ENERGY
SECTOR

PEOPLE IN NEED

2,035,461

PEOPLE TARGETED

678,487

REQUIREMENTS(US$)

2019 99.2 million

2020 171 million

PARTNERS

14

GENDER MARKER

2a

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SECTOR OUTCOMES

Outcome #1 — $39.1 m

Increase energy production through implementation of renewable energy sources.

Indicators

Increase in MWh resulting from installed capacity through renewable energy sources.

Outcome #2 — $7.5 m

Reduce energy demand due to implementation of energy efficient initiatives.

Indicators

Reduction resulting from installed capacity through energy efficient measures in MWh.

Outcome #3 — $51.6 m

Improve access to electricity through Rehabilitation and Reinforcement works on the Transmission and Distribution networks.

Indicators

Number of people benefiting from rehabilitation and reinforcement works on the transmission and Distribution networks.

Outcome #4 — $1 m

Enhance capacity of MoEW to plan, budget and oversee energy sector initiatives.

Indicators

Number of new energy initiatives and projects resulting from capacity development and support to MoEW.

POPULATION BREAKDOWN

POPULATION COHORT	PEOPLE IN NEED	PEOPLE TARGETED	51% Female	49% Male
Lebanese	1,219,094	406,365	207,246	199,119
Displaced Syrians	816,367	272,122	138,782	133,340

Situation analysis and context

Energy for vulnerable and public services

The increased electricity demand caused by the Syria crisis has created additional stress on Lebanon's already-weak electricity system and aggravated its lack of resilience, mostly affecting vulnerable Lebanese, displaced people and essential public service providers such as schools and hospitals. A study undertaken by the Ministry of Energy and Water (MoEW) in collaboration with UNDP revealed an additional 486 megawatts (MW) of power supply are needed to cover the increased demand of the 1.5 million displaced Syrians in Lebanon.[i] Since the Lebanese energy sector was weak, inefficient, and unable to meet the electricity demand already before the crisis, this massive and abrupt increase in demand caused more frequent power cuts and aggravated the quality of power, forcing people to rely on expensive and pollutive private diesel generators.

Access to electricity

According to Ministry of Energy and Water and UNDP's study,[i,ii] even though most of the interviewed households have connections to the national electricity grid, the majority of them have non-metered power connections and subscribe to private generators,[iii] indicating the heavy reliance on expensive and pollutive source of electricity among displaced Syrian. Regarding the availability of grid electricity, there are significant geographical variations of electricity supply from the grid, where Beirut and Bekaa received approximately 20 hours with the rest of governorates receiving less than 13 hours. Since private generators are more expensive than grid electricity, these variations are disproportionally affecting the already-fragile economic situation of vulnerable Lebanese, displaced Syrians and public institutions by forcing them to spend more electricity costs.

Impacts on public services

Because electricity is an essential service for all sectors, the exacerbated situation of electricity access and quality has negatively impacted the following vital public services causing social and security issues.

Education: Schools normally work six hours a day (first-shift), but schools hosting displaced Syrian students are working an additional four-hour shift (second-shift). As the number of public schools offering second-shift has increased since the crisis to ensure the equitable education for all children including displaced, both electricity and fuel oil bills of these schools have increased dramatically, putting more strain on the national budget. Moreover, due to the poor quality of power and high voltage drops in some areas due to overloaded medium voltage feeders or medium and low voltage substations, some schools operate on diesel generators even during power supply hours because office machines do not function when voltage levels are low. The UNDP and Ministry of Energy and Water's survey estimated a total increase of around 10,895 kWh/day in energy consumption as an indirect impact of additional demand.[i] These utility costs are borne by the Government, further constraining their budgetary allocations for other educational costs.

Heath: Although it was difficult to estimate the quantitative impact on the electricity bill of hospitals because most hospitals already operate 24 hours at full capacity, there was a qualitative impact resulting from the additional power consumption of the displaced Syrians in the areas close to the supply points of the respective hospitals. The impact is in the form of overloading the distribution network which results in poor power quality and voltage drop (180V - 190V) in many areas, forcing hospitals to run diesel generators even with a power supply hours as most medical equipment does not function with low voltage[i], placing additional financial burdens on the hospitals already strained by the high healthcare needs of displaced Syrians.

Water: The expenses of the water establishments have increased due to water pumps having to operate for longer hours to cover increases in demand by displaced people. Furthermore, the frequent electricity cuts and poor power quality lead to insufficient treatment of wastewater, aggravating a threat to public health and the environment.

Livelihoods and Social Stability: Due to the inadequate electricity supply exacerbated by the crisis, Lebanese enterprises are facing increased costs, production disruptions, and reduction of profitability, causing major impediments to the business environment and loss of economic opportunities. The lack of electricity also results in dark roads and contributes to security-related problems. Hence, there is an opportunity where municipalities can prioritize renewable energy for street lights while also reducing security risks.

