A ROADMAP FOR ENERGY ACCESS IN DISPLACEMENT SETTINGS:

LEBANON

United Nations Institute for Training and Research
GPA GLOBAL PLATFORM FOR ACTION
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About the GPA

The **Global Platform for Action on Sustainable Energy in Displacement Settings** (GPA) is the global initiative to promote actions that enable sustainable energy access and use in displacement settings. The GPA strives to remove barriers to energy access in countries which host large populations of forcibly displaced people by providing a collaborative agenda for energy, development, and humanitarian partners to deliver concrete actions of Sustainable Development Goal 7 (SDG 7). It promotes and contributes to the humanitarian sector's transition to renewable energy, which will increase efficiency and reduce costs and carbon emissions. Hosted by the United Nations Institute for Training and Research (UNITAR), the GPA Coordination Unit galvanises collective action towards the GPA's realisation.

About the READS Programme

The **Roadmaps for Energy Access in Displacement Settings (READS) Programme**, funded by the IKEA Foundation and implemented by the GPA Coordination Unit at UNITAR, will produce a “roadmap report” for each of the ten countries in its scope. The programme defines displacement settings as countries which host large populations of forcibly displaced people and aims to take stock of the state of energy access in each country with a focus on identifying gaps and high-impact project opportunities to increase sustainable energy access for vulnerable and displacement-affected communities.

These reports consolidate existing data and are informed by workshops with in-country stakeholders to develop and refine the research, including community representatives, energy companies, humanitarian and development organisations, and governmental authorities, among others. The roadmap reports present project concepts that have been prioritised by local partners as being the most impactful types of sustainable energy interventions. Each roadmap report is produced in partnership with organisations working with vulnerable and displacement-affected communities in the focus country.

About the READS Partners

The **Near East Foundation** (NEF) has supported community-led economic and social development in the Middle East, Africa, and Caucasus since 1915. As a non-profit international development organisation, NEF draws on local teams, experience, and partnerships in these regions to create community-led solutions to reduce poverty, create economic opportunity, increase resilience, and empower conflict-, climate-, and crisis-affected people to improve their outlook and wellbeing. Its programmes span three focal areas: Inclusive Economic Development, Climate Resilient Development, and Peace and Stability.

Anera, established in 1968, is an international development organisation advancing the well-being of refugees and vulnerable communities in the Middle East through comprehensive humanitarian aid and sustainable development programmes. Unaffiliated with any political or religious entities, Anera effectively navigates complex regional challenges to deliver critical support in health, education, and economic development. In 2023 alone, Anera mobilised over $171 million to support these initiatives, maintaining a steadfast commitment to fostering dignity, purpose, and opportunity across the Middle East.

About the IKEA Foundation

The **IKEA Foundation** is a strategic philanthropy that focuses its grant making efforts on tackling the two biggest threats to children’s futures: poverty and climate change. It currently grants more than €200 million per year to help improve family incomes and quality of life while protecting the planet from climate change. Since 2009, the IKEA Foundation has granted more than €1.5 billion to create a better future for children and their families. In 2021 the Board of the IKEA Foundation decided to make an additional €1 billion available over the next five years to accelerate the reduction of greenhouse gas emissions.

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Abbreviations

ADR	*Association du Développement Rural*
CFL	*Compact fluorescent lamp*
COM	*Council of Ministers*
COVID-19	*Coronavirus disease 2019*
EDL	*Electricité du Liban*
EDZ	*Electricité de Zahlé*
ERA	*Electricity Regulatory Authority*
GCO2EQ	*Gram of carbon dioxide equivalent*
GIZ	*Deutsche Gesellschaft für Internationale Zusammenarbeit*
GW	*Gigawatt*
ID	*Identification document*
IPP	*Independent power producer*
IRENA	*International Renewable Energy Agency*
kW / kWp	*Kilowatt / Kilowatt-peak*
KWH	*Kilowatt-hour*
LBP	*Lebanese Pound*
LCEC	*Lebanese Center for Energy Conservation*
LCRP	*Lebanon Crisis Response Plan*
LED	*Light-emitting diode*
LPG	*Liquefied petroleum gas*
MEW	*Ministry of Energy and Water*
MFI	*Microfinance institution*
MW / MWp	*Megawatt / Megawatt-peak*
NEEAP	*National Energy Efficiency Action Plan*
NEF	*Near East Foundation*
NGO	*Non-governmental organisation*
NRC	*Norwegian Refugee Council*

