

# ENERGY SECTOR

### PEOPLE IN NEED



### PEOPLE TARGETED



### REQUIREMENTS(US\$)



### PARTNERS



### GENDER MARKER



### CONTACTS

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## SECTOR OUTCOMES

**Outcome #1** **99.2 m**

By the year 2020, all vulnerable populations in Lebanon will have improved, equitable and gender appropriate access to electricity in terms of quality, quantity and sustainability.

#### Indicators

Percentage of vulnerable populations with improved quality of electricity

Percentage of vulnerable populations with improved supply hours of electricity

Percentage of vulnerable populations with access to sustainable renewable energy

Percentage of vulnerable populations with access to energy efficient products

Number of sites and municipalities with access to off-grid street lighting

Number of public wells with installed solar power for water pumping

## POPULATION BREAKDOWN

POPULATION COHORT	PEOPLE IN NEED	PEOPLE TARGETED	Gender Breakdown	
			51% Female	49% Male
Lebanese	1,500,000	626,707	319,620	307,086
Displaced Syrians	1,500,000	492,464	251,157	241,307
Palestine Refugees from Syria	31,502			
Palestine Refugees in Lebanon	277,985			

## Situation analysis and context

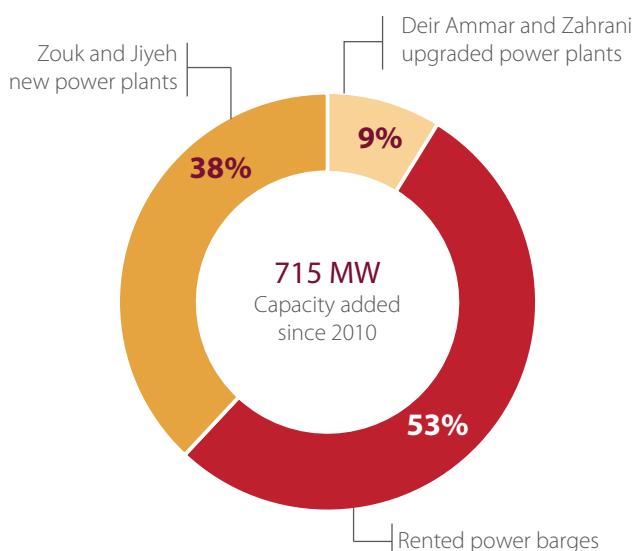
The increased electricity demand caused by the Syrian crisis has created additional stress on the already weak electricity system and underscored its lack of resilience. A study currently undertaken by the Ministry of Energy and Water (MoEW) and UNDP reveals the need to supply an additional 450 to 480 MegaWatts (MW) to cover the demand of the 1.5 million displaced Syrians.

In 2010, prior to the onset of the Syrian crisis, the GoL recognized the critical need to address Energy sector issues and endorsed a Policy Paper for the Energy Sector in June 2010.<sup>1</sup> The paper outlines policy, investments and reforms aimed at increasing the level and quality of electricity supply, managing demand growth, decreasing the average cost of electricity production, increasing revenues and improving sector governance. The paper outlines a set of well-articulated initiatives that ultimately aim at improving service delivery and reducing the fiscal burden that the sector places on public resources.

Starting in 2010, several projects that increase electricity supply were initiated. By the end of 2016, the MoEW and Electricite du Liban (EDL) will have provided an additional 715MW in energy supply capacity through the following projects:

- The upgrade and rehabilitation of the Deir Ammar and Zahrani power plants resulted in additional capacity of 63MW.
- The addition of stand-by capacity through rented power barges provided 380MW.
- By the end of 2016, two new power plants in Zouk and Jiyeh (annexed to the existing plants) will add 272MW to the national grid.

### Added Capacity since 2010 (MW)



To date, due to the implemented projects, EDL has 2,950MW<sup>1</sup> of installed capacity (not necessarily generated) available at peak which is almost 90 percent of the current peak demand of 3,300 MW.<sup>2</sup>

The implementation of the Government's reform and investment programmes is underway but it is being hindered by financial and political obstruction. Until these are fully implemented, Lebanon's electricity sector will continue to underperform and therefore remain a significant burden on public resources. The sector will therefore continue to be highly vulnerable to the shock of increased demand brought about by the displacement of a significant Syrian population to Lebanon.

In addition to simply having insufficient installed generating capacity, the efficiency of the existing system is below normal levels due to poor maintenance, deterioration of facilities, high losses and the need for reinforcement of the transmission network.

Deteriorating and inadequate infrastructure has resulted in poor reliability and inadequate levels of electricity supply. Service delivery standards are low compared to other countries with similar GDP per capita. Even prior to the Syrian crisis, Lebanon suffered extensive load-shedding, with supply cuts in Beirut of at least 3 hours per day and up to 12 hours per day outside of Beirut. The majority of consumers are therefore forced to rely on costly and environmentally unfriendly small diesel generators to provide the balance of their electricity requirements.

The sector is causing a massive drain on the GoL which subsidizes the cost of fuel used in EDL's power plants. The sector cost the government US\$3.056 billion in 2014, \$2.056 billion in 2015 and \$2.1 billion in 2016.<sup>3</sup>

With tariffs set at below cost recovery, high system losses, and low revenue collections, the sector is entirely reliant on public resources to subsidize the purchase of fuel for power generation.

In September 2015, the GoL signed the UN's resolution regarding the adoption of 17 Sustainable Development Goals (SDG), the seventh of which is: Ensure access to affordable, reliable, sustainable and modern energy for all. For this purpose, the MoEW is currently collaborating with the Prime Minister's Office to draft the Energy chapter of the National Strategy for Sustainable Development that is in line with its Policy Paper and its Renewable Energy strategies. The World Humanitarian Summit considers the SDGs to lie at the core of humanitarian response planning, not to mention that SDG 6 (access to water and sanitation), SDG 3 (access to healthcare) and SDG 4 (access to education) depend largely on the availability of electricity.