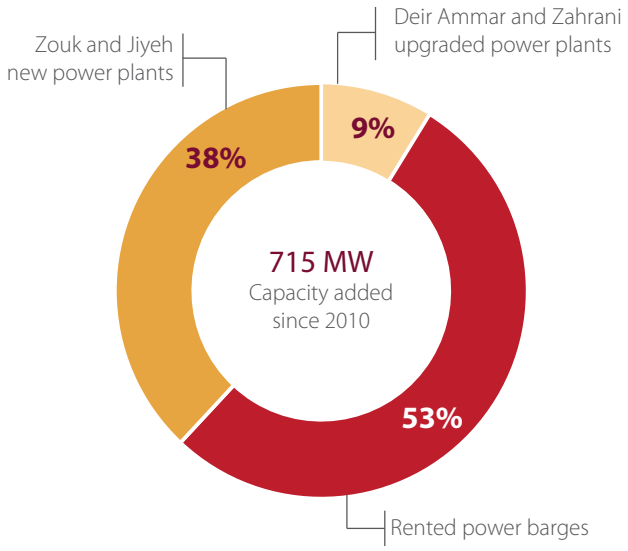
Environment: Since the onset of the Syria crisis, Lebanon has been unable to meet the additional demand for electricity created by displaced people. As a result, private generators are widely used to fill the electricity supply and demand gap, increasing the emissions of air pollutants. The deterioration of air quality and impacts on health were briefly examined in the Environmental Impact Assessment of the Syria Crisis in 2014, with incremental increases of air pollutants estimated to be 10 per cent for nitrous oxides and around 2 per cent for carbon monoxide, sulphur and finer particulate matter.[iv] More recent figures of electricity demand by displaced populations is estimated at 486 megawatts, and incremental quantities of air pollutant emissions may also be much higher. Given that private generators emit high concentrations of nitrous oxide and finer particulate matter hazardous to the human health, serious health risks are imposed on nearby communities, especially children. Intensive efforts are needed to start a transition in the energy sector in Lebanon which involves introducing renewable energy sources photovoltaic energy systems, in sectors such as education and health as well as in communities hosting displaced Syrians. In

addition to reducing carbon emissions, such systems generate financial savings that can be re-directed to core education and health activities and reduce reliance on polluting generators.

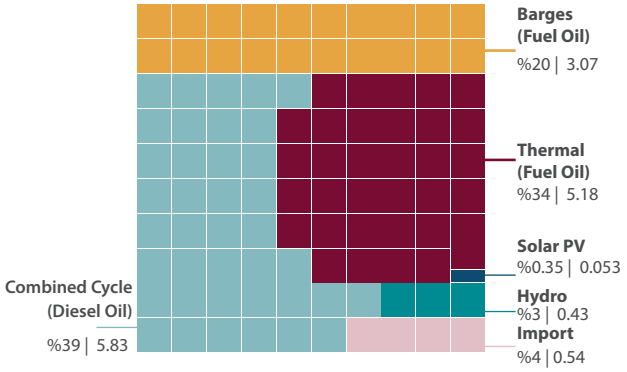
Impact of the crisis on the Energy sector

In 2010, before the onset of the Syria Crisis, the Government of Lebanon (GoL) recognized the critical need to address energy-sector issues and endorsed a Policy Paper for the Energy Sector in June 2010.[v] The paper outlines policies, 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 strategic initiatives that aim to improve service delivery and reduce the fiscal burden that the sector places on public resources. Notably, the policy paper also commits to launching, supporting, and reinforcing all public, private, and individual initiatives to use renewable energies to reach 12 per cent of electric and thermal supply by 2020. To support this target, the National Energy Efficiency and Renewable Energy Action (NEERA) national financing mechanism was initiated in 2010, targeting initiatives led by the private sector in renewable energy and energy efficiency. Several projects increasing electricity supply have been initiated since 2010. By the end of 2017, the Ministry of Energy and Water and Electricité du Liban (EdL), the national utility company, had installed an additional 715 megawatts in energy supply capacity through the upgrading of the existing plants, establishment of the new power plants and addition of stand-by capacity.

Added Capacity since 2010 (MW)



To date, Electricité du Liban has 2,100 MW[1] of generation capacity available at peak supply, which is almost 60 per cent of the current peak demand of 3,400 MW.[2] The massive electricity supply and demand gap is mostly filled by pollutive private diesel generators at the expense of customers. Regarding renewable energy development, the cumulative installed decentralized small-scale solar photovoltaic capacity grew by the rate of 100 per cent per year from 2010 until the end of 2017 driven by private investment from Industrial and commercial sector, catalysed by the National Energy Efficiency and Renewable Energy Action soft-loan programme, amounting to 35.34 megawatt peak in total.[vi] In 2017, Electricité du Liban's share of the total electricity generation equalled 15.05 terawatt hours while the solar photovoltaic 'share equalled 0.053 TWh or 0.35 per cent of the total electricity generation (up from 0.26 per cent in 2016) (Figure 2). With solar photovoltaic added to hydro, the renewables' share of the total annual electricity generation in 2017 is equal to 3.35 per cent.



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. As recently as 2010, the electricity losses were estimated at 15 per cent by technical losses, 20 per cent by non-technical losses, and 5 per cent by uncollected bills.[v] With tariffs set 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. As a result, the sector is causing a massive drain on the Government of Lebanon, which subsidizes the cost of fuel used in Electricité du Liban's power plants. The energy sector cost the Government, as a transfer to EdL, US$2.1 billion in 2014, $1.1 billion in 2015, $0.9 billion in 2016, $1.3 billion in 2017 and $0.75 billion as of June 2018.

Although the implementation of the Government's reform and investment programmes are underway, it has been severely hindered by financial and political obstructions. Until these programmes 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 caused by the Syria crisis.

(1) Theoretically, 2,720 megawatts is the maximum capacity of all power plants; however, at no point is Electricité du Liban capable of supplying the available energy due to aging plants that require recurrent closing for maintenance, and to losses generated from operating other inefficient or costly processes.

(2) 3,400 megawatts include demand of all consumers on Lebanese territory.