Abbreviations

NSSF	*National Social Security Fund*
O&M	*Operations and maintenance*
OCHA	*United Nations Office for the Coordination of Humanitarian Affairs*
PPA	*Power purchase agreement*
PRL	*Palestine refugees from Lebanon*
PRS	*Palestinian refugees from Syria*
PV	*Photovoltaic*
READS	*Roadmaps for Energy Access in Displacement Settings*
SHEILD	*Social, Humanitarian, Economical Intervention for Local Development*
SME	*Small and medium-sized enterprise*
SWH	*Solar water heating*
TCO2EQ	*Tonne of carbon dioxide equivalent*
UN	*United Nations*
UNDP	*United Nations Development Programme*
UNEP	*United Nations Environment Programme*
UNHCR	*Office of the United Nations High Commissioner for Refugees*
UNICEF	*United Nations International Children's Emergency Fund*
UNIDO	*United Nations Industrial Development Organization*
UNRWA	*United Nations Relief and Works Agency for Palestine Refugees in the Near East*
USAID	*United States Agency for International Development*
USD	*United States Dollar*
VASYR	*Vulnerability Assessment of Syrian Refugees in Lebanon*
WASH	*Water, sanitation, and hygiene*
WE	*Water establishment*
WFP	*World Food Programme*

Overview of common energy terms

Energy technologies, and the terms used to describe them, can vary between countries, contexts, and organisations. The descriptions used in this report aim to conform with the most commonly-used definitions but may differ from those used by other organisations.

TERM	DESCRIPTION
DISTRIBUTED GENERATION OR DECENTRALISED ENERGY SYSTEMS	*"Distributed generation" or "decentralised" energy systems generate power independently of the national grid network. These can be of any size, ranging from smaller systems for households or larger systems for public institutions or entire communities. Such systems can be powered by fossil fuels such as diesel or renewable sources such as solar. Some systems require the national grid to be available during use (but provide power that would have otherwise would have come from the grid) whilst others can provide power when the grid is unavailable.*
ENERGY EFFICIENCY	*Energy efficiency measures include any actions or interventions which reduce the overall energy used for or during an activity or process. These measures could be behavioural (such as shutting windows when air conditioning is in use) or technological (such as using LEDs rather than incandescent bulbs).*
NATIONAL GRID	*The national grid is the main electricity infrastructure of a country. It provides power through high-voltage transmission and distribution lines and is supplied by large-scale generation, such as fossil fuel power plants or utility-scale renewables. The national grid can provide high-quality and reliable electricity but in some contexts the supply may be unreliable or unavailable.*
NET METERING	*Net metering is a mechanism that allows customers which generate electricity to provide that power to another user and be credited for that electricity at a different point in the billing cycle, rather than needing to use it immediately themselves. For example a household with solar panels could generate electricity, provide it to the national grid, and subsequently receive credit which would reduce their overall electricity bill at the end of the month or year.*
POWER PURCHASE AGREEMENT (PPA)	*A power purchase agreement (PPA) is a long-term agreement for the sale of electricity from a generator to a consumer. The price, duration, and quantities are defined by each agreement but could vary between PPAs. For decentralised generation, a PPA could be between a buyer (such as a school or hospital) and the owner of power-generating equipment (such as solar PV, which could also be installed on the buyer's premises) without the involvement of the electric utility.*
PRODUCTIVE USES OF ENERGY (PUE)	*Productive uses of energy (PUE) include any applications of energy for businesses, income generation, or economic activity. This could include appliances or machinery to make work easier or more efficient, or to make new activities possible. PUE usually refers to electricity, but it also includes energy for cooking and other applications.*
SOLAR PHOTOVOLTAICS (PV)	*Solar photovoltaics (PV) use panels to convert light into electricity. Solar PV systems can generate electricity to be used immediately, stored in batteries, or sent to the national grid network.*
SOLAR WATER HEATING (SWH)	*Solar water heating (SWH) systems use panels to raise the temperature of water. This could be for domestic uses such as bathing or washing dishes, or in other settings such as for schools and hospitals.*
STANDALONE SYSTEM	*A standalone system can provide electricity independent of the national grid, either fully off-grid or as a backup power source. Any type of electricity generation could supply a standalone system but these are usually powered by diesel or solar with battery storage. Standalone systems typically refer to those which supply buildings or operational purposes such as water pumps, but could include any off-grid system such as a mini-grid.*

