

This chapter does not cover the awareness and training measures for the public officials. These were covered in the previous section dealing with horizontal measures. It also does not target the measures specifically relevant to the building itself. These are covered in the section entitled "End-Use Measures in the Building Sector". As for the public transportation sector, it is included in the chapter entitled "Measures in Mobility and Transport". Four initiatives are proposed in this section regarding improving energy efficiency in the public sector as follows.

9.1 Creation of a financing mechanism for the public sector

PU 01	**CREATION OF A FINANCING MECHANISM FOR THE PUBLIC SECTOR**		
Description of the Measure	This measure aims at creating a financing mechanism that encourages public bodies to invest in energy efficiency projects to reduce their energy load.		
Type of Measure	Financing scheme		
Sector	Public		
Target Group	Public bodies		
Implementing Bodies	BDL, commercial banks, LCEC, Ministry of Interior and Municipalities		
Start Date	2016	**End Date**	2020
Current Status and Plan for Implementation			
Currently, the NEEREA financing mechanism targets mainly the private sector. Public bodies, in the current situation, do not have an easy procedure to take loans for energy efficiency investments. Based on the successful experience with NEEREA, a financing scheme is to be designed specifically for public entities. The elaboration of this mechanism will consist of the following steps: - Elaboration of options of financial mechanisms - Formulation of the implementation modality for these options			

Set Targets and Estimated Impact on Energy Saving			
No direct impact can be measured through this initiative. Savings will depend on the number of projects financed and types of implemented measures in later stages.			
Yearly	N/A	**Altogether (2016-2020)**	N/A
Calculation Methodology	N/A		
Data Needs/ Availability	Energy consumption of each public entity		
Monitoring Method/ Savings Measurement	- Input indicator(s): Existing public financing mechanisms - Input indicator(s): ▪ Options of financing mechanisms ▪ Implementation modality ▪ Entities in charge of implementation and monitoring - Outcome indicator(s): Expected energy savings when implementing the proposed financing mechanism		
Monitoring/ Verification	The application to benefit from the financing scheme will include a section on the energy consumed by the public entity and the reduction in consumption foreseen, as per the planned measures. A report should be submitted by the applying entity to the LCEC, presenting energy savings, with energy bills as reference.		
Next Steps After 2020	The next step would be to apply this financing mechanism in the public sector.		
Funding			
100,000 USD	An estimation of budget needed for creating the financing mechanism. Budget not available.		

9.2 Green procurement for new and existing public buildings

PU 02	GREEN PROCUREMENT FOR NEW AND EXISTING PUBLIC BUILDINGS		
Description of the Measure	This measure aims at increasing the use of energy efficient products to reduce the energy load of new and existing public buildings. This measure will be implemented in 25 buildings (as pilot projects), each having an area of 500 m^2.		
Type of Measure	Regulation, implementation		
Sector	Public		
Target Group	Public bodies		
Implementing Bodies	MoF, CDR, municipalities, LCEC		
Start Date	2016	**End Date**	2020
Current Status and Plan for Implementation			
Green procurement consists of purchasing energy efficient and environmentally friendly products. First, this measure should be initiated by the adoption of a guideline for green procurement. The guideline should include the procedure for each procurement mechanism, adapted to the Lebanese case. Second, training of the personnel involved in the procurement process should be performed. Third, 25 new and existing public buildings should use this guideline to purchase their equipment.			

PU 02	GREEN PROCUREMENT FOR NEW AND EXISTING PUBLIC BUILDINGS		
Current Status and Plan for Implementation			
This will be incentivized by the financing mechanism developed in Pu 01, and then will be made part of the mandatory requirements for new public constructions. Greater attention will be given to local public authorities in terms of their awareness and training on how to prepare and unroll public tenders pursuant to the energy efficiency principles.			
Set Targets and Estimated Impact on Energy Saving			
Savings are directly related to the type of equipment chosen or modified. It depends also of the MEPS set especially for medical equipment.			
Yearly	2,130 kWh/m^2.year	**Altogether (2016-2020)**	4,260,0000 kWh (considering 1 year of implementation and funds raising is needed)
Calculation Methodology	See below		
Data Needs/ Availability	- Energy consumption of public bodies (Total and per equipment) - Quantity and type of purchased equipment per entity		

Picture 18 In addition to the market incentives, the Central Bank implements energy efficiency measures in its own premises

Monitoring Method/ Savings Measurement	- Input indicator(s): Current type of equipment being purchased and the consumption of each of them - Output indicator(s): ▪ Green procurement guideline: to base the tenders on the best economic offer, environmental performance and economic considerations. Life Cycle Costs (LCC): purchasing, running and disposal costs ▪ Number of equipment replaced, number of new equipment purchased and the consumption of each of them, copy of invoices/receipts. The choice of the new equipment should be based on the energy class set by the MEPS (Horizontal Measure H 01) - Outcome indicator(s): Savings achieved due to the replacement with more efficient equipment and the reduction of GHG emissions achieved
Monitoring/ Verification	- LCEC to check the implementation in the pilot projects - LCEC to keep track of type and performance of equipment purchased (replacement or new) This information should be mandatory if, after the construction of the building, the administration wishes to benefit from the financing scheme developed in Pu 01
Next Steps After 2020	- Making the guideline mandatory for all new public buildings - Introduce sustainable requirements in the specification books and other bidding documents
Funding	
100,000 USD	Budget needed to develop the green procurement guideline. Budget not available.
1.3 Million USD	Budget to replace equipment in 25 public buildings. Budget not available.