Increases in electricity demand after the crisis

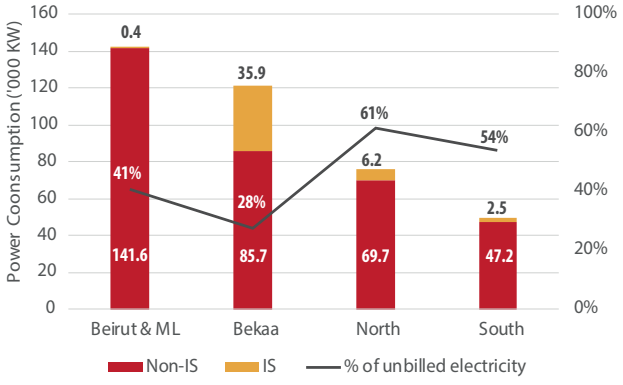
The most immediate impact of the influx of displaced Syrians is a significant increase in electricity demand. This demand in electricity is directly created by:

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

The indirect impact of additional power consumption by schools hosting displaced Syrian students is caused by the additional four-hour shift. The longer working hours of water pumps to cover additional water consumption by displaced Syrians also represent the indirect impact on the power consumption by displaced Syrians. The increased demand causes overloads, poor power supply and voltage drops, forcing people and institutions to use diesel generators even with power supply, further increasing the demand of electricity at user-side. Non-metered connections to a large portion of Syrian shelters also damage the distribution network, increasing non-technical losses.

Quantified impact of the crisis on the electricity sector

The study conducted by Ministry of Energy and Water, in collaboration with UNDP, calculates that the additional direct and indirect power generation needed to cater to the demand of displaced Syrians amounts to around 486 MW[i]. The distribution of the electricity consumption of displaced Syrians across the governorates is shown in the figure below.



As indicated, the power consumption inside informal settlement accounts for only 12 per cent of total power consumption of the displaced Syrians. Notably, the amount of unbilled electricity consumption by displaced Syrians is significant, aggravating the cost recovery of Electricité du Liban, a tariff already set below the generation cost.

The burden of supplying this additional demand implies two service and financial requirements:

• **Need for the Government to cover the cost of supplying electricity to displaced Syrians:** The yearly consumption of Syrian households amounts to 2,013 gigawatt hours (GWh)/year[3] – an average power consumption of 428 megawatts, or an equivalent capacity that should be generated by Electricité du Liban's existing power plants of 486 megawatts.[4] Knowing that the average production cost is currently US¢13.5/kilowatt hour (USC/kWH),[5] and that fees are collected at a subsidized rate of 8.97 ¢/kilowatt hour (equally from Lebanese and others), the cost of providing an additional 486 megawatts by the national utility is estimated at $313 million in 2016, causing an estimated deficit[6] of $222 million per year. These losses are covered by the Government of Lebanon, which already lacks the means to cover its subsidies to the sector and is therefore not in a position to afford additional expenses. According to the study conducted by the Ministry of Energy and Water and UNDP, approximately 45 per cent of the Electricité du Liban's electricity bills are not collected, which not only implies loss of revenue for the Government and Electricité du Liban, but also incurs technical losses and damages on the grid where illegally connected to the grid.

• **Cost to grid consumers of alternative electricity supply:** Since 2010, the Ministry of Energy and Water has made an effort to increase electricity production by 715 megawatts, in order to achieve an additional supply of four hours. Despite this effort, the 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 supplied electricity 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, adding an additional burden on a population already suffering from an economic crisis. The economic cost of providing around 486 megawatts of additional power at US$¢8.97 /kilowatt hour is borne by Lebanese, who pay for private generation at a unit rate of US$¢14.5/kilowatt hour, or around US$292 million in 2016, resulting in US$111 million in losses incurred by Lebanese consumers.

Therefore, the overall losses on Lebanon's energy sector attributed to the Syria crisis is US$333 million per year, or US$1.33 billion between 2017 and the end of 2020.[7]

(3) This figure corresponds to 5,514,630 kilowatt hours consumed per day by the 1.5 million displaced Syrians.
(4) This figure is not constant, as it fluctuates with the cost of fuel worldwide. Before 2015, the cost of production was much higher.
(5) This figure is the capacity required at production level to supply energy at a consumption level equivalent to 428 megawatts plus 15 per cent to account for technical losses.
(6) This represents the difference between the fees collected from displaced Syrians and the cost of production for 486 megawatts.
(7) 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.

Achievements and challenges under the LCRP 2017-2020 (2018)

Achievements

The projects implemented by Energy LCRP partners focus on the installation of renewable energy equipment (Output 1.1: Increase in electricity production through implementation of renewable energy) and the rehabilitation of the electric distribution networks (Output 1.4: Improve access to electricity through implementation of reinforcement and rehabilitation works on the distribution network) as per the sector`s priorities.

Regarding renewable energy, the installation of distributed solar photovoltaic systems in public institutions has succeeded in creating sustainable impacts on various institutions, which can be a transition solution for other LCRP sectors. While distributed solar photovoltaic systems are fast becoming a cost-effective energy solution in Lebanon and are being widely adopted in industrial and commercial sectors due to their decreasing price and soft loans , public-sector institutions and communities cannot often afford the high initial capital investment costs required for renewable energy technologies by themselves. To support the vulnerable public and non-governmental organisations in mitigating their financial burden regarding electricity bills, distributed solar photovoltaic systems have been installed under LCRP. The Energy sector so far installed hybrid solar photovoltaic systems in 12 public institutions such as schools and hospitals across Lebanon. In total 1,411 kilowatts of solar photovoltaic systems were installed. This will save around 2,080 megawatt hours of electricity consumption per year from the diesel generator and the grid and provide around $375,000 a year in electricity bill reductions throughout its lifetime (c.a. 20 years). Since the cumulative financial savings from the solar photovoltaic systems are much larger than their investment cost, the project will have sustainable impacts on the public institutions, which can potentially shift energy savings to their service provision and its greater access. Interestingly, through the provision of the grant, some of the beneficiaries (e.g. private hospital and NGO) could even mobilize their capital from the financial savings it provided to re-invest in renewable energy or even in enhancing some of their services, hence multiplying the impacts of the grant element.