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Lebanon faces deep and multifaceted crises. The severe economic decline sparked by the 2019 financial crisis continues to impact the country, with worsening conditions due to the severely limited availability of electricity. Initial signs of stabilisation of the economic situation due to the increasing dollarisation of the economy are hopeful, but there is little research on this development and economic recovery will take time.

Compounding its economic issues is the huge population influx Lebanon has experienced as a result of displaced Syrians fleeing conflict in their home country, resulting in further pressure on public services. Almost two-thirds of the country's residents – including Lebanese people, displaced Syrians, and Palestinian refugees – are considered vulnerable. The Israel-Gaza crisis and cross-border escalations in the South of Lebanon which has forcibly displaced thousands of people continues to contribute to an uncertain enabling environment for investments and interventions to support Lebanon's vulnerable populations.

Sustainable Development Goal 7 (SDG 7) calls for universal access to affordable, reliable, sustainable, and modern energy for all by 2030 – including communities affected by displacement and their host communities. The Roadmaps for Energy Access in Displacement Settings (READS) Programme aims to support the achievement of SDG 7 in ten countries which host large populations of forcibly displaced people. This report consolidates the status of energy access among vulnerable populations in Lebanon, provides an overview of the stakeholders working towards SDG 7, and presents opportunities for high-impact projects to support increased access to sustainable energy for vulnerable populations residing in Lebanon.

Energy for vulnerable populations in Lebanon

The energy sector in Lebanon represents a significant area of expenditure for the economy, government, and individuals. Over 98% of the country's primary energy is imported, almost all in the form of fossil fuels. Both utility-scale power plants and smaller generator networks rely on diesel to supply electricity, and the costs of providing power have increased significantly. In theory Lebanon has a relatively strong policy environment towards renewable energy but in practice the implementation and potential benefits of these policies have been stymied by the ongoing crises.

Data from the World Bank states that Lebanon has universal access to electricity. Whilst electricity connections may be available to all, the duration of the electricity supply is very limited. The use of liquefied petroleum gas (LPG) and electricity for cooking are ubiquitous; as a result, access to clean cooking can be assumed to be practically universal. ››

Over 98% of Lebanon's energy is imported, almost all in the form of fossil fuels.

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Energy for households and businesses

Households in Lebanon are heavily impacted by the energy crisis. A 2023 study by Human Rights Watch (HRW) found that the average provision of electricity from EDL had decreased from 12 hours per day before the crisis to just two hours per day, and unregulated private diesel generator networks have become the primary electricity source for many households and businesses. The Vulnerability Assessment of Syrian Refugees in Lebanon (VASyR) survey found that in 2022 households spent an average of LBP 406,810 on electricity from both the grid and private generators, a stark increase from LBP 17,674 for the national grid and LBP 47,566 for diesel networks in 2021. A stable supply of electricity has become a great expense and unaffordable for many: households in the lowest-income quintile have been found to spend 88% of their income on generator bills, compared to 44% for the average household and 21% for those in the highest-income quintile.

Almost 90% of surveyed respondents reported that electricity costs have affected their ability to pay for other essential services. Two-thirds said the lack of electricity had meant they were not able to keep food refrigerated or frozen and 47% said that it hindered them from getting sufficient water, as most households rely on electric water pumps.

Small businesses represent 97% of formal businesses in Lebanon and embody the backbone of the economy, spanning the services, manufacturing, and trade and retail sectors. Around 51% of Lebanon's population rely on small business for their livelihoods in sectors like agro-food processing, manufacturing, construction, retail, cosmetics, and digital services.