At this current stage, no data are available regarding energy consumption in the public entities. This section will detail the estimated savings based on several assumptions. First of all, the public entities, except for hospitals, are treated as office buildings. Based on the same methodology of calculation used for the measure H 01.

Several assumptions were taken such as the number of equipment in an office of 100 m^2:

- Electrical consumption due to heating and cooling was calculated based on the heating and cooling demand for Beirut calculated in details in the ''LCEC Guidelines on preparing technical proposals for non-certified High Performance Buildings-2014''
- One Refrigerator
- One Television
- Need of light is around 450 lumen/m^2
- Ten Desktop computers

The operating time for some equipment were chosen based on EU labelling recommendations such as 24 hours per day for refrigerators, 4 hours for televisions, 8 hours per day for desktops. The baseline chosen for savings calculation is the lowest class of each equipment (usually G is the least efficient). The maximum savings (132 kWh/m^2.year) consists of energy savings due to setting the minimum energy performance standard at the highest class (Most efficient usually A+++). Whereas the minimum performance (15 kWh/m^2.year) is found by setting the minimum energy performance level at the second least efficient class (means moving only one class upward).

Based on the audits performed by the LCEC in 2008, the hospitals were found to have an average energy consumption of 260 kWh/m^2.year for heating, cooling, lighting, ventilation and hot water. It was also found that biomedical equipment and auxiliary equipment consume 19% and 27% of the overall hospital consumption (25). This implies that the overall average consumption of a hospital is around 380 kWh/m^2.year.

Regarding green procurement, an assumption of 10% of consumption reduction is taken. Thus, savings in public hospitals would be estimated to be around 38 kWh/m^2.year. Considering 25 buildings as pilot projects, with each building having an area of 500 m^2, then savings for the four years would be between 750,000 kWh and 6,600,000 kWh. For this measure:

- Equipment in 15 buildings will be upgraded from class G to A+++ implying savings around 990,000 kWh/year thus 3,960,000 kWh for 4 years

- Equipment in 10 buildings will be upgraded from class G to the second least efficient class implying savings of 75,000 kWh/year thus 300,000 kWh during 4 years

The total savings of this measure is the sum of the fore-mentioned savings around 4,260,000 kWh during 4 years.

9.3 SEAPs for municipalities

The third measure deals with the development of SEAP's for municipalities. As defined by the Covenant of Mayors, a Sustainable Energy Action Plan (SEAP) is the key document in which the Covenant signatory outlines how it intends to reach its CO2 reduction target by 2020. It defines the activities and measures set up to achieve the targets, together with time frames and assigned responsibilities.

CES-MED PROJECT

The overall objective of the project "Cleaner Energy Saving Mediterranean Cities" is to support the Local Authorities (municipalities, cities, unions of municipalities etc.) in the "European Neighborhood and Partnership Instrument (ENPI) South Mediterranean partner countries" to respond more actively to sustainable development challenges.

The purpose is to develop the capacities of these authorities to prepare, fund and implement Sustainable Energy Action Plans (SEAPs) and potentially join the Covenant of Mayors initiative for the willing ones.

Project's outputs:

1. Two national reports have been prepared jointly with national stakeholders: the "Recommended National Sustainable Urban and Energy Savings Actions" report and the "Donor's and other funding initiatives in the areas of sustainable development at the local level" report.
2. An info tool kit has been elaborated and dispatched, comprising several manuals to assist local authorities in the preparation of their SEAPs including comprehensive technical guidelines to prepare Sustainable Energy Action Plans (SEAPs) adapted for the ENPI South region.
3. Three SEAPs prepared in each adhering country, with related Baseline Emissions Inventories for three local authorities per country. Three SEAPs for the municipalities of Beirut, Kab Elias and Baakline have been elaborated. "Citizens' Awareness Promotion Plans" or each city prescribing specific actions (campaigns, events, promotional publications).