(1) Theoretically, 2,950MW is the maximum capacity of all power plants; however, at no point is EDL capable of supplying the available energy due to aging of plants that require recurrent closing for maintenance and to losses generated from operating other inefficient or costly processes.

(2) 3,300MW includes demand of all consumers on Lebanese territories.

(3) The decline in value of subsidies in 2015 and 2016 relative to 2014 is due to the decline in the cost of fuel in the world.

## 1.1 Impact of the Crisis on the Lebanese Electricity Sector

The displacement of a significant Syrian population to Lebanon due to the ongoing crisis is placing additional stress on an already weak and inefficient electricity system. The most immediate impact of this additional refugee population is evident through a significant increase in demand for electricity. This increase in demand is created by:

- The connection of improvised accommodation such as Informal Settlements, collective sites, substandard shelters and unfinished buildings to the electricity grid;
- Increased residential load where displaced are being hosted in Lebanese households;
- Increased residential load where displaced are renting accommodation;
- Increased load from hotels and other rented accommodations, where occupancy is above normal rates;

Already before the crisis, the Lebanese Energy sector was weak and inefficient and unable to meet the electricity demand. It had reached a point where electricity reliability and service delivery had become significant impediments to economic development and where financial sustainability was unattainable without major reform.

The additional demand created by the displaced Syrians is therefore an increased burden on the deficient system. The increased demand created by an increase in population is either being met through privately operated generators or through illegal connections to the national grid (approximately 45 percent of the displaced Syrians have such connections).<sup>ii</sup> The illegal connections result in high technical damages to the grid and increase maintenance and reparation costs resulting in additional losses on the Lebanese Energy sector, EDL and GoL. This leads to reduced supply quality and quantity and the Lebanese population face lost economic opportunities.<sup>4</sup>

The fees collected for every supplied kWh does not cover the production and operation costs and therefore does not allow further rehabilitation or extension of the grid. This is further exacerbated by the unpaid bills of customers illegally connected to the grid.

Moreover, and based on UNHCR assessments, significant electricity fees are being paid by the displaced Syrians to EDL as well as for the use of privately owned generators, which is contributing in increasing their already frail economic situation.

It is also important to remember that energy is a cross-cutting element along all sectors, these sectors which are impacted as follows:

(4) Bad electricity supply causes economic losses to businesses which would be more productive if electricity supply was improved and if the costs of private generators were reduced.

1. In addition to their uncovered operation and maintenance costs, the expenses of the Water Establishments (WE) have greatly increased due to their reliance on diesel generators to operate pumps at water sources in an attempt to cover the required water supply.
2. The lack of electricity results in dark roads and contributes to security related problems. Municipalities are forced to prioritize renewable energy settings for street lights to reduce robberies and other security issues.
3. Healthcare institutions are forced to rely more on private generators due to the insufficient supply hours and the poor quality of the supplied electricity.
4. The electricity bills of public schools providing double shifts to enable educating the displaced Syrians' children have doubled due to the crisis.
5. The environmental cost of the additional reliance on diesel generation has not been calculated but should also be considered. It is important to assess the indirect costs of using fuel for household heating and transportation and their impact on greenhouse gases (GHG) emissions. The environmental impacts on air quality and on people's health have been looked at briefly in the Environmental Impact Assessment of the Syrian Crisis but needs further investigation and studies.<sup>iii</sup>

The unexpected increase in demand makes upgrading of the electricity infrastructure inevitable in order to provide this service as per the national norms and standards, safely and equally to all. In the Lebanese context, electricity is a humanitarian need directly linked to the provision of vital services and, to a large extent, to security and social stability.

## 1.2 Quantified Impact on Lebanon's Energy Sector:

MoEW is currently conducting a study entitled "Survey and assessment of the implications on electricity in Lebanon from the current Syrian crisis and the prioritization of interventions".<sup>5</sup> The study reflects a preliminary production requirement of 447MW to supply 1.5 million displaced Syrians with electricity.<sup>iv</sup> The distribution of the needs across the Governorates is shown on the bar chart (next page).<sup>v</sup>

The burden of supplying this additional demand imply two service and financial needs:

- A. Needs of the Government to cover the cost of supplying electricity to the displaced Syrians

MoEW/UNDP's study shows that the yearly consumption of Syrian households amounts to 2,013GWh/year,<sup>6</sup> or an average power consumption of 390MW, or an equivalent capacity that should be generated by EDL's existing

(5) Note that all values in this report pertaining to this study are preliminary figures; a margin of error of 10 percent should be accounted for until the final approved results and reports are published in December 2016.

(6) This figure corresponds to 5,514,630 kWh consumed per day by the 1.5 Million refugees.

power plants of 447MW.<sup>7</sup> Knowing that the average production cost is currently 13.5USc/kWh,<sup>8</sup> and that fees are collected at a subsidized rate of 8.97USc/kWh (equally from Lebanese and others), the cost of providing additional 447MW is estimated at \$313 million in 2016, causing an estimated deficit of \$222 million a year.<sup>9</sup> These losses are borne by the GoL who is already lacking means to cover its subsidies to the sector, and is therefore not in a position to afford additional expenses.