These small and medium-sized enterprises (SMEs) have also struggled immensely due to the electricity crisis. An assessment by NEF in 2022 found that 67% of surveyed SMEs were unable to operate normally due to electricity shortages whilst 35% reported insufficient water (which also relies on electricity) impacted their operations. Over 50% of SMEs surveyed by a Mercy Corps assessment from 2023 own a private generator to ensure a continuous supply of electricity. Bills for diesel generator owners have increased up to $1,500 per month and businesses which rely on diesel subscriptions spend an average of $330 per month. Though solar installations have become more widespread and the number of registered solar energy providers has also increased exponentially, businesses struggle to make the initial investment in renewable energy equipment due to high upfront costs.

In response to the national energy crisis, Lebanon has turned to solar technologies and is experiencing a "solar revolution". The country went from having almost no solar generation in 2010 to having installed over 1,000 MW of rooftop solar by 2023. These systems offer the potential to provide both a more stable supply of electricity as well as reduce electricity bills. Solar water heaters, which use thermal collectors rather than electricity to heat water for domestic uses, have also become popular with estimates that these systems can reduce household electricity bills by 80%.

A lack of clear regulations poses a threat to the benefits of solar energy as systems do not always meet quality standards and are often not sized correctly. Vulnerable households often rely on purchasing cheaper, substandard systems that have shorter lifetimes, meaning that low-income households ultimately pay more for lower-quality installations. Higher-income households, meanwhile, are more likely to be able to afford quality systems with upfront costs typically reaching $5,000. The unequal access to solar energy is further emphasised through the fact that many vulnerable households live in rented accommodation and cannot access solar systems due to the limited availability of (or denial of permission for accessing) rooftop space in overcrowded urban areas.

Though several projects have been implemented in order to address the energy challenges faced by households and SMEs alike, the need continues to greatly outstrip the support available. Access to financing mechanisms will need to play a key role in making these solutions more affordable and quality standards coupled with increased oversight and clear regulation are imperative in supporting a more fair, sustainable transition to clean energy. ››

Nearly one in four households surveyed by HRW reported having had their electricity shut off due to failing to pay their bills, either for diesel subscriptions and/or for EDL.

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Energy for public institutions

Overlapping crises in Lebanon have put an increasing strain on public services. This has been further exacerbated by inadequate access to reliable and affordable energy. Lebanon's education and health sectors have been heavily impacted by the high costs and low availability of electricity, compromising learning environments for young people and the ability of clinics and hospitals to provide high-quality care.

Due to the large number of displaced Syrian children residing in Lebanon, the national education system's resource requirements and operational costs – including for energy – have increased significantly. The 2023 Lebanon Crisis Response Plan (LCRP) features opportunities for several energy-related measures and targets 864 schools for energy interventions to support efforts in providing a conducive learning environment for all ages. Implemented projects highlight the potential of solar systems for educational institutions but they fall short of the estimated capacity that could be installed on school rooftops. Schools which already have solar installations, meanwhile, now require additional battery capacity owing to the reduced availability of the national grid.

Similarly, medical centres in Lebanon are under great strain. As health facilities rely primarily on power from EDL, the frequency and duration of blackouts has severely affected their ability to provide essential services to communities. Health centres typically use diesel generators but the high cost of fuel causes further affordability issues. Solar systems have become increasingly widespread and have helped meet electricity needs, with the LCRP estimating that solar power can reduce the electricity costs by tens of thousands of dollars per year for a typical health centre. However, many facilities do not yet have access to solar energy or do not have sufficient space for an adequately-sized system.

The LCRP targets 147 hospitals, primary health centres, and other healthcare institutions for energy interventions. It proposes energy audits to identify and implement energy efficiency measures, increasing the battery storage capacity of existing systems, combining the energy needs and generation capacities of institutions, and moving to private sector-led energy-as-a-service models. ››

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Energy for water and sanitation

A lack of reliable electricity severely limits the functions of water, sanitation and hygiene (WASH) facilities. Nearly 2.8 million people face challenges in accessing sufficient quantities of water for drinking, sanitation and domestic use. Limited access to WASH affects all communities, however vulnerable groups are disproportionately impacted. Across the WASH sector an estimated 70-80% of electricity is consumed by water pumping and distribution with the remainder needed in wastewater plants to remove contaminants and pollutants. EDL is the main electricity source for 87% of water supply facilities across the country and, as only a few hours of power are available per day, these facilities must either suspend operations or rely on diesel generators for backup power.