For more info: www.ces-med.eu

Picture 19 A Sustainable Energy Action Plan (SEAP) aligns the efforts of local authorities

Picture 20 Energy efficiency could be an economy driver in rural municipalities

PU 03	SEAPS FOR MUNICIPALITIES		
Description of the Measure	This measure aims at establishing SEAPs for ten municipalities to help reduce their energy load.		
Type of Measure	Action plan		
Sector	Public		
Target Group	Municipalities		
Implementing Bodies	Ministry of Interior and Municipalities, LCEC		
Start Date	2016	**End Date**	2020
Current Status and Plan for Implementation			
The Sustainable Energy Action Plan (SEAP) aims at the creation of a plan for the efficient use of energy. In this measure, 10 municipalities will be assisted in the design of their SEAP. Three municipalities of them will be fully assisted by the CES-MED Project and the remaining 7 municipalities will be assisted through other technical assistance.			
Set Targets and Estimated Impact on Energy Saving			
No direct savings can be estimated. In fact, savings will depend on the type of measures in each municipality and its impact in reducing energy consumption.			
Yearly	N/A	**Altogether (2016-2020)**	N/A
Calculation Methodology	See below		
Data Needs/ Availability	- Energy consumption of each municipality in at least three of the four sections mentioned below: ■ Municipal buildings, equipment and facilities ■ Residential and commercial Buildings ■ Transport (Municipal fleet and Public) ■ Municipal Street lighting and public spaces - Electricity generation after SEAP implementation (if any) - Reduction in energy consumption after SEAP implementation (if any)		
Monitoring Method/ Savings Measurement	- Input indicator(s): Data collected in the section above, energy bills of municipalities - Output indicator(s): ■ SEAP Documents ■ Measures to be implemented/audit reports - Outcome indicator(s): Energy savings expected after SEAP implementation thus emissions reduced.		
Monitoring/ Verification	- SEAPs should include a section on the energy consumed by the public entity and the reduction in consumption foreseen, as per the planned measures. They should also include a section on monitoring the measures' results, with reporting including energy savings - The General Directorate of Municipal Administration and Local Councils, within the Ministry of Interior, will be supervising the SEAPs progress in cooperation with relevant national authorities and the municipalities		
Next Steps After 2020	- Encouraging more municipalities to work on preparing their SEAP - Set-up a national mechanism to encourage and support municipalities in the preparation of SEAP and to facilitate the implementation of its actions		
Funding			
200,000 USD	Rough estimated budget.		

The choice of these municipalities will greatly affect the impact of the implementation of their SEAPs on the estimated energy savings. These municipalities are chosen, from the three categories defined in Pu 01, based on their estimated energy consumption. We consider that 2 municipalities will be a LPC, 4 will be MPCs and 4 SPC[4]s. For each of the chosen municipalities, the following procedure is used to estimate the impact on energy savings:

- First, the municipality's current energy consumption should be defined
- Second, an estimate of the savings from the measures included in the SEAP should be predicted (kWh and toe)
- Third, the number of measures that would be implemented should be estimated.
- Lastly, the final estimated savings in TOE will be obtained

In order to calculate the total savings expected in this measure, the needed procedure is as follows:

- Number of municipalities
- Current average energy consumption: x_i
- Estimated size of measures: y_i
- Estimated percentage of measures implemented: z_i
- Estimated total savings (ETS) of each municipality: $ETS_i = x_i \times y_i \times z_i$

The total impact of this measure will be calculated as follow:

$$\text{Total Energy Savings} = \sum_{(i=1)}^{10} ETS_i \quad (4)$$

9.4 Management of Public Street Lighting

PU 04	SETUP AND IMPLEMENT A PLAN FOR PUBLIC STREET LIGHTING		
Description of the Measure	This measure aims at developing and setting-up a multi-level plan for the management of public street lighting, including implementation of energy efficient solutions.		
Type of measure	Policy		
Sector	Public		
Target Group	Ministry of Public Works, CDR, municipalities		
Implementing Bodies	Ministry of Public Works, CDR, municipalities, LCEC		
Start Date	2016	**End Date**	2020

4

SPC: small public consumer, MPC: medium public consumer, LPC: large public consumer

PU 04	SETUP AND IMPLEMENT A PLAN FOR PUBLIC STREET LIGHTING		
Current Status and Plan for Implementation			
This measure will consist of the following steps: - Adoption of a street lighting guide including the optimal specifications of the lamps used and a smart management system, among others - Replacing 9,000 street lamps with more efficient ones in 9 municipalities all over Lebanon - Implementation of a smart management system for street lighting in 10 municipalities			
Set Targets and Estimated Impact on Energy Saving			
N/A			
Yearly	3,867,905 kWh/year	**Altogether (2016-2020)**	15,471,620 kWh
Calculation Methodology	See below		
Data Needs/ Availability	- Current energy consumption of the chosen municipalities - The energy consumption of these municipalities after the implementation of the management system		
Monitoring Method/ Savings Measurement	- Input indicator(s): Current street lighting consumption (number of poles, type of lamps, operating hours) - Output indicator(s): Number of lamps replaced, number of new poles installed, number of timers or photosensors installed, operating hours, lamps consumption - Outcome indicator(s): ▪ For the replacement of 9,000 lamps, savings can be measured by a simple comparison of the energy consumption of the currently installed lamps and the more efficient ones ▪ For the management systems in municipalities, savings can be measured by comparing the current energy consumption of the municipalities to the consumption after the implementation of the management system		
Monitoring/ Verification	- Monitoring should be done by a site inspection and verification of the energy bills of the municipalities involved - The LCEC will be in charge of site check and verification - Municipalities should deliver an annual report to the LCEC including the energy bills related to the street lighting consumption		
Next Steps After 2020	The replacement of public street lighting systems with more efficient ones should be continued, and there will be a need to cover a larger number of municipalities with smart management systems.		
Funding			
0	Budget needed to develop the guide by in-kind contribution.		
0	Budget to replace 9,000 lamps to be covered by MEW.		
500,000 USD	Budget needed to implement smart management systems in 10 municipalities. Budget not available.		

