2025–2030

THE NATIONAL RENEWABLE ENERGY ACTION PLAN OF LEBANON

LCEC
LEBANESE CENTER FOR ENERGY CONSERVATION
المركز اللبناني لحفظ الطاقة

LEBANESE REPUBLIC
MINISTRY OF ENERGY AND WATER

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Foreword

Renewable Energy Value and the Commitment of the Lebanese Ministry of Energy and Water

Lebanon is committed to international agreements on sustainable development and climate change, and to scaling-up renewable energy, which is currently driving both the national and international energy transition. Declining costs and a strong business case favour the development of renewable energy in Lebanon; however, rapid infrastructure upgrades combined with deep legal and regulatory reforms are needed to create a suitable investment landscape.

Lebanon has undergone unprecedented global and local crises since 2019. Nevertheless, there is now a unique opportunity for growth and proper planning, backed by the government's commitment to act and to promote a way forward for renewables, and to re-establish Lebanon as a centre of excellence, prosperity, and development in the Arab world.

Endowed with abundant solar, water, and wind resources, Lebanon can benefit from a diverse array of renewable energy technologies. The supply chain created from the deployment of these technologies, in addition to significant expected savings on the oil bill, has the potential to drive economic diversification and create new jobs in local economies.

The Ministry of Energy and Water fully understands that the road to unlock renewable energy's full potential in Lebanon will be challenging, but it is highly committed to ensuring the necessary institutional, strategic, infrastructure, legal reforms, and structural changes to create a suitable landscape and pave the way for 2030.

Scaling up renewable energy generation in line with the ambition set out in this document will require mobilising hundreds of millions of dollars in private investment. This will be underpinned by steps to ensure that the conditions for independent power producers (IPPs) with committed and bankable power purchase agreements (PPAs) are in place, and that revenue streams from the sale of wholesale power generation into the electricity grid are attractive and reliable. Accordingly, serious policies, reforms, and tailored financial instruments are needed to attract a high number of international potential investors to foster both expertise and financing.

It is also the time for the international development and financing community to step up to the challenge. Lebanon will need the financial and technical resources of international players, who will need to be prepared to bear risk and support an accelerated scale-up of renewable energy in Lebanon. It is recognised that renewable energy is critical for sustainable and peaceful development in the region, and for the global environment.

The time has come to take bold and decisive steps in this direction for the greater good of the country. The Ministry of Energy and Water will be the main entity driving the push for the successful implementation of national energy targets, as proposed in its plan for 2025. It sends a beam of light into the middle of the storm that the country currently faces.

The next necessary steps are a containment of the situation, a safeguarding of current renewable energy projections, and quick adoption of the measures proposed in this document. All this work will need continuous monitoring in addition to regular assessment based on clear performance indicators. Proper planning, design, and monitoring, coupled with the commitment and cooperation of several ministries, organisations and the private sector, could trigger a decisive shift towards a decentralised, clean, intelligent, mobile, and resilient power system, fostering a just transition for all.

Joseph Saddi
Minister of Energy and Water

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List of Acronyms

AC	Alternating Current
AFD	Agence Française de Développement
AfDB	African Development Bank
BDL	Banque du Liban / Central Bank of Lebanon
BUSD	Billion USD
BMP	Bird Migration Protocol
CO_2	Carbon Dioxide
CF	Capacity Factor
CAPEX	Capital Expenditure
CEDRE	Conférence Économique pour le Développement, par les Réformes et avec les Entreprises
CoM	Council of Ministers
COD	Commercial Operation Date
CSD	Condition Satisfaction Date
CSP	Concentrated Solar Power
COVID-19	Coronavirus Disease
DBFOM	Design Build Finance Operate Maintain
DGO	Directorate General of Oil
DRE	Distributed Renewable Energy
EDL	Électricité du Liban
EIB	European Investment Bank
ESIA	Environmental and Social Impact Assessment
EPC	Engineering Procurement and Construction
EoI	Expression of Interest
FACTS	Flexible AC Transmission System
FMO	Nederlandse Financierings-Maatschappij voor Ontwikkelingslanden
GW	Gigawatt
GWh	Gigawatt Hour
HP	Heat Pump
HVDC	High Voltage Direct Current
IFC	International Finance Corporation
IFI	International Financial Institution
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
IoT	Internet of Things
Ktoe	Kilo tonnes of oil equivalent
LBP	Lebanese Pound
LCOE	Levelised Cost of Electricity
LCEC	Lebanese Center for Energy Conservation
LDC	Load Duration Curve
LPA	Lebanese Petroleum Administration
MASE	Italian Ministry of Environment and Energy Security
MEW	Ministry of Energy and Water
MoE	Ministry of Environment

MoF	Ministry of Finance
MoI	Ministry of Industry
MUSD	Million United States Dollars
MEDREG	Mediterranean Regulators for Electricity and Gas
MW	Megawatt
MWh	Megawatt Hour
MWp	Megawatt Peak
NEEAP	National Energy Efficiency Action Plan
NEEREA	National Energy Efficiency and Renewable Energy Action
NREAP	National Renewable Energy Action Plan
OCGT	Open Cycle Gas Turbine
OEA	Order of Engineers and Architects
O&M	Operation and Maintenance
OPEX	Operational Expenditure
PPA	Power Purchase Agreement
PV	Photovoltaic
PVS	PV Plus Storage
PPP	Public Private Partnership
P2P	Peer to Peer
RFP	Request for Proposals
RE	Renewable Energy
REmap	IRENA's Renewable Energy Roadmap
SO	Solar Ordinance
SWH	Solar Water Heater
USD	United States Dollars
USC	United States Cents

Introduction

To Lebanon's Grand Energy Transition

The document offers a comprehensive review of the development of renewable energy in Lebanon over the past 14 years, and proposes actions to carry the country forward in the next five years.

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Setting Targets, and Meeting Them

This Lebanese National Renewable Energy Action Plan (NREAP) for the period 2025–2030 has been written at a challenging moment in the history of Lebanon. Its publication follows unprecedented economic and financial crises that continue to pose enormous challenges to the national economy and to the energy sector specifically. Lebanon is still recovering from the devastating effects of the COVID-19 pandemic, and suffering the ongoing impacts of a violent and devastating war.

This updated NREAP is a statement of belief that renewable energy and energy efficiency remain high priorities for Lebanon. Developing renewable energy alternatives and promoting energy efficiency are key levers for exiting current economic and financial crises, and for meeting the energy demand that the conventional power sector cannot meet.

The document offers a comprehensive review of the development of renewable energy in Lebanon over the past 14 years, and proposes actions to carry the country forward in the next five years. It builds on the two previous NREAP reports for the periods 2011–2015 and 2016–2020. Unfortunately, the Lebanese Center for Energy Conservation (LCEC) was unable to publish the NREAP 2021–2025 edition as a result of the COVID pandemic and the economic crisis facing Lebanon.

The long-term objective is to achieve the target of 30% renewable energy in the country by 2030, as set out in the Lebanon Renewable Energy Outlook (IRENA, 2020). This is a key document developed by the International Renewable Energy Agency (IRENA), the Lebanese Ministry of Energy and Water (MEW), and the Lebanese Center for Energy Conservation (LCEC). It is based on a renewable energy resource mapping and readiness assessment, which shows the potential to reach 30% renewable energy in electricity consumption by 2030.

This current NREAP 2025–2030 report provides an in-depth assessment of, and a plan to achieve, the 2030 target of 30% renewable energy in the country. It introduces a roadmap for policies and measures to accelerate the adoption of renewable technologies to enhance the sustainability of the energy sector and to promote sustainable development in general. New emerging technologies such as e-mobility form part of this new action plan.

This report provides a solid basis for identifying the barriers and challenges hindering the development of renewable energy and energy efficiency in Lebanon, and will be a cornerstone for setting various policies to resolve the regulatory, financial, technical, and social challenges ahead. All these aspects are essential to successfully reach Lebanon's short-term and long-term energy sustainability targets.

'Through an updated, sustainability-focused energy policy, Lebanon could achieve 30% renewable electricity consumption by 2030, saving nearly USD 250 million per year in the power sector, mainly through avoided fossil fuel imports.' Dr. Francesco La Camera Director-General, International Renewable Energy Agency. Extract from Lebanon Renewable Energy Outlook 2030.

On Lebanon's Resilient Spirit

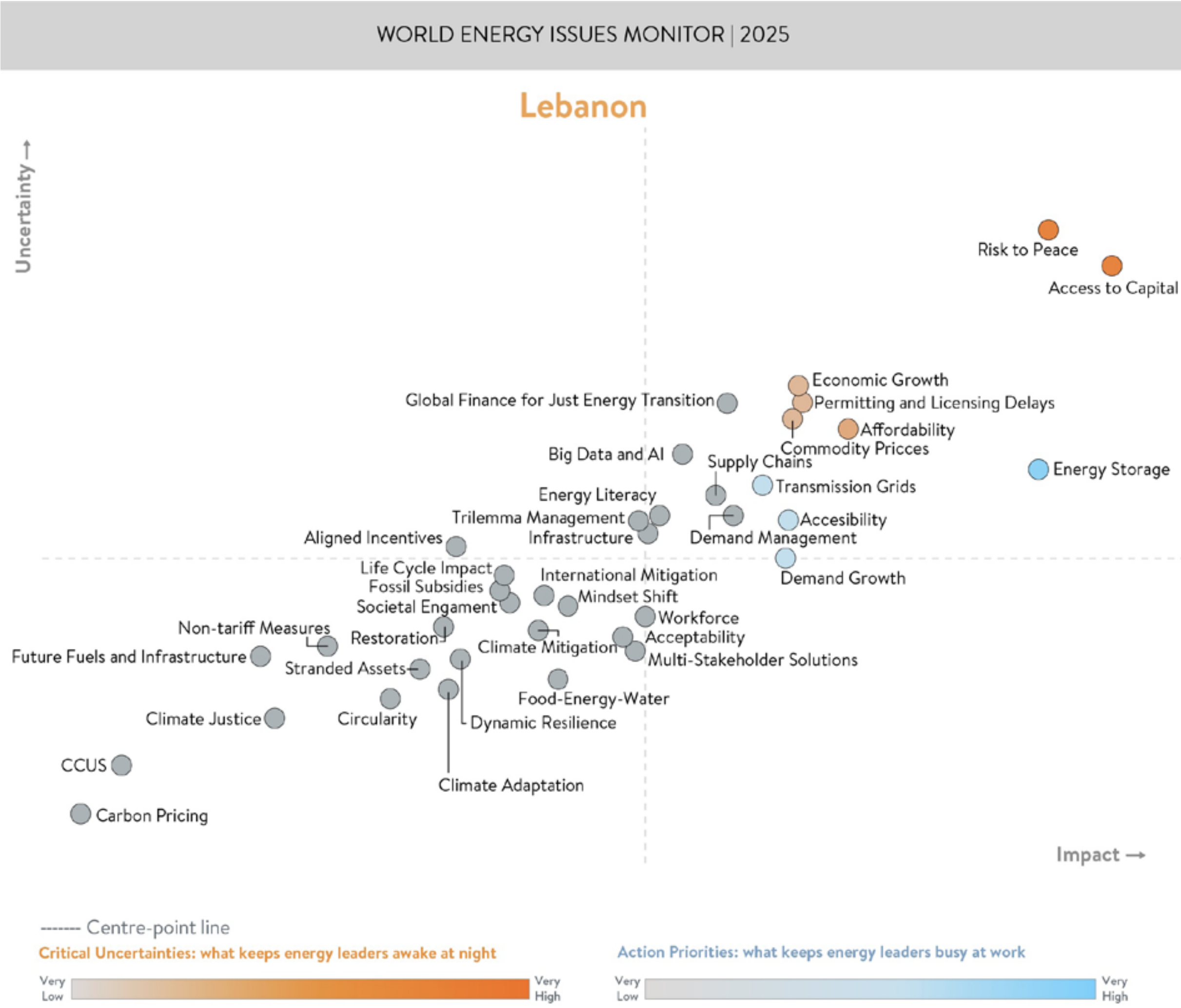
Clean power generation technologies offer remarkable advantages, such as economic growth, lower costs, and environmental benefits, in addition to energy security and diversity. For Lebanon, renewable energy is also a major lever for alleviating the negative effects of the long-running electricity crisis. By promoting cleaner, greener, and more inclusive energy systems, a more resilient and more prosperous future can be created for both current and future generations.

Many uncertainties weigh on the energy sector in Lebanon, including ongoing fluctuations in the oil price owing to the deterioration of the national currency and various wars and crises affecting many regions of the world. Amid this volatile environment, climate change issues and impacts, and decisions about the best way to respond to them, have become a priority for energy leaders all over the world.

While Lebanon experienced a significant increase in electricity and energy demand between 2010 and 2019, combined with rapid growth in its population, the economic and financial crises have resulted in abrupt changes to the country's energy sector. These changes were exacerbated by the COVID-19 pandemic and the relocation of huge numbers of Syrian refugees into Lebanese territories.

As a result of this unstable situation, the electricity sector has faced significant challenges. Electricity supply went as low as one hour per day between 2021 and 2024, with a slight improvement to around four to six hours per day in 2023, thanks to the support of the Iraqi government.

In 2022, the Ministry of Energy and Water (MEW) took the tough decision to remove fuel and electricity subsidies. This has resulted in an unprecedented increase in the deployment of small-scale distributed rooftop solar. Indeed, by the end of 2022, renewable energy contributed 21% of total energy supplied.



'Despite the severe economic and energy crises since 2019, Lebanon's resilient spirit shines through. In the energy sector, there has been a notable shift towards sustainable solutions, with significant investments in solar photovoltaic (PV) systems. […]

'Lebanon's energy sector faces significant challenges but presents opportunities for change. The focus must be on addressing critical uncertainties, fostering strong leadership, and promoting policies that drive faster, fairer, and more far-reaching energy transitions. Leveraging international support and engaging local communities will be essential for achieving sustainable energy goals.' World Energy Issues Monitor 2024, published by the World Energy Council.

A Structured Approach Leading to a Grand Energy Transition

To develop the NREAP 2025–2030, the LCEC strove to involve key national and international players. A document was compiled listing all national initiatives, statistics, and projects undertaken by MEW in the renewable energy sector, as well as the initiatives of partners in the private and public sectors. This document was shared with various stakeholders and experts to obtain additional insights, validate the findings, and ensure that the document aligned with national plans and international best practices.

The current document offers a clear list of steps to which the MEW is committed to meet our national objectives for the year 2030. It also identifies the steps and actions required by different administrations and bodies of the Lebanese government to develop the renewables sector at the needed pace.

The methodology to develop this document required a detailed assessment of the 2020 targets proposed in the previous NREAP 2016–2020 report, in order to quantify the current status of the renewables sector. This assessment was followed by setting 2018 as the base year, supported by a detailed numerical analysis that breaks down national energy consumption per sector and per energy carrier. A year-by-year forecast was then developed, using three different scenarios, which resulted in three potential outcomes for renewable energy deployment by 2030. The most optimistic scenario is extremely promising and fortunately feasible. It is recommended as a country, we dedicate our efforts to meeting its objectives.

CHAPTER 01

National Energy Balance and Projections

The 2018 Energy Balance and the 2030 Energy Projections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1.1 Methodology to Calculate Lebanon's Energy Balance

The national energy balance of Lebanon for 2018 is presented in this chapter, based on a reconciliation between energy demand and supply. The chapter includes data on electricity supply and demand in Lebanon during the period 2018–2023, followed by projections until 2030. The year 2018 was selected as the baseline since the time span from 2019 to 2023 was marked by political and economic disturbances, coupled with the COVID-19 lockdown.

The estimate of total national energy demand was calculated as the sum of the consumption from the industrial sector (industrial processes only) and the building sector (from all buildings types). Energy consumption for these two sectors, and of total energy demand, is presented in the following sections. This is followed by a reconciliation of total energy demand and energy imports, and the energy balance for the year 2018.

The methodology adopted in this chapter is explained in the 'First Energy Indicators Report for the Lebanese Republic' published by the LCEC in 2018 (Mortada, 2018). This methodology is summarised in Figure 1.

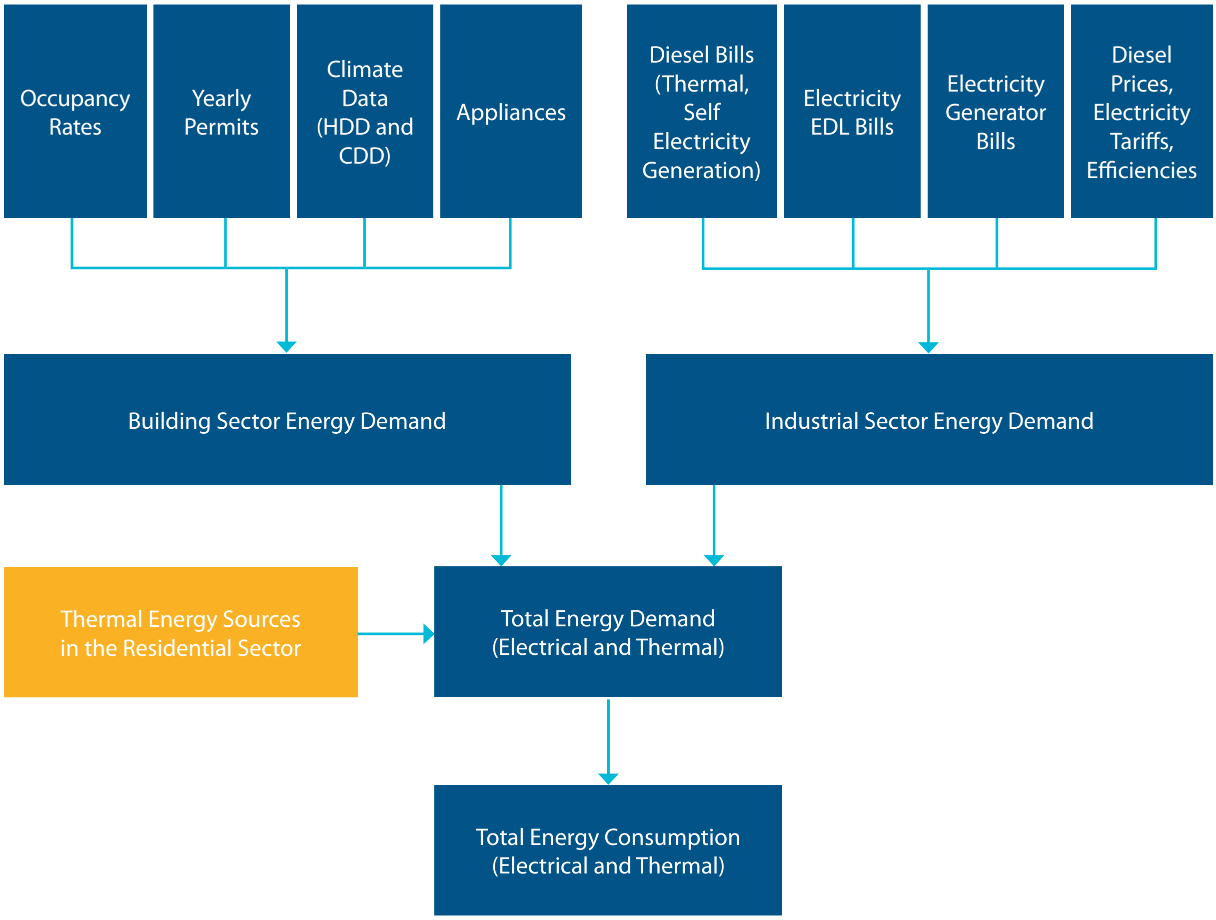

FIGURE 1 Summary of the methodology adopted for energy demand calculations

1.2 National Energy Demand

The industrial sector in Lebanon contributes 8% to the Gross Domestic Product (GDP), accounting for USD 4.2 billion. Industrial exports constitute around 95% of all Lebanese exports, destined to several countries, with Switzerland on the top of the list in 2019 (30%), followed by United Arab Emirates and the Kingdom of Saudi Arabia (12% and 6%, respectively) (IDAL, n.d.). There were 5,584 licensed industrial facilities operating in the country in 2018 (just before the COVID-19 pandemic lockdown and the subsequent economic crisis).[1]

Based on data shared by the Ministry of Industry (MoI), electrical energy and thermal energy are the two main sources of energy in the industrial sector. While electrical energy has three different sources (the network of the national power utility, EDL; subscriptions to 'neighbourhood generators'; and self-generation using privately owned diesel generators), thermal energy is mainly provided by the combustion of diesel oil and fuel oil.

The MoI provides data on all types of electrical and thermal energy consumption in 1,520 industrial facilities, as well as the number of licensed industrial facilities for each industry type. This data was obtained from a survey conducted by the MoI in 2017.

1 According to data shared by the Ministry of Industry (MoI) (June 2020).

Based on this data, the average energy consumption per factory and per type of industry was calculated. The average annual consumption per industrial facility is 525.2 MWh_e (48%) and 562.7 MWh_{th} (52%). The industrial sector relied mainly on the state-owned electricity company EDL, which supplies 55% of electricity, when available. In total, 43% of consumption is from private generator subscriptions and 2% is supplied by privately owned generators kept on business premisses.

In 2018, total energy consumed by industrial processes (excluding the cement industry – explained below) was 8,177 GWh, with 3,256 GWh used as electrical energy and 4,921 GWh as thermal energy. Of this, 1,367 GWh were supplied using fuel oil. Imported fuel oil is used by the private sector for industrial processes to cover one part of thermal needs.

Taking into account the energy consumption of industrial buildings, the total amounts of electrical energy and thermal energy consumed in industrial processes increases to 3,744 GWh and 5,246 GWh, respectively.

The industrial sector's thermal energy demand does not account for the cement industry. According to the energy bills provided by the Directorate General of Oil (DGO) at the Ministry of Energy and Water (MEW), Lebanon imported around 441,000 tonnes of petcoke in 2018 (equivalent to around 4,000 GWh). All imported petcoke is assumed to be used as thermal energy solely in the cement industry. During those years when the national energy bills show no import of petcoke, it is estimated that the thermal demand of the cement industry was satisfied using diesel oil.

The residential sector occupied around 71% of total built area from 2017 to 2023 (Figure 2). This figure is based on data published by the Order of Engineers and Architects (OEA) and the General Directorate of Land Registration and Cadastre. This data is supported by data the number of construction permits issued for each type of building each year, published by the OEA.

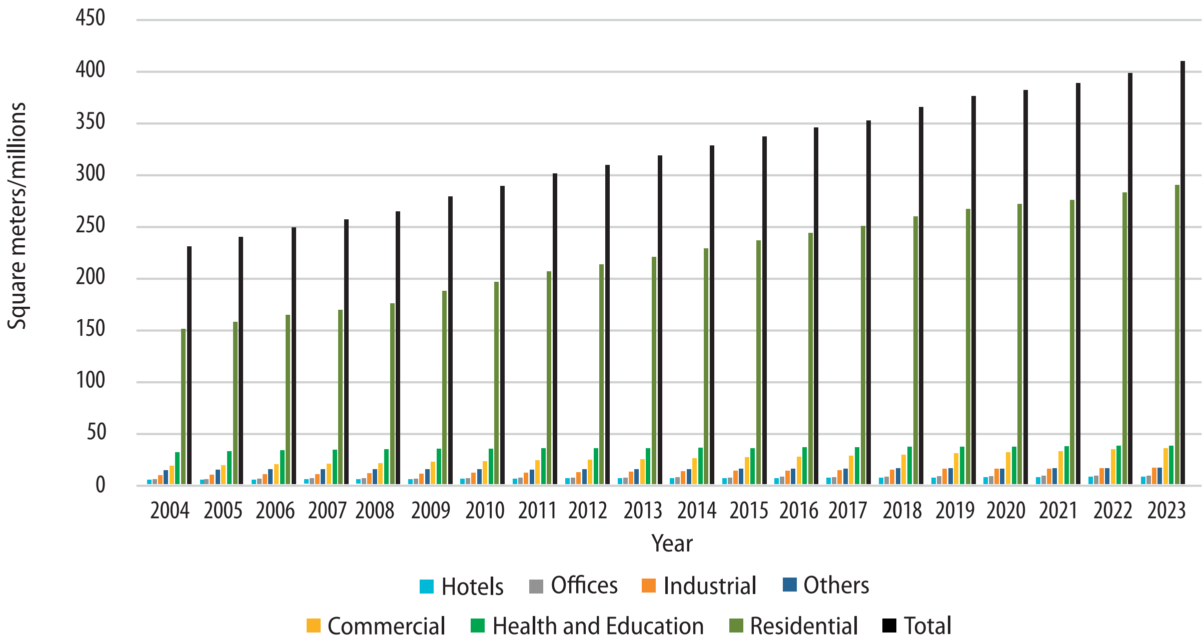

FIGURE 2 **Built area distribution by type of building 2004–2023**

Residential units, including primary and secondary residences, numbered around 1.69 million in 2018 and 1.72 million in 2019 (Figure 3). These numbers are based on data published by the OEA for certain years, complemented by extrapolations for the missing years. A recent publication by the Central Administration of Statistics (CAS) estimates the number of primary residences in Lebanon at about 1.2 million (Labour Force and Household Living, Conditions Survey 2018–2019), which leads to the conclusion that the number of secondary residences was around 0.52 million units in 2019.