Programmes which support the transition to local renewable energy have been identified as key components to strengthen the WASH sector. Providing distributed and decentralised power to facilities, especially those in more remote locations, could both increase the availability and reliability of power as well as reduce costs. The LCRP recommends that the water and energy sectors collaborate to reduce the reliance on the national grid and fossil fuels through implementing renewable energy projects and gravity-fed systems where feasible.

Facilitating net metering, through which electricity could be sold to other consumers or provided to the EDL grid, could utilise this electricity and increase the overall availability of the network for other users. Public-private partnerships could be developed to spread the costs of systems over a longer term for the operators of water facilities, whilst companies could gain a steady revenue stream from recurring payments.

Energy for food and agriculture

The agricultural sector in Lebanon has been severely impacted by the economic crisis but continues to provide a large share of jobs and income, especially in rural areas and for poorer households. The agri-food sector is one of the three sectors in which displaced Syrians are legally permitted to work and is their second-highest employment area. Working conditions for both Lebanese nationals and displaced Syrians are typically poor and the sector has high levels of informal employment for daily workers, low wages, and uses child labour.

Energy for agriculture is dependent on diesel (70%) and gasoline (30%); renewable energy therefore offers an attractive solution for businesses in the sector to reduce their costs. Solar power can be used to pump water for irrigation and to power post-harvest machinery as a direct replacement for diesel generation, or as a supplement to the low availability of grid power from EDL. When coupled with battery storage, renewable energy can provide reliable power for cooling rooms and storage facilities; this can extend the lifetime and maintain the quality of products, especially for more sensitive foods such as fish. For both businesses and cooperatives in the agri-food sector, assistance – for technical matters, longer-term financing, and project management – would likely be required from renewable energy companies or independent entities, such as NGOs, to guide the transition to sustainable power. ››

Nearly 2.8 million people face challenges with accessing sufficient quantities of water.

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	BARRIER	OPPORTUNITY
GENERAL	Reliance on expensive and unregulated diesel networks which cause significant pollution Solar systems are not affordable for most lower-income households and SMEs, and there is a lack of financial schemes for renewable energy systems Lack of clear regulatory frameworks for off-grid generation Substandard solar PV systems and systems are being installed in an unregulated manner Lack of post-sales services and generation of e-waste Risk aversion and lack of consumer awareness	Municipal-level solar installations, high-quality smaller-scale solar systems with battery storage, and combining generators with PV and storage solutions De-risking green financial products like credit guarantee funds, solar leasing schemes, instalment payments, subsidies for lower-income households, pooling SMEs to invest in renewable energy Develop supportive, enforced government policies and incentives for decentralised generation Enforce quality standards and checks, create a comprehensive list of accredited suppliers Require suppliers to provide post-sales services, develop and implement e-waste management systems Promote information about cost-value comparisons and energy efficiency measures, affordable energy audits to support businesses in making decisions
SOCIAL INSTITUTIONS	Low ability to pay for solar power for social institutions Different amounts of electricity generated and consumed by each institution Limited space for rooftop installations and battery storage systems	Leverage grant funding from international and governmental donors, including the diaspora and other private entities Establish PPAs between health centres and private companies, paying for electricity through cost savings from reduced diesel consumption Establish a network to combine public institutions, transferring excess electricity from one facility to one in need of more power
WATER AND SANITATION	High cost and unavailability of diesel fuel lead to water shortages Poor wastewater infrastructure leads to disease outbreaks and pollution Low water tariffs and low collection rates lead to low revenue and underfunded infrastructure Illegal infringements on main water networks	Solarisation of water pumping and gravity-fed projects through grant funding, blended finance or public-private partnerships, leverage savings on electricity bills Solarisation of wastewater treatment to improve services, increase government monitoring and oversight Reform of electricity and water tariffs, invest in improved collection mechanisms Stricter enforcement of regulations, financial or in-kind support to most vulnerable households

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Stakeholders in Lebanon

Sustainable energy in Lebanon is delivered through a wide variety of stakeholders, each with their own aims, projects, and objectives. Through the LCRP, a focus has been brought to providing electricity services to particularly vulnerable populations across the country in an environmentally sustainable and financially viable manner.