For this matter, public entities are divided into categories, based on the estimated size and estimated consumption of each one. The following categories are established:

TABLE 15 TYPES OF PUBLIC ENTITIES

	SPC	MPC	LPC
Public entities	GB, MB	LAFB, LSFB, PS, MB	PH, LU, ST, MB

LEGEND

SPC: small public consumer, **MPC:** medium public consumer, **LPC:** large public consumer, **GB:** governmental buildings, **MB:** municipal buildings, **LAFB:** Lebanese Armed Forces buildings, **LSFB:** Lebanese Security Forces buildings, **PH:** public hospitals, **PS:** public schools, **LU:** Lebanese University, **ST**: streets

The calculation methodology of the 9,000 lamps is described here below. First, the currently used lamps are high-pressure sodium lamps, with an average 201 W consumption, and the new ones are LED lamps, with an average 120 W consumption estimated. The average difference in power consumption between these two types of lamps is 81 W.

Second, the current daily average working hours for the HPS lamps is 13 hours. When photosensors were added in Initiative 5 of the previous NEEAP (2011-2015), the working hours were reduced to 11.855 hours. The following scenario will be considered:

TABLE 16: SCENARIO OF INSTALLING EFFICIENT STREET LIGHTING (PHOTOSENSORS)

	Municipality		
	SPC	MPC	LPC
Number of lamps	200	1,000	3,000
Number of working hours	13/11.855	13/11.855	11.855
Number of municipalities participating in the measure	5	2	2
Number of municipalities that have installed photosensors	2	1	1
Total number of lamps*hours	12,542	24,855	74,565
Daily energy savings (kWh)	1,016	2,013	6,040
Yearly energy savings (kWh)	370,840	734,745	2,204,600
Yearly total energy savings (kWh)		3,310,185	

As for the implementation of a smart management system in 5 municipalities, municipalities involved in this measure will be distributed, according to the previously set categories, as follows:

1 municipality will be a LPC, 2 will be MPC and 2 will be SPC.

The smart management system implemented in each participating municipality should comply with the guide set in this measure. But to calculate the estimated savings, we will consider the minimum requirements to be as follows:

- A lighting schedule for all the streets under the governance of the concerned municipality. This schedule is ideally controlled by street light timers, including an astronomical clock (or GPS), but in our case we will consider that only photosensors are used
- Scheduled dimming during late night hours (using timers only)

The applications of these two measures will lead to the following energy savings:

TABLE 17: SAVINGS DUE TO IMPLEMENTING EFFICIENT STREET LIGHTING

		Municipality		
		SPC	**MPC**	**LPC**
Number of lamps		200	1,000	3,000
Number of municipalities		2	2	1
First measure: photosensors installation	Hours saved	1.145	1.145	1.145
	Hourly consumption of each lamp (Wh)	201	201	201
	Daily savings (kWh)	92	460	690
	Yearly savings (kWh)	33,580	167,900	251,850
Second measure: scheduled dimming	Hours of dimming	4	4	4
	Average dimming percentage (%)	50	40	30
	Daily savings per lamp (kWh)	402	322	241
	Daily savings (kWh)	161	644	723
	Yearly savings (kWh)	58,765	235,060	263,895
	Total yearly Savings (kWh)		557,720	

Picture 21 Smart management of public street lighting is a must

10 CONCLUSIONS

CHAPTER 10 **CONCLUSIONS**

10.1 Calculation of overall savings

The savings for each measure are estimated in the different sections of this report. Some of them are still non quantifiable such as the horizontal measures. Also, savings related to the financing mechanism measures are not counted in this overall savings to avoid double counting. In fact, some of the proposed measures could be financed through NEEREA so they should be counted once. This point will be taken into account when evaluating the second NEEAP.

The savings regarding the mobility and transport sector are not counted in the overall target of the second NEEAP because their implementation depends on a political decision that is out of this report's scope. Tables 18 and 19 below summarize the overall savings in the primary energy and end-use sectors respectively.