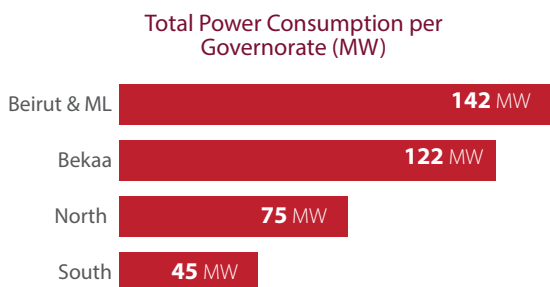
In addition the study shows that at least 45 percent of the electrical connections of Syrian households to the grid are done in an illegal manner, which not only implies lost sales to the already exhausted Government and EDL, but also incurs technical losses on the grid and deprivation of other legally connected customers from proper electricity.<sup>vi</sup>

#### B. Cost to Lebanese Consumers of Alternative Electricity Supply

Since 2010, MoEW has made an effort to increase electricity production by 715MW, of which 445MW are currently being supplied, supposed to achieve an additional supply of four hours. Despite this the average available hours of power to Lebanese consumers has remained constant at an average of 14 hours per day between 2012 and 2016. Additional outage hours at peak times are more frequent and the quality of the electricity supplied has decreased due to the overloaded transmission and distribution networks. Lebanese consumers are therefore forced to meet the lost supply through more expensive options such as private generators which adds a burden on a population already suffering from an economic crisis. Therefore, the economic cost for providing around 447MW of additional power at 8.97USc/kWh and which is borne by Lebanese who pay for private generation at a unit rate of 14.5USc/kWh is around \$292 million in 2016, resulting in \$111 million losses incurred by the Lebanese consumers.

Therefore, the overall losses on Lebanon's Energy sector resulting from Syrian refugees is \$333 million per year, or \$1.33 billion until 2020.<sup>10</sup>

#### Power Consumption of displaced Syrians



(7) This figure is the capacity required at production level to supply energy at a consumption level equivalent to 390MW plus 15 percent to account for technical losses.

(8) US cents/KWh. This figure is not constant, as it fluctuates with the cost of fuel worldwide. Before 2015, this cost of production was much higher.

(9) This represents the difference between the fees collected from displaced Syrians and the cost of production of 447MW.

(10) Assuming that the Syrian population in Lebanon will remain at 1.5 million, fees, rates of collection and percentage of illegal connections will remain constant until 2020.

## Overall Sector Strategy<sup>11vii</sup>

The overarching objective of the Energy sector in Lebanon is to improve access to electricity at agreed minimum standards to households affected by the Syrian crisis and across sectors providing vital services. It aspires to provide electrical services to Lebanese hosting communities and displaced Syrians in an equitable manner while also reducing the negative impact on the environment and limiting the financial impact on the Lebanese consumers and the Government.

Consequently, the required interventions (outputs and activities) can be summarized as follows:

- Capital investment in generation capacity and associated transmission and distribution networks to meet the additional demand created by the displaced Syrians; and
- Supporting the implementation of the Government's development plans through institutional capacity and technical assistance.

While MoEW continues to steadily implement its Policy Paper for the Energy Sector, a number of short and medium term projects will be selected and accelerated in order to directly target the impact of the Syrian crisis on the sector.

### 2.1 Sector Outcomes and Outputs

The strategy is based on one outcome reflecting the above-stated overarching objective, four outputs and 24 activities to implement it, and an overall budget of this plan of \$444 million over a period of four years. For 2017, the budget is estimated at \$99.3 million.

**Outcome 1 - By the year 2020, all vulnerable populations in Lebanon will have improved, equitable and gender appropriate access to electricity in terms of quality, quantity and sustainability.**

In the following section, outputs and activities of the Energy sector under the LCRP are presented together with an implementation plan, target and budget. It should be noted that the proposed plan will not target households in informal settlements for the following reasons:

- The policy of GoL is that no permanent infrastructure should be installed in the informal settlements.
- The risk of evictions is very recurrent which threatens sustainability of implemented works.
- The electric demand of 239,000 Syrians living in

(11) The Energy Sector is guided by the broader strategies and plans of the GoL; principal among these are the Policy Paper for the Electricity Sector (MoEW, 2010); the National Energy Efficiency Action Plan for Lebanon (NEEAP 2016-2020), the National Renewable Energy Action Plan for Lebanon (NREAP 2016-2020), the National Sustainable Development Strategy (GoL, under preparation, to be issued in 2017), and the Lebanon Environmental Assessment of the Syrian Conflict and Priority Interventions (MoE, 2014) and its updates. In addition, it uses various assessments conducted by MoEW in collaboration with different agencies to understand where the most urgent and critical needs are, such as the "Survey and assessment of the implications on electricity in Lebanon from the current Syrian crisis and the prioritization of interventions" (UNDP, 2016), the Economic and Social Impact Assessment of the Syrian Conflict in Lebanon (World Bank, 2013), and the Vulnerability Assessment of Syrian Refugees (VASyR, 2016).

informal settlements does not exceed 30MW, less than 8 percent of total demand.

### Output 1 - Increased Electricity Generation from Renewable Energy Sources<sup>12</sup>

Activities under this output aim at implementing projects that can partly satisfy the additional energy requirements through renewable energy sources, as listed below.

Population assumptions under this output are based on MoEW's ongoing study of the implications the current Syrian crisis has on electricity.<sup>viii</sup>

- Number of Syrian households: 333,869 (291,222 not residing in IS and 42,647 residing in IS)
- Number of displaced Syrians: 1,260,357 not residing in IS and 239,643 residing in IS
- Power Consumption: 359,430 kW outside the IS and 30,075 kW inside the IS
- Energy Consumption: 5,120,196 kWh outside the IS and 394,434 kWh inside the IS

#### a. Solar Water Heaters for Residential Facilities:

This activity optimistically targets a total number of 291,222 households divided equally between vulnerable Lebanese and displaced Syrians. If fully implemented, this activity would save 750,000 MWh/year and cause a yearly reduction in CO2 emissions of 500,000 tons. It has the biggest share of the sector's budget amounting to \$233 million, but it is a sustainable measure that would remain a renewable energy source for the Lebanese after the safe return of the displaced populations.