The reinforcement of the distribution network is one of the key interventions aiming to increase the capacity to deliver quality electricity to additional end-users, especially to the most vulnerable people and communities. Installation of the new transformers was done in the most vulnerable communities and around 10,000 households connected to the national grid are now benefiting from the improved quality of grid electricity. Through a project that aims at the prevention of illegal connections, a total of 345 legal electrical connections, along with net metering systems, have been installed in Bekaa, Akkar, Baalbek, and the North.

Challenges

The main challenge of the sector remains to raise funds and to advocate for the importance of the sector. Electricity in Lebanon remains a controversial issue: the challenges that the sector faced before the Syria crisis have been severely exacerbated by the extra consumption of electricity, causing more losses to the Government and the Lebanese population.

Regarding the installation of renewable energy, given solar photovoltaic positive return on investment, and immediate and sustainable monetary saving, the possible solutions for this are to; 1) mainstream renewable energy and energy efficient projects in other sector's strategic interventions, especially support to public institutions, and; 2) leverage private investments through technical and financial support with grant.

The ministry estimated that the installation of approximately 700 new medium and low voltage transformers are needed to accommodate the demand increase while the partners have installed 122 transformers to date. Because upgrading of the distribution network is a capital-intensive activity, it is a difficult challenge to raise sufficient funds to reach the vulnerable communities most in need.

Overall sector strategy

The overarching objective of the Energy sector in Lebanon is to improve access to electricity at agreed minimum standards to households affected by the Syria crisis, and across sectors providing vital services. It aspires to provide electrical services to Lebanese host communities and displaced Syrians equitably, while also reducing the negative impact of the crisis on the environment and limiting the financial impact on the Lebanese Government and consumers. This overall objective of the Energy sector is as follows: 'By the year 2020, all vulnerable populations in Lebanon will have improved and equitable, sustainable access to all form of the electricity'. By enhancing electrical services and capacity at the national and local level in a sustainable manner, the Energy sector contributes to the LCRP`s third objective of supporting service provision through national systems, and the fourth objective of reinforcing Lebanon`s economic, social, and environmental stability. Thus, the theory of change of the Energy sector toward these overall objectives is as follows:

If, a) the Energy sector increases the capacity of electricity generation through the installation of renewable energy systems (Outcome 1) or decreases the demand for electricity through the provision of energy efficient products (Outcome 2), b) rehabilitates and reinforced the electricity network (Outcome 3), and c) enhances the capacity of implementing partners, such as the Ministry of Electricity and Water and other actors (Outcome 4), then, the sector can partially and locally reduce the supply/demand gap created by the displaced population and increase the network's capacity to

deliver non-fluctuated/intermittent electricity access to the most vulnerable in an environmentally friendly manner, reducing the reliance on diesel generators and air pollution caused by it.

Before the outbreak of the Syrian crisis, the Ministry of Energy and Water had been improving Lebanon's electricity infrastructure, guided by the Policy Paper for the Electricity Sector (Ministry of Energy and Water, 2010)[v] and the other national action plans for renewable energy[vii] and energy efficiency.[viii] The strategy for the LCRP Energy sector is built on these national strategies, while also considering various vulnerability assessments to understand and identify where the most urgent and critical needs exist as described in the situation analysis.[i]

Sector outcomes, outputs and indicators

The required interventions can be summarized as follows:

• Capital investment in decentralized energy generation capacity (Outcome 1), energy efficiency measures (Outcome 2) and associated transmission and distribution networks (Outcome 3) to partially meet the additional demand created by the displaced Syrians while also supporting vulnerable communities and public institutions by improving access, availability and affordability of electricity, and;

• Supporting the implementation of the Government's development plans for the Energy sector through increased institutional capacity and technical assistance (Outcome 4).

While the Ministry of Energy and Water continues to 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 Syria crisis on the sector. The sector's strategy entails four outcomes towards implementation, and an overall requested budget of $443 million over the course of the LCRP 2017-2020. However, in view of the lack of funds disbursed into the Energy sector in previous years, the requested budget of 2019 is estimated at $99 million. In the following section, outcomes, outputs and activities of the Energy sector under the LCRP are presented together with an implementation plan, target, and budget.

Outcome 1: Increase energy production[8]

This outcome seeks to increase the capacity of electricity supply to reduce the expanded gaps due to the presence of displaced populations through the installation of distributed renewable energy systems in vulnerable host communities and public institutions that are under severe financial pressure to meet the increase in demand brought about by the Syria crisis. As demonstrated in the sector's achievements, the installation of renewable energy systems has sustainable and long-lasting direct impacts on vulnerable communities and public institutions through monetary savings. Also, given its positive net-present-value, the renewable energy project can also catalyse private finance, multiplying the impact of the grant support.

For community-scale support, the innovative initiative called "Village 24 Initiative", developed by UNDP-CEDRO with the European Union fund based on the experience of the first community-led solar photovoltaic systems in Kabrikha, could be of great potential[ix]. Although it is still at pilot stage (as of October 2018), this community-scale hybrid microgrid (utility, diesel generator, renewable energy) can provide clean and affordable electricity to multiple households by utilising the digitisation of net-metering scheme while also promoting community cooperation. A community-scale solar photovoltaic system can lower the investment cost (economies of scale), potentially enabling the communities to tap into private finances such as soft-loans and microfinancing.