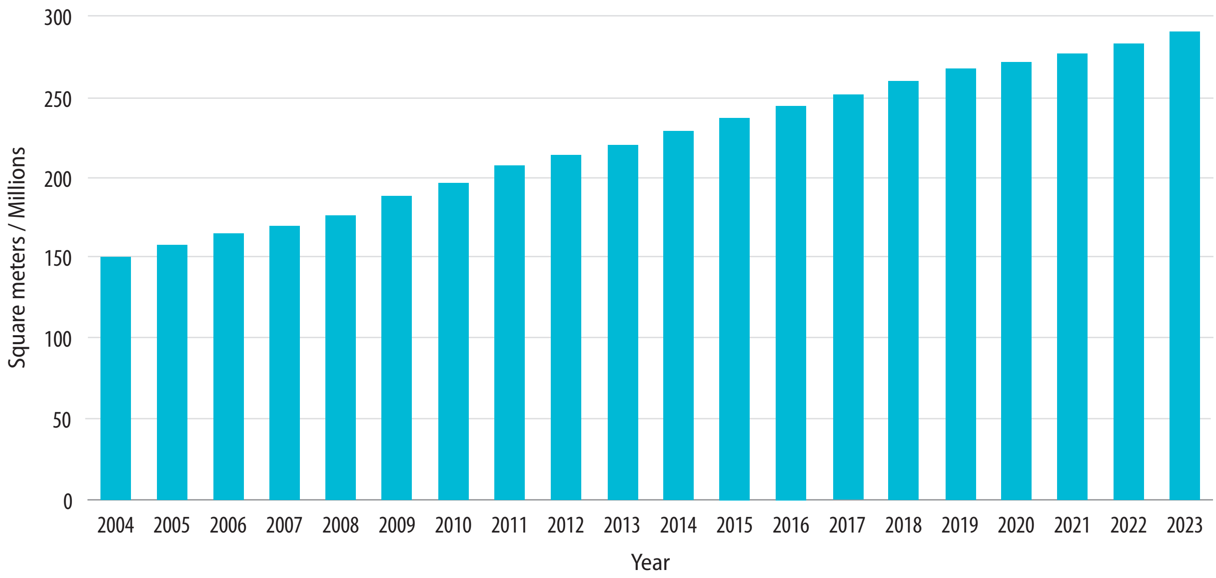

FIGURE 3 **Residential built area 2004–2023**

Based on the estimation of the total built area and its composition by building type, along with a number of other parameters, the energy demand of the buildings sector was estimated.

Energy demand in the building sector is significantly influenced by climate zone, particularly with regard to heating and cooling requirements. Based on Heating Degree Days (HDD) and Cooling Degree Days (CDD), the energy needs for each climate zone were estimated using the methodology outlined in the First Energy Indicators Report (Mortada, 2018). In addition, the baseline energy demand considers building occupancy rates and thermal energy usage, which primarily encompasses space heating and domestic hot water generation. Heating systems in the building sector predominantly consist of electric heaters and diesel or gas boilers, with solar water heaters (SWH) also contributing as a thermal energy source.

Based on the previous assumptions and calculations, the electrical energy consumption in the buildings sector in 2018 was approximately 19,625 GWh, while the thermal energy consumption is estimated at 2,711 GWh. Figure 4 shows the electrical and thermal energy consumption between 2010 and 2018. In 2018, the total electricity consumption in the country was approximately 22,880 GWh, whereas the total thermal consumption was 7,632 GWh.

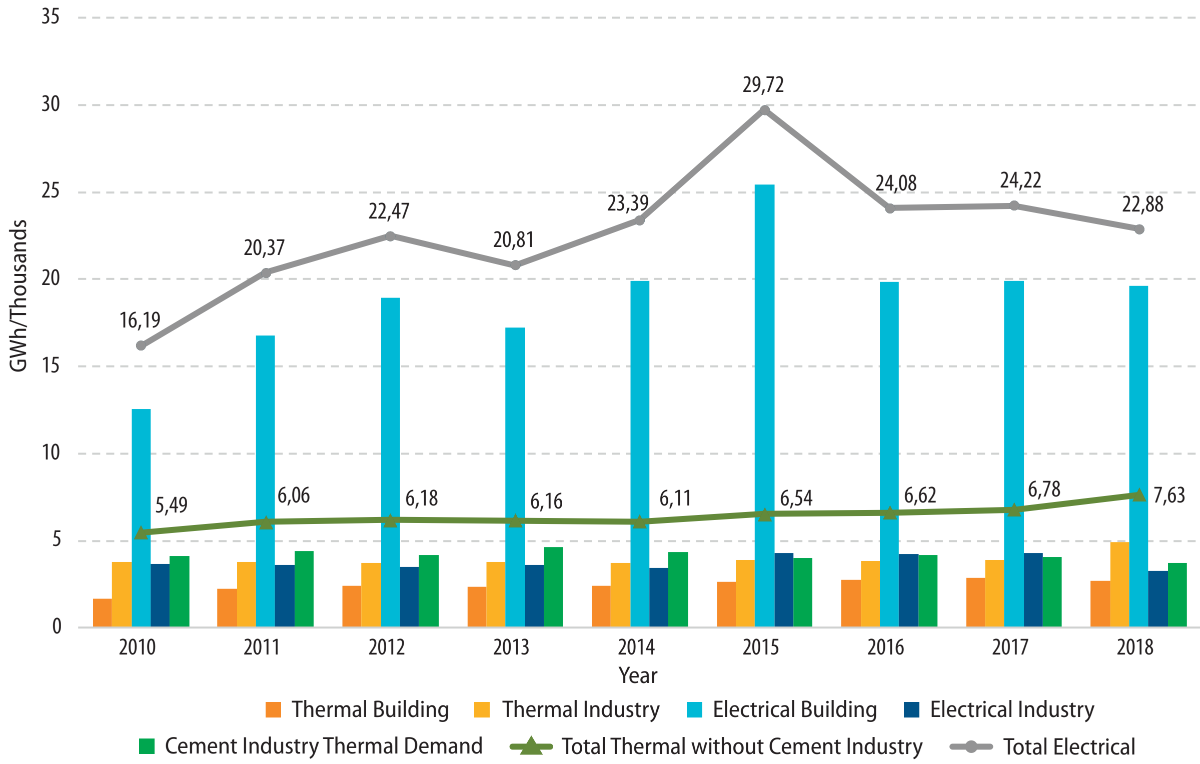

FIGURE 4 **Electrical and Thermal Consumption 2010–2018**

1.3 Supply and Demand: Lebanon's National Energy Balance

In order to define the energy balance of Lebanon for the year 2018, selected as the baseline year, a reconciliation between supply and demand is needed. Electrical and thermal consumption in Lebanon was calculated in the previous section; this section presents the different sources of energy used to meet demand. For this purpose, the energy bills provided by the DGO were used. Figure 5 shows fuel imports to Lebanon between 2014 and 2023 (measured in tonnes).

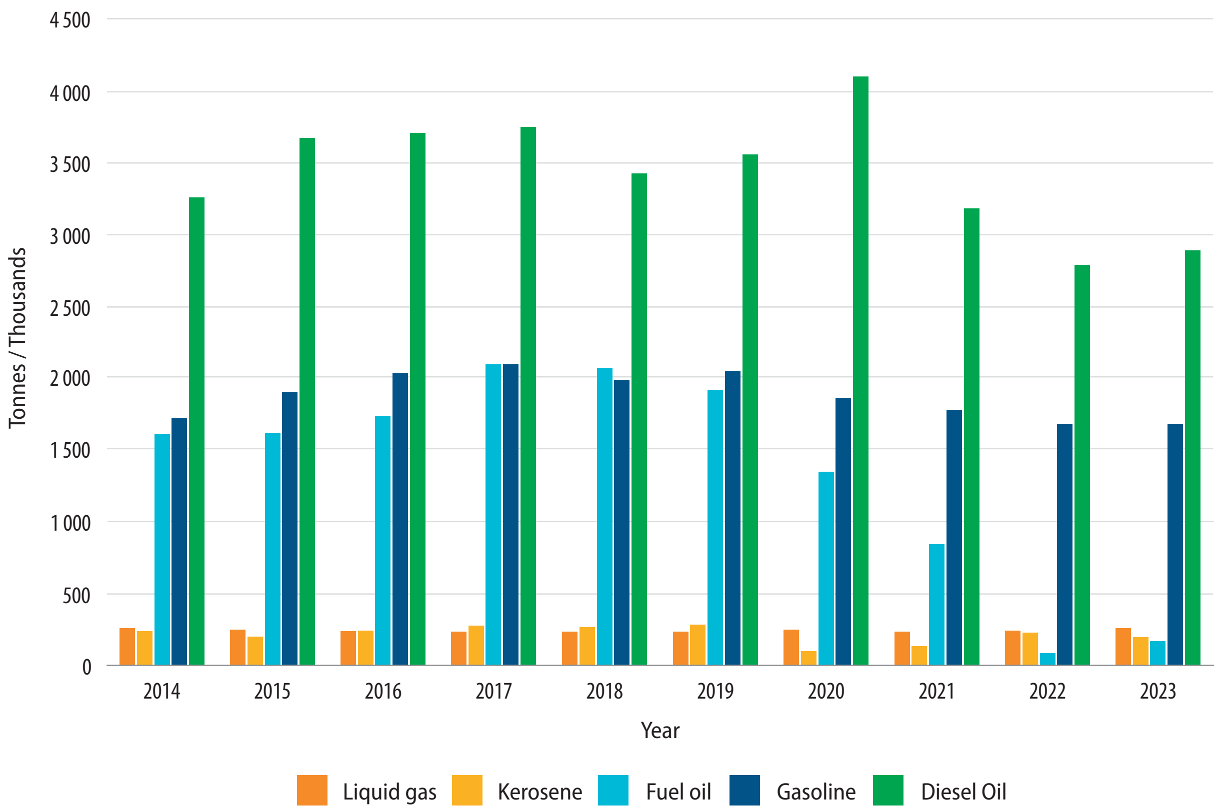

FIGURE 5 Fuel imports during the interval 2014–2023 (Source: Directorate General of Oil)

Diesel Oil Consumption per Sector

Diesel oil has many uses: electricity generation, thermal energy (heating and processes) and transport. Lebanon imported around 3,426,144 tonnes of diesel oil in 2018, using it in different sectors, as shown in Figure 6.

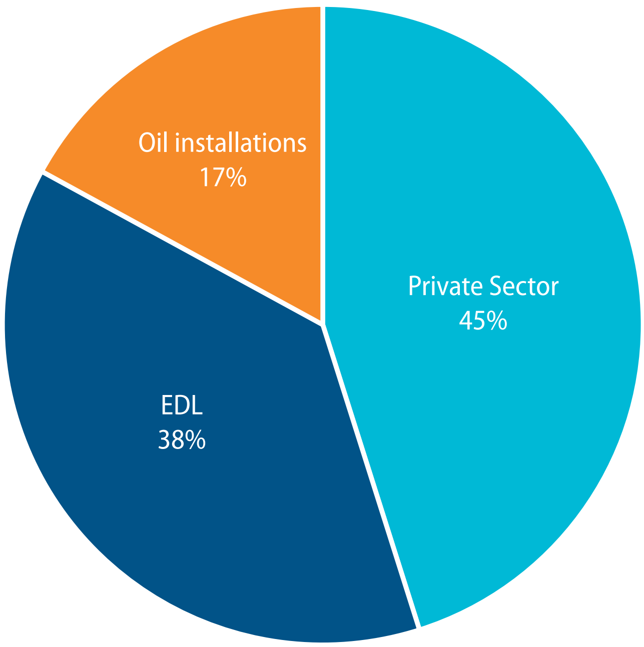

FIGURE 6 Diesel oil imports in 2018

The rate of diesel oil consumption in the private sector increased between 2018 and 2020 (Figure 7), and had a constant rate of consumption during the COVID-19 recovery period. From 2021, the rate of consumption increased again owing to the frequent blackouts in EDL electricity supply, mainly a result of the financial crisis in Lebanon. The outputs of the major oil installations at Zahrani and Tripoli, as well as the EDL rate of consumption, has declined since 2020, largely because of a lack of maintenance, serious renovations and, in some cases, decommissioning. EDL is unable to meet the Lebanese demand because of a shortage in supply and the sudden increase in fuel prices, coupled with the devaluation of the Lebanese pound.

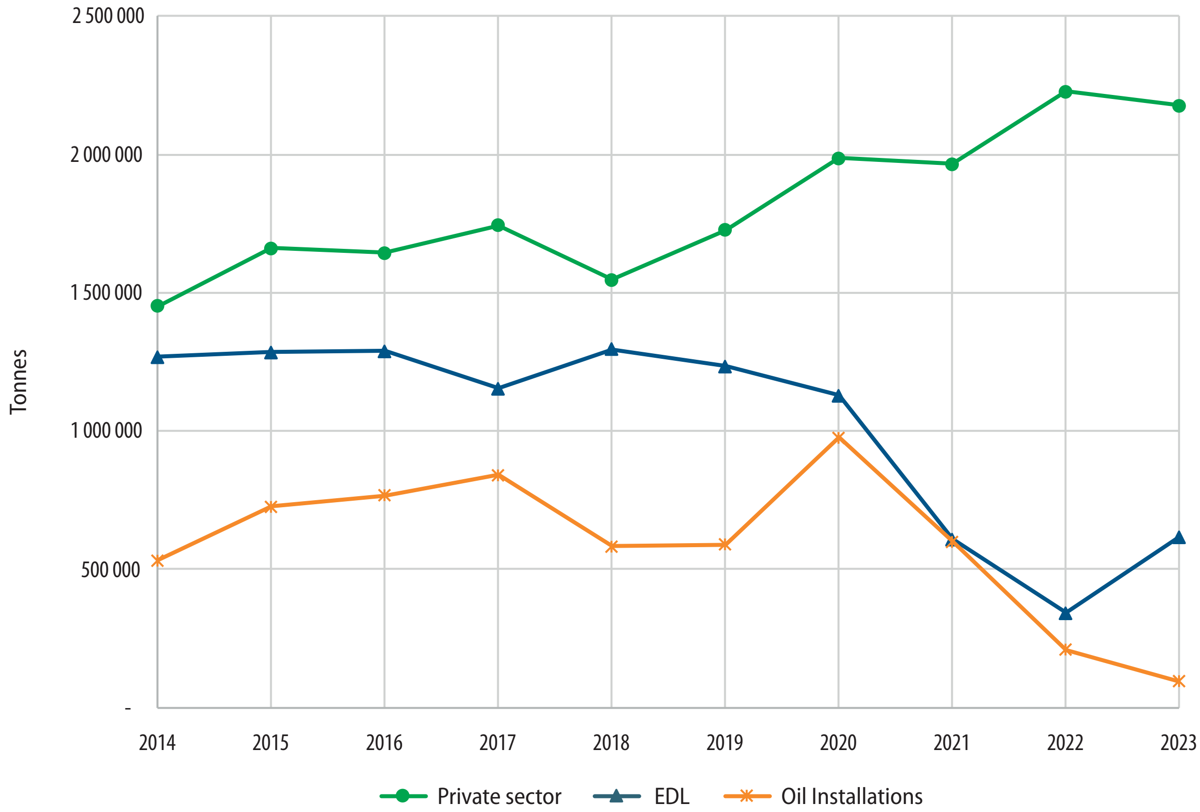

FIGURE 7 **Diesel oil consumption in different sectors from 2014–2023**

Diesel is used in several sectors, including electricity generation by EDL and the private sector, thermal needs, and the transport sector. The energy needs in GWh for these sectors were previously estimated and are considered in the national diesel oil balance.

Figure 8 shows the quantities of diesel oil used in each sector. In 2018, the industrial sector used diesel to ensure 1,673 GWh of electricity supply using gensets (subscription and private generators) and 3,880 GWh of its thermal consumption. The diesel oil used for heating and domestic hot water generation in the building sector was estimated to be around 540 GWh, equivalent to 29,000 tonnes in 2018.

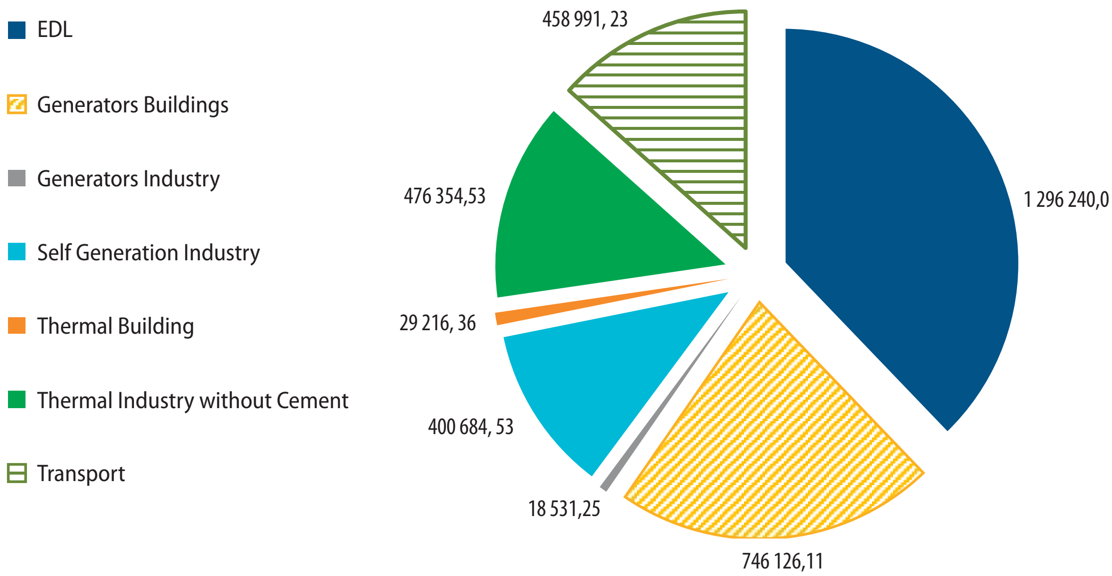

FIGURE 8 **Diesel usage per sector in 2018**

The total electricity supplied by EDL in 2018 was around 15,400 GWh, with 2,000 GWh used by the industrial sector and 13,400 GWh by the buildings sector. Taking into account the solar photovoltaic systems installed before 2018, a calculation reveals a shortage of 2,900 GWh in the buildings sector, expected to be supplied through private generators. However, considering the quantity of diesel oil officially imported, only 52% of this shortage was supplied by private generators.

Figure 9 shows the use of diesel oil per sector for the period 2018–2023. It can be seen that the share of EDL-supplied electricity dropped from 38% in 2018 to 12% in 2022, accompanied by an increase in private generator supply from 22% in 2018 to 47% in 2022.

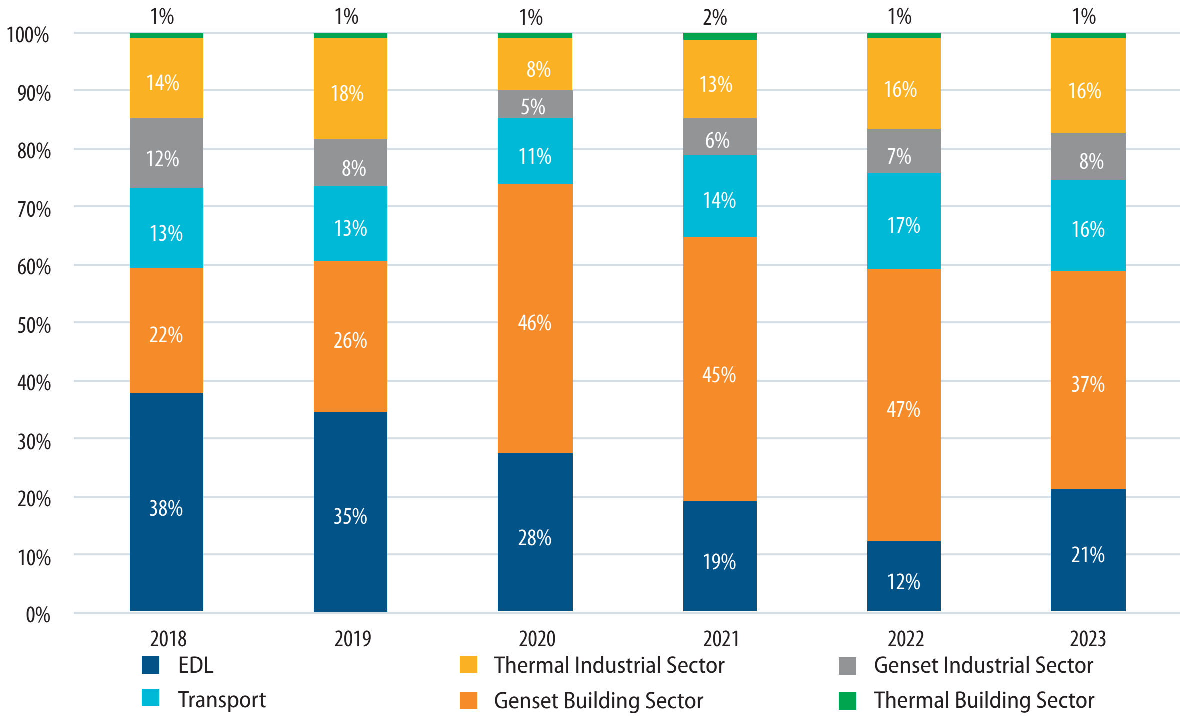

FIGURE 9 **Diesel oil consumption in Lebanon per sector (2018–2023)**

Following the same methodology, the electricity supplied by gensets was calculated. A 3% increase in demand is apparent from 2018 to 2020. In 2021, a drop of 10% compared to 2020 is observed, a result of the removal of subsidies on all imported fuel. In 2022, there was a further 25% drop in demand, probably a result of reduced use prompted by the official tariff increase on electricity supplied by EDL. The year 2023 witnessed a 2.4% increase in demand as the Lebanese economy started to recover. The electricity supplied by EDL was also affected by the economic crisis, as shown in Figure 10.

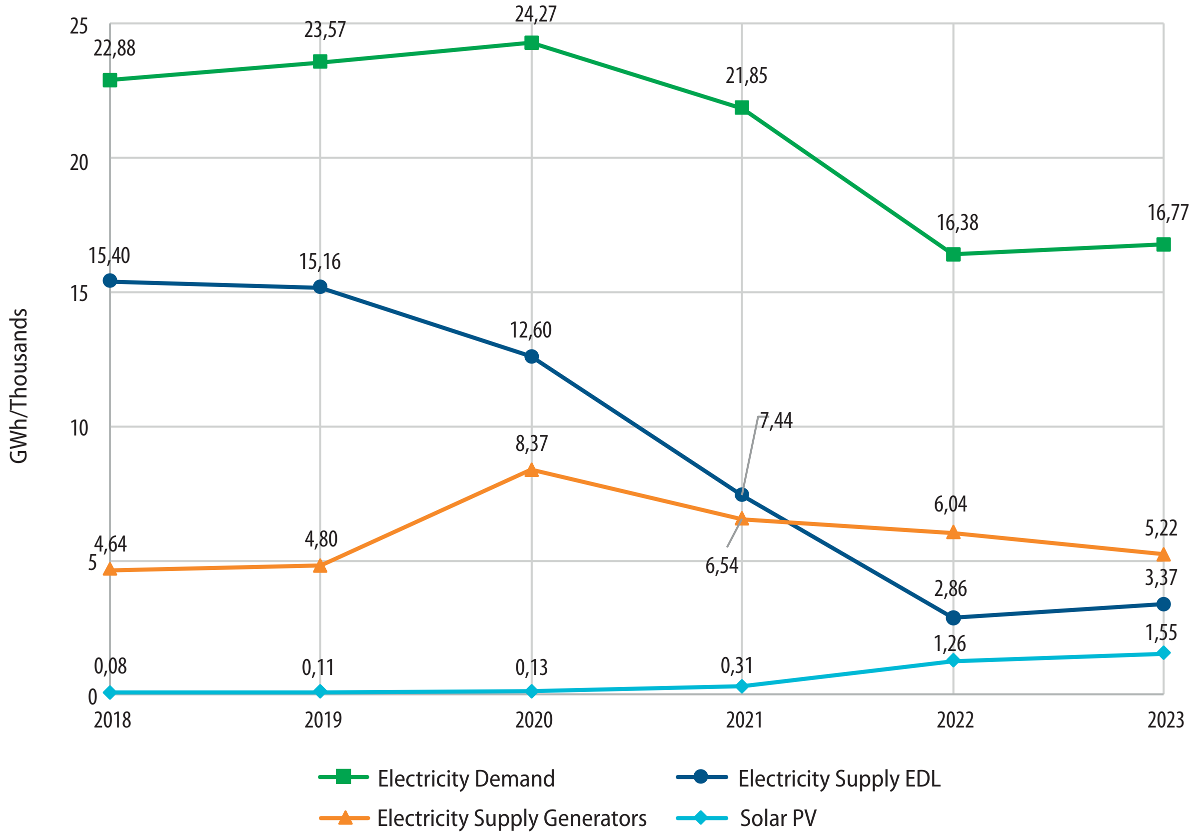

FIGURE 10 **Electricity demand and supply (2018–2023)**

1.4 Energy Needs Projections for 2030

According to the updated policy paper for the electricity sector, electricity consumption is expected to grow at a yearly rate of 3%. This rate is used for years 2024–2027. In 2028, the economy is expected to fully recover; thus a 5% yearly growth rate is assumed until 2030. Figure 11 shows the corresponding growth in electricity demand until 2030.

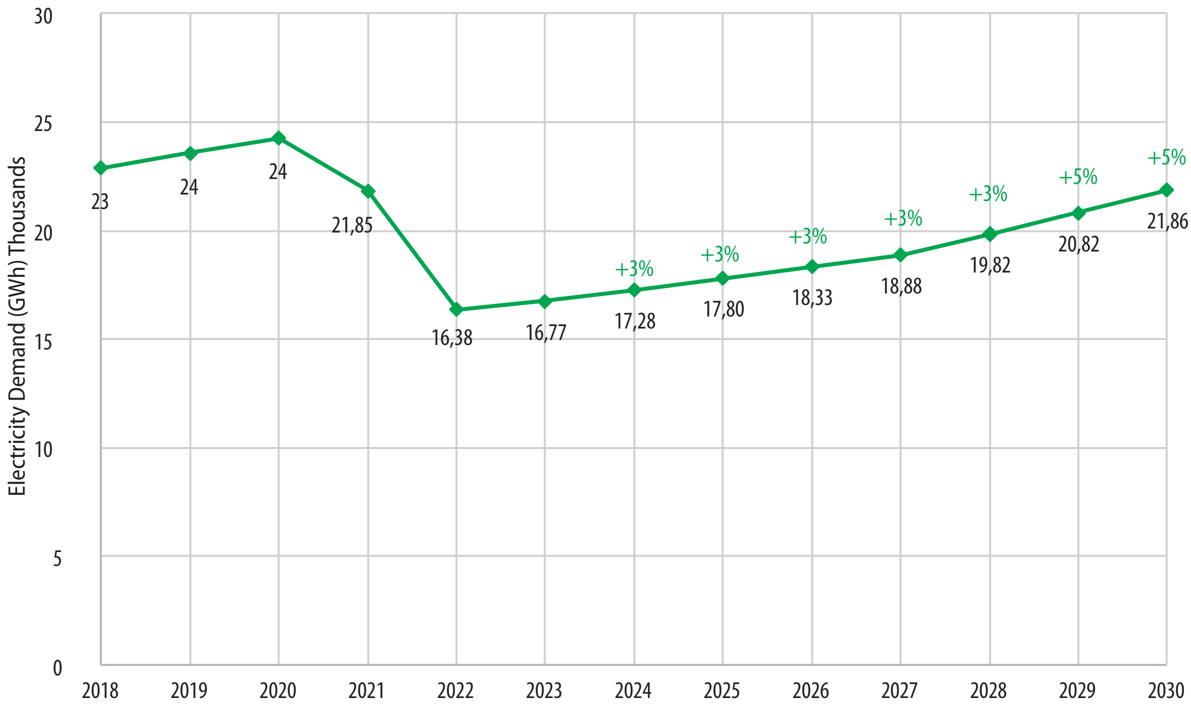

FIGURE 11 **Projection of total electricity demand until 2030**

The projection of the total thermal demand is presented in Figure 12. Thermal energy needs are divided into two main categories: domestic hot water, and other heating needs. The yearly growth rate used for thermal energy is the same one observed for the electricity sector, starting with the year 2018.