#### b. Solar Off-Grid Lighting around informal settlements and on public municipal streets:

It is recommended to install about 5,000 off-grid solar lighting poles in different outdoor areas, around informal settlements and on main roads in municipalities

hosting vulnerable populations. This would ensure safer movement for both Lebanese communities and displaced Syrians. The total budget is \$6 million.

#### c. Solar Pumping for Public Wells:

Water Establishments have been suffering from additional expenses on private generators to supply additional volumes of water to localities with high concentration of displaced Syrians. Providing solar panels to power pumps at public wells would reduce the generator bills, and would be an environmentally friendly energy source that requires minimum maintenance. The maximum estimated installed capacity is 7 MW peak (MWp) and can be distributed among vulnerable localities according to the pumping requirements and land availability surrounding the public well. The total budget is \$10.5 million.<sup>13</sup>

#### d. Solar PV Farms for Electricity Generation:

This activity recommends the installation of solar PV panels to serve a small community or public institutions. This activity targets vulnerable localities and is intended to provide cheaper electricity to consumers and to alleviate the demand on the national grid.

The maximum estimated installed capacity is 7.5 MWp and can be distributed among the different governorates. The total budget is \$11.25 million.

The implementation of activities under Output 1 would reduce the demand on the national grid and the distribution and transmission networks, decrease the losses on EDL and more importantly provide better quality and cheaper electricity to both the Lebanese hosting communities and the displaced Syrians, and as such impact positively their economic vulnerability.

Table 1: Summary of Proposed Activities, Energy Savings and Budgets for 2017-2020 for Output 1:

Source	Energy Saving in 2017 (MWh/yr (15%))	Budget 2017 (\$)	Energy Saving 2018-2020 (MWh/yr (85%))	Budget 2018-2020 (\$)	Total yearly CO2 emissions reduction (tons)
Solar water heating for residential facilities	112,500	35,000,000	637,500	198,000,000	500,000
Solar off-grid lighting	328.5	900,000	1,861.5	5,100,000	1,423
Solar pumping	1,680	1,575,000	9,520	8,925,000	7,280
Solar PV farms for electricity generation	1,800	1,687,500	10,200	9,562,500	7,800
<b>Total</b>	<b>116,309</b>	<b>39,162,500</b>	<b>659,081</b>	<b>221,587,500</b>	<b>516,503</b>

(12) Activities and corresponding figures under Outputs 1 and 2 have been calculated by the Lebanese Center for Energy Conservation (the technical partner of MoEW for renewable energy, also known as LCEC) specifically to mitigate impact of displaced Syrians on energy in Lebanon.

(13) Based on estimation of land availability around areas with high concentration of refugees.

## Output 2 - Electric Demand is reduced through provision of Energy Efficient products

If Output 1 targets the upstream, supply side of electricity, Output 2 targets the downstream, demand management side of the sector. The activities under this output energy efficiency measures will be deployed with that aim of reducing the energy consumption in Lebanese communities, Syrian shelters, schools, health care centers, hospitals and SDCs. In these locations, the common types of electricity use is for heating and cooling, domestic water heating, lighting and cooking (mainly in residential facilities).

Based on the type of shelter/facility and the same population assumptions as in Output 1, the proposed energy efficiency activities are as follows:

### e. Indoor LED Lighting and Solar cookers in Households:

The needed number of LED lamps is estimated to be eight for households not residing in IS and two for households residing in IS, which is equivalent to 2,415,000 lamps given that the number of households is 333,869 units. Also, it is assumed that electric stoves can be successfully replaced by solar cookers in 20 percent of the households equally divided between vulnerable Lebanese households and households of displaced Syrians.

Improved lighting would foster protection of women and children and would ensure a higher safety in buildings and households. These energy efficient measures would reduce the electricity bills of consumers as well as alleviate the demand on the national grid. The total budget is \$35.4 million.

### f. Indoor LED Lighting and Lighting Control in Public Schools:

The proposed lighting measure aims at reducing the additional lighting consumption due to the second afternoon shift in public schools. Considering that each classroom comprises eight linear or compact fluorescent lamps, then the total number of LED retrofits required is 33,280.<sup>14</sup> Also, installing motion detectors in WCs and circulation areas such as corridors and stairways in 160 schools, would result in additional energy savings. These activities will reduce the electricity bill of schools and allow them to install more lighting to secure safety of children. The total budget is \$960,000.

### g. Energy Audits in Hospitals and Implementation of Measures:

According to the Ministry of Public Health (MoPH), the total number of governmental hospitals in Lebanon is 29.

Energy audits are required in hospitals in order to identify the energy consumption profiles and implement recommended energy efficiency measures. The measures would be mainly related to efficient lighting,

lighting control and water heating. Reducing the demand of electricity in hospitals will improve the quality of the supply and as such will reduce their reliance on private generators and the consequent expenses. The total budget is \$6.3 million.

### h. Walk-in Energy Audits in PHC, SHC, SDC and Implementation of Measures:

As per MoSA and the Inter-Agency Information Management Unit, there are 220 primary healthcare centers in Lebanon, 128 secondary healthcare centers, and 220 SDCs.

In such types of facilities, a walk-in energy audit is sufficient to replace conventional lighting by LED lighting. Reducing their demand of electricity will improve the quality of the supply and as such will reduce their reliance on private generators and the consequent expenses. The total budget is \$6 million.