Output 1.1: Renewable energy systems implemented

Given these comparative advantages of renewable energy projects, Lebanon's current market and legal situation, and technical studies, the activities listed below are considered cost-effective interventions with long-lasting impact under Outcome 1. All proposed activities are sustainable measures that would remain as renewable energy sources for the country beyond the current crisis.

a. Solar water heaters (SWH): Solar water heaters are a highly cost-effective way (good turnover) to reduce electricity consumption from heating water. While most Lebanese households still use electricity to heat water and pay expensive bills, the capacity of local manufacturing and deployment of solar water heaters is already well-established. Thus, with the appropriate support, this activity could reach a large number of vulnerable households while also stimulating local industries. The sector estimates that there are a total number of 291,222 households in need, divided equally between vulnerable Lebanese and displaced Syrians. If they are fully targeted, it would save 750,000-megawatt hours per year and contribute to a yearly reduction of 500,000 tons of carbon dioxide emissions.

b. Solar off-grid lighting: The installation of solar off-grid lighting plays an important role in reducing crime and vandalism, making residents and pedestrians feel safer during the night, ensuring social stability and safer movement. The system can be installed in different outdoor areas such as around informal settlements and on main roads in vulnerable municipalities. The sector estimates that about 5,000 off-grid solar lighting poles should be installed to meet the needs of vulnerable communities.

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 a high concentration of displaced Syrians. Providing solar panels to power

(8) 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.

Table 1: Required budget per Outcome 1:

Type of Activity under Output 1.1	Primary Target in Need	Required Budget	Amount of renewable energy generation (MWh/year)	Amount of CO2 emission reduced (tCO2/year)
A. Solar Water Heater	291,222 vulnerable households	$ 221,587,500	659,081	516,503
B. Solar Off-Grid Lighting	251 most vulnerable municipalities vulnerable households			
C. Solar Water Pumping	27 public institutions/communities			
D. Distributed Renewable Power Generation	27 public institutions/communities			

pumps at public wells would reduce generator costs and serve as an environmentally friendly energy source that requires minimum maintenance. The maximum estimated installed capacity is seven megawatt-peak (MWp) across vulnerable localities according to the pumping requirements and land availability surrounding the public well.

d. Distributed renewable energy power generation: The Energy sector strongly recommends the installation of renewable energy systems, such as solar photovoltaic systems, biomass energy and ground source heat pumps to serve communities and public institutions. This activity targets vulnerable localities and is intended to provide cheaper and cleaner electricity to vulnerable consumers in a sustainable manner. As Lebanon has numerous renewable energy resources including affluent solar irradiation, wind and biomass but it currently generates most of the electricity from imported oil with massive deficit, the promotion of renewable energy has multi-fold benefits such as cash fluidity within the community, multiplier effects on the national economy and job creation. With installation costs decreasing continuously, distributed renewable energy systems are increasingly more competitive and give positive returns on investment. For the installation of renewable systems, it would be possible to leverage private finance through the partial grant supports as demonstrated in 2018 achievements.

The National Renewable Energy Action Plan for Lebanon (NREAP 2016-2020) lays out the potential of these technologies and national implementation strategies in broader contexts. Furthermore, the technical guidelines for these technologies in the Lebanon context are available on UNDP's website[9] and the Lebanese Center for Energy Conservation (LCEC) will be able to provide sector partner with technical and coordination assistance to support effective and efficient project formulation.

Outcome 2: Reduce energy demand through the implementation of energy-efficient initiatives

While Outcome 1 targets the upstream/supply side of electricity provision, Outcome 2 targets the downstream, demand-management side of the sector. Through the activities under this Outcome, energy efficiency measures will be deployed with the aim of reducing energy consumption in Lebanese communities, shelters for displaced Syrians, schools, healthcare centres, hospitals and social development centres. In these locations, electricity is primarily used for heating, domestic-water heating, lighting, and cooking (mainly in residential facilities).

Output 2.1: Energy-efficient products provided to households and public institutions

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

- Light-emitting diode (LED) lighting and solar cookers in households: The required number of LED lamps is estimated to be eight for households not residing in informal settlements and two for households residing in informal settlements, equivalent to 2,415,000 lamps for the 333,869 displaced Syrian households targeted. Improved lighting would foster the protection of women and children and would ensure a higher degree of 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.
- LED lighting and lighting control in public schools: This proposed measure aims at reducing additional lighting consumption due to the afternoon second shifts in public schools. Installing LED lighting and motion detectors will reduce the electricity bill for these schools.
- Energy audits in hospitals and implementation of measures: According to the Ministry of Public Health, there are 29 Government hospitals in Lebanon. Energy audits are required in hospitals to identify energy consumption profiles and implement recommended energy efficiency measures. The measures would be mostly related to efficient lighting, lighting control, and water heating. Reducing electricity demand in hospitals will improve the quality of supply, and as such, will their reliance on private generators and the consequent expenses.
- Walk-in energy audits in primary and secondary health centers, social development centres and implementation of measures: As per the Ministry of Social Affairs and the Inter-Agency Information Management Unit, there are 218 primary healthcare centres, 128 secondary healthcare centres, and 233 social development centres in Lebanon. In such

(9) www.cedro-undp.org

Table 2: Required budget per Outcome 2:

Type of Activity under Output 1.1	Primary Target in Need	Required Budget	Amount of renewable energy generation (MWh/year)	Amount of CO2 emission reduced (tCO2/year)
A-1. Indoor LED lighting	291,222 vulnerable households	$ 221,587,500	659,081	516,503
A-2. Solar cookers				
B-1. Schools – Indoor LED lighting	343 public schools			
B-2. Schools – Motion detectors				
C-1. Hospitals – Energy audits	29 public hospitals			
C-2. Hospitals – EE measures implementation				
D. PHC, SHC, SDC – walk-in energy audits and implementation	579 public institutions (PHC 218/SHC 128/SDC 233)			
E. VSD for pumps	343 public wells			

types of facilities, a walk-in energy audit is sufficient to replace conventional lighting with LED lighting. Reducing electricity demand in these facilities will improve the quality of supply and reduce their reliance on private generators and subsequent expenses.