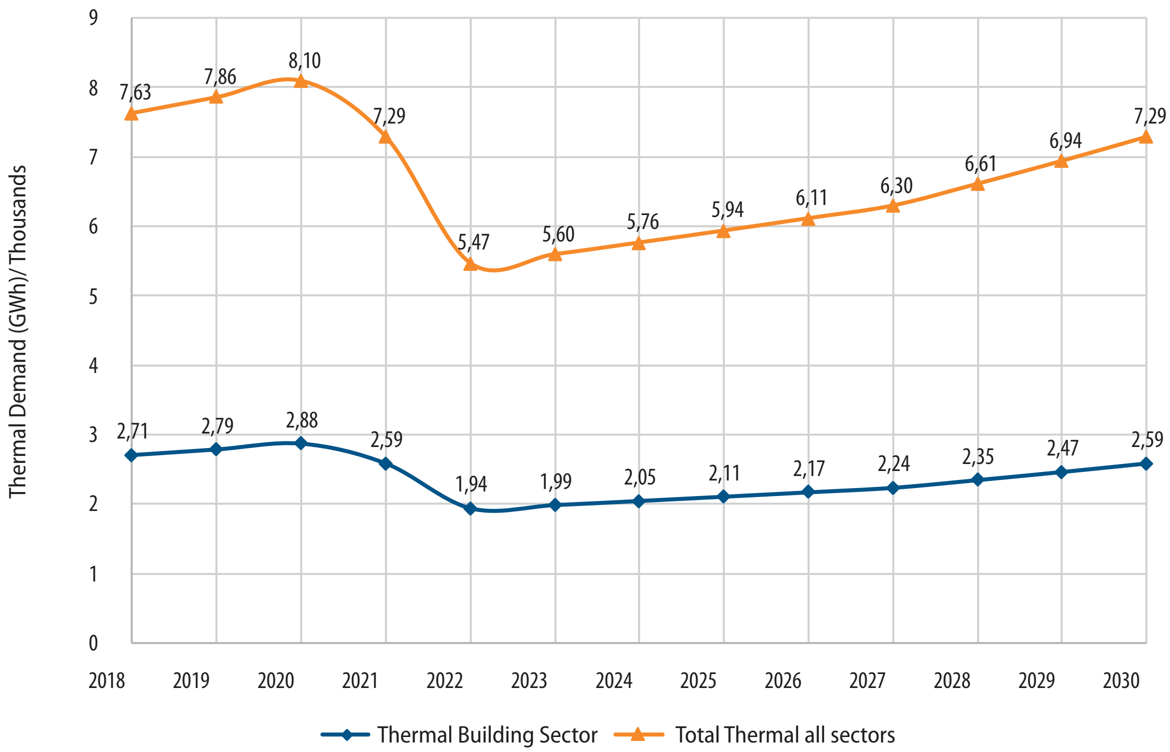

FIGURE 12 **Thermal energy demand projection for 2030**

CHAPTER 02

Current Status of Renewable Energy in Lebanon

Achievements, Disappointments, and Ongoing Projects

Historically, most renewable energy production in Lebanon has been from hydropower plants, with the Litani hydro projects accounting for a large share. Since 2010, solar water heaters have emerged as a promising technology, driven by initiatives by the MEW and development partners. By 2012, Lebanon was among the top 10 countries worldwide in terms of solar water heater deployment, according to the International Energy Agency (IEA). Since then, interest in installing rooftop solar systems has increased considerably, thanks to initiatives by the MEW and the national financing mechanism National Energy Efficiency and Renewable Energy Action (NEEREA) of the Central Bank of Lebanon.

Other renewable energy technologies were planned as part of the previous NREAP 2016–2020, but deployment has unfortunately been delayed. This chapter sets out the current status of each renewable energy technology in relation to the targets set out in the previous NREAP 2016–2020, and identifies the relevant barriers and corresponding success factors, where applicable.


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2.1 Solar Water Heaters (SWHs) and Heat Pumps

The solar water heater (SWH) market witnessed a huge leap forward between 2010 and 2019 (Figure 13), growing from coverage of around 211,000 m^2 to around 690,000 m^2, almost tripling its size over the course of a decade. This has been driven by SWH subsidised financing through the Lebanese commercial banks and grants offered by the MEW.

However, between 2017 and 2020, SWH installations saw a decline, mainly because of the emergence of the solar photovoltaic market and a lack of interest among banks in offering small loans for the installation of these systems.

However, the financial crisis since 2019 has had a positive effect on SWH installations, reigniting the SWH market. In 2021, a total of 50,339 m^2 were installed, with an additional 123,330 m^2 installed in 2022, to reach a total installed surface area of 909,070 m^2. This marked a world record of a 145% annual increase (IEA, n.d.). This growth is mainly driven by the removal of electricity subsidies, higher fuel costs, and local currency depreciation, prompting a shift to solar water heaters as a practical and cost-effective heating solution. By the end of 2023, a cumulative installed area of 1,011,181 m^2 was reported.

Total investments in the solar water heaters market between 2010 and 2023 reached USD 267,897,571, with 163,720 systems installed over the period.

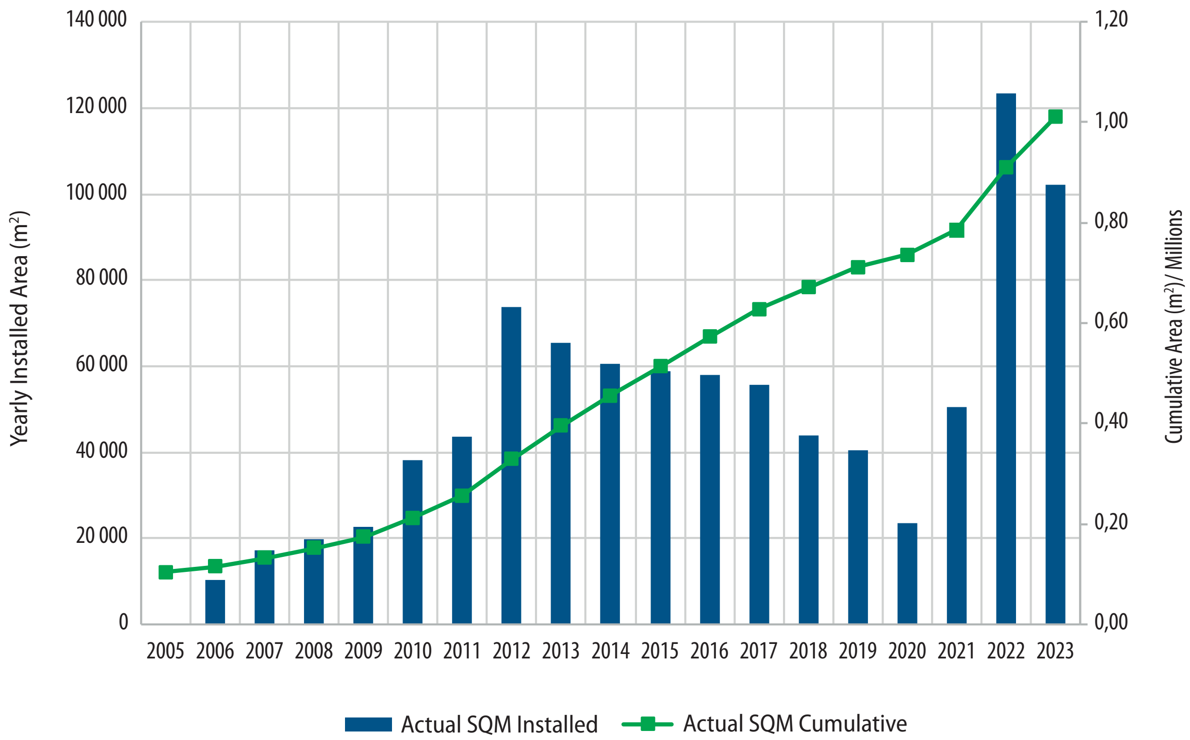

FIGURE 13 **Variation of SWH installed surface area throughout the years**

Because of the recent increase in SWH installations, Lebanon was still able to secure its place as one of the top installers of SWHs per capita worldwide. According to a study developed by the Solar Heating and Cooling Programme (SHC) of the International Energy Agency (IEA) published in May 2023 (IEA, n.d.), Lebanon had a total SWH installed capacity of 533 MW_{th} by the end of 2021. After normalising the capacity per 1,000 inhabitants, Lebanon is ranked the 14th country worldwide for SWH installations, with 101.23 kW_{th} per 1,000 inhabitant. The installed capacity offset the emission of around 217,408 tonnes of CO_2 per year.

The SWH market in Lebanon is expected to keep growing until 2030, with the financial feasibility of SWH systems being widely known. The market is well regulated by the framework of Decision 32/2019 of the Higher Council for Urban Planning regarding solar installations on the rooftops of buildings. The level of know-how and expertise among engineers and technicians working in this field is also acceptable, with minor negative feedback reported. Yet there is a clear 'competition' between SWH systems and solar PV systems, given the limited available rooftop area in different regions of Lebanon. The one clear alternative to overcome the problem of rooftop availability is the use of heat pump technology as an alternative to SWHs.

The heat pumps market in Lebanon is expected to grow rapidly in the next few years. Heat pump technology is the best fit for the heating, domestic hot water production and cooling sectors (mainly for residential and tertiary applications). This market will be strongly supported by a joint initiative of the Italian Ministry of Environment and Energy Security (MASE) and the LCEC.

In line with European legislation and the Montreal Protocol for the phasing out of high-emission refrigerant gases (fluorinated greenhouse gases, including hydrofluorocarbons, or HFCs), MASE will support the local heat pumps market through a number of actions: ensuring the quality of products on the market; establishing capacity and infrastructure that can make Lebanon a landmark for heat pumps development in the region; and ensuring quality in the design and installation of heat pump systems, by demonstrating the economic and environmental advantage of such systems through pilot applications in Lebanese buildings.

Visit of LCEC team to the testing facility at Politecnico di Milano (Polimi) in the National Heat Pumps project funded by MASE

Part of the testing facility at Politecnico di Milano (Polimi)

2.2 Onshore and Offshore Wind

The previous NREAP 2016–2020 included the target 200 MW of onshore wind achieved by 2020. To this end, on 1 February 2018, the Lebanese government signed three power purchase agreements (PPAs) with three private sector companies to build 226 MW of wind farms in the northern Akkar region.

H.E. Minister of Energy and Water with the wind licensees and the EDL DG

The duration of the PPAs is 20 years, with the licensees responsible for project development under a 'design, build, finance, own, operate, and maintain' approach. The energy generated will be sold to EDL as the single buyer, at 10.4 USC/kWh for the first three years, to account for the required auxiliary grid infrastructure upgrade and development, and at 9.6 USC/kWh afterwards, until the end of the term of the PPA.

The wind farm procurement initially made good progress. However, delivery has been repeatedly delayed by challenging macroeconomic conditions and financial uncertainty in the country. This has limited the ability of international financing institutions to finance any projects in Lebanon without progress on economic and energy sector reforms. Annex 1 shows all the main milestones in the wind projects to date.

Following the awarding of the three wind farms, in September 2019 the MEW launched a second request for proposals to build wind farms that could generate 400 to 600 MW each. However, the bid was put on hold because of the macro-fiscal situation, which is jeopardising the availability of financing for these projects, and the lack of appetite from the private sector. Reactivating this path will be a main milestone for the next phase, 2025–2030.

2.3 Solar Photovoltaic (PV)

The first solar PV systems were installed in Lebanon in 2010. The number of solar PV projects increased steadily between 2010 and 2019, thanks to the National Energy Efficiency and Renewable Energy Action (NEEREA), a national financing mechanism that allows private sector entities to obtain subsidised loans for any type of energy efficiency and/or renewable energy project. NEEREA was active through all Lebanese commercial banks under the leadership and management of the Central Bank of Lebanon (BDL). From 2010 to 2019, key standards related to solar PV products were made mandatory, thanks to cooperation between Libnor and LCEC. This helped to ensured that the import of solar PV products to Lebanon was limited to good quality products. In addition, a close cooperation between the Industrial Research Institute (IRI) and LCEC resulted in the implementation of a large number of testing facilities at IRI. More importantly, several training programmes related to solar PV systems were put in place, including a major training programme at IRI.

Solar PV PPA signature ceremony at MEW, 5 May 2023

While distributed rooftop solar has progressed well, utility-scale solar generation has stalled. In 2017, the MEW launched a request for proposals to build 12 solar farms, each for 15 MW, for a total of 180 MW, as proposed in the NREAP 2016–2020.

On 12 May 2022, the Council of Ministers (CoM) issued 11 licenses of the initial 12 selected bidders. PPAs for the 11 projects totalling 165 MW were signed a year later, on 5 May 2023. The tariff was set at 5.7 USC/kWh for three projects in the Bekaa region, and 6.27 USC/kWh for all other projects, with the PPA in place for 25 years.

However, all 11 projects have been delayed as they have struggled to put financing arrangements in place. This is due to the financial uncertainty in the country, along with the reluctance of international financing institutions to support such projects without the needed reforms.

While it is expected that the projects' implementation will be delayed further, an increasing appetite from private sector entities might change the situation. Recently, a reputable international company bought three solar licenses. Growing momentum is being witnessed in this regard.

Annex 2 shows the timeline and the main milestones of the 180 MW solar PV project since its launching. Demonstrated success in the implementation of the 11 individual projects would be a key step, catalysing interest in and financing for other similar projects.

Unlike large-scale projects, the development of decentralised solar PV projects is not affected by legislative and financial barriers. In fact, Law 462/2002 guarantees the production of renewable energy for personal use, while Decision 39/2019 from the Higher Council of Urban Planning regulates the installation of solar PV systems on building rooftops. Accordingly, the dynamics of decentralised rooftop solar PV are different from large-scale projects.

The NREAP 2016–2020 set a target of cumulative 100 MW of decentralised solar PV installations by 2020, with around 92 MW actually installed by that year. The growth of the solar PV market during the period 2011–2015 was positively affected by the availability of soft financing and subsidised interest rates offered by BDL's NEEREA financing mechanism. In addition, several pilot projects by donors were key factors in the deployment of this technology – notably PV street lighting and water pumping.

The years 2021 and 2022 witnessed an unprecedented increase in the implementation of decentralised solar PV solutions that amounted to 777 MW of additions. In other words, within a span of only two years, the initial 100 MW target was multiplied more than ten times, as the cumulative installed solar PV capacity exceeded 1,000 MW by end of 2023. One major reason for this remarkable increase is the decision taken by MEW to remove subsidies on all fuel and electricity products. The financial feasibility of solar PV systems has become extremely appealing.

Another major highlight of the solar PV market's development in the past couple of years is the shift in the objectives of these solutions. Securing energy needs and having a reliable and cheap source of electricity has a higher priority than simply reducing electricity bills. This led to an amplification of the share of battery storage components in the market, reflected in the integration of these components to around 65% of the total installed capacity by the end of 2022.

As a result, the share of solar PV production reached around 13% of the electricity generation mix in 2022 and, remarkably, contributed to reducing the demand on electricity in the country. This has shrunk the gap between the capacity of the national supplier on the one hand, and the energy demand on the other.

Today, LCEC estimates that solar PV installations had exceeded a cumulative 1,000 MW by the end of 2023, as shown in Figure 14. The momentum is still being witnessed in the market, albeit at a slower pace. The rooftop solar PV market is expected to undergo another spike once the Decentralised Renewable Energy Law (318/2023) becomes fully applicable.

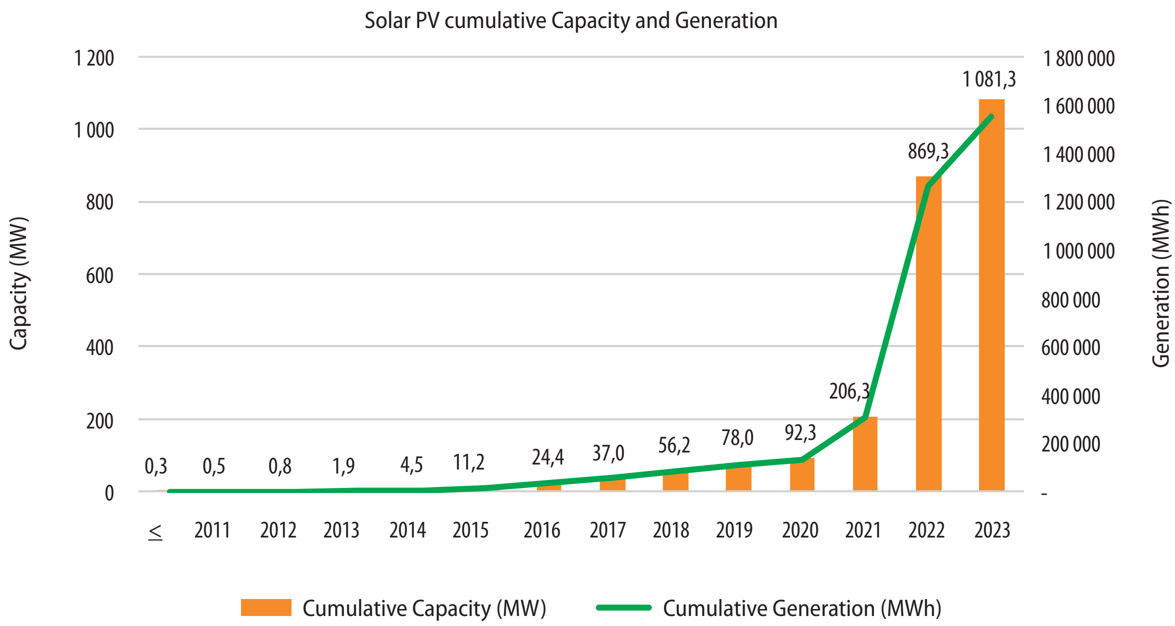

FIGURE 14 Solar PV installation 2010–2023

It is also worth noting that MEW has issued an invitation for Expressions of Interest (EoI) to the private sector to build state-of-the-art battery storage systems coupled with utility-scale solar PV plants. The planned 300 MW of solar farms with 210 MW of battery storage is expected to provide ancillary services and support to the national electricity grid. In 2018, the number of EoIs received for the PV plus Storage (PVS) project indicated a high level of interest in this technology in the private sector.

A Request for Proposals (RFP) has been prepared to procure a total of six solar PV farms with battery energy storage, amounting to 300 MWp at various locations throughout Lebanon. Again, the bid was put on hold given the macro-fiscal situation, which is jeopardising the availability of financing.

The European Bank for Reconstruction and Development (EBRD) offered MEW and LCEC the technical support needed for the preparation of all needed documentation for the 300 MW Solar and Battery Energy Storage System (BESS) auction. The scope of EBRD's support is to assess their feasibility, structure bankable projects, and draft the auction documents, including the relevant legal agreements such as the Power Purchase Agreement (PPA).

2.4 Concentrated Solar Power (CSP) Plants

The NREAP 2016–2020 included the construction of a 50 MW concentrated solar power (CSP) plant by 2020. However, the financial feasibility of implementing such a project was not encouraging at the time. In addition, a CSP plant's impact on agriculture, land use, and water resources posed a major barrier to its development.

To clarify all these issues, and thanks to a grant by the Facility for Infrastructure Development Develop to Build (D2B) of the Dutch Ministry of Foreign Affairs represented by the Netherlands Enterprise Agency, a full feasibility study of a 50 MW CSP plant with 7.5 hours of storage was initiated in the northern Hermel region. The study shows that CSP remains an expensive solution. For this reason, further analysis may be needed.

The study also identified the Kaa and Raas Baalbek regions as suited to a CSP plant, designed to deliver a gross power output of 70 MWe. Together, they will incorporate 164 loops and provide 7.5 hours of thermal storage. The project has an estimated capital expenditure (CAPEX) of MUSD 384.6 and a total yearly operational cost of MUSD 6.3. The project is anticipated to achieve an internal rate of return (IRR) of 15%. With an anticipated construction period of 2.5 years, the plant will cover a land area of approximately 3,777,000 square meters. The CSP plant is expected to produce 241,605 MWh/year of electricity, with a planned operational lifespan of 25 years.

2.5 Hydropower

Hydroelectricity is one of the oldest forms of renewable energy exploited in Lebanon. Hydroelectricity power plants are closely related to water demand and water supply, often in contradictory ways. According to the National Water Sector Strategy (NWSS), water demand in Lebanon is around 1,500 million cubic meters per year, with 61% going to agricultural use, 18% to domestic use, and 11% to industrial use. These percentages highlight the importance of this resource and the fundamental role it plays in the Lebanese socioeconomic system.

Installed hydroelectric capacity in Lebanon reached 282 MW by 2018, mostly installed over the past 70 years. In the 1960s, it provided about 70% of the country's energy supply. Currently, the only new major hydropower development is the one linked to the development of the Janneh Dam, with an expected capacity of around 100 MW.

TABLE 1 The energy production of hydropower plants in Lebanon[2]

Yearly Hydro Power Plants Generation (GWh)								
Hydro Power plants	2016	2017	2018	2019	2020	2021	2022	2023
Kadisha	56.8	64.4	58.2	57.3	45.1	38.3	28.3	40.9
Bared1				44.7	39.2	41.9		
Bared2				5.6	8.8	5.1		
Aux Bared						-0.1		
Total Bared	**33.9**	**33.2**	**29.4**	**50.4**	**48.0**	**46.9**	**36.3**	**9.5**
Safa	11.3	10.5	11.3	1.8	0.0	0.0	0.0	0.0
Total Kad.-Bar.-Safa	101.9	108.2	98.8	109.5	93.1	85.2	64.6	50.3
Abdel Al				124.9	156.1	68.6	104.2	74.7
Ain El Zarka				6.5	0.0	0.0	0.0	0.0
Arcache				383.8	422.4	219.9	302.3	211.6
Helou				227.4	249.3	119.6	173.3	118.6
Aux Litani						-1.6	-2.0	1.4
Total Litani	**205.7**	**240.6**	**184.4**	**742.5**	**827.8**	**408.1**	**577.9**	**406.3**
Nahr Ibr.1				53.7	42.5	0.0	36.3	8.3
Nahr Ibr.2				43.4	39.6	68.3	30.3	41.1
Nahr Ibr.3				18.4	15.7	14.4	13.4	11.2
Total Nahr Ibr.	77.5	72.5	64.2	115.6	97.9	82.6	80.0	60.6
Total Hydro	**385.1**	**421.3**	**347.5**	**967.6**	**1018.7**	**575.9**	**722.4**	**517.0**

Recently, the MEW launched a series of initiatives to rehabilitate Lebanon's existing micro-hydropower plants, with a new bid to rehabilitate the Jeita-Hrach hydropower plant recently published. The expected capacity of this hydropower plant is 1.2 MW.

2 According to data shared by Electricité du Liban (EDL) and the Litani River Authority (LRA)

2.6 Bioenergy, Biomass and Geothermal Energy

Bioenergy and biomass implementations could be used for the production of both electricity and heat output. Currently, the size of the bioenergy market in Lebanon is still limited and unexploited. Support is definitely needed to develop a strong strategy for biomass and biogas production in the country.

The use of biomass to generate electricity was validated by the implementation of on project: the Naameh project implemented by the EDL. The capacity of the plants is around 7 MW. Both plants extract biogas from municipal solid waste to drive a gas turbine and generate electricity.

Although the implementation of this pilot project was successful, the market of waste-to-energy has not experienced much momentum. It is a controversial technology, given sensitivities around the topic and its low level of social acceptance, and the development of further projects has been slow. An additional barrier is the lack of public trust in the long-term management and operation of such facilities, in the absence of a plan for effective segregation of waste at the source. Additional barriers include the proximity of landfills to houses, ambiguity regarding the party responsible for developing this sector, and the limited number of suitable sites for upscale of this technology.

On the other hand, biomass deployment for heat generation faces other types of barriers, including questions to do with the sustainable use of land, the lack of sufficient volumes, and impact on biodiversity. Yet the availability of soft financing, international support, and grants has helped move the sector towards a larger integration of such facilities.

Several pilot projects have been established, specifically briquetting and pelleting plants in several districts, notably around the areas of Chouf, Bkassine, and Balamand. Based on the output of similar plants and the net calorific value of their biomass production, in addition to previous estimates on biomass heating use, it is anticipated that biomass use for household heating is around 730 GWh per year.

The development of geothermal technology in Lebanon is still limited to a few implemented projects. The most prominent local example for this technology is a seawater geothermal cooling facility in a hotel in Beirut. This project is sufficient to reach the modest geothermal targets previously proposed, as shown in Table 2.

TABLE 2 **Geothermal energy: Current status and targets**

NREAP Target 2020			Status in 2020		
MW	GWh	ktoe	MW	GWh	ktoe
1.3	6.0	1.3	2	9.2	2.0

Significant efforts have been established to promote geothermal technology through the publication of reports and supportive technical documentation, notably regarding the guidelines, design, and installation of these systems. A national geothermal resource assessment report was also published to provide further insights, supplementing the accumulated learning gained from pilot projects.

Further development of this technology faces several barriers; notably high development costs, limited suitable locations, and the complexity of the technology. Additional barriers include the limited visibility of the resource, and the licensing requirements for drilling.