### i. Horizontal Measure – Variable Speed Drives for Pumps

The total number of wells in Lebanon is 841 with a total discharge of 248,775,097 m<sup>3</sup>/year.<sup>ix</sup>

When installing variable speed drives on pumps, the energy consumption would be reduced by 50 percent, resulting in major energy savings to Water Establishments and a reduction in electricity and fuel bills. The total budget is \$1.5 million (corresponding to Variable Speed Drives [VSD] pumps in 340 public wells).

Table 3: Summary of Output 1 and 2:

	Energy Saving 2017-2020	Budget 2017-2020	Total CO2 emissions reduction
	MWh/year	\$ million	Tons
Output 1	775,400	260.75	2,066,012
Output 2	200,000	50.17	512,400
<b>Total 1+2</b>	<b>975,400</b>	<b>311.00</b>	<b>2,578,412</b>

Following the implementation of Output 1 and Output 2 above, the total load reduction from the national grid is 975,400 MWh/year or 191MW per year.

The energy consumption by Syrian displaced that remains to be covered is 2,314,706 - 975,400 MWh/year = 1,339,306 MWh/year equivalent to 256MW per year.

### **Alternative action: Provide Alternative Sources to fill supply gaps**

The first two outputs, if completely implemented, can provide a reduction of only 43 percent (191MW out of 447MW) of the energy requirements by the Syrians, for an overall budget of \$311 million by 2020.

Even if the \$444 million requested by the Energy sector in the LCRP would be fully funded by 2020, the full cost of \$1.33 billion incurred solely by the electricity demand of the displaced Syrians in Lebanon will not be covered. Not only is this cost being directly borne by the Government and its people, but the Lebanese are also not witnessing what their Government has achieved in terms of increased power generation over the past four years, and

(14) 42 percent of Syrian students attend the first shift while 58 percent attend the second shift. The latter share is equivalent to 61,942 students distributed over 160 schools opening in the afternoon. Accordingly, the average number of students per school is 388. Assuming each classroom includes 30 students, then 13 classrooms are occupied per school, equivalent to 2,080 classrooms in 160 schools.

this is creating more resentment and social tensions.

Therefore, it is essential to either find new sources of energy production or to assist MoEW and the GoL to assume the additional costs resulting from the impact of the Syrian crisis.

Irrespective of the source of power production, the increased load borne by the transmission and distribution networks requires to rehabilitation and/or reinforcement of the networks as detailed in the following sections.

Hence a total of around 1,100 Mega-volt ampere (MVA) are currently being added to the capacity of the transmission network.

Regions with large populations of displaced Syrians are fed by substations on the 66 kV network. Most of these substations are overloaded. They require rehabilitation and upgrading as well as reinforcement of the corresponding 66 kV overhead transmission lines.

As a result, the Syrian crisis has had a direct impact on the

Table 2: Summary of Proposed Activities, Energy Savings and Budgets for 2017-2020 for Output 2:

Source	Energy Saving in 2017 (MWh/yr)(15%)	Budget 2017 (\$)	Energy Saving 2018-2020 (MWh/yr) (85%)	Budget 2018-2020 (\$)	Total yearly CO2 emissions reduction (tons)
Indoor LED Lighting	13,487	4,350,000	76,424	24,650,000	56,200
Solar Cookers	12,994	963,000	73,631	5,457,000	56,300
Schools – Indoor LED Lighting	151	120,000	857	680,000	655
Schools – Motion Detectors	-	24,000	-	136,000	-
Hospitals – Energy Audits	-	290,000	-	-	-
Hospitals – Measures Implementation	-	900,000	-	5,100,000	-
PHC, SHC, SDC – Walk-in Energy Audits and Implementation	-	900,000	-	5,100,000	-
Horizontal Measure – VSD for Pumps	3,358	225,000	19,031	1,275,000	14,933
<b>Total</b>	<b>30,000</b>	<b>7,772,000</b>	<b>170,000</b>	<b>42,398,000</b>	<b>128,100</b>

### Output 3 - Transmission Network is reinforced

The transmission network serves to transmit the energy produced by the generation sites to the distribution networks through Overhead Transmission Lines (OHTL), High Voltage Substations (SS), and Underground High Voltage Cables (UGC). Substations of the transmission network reduce the high voltage in the power plants to medium voltage. The medium voltages used in Lebanon are 220 kV, 150 kV and 66 kV. In some areas 33 kV voltage is still used.

Currently, the transmission network is being rehabilitated and upgraded as per the National Electricity Policy paper, with the following projects being implemented by MoEW under law 181/2011:

1. Substations: 3 Gas Insulated Switchgears 220 kV in Dahieh, Achrafieh and Bahsas.
2. New transformers: 6 new 70MVA have been added in existing Substations in Deir Nbouh, Deir Ammar, Zouk, Bsalim, Zahrani, and Sour.
3. Capacitor banks have been added inside remote Substations to sustain the level of Voltage in Nabatieh, Sultanieh, Labiue, Hermel, Qobayyat.
4. Overhead transmission line 66 kV double circuit from Dear Nbouh to Baalbeck passing through Substations of Bared, Halba, Kobayyat, Hermel, Laboue, Bidnayel and Baalbeck has been installed.
5. EDL is executing two 220 kV substations in Saida and Baalbeck.

transmission sector, because it overloads the high voltage substations and transmission lines. This is forcing many large consumers, like hospitals and industries, to rely on private generators, not only because of power shedding, but also due to the significant drop in voltage resulting from the additional load carried by the substations.

In conclusion, and based on the ongoing MoEW study on power consumption rates per caza, it can be deduced that the following Substations should be upgraded or completely reconstructed depending on the available space. The table below shows works currently under execution or planned to be carried out by MoEW/EDL.

If implemented these works would result in better voltage quality of the electricity supplied to consumers and a reduction in the losses of the transmission system, and consequently an increase of supply hours.