A wide variety of non-profit actors work on the topic of sustainable energy. These include international and local NGOs, which often have a strong focus on minimising the financial burden of electricity provision and aim to address cross-cutting issues including for WASH, education, health, and social stability between communities. Private companies provide sustainable energy technologies, especially solar PV, both to individuals and for larger-scale projects for companies, industries, and cooperatives. These efforts are often led by municipal governments and supported by finance institutions, research institutions, and other actors.

Opportunities to scale up sustainable energy

Increasing the uptake of reliable and sustainable energy will require a concerted effort from stakeholders across Lebanese society. Companies, non-profit organisations, government departments, municipalities, and many others will need to provide support for sustainable energy interventions, and the involvement of community members in the design of solutions will be critical to ensure that projects meet the needs of vulnerable groups.

The READS workshops brought together a diverse range of stakeholders to co-design potential high-impact projects. Whilst these are presented as individual opportunities – and would each merit investment and implementation on their own – rolling out coordinated interventions addressing several sectors could have a truly catalytic effect on increasing the uptake of sustainable energy as a whole. ››

A great variety of stakeholders will need to play a role to improve access to sustainable energy across communities in Lebanon.

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TABLE 1

High-impact project concepts to increase sustainable energy access with estimates of their potential reach, duration, budget, and scalability

PROJECT	NAME	REACH	DURATION	BUDGET	SCALABILITY
1	*Municipal-scale solar plants for villages*	*10 villages*	*1 year*	*$6 million*	*High*
2	*Solar water heating and rent reduction*	*10 municipalities*	*1 year*	*$2 million*	*Moderate*
3	*Solar for water systems with smart metering for excess electricity*	*10 locations*	*1 year*	*$1.5 million*	*High*
4	*Solar installations for the fishing industry*	*10 ports and fishing cooperatives*	*6 months*	*$500,000*	*High*
5	*Solar systems for agricultural cooperatives*	*20 agricultural cooperatives*	*1 year*	*$400,000*	*Moderate*
6	*Solar systems for health centres and schools*	*200 institutions*	*2 years*	*$5 million*	*High*
7	*Vocational and re-training programmes*	*10 locations*	*2 years*	*$500,000*	*Moderate*
8	*Blended financing for renewable energy investments for SMEs*	*2500 SMEs*	*3 years*	*$20 million*	*High*
9	*Em(power) II*	*20 large scale projects*	*2 years*	*$1 million*	*High*

The challenge is huge and supporting affordable, sustainable, and reliable electricity for all vulnerable populations in Lebanon faces many obstacles. It is compounded by the severe economic and energy crises, the Israel-Gaza crisis with cross-border escalations in Southern Lebanon, and the ongoing war in Ukraine. These same factors highlight the immense benefits in investing in renewable energy systems to reduce Lebanon's reliance on fossil fuels. By investing in decentralised sustainable energy alongside improvements to the national grid, Lebanon can continue its "solar revolution" to bring back more reliable and affordable electricity to its residents to improve their lives and livelihoods. ●

Lebanon's "solar revolution" can be continued by investing in decentralised renewable energy alongside improvements to the national grid to increase the reliability and affordability of electricity.

01

Setting the scene

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Setting the scene

Lebanon faces deep and multifaceted crises. The economic crisis of 2019 has had a paralysing effect on the country and has been worsened by the severely limited availability of electricity from the national grid. Despite initial signs of stabilisation of the economic situation, most notably through the dollarisation of the economy, there is little research on this development and it is clear that economic recovery will take time. Meanwhile, Lebanon has experienced a huge population influx as a result of displaced Syrians fleeing conflict in their home country which has resulted in further pressure on public services. Almost two-thirds of the country's residents – including Lebanese people, displaced Syrians, and Palestinian refugees – are considered vulnerable. More recently, the conflict between Hamas and Israel which began in October 2023 has had a destablilising effect on the entire region, but is particularly felt in the South of Lebanon where thousands of people have been displaced by cross-border escalations.