2.7 NREAP 2016–2020: Target Vs. Actual Implementations

Table 3 summarises the status of renewables in Lebanon at the end of 2020, compared to the targets established by the NREAP 2016–2020. The headline target was to reach 12% RE in the total energy mix by 2020.

TABLE 3 Current status of renewable energy technologies in Lebanon

Technology	NREAP Target 2020			Status 2020		
	MW	GWh	ktoe	MW	GWh	ktoe
Onshore Wind	200.0	595.7	128.7	–	–	–
Utility scale PV	150.0	240.0	51.8	–	–	–
Distributed PV	100.0	160.0	34.6	92.0	133	28.8
CSP	50.0	170.6	36.8	–	–	–
SWH (m^2)	1,053,988.0	685.5	148.1	735,401	408	88.1
Hydro	331.5	961.9	207.8	282.0	1019[3]	220.1
Geothermal	1.3	6.0	1.3	2.0	9	2.0
Bioenergy (Heat)	–	510.5	110.2	–	774[4]	167.2
Bioenergy (Electricity)	–	261.0	56.4	7.0	22.0	4.8
Total RE Generation	–	3,591.2	775.7	–	2,426	510.9
Total Electricity & Heating Consumption	–	29,578.7	6,389.0	–	32,370[5]	6,992.0
RE Percentage from total energy mix	12%			7.31%		

3 According to data shared by Electricité du Liban (EDL) and the Litani River Authority (LRA)
4 730 GWh in 2018 with a 3% yearly growth rate, as stated in Chapter 1.
5 24,273 GWh for electricity consumption, and 8,097 GWh for heat consumption.

2.8 Current Status

Between 2020 and 2024, the economic crisis highly affected energy demand at the national level as well as EDL's ability to supply electricity. In response to MEW's bold decision to remove subsidies on all types of conventional fuel sources, the well-established renewable energy market witnessed a remarkable leap. This may be seen in the increase of the renewable energy share in the electricity supply from 2.6% in 2018 to 20.4% in 2023, as shown in Table 4.

TABLE 4 **Renewable Energy Installed Capacities and Energy Generation 2018–2024**

Year	2018	2019	2020	2021	2022	2023	2024
Solar PV - Distributed (MW)	56	78	92	206	869	1,081	1,190*
Solar PV - Distributed (GWh)	85	112	133	309	1,262	1,550	1,706
Hydro (MW)	282	282	282	282	282	282	282
Hydro (GWh)	347	968	1019	576	722	517	517
Biogas (MW)	7	7	7	7	7	7	7
Biogas (GWh)	83	35	22	–	–	–	–
Total RE (MW)	345	367	381	495	1,158	1,370	1,479
Total RE (GWh)	515	1,115	1,173	885	1,985	2,067	2,223
Demand (GWh)	22,880	23,566	24,273	21,846	16,385	16,775	17,278
Total Generated RE Share from Electricity Demand	2.3%	4.7%	4.8%	4.0%	12.1%	12.3%	12.8%
Actual Supply (GWh)	20,127	20,066	21,104	14,283	10,159	10,134	10,290
Total Generated RE Share from Actual Electricity Supply (%)	2.6%	5.6%	5.6%	6.2%	19.5%	20.4%	21.6%

Furthermore, the SWH market witnessed and is still witnessing a remarkable increase, as shown in Table 5 below.

TABLE 5 **SWHs installed area and energy generated between 2018–2023**

Year	2018	2019	2020	2021	2022	2023
SWH (sqm)	671,323	711,778	735,401	785,740	909,070	1,011,181
SWH (GWh)	373	395	408	436	505	561

The devastating war Lebanon witnessed throughout 2024, and severely escalated by September of that year, led to the destruction of around 131 MWp of rooftop solar PV panels. According to the World Bank, around 100,000 housing units were partially or completely destroyed during the war (World Bank, 2024). Around 5.3% of these housing units are within the Greater Beirut area, where the number of PV panels installed per housing unit is relatively limited. Based on the average installed solar PV system sizes in the residential sector between 2020 and 2023, and the average number of housing units per building in the Greater Beirut area and in different other damaged governorates, districts, and villages, the total number of destroyed PV panels is estimated to be more than 244,000.

On the other hand, approximately 240 MWp were installed in 2024, which leaves the additional installed capacity at 109 MWp.

Challenges Hindering the Renewables Sector

CHAPTER 03

The political economy of the energy sector in Lebanon stands at a critical juncture. The appointment of a new cabinet presents a window of opportunity to advance long-overdue reforms, especially in the renewable energy sector. With growing international support and a renewed reform momentum, the energy sector can become a catalyst for recovery, enabling progress across other sectors and signalling seriousness in governance. However, this momentum is shadowed by persistent political instability and shifting regional dynamics, which could either reinforce reform efforts or derail them.

Multiple efforts exerted by national and international parties and stakeholders to boost the RE sector in Lebanon have resulted in some successes during the past decade. At the same time, various obstacles and barriers have hindered the development of some RE technologies. This is reflected in the under-achievement of just 5.8% RE in the energy mix of the country versus the target share of 20% by 2020. However, recent progress is notable, with the share of RE in electricity supply increasing to more than 20% in 2023.

The COVID-19 pandemic and the severe economic crisis were major unforeseen obstacles. While the 2019–2023 economic crisis slowed down the development of major RE projects, the same crisis triggered to the MEW's decision to remove subsidies on fuel and electricity prices. Combined with EDL's inability to supply electricity, the decision was the main driver of the rapid spread of solar PV systems that the country witnessed in 2021 and 2022.

This chapter focuses on the main barriers and challenges that have hindered the development of some RE technologies during the specified interval and that could keep hindering that development in the years to come. These challenges may be classified into the following categories: legal and regulatory, institutional, macro-fiscal and commercial, technological, and social and environmental. Each of these is discussed below.

Flagship air monitoring station in Beirut

3.1 Legal and Regulatory Challenges

Decree 4517 and Law 462/2002 are the two main regulatory tools for the energy sector in Lebanon. While Decree 4517 gives the exclusivity of generation, transmission, and distribution of electricity to EDL, Law 462/2002 includes provisions on the complete unbundling of EDL and the privatisation of both generation and distribution sectors. Law 462/2002 also calls for the setting up of an independent Electricity Regulatory Authority (ERA), stipulating its roles and responsibilities following the unbundling of EDL. This law opens the door for major RE projects to be implemented by private sector companies, which would sell electricity to EDL (or the transmission company, once EDL is unbundled) based on Power Purchase Agreements (PPA). However, Law 462 has not been implemented since its enactment 22 years ago.

Accordingly, one major challenge facing the development of large-scale RE projects in the future is the implementation of Law 462/2002. Several amendments to Law 462/2002 in the past decade have temporarily granted the Council of Ministers (CoM) the authority to issue permits and licenses for electricity generation until the ERA is appointed, either upon the proposal of the MEW (Law 775/2006) or upon a joint proposal by the MEW and the Ministry of Finance (MoF) (Law 288/2014, Law 54/2015, and Law 129/2019). The licences given to the three wind power plants were granted based on these amendments, notably Law 54/2015 and Law 288/2014. The licences given to the 11 solar PV farms were granted based on amendment Law 129/2019.

A different set of challenges faced the implementation of rooftop decentralised solar PV projects. One main barrier was net metering, an initiative undertaken by EDL in 2010. However, the net-metering mechanism is renewed on a yearly basis, which adds an additional layer of uncertainty to its application. In addition, EDL's inability to supply electricity for long periods of time has made net metering a less attractive option.

The Decentralised Renewable Energy Law (DRE Law 318/2023), ratified by the Lebanese Parliament on 14 December 2023, is a significant step toward enhancing Lebanon's RE sector. This law establishes a legal framework to support decentralised RE production and trading, addressing both net metering and peer-to-peer energy contracts for systems with capacity of up to 10 MWp.

قانون رقم ٣١٨
قانون انتاج الطاقة المتجدّدة الموزعة

أقر مجلس النواب،
وينشر مجلس الوزراء استناداً للمادة ٦٢ من
الدستور القانون التالي نصه:
وبعد موافقة مجلس الوزراء بتاريخ ١٩/١٢/٢٠٢٣
المادة الأولى: التعريفات

Publication of Law 318/2023 in the official journal

Key aspects of Law 318/2023 include:

- Net Metering: The law legalises net metering in Lebanon, allowing consumers to generate their own electricity from RE sources and feed excess power back into the national grid. Various forms of net metering have been introduced, including individual, multiple-tenants, and collective net metering options.
- Peer-to-Peer Energy Trading: The law facilitates direct RE trading between private entities. This system permits power exchanges between buyers and sellers located on the same or adjacent properties without their having to use the national grid, and through wheeling arrangements using the EDL grid for distant trades.
- Infrastructure and Regulatory Requirements: For successful implementation, Lebanon needs to modernise its grid infrastructure and establish a National Electricity Regulatory Authority, as outlined in Law 462/2002. This authority will be responsible for setting wheeling fees and ensuring compliance with the new regulatory framework.

Law 318/2023 will drive the development of additional RE capacity in the coming years. Overall, Decentralised Renewable Energy Law 318/2023 is a pivotal move towards a more sustainable and resilient energy system in Lebanon, encouraging investment in RE and fostering innovation in energy management. However, many articles of Law 318/2023 are based on the important role of the ERA, and accordingly, this law will not be fully implemented in the absence of the ERA.

3.2 Institutional Challenges

The development of RE has experienced significant delays because of institutional barriers, particularly following the MEW's initiation of large-scale projects in partnership with the private sector. A key challenge for all involved public entities is the limited number of expert technical staff, which has hampered their ability to manage the extensive workload. This requires specialised expertise and full-time commitment, especially within institutions like Electricité du Liban (EDL).

In addition, as the RE sector is still relatively new, many of the institutions involved have struggled to adapt to the demands of new projects and to advance their implementation. A lack of sufficient financing and budgeting has impeded both the establishment of a leading institution and the strengthening of existing ones, making it difficult to recruit and retain specialised full-time personnel to support the sector's growth. Moreover, the absence of an independent Electricity Regulatory Authority (ERA) as a central coordinating body for the development of RE projects remains a major obstacle.

Institutional challenges are equally prevalent in the hydroelectricity sector. In addition to conflicts of priority between water usage and hydroelectricity production, and differing views on sustainable resource management, the sector faces numerous other challenges that continue to hinder the development of new projects.

These challenges, already identified by a World Bank study in 2017, concern the legal and administrative constraints to the development of a national hydropower market in Lebanon (Assessment of the Legal and Administrative Constraints to the Development of the National Hydropower Market for Lebanon, 2017). According to the study, insufficient payments to existing hydro producers, unclear legislation for expired concessions, and the absence of provisions for developing a competitive electricity market have hindered refurbishment and upgrades to old hydroelectric plants.

Moreover, the absence of a core institution responsible for the specific management of hydroelectricity, complex licensing procedures, cultural and environmental issues, water usage rights, and unfavourable financial conditions are also hindering the development of new projects. The study referred to above (Assessment of the Legal and Administrative Constraints to the Development of the National Hydropower Market for Lebanon, 2017) suggests solutions and recommendations to create a suitable investment landscape and drive the sector forward, as detailed in Chapter 6.

3.3 Macro-fiscal and Commercial Challenges

Given the current economic situation in the country, the most critical criteria to be addressed before contractual terms are negotiated are the macro-fiscal conditions, particularly the availability and convertibility of funds, the payment structure (including the currency of payment), and the transferability of funds to offshore accounts.

These criteria are vital for aligning with the recommendations of international financial institutions (IFIs), which are typically based on international best practices. They are essential bankability conditions for financing projects, such as the onshore wind and utility-scale solar PPAs.

The availability of funds is crucial to ensuring sufficient cash flows for projects, but it is equally important that these funds are disbursed in hard currency. This becomes particularly complex in the context of the fluctuating and generally depreciating value of the Lebanese pound. Even if disbursed in hard currency, a significant portion of these funds must be transferred to offshore accounts to service outstanding debt and repay foreign equity investors. This is a highly sensitive issue, especially in a local context marked by a budget deficit, unregulated capital controls on local accounts, and restrictions on the outflow of currency from the country.

Given that these challenges are potential deal breakers, this document proposes, in the recommendations section, an action plan from MEW, alongside efforts that the Ministry will undertake to:

- secure adequate budget allocations for renewable energy PPAs;
- ensure the availability of hard currency or an equivalent local currency through a bankable formula; and
- ensure the ability of private sector project developers to transfer revenues partially or fully to offshore accounts.

Other commercial challenges that hinder the development of renewable energy projects include the lack of clear financing and numerous political and budgetary risks, which further diminish the interest of the private sector, especially in the absence of sovereign guarantees.

However, it is worth noting that the recent increase in tariffs and Electricité du Liban's (EDL) improved capacity to collect payments in USD have significantly bolstered the utility's financial stability. This development positively impacts large-scale renewable energy projects by enhancing EDL's ability to meet its financial obligations, creating a more reliable and attractive environment for investors in the sector. Collecting tariffs in USD provides a more stable revenue stream, mitigating the currency risks associated with the Lebanese pound's volatility.

3.4 Technological Challenges

A thorough follow-up on the installations of solar PV and solar water heaters projects in Lebanon has shown that the quality of installations is remarkably good as a result of market development activities that started in 2010. This is not the case with other technologies, such as biomass, geothermal, and wind energy, where the level of know-how is still weak.

On the other hand, the implementation of renewable energy projects has faced significant technological challenges, including the connection to the national electricity grid, grid impact, resource intermittency, fragile infrastructure, and a shortage of control and spinning reserves. These challenges are particularly acute, given the current state of EDL power supply. Some of these issues, such as the need for transmission and distribution network development, are highly complex and require substantial work.

In response, MEW, with support from the World Bank and EDL, has initiated a least-cost generation plan and a master plan for the electricity network. These plans incorporate RE targets as outlined in the updated 2019 policy paper for the electricity sector and the Lebanon Renewable Energy Outlook (IRENA, 2020).

Another critical technological aspect is the availability of a local spare parts industry to support the development and maintenance of RE power plants. This includes essential network connection components such as transformers, breakers, and cables.

Additional challenges that hinder the seamless integration of large-scale RE projects into the grid include limited access to grid-related data, the absence of comprehensive grid codes – especially for photovoltaic systems – and uncertainty regarding the procedures for generation and dispatch priority.

The situation was further exacerbated by the destruction of Beirut's National Control Center during the port explosion, which severely affected Lebanon's ability to monitor and manage its electricity grid. This critical infrastructure loss has led to increased difficulties in controlling grid stability, further complicating the integration of renewable energy sources and the overall modernisation of the electricity sector. Restoring and rebuilding such key infrastructure is essential for ensuring the successful implementation of RE projects and maintaining grid resilience.

3.5 Social and Environmental Limitations

Social and environmental constraints can present significant challenges in the development of RE projects, particularly for large-scale infrastructure initiatives. A key requirement in such developments is conducting a comprehensive Environmental and Social Impact Assessment (ESIA) to evaluate the potential impacts of the project. Despite efforts by stakeholders to meet these requirements, certain aspects remain ambiguous, which is expected in a developing market.

One prominent example is the Bird Migration Protocol (BMP), a critical component of the ESIA for the first round of wind farms planned in the Akkar region. Substantial efforts have been made to create a replicable and bankable ESIA template that includes detailed BMP provisions. Other environmental concerns associated with large-scale RE projects include land degradation, impacts on local wildlife and endangered species, disruption to archaeological sites, and the effects on local habitats.

However, the social dimension poses an even greater challenge, particularly in rural areas where utility-scale projects are often located. There is often low trust in similar energy projects and a lack of familiarity with RE technologies, leading to concerns within local communities, especially those in underserved rural regions, about the sustainability and potential negative impacts of such developments.

Despite these hurdles, stakeholders have successfully communicated the full range of benefits and drawbacks of wind farms to society, addressing concerns rationally. These same barriers are also encountered in other RE technologies, notably hydro and solar PV.

Another critical social factor arises under the current bidding model, where private developers are responsible for selecting suitable land. Naturally, developers seek the most cost-effective land with the richest resources, close to the grid, and with minimal environmental impact. However, a balance must be struck between these factors to ensure feasible project implementation. In Lebanon, this issue is further complicated by tribal dynamics, where unequal distribution of benefits among community members can lead to social tensions.

Drawing from the first round of wind farm development, the lands initially chosen by developers were selected based on their suitability for wind farm installation, in line with ESIA requirements such as noise and shadow flicker limits.

On a positive note, the widespread installation of PV systems in the residential sector over the past two years has helped mitigate air and noise pollution caused by diesel-powered backup generators, which are scattered across urban and rural areas. These generators, often with stacks only a few meters above ground, have led to emissions far exceeding international standards and a 6–8 dB rise in noise pollution levels, or more than threefold. The increased adoption of PV systems has reduced reliance on these polluting generators, providing a cleaner and quieter environment.

In conclusion, social and environmental concerns can be effectively addressed through awareness-raising efforts and promoting a culture of sustainability. The lack of public awareness has long been, and continues to be, a significant obstacle to advancing the energy sector. While progress has been made in educating the population, these efforts have not been sufficient. Moving forward, more must be done to engage all segments of Lebanese society in the energy transition.

CHAPTER 04

2030 Renewable Energy Target Scenarios

The Good, the Bad, and the Beautiful

This chapter outlines the projected evolution of renewable energy capacity each year up to 2030, based on three scenarios, which represent different macroeconomic conditions and levels of ambition:

- **Scenario 1 – Green Revolution:** A substantial resurgence leading to the full implementation of pipelined projects.
- **Scenario 2 – Realistic:** A more moderate yet optimistic scenario that sees the successful execution of mature RE projects with acceptable progress.
- **Scenario 3 – Stagnation:** The absence of reforms leading to a rapid deterioration of the macroeconomic situation – a scenario to be avoided at all costs.

4.1 Scenario 1: 'Green Revolution'

A Significant Recovery That Leads to the Implementation of the Pipelined RE Projects

The 'Green Revolution' scenario hinges on the country's economic recovery, the successful election of a president, and the formation of a new government supported by international assistance. It requires swift implementation of macro-fiscal reforms and electricity sector reform. International capital availability and financial backing from the global finance community would provide crucial support, helping to alleviate the socioeconomic crisis. As a result, the nation's financial situation would gradually improve, allowing for the successful execution of reforms and strengthening financial stability. This progress would restore private sector confidence and lead credit rating agencies to revise Lebanon's credit outlook positively.


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The total installed capacity of RE sources between 2025 and 2030 expected under this scenario, together with the energy yield, is summarised in Table 6.

TABLE 6 **Total yearly RE projections under 'Green Revolution' scenario**

Year	2025	2026	2027	2028	2029	2030
Wind (MW)	226	226	226	826	826	826
Wind (GWh)	615	615	615	2,247	2,247	2,247
Solar PV – utility scale (MW)	165	165	265	565	865	1,165
Solar PV – utility scale (GWh)	287	287	460	981	1,503	2,024
Solar PV – distributed (MW)	1,490	1,790	2,090	2,390	2,640	2,840
Solar PV – distributed (GWh)	2,459	2,954	3,449	3,944	4,356	4,686
CSP (MW)	-	100	100	100	300	300
CSP (GWh)	-	344	344	344	1,033	1,033
Hydro (MW)	386	416	446	476	506	536
Hydro (GWh)	733	797	862	927	991	1,056
Biogas (MW)	20	31	42	53	64	75
Biogas (GWh)	184	285	386	487	588	689
Total RE (MW)	2,287	2,728	3,169	4,410	5,201	5,742
Total RE (GWh)	4,278	5,282	6,116	8,920	10,718	11,735
Demand (GWh)	17,797	18,330	18,880	19,824	20,816	21,856
Total Generated RE Share from Electricity Consumed (%)	24%	29%	32%	45%	51%	54%

As seen in Table 6, this scenario would see RE generation rise to 11,735 GWh by 2030, accounting for 54% of all electricity demand in that year. Figure 15 illustrates the cumulative annual RE installed capacity additions, reaching 5,742 MW by 2030.

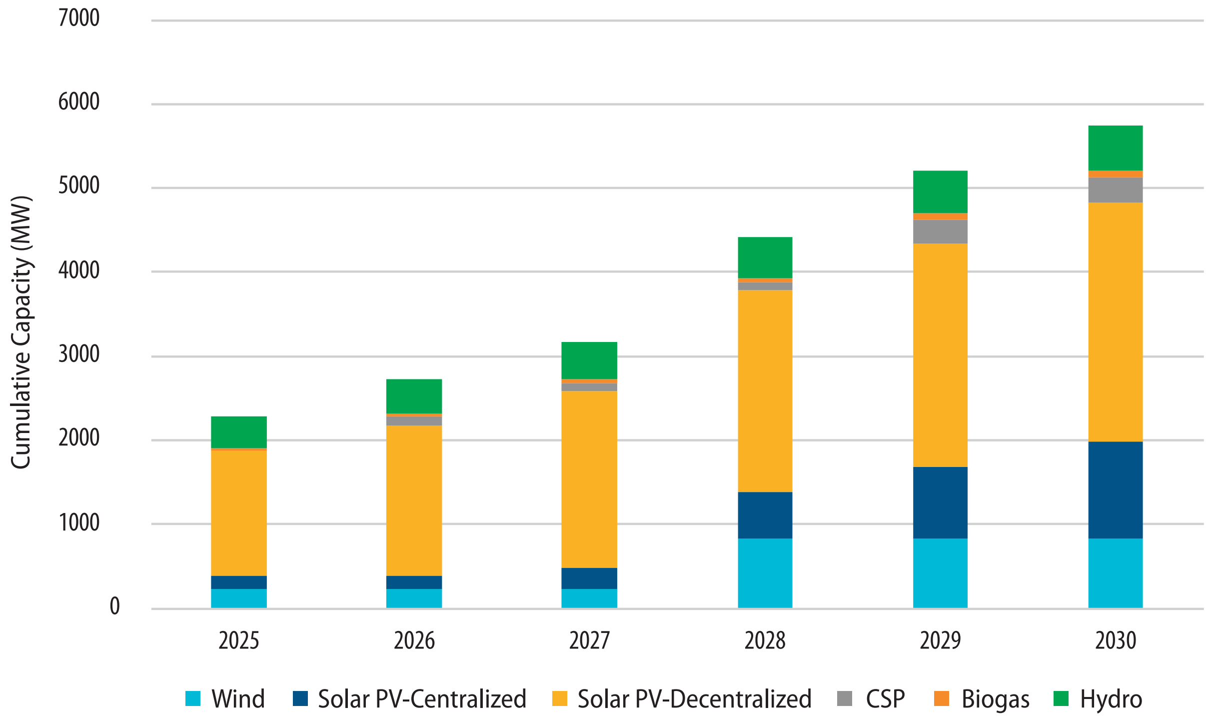


FIGURE 15 **Total cumulative installed RE capacity under 'Green Revolution' scenario**

This scenario is based on the development of multiple RE projects in the country. With proper reforms and funds, a 226 MW wind capacity was expected to be established by 2025, with an additional 600 MW added in 2028. This would bring total wind capacity to 826 MW by 2030. However, the onshore wind farm has not yet been installed.

Utility-scale solar PV capacity would be added within the first few years of the NREAP 2025–2030, with a first 15 MW installation followed quickly by the remaining 10 sites planned under existing PPAs, to reach 165 MW. An additional 100 MW are expected in 2027, to reach a total installed capacity of 265 MW. In 2028, 2029, and 2030, capacity would be expanded substantially, with an additional 300 MW in each year, bringing total installed capacity to 1,165 MW.

Following finalisation of relevant feasibility studies, a CSP project would be launched and could attract considerable interest from the private sector, with a first CSP of 100 MW brought online in 2026. A further 200 MW of CSP would be added in 2029.

Building on recent momentum, which saw decentralised rooftop solar reach 1,081 MW by 2023, a linear continuation of this trend would see installed capacity almost triple to 2,840 MW by 2030.

Further hydro capacity would be added to the 282 MW in 2023; in 2025, an additional 104 MW capacity is expected, followed by an annual increase of 30 MW, to reach an installed capacity of 536 MW by 2030.

A bioenergy plant of 7 MW has been operational since 2018. An additional 13 MW is planned for 2025, with a similar increase expected each year until 2030, reaching an expected capacity of 75 MW.

Solar water heaters are not part of the total RE target for 2030. However, they contribute to a reduction in electricity demand. A linear increase is feasible, with an additional 17,000 sqm/year of installed area added for SWHs. This would lead to a cumulative installed area of 1,130,180 sqm equivalent to 627 GWh_{th}.

Regarding heat pumps (HPs), it is estimated that prices will continue to be high. Assuming positive market conditions, the enforcement of the Solar Ordinance is arbitrarily estimated to allow the equivalent energy provided by the yearly additions of SWHs to be supplied by HPs, assuming a coefficient of performance (CoP) of 3. Accordingly, installation is not expected until 2025, when 634 kWth will be installed. Each subsequent year will see an addition of the same amount, reaching 3,800 kWth by 2030, which would increase the electricity demand by 11 GWhe. These increases would not have a big impact on the total country's electricity demand. It is worth noting that according to Article 5 of Directive 2009/28/EC of the European Parliament and of the Council, 22 GWh is the cumulative RE part of the heat pumps' installed capacity by 2030.

4.2 Scenario 2: 'Realistic'

The Successful Implementation of Some Mature Projects

The 'Realistic' scenario envisions gradual improvements in the nation's economic situation, with the formation of a transparent administration backed by international funding. Key government officials push forward with the necessary macro-fiscal changes, including critical sectoral reforms, particularly in the power sector. However, certain challenges arise, causing delays in the timely implementation of these reforms. Despite favourable signals from international investors and the lending community, these delays prevent the immediate release of funds.

Eventually, the Government of Lebanon overcomes these obstacles, enabling the private sector to maintain a strong interest in financing green projects. As financial support becomes available, the socioeconomic crisis begins to ease, and the country's financial situation gradually improves. While the successful implementation of reforms leads to a partial recovery of private sector confidence, credit rating agencies adjust Lebanon's outlook to stable. Under these conditions, the development of each renewable energy technology would progress positively, albeit with some delays.

Table 7 summarises the possible annual evolution of the total RE capacity installations between 2025 and 2030, with RE production reaching 8,998 GWh in 2030, accounting for 40% of annual electricity demand.