- Energy saving measure in the Agriculture sector – Variable Speed Drives (VSD) for Water Pumps: Increasing water scarcity is threatening the agriculture sector in Lebanon. With a total of 841 public wells in Lebanon, the total discharge amounts to 248,775,097 m3/year.[x] Thus, it is critical to promote the rational and efficient use of water resources. By installing variable-speed drives on water pumps, energy consumption could be reduced by 50 per cent, resulting in major energy savings to water establishments and a reduction in electricity and fuel bills. This technology would also allow farmers to save energy and money when using irrigation pumps and will lead to rational use of water resources and reduced pressure on groundwater, benefiting the Energy, Agriculture, and Water sectors.

Outcome 3: Improve access to electricity through rehabilitation and reinforcement works on the transmission and distribution networks

This outcome is divided into two Outputs, one related to work on the transmission network, and the other to work on the distribution network, as described hereafter.

Output 3.1: Transmission network reinforced through the installation of high and medium voltage transformers

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 from power plants to medium voltage. The medium voltages used in Lebanon are 220,150 and 66 kilo volts (kV). In some areas 33 kilo volt voltage is still used.

Currently, the transmission network is being rehabilitated and upgraded as per the National Electricity Policy Paper: A total of around 1100 mega volt amp (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-kilo volt network. Most of these substations are overloaded and require rehabilitation and upgrading, as well as reinforcement of the corresponding 66 kilo volt overhead transmission lines.

As a result, the Syria crisis has had a direct impact on the transmission sector, because it has led to overloading 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 because of the significant drop in voltage due to additional loads carried substations.

In conclusion and based on the ongoing Ministry of Energy and Water's 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 work currently being undertaken or planned by the Ministry of Energy and Water / Electricité du Liban.

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

Output 3.2: Distribution network reinforced through the installation of medium and low voltage transformers

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

Table 3: Work currently being undertaken or planned by the Ministry of Energy and Water/ Electricité du Liban

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 ($/Unit)	250,000	250,000	300,000	450,000	500,000	
Total Budget 2019-2020 ($)				**14,000,000**		

cables can be underground or overhead;

2. Transformers, supported with network-protection devices and accessories, reduce the medium voltage to low voltage ; and
3. Poles and cables, through which Low Voltage currents are carried to consumers.

In the context of implementing the Policy Paper, the majority of the distribution networks in Lebanon were rehabilitated in all Lebanese areas since 2010.

However, the sudden overloading of these networks, as a result of the presence of displaced Syrians 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; and
5. Deprivation of electricity to Lebanese host communities.

To account for the 486 megawatts generated and servicing additional populations, medium and low voltage transformers and their related poles, cables, network protection devices, and accessories require the provision of 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 install 700 new transformers in highly vulnerable communities 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 are damaged or underperforming due to the additional load. To have a significant impact by the end of 2019, the sector plans to rehabilitate 40 per cent, or 280 transformers, in the coming year and to add 614 new ones. The proposed work would cost around $46 million out of a total budget of $115 million over three years. For a baseline population of 1.5 million displaced Syrians, the cost/person/month, corresponding to the cost of rehabilitating a portion of the distribution network, does not exceed $1.6/person/month or $19/year. If this proposed work on the distribution network is implemented, Lebanese host communities and displaced Syrians would feel an improvement in the quality of the electric current supplied and an increase in the number of hours electricity is available. As such, their reliance on private generators and energy bills would

Table 4: Required budget for Output 3.2:

Governorate	Required # of new trans-formers	# of installed new trans-formers un-der LCRP (Oct 2018)	Required # of Rehab. Trans-formers	Required # of MV Feeders / OH	Required # of MV Feeders / UG	Required Budget by 2020 (US$)
Akkar	50	31	111	2	1	6,723,042
North	99	29	217	4	2	14,759,642
Bekaa	79	3	174	3	2	12,837,253
Baalbek-Hermel	57	18	124	2	1	8,374,351
Beirut	56	0	123	2	1	9,189,064
Mount Lebanon	242	28	531	10	5	38,310,475
South	74	10	161	3	2	11,568,642
El Nabatieh	43	1	95	2	1	7,067,280
Total	**700**	**120**	**1,535**	**29**	**16**	**108,829,750**

decrease. These works would also likely decrease illegal connections to the grid and the losses to the system. It is crucial that illegal connections are prevented as a means to reduce technical losses through the distribution system and appropriately recover the cost of electricity generation.

Outcome 4: Ministry of Energy and Water staff specialized in different areas of the Energy sector provided

The Energy Sector Policy Paper is being implemented by a group of specialized experts and consultants under the employment of the Ministry, who have become overburdened in responding to the impact of the Syria crisis. Therefore, to implement and manage the activities proposed in this strategy, a dedicated team of experts and consultants is required to provide 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. The Ministry of Energy and Water estimates the budget for a team of senior and junior consultants for the implementation of the above plan to be $3 million for a three-year period.

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:

a. Those living in informal settlements constitute 18 per cent of displaced Syrians and are typically located in agricultural areas. They require comprehensive assistance in basic services, especially electricity, to provide them with basic household lighting, cooking appliances, and hot water for bathing and other uses. Provision of street lighting in informal settlements is also a major benefit to the security of displaced Syrians, as well as Lebanese host communities, and reduces social tensions between both populations.

b. Those settled within host communities constitute 82 per cent of displaced Syrian population. They typically concentrate in densely-populated urban centres, particularly in already impoverished neighbourhoods 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 for all.