TABLE 18: PRIMARY ESTIMATED ENERGY SAVINGS

Primary energy measures	**Savings (kWh)**
Total	**686,136,822**
P 01 Upgrading OCGT to CCGT	254,583,525
P 02 Increase of the efficiency of EDL transformers	18,892,692
P 03 Reduction of system reactive power	47,231,730
P 04 Modification of the voltage level at the distribution system	365,428,875
P 05 Installation of Automated Meter Reading (AMR)	N/A

TABLE 19: END-USE ENERGY ESTIMATED SAVINGS

End-use measures	**Savings (kWh)**
Total	**828,105,060**
End-use measures: horizontal measures	
H 01 Minimum Energy Performance Standards (MEPS)	N/A
H 02 Financing mechanism	49,200,000
H 03 Awareness campaigns and capacity building	N/A
H 04 ESCOs' business development	N/A
H 05 Adoption of the Energy Conservation Law	N/A
End-use measures in the building sector	
B 01 Double wall ordinance	26,577,440
B 02 Testing facility for building components	N/A
B 03 Building code	N/A
B 04 Use of efficient equipment	55,600,000

TABLE 19: END-USE ENERGY ESTIMATED SAVINGS	
B 05 Energy performance certificate for buildings	66,400,000
B 06 Energy audits for public buildings	N/A
B 07 Implementing measures in selected public buildings	N/A
B 08 Pilot project	345,000
B 09 Capacity building for refurbishment	N/A
End-use measures in Industry and Agriculture	
I 01 Mandatory energy audits	84,120,000
I 02 Implementing energy efficiency measures in 20% of the Lebanese industries	525,690,000
I 03 Installing 100 variable speed drives on irrigation pumps	441,000
Energy efficiency in the public sector	
Pu 01 Creation of financing mechanism for the public sector	N/A
Pu 02 Green procurement for new and existing public buildings	4,260,000
Pu 03 SEAPs for municipalities	N/A
Pu 04 Management of public street lighting	15,471,620

10.2 Summary of NEEAP's measures

10.2.1 Power sector measures

TABLE 20: SUMMARY OF POWER SECTOR MEASURES IN NEEAP 2016-2020

Measure	Savings (kWh)	Funds needed (MUSD)	Source of Funds
Total	**686,136,822**	**473.5**	
P 01: Upgrading OCGT to CCGT	254,583,525	130	Covered through the budget allocated to implement the Policy paper for the electricity sector
P 02: Increase of the efficiency of EDL transformers	18,892,692	20	Covered through the budget allocated to implement the Policy Paper for the electricity sector
P 03: Reduction of system reactive power	47,231,730	0.5	An estimation of the costs of the full study and analysis of the system. Funding not available
		22	A rough estimation to be detailed in further documents. Funding not available
P 04: Modification of the voltage level at the distribution system	365,428,875	1	Covered through the budget allocated to implement the Policy Paper for the electricity sector
P 05: Installation of Automated Meter Reading (AMR)	N/A	300	Covered through the budget allocated to implement the Policy Paper for the electricity sector

10.2.2 Horizontal end-use measures

TABLE 21: SUMMARY OF SAVINGS OF HORIZONTAL END-USE MEASURES IN NEEAP 2016-2020

Measure	Savings (kWh)	Funds needed (MUSD)	Source of Funds
Total	**49,200,000**	**587.875**	
H 01 Minimum Energy Performance Standards (MEPS)	N/A	1	An estimation of the costs of the full study and analysis of the system. Funding not available
H 02 Financing mechanism	49,200,000	500	An estimation of the NEEREA loans over a period of 5 years. Around 100 Million USD per year by the national subsidy program by BDL
		80	New credit line proposed by EIB (50 Million Euros) and AFD (30 Million Euros)
		5	Technical assistance by the EU
H 03 Awareness campaigns and capacity building	N/A	0.05	Available contributions by different funding windows (like WEC, MED-DESIRE project, cooperation with MED-ENEC, League of Arab States, etc.)
		-	EU-funded TAIEX events
		0.6	Budget not available
		0.1	100,000 Euros. Available by EU (year 1 only)
		0.1	Budget not available
H 04 ESCOs' business development	N/A	0.8	Estimated at around 200,000 USD per year for a period of 4 years. Budget not available
H 05 Adoption of the Energy Conservation Law	N/A	0.225	Estimated at around 75,000 USD per year for three years (2016, 2017, and 2018). Budget to be made available by MEW

10.2.3 End-use measures in the building sector

TABLE 22: SUMMARY OF SAVINGS OF END-USE MEASURES IN THE BUILDING SECTOR IN NEEAP 2016-2020

Measure	Savings (kWh)	Funds needed (MUSD)	Source of Funds
Total	**148,922,440**	**37.2**	
B 01 Double wall ordinance	26,577,440	0.3	For ordinance establishment. Budget not available
		8	For implementing in 100 buildings. Budget not available
B 02 Testing facility for buildings components	N/A	0.7	Budget not available
B 03 Building Code	N/A	0.6	Estimated at 150,000 USD per year over 4 years. Budget not available
B 04 Use of efficient equipment	55,600,000	1	Budget not available
B 05 Energy performance certificate for buildings	66,400,000	1	Budget not available
B 06 Energy audits for public buildings	N/A	2	Budget not available
B 07 Implementing measures in selected public buildings	N/A	20	Funding potential by the World Bank
B 08 Pilot project	345,000	1	Available through the LCEC budget
		2	For fund raising
B 09 Capacity building for refurbishment	N/A	0.6	Estimated at 150,000 USD per year over 4 years. Budget not available.