TABLE 7 Total yearly RE projections under 'Realistic' scenario

Year	2025	2026	2027	2028	2029	2030
Wind (MW)	–	226	226	226	226	826
Wind (GWh)	–	615	615	615	615	2,247
Solar PV – utility scale (MW)	105	105	405	405	405	705
Solar PV – utility scale (GWh)	182	182	704	704	704	1,225
Solar PV – distributed (MW)	1,390	1,560	1,730	1,900	2,070	2,250
Solar PV – distributed (GWh)	2,294	2,574	2,855	3,135	3,416	3,713
CSP (MW)	–	–	100	100	100	100
CSP (GWh)	–	–	344	344	344	344
Hydro (MW)	282	282	282	386	386	386
Hydro (GWh)	517	517	517	733	733	733
Biogas (MW)	9	9	20	31	42	53
Biogas (GWh)	83	83	184	285	386	487
Total RE (MW)	1,784	2,180	2,763	3,048	3,229	4,320
Total RE (GWh)	3,076	3,971	5,219	5,816	6,198	8,749
Demand (GWh)	17,797	18,330	18,880	19,824	20,816	21,856
Total Generated RE Share from Electricity Consumed (%)	17%	22%	28%	29%	30%	40%

Figure 16 shows the annual RE capacity additions, which would reach 4,320 MW by 2030. While this target is lower than that predicted in the Green Revolution scenario, achieving it nonetheless depends on successful implementation of necessary macro-fiscal changes and strategic procurement design upgrades.

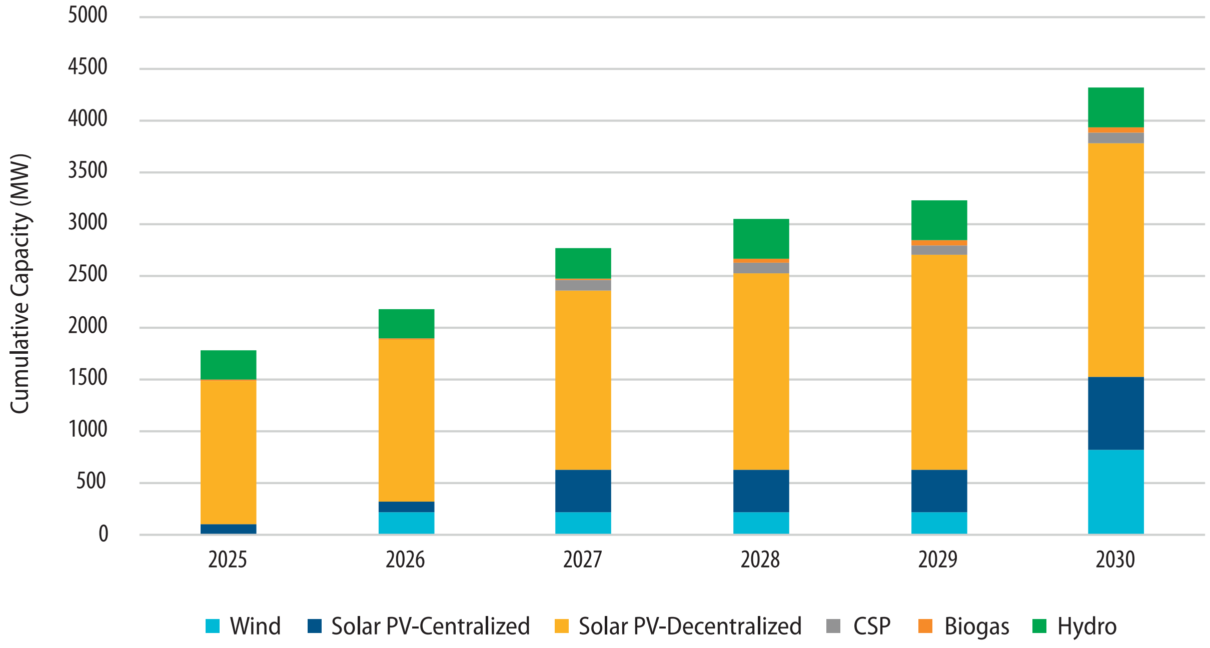


FIGURE 16 **Total cumulative installed RE capacity under 'Realistic' scenario**

In this scenario, onshore wind capacity is delayed until 2026, at which point the 226 MW anticipated under previous PPAs comes online. This capacity remains constant until 2030, with an additional 600 MW added, bringing wind capacity to 826 MW by 2030.

In 2025, the first 105 MW of utility-scale solar PV would be brought online, quickly followed by a further 300 MW in 2026. By 2030, another 300 MW would be added, bringing total installed capacity to 705 MW.

Similar to the Green Revolution scenario, decentralised solar PV sees a steady increase year on year, albeit at a slower rate of growth, to reach 2,250 MW by 2030.

No CSP is expected until 2027, when an initial 100 MW plant would be added, probably in the Hermel region. No further CSP would then be anticipated until 2030.

For hydropower, no additions beyond the current 282 MW are expected before 2027, when a further 104 MW would be brought online, for a cumulative capacity of 386 MW by 2030.

For bioenergy, the first addition on top of the current 7 MW operational since 2018 is expected in 2027, from which point an additional 13 MW will be added each year, reaching a cumulative capacity of 53 MW by 2030.

As for solar water heaters (SWHs), a linear increase is considered, with an additional 10,000 sqm/year of additional SWH area installed. This would lead to a cumulative installed area of 1,081,180.52 sqm by 2030, equivalent to around 600 GWh of thermal energy.

4.3 Scenario 3: 'Stagnation'

Lack of Reforms, Followed by a Rapid Deterioration of the Macroeconomic Situation

The 'Stagnation' scenario assumes that the country's economic and political conditions fail to improve, exacerbated by a lack of international support, leading to further macroeconomic and financial challenges. The situation is compounded by the absence of transparent and effective sectoral reforms, particularly in the power sector. As a result, funding remains inaccessible, and Lebanon misses critical opportunities for development, while its financial situation continues to worsen.

The government's inability to secure fuel for thermal power plants would prompt international credit rating agencies to downgrade Lebanon's rating, further eroding investor confidence in the private sector. In this context, projects like the wind farm initiative would be nearly abandoned. However, despite these setbacks, some international actors remain engaged, with certain international financing institutions still willing to make exceptions to fund environmental projects.

This scenario would lead to significant delays in the development of renewable energy technologies. Nonetheless, continued challenges with EDL services caused by rising fuel prices, along with deterioration of the national currency, encourages the private sector to continue to shift to decentralised solar PV as an alternative power source.

Table 8 shows the annual RE capacity rising to 4,991 GWh by 2030, accounting for 23% of the total electricity consumed in 2030.

TABLE 8 **Total yearly RE projections under 'Stagnation' scenario**

Year	2025	2026	2027	2028	2029	2030
Wind (MW)	–	226	226	226	226	226
Wind (GWh)	–	615	615	615	615	615
Solar PV – utility scale (MW)	–	105	105	105	105	405
Solar PV – utility scale (GWh)	–	182	182	182	182	704
Solar PV – distributed (MW)	1,290	1,390	1,490	1,590	1,690	1,790
Solar PV – distributed (GWh)	2,129	2,294	2,459	2,624	2,789	2,954
CSP (MW)	–	–	–	–	–	–
CSP (GWh)	–	–	–	–	–	–
Hydro (MW)	282	282	282	282	282	282
Hydro (GWh)	517	517	517	517	517	517
Biogas (MW)	7	7	20	20	20	20
Biogas (GWh)	83	83	184	184	184	184
Total RE (MW)	1,579	2,010	2,123	2,223	2,322	2,723
Total RE (GWh)	2,729	3,691	3,957	4,122	4,287	4,974
Demand (GWh)	17,797	18,330	18,880	19,824	20,816	21,856
Total Generated RE Share from Electricity Consumed (%)	15%	20%	21%	21%	21%	23%

Figure 17 shows the annual RE additions, rising from 1,579 MW in 2025 to 2,723 MW by 2030. Owing to an absence of reforms and shortages in both external and internal funding, many obstacles hinder the development of RE projects. Wind power is limited to fulfilling implementation of the previous PPAs, with 226 MW expected to be added by 2030. For utility-scale solar PV projects, 105 MW are expected to be installed in 2026 with an additional 300 MW added in 2030, resulting in a cumulative total of 405 MW.

As in the aforementioned scenarios, decentralised solar PV units would follow a linear trend until 2030, reaching an expected cumulative capacity of 1,790 MW.

No CSP is expected to be brought online in this scenario, and no additional hydro capacity is implemented. As for bioenergy, starting in 2027, an additional 11 MW are expected to be added by 2030.

The solar water heaters market would witness a linear increase with around 5,000 sqm added per year. This would lead to a cumulative installed area of 1,046,180.52 sqm by 2030, equivalent to around 580 GWh of thermal energy.

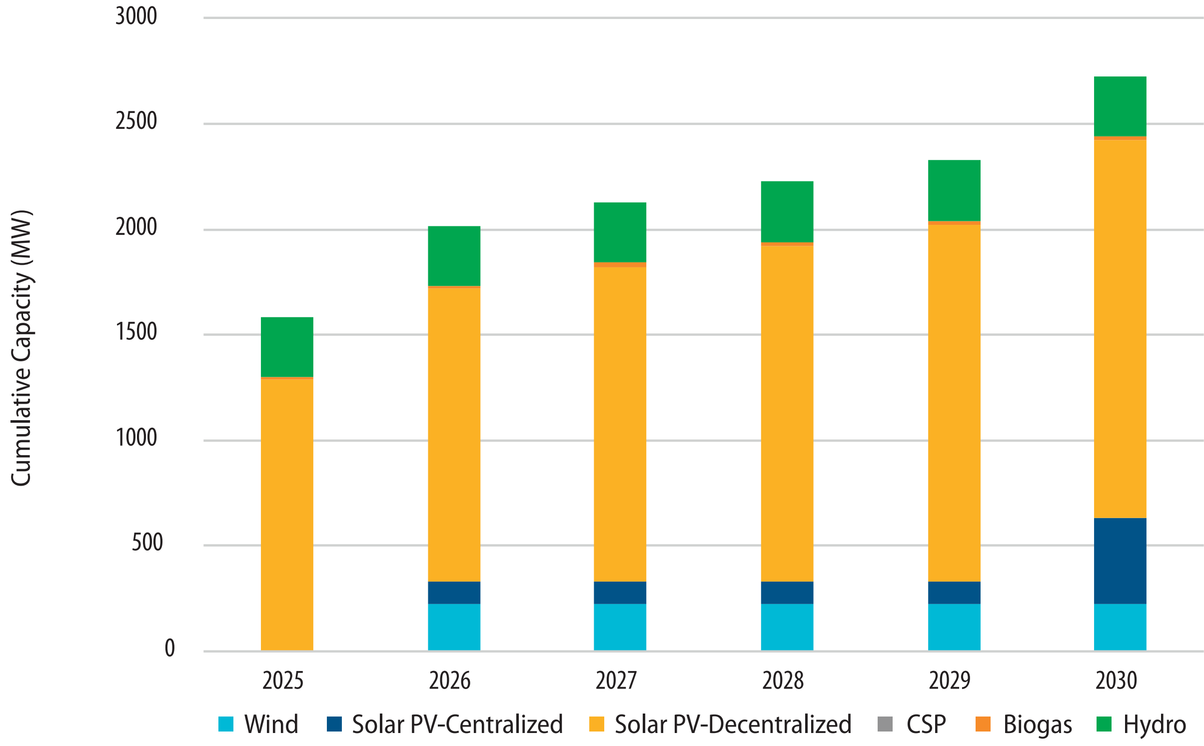


FIGURE 17 Total cumulative installed RE capacity under 'Stagnation' scenario

4.4 At the Crossroads: The Good, the Bad, and the Beautiful

The evolution of electricity generation by renewable energy sources according to the three mentioned scenarios is shown in Figure 18. The figure also shows the evolution of national energy demand, as expected to grow until 2030.

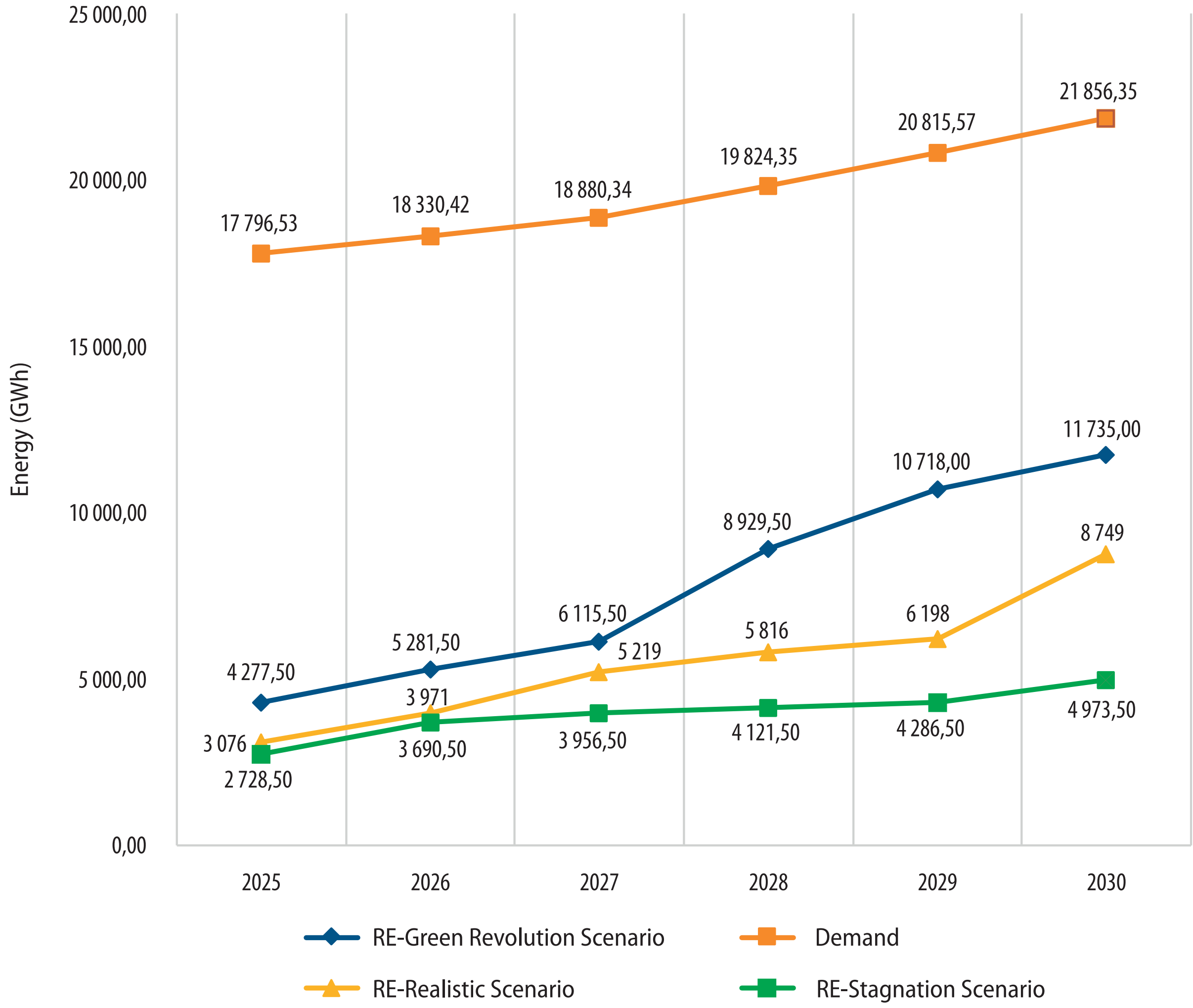


FIGURE 18 **Electricity generation from RE related to the three scenarios vs demand**

Figure 19 shows the RE share of the total electricity consumed in the three scenarios, with the 'Green Revolution' scenario leading to a 54% share for RE, compared to the 'Realistic' scenario with a share of 40% RE and a 'Stagnation' scenario of 23% RE in 2030. Whereas the lower limit of 23% is still relatively acceptable, reaching the ambitious 54% would reflect implementation of a highly ambitious green energy transition.

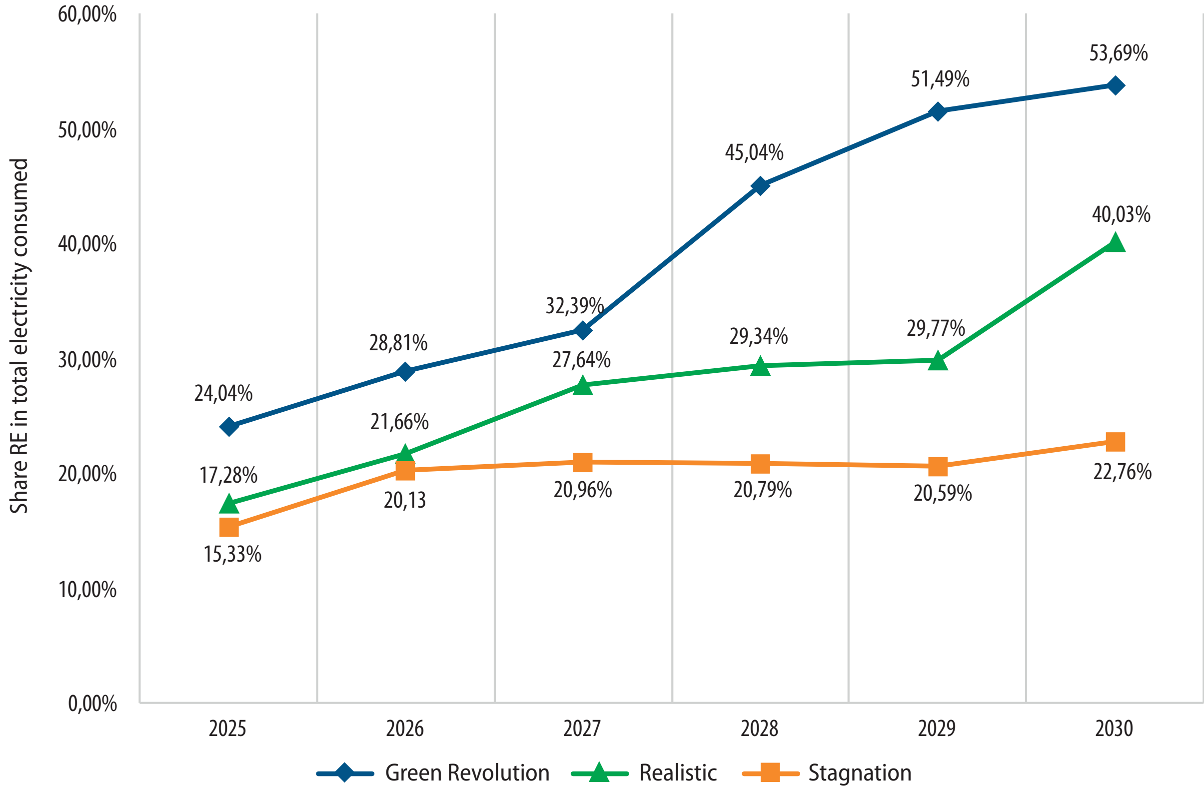


FIGURE 19 The evolution of the RE share for the three scenarios

CHAPTER
05

Investments Needed

How Feasible Is It?

This chapter quantifies the costs of the deployment of renewable energy projects for each of the three developed scenarios. The quantification procedure is inherently uncertain, as there are unknown variables, such as how costs may evolve or be applied in the Lebanese context, and various other complexities. This chapter presents a reasonable indication of the scale of investments needed and the corresponding benefits.

Renewable energy sources are becoming increasingly cost-competitive compared to conventional energy generation sources. Data from IRENA's Renewable Cost Database (Renewable Power Generation Costs in 2020, 2021) indicates that cost declines continued in 2020, with the cost of electricity from utility-scale solar PV decreasing by 7% year-on-year, offshore wind by 9%, onshore wind by 13%, and concentrated solar power (CSP) by 16%.

The period from 2010 to 2020 witnessed substantial improvements in the competitiveness of solar and wind power technologies. During this decade, the cost of electricity from utility-scale solar PV dropped by 85%, CSP by 68%, onshore wind by 56%, and offshore wind by 48%. This has helped to make these technologies competitive with – and indeed often more attractive than – investment in new fossil fuel-fired capacity.

5.1 Cost Estimations for Each Scenario

For each of the three scenarios introduced in Chapter 4, the expected capital expenditure (CAPEX) costs are estimated. CAPEX is estimated for each RE technology based on technological costs, independent of the selected procurement method (which may affect financing costs). The costs of solar water heaters and heat pumps are not included in the CAPEX estimations, since it is assumed that the implementation of these smaller-scale technologies will be driven by private financing or grants.

Another important assumption is that the investment cost will be covered in one full upfront payment at Commercial Operating Dates (COD) to avoid complex cash flows and having to calculate the time value of money for each. In practice, most of the procurement methods require that the necessary CAPEX is paid before the COD, but for simplicity, we will assume that the CAPEX is paid at proper COD for each project.

It should also be noted that the cost of storage for the PV projects is not included in these CAPEX estimates. Despite the simplified approach, a yearly price drop in CAPEX calculations is considered for each RE technology, assuming there are no delays affecting the proposed project implementation timeline.

Based on the financial modelling performed for the 226 MW wind farms and the 165 MW solar PV farms, the following costs per kW are assumed, as shown in Table 9. For CSP, the cost is based on the previously mentioned study performed in cooperation with the Netherlands Enterprise Agency (RVO) and the LCEC (the feasibility of a concentrated solar power plant at Hermel, Lebanon). The study reveals that the cost to install a 70 MWe plant with a parabolic trough technology and molten salt storage of 7.5 hours is 5,465 USD/kWp.

For hydro, the prices are based on the lowest cost generation plan developed by EDF and EDL. There is an assumption that there will be no considerable drop in prices, since conventional turbines and civil works are the major cost components of hydro plants. As for biogas, based on IRENA's report, the CAPEX price in 2016 was around USD 4,000/kW. Accordingly, and assuming a linear yearly drop, the used cost in this NREAP would be around USD 3,835/kW.

For decentralised solar PV, according to the LCEC national yearly survey, the yearly installed capacities and the cost per type of technology (with and without storage), the average cost of all technologies combined is currently around USD 1,000/kW.

A final caveat is that these costs are built on reasonable best estimates from international examples. The cost of implementation may be higher in the current context in Lebanon, and will include items such as insecurity, access constraints, etc. Also, while the investment need estimated here is for new RE generating assets only, broader energy infrastructure investments may be needed in order to respond to climate change impacts; for example, ensuring that any new hydro investment is resilient and in line with increasingly scarce and variable water availability.

TABLE 9 RE technologies per unit cost (USD/kW)

Utility-scale solar PV	702
Decentralised solar PV	1,000
Onshore wind	1,603
CSP	5,495
Hydro	1,800
Biogas	3,835

Table 10 shows the needed investment per type of technology, assuming the unit cost is constant for the whole period. The investment varies from USD 1.4 billion for the 'Stagnation' scenario to USD 6.4 billion for the 'Green Revolution' scenario and around USD 4 billion for the 'Realistic' scenario.

TABLE 10 Estimated investments needed for the three scenarios

Additional Capacities	Stagnation	Realistic	Green Revolution
Wind (MW)	226	826	826
Wind (MUSD)	$362 m	$1,324 m	$1,324 m
Solar PV – utility scale (MW)	405	705	1,165
Solar PV – utility scale (MUSD)	$284 m	$495 m	$818 m
Solar PV – distributed (MW)	600	1,060	1,650
Solar PV – distributed (MUSD)	$600 m	$1,060 m	$1,650 m
CSP (MW)	–	100	300
CSP (MUSD)	–	$550 m	$1,649 m
Hydro (MW)	–	104	254
Hydro (MUSD)	–	$187 m	$457 m
Biogas (MW)	13	46	68
Biogas (MUSD)	$49.9 m	$176 m	$261 m
Total Additional RE (MW)	1,244	2,841	4,263
Total Additional RE (MUSD)	1,296.8 USD	3,792.1 USD	$6,158 m
Total Additional RE (billion USD)	$1.3 bn	$3.8 bn	$ 6.2 bn

5.2 Benefits of Reaching National RE Targets

Despite the relatively high CAPEX cost requirements, implementing and upgrading RE technologies brings many benefits and added value at different levels, notably financial, environmental, socioeconomic, and, most importantly, strategic.

The financial and monetary cost savings are one essential benefit that makes RE an attractive option. The witnessed remarkable drop in the prices of RE technologies has led to attractive low amounts of Levelised Cost of Electricity (LCOE) which is now highly competitive with the LCOE of conventional thermal power generation. It is evident that RE technologies in Lebanon have high potential to generate large financial savings, when one compares the selling tariff for wind (9.6 USC/kWh) with the average generation cost of EDL's conventional tariff (around 27 USC/kWh). Solar PV farms are even more attractive, with a selling price of 5.7 USC/kWh in the Bekaa region and 6.2 USC/kWh in all other regions of Lebanon.

The deployment of RE could provide more hours of electricity supply, which would have huge economic implications at the national level. Moreover, the development of a solid and sustainable RE market is expected to create jobs and boost infrastructure development, thus mitigating the harsh economic conditions of the country.

Today, in light of the global green energy transition and revolutionary technological advancements being made in the power sector worldwide, there is a golden opportunity for Lebanon to benefit from its renewables programme and to plan the design and implementation phases for a futuristic, digitised, smart, clean, intelligent, flexible, and mobile electricity system.

The deployment of RE would also bring strategic added value to the energy security of the country. In fact, having large amounts of renewable electricity resources would allow Lebanon to reduce the volume of imported fuel, diversify fuel sources, promote sustainability in its trade balance, and hence increase its strategic and financial independence.

Finally, contributing to global CO2 emission reductions is an important benefit, as is improving the quality of local air quality. A successful implementation of the 'Green Revolution' scenario could lead to a considerable reduction of as much as 7,877,000 tonnes of CO2 per year (considering a carbon emission factor is 0.663 kg CO2/kWh as calculated by the LCEC).

The environmental savings related to the three scenarios are shown in Table 11 below.