As for the Palestinian refugees from Lebanon and Palestinian refugees from Syria living in camps in Lebanon, the Ministry of Energy and Education and Electricité du Liban have pending claims with UNRWA extending from 2003 until 2018. These claims are currently being handled by the Ministry of Foreign Affairs. As such, the Ministry of Energy and Water is in no position, thus far, to take into account the demand of these populations within the LCRP. If solutions are reached within the 2018 and 2020 period, the Energy sector strategy under the LCRP will be revisited accordingly.

It should be noted that the above proposed plan does not target households in informal settlements for the following reasons:

- The policy of the Government of Lebanon is that no permanent infrastructure should be installed in informal settlements;
- There is a recurrent risk of evictions, which threatens the sustainability of implemented works; and
- The electricity demand of 239,000 Syrians living in informal settlements does not exceed 30 MW, less than 8 percent of the total demand.

Population assumptions under Outcomes 1 and 2, used in the Ministry of Energy and Water's study of the implications of the Syria crisis on electricity,[iv] are as follows:

- Number of displaced Syrian households: 333,869 (291,222 not residing in informal settlements and 42,647 residing in informal settlements)
- Number of displaced Syrians: 1,500,000 (1,260,357 not residing in informal settlements and 239,643 residing in informal settlements)

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

- 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;
- Implement 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;
- Focus on the highest risks of environmental degradation in areas with the highest concentrations of displaced Syrians, impacting natural resources;
- Focus on areas presenting security challenges and social stability issues;
- Focus on vulnerable groups, households, and individuals (i.e. female/child-headed households, elderly or disabled persons and minors, children in schools or hospitals) for specific assistance;
- Focus on public institutions providing vital services to displaced Syrians and to vulnerable host communities affected by their presence.

By taking into account the mapping of the 251 vulnerable localities, the Mapping of Risks and Resources (MRR), the priority list of vulnerable municipality requests submitted to Ministry of Energy and Water and Electricité du Liban, and the Ministry of Energey and Water/UNDP's study, the energy strategy aims to improve electricity services to all vulnerable populations in Lebanon, be they Lebanese or Syrian, within the coming two years, if all the Outputs and activities are fully implemented.

Table 5: Target beneficiaries of the Energy sector.

Population Cohort	Total Population in Need	Targeted Population	No. of Females	No. of Male
Lebanese	1,500,000	626,707	745,500	753,938
Displaced Syrians	1,500,000	492,464	774,043	725,955
Palestinian Refugees from Syria	31,502	-	-	-
Palestinian Refugees from Lebanon	277,985	-	-	-
GRAND TOTAL	**3,309,487**	**1,119,171**	**1,519,543**	**1,479,893**

Type of Institutions	Total	Targeted
Individuals		
Municipalities	1005	All municipalities hosting refugees
Unions of Municipalities	46	TBD
Hospitals/healthcare institutions (PHC, etc)	608	29 Governmental hospitals, 218 PHC, 128 SHC, 233 SDC
Public Schools	364	364
Central Ministries	1	MoEW
Electricite du Liban	1	1
Water Establishments	4	4
Communities		
Governorates	8	8
Sites		
Informal Settlements	4,312	4,312
Palestinian Camps	12	TBD
Palestinian Gatherings	42	TBD

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 solar photovoltaic street lights, and reinforcement of the transmission and distribution network are all activities that improve the quality and quantity of electricity supply, thus reducing social tensions between Lebanese host communities and displaced Syrians.

People with Specific Needs

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

Environment

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

Inter-sector linkages

All vital services in Lebanon depend on the provision of electricity. Therefore, the overstretched condition of the Energy sector is negatively affecting most of the sectors. In addition, the Energy sector has close inter-sector linkages with other sectors in terms of interventions. For instance, the installation of renewable energy (solar water heaters) or energy efficiency products (LED lighting) will directly benefit vulnerable populations and communities by reducing electricity costs while mitigating the burden on national grid, which is perceived by many Lebanese as strained due to the Syria crisis. Specific cross-sector linkages are as follows.

Education: To host displaced Syrians, a large number of public schools are now providing second shifts, which strain the operational capacity of the schools. The implementation of energy efficiency and renewable energy measures are a cost-effective way to reduce the electricity bills of schools. The Education sector and the Energy sector, under the guidance of MEHE will implement Renewable Energy projects mainly distribution of Solar PV systems and installation of energy efficient (LED Lighting) projects in public schools. The installation of solar PV in schools can generate monetary savings throughout its lifespan (c.a. 20 years). The financial savings can be re-directed to core education activities such as school enrolment.

Basic Assistance, Health and Water: The Energy sector's interventions aim at enhancing public service

delivery by these sectors through the reduction of electricity costs and the provision of cleaner energy. The Energy sector will coordinate with these sectors when planning and implementing projects to ensure the selection of beneficiaries most in need, or prioritized facilities for support. For example, the Basic Assistance sector is providing vulnerable populations with multi-purpose cash assistance to help them address their basic needs, including utility costs. Thus, in order to reduce the economic vulnerability of vulnerable populations in a sustainable manner, it is very important to install renewable energy and energy-efficient applications in households, which will reduce the use of private generators and contribute to the reduction of electricity fees.

As for the Health sector, ensuring uninterrupted power supply is critical for all health institutions, which in most cases, is currently ensured by expensive and polluting diesel generators. The installation of renewable energy and energy efficiency measures will reduce healthcare institutions' electricity bills, thereby easing their financial burden and leading to a positive return on investment.