10.2.4 End-use measures in industry and agriculture

TABLE 23: SUMMARY OF SAVINGS OF END-USE MEASURES IN THE INDUSTRY AND AGRICULTURE IN NEEAP 2016-2020

Measure	Savings (kWh)	Funds needed (MUSD)	Source of Funds
Total	**610,251,000**	**120.6 - 215.6**	
I 01 Mandatory energy audits	84,120,000	25	Budget not available
I 02 Implementing energy efficiency measures in 20% of the Lebanese industries	525,690,000	95-190	Budget depending on the measures implemented and the amount of savings achieved. Budget not available
I 03 Installing 100 variable speed drives on irrigation pumps	441,000	0.6	Budget not available

10.2.5 End-Use Measures in the Public Sector

TABLE 24: SUMMARY OF SAVINGS OF END-USE MEASURES IN THE PUBLIC SECTOR IN NEEAP 2016-2020

Measure	Savings (kWh)	Funds needed (MUSD)	Source of Funds
Total	**19,731,620**	**2.2**	
Pu 01 Creation of financing mechanism for the public sector	N/A	0.1	An estimation of budget needed for creating the financing mechanism. Budget not available
Pu 02 Green procurement for new and existing public buildings	4,260,000	0.1	Budget needed to develop the green procurement guideline. Budget not available
		1.3	Budget to replace equipment in 25 public buildings. Budget not available
Pu 03 SEAPs for municipalities	N/A	0.2	Rough estimated budget
Pu 04 Management of public street lighting	15,471,620	0	Budget needed to develop the guide by in-kind contribution
		0	Budget to replace 9,000 lamps to be covered by MEW
		0.5	Budget needed to implement smart management systems in 10 municipalities. Budget not available

10.2.6 Summary of savings and implementation cost in NEEAP 2016-2020

TABLE 25: SUMMARY OF SAVINGS AND IMPLEMENTATION COST BY SECTOR IN NEEAP 2016-2020

Measure	Savings (kWh)	Funds needed (MUSD)
Power Sector	686,136,822	473.5
End-use	828,105,060	748-843
Horizontal end-use measures	49,200,000	587.875
End-use measures in the building sector	148,922,440	37.2
End-use measures in industry and agriculture	610,251,000	120.6-215.6
Energy efficiency in the public sector	19,731,620	2.2

10.2.7 Summary of all NEEAP 2016-2020 Measures

TABLE 26: SUMMARY OF ALL NEEAP 2016-2020 MEASURES

Measure	Savings (kWh)	Funds needed (MUSD)	Source of Funds
P 01 Upgrading OCGT to CCGT	254,583,525	130	Covered through the budget allocated to implement the Policy Paper for the Electricity Sector
P 02 Increase of the efficiency of EDL transformers	18,892,692	20	Covered through the budget allocated to implement the Policy Paper for the Electricity Sector
P 03 Reduction of system reactive power	47,231,730	0.5	An estimation of the costs of the full study and analysis of the system. Funding not available
		22	A rough estimation to be detailed in further documents. Funding not available.
P 04 Modification of the voltage level at the distribution system	365,428,875	1	Covered through the budget allocated to implement the Policy Paper for the Electricity Sector
P 05 Installation of Automated Meter Reading (AMR)	N/A	300	Covered through the budget allocated to implement the Policy Paper for the Electricity Sector
H 01 Minimum energy performance standard (MEPS)	N/A	1	An estimation of the costs of the full study and analysis of the system. Funding not available
H 02 Financing mechanism and incentives	49,200,000	500	An estimation of the NEEREA loans over a period of 5 years. Around 100 Million USD per year by the national subsidy program by BDL
		80	New credit line proposed by EIB (50 Million Euros) and AFD (30 Million Euros)
		5	Technical assistance by the EU
H 03 Awareness campaigns and capacity building	N/A	0.05	Available contributions by different funding windows (like WEC, MED-DESIRE project, cooperation with MED-ENEC, League of Arab States, etc.)
			EU-funded TAIEX events
		0.6	Budget not Available
		0.1	100,000 Euros. Available by EU (year 1 only)
		0.1	Budget not available
H 04 ESCOs' business development	N/A	0.8	Estimated at around 200,000 USD per year for a period of 4 years. Budget not available