TABLE 11 **Potential reductions of CO2 emissions from each scenario**

2030 Scenarios	RE Production (GWh)	kTonnes of CO_2
Stagnation	4,973.5	3,297.4
Realistic	8,749	5,800.6
Green Revolution	11,735	7,780.3

5.3 Green and Climate Finance Potential for Lebanon

As Figure 20 shows, climate finance flows to Lebanon were low from 2012 to 2019, with a small peak in 2018, and a sharp rise in 2022 and 2023. Since 2012, Lebanon has mobilised USD 900 million in climate finance flows, with an almost 50% split between adaptation and mitigation finance.[6] The top three target sectors are water supply and sanitation (31% of all climate finance), followed by agriculture and forestry (13%) and energy (10%). In this last category, 60% of finance has been allocated to energy generation from renewable resources and 20% to energy conservation and demand-side efficiency. In total, the energy sector has received USD 86 million in climate finance flows, 75% of which was received in 2022 and 2023.

6 OECD Climate finance tracking. Link

The largest funder of climate finance in Lebanon over the last decade is the EU, which has contributed USD 235 million, or a quarter of total mitigation and adaptation flows. This is followed by Germany (22%), France (16%) and the United States (10%).

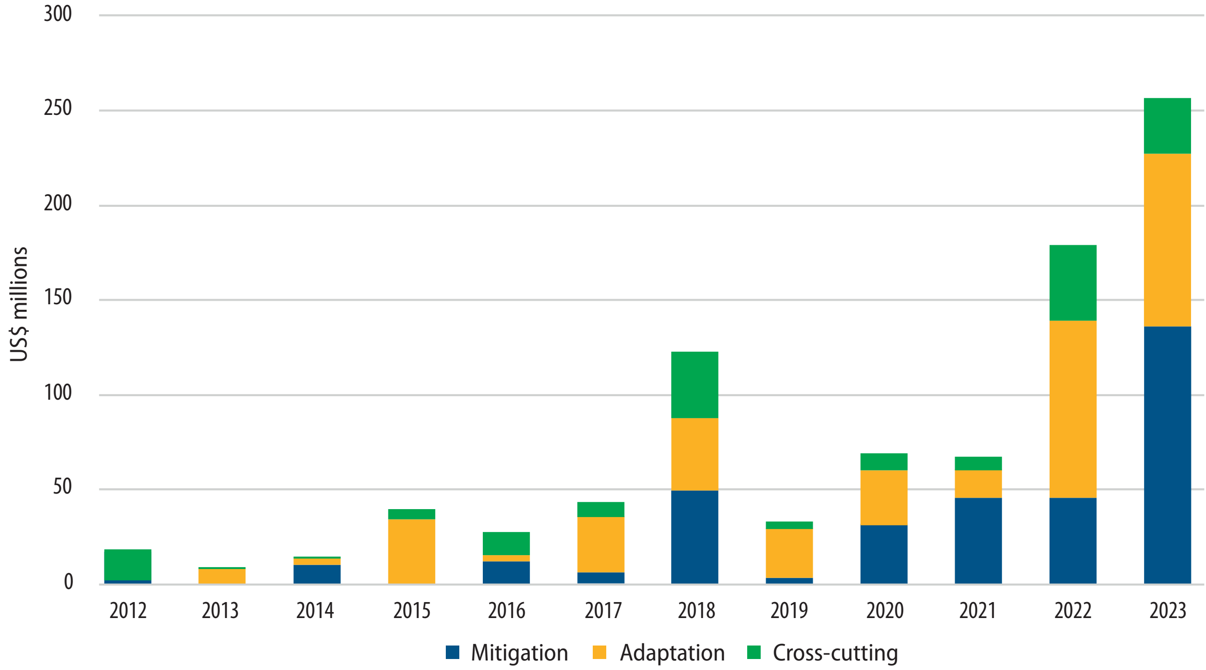


FIGURE 20 **OECD-tracked climate finance flows (adaptation and mitigation) to Lebanon between 2012 and 2023**

The major international climate funds could be a significant source of financing, although they have not mobilised many resources for Lebanon in recent years. Between 2013 and 2025, Lebanon received USD 71 million from the three climate funds, which includes both local and regional projects. Of this, just USD 6 million was dedicated to small-scale energy projects.[7] Fund financing grew between 2013 and 2015, after which it dropped sharply until 2020. There was a peak in 2021 and 2022, but fund investments have dropped again to pre-2015 levels (Figure 21). There is a strong energy pipeline from the Green Climate Fund, which projects USD 42.5 million in energy investments in the coming years (Green Climate Fund, 2024). Lebanon has not received any finance from the Climate Investment Fund, which has, however, supported renewable energy projects in the region. For example, it transferred USD 125 million to support a wind power project in Egypt and USD 370 million to support wind and solar projects in Morocco.[8]

7 See Global Environment Facility database (link) and Adaptation Fund database (link)

8 Climate Investment Funds project overview. Link

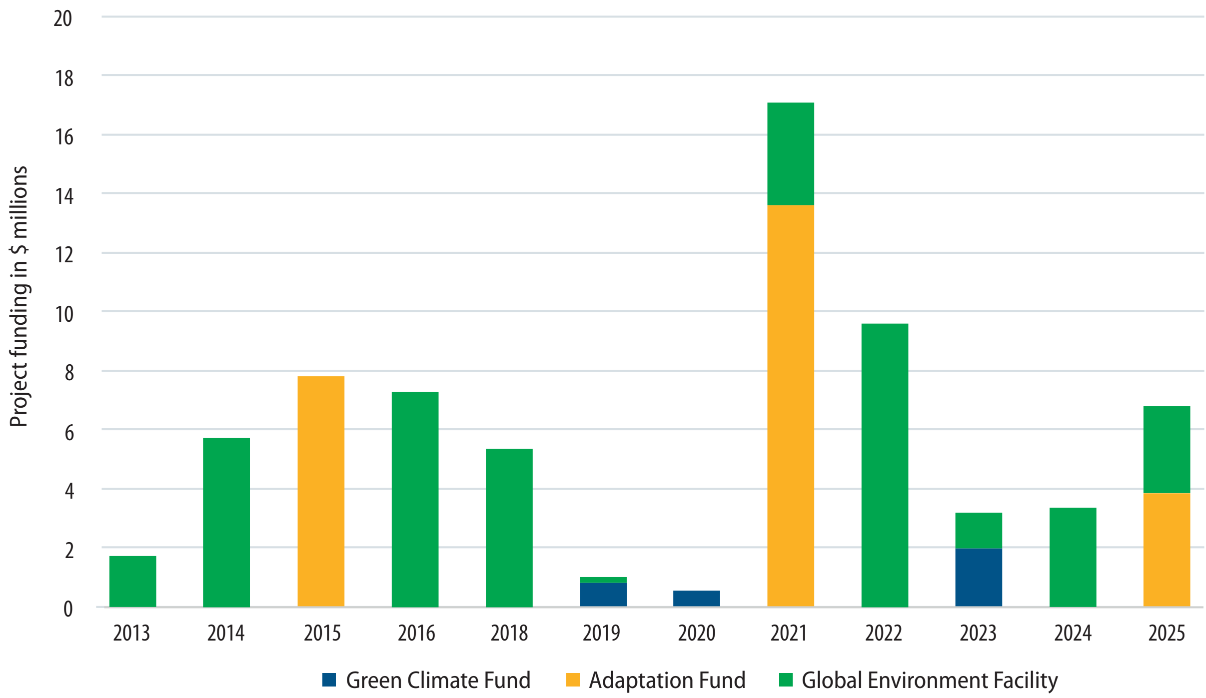


FIGURE 21 International climate fund allocations to projects in Lebanon between 2015 and 2025

International financial institutions (IFIs) are generally very active in utility-scale renewable energy finance in the region. The EBRD has financed numerous renewable energy-related projects (37 in Egypt, 17 in Jordan, and six in Morocco).[9] The EBRD also founded the Blue Mediterranean Partnership in 2022, which has mobilised EUR 500 million,[10] with first projects in offshore wind in Morocco, thermal energy storage in Jordan and a wastewater treatment plant in Egypt.[11] In 2022, the IFC and other DFIs announced a USD 1.1 billion financing package to build the largest solar plant and wind farm in Egypt.[12] In 2023, the IFC and the African Development Bank (AfDB) announced the first large-scale privately financed solar project in Tunisia worth USD 86 million.[13] Since 2013, the Dutch development bank, FMO, has invested USD 140 million in solar PV projects in Jordan, and since 2017, USD 340 million in solar in Egypt, USD 100 of which went to the construction and operation of a 1000 MW solar plant and 300 MW battery storage system (in 2025) – effected via a PPA with the Egyptian utility company.[14] Other DFIs, such as Proparco, the US DFC and GIZ, have also invested in renewable energy in the region.

9 EBRD project database. Link
10 https://ufmsecretariat.org/first-blue-mediterranean-partnership-investments/
11 Union for the Mediterranean, 'Blue Mediterranean Partnership. Link
12 IFC Press Release (30th November 2022). 'IFC and Partners Invest USD 1.1 Billion to Build the Largest Solar Plant and Wind Farm in Egypt'. Link
13 IFC Press Release (26th September 2023). 'IFC, AfDB and AMEA Power Introduce First Large-Scale Privately Financed Solar Project in Tunisia'. Link
14 FMO project database (link); FMO Abydos (II) for Renewable Energy S.A.E. project. Link
15 EIB. 'Lebanon and the EIB'. Link

However, IFIs have been largely unable to invest in Lebanon since the crisis in 2019, and no utility-scale energy sector investments have been made. The European Investment Bank (EIB) has been active in Lebanon since the 1970s, with a total investment portfolio of EUR 2.3 billion, including the costs of major infrastructure development in the wastewater and transport sectors.[15] However, it has made just one investment since 2019, in health resilience (2025). The EBRD has also been a major historical investor in Lebanon, but has not closed any investments since 2019, in which year further financing for the Green Economy Financing Facility (GEFF) and for EDL were cancelled. Other DFIs, such as FMO, DFC, and GIZ, have been active in Lebanon but have not invested in any energy-related projects, although FMO has extended financing lines to local financial institutions for on-lending to SMEs. The UK's DFI, British International Investment (BII) has no investment in Lebanon.

Bilateral and multilateral development partner support has been focused on humanitarian response, peace, and security. For example, the EU has provided USD 600 million, mainly for humanitarian assistance. Lebanon has been a historical priority for the French Development Agency, AFD, with a EUR 52 million portfolio between 2016 and 2020, but no projects in the energy sector (AFD, 2021).

However, the tide may be turning, with recent evolution and reasons to be optimistic that financing may flow back. The World Bank recently launched two major energy sector financing initiatives: (i) a USD 250 million loan to EDL under the Lebanon Renewable Energy and System Reinforcement Project, and (ii) a USD 250 million financing facility to repair and reconstruct damaged public infrastructure.[16]

The story is different for decentralised renewable energy, which has successfully attracted private sector financing. The rapid scale-up of SWH and rooftop solar PV offers a blueprint for finance that may be built on. The National Energy Efficiency and Renewable Energy Action (NEEREA), a national financing mechanism for small-scale subsidised loans for energy efficiency and renewable energy projects, had allocated USD 600 million for 1,000 projects in energy efficiency and renewable energy by 2020.[17] The Lebanon Energy Efficiency & Renewable Energy Finance Facility (LEEREFF) provided loans between USD 45,000 and USD 16 million for energy efficiency and renewable energy improvements, including distributed rooftop solar PV.[18] The LEEREDD successfully mobilised a EUR 50 million loan from the EIB and a EUR 30 loan from AFD.[19]

There are also national and regional financing vehicles that could support RE deployment. In 2024, UNDP, the Ministry of Environment and Cedar Oxygen launched the Lebanon Green Investment Facility (LGIF) with an initial USD 50 million, to increase blended finance into projects such as renewable energy and sustainable agriculture.[20] The fund is currently being set up and aims to mobilise funds from the GCF.

16 World Bank. 'Lebanon Renewable Energy and System Reinforcement Project' (link) and World Bank (2025) 'Lebanon: New USD 250 Million Project to Kickstart the Recovery and Reconstruction in Conflict-Affected Areas'. Link

17 LCEC. 'NEEREA'. Link

18 LEEREFF overview document. Link

19 GFA Consulting Group. 'Lebanon Energy Efficiency & Renewable Energy Finance Facility (LEEREFF)'. Link

20 UNDP. (2024). 'Lebanon Green Investment Facility set to accelerate climate finance, enable climate targets'. Link

5.4 Financing the NREAP 2025–2030

To achieve the scale of investment needed will require mostly private investment, supported by the efficient use of public funds for de-risking. The energy sector can offer a return on investment, and should be open to investment from both domestic and international financiers. However, given the challenges mentioned in Chapter 3, this private financing is unlikely to flow at the volumes needed without at least some de-risking public finance, or potentially a joint public–private partnership approach.

The biggest barrier to investment in utility-scale RE generation has been the absence of a reliable revenue stream. EDL is the owner and operator of transmission and distribution. (T&D) assets, and the single purchaser of power generated by IPPs under PPAs. However, it has been in severe financial distress, with annual budget transfers equivalent to 3.8% of GDP over the past decade, accounting for half of Lebanon's fiscal deficit, with 40–45% of national debt arising from subsidies to EDL.[21] Independent Power Producers (IPPs) have previously entered the market with international investment, such as Karpowership, which provided electricity to Lebanon from two barges, but shut down supply in 2021 because of payment delays.[22]

Recent tariff reform and support from the World Bank may be setting the energy sector (and EDL) back on a sustainable path, which could impart the confidence investors need around generating committed revenue from power generation projects. The revised tariff structures should allow for a credible return on investment above the wholesale price of electricity sold under PPAs. Furthermore, reform to the PPA structure has helped enhance bankability, by, for example, facilitating payment in accessible USD and the transfer of funds overseas.

Nonetheless, there is still a high perceived risk in investing in Lebanon's energy sector, given the broader macroeconomic context and the financial history of EDL as the single buyer of wholesale power. In the short to medium term, structures such as partial revenue guarantees, political risk insurance, and currency exchange hedging may be needed to provide additional security to private sector investors. Ensuring the implementation of existing energy sector laws and regulations will also be essential to attracting investment, and there may be opportunities to further improve the legal and regulatory environment to support project developers. For example, the Lebanon government could provide sovereign guarantees, allow deferred payment of taxes, or commit to revenue-correction mechanisms in the case of any delays in payment from EDL.

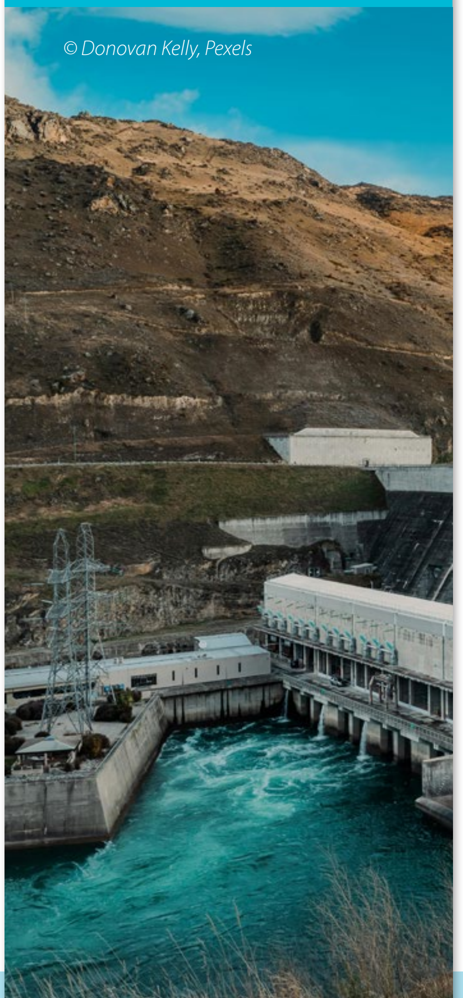
21 https://ialebanon.unhcr.org/vasyr/files/vasyr_chapters/2021/VASyR%202021%20-%20Energy.pdf
22 https://www.reuters.com/world/middle-east/turkeys-karpowership-says-it-is-shutting-down-power--lebanon–2021-05-14/

CHAPTER 06

The Roadmap for the Successful Implementation of the NREAP 2025–2030

Moving on Different Fronts

This chapter proposes a roadmap for initiatives to chart a path forward for successfully implementing the long-term RE targets for 2030 and beyond. Potential measures to overcome the major challenges identified in Chapter 3 are proposed. These measures coupled with effective monitoring and performance tracking will be essential to achieve national long-term energy plans.



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6.1 Legal and Regulatory Sphere

The lack of a regulatory authority continues to hinder the development of sustainable energy projects in Lebanon. In addition, access to funds will always be fundamental for the development of large energy infrastructure projects, which will be mostly based on project financing techniques, considering the lack of sovereign budget liquidity.

Policies related to renewable technologies, setting national RE targets, strategies, and a pipeline of projects, will need to be established and pre-adopted by the government, which will need to formulate a long-term vision for the sector and commit to renewables within the national budgetary constraints. The ERA will need to perform its regulatory duties for all RE projects, irrespective of size. However, special care should be taken with large-scale projects since their financial implications would have a considerable impact on the state budget.

The creation of the ERA would bring additional benefits, notably the quicker processing and issuing of generation licences, which are mandatory under the current framework, to allow the private sector to participate in electricity-generation activities. This would allow private sector developers to avoid the hurdle of going through a complex procedure to obtain generation licences from the government, since the regulatory authority will be dedicated to these activities.

The regulator should be an independent entity that respects the three fundamental regulatory principles: independence, fairness, and transparency. Annex 4 proposes an action plan for the establishment and implementation of the ERA.

A starting point is to ensure that the adopted amendments of Law 462 include a fair and transparent appointment process of ERA members, based on competence rather than political affiliation. It is worth noting that the Association of Mediterranean Energy Regulators (MEDREG), in close collaboration with the LCEC, has published a detailed study that assesses the impact of the proposed Lebanese ERA on the Lebanese electricity market. Aspects of this study are discussed below.

An empowered and well-conceived regulator is a fundamental step to securing international financing and promoting renewable energy development, yet complementary legal measures are needed to further boost the sector. A long-term pipeline of government-adopted projects signals national commitment to renewables, encouraging the private sector participation that is crucial for their successful development.

With regard to the development of distributed rooftop solar PV, solar water heater and heat pump projects in the next five years, it is crucial that the solar ordinance is adopted and implemented. This will be a priority for the LCEC in the short term, especially in the wake of the widespread deployment of decentralised PV systems on rooftops.

6.2 Institutional and Structural Sphere

It is important to allocate the necessary resources for renewable energy projects from the moment they pass the preliminary screening phase (for technical, economic, and financial viability). A dedicated team should be appointed at an early stage to make sure that sufficient time and resources are allocated to conduct detailed feasibility studies and to structure the bids.

In parallel, a clear framework that identifies the duties, responsibilities, and obligations of each stakeholder at every stage of the development of all renewable energy projects will also increase confidence and transparency, and the organisation of the entire process.

These suggestions would be easier to implement if the electricity sector were unbundled; that is, if the activities related to the generation, transmission, and distribution of electricity were separately controlled. The current vertical scheme is already suffering from many challenges, notably from a managerial perspective, owing to the many complex tasks involved. Having separate entities to deal with the different electricity undertakings would allow these entities to be more focused and enable better management of generation, transmission, and distribution activities.

Unbundling the electricity sector also promotes the IPP concept, which in general improves the efficiency and operation of generation activities under a liberalised market model, since these specialised regulated entities have significant accumulated expertise in their field. The same applies to transmission and distribution activities, since the system operator would be specialised, experienced, and dedicated to the relevant duties. These would include managing the power flow in the network, imposing detailed grid connection requirements, and efficiently operating the transmission and distribution networks.

Regarding the hydropower sector, a key recommendation is to adopt a strategy, establish a dedicated unit for sector management, and create a hydro account to enhance financial conditions. These measures need to be effectively empowered through the promulgation of necessary legal and regulatory amendments. In addition, an integrated action plan should be promoted that includes the required set of actions and expected results over different timeframes.

6.3 Macro-fiscal and Commercial Sphere

Lebanon has a relatively advanced PPA framework, with a key building block already in place to crowd in international and domestic sources of finance for utility-scale RE projects. Bankability of project documents has previously been established to a large extent through the PPA of the WR1 project, which benefited from the detailed review of several IFIs and international transaction advisors.

The major hindrance to investment in RE at present is the lack of bankability of such projects, which could provide a rate of return to equity investors and lenders. Fundamentally, projects need to be able to generate a (reliable) revenue stream against which investors and lenders can expect to recover their upfront investment. The severe macroeconomic challenges facing the country, coupled with the financial challenges facing EDL (the single buyer of utility-scale electricity generation) have posed a serious obstacle to the financial viability of utility-scale RE projects.

Key macroeconomic challenges that have hindered investment in Lebanon since 2019 include the deterioration of the credit rating following the default on government payment obligations, the fiscal and budgetary deficit, and the ongoing rapid deterioration of the Lebanese pound.

Generic solutions include hedging currency risks if available, establishing sovereign guarantee funds to restore trust, and developing a secure investment environment to attract investors and lenders. Other incentives for both local and international players should be promoted such as guarantee funds, backstop agreements for credit rating enhancement, guarantees on obligations, and termination payment guarantees.

Figure 22 proposes a potential architecture to facilitate the development of large-scale RE projects from a commercial perspective. It was adapted from the Financial Solutions Briefs for Renewable Energy Auctions in Argentina, developed by the World Bank Group (World Bank, n.d.) to successfully drive their renewable energy sector, which was facing challenges similar to those currently facing Lebanon. This architecture could serve as a base model, but it remains subject to a detailed due diligence and high-level official approval from Parliament and the COM. Figure 22 also proposes the creation of a sovereign investment fund dedicated to renewables, which could serve as a basis for potential guarantees, and hence mitigate related risks.

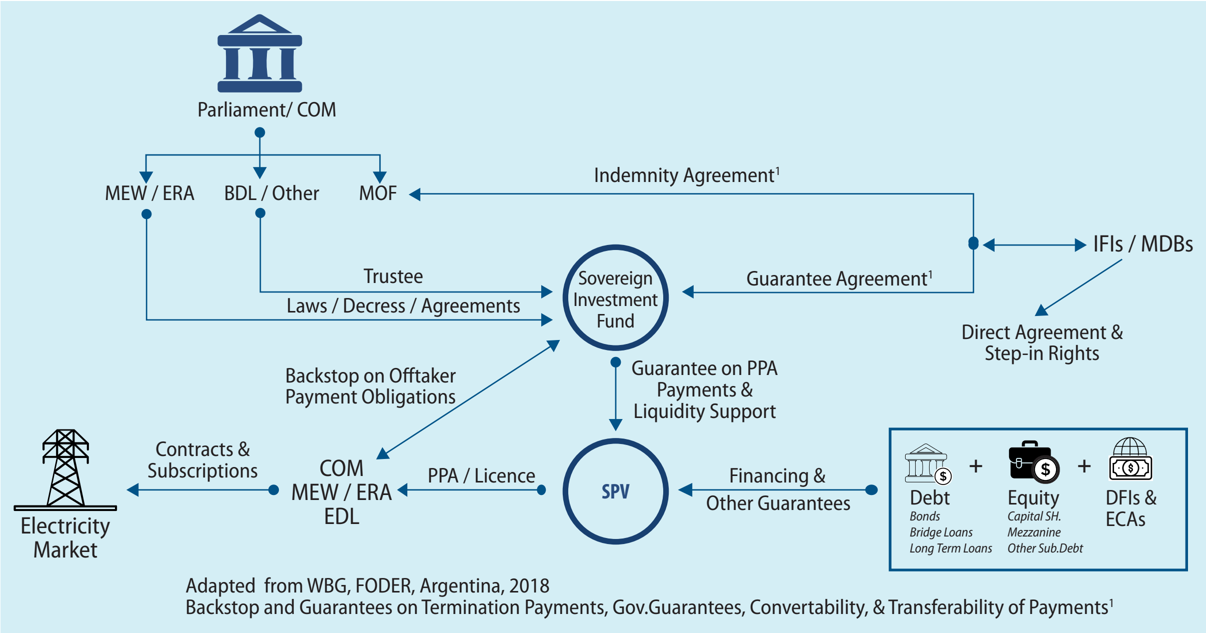

FIGURE 22 **Potential architecture to facilitate the development of large-scale RE projects (World Bank, n.d.)**

National resources should be sustainably allocated in line with the country's top strategic goals; therefore, there is an option to investigate the creation of a dedicated sovereign green investment fund that facilitates access to capital for the development of RE projects. The most obvious direct benefit from this would be the availability of local financing to launch and implement RE projects, but many other benefits could be leveraged, such as the sustainable use of resources, the creation of jobs, and the improvement of the energy security of the country.

With regard to small-scale RE projects, solar PV is perhaps the most prominent technology in Lebanon, boosted by the famous NEEREA scheme. Inevitably, NEEREA has been badly affected by the complex national crisis. From 2021 to 2023, solar PV installations witnessed a huge increase, reaching around 1,081 MW in 2023, owing to a drop in their cost accompanied by a substantial rise in EDL tariffs, and the prices of diesel fuel and private generators. Yet peer-to-peer (P2P) trading mechanisms and upgraded net metering agreements will create attractive incentives that enable the trade of electricity under a free liberalised market model. This would improve the return and attractiveness of such systems.

Other long-term capital tools that help the acceleration of RE include initiatives such as green bonds, tax reductions, and carbon dioxide (CO2) trading options. These would generate financial interest among different players and promote the development of renewables.

6.4 Technological Sphere

National energy infrastructure will need to be upgraded on several levels (generation, transmission, and distribution), to ensure the network's readiness, flexibility, accessibility, and capability to absorb a higher penetration of intermittent RE generation.

The generation-side upgrade enables the system to keep pace with rapid changes in generation capabilities while ensuring the dynamic stability of the system. This can be achieved by introducing spinning reserves and storage technologies with fast response times to balance any fluctuating electricity generation caused by the high penetration of renewables. These reserves can be operated under the current model, owned and operated by EDL. However, the unbundling of the sector and an exploration of the possibilities of an electricity market specifically for ancillary services is recommended. At the same time, detailed analysis will be necessary to assess the advantages and disadvantages of a separate ancillary market under an unbundled regime, especially in a semi-islanded small system like Lebanon.