Table 4: Summary of Output 3:

Governorate	66 kV outgoing Bay	66 kV incoming Bay	20 MVA transformer	40 MVA transformer	MV Switchgears	Current Works by MoEW/EDL
Hermel	2	1	1		1	upgrading the 66 kV Overhead Transmission Line (OHTL)
Laboueh	2	1	1		1	
Anjar	2	1	1		1	
JibJanine	2	1	1		1	
Marjeyoun	2	1	taken From Nabatieh SS		1	upgrading the 66 kV OHTL from Sultanieh to Marjeyoun S/S
Nabatieh				1	1	
Beiteddine	2	1	1		1	EDL is upgrading the 66 OHTL
Sibline				1	1	
Kobayat	2	1	1		1	MoEW is upgrading the 66 kV OHTL linking Kobayat to Halba and Hermel S/S.
Halba	2	1	1		1	MoEW is upgrading the 66 kV OHTL linking Halba and Kobayat and Bared S/S.
Total (Units)	16	8	7	2	10	
Estimated Budget (\$/Unit)	250,000	250,000	300,000	450,000	500,000	
<b>Total Budget 2017-2020 (\$)</b>				<b>14,000,000</b>		

#### Output 4 - Reinforce the Distribution Network

The distribution network is the final stage in the delivery of electric power. Its function is to reduce the medium voltage carried by the transmission substation to a low voltage. The medium voltage is carried by Medium Voltage feeders (cables) to the transformers which reduce the current to a low voltage usable by consumers. A distribution network consists of the following elements:

1. Primary distribution cables (MV feeders) carry the medium voltage to MV/LV transformers. These cables can be underground or overhead.
2. Transformers, supported with network protection devices and accessories, reduce the medium voltage (MV) to low voltage (LV).
3. Poles and cables through which LV current is carried to customers.

In the context of implementing the Policy Paper, the majority of the distribution network in Lebanon has been rehabilitated in all Lebanese areas since 2010.

However, the sudden overloading of these networks as a result of the Syrian refugees in the country is resulting in:

1. Failure or damage of distribution transformers
2. Additional losses in the systems, especially with the increased number of illegal connections to the grid
3. Poor quality of the electric current reaching consumers
4. Decreased supply hours due to the incapacity of transformers to accommodate additional load
5. Deprivation of electricity to Lebanese hosting communities

Today around 18,200 transformers service more than 5.85 million Lebanese and Syrians, which implies that

each unit is servicing 320 people, instead of 220 people as planned before the crisis.

A number of projects have been proposed to mitigate the effects of the additional electrical consumption. These projects will provide reliable access to electricity and reduce the technical losses in areas of high consumption and provide displaced Syrians with more reliable power to cover their needs.

The generation of 447MW for 250kva MV/LV transformers and their related poles, cables, network protection devices and accessories with a MV/LV utilization factor of 80 percent would result in providing 2,250 fully operational transformers (their distribution depends on population consumption and density).

In general, it is necessary to rehabilitate 1,535 of the existing 18,200 transformers and to provide 700 new transformers to be installed in highly vulnerable communities in order to improve services to both Lebanese and displaced Syrians. However, a more detailed assessment will be conducted to make sure that rehabilitation work is done on transformers that have been damaged or are underperforming as a result of the additional load.

To have a significant impact by the end of 2017, it is planned to rehabilitate 40 percent or 280 transformers in the coming year and add 614 new ones. The proposed works would cost around \$46 million out of a total budget of \$115 million over four years.<sup>15</sup>

For a baseline population of 1.5 million displaced Syrians, the cost per refugee per month corresponding to the cost of rehabilitating a portion of the distribution network does not exceed \$1.6/refugee/month or 19\$ per year.

If these proposed works on the distribution network are implemented, Lebanese hosting communities and

(15) Excluding design and supervision costs



displaced Syrians would feel an improvement in the quality of the electric current supplied and an increase in the number of hours supplied. As such, their reliance on private generators will decrease and their bills would be less of a burden. It is also expected that these works would decrease illegal connections to the grid and the losses in the system.

Table 5: Summary of Output 4:

Governorate/ District	Estimated No. of New Transformers	Estimated No. of Rehab. Transformers	MV Feeders / OH	MV Feeders / UG	Total Budget Per Region (\$)
Akkar	50	111	2	1	8,273,042
North	99	217	4	2	16,209,642
Bekaa	79	174	3	2	12,987,253
Baalbek-Hermel	57	124	2	1	9,274,351
Beirut	56	123	2	1	9,189,064
Mount Lebanon	242	531	10	5	39,710,475
South	74	161	3	2	12,068,642
El Nabatieh	43	95	2	1	7,117,280
<b>Grand Total</b>	<b>700</b>	<b>1,535</b>	<b>29</b>	<b>16</b>	<b>114,829,750</b>

**Proposed Activities:** In summary, the table above shows the proposed mitigation works on the distribution network in the coming four years.

#### Technical Assistance to Implement the Proposed Outputs

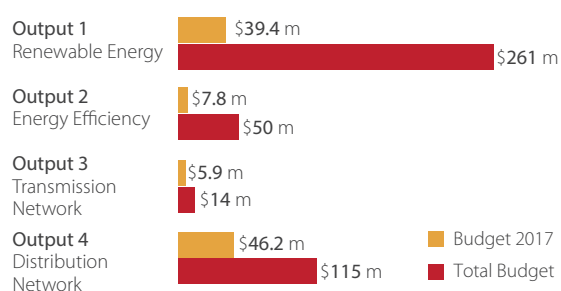
The Energy sector Policy Paper is for the most part being implemented by a group of specialized experts and consultants under the employment of the Ministry, who have become overburdened by trying to respond to the impact of the Syrian crisis.