TABLE 26: SUMMARY OF ALL NEEAP 2016-2020 MEASURES			
H 05 Adoption of the Energy Conservation Law	N/A	0.225	Estimated at around 75,000 USD per year for three years (2016, 2017, and 2018). Budget to be made available by MEW
B 01 Double Wall Ordinance	26,577,440	0.3	For ordinance establishment. Budget not available
		8	For implementing in 100 buildings. Budget not available
B 02 Testing Facility for Buildings Components	N/A	0.7	Budget not available
B 03 Building Code	N/A	0.6	Estimated at 150,000 USD per year over 4 years. Budget not available
B 04 Use of efficient equipment	55,600,000	1	Budget not available
B 05 Energy Performance Certificate for Buildings	66,400,000	1	Budget not available
B 06 Energy Audits for public buildings	N/A	2	Budget not available
B 07 Implementing measures in selected public buildings	N/A	20	Funding potential by the World Bank
B 08 Pilot Project	345,000	1	Available through the LCEC budget
		2	For fund raising
B 09 Capacity Building for refurbishment	N/A	0.6	Estimated at 150,000 USD per year over 4 years. Budget not available
I 01 Mandatory Energy Audits	84,120,000	25	Budget not available
I 02 Implementing Energy Efficiency measures in 20% of the Lebanese Industries	525,690,000	95-190	Budget depending on the measures implemented and the amount of savings achieved. Budget not available
I 03 Installing 100 variable speed drives on irrigation pumps	441,000	0.6	Budget not available
Pu 01 Creation of financing mechanism for the public sector	N/A	0.1	An estimation of budget needed for creating the financing mechanism. Budget not available
Pu 02 Green procurement for new and existing public buildings	4,260,000	0.1	Budget needed to develop the green procurement guideline. Budget not available
		1.3	Budget to replace equipment in 25 public buildings. Budget not available
Pu 03 SEAPs for municipalities	N/A	0.2	Rough estimation. Budget not available
Pu 04 Management of public street lighting	15,471,620	0	Budget needed to develop the guide by in-kind contribution
		0	Budget to replace 9,000 lamps to be covered by MEW
		0.5	Budget needed to implement smart management systems in 10 municipalities. Budget not available

The successful implementation of the NEEAP is dependent on both the public and

private sectors (photo from the International Beirut Energy Forum iBEF 2015)

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ANNEXES

ANNEX I CONVERSION TABLE

TABLE 27: CONVERSION FACTORS TO TOE FOR THE DIFFERENT PETROLEUM PRODUCTS USED IN NEEAP 2016-2020

Oil and Products	Unit	GJ	toe
Oil	1 tonne	42	1
Liquefied Petroleum Gas (LPG)	1 tonne	46	1,095
Natural Gas	1000 Nm^3	39.3	0.935
Heavy Fuel Oil	1 tonne	40	0.952
Gasoline	1 tonne	43.1	
Diesel	1 tonne	42.8	
Kerosene	1 tonne	43.2	http://unstats.un.org/unsd/energy/balance/conversion.htm
Asphalt	1 tonne	41.8	http://unstats.un.org/unsd/energy/balance/conversion.htm

ANNEX II MEPS CALCULATIONS

Table 28 below shows the energy consumption of the least efficient class per type of equipment. This table is used to estimate the savings in Measure ''H 01: Minimum Energy performance Standard''.

TABLE 28: ENERGY CONSUMPTION OF THE LEAST EFFICIENT CLASS PER TYPE OF EQUIPMENT

Refrigerator consumption for Class G for each category kWh/year				
Category	**G**			
1	582.3			
2	582.3			
3	582.3			
4	747.3			
5	712.5			
6	995.7			
7	995.7			
8	870.9			
9	787.2			
Beirut- AC electric Consumption of Class G in kWh/year.m²				
	Cooling, except single duct & double duct	**Cooling for single duct and double duct**	**Heating, except single duct and double duct**	**Heating for single duct and double duct**
Residential Standard	46	88.46	1.67	2.73
Residential Seasonal	38.8	74.62	3.33	5.45
Hotel	60.8	116.92	2.22	3.64
Office	42.8	82.31	0	0
Retail	103.6	199.23	0.56	0.91
Hospitals	32.4	62.31	6.11	10
TV kWh/year of Class G				
System	G			
15''≤D[5]<40''	133			
40''≤D<85''	684			
Eco design - PC kWh/year				
Least efficient Desktop				
192 [6]				
Washing Machines kWh/year				
D Class (Is the least efficient for Washing machines)				
302				

5, 6

5 D=Screen Diagonal

6 Based on the assumption of an average consumption of 150 W for 8 hours per day, 5 days per week as per the recommendations of Directive 2009/125/EC of the European Parliament and of the Council with regard to eco-design requirements for computers and computer servers

Lights kWh/year (average for 700 lumen)		
Class E (is the least efficient for Lights)		
Non directional <1300 lumen	56.67	
Directional < 1300 lumen	102.18	
Vacuum Cleaner (kWh/year)[7]		
	E	G
Label 1		59
Label 2	46	

Table 29 shows energy savings when replacing an old equipment (the least efficient) with a new one (A+++ for maximum savings and F for minimum savings).