It is important to rely on accurate anticipated forecasts for RE generation when setting the base operational strategy of these services. It is also worth mentioning the potential multiple uses of these facilities and cross-sector synergy, notably between storage facilities and their role in the rollout of electric vehicles in the transport sector. Accordingly, a smart integrated charging infrastructure should be further investigated to create synergy between the power sector and the transport sector and maximise the efficient use of all available resources.

Next, it is recommended that the transmission and distribution networks be expanded, based on detailed planning studies that prioritise the lowest cost and fewest resources, in alignment with government policies, particularly for RE. Performing network upgrades and reinforcements could be complemented by Flexible AC Transmission System devices (FACTS), which allow higher flexibility levels. Hence, there is a need to investigate the potential optimisation of the wind grid code and develop a detailed grid code for PV systems.

Operational requirements should prioritise dispatch and connection for RE generators to guarantee a minimum percentage of renewables in the generation mix, in line with general national RE targets.

In addition, secure communication protocols should be adopted to avoid cyber security breaches on the communication channels between the different IPPs and the system operator and to ensure safe and reliable system operation.

The implementation of these suggestions should be closely followed by a solid capacity-building process and talent acquisition strategy. Sufficient data accessibility and documented clear grid connection requirements are also key issues to be resolved. It is recommended that bankable data be gathered on wind and solar resources with commercial viability that would also facilitate energy yield estimations and reduce development costs. This could result in reduced tariffs.

Demand-side measures, including actions taken at the customer level, could be considered to reduce electricity consumption in general and in specific cases as needed. Demand-side measures are important for two reasons: to increase energy efficiency (EE) and to strategically reduce the growth rate of electricity demand.

Mitigating daily peaks and achieving smoother control of the Load Duration Curve (LDC) would lead to easier, more efficient, and more cost-effective system operation. This implies the scheduling of generating units in advance for areas that have the highest merit. Corresponding demand-side measures could include price incentives such as time-of-use tariffs and critical peak pricing, which aims to reduce peak demand consumption, as the name indicates, and to lower the overall system operation cost.

Demand bidding in an unbundled liberalised market shifts the risk of increased demand to users or allows operators to charge for excess demand. This would cover the generation costs typically associated with costly fast-response units like Open Cycle Gas Turbines (OCGT).

These factors may not be specific to renewables, but given the focus on high penetration, they could add value to a renewables-oriented power system by ensuring proper system operation, facilitating easier integration of RE technologies.

6.5 Social and Environmental Sphere

On a global level, tremendous efforts have been made to raise public awareness of the value of renewable energy. Aspects of the various technologies have been explained in a simple yet scientific and objective manner. Since public support is extremely important for the success of these projects, it is essential to educate the public about the true pros and cons of RE and engage citizens in community meetings to adjust their perceptions of RE.

Local authorities and IFIs often require a thorough ESIA for large-scale RE projects and would want to make sure that public acceptance is secured before ground mobilisation begins, in order to ensure a smooth process. Even with the stringent ESIA requirements proposed by local authorities and IFIs, special care should be taken when dealing with some rural communities, to ensure that their uncertainties and questions are properly addressed.

Therefore, tailored public meetings should be conducted at each stage of each project, including conception and development, to understand and address all public concerns in different locations and contexts. These meetings should be complemented by a national awareness-raising campaign disseminated on TV, radio, and social media to educate people about the real dynamics of RE technologies. An interesting illustrative example in this case would be the ESIA conducted for the WR1 project, which included a detailed community engagement programme complemented by a stringent Bird Mitigation Protocol (BMP).

The competent authorities should set official borders on land plots, facilitate land access in cases where land is publicly owned, and classify remaining lands according to their suitability or category such as industrial, agricultural, natural reserves, or others. Such preparation requires the development of plans at an early stage, to identify, manage, and mitigate all these issues and avoid adverse effects on the development of RE technologies.

6.6 Regional Cooperation

Several countries in the MENA region have already achieved key milestones in their national targets for renewable energy deployment. Successes such as these offer Lebanon examples of how to efficiently implement various types of mechanism suited to the country's local context, based on regional best practices and lessons learned.

There is a clear need to encourage developers to enter the renewables market. In this regard, Egypt's experience in grid modernisation, coupled with its adoption of streamlined investment procedures, offers an example that may be leveraged to encourage investor confidence. At the technical level, grid capacity limitations in Jordan and the corresponding mitigation procedures would allow Lebanon to anticipate the technical challenges that result from the excessive production of solar energy throughout the year's solar peak hours. Moreover, cross-border energy trade agreements developed in Morocco show how regional partnerships can secure funding and reduce energy costs. They also highlight the importance of long-term policy stability in sustaining renewable energy growth.

Lebanon can benefit from regional knowledge-sharing platforms and technology transfer agreements to enhance the technical expertise of key local stakeholders. Harmonised regulatory frameworks and interconnected energy markets would allow Lebanon to minimise the impact of technical, financial, and regulatory gaps on the development of renewable energy projects, by creating new investment opportunities and reducing energy costs.

CHAPTER 07

Moving Forward

The Ministry is Committed

The MEW will be working towards reaching the highest possible RE targets for 2030 in accordance with the previously proposed scenarios, and will therefore push for the proper implementation of the necessary policies and measures needed for the successful development of a 'Green Revolution' scenario. These measures are listed in Annex 5.

7.1 Full Commitment of the MEW

The commitment of the MEW will be materialised through a set of measures:

a. The MEW will push for the creation of an Energy Regulatory Authority (ERA) for the power sector and for amending Law 462, taking into consideration the needs of large-scale RE farms. In fact, the ministry has already broadcast the need to appoint ERA board members and has started the shortlisting process to select candidates. The creation of a regulatory authority for the power sector and the ratification/amendments of laws specific to the RE sector will consolidate the necessary framework, as the ERA will reduce the complexity of issuing generation licenses, clarify any legal ambiguities, and set the duties and responsibilities for parties concerned with RE development. This will send a positive signal to market players, promote competition, build credibility, improve financial offers, and accelerate the development of renewables.

b. The MEW will push for the development of a dedicated RE programme in its upcoming policy paper and will further aim to allocate human resources and budget to empower the development of the sector. This will be accompanied by an upgrade of the existing framework to remove any complexities and increase clarity.

c. The MEW will also be adopting and promoting the digitisation of the bidding process by establishing a dedicated website for ministerial procurements and allocating a digital portal for each candidate, which will help speed up bid evaluations and increase transparency. Potential improvements to procurement procedures and auction design will be explored, keeping the principle

Lebanese Flag on Pole with the Marina Tower in Beirut. Photo by Jo Kassis

of simplicity in mind, with clear and objective exclusion criteria. In addition, the potential adoption of descending clock auctions will be assessed in light of existing legal requirements. The MEW believes that good design and implementation of these measures will lead to increased transparency, faster processing times, and clear procedures. This will help generate market interest and scale up the development of RE technologies.

d. The MEW will explore consolidating a 'one stop shop', making the necessary authorisations and permits available in one list, together with a clear description of all relevant processes. To this end, the MEW has been providing and will continue to provide reasonable support to private sector developers regarding permits and authorisations with other governmental entities.
e. Additional support will be explored through the design of a full de-risking approach for project documents. This would include suggestions for suitable public land with adequate grid access based on nodal capacity allocation for renewable development. The aim would be to catalyse expansion in the sector and promote successful pilot projects. Such support will be gradually reduced when sufficient experience is built and when the market is de-risked.
f. The MEW will also promote the adoption of the IPP model for power generation in parallel with progressive market liberalisation and unbundling. This will facilitate the integration of specialised entities with management expertise tailored to each electricity undertaking, increasing the operational efficiency of this public sector. MEW will also deploy technological advancements in upgrading electricity infrastructure, operational requirements, and demand-side management. Such upgrades include, most notably, the creation of spinning reserves and ancillary services, mainly battery storage and fast response units, which will increase system operational reliability and the stability of supply. These upgrades will be complemented by expansions and enhancements in the transmission and distribution networks, such as the creation of smart grids and smart meter rollover.

7.2 Coordination with National and International Entities

The successful outcome of the MEW commitments outlined above will depend, to a large extent, on the levels of support and commitment provided by other national ministries, relevant authorities, institutions, and stakeholders. The most important factor will be the commitment of Parliament and the government to implementing macro-fiscal reforms and anti-corruption measures to restore confidence among international donors.

This needs to be translated by effective hands-on measures, supported by UN and other international entities, to stabilise the macro situation in the country and create a suitable investment landscape that attracts financial capital, donors, international developers, and investors. Sovereign guarantees and hard currency payments should also be facilitated by the GoL to avoid jeopardising the availability of international financing and causing project failure, considering the country's tight budget and fiscal deficits.

This commitment would need to be backed up by support from the Ministry of Finance, with sufficient budget allocations for good fiscal management practice and transparency in the bidding process.

Commitment is also needed from the Ministry of Environment, which needs to set the requirements for ESIA studies to ensure better impact, aligning its procedure with international best practices and norms.

The Ministry of Education and Higher Education would be involved as well, by promoting RE programmes in its curricula and by providing scholarships to support dedicated degrees in RE. This would be an essential requirement to limit the dependency on foreign expertise and create a skilled, competent, and efficient team of experts capable of developing and operating state-of-the-art RE projects.

The Ministry of Industry should be actively engaged in the full scaling-up of RE by promoting the creation of industrial research centres specialised in RE research and the adoption of standards.

The Ministry of Public Works and Transport should support the development of RE, notably through the design of master plans that include the integration of electric and hybrid vehicles and other relevant initiatives. This could be achieved by implementing supportive policy measures to promote the adoption of these vehicles, using incentives such as customs reduction, tax incentives, and the development of the required charging infrastructure, in collaboration with the competent public institutions. Annex 6 explains the preliminary e-mobility strategy for Lebanon, indicating its potential impact on total electricity demand.

The support of the Ministry of Information is also an essential pillar, as it would raise public awareness about the importance of RE. Such support can be provided by massive public awareness campaigns that include sponsored ads and marketing on social media, TV and radio, highlighting the advantages of renewables and increasing public acceptance of this technology.

At the sub-ministerial level, the EDL should be proactively involved, taking responsibility for the management of the project development phase. It should also enhance its responsiveness and technical engagement to facilitate the successful implementation of the works in large-scale projects. Moreover, grid stability, flexibility, and reliability would need to be considerably upgraded, along with stringent and clear operational requirements, such as the solar PV grid code, to facilitate the integration of large-scale RE projects. The EDL should also expedite and upgrade its processes to avoid spoiling the value for money of decentralised RE generation while implementing the DRE law.

Additional support would be needed from the Directorate General of Urban Planning to implement the solar ordinance, with proper oversight.

Table 12 summarises the high-level implications and benefits that are likely to result from the successful implementation of all the measures proposed in this section. The measures are listed on the left, with the benefits arranged across the top. All of these measures are needed to drive the successful development of RE in Lebanon.

TABLE 12 **High-level impacts of the measures needed to drive the RE sector in Lebanon**

	Clear Legal Enforcement	Transparency & Integrity	Rapid Scalability	Liquidity & Sustainability	Transferability & Convertibility	Reduced Deemed Payment	Increased Competition	Improved Bankability
Legal & Regulatory Framework	×						×	
Auction Upgrades		×	×					
Guarantees & Indemnities				×	×			
Grid Balancing & Connection						×	×	
Lobbying & Advertising							×	
IFI Review of Bid Documents		×	×					×

CHAPTER 08

Conclusion

There is a pressing need to accelerate efforts and focus attention on the development of RE capacities in Lebanon. RE technologies not only offer clean energy generation with global climate benefits, but can increase the overall welfare of Lebanon society and contribute to economic, environmental and social prosperity.

The need for action is urgent as Lebanon seeks to assume its responsibilities, not only at the national level but at the international level, by achieving the UN global target of 30% RE generation by 2030.

Lebanon has a golden opportunity to benefit from international support in attaining the global green energy transition, if it can overcome key internal challenges. There is a chance to upgrade the old national infrastructure while integrating state-of-the-art RE technologies, notably solar PV and wind, with long-term national plans. The availability of international climate finance is increasing, and Lebanon should seek to unlock sources of concessional finance, which will mean creating the prerequisite enabling environment.

Relatively new technologies in Lebanon, such as heat pumps, electric vehicles, and concentrated solar power, in addition to innovative digitisation measures in the power sector, such as smart grids, distributed storage, and P2P trading schemes, may play a significant role in the national energy transition and the deployment of RE. In the immediate term, well-established technologies such as utility-scale and decentralised solar PV and onshore wind energy will be essential pillars in reaching the 2030 RE targets.

Implementing the proposed policy measures and adopting the suggested reforms are necessary and inevitable steps in putting the country on the road to reaching these ambitious 2030 RE targets. The serious adoption of all the measures proposed in this document, and most importantly the positive collaboration of all involved stakeholders, could lead to the deployment of 5,900 MW of RE by 2030 under the 'Green Revolution' scenario.

Nonetheless, significant uncertainty lies ahead, owing to the complex macroeconomic situation of the country, which will be a critical aspect of RE development. Lebanon is at a deterministic crossroad that will shape its future: The hard truths of the gap between energy supply and demand, which has been draining the government, the economy, and the citizens for decades, cannot

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be postponed any longer. Serious reforms, which will inevitably include the large-scale deployment of RE, are planned for the power sector to resolve this seemingly everlasting Lebanese dilemma.

In short, Lebanon faces two possible routes in the coming years: to continue with business as usual, i.e. the 'Stagnation' scenario and suffer the consequences, or undertake profound changes and reforms to unlock the 'Green Revolution' scenario (or, with less favourable results, the 'Realistic' scenario).

The most important recommendation to unlock RE investments and boost the sector is to implement a full risk mitigation approach that targets legal, economic, social, financial, institutional, and regulatory aspects. A key component to scale up global investments in RE remains a committed long-term national plan, empowered by a set of enabling laws, regulations, and policies. The proper implementation of these measures alongside a full risk mitigation structure is expected to create a stable investment landscape and foster a positive environment that attracts capital and investors.

In all cases, the MEW is and will remain committed to performing all necessary measures to promote a 'Green Revolution', speed up RE deployment, and resolve the challenges faced in the power sector. All that is needed is the power of will and a sincere engagement from all the stakeholders to play a positive role and support the ministry in implementing, monitoring, and updating its national plans.

Implementing RE projects within a comprehensive integrated resource management plan for food, energy and water, will inevitably enhance societal welfare and contribute to the prosperity, development, and growth of the country.

Annexes

Annex 1: Main Milestones of Wind Farm Development

Policy Background

- In 2009, the Government of Lebanon commits to reaching specific renewable energy targets in 2020.
- On 21 June 2010, the Council of Ministers (CoM) approves a policy paper for the electricity sector, which adopts these renewable energy targets.

EoI Phase

- On 13 September 2012, during the opening of the Beirut Energy Forum, the MEW launches a call for Expressions of Interest (EoI) by the private sector for wind farm development, as part of the 2020 targets.
- On 18, 19 and 20 September 2012, the call for EoI is highlighted in articles published by prominent local newspapers.
- On 19 September 2012, the MEW shares the call for EoI by email with more than 4,000 contacts and stakeholders in the RE field.
- On 13 October 2012, 23 EoIs are received from the private sector in response to the call.
- The CoM takes note of the results of the EoI phase in its Decision 30, dated 4 December 2012

RFP Phase

- On 21 March 2013, a Request for Proposals (RFP) is prepared and shared by email with interested bidders who submitted EoI. The deadline for the submission of bids is set for 21 May 2013 and later postponed to 25 June 2013.
- On 25 June 2013, four bids are submitted by the private sector in response to the RFP.

Evaluation Phase

- On 6 June 2014, an inter-ministerial evaluation committee is formed, including representatives from the Presidency of the Council of Ministers, the Ministry of Environment, the Ministry of Justice, the Ministry of Finance, MEW, EDL and LCEC. The inter-ministerial evaluation committee starts its evaluation of the bids on the same day.
- The committee disqualifies one bidder based on the pass/fail criteria.
- The committee opens financial bids for the three qualified bidders on 7 April 2015. The lowest tariff received is 12.45 USC/kWh.
- On 6 May 2015 the inter-ministerial evaluation committee concludes its work and submits its report to the Minister of Energy and Water. Its work includes several clarification rounds with the bidders and technical assistance by an international consultant.

Negotiation Phase: Licensing

- On 27 April 2016, the report is presented to the CoM. In Decision 6, dated 27 April 2016, the CoM returns the project to the MEW, tasking the inter-ministerial committee with negotiating with the three qualified bidders, with the assistance of international consultants if needed.
- Between May and June 2016 all members of the inter-ministerial committee are re-assigned.
- On 1 and 2 September 2016 the inter-ministerial committee meets with experts from RCREEE in an interactive workshop on the lessons learned from the Egyptian renewable energy experience.
- On 2 September 2016, an international consultant is assigned.
- On 17 October 2016 the inter-ministerial committee meets with the Minister of Energy and Water and the international consultant to kickstart the negotiation process. A request is sent to the bidders to update their financial offers.
- On 9 December 2016 the inter-ministerial committee meets with experts from RCREEE and decides to share a draft PPA with the bidders based on the Egyptian model. The draft PPA is shared on 12 December 2016.
- On 18 December 2016 a new government is formed.
- On 17 February 2017 the international consultant concludes that the tariff could be negotiated downwards within the 10.1–11.3 USC/kWh range.
- Following several negotiation rounds, including a meeting between the bidders and the inter-ministerial committee on 1 March 2017, the lowest unconditional tariff received on 6 March 2017 is 12.4 USC/kWh or 11.4 USC/kWh conditional on support from the government.
- On 16 March 2017 the Minister of Energy and Water meets with the three bidders individually.
- On 20 March 2017 the bidders send an updated reduced tariff. The lowest unconditional tariff received is 12 USC/kWh or 11 USC/kWh, conditional on support from the government.
- On 22 March 2017 the inter-ministerial negotiation committee concludes its work and submits its report to the MEW. The report includes two options: approval of the licensing if the bidders propose an unconditional tariff falling within the range of 10.1–11.3 USC/kWh, which could be reduced to below 10 USC/kWh if further support is granted, or cancellation of the bid owing to failure of the negotiation process, followed by a new RFP.
- The bidders request a meeting with the MEW on 29 March 2017 and submit an official commitment to a tariff of 10.3 USC/kWh.
- On 12 July 2017, in Decision 62, the CoM grants preliminary approval based on a joint proposal by the MEW and the MoF to the licensing of the three bidders, subject to a further reduction in the tariff.
- A delegation from RCREEE holds a one-day workshop at MEW on 7 August 2017 to perform financial modelling on the three wind farm proposals, based on available data. This helps to prepare the key negotiation items to be discussed with the selected bidders.
- A further workshop is held with the bidders, which results in the submission of proposals from two of the bidders with tariffs reduced to 10.85 USC/kWh.
- Between 7 and 13 September 2017, an international consultant assists the MEW to perform the financial models for the wind farms based on inputs from the bidders. The exercise concludes that a fair tariff would be 10.75 USC/kWh. The work is presented at a workshop with the bidders and the Minister of Energy and Water. The bidders officially agree to a tariff of 10.75 USC/kWh.
- On 2 November 2017 the CoM approves Decision 43 on the licensing of the three bidders for 20 years based on a tariff of 10.75 USC/kWh and delegates the MEW to negotiate a further reduction in the tariff and negotiate and sign a PPA.

Negotiation Phase: PPA

- On 21 November 2017 PPA negotiations are kicked off with the licensees based on the CoM decision.
- On 28 November 2017, EBRD assigns a legal advisor to assist the Lebanese government to finalise the PPA.
- On 7 December 2017 a meeting is held at the Ministry of Environment (MoE) to kickstart the ESIA preparation process and to stress the social and environmental requirements to be included in the PPA (conditions precedent to the PPA and Bird Migration Protocol).
- On 23 December 2017 comments on the PPA are received from EBRD and its legal advisors.
- On 17 January 2017 an updated PPA, including major schedules, is shared with the licensees. Several meetings follow between the MEW Minister, LCEC, the licensees, their assigned lead arrangers and legal advisors, mainly on a daily basis during the week of 22 January 2017.
- On 29 January 2017, experts from RCREEE are at the MEW assisting in the PPA negotiation and the finalisation process, based on the Egyptian experience.
- Negotiation meetings are ongoing during the week of 29 January until 1:00 and 2:00 a.m. each day.
- The PPAs are finalised and signed on 1 February 2017. The signed PPA includes an Interim Conditions Satisfaction Date to finalise pending schedules to the PPA and to guarantee CoM approval on certain clauses (including foreign arbitration).
- Negotiation meetings with the developers continue.
- On 1 March 2018, a committee from EDL is formed to assist in the PPA negotiation and finalisation procedure. EDL committee members participate actively in negotiations with the developers. Grid connection meetings are held at EDL.
- On 9 March 2018 the lenders send their comments on the PPA.
- 16 March 2018 LCEC holds a national workshop with international financing institutions (including lenders) to obtain their feedback on the bankability of the PPA. The workshop is also attended by the developers and EDL committee members.
- Several comments and mark-ups are exchanged.
- On 24 and 25 April 2018 EDL sends a comprehensive list of comments on the PPA and schedules.
- On 30 April 2018 the Interim Conditions Satisfaction Date is extended for an additional month.
- With Decision 72 of 16 May 2018, the CoM approves the clauses of the PPA that require its approval and delegates the Minister of Energy and Water to renegotiate the tariffs.
- On 31 May 2018 the Interim Conditions Satisfaction Date is extended for an additional month.
- On 23 June 2018 the Interim Conditions Satisfaction Date is extended for an additional 41 days.
- From 29 June 2018 onwards, full-day negotiation meetings are held on a daily basis. The Minister of Energy and Water personally negotiates the tariffs.
- The PPA is novated, amended and restated on 13 July 2018. A tariff of 10.45 USC/kWh for the first three years is agreed on, followed by 9.6 USC/kWh for the rest of the term of the PPA.
- The Interim Conditions Satisfaction Date is achieved on 13 July 2018.

Development Phase

- On 10 November 2018 the MEW assists at several public hearings organised by the project developers in Akkar.
- On 16 November 2018 schedules related to the calculation of payments, termination pricing, and testing and commissioning are finalised. The MEW completes all its CPs by 8 January 2019. Regular meetings are held with the project developers to ensure progress of the project.
- On 29 May 2019 EDL accedes to the PPA.
- On 29 June 2019 the final independent energy yield assessment is submitted.
- On 1 August 2019 the MEW submits the requirements for invoices and network connections. The project developers submit a request for an extension of time.

- On 23 August 2019 the project developers submit an updated ESIA with conditional approval from the MoE.
- On 24 September 2019 the MEW submits a draft Bird Migration Protocol.
- On 17 October 2019, mass protests by people in Lebanon constitute an event of Governmental Force Majeure as defined in the PPA. This leads to a closure of banks and financial institutions, and blocking of major roads across the country.
- On 19 November 2019 the Governmental Force Majeure ceases, having delayed the project by four weeks at most. Banks in Lebanon resume uninterrupted operation and civil unrest no longer impedes transportation in the country.
- On 24 December 2019 the project developers request an extension of the Scheduled Commercial Operation Date of 12 months.
- On 2 March 2020 the MEW extends the new Scheduled Satisfaction Date to 28 October 2020 and the new Scheduled Commercial Operation Date to 28 April 2022.
- On 5 March 2020 the implementation schedule, project programme, and asset completion schedules are submitted.
- On 7 March 2020, the GoL announces for the first time that Lebanon will not pay a USD 1.2 billion Eurobond due on March 9 and will seek to restructure its sovereign foreign currency debt, which reached USD 31 billion in 2019. The country is officially in default on the March 2020 series, triggering a cross-default on all outstanding bonds, freezing any potential financing for upcoming projects, including wind farms.
- On 15 March 2020, the government declares a state of emergency followed by a personal state of emergency related to the COVID-19 outbreak. Lockdown measures and the adverse global effect of COVID-19 on financial markets, manufacturing, and transportation add further complexities and limit progress on the wind farms
- On 23 July 2020 the MEW performs a site visit with the developers to inspect various aspects of the project in Akkar.
- On 24 July 2020 the project developers request another extension of the Scheduled Satisfaction Date in light of the continuation of the pandemic.
- On 4 August 2020 the tragic Beirut Port explosion occurs, leading the government to declare a State of Emergency on 7 August 2020.
- On 27 August 2020 the project developers request another extension of the Scheduled Satisfaction Date because of the pandemic and the Beirut Port explosion.
- On 4 September 2020 the project developers submit their most recent updates to the Grid Capacity Study and the Network Connection Study based on numerous previous meetings with MEW and EDL.
- On 13 October 2020 the Minister of Energy and Water meets with the project developers in response to their request to discuss major project updates.
- On 27 October 2020, at the project developers' request, the MEW extends the Scheduled Satisfaction Date from 28 October 2020 to 31 January 2022.
- On 28 October 2020, EDL nominates a committee to work with the MEW on implementation of the project. MEW holds a meeting with the EDL committee to recap project progress and updates.
- On 5 November 2020 the project developers submit a draft decommissioning plan.
- Work is ongoing, despite the challenges and the complex conditions under which all concerned are working. The project developers continue to provide regular updates on project progress, notably progress on authorisations, land agreements, and Seller Conditions Precedent.
- Project execution has been delayed by circumstances, but the MEW and the project developers are still committed to the successful completion of this project.

Annex 2: Timeline for the 180 MW Solar PV Project

Expressions of Interest

Policy Background

- In 2009, the GoL commits to reaching specific renewable energy targets by 2020.
- On 21 June 2010 the CoM approves the policy paper for the electricity sector, adopting these renewable energy targets.

EoI Phase

- On 12 January 2017, through local papers, MEW launches a call for Expressions of Interest (EoI) for a first round of solar PV farms as part of the 2020 targets.
- On 17 and 19 January 2017, the MEW shares the call for EoI by email with more than 5700 stakeholders in the RE field.
- On 28 February 2017, 256 EoIs are received from the private sector in response to the call.

RFP Phase

- On 16 May 2017 a Request for Proposals (RFP) is prepared and shared by email with all interested bidders who submitted EoI.
- On 30 October 2017, 42 bids are submitted from the private sector in response to the RFP.