Therefore, to implement and manage the activities proposed in this strategy, a dedicated team of experts and consultants is required to provide the necessary support, due diligence and supervision.

The international community is requested to provide immediate support to ensure sufficient institutional capacity to oversee implementation and completion of the above mentioned projects and the short term improvement interventions in electricity supply.

MoEW would estimate the need for a team of senior and junior consultants for the implementation of the above plan for four years at an estimated budget of \$4 million.

#### Energy Sector Budget



## 2.2 Identification of sector needs and targets at the individual, institutional and geographic level

In Lebanon, displaced Syrians are mainly residing in two types of areas:

- Those living in informal settlements constitute

18 percent of the displaced Syrians and are located typically in agricultural areas. They require comprehensive assistance in basic services, especially electricity, to allow them to have basic household lighting, cooking appliances, hot water for bathing and other usages. Provision of street lighting in informal settlements is also a major element for security for the displaced Syrians as well as the Lebanese hosting communities, and as such reduces social tensions between both populations.

- Those that have settled within hosting communities constitute 82 percent of the displaced Syrian population. They typically concentrate in densely populated urban centers, in particular in already impoverished neighborhoods and in informally developed urban areas, where access to essential electricity is insufficient. Lebanese and displaced Syrians living in substandard shelters require improved electricity services, ensuring sufficient access to all.
- As for the Palestine Refugees in Lebanon and Palestine Refugees from Syria living in camps in Lebanon, the MoEW and EDL have pending claims with UNRWA extending from 2003 until 2014. These claims are currently being handled by the Ministry of Foreign Affairs. As such, MoEW is in no position, thus far, to take into account the demand of these populations within the LCRP. If solutions are reached within the period between 2017 and 2020, the Energy sector strategy under the LCRP will be revisited accordingly.

The sector's response targets the needs of the most vulnerable first, using the following criteria to prioritize activities and projects:

- a. Focus on geographical areas with the highest concentration of affected people and with no/poor access to sufficient quantity, quality and continuity of services related to electricity.
- b. Implementation of pre-planned priority projects that are part of the GoL's strategies and masterplans which ensure vital service provision to the most vulnerable communities in a sustainable manner.
- c. Focus on the highest risks to environmental degradation in areas with the highest concentrations of displaced Syrians impacting natural resources.
- d. Focus on areas presenting security challenges and social stability issues.
- e. Focus on vulnerable groups, households and individuals (i.e. female/child headed households, elderly or disabled persons and minors, children in schools, hospitals) for specific assistance.
- f. Focus on public institutions providing vital services to the displaced Syrians and to the vulnerable host community affected by their presence.

By taking into account the mapping of the 251 vulnerable localities, the MRR, and the priority list of requests of vulnerable municipalities submitted to MoEW and EDL, and the ongoing MoEW assessment, the Energy strategy aims at improving electricity services to all vulnerable populations in Lebanon, be it Lebanese or Syrian, within the coming four years if all the outputs and activities are fully implemented.

## Mainstreaming of conflict sensitivity, gender, youth, people with specific needs (PwSN) and environment

### Conflict Sensitivity

Electricity generation through renewable energy, provision of energy efficient products, off-grid PV street lights and reinforcement of the transmission and distribution network are all activities that improve the quality and quantity of electricity supply and that reduce social tensions between Lebanese hosting communities and displaced Syrians.

### People with Specific Needs

Special attention would be given to prioritize service provision to persons with disability, families with young children and to elderly.

### Environment

Renewable energy sources, use of energy efficient products and connection to the grid are the best examples on how the sector would help in reducing the impact of the Syrian crisis on air quality in Lebanon through reducing the use of diesel generators.

## Total sector needs and targets 2017

Population Cohort	Total Population in Need	Targeted Population	No. of Female	No. of Male	No. of Children (0-17)	No. of Adolescent (10-17)	No. of Youth (18-24)
Lebanese	1,500,000	626,707	319,620	307,086	195,219	102,404	
Displaced Syrians	1,500,000	492,464	251,157	241,307	263,961	94,061	50,724
Palestine Refugees from Syria	31,502		-	-	-	-	
Palestine Refugees in Lebanon	277,985		-	-	-	-	
<b>GRAND TOTAL</b>	<b>3,309,487</b>	<b>1,119,171</b>	<b>570,777</b>	<b>548,393</b>	<b>459,180</b>	<b>196,465</b>	<b>50,724</b>

Type of Institutions	Total	Targeted
Municipalities		TBD
Public Schools	24	24
Water Establishments	4	4
Social Development Centers	33	33
Central Ministries	1	1
Public Hospitals	5	5
Primary Healthcare Centers	33	33
SHC	19	19
Electricité du Liban	1	1

## Inter-sector linkages

All vital services in Lebanon depend on provision of electricity. The sector therefore has close linkages with a number of other sectors.

**Health:** Ensure proper functioning of fridges and other equipment in health facilities in addition to reduce the healthcare institutions' electricity bills through renewable energy sources and energy efficient products.

**Education:** Reduce electricity bills on public schools hosting displaced Syrians.

**Basic Assistance:** Reduce the use of private generators, and contribute to reduction of electricity fees paid by vulnerable populations in order to reduce their economic vulnerability in a sustainable manner.

**Shelter:** Burning of tents in informal settlements from the use of candles took the life of several Syrian children in the past years. Improving the quality and supply hours of electricity would improve the shelter conditions and reduce such risks.

**Social Stability/Livelihoods:** Renewable energy sources and the increase of electricity supply hours will improve the lighting of public spaces (roads, etc.) which will enhance the security within the community and contribute to the social stability between the host community and the displaced Syrians.