TABLE 29: SAVINGS PER TYPE OF EQUIPMENT

Refrigerator Average savings for each category kWh/year									
Category	**A+++**	**A++**	**A+**	**A**	**B**	**C**	**D**	**E**	**F**
1	500.8	458.1	423.2	372.7	295.1	217.4	159.2	101	3.9
2	500.8	458.1	423.2	372.7	295.1	217.4	159.2	101	3.9
3	500.8	458.1	423.2	372.7	295.1	217.4	159.2	101	3.9
4	642.7	587.9	543.1	478.3	378.7	279	204.3	129.6	5
5	612.8	560.5	517.8	456	361	266	194.8	123.5	4.8
6	856.4	783.3	723.6	637.3	504.5	371.8	272.2	172.6	6.7
7	856.4	783.3	723.6	637.3	504.5	371.8	272.2	172.6	6.7
8	749	685.2	632.9	557.4	441.3	325.2	238.1	151	5.9
9	677	619.3	572.1	503.9	398.9	293.9	215.2	136.5	5.3
Beirut- AC for Cooling except single duct and Double duct kWh/year.m²									
	A+++	**A++**	**A+**	**A**	**B**	**C**	**D**	**E**	**F**
Residential Standard	32.47	27.15	25.46	23.45	21	17.95	14.06	8.9	1.77
Residential Seasonal	27.39	22.9	21.48	19.78	17.71	15.14	11.86	7.51	1.49
Hotel	42.92	35.88	33.66	31	27.76	23.73	18.58	11.77	2.34
Office	30.21	25.26	23.69	21.82	19.54	16.7	13.08	8.28	1.65
Retail	73.13	61.14	57.35	52.82	47.3	40.43	31.66	20.05	3.98
Hospitals	22.87	19.12	17.94	16.52	14.79	12.64	9.9	6.27	1.25

7

7 The commission Delegated Regulation (EU) No 665/2013, defines two labels that differs in the form and the data required

TABLE 29: SAVINGS PER TYPE OF EQUIPMENT

Beirut- AC for Cooling for single duct and Double duct kWh/year.m²									
	A+++	A++	A+	A	B	C	D	E	F
Residential Standard	60.41	56.52	51.36	44.23	40.54	33.7	24.57	16.59	6.32
Residential Seasonal	50.96	47.67	43.33	37.31	34.2	28.42	20.73	13.99	5.33
Hotel	79.85	74.7	67.89	58.46	53.59	44.54	32.48	21.92	8.35
Office	56.21	52.59	47.79	41.15	37.72	31.36	22.86	15.43	5.88
Retail	136.06	127.29	115.68	99.62	91.31	75.9	55.34	37.36	14.23
Hospitals	42.55	39.81	36.18	31.15	28.56	23.74	17.31	11.68	4.45
Beirut- AC for Heating except single duct and Double duct kWh/year.m²									
	A+++	A++	A+	A	B	C	D	E	F
Residential Standard	1.94	1.83	1.65	1.41	1.26	1.07	0.84	0.55	0.16
Residential Seasonal	3.88	3.65	3.3	2.82	2.52	2.14	1.68	1.09	0.32
Hotel	2.59	2.43	2.2	1.88	1.68	1.43	1.12	0.73	0.21
Office	0	0	0	0	0	0	0	0	0
Retail	0.65	0.61	0.55	0.47	0.42	0.36	0.28	0.18	0.05
Hospitals	7.12	6.7	6.05	5.18	4.61	3.93	3.08	2	0.58
Beirut- AC for Heating for single duct and Double duct kWh/year.m²									
	A+++	A++	A+	A	B	C	D	E	F
Residential Standard	1.89	1.76	1.57	1.42	1.23	1.06	0.85	0.58	0.23
Residential Seasonal	3.79	3.52	3.15	2.85	2.45	2.12	1.7	1.17	0.45
Hotel	2.53	2.35	2.1	1.9	1.64	1.41	1.14	0.78	0.3
Office	0	0	0	0	0	0	0	0	0
Retail	0.63	0.59	0.52	0.47	0.41	0.35	0.28	0.19	0.08
Hospitals	6.94	6.45	5.77	5.22	4.5	3.89	3.13	2.14	0.83
TV kWh/year									
System	A+++	A++	A+	A	B	C	D	E	F
15" D[1]<40"	131.97	119.85	111.86	102.54	93.22	77.24	53.27	26.63	13.32
40" D<85"	678.17	615.9	574.84	526.94	479.03	396.91	273.73	136.87	68.43

Eco design - PC kWh/year									
Category A[9]	98								
Category B	70								
Category C	58								
Category D	42								
Washing Machines kWh/year									
	A+++	**A++**	**A+**	**A**	**B**	**C**			
	163.18	159.3	135.99	108.79	73.82	38.85			
Lights kWh/year (average for 700 lumen)									
	A++	**A+**	**A**	**B**	**C**	**D**			
Non directional < 1300 lumen	50.52	47.12	43.14	22.71	11.35	2.84			
Directional < 1300 lumen	94.8	91.96	79.47	48.25	34.06	2.84			
Vacuum Cleaner (kWh/year)									
	A+++	**A++**	**A+**	**A**	**B**	**C**	**D**	**E**	**F**
Label 1				31	25	19	13	7	1
Label 2	36	30	24	18	12	6			

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9 Categories for desktops are detailed in Ecodesign directive EUNO617/2013. They depend on several parameters such as processing unit, graphics card ...

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