Evaluation Phase

- On 15 February 2018 a technical committee is formed by the MEW to evaluate the received bids, based on certain pass/fail criteria; 28 of 42 bidders successfully pass through to the next phase.
- On 17 January 2019, the capability and technical scoring system is launched.
- On 8 April 2019 the CoM approves the updated policy paper for the electricity sector, which includes the continuation of RE projects.
- On 30 April 2019 Parliament passes Law 129, which extends Law 288/2014, necessary to issue generation licences for RE projects.
- On 11 July 2019 the MoF appoints a representative for committee oversight.
- On 23 July 2019 the MEW appoints the technical and financial evaluation committee.
- On 23 Aug 2019 the technical and financial committee approves the results of the capability and technical scoring.

Negotiation Phase

- On 16 September 2019 the committee meets to consider the financial offers. The lowest tariff received is 5.7 USC/kWh. At the end, 17 of 28 bidders are qualified to move to the negotiations stage.
- On 9 and 10 October 2019 negotiation meetings are held with the qualified bidders.
- On 16 October 2019 the bidders in the Bekaa and Hermel region agree to match the lowest tariff received, while bidders in other regions refuse to match it.
- On 21 May 2020 the MoF nominates its representative, based on the MEW request, and a new evaluation committee is formed.
- On 3 July 2020 the committee issues a report to the MEW. The qualified bidders in the Bekaa and Hermel region reconfirm their offers. It is agreed that the method of payment will be included in the PPA, since issuing of licenses could facilitate access to finance.
- On 10 July 2020 the MEW sends a letter to the MoF requesting approval of a joint proposal to license the three qualified bidders in the Bekaa and Hermel region.

Stalemate

- On 24 July 2020 negotiation meetings are held with the bidders qualified for the negotiation phase in the other regions, and a further meeting is scheduled for 5 August 2020.
- On 4 August 2020 the Beirut port explosion occurs, leading to loss of momentum.
- On 19 October 2020 MEW issues a reassurance letter and confirms its commitment to the project.
- On 30 October 2020 the qualified bidders confirm their commitment and the bid validity is extended to 27 April 2021.

Annex 3: Main Qualitative Assessment Criteria for the Development and Implementation of Large-Scale RE Projects Based on the Initial Progress Assessment of the WR1 Project

Assessment Criteria	Relevant Barriers	Success Factors
Commercial Closure		
Preparing, Advertising, and Launching the Bids	• Limited Experience • Limited Institutional Capacity Delays and Political Instability	• Accumulated Knowledge and Capacity Building
Evaluating the Bids and Awarding the Contracts	• Limited Experience • Limited Institutional Capacity • Delays and Political Instability	• Demonstrated the Feasibility of a Transparent Competitive Negotiation Process
Conducting Negotiations and Aligning the Tariffs	• Limited Experience • Limited Institutional Capacity • High Risks and Low Credit Rating Delays and Political Instability	• Accumulated Knowledge and Capacity Building • Mitigated Risks and Secured Cost Savings on Generation
Signing the PPAs and Issuing the Generation Licenses	• Limited Experience • Limited Institutional Capacity Delays in Generation License	• Accumulated Knowledge and Capacity Building
Conditions Satisfaction Date (CSD)		
Validating the Resource and the Energy Yield Assessment	- Availability of Data	• Confirmed the Resource Availability in the Area • Created a Resource Database
Finalizing the Land Agreements and Decommissioning Plan	• Social Acceptance • Foreign Ownership • Disputes Over Ownership • Proof of Ownership • Tribal Behaviour • Suitability of Land - Resource Availability - Grid Access - Roads and Site Access - Effect on Agriculture - Effect on Fauna and Flora - Effect on Water Resources	• Created Social Inclusion • Promoted the Acceptance of RE Technologies • Involved Locals via Awareness Events • Created Project Champions • Created Direct and Indirect Local Job Opportunities • Validated Several Land Ownership Agreements • Reconciled Tribes and Removed Regional Barriers • Demonstrated the Suitability of the Land • Confirmed Resource Availability in the Region • Minimised Land Usage Footprint • Ensured Land Preservation

Signing the EPC and OM Contracts	• Availability of Major Equipment • Guarantee of Financing • Lack of Local Content	N/A
Reaching Financial Closure	• Bankability of Project Documents • Macro-fiscal Risks • Political Risks • Sectorial Risks • Relevant Insurance and Guarantees	• Upgraded PPA to Obtain Bankable Documents Satisfactory to IFIs
Securing Permits and Authorizations	• Access to Data and Information • Grid Readiness and Flexibility • Atypical New Requirements • Political Risks	• Accumulated Relevant Experience • Improving the Status of Infrastructure (Ongoing) • Establishing a 'One-Stop Shop' for All Requirements • Pushing for an Independent Regulatory Authority
Project Implementation and Commercial Operation Date (COD)		
Upgrading Transport Routes and Site Access	• Atypical New Requirements • Underdeveloped Infrastructure	N/A
Delivering Major Equipment	• Atypical New Requirements • Underdeveloped Infrastructure • Lack of Local Content	N/A
Completing Civil Works	• Atypical New Requirements	N/A
Completing Mechanical Works	• Atypical New Requirements • Lack of Local Content	N/A
Completing Electrical Works	• Atypical New Requirements • Lack of Local Content	N/A
Testing and Commissioning	• Atypical New Requirements	N/A
Launching and Monitoring	• Atypical New Requirements	N/A
Operational Ramp-up		
Optimising Operation and Generation Forecasts	• Atypical New Requirements • Lack of Experience	N/A

Annex 4: Action Plan for the Creation of an ERA

No.	Essential Steps
1	Adopt the law that governs electricity regulation (such as Law 462 from 2002 or any of its amended versions, as well as all other connected laws) and implement the provisions relevant for the establishment of the ERA. This represents a basis for electricity regulation by the ERA.
2	Create the ERA as defined by the law(s), following a corresponding decision of the CoM (e.g. Decision on Establishing the Electricity Regulatory Authority) by a certain date. Base such decision on the law(s) and define its initial proceedings, funding and timelines.
3	Nominate and appoint commissioners (the President and the members of the board/panel), and find a solution for initial funding of commissioners. Conduct the procedure in accordance with the law(s).
4	Oblige commissioners (the President and members of the board/panel) to issue secondary legislation/regulations on the electricity regulation processes, i.e. on topics such as: i. statute (e.g. Rule on Organisation and Operation of the Electricity Regulatory Authority); ii. conduct and ethics (e.g. Code of Conduct and Ethics for Commissioners and Staff); iii. commercially sensitive information (e.g. Rule on Confidential Information); iv. collection of fees (e.g. Rule on Taxes); v. complaints and disputes (e.g. Rule on the Resolution of Complaints and Disputes); and vi. violations (e.g. Rule on Administrative Measures and Fines), etc.
5	Oblige commissioners (the President and members of the board/panel) and staff to start working on the secondary legislation/regulations relating to electricity regulation competencies, i.e., on topics such as: i. licences (e.g. Rule on Licensing of Electricity Activities, Reporting Manual for the Electricity Sector); ii. authorisations (e.g. Rule on Authorisation Procedure for New Generation Capacity); iii. tariffs (e.g. Rule on Regulated Generator Pricing, Rule on Transmission System Operator and Market Operator Pricing, Rule on Distribution System Operator Pricing, Rule on Public/Universal Supplier Pricing); and iv. codes (e.g. Transmission Network Code, Distribution Network Code, Market Rules, Rule on Allocation of Cross-Border Transmission Capacity and Congestion Management, Rule on General Conditions of Electricity Supply, Supplier Switching Rule, Rule on Disconnection and Reconnection of Final Customers in the Electricity Sector), etc.

No.	Essential Steps
6	Oblige the board of commissioners (the panel) to establish the first budget of the ERA at the beginning of the first year, and plan to establish the second one before the beginning of the second year. The budget for the first two-year period should come from the CoM appropriation (the State budget). The board of commissioners (the panel) should plan to establish the third budget of the ERA before the beginning of the third year, derived from the fees in accordance with standards.
7	Oblige the board of commissioners (the panel) to issue the first annual report of the ERA for the first year of its operation in the first half of the second year and to submit it to Parliament (preferably) for discussion and approval (preferably).
8	Oblige the board of commissioners (the panel) to enable the first audit of the ERA and publish its results.
9	Oblige the board of commissioners (the panel) to arrange for the creation and maintenance of the ERA's website and social network channels for publishing its decisions and communicating with the public.
10	Oblige the board of commissioners (the panel) to establish and make use of advisory councils (at least two – one for technical issues and another for consumer protection), as well as hearings or other public processes for the collection of inputs on electricity regulation decision-making.

Annex 5: Summary of the Main Measures Required Under Each Scenario

Measures and Reforms	Main Party	Stagnation Scenario	Realistic Scenario	Green Revolution
Legal and Regulatory				
ERA	COM/MEW	Not Created	Created	Empowered
DRE law	MEW/EDL/ERA	Not Enforced	Enforced	Enforced
Solar Ordinance	Urban Planning	Not Passed	Passed	Enforced
Institutional and Structural				
RE Framework	COM/MEW	Ambiguous	Clear	Optimised
Digital Auctions	COM/MEW	Unavailable	Available	Optimised
Bid Upgrades	COM/MEW	Minor	Acceptable	Advanced
RE Program	COM/MEW	Normal	Committed	Ambitious
Resource Allocation	COM/MEW	Low	Medium	High
'One Stop Shop' for Permits	COM/MEW	Not Created	Created	Enhanced
Unbundling	COM/MEW	Not Passed	Passed	Optimised
Market Liberalisation	COM/MEW	Not Passed	Passed	Optimised
Macro-Fiscal and Commercial				
Country Stability	Parliament/COM	Negative	Stable	Positive
Political Reforms	Parliament/COM	Limited	Sufficient	Abundant
Transparency	Parliament/COM	Weak	Fair	Excellent
Anti-Corruption	Parliament/COM	Weak	Fair	Excellent
Fiscal Stability	Parliament/COM	Weak	Fair	Excellent
Budget Commitment	Parliament/COM	Limited	Sufficient	Abundant
Hard Payments	Parliament/COM	Limited	Sufficient	Abundant
Sovereign Guarantees	Parliament/COM	Limited	Sufficient	Abundant
Credit Rating	Parliament/COM	Negative	Stable	Positive
Bankability	Parliament/COM	Weak	Fair	Excellent
Other De-risking (i.e. Grid)	Parliament/COM	Weak	Fair	Excellent
Financing Mechanisms	COM/BDL	Limited	Sufficient	Abundant
Subsidised Support	COM/BDL	Limited	Sufficient	Abundant
Sovereign Investment Funds	COM/BDL	Limited	Sufficient	Abundant
Land Availability	Parliament/COM	Limited	Sufficient	Abundant
Technological				
Generation				
Ancillary Services	MEW/EDL	Absent	Sufficient	Optimised
Spinning Reserves	MEW/EDL	Absent	Sufficient	Optimised
Improved RE Forecast	EDL/IPPs	Weak	Good	Excellent
Storage Facilities	EDL/IPPs	Absent	Sufficient	Optimised

Measures and Reforms	Main Party	Stagnation Scenario	Realistic Scenario	Green Revolution
Connection Requirements	MEW/EDL	Ambiguous	Clear	Optimised
Transmission				
FACTS	MEW/EDL	Absent	Sufficient	Optimised
Interconnections	MEW/EDL	Absent	Sufficient	Optimised
Smart Grids	MEW/EDL	Not Deployed	Deployed	Optimised
IOT	MEW/EDL	Not Deployed	Deployed	Optimised
Distribution				
Smart Metering	EDL/DSPs	Limited	Sufficient	Optimised
Soft Planning				
Least Cost Generation	MEW/EDL	Basic	Advanced	Optimised
Capacity Expansion	MEW/EDL	Basic	Advanced	Optimised
Master Plan	MEW/EDL	Basic	Advanced	Optimised
Communication Protocols	MEW/EDL	Basic	Advanced	Optimised
Demand-side Measures				
Price Signals	MEW/EDL	Basic	Advanced	Optimised
Tariff Restructuring	MEW/EDL	Basic	Advanced	Optimised
Net Metering	MEW/EDL	Limited	Sufficient	Abundant
P2P Trade	MEW/EDL	Basic	Advanced	Optimised
Behind the Meter Storage	MEW/EDL	Limited	Sufficient	Abundant
Other Flexibility Tools				
Smart EV Charging	MEW/EDL	Basic	Advanced	Optimised
Developed SCADA	MEW/EDL	Basic	Advanced	Optimised
Social and Environmental				
ESIA Requirements	MoE	Ambiguous	Clear	Optimised
Awareness Raising	Media/ Municipalities	Limited	Sufficient	Abundant
Land Access Rights	Parliament/COM	Ambiguous	Clear	Optimised
Land Borders	Parliament/COM	Ambiguous	Clear	Optimised
Marketing Campaign	Media/ Municipalities	Limited	Sufficient	Abundant
Educational Programmes	MEHE	Limited	Sufficient	Abundant
Skilled Labour	MOL	Limited	Sufficient	Abundant
Research Centres	MEHE	Limited	Sufficient	Abundant
Scholarships	MEHE	Limited	Sufficient	Abundant
Community Hearings	Municipalities	Limited	Sufficient	Abundant

Annex 6: E-mobility Strategy and Impact

The transport sector in Lebanon is responsible for one of the highest shares of total energy consumption, as reflected in the high dependence on fuel imports in Lebanon, specifically of gasoline. Its high use of fossil fuels naturally increases the sectors' contribution to greenhouse gas emissions at the national level. In addition, largely owing to mismanagement in the public transport sector, road transport is a major daily struggle for commuters.

The growing population, with many individuals owning a private car, has worsened both the congestion and the emissions problem in the country. Passenger cars are still the main means of everyday transport in Lebanon, and are expected to remain so in the medium term. Accordingly, electrifying the transport sector is a key factor in promoting the transition to a sustainable, less emissive, and more energy-efficient sector.

The renewable energy outlook developed by the International Renewable Energy Agency (IRENA) and published in 2020 in collaboration with the Ministry of Energy and Water (MEW) and the Lebanese Center for Energy Conservation (LCEC), included a roadmap for reaching the national target of 30% RE in the total electricity consumed by 2030. The document underlined the importance of shifting 3% of passenger kilometres (pKm) of passenger cars to electric vehicles by the end of this decade.

The main pillars of the development of the electric vehicle (EV) market in Lebanon are EV cars and EV charging stations. In addition, scaling up the deployment of solar PV systems will be a game changing factor in the development of the EV market, affecting the cost of electricity production for the charging stations and increasing the grid flexibility that is necessary to overcome increasing power demand. The unprecedented increase of decentralised solar PV systems across Lebanon in the past couple of years offers an exceptional opportunity to boost the integration of EV cars and EV charging stations in the country.

The LCEC is aligning national efforts with different stakeholders towards integrating an e-mobility strategy in Lebanon, a major milestone on the road towards electrifying the transport sector. This pilot initiative will set the example for other national sectors and lead the energy transition in one of the largest energy-demanding sectors in Lebanon.

The LCEC developed a 'reference case' and an 'e-mobility case' to highlight the expected growth trend of the EV market with regard to both EV cars and EV charging stations, in addition to other factors, as discussed below.

Starting from the current number of EV cars in Lebanon, the year-on-year increase in the number of cars in the e-mobility case was identified to match the target set in the RE roadmap for Lebanon. The e-mobility case reflects the developments that will be required for Lebanon to reach its national target of converting 3% of passenger kilometres (pKm) to electric vehicles by 2030.

The LCEC created a database of the autonomy ranges and battery-charging capacities of EV cars, featuring 15 car manufacturers and 138 models of vehicles, covering various sizes and levels of luxury. This database was used throughout the analysis, not only to estimate the impact of charging services on national electricity demand, but also to study the financial profitability of using an EV car rather than a gasoline car.

For the charging stations, the LCEC identified the number of charging stations and their required distribution across Lebanon to successfully implement the strategy, based on population density, frequency of use, the geographical factor, the location of main roads, and the expected growth of the EV cars market. These factors and others were used to estimate the needed shares of DC and AC in the charging stations.

From a financial point of view, the yearly investments needed to reach the national target by 2030 were estimated based on the different prices of EV charging stations, which depend on the technologies used and the sizes of these stations. Moreover, a break-even cost was set for the EV and gasoline cars comparison, to identify a threshold for charging tariffs. This price ceiling will be a starting point for encouraging road users to switch to EV cars.

The following paragraphs discuss the analysed data for both cases, with the remarkable difference between the reference case and the e-mobility case reflected in projections for the coming years.

The average yearly increase rate of EVs in the whole cars market from 2024 to 2030 is estimated to be less than 5% in the reference case, whereas implementing an e-mobility strategy in Lebanon will double this figure. This strategy would allow the share of EVs to be around 3% of the whole cars' market by the end of 2030. Based on the cars market for the past five years, the reference case projects a 'business as usual' development of the market for the next seven years.

Figure 23 shows the projected yearly growth in the EV car market, indicating the different rates of growth between the two cases. The impact of implementing the e-mobility strategy would only be apparent in 2025, considering the time needed for the full implementation, starting from early 2024. In order to match the increasing demand for EVs, the number of EV charging stations will need to increase as well. The LCEC studied the development trend of public charging stations in both the reference case and the e-mobility case. The latter would remarkably affect the private charging stations market.

Applying the e-mobility strategy would allow around 3,500 charging stations to be built by 2030, of different technologies and sizes – 230% more than that expected in the reference case. Figure 24 shows how this initiative will boost the development of the charging stations market in the upcoming years.

In the reference case, the projected data considered a ratio of 30 cars for every charging station, whereas in the e-mobility case, the ratio is set at 20. It is worth noting that in several countries where the EV market is well developed, the EV to charging station ratio is between 10 and 20.

Figures 23 and 24 show the estimated cumulative numbers of EVs and charging stations for each case by 2030.

FIGURE 23 Cumulative number of EVs: Ref case vs e-mobility case

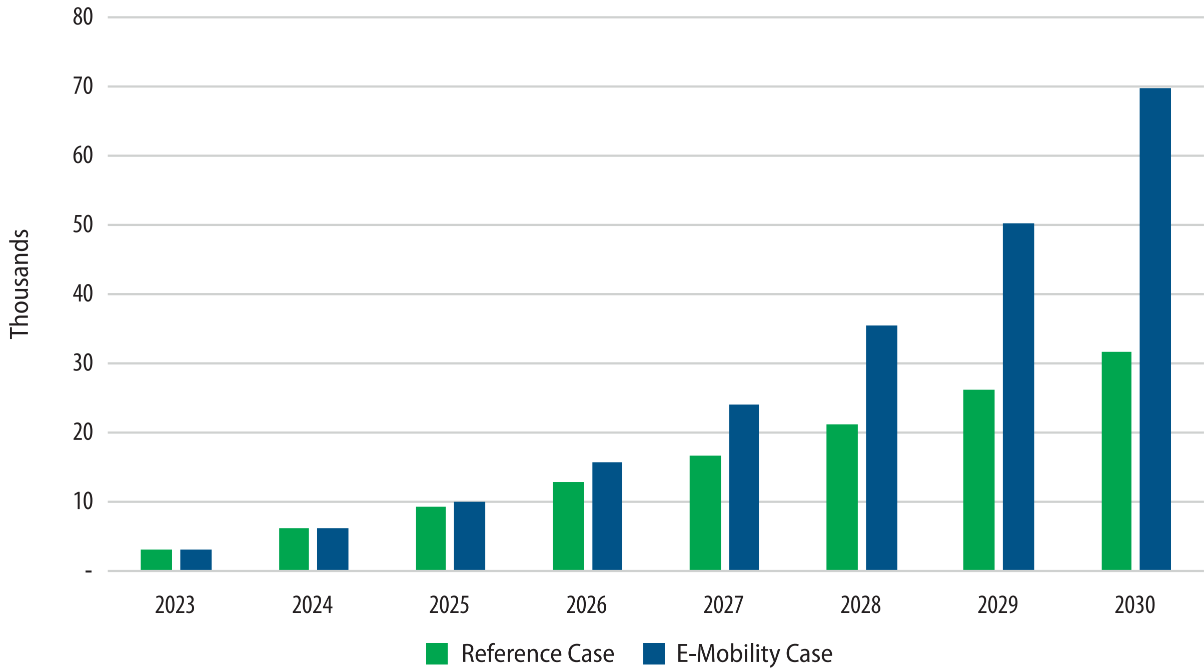
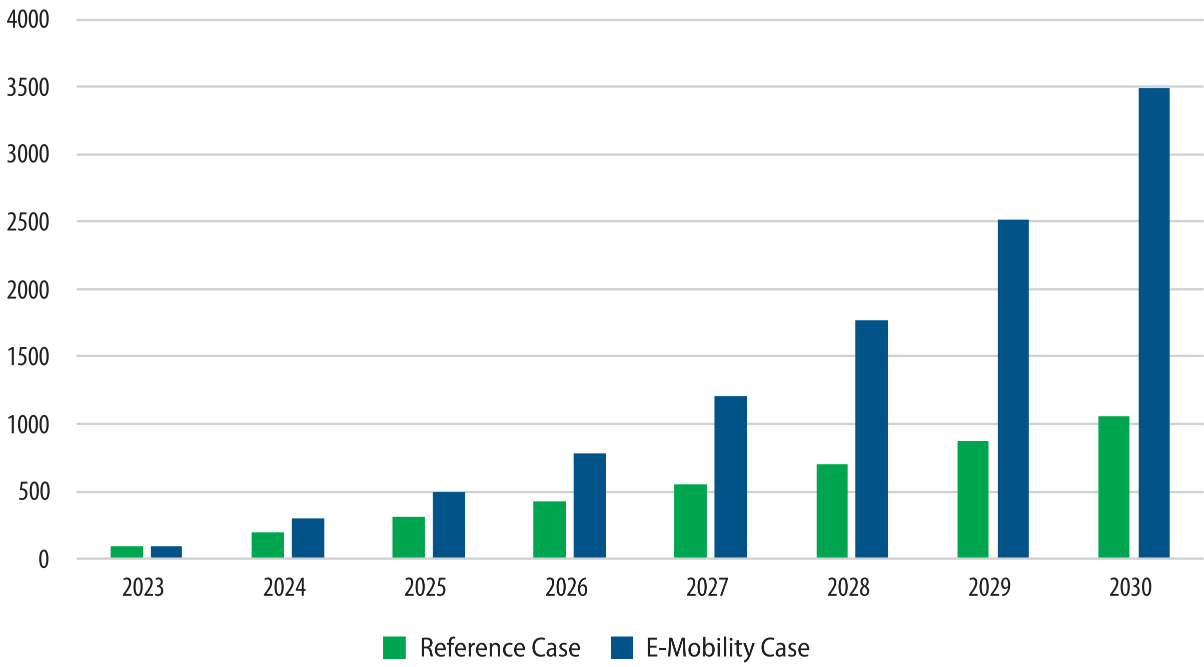


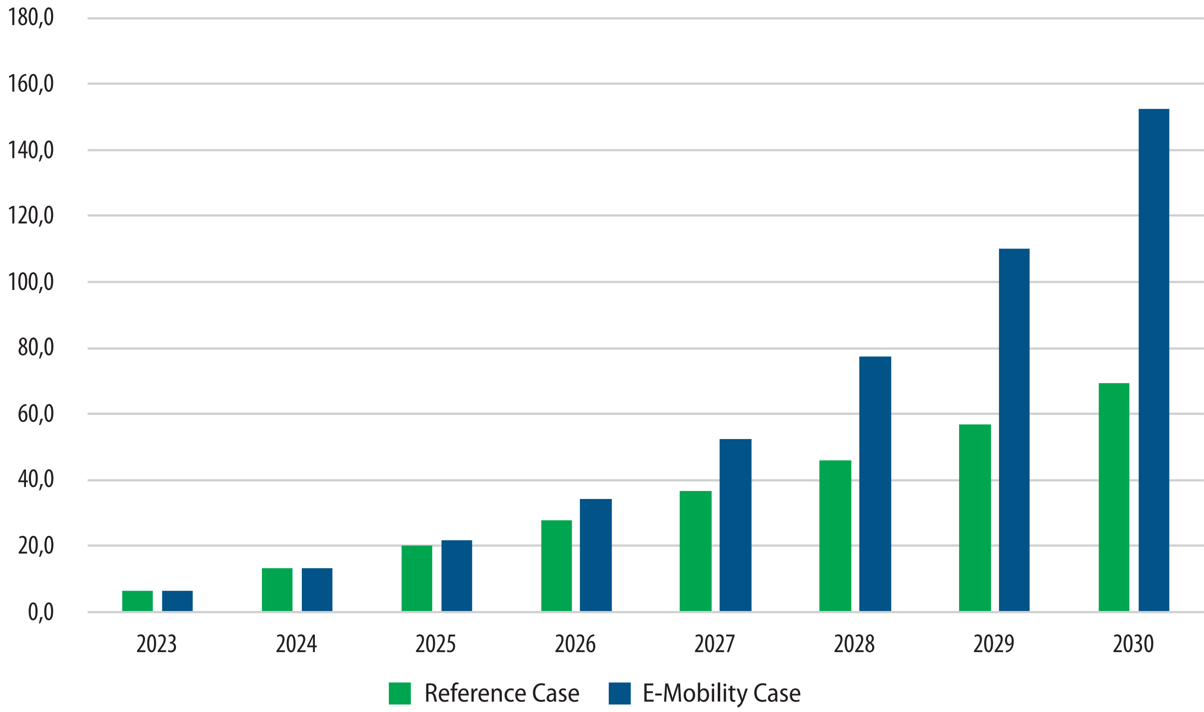
FIGURE 24 Cumulative number of EV stations: Ref case vs e-mobility case



The electricity supply and demand status in Lebanon raises concerns about the increased demand on electricity caused by the increased number of EV charging stations. However, even in the e-mobility case, the share of yearly electricity demand will remain less than 2% of national demand.

Figure 25 shows the difference between the charging needs of both cases. The estimated demand on charging services was based on the EV cars database, where the capacity of the EV battery (kWh) also shows the distance that can be covered by an EV car in kilometres. In total, 120% of additional energy will be needed by 2030 to secure the demand on electric charging services, when comparing the e-mobility case to the reference case.

FIGURE 25 **Electricity charging demand: Average electricity needed (GWh/year) in the ref case and e-mobility case**



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