Food Security: The availability, access and affordability of electricity is a crucial factor in the agriculture value chain – from food production to conservation. The promotion of energy-efficient practices in agriculture is emphasized in both the Energy and Food Security and Agriculture sectors. For instance, the installation of energy-efficient water pumping systems will contribute not only to the Energy sector, but also the Food Security and Water sectors. The Energy sector will coordinate with the Food Security and Agriculture sector for agriculture-related activities to ensure the coherent targeting of beneficiaries and the selection of appropriate technologies on the ground.

Livelihoods: An unreliable electricity supply and high production costs have significantly hampered local economic development and job creation in Lebanon.[vi] To address these critical challenges, interventions in the Energy sector will improve the investment climate in Lebanon, which will have a positive impact on energy efficiency and employment opportunities. In parallel, the Energy sector will also make an effort to track the impact of interventions on job creation.

Even though the proposed activites in the Energy sector's response plan essentially target the public sector, the technical capacity in this sector, together with the increasing private investment in renewable energy and energy efficiency (including green building) projects stimulated by the green finance mechanisms, could provide cross-cutting opportunities for the Livelihoods sector. When the Livelihoods sector plans to work on the development of value chains related to renewable energy, energy efficiency, and green building, the Energy sector will provide the necessary information and technical advice, so that partners can efficiently captitalize on knoweldge and resources in the Ministry of Energy and Water and other relevant institutions, and ensure strategic alignment with national plans and policies. This coordination will also apply to activites related to vocational training programmes.

Protection and Social Stability: Solar street lighting around public spaces (e.g. municipal roads) will enhance security within the communities and contribute to the protection of vulnerable populations and social stability between host communities and displaced Syrians. Installation of solar street lighting or replacement with LED lighting would be considered for this purpose. To improve the quality of electricity supply at the municipality level, the installation of transformers could be an effective intervention. The Ministry of Energy and Water has been undertaking the reinforcement of the distribution network, operated and maintained by Electricité du Liban, by prioritizing the sites based on both local needs and technical assessments.

Shelter: The Shelter sector promotes the proper installation of electrical connections within targeted shelters, while the Energy sector is responsible for the provision of universal access to electricity for all vulnerable populations. Since illegal connections to the grid undermine the distribution network, it is very important to ensure proper electricity connections from shelters to the national grid. The Energy sector will provide Shelter partners with technical support as needed. In the case of the area-based approach pilots, the Shelter sector will work closely with the Energy sector on targeting needs and coordinating planned activities.

Endnotes

i. UNDP and the Ministry of Energy and Water (MoEW) (2017), I*mpact of the Syrian Crisis on Power Sector.*

ii. UNHCR, UNICEF, WFP (2018), V*ulnerability Assessment of Syrian Refugees (VASyR 2018).*

iii. UNHCR, UNICEF, WFP (2016), *VASyR 2016.*

iv. UNDP and MoE (2014), *Environmental Assessment of the Syrian Conflict.*

v. MoEW (2010), Policy Paper for the Electricity Sector.

vi. UNDP (2018), *2017 Solar PV Status Report for Lebanon.*

vii. MoEW and the Lebanese Center for Energy Conservation (2016), *The National Renewable Energy Action Plan for the Republic of Lebanon 2016-2020.*

viii. MoEW and Lebanese Center for Energy Conservation (2016), *The Second National Energy Efficiency Action Plan for the Republic of Lebanon 2016-2020.*

ix. UNDP (2018), *Sustainable Energy for Lebanese Villages and Communities: The Village 24 Initiative.* (Link: http://www.cedro-undp.org/Publications/National%20Studies/153)

x. Lebanon, Ministry of Energy and Water and UNDP (2014), *Assessment of Groundwater Resources of Lebanon.*

Sector Logframe

Outcome 1: Increase energy production through implementation of renewable energy sources

Indicator 1	Description	Means of Verification	Unit	Frequency
Increase in MWh resulting from installed capacity through renewable energy sources		Project reports from partners in Activity info.	MWh	yearly

MWh/year

Baseline	Result 2018	Target 2019	Target 2020
		116,300	280,375

Outcome 2: Reduce energy demand due to implementation of energy efficient initiatives

Indicator 1	Description	Means of Verification	Unit	Frequency
Reduction resulting from installed capacity through energy efficient measures in MWh		Project reports from partners in Activity info	MWh	yearly

MWh/year

Baseline	Result 2018	Target 2019	Target 2020
		30,000	72,250

Outcome 3: Improve access to electricity through Rehabilitation and Reinforcement works on the Transmission and Distribution networks

Indicator 1	Description	Means of Verification	Unit	Frequency
Number of people benefiting from rehabilitation and reinforcement works on the transmission and Distribution networks		Partners report in activity info	Individuals	Monthly

Lebanese				Displaced Syrians				Palestinian Refugees from Syria (PRS)				Palestinian Refugees from Lebanon (PRL)			
Baseline	Reslt 2018	Target 2019	Target 2020	Baseline	Result 2018	Target 2019	Target 2020	Baseline	Result 2018	Target 2019	Target 2020	Baseline	Result 2018	Target 2019	Target 2020
		263,912	263,912			107,828	107,828								

Outcome 4: Enhance capacity of MoEW to plan, budget and oversee energy sector initiatives

Indicator 1	Description	Means of Verification	Unit	Frequency
Number of new energy initiatives resulting from capacity development and support to MoEW	Number of projects identified and implemented by the recruited staff at MoEW	Activity Info and/or direct reporting to LCEC/MoEW	Number of projects	Yearly

Projects

Baseline	Result 2018	Target 2019	Target 2020
		66	115