**Food Security:** Food conservation of cooked dishes requires refrigeration especially in Lebanon where the temperature can reach 38 degrees. Many diseases are noticed due to food intoxication. Improving access to electricity would improve food security.

**Protection:** Lighting of Informal Settlement sites and municipal roads will largely contribute to the creation of a protection space mainly for women and kids but also for youth, disabled and all vulnerable population.

**Water:** Water supply is facing a large challenge of unaffordable bills of diesel for private electricity generation. Connection of pumping stations to the grid or to renewable energy sources would highly improve water supply and reduce economic burdens on Water Establishments. Moreover, pumping wastewater in networks and treating it in wastewater treatment plants require electricity. The cuts lead to bad treatment of wastewater and are therefore a threat to the environment and to public health especially when wastewater is discharged raw in rivers and when untreated wastewater is reused for irrigation purposes.





## Endnotes

- i. Lebanon, Ministry of Energy and Water (June 2010), *Policy Paper for the Electricity Sector*.
- ii. Lebanon, Ministry of Energy and Water and UNDP (2016), *Assessment of the Impacts of the Syrian Crisis on the Lebanese Electricity Sector*.
- iii. Lebanon, Ministry of Environment, European Union, UNDP (September 2014), *Lebanon Environmental Assessment of the Syrian Conflict and Priority Interventions*.
- iv. Lebanon, Ministry of Energy and Water and UNDP (2016), *Assessment of the Impacts of the Syrian Crisis on the Lebanese Electricity Sector*.
- v. Ibid.
- vi. Ibid.
- vii. Lebanon, Ministry of Energy and Water (June 2010), *Policy Paper for the Electricity Sector* ; Lebanon, Ministry of Energy and Water (March 2016), *Second National Energy Efficiency Action Plan for the Republic of Lebanon: NEEAP 2016-2020* ; Lebanon, Ministry of Energy and Water, *National Renewable Energy Action Plan for Lebanon: NREAP 2016-2020*; Lebanon, Ministry of Environment, European Union, UNDP (September 2014), *Lebanon Environmental Assessment of the Syrian Conflict and Priority Interventions* ; Lebanon Ministry of Energy and Water, UNDP (2016), *Survey and assessment of the implications on electricity in Lebanon from the current Syrian crisis and the prioritization of interventions*, UNHCR, UNICEF, WFP (2016), *Vulnerability Assessment of Syrian Refugees 2016*, Lebanon.
- viii. Lebanon Ministry of Energy and Water, UNDP (2016), *Survey and assessment of the implications on electricity in Lebanon from the current Syrian crisis and the prioritization of interventions*.
- ix. Lebanon, Ministry of Energy and Water and UNDP (2014), *Assessment of Groundwater Resources of Lebanon*.





## Sector Logframe

**Outcome 1:** By the year 2020, all vulnerable populations in Lebanon will have improved, equitable and gender appropriate access to electricity in terms of quality, quantity and sustainability.





Indicator 1	Description	Means of Verification	Unit	Frequency
Percentage of vulnerable populations with improved quality of electricity	Measure the improvement of quality due to rehabilitation/upgrading of the electricity infrastructure in affected areas	Assessment study in 2018	Percentage	Bi-annual

 Lebanese				 Displaced Syrians				 Palestine Refugees from Syria (PRS)				 Palestine Refugees in Lebanon (PRL)			
Baseline	Target 2017	Target 2018	Target 2020	Baseline	Target 2017	Target 2018	Target 2020	Baseline	Target 2017	Target 2018	Target 2020	Baseline	Target 2017	Target 2018	Target 2020
0%	18%		45%	0%	7%		17%								





Indicator 2	Description	Means of Verification	Unit	Frequency
Percentage of vulnerable populations with improved supply hours of electricity	Measure the improvement in the number of supply hours of electricity due to rehabilitation/upgrading of the electricity infrastructure in affected areas	Assessment study in 2018	Percentage	Bi-annual

 Lebanese				 Displaced Syrians				 Palestine Refugees from Syria (PRS)				 Palestine Refugees in Lebanon (PRL)			
Baseline	Target 2017	Target 2018	Target 2020	Baseline	Target 2017	Target 2018	Target 2020	Baseline	Target 2017	Target 2018	Target 2020	Baseline	Target 2017	Target 2018	Target 2020
0%	18%		45%	0%	7%		17%								

Indicator 3	Description	Means of Verification	Unit	Frequency
Percentage of vulnerable populations with access to sustainable renewable energy	Measure the number of interventions that allowed implementation of renewable energy sources	NREAP (LCEC/MoEW assessment in 2018)	Percentage	Bi-annual

 Lebanese				 Displaced Syrians				 Palestine Refugees from Syria (PRS)				 Palestine Refugees in Lebanon (PRL)			
Baseline	Target 2017	Target 2018	Target 2020	Baseline	Target 2017	Target 2018	Target 2020	Baseline	Target 2017	Target 2018	Target 2020	Baseline	Target 2017	Target 2018	Target 2020
0%	6%		39%	0%	7%		49%								

Indicator 4	Description	Means of Verification	Unit	Frequency
Percentage of vulnerable populations with access to energy-efficient products	Measure the number of energy-efficient products that have been implemented at household and institutional levels	NEEAP (LCEC/MoEW assessment in 2018)	Percentage	Bi-annual

 Lebanese				 Displaced Syrians				 Palestine Refugees from Syria (PRS)				 Palestine Refugees in Lebanon (PRL)			
Baseline	Target 2017	Target 2018	Target 2020	Baseline	Target 2017	Target 2018	Target 2020	Baseline	Target 2017	Target 2018	Target 2020	Baseline	Target 2017	Target 2018	Target 2020
0%	4%		39%	0%	4%		49%								