The Government of Lebanon has acknowledged the significant role of the energy sector in improving the lives of the country's most vulnerable populations, both through electricity for households and in the provision of public services. With the majority of Lebanon's energy coming from imported fossil fuels and subject to fluctuating international oil prices, the ongoing crises have led to power from the national grid being available for only a few hours each day. Many in Lebanon therefore subscribe to private generator networks but, owing to rising prices, these are unaffordable to many lower-income households. Municipalities and social institutions, such as hospitals and water establishments, for example, face high fuel costs for their own generators or risk compromising the provision of essential services. In addition, pollution caused by generators has severe health and environmental impacts.

As a result, individuals and organisations in Lebanon have turned to alternative sources of power which has led to the country's "solar revolution". Since 2021, Lebanon has experienced a steep rise in the demand for solar systems, increasing renewable energy production and mitigating the costs and adverse environmental and health impacts of fossil fuel reliance. Despite this rapid growth, the uptake of sustainable energy is often limited by high upfront costs, a lack of capital and financing schemes, a lack of regulatory and political clarity, and the ongoing effects of the economic crisis.

In the face of these challenges, stakeholders from across the government, humanitarian and development organisations, the private sector, and local communities have initiated a wide range of projects aimed at providing sustainable energy for households, businesses, and institutions. Whilst these are growing, both in number and impact, they require more investment and coordination to scale up to the challenge of providing sustainable access to energy for Lebanon's vulnerable populations.

Addressing the challenge of scaling up sustainable energy amidst the energy and economic crises requires coordination at all levels – from local to global [1]. Targets for sustainable energy are met through implementation on the ground with each region and community needing its own consideration and planning to reach this shared goal. Substantial funding gaps further affect the planning and implementation of effective energy programmes. Additionally, the amount of research and evidence to fully understand the energy needs of vulnerable groups and develop appropriate solutions does not match the scale of the challenge and is typically disparate and hard to find.

Acknowledging this, the READS Programme aims to provide a country-level overview of sustain- ››

Lebanon has been experiencing a "solar revolution", with demand for solar systems rising steeply.

Setting the scene

able energy and its benefits for Lebanon's vulnerable populations. The Programme works across ten countries which host large populations of displaced people including Lebanon, Jordan, Rwanda, Uganda, Kenya, and Ethiopia, among others.

A goal of the READS Programme is to identify new opportunities for high-impact projects by consolidating the existing knowledge on sustainable energy in particularly vulnerable settings. This includes published literature – such as government policies, programme output reports, datasets, academic papers, and press releases – but also the experiences and expertise of practitioners working on project implementation and, most importantly, of community members. In support of this, the READS Programme hosted a workshop in Beirut in September 2023 to engage with these stakeholders. Participants included humanitarian and development organisations, the private sector, community representatives, local government authorities, and research institutions, among others.

Using published literature, the knowledge and experiences shared during this workshop, and primary qualitative research, the READS Lebanon Roadmap Report highlights the most pressing gaps, barriers, and opportunities for providing sustainable energy to Lebanon's most vulnerable populations, as well as the roles of the stakeholders involved. It also provides a spotlight for potential high-impact projects, co-designed in the workshops by different stakeholders, which could rapidly and radically improve sustainable energy access if they received support and investment.

The energy needs of each community, household, business, or social institution will vary, as will the most effective ways of addressing them. This report aims to be as broad as possible in covering different kinds of energy access, and as comprehensive as possible in each topic, but is inherently limited by the nascent nature of research on sustainable energy in Lebanon and its unique context. The authors hope that further research can build on this report by diving deeper, ultimately promoting a greater uptake of sustainable energy in Lebanon. ●

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The multifaceted crisis in Lebanon is compounded by the severely limited availability of electricity from the national grid. As a result, the country is experiencing a "solar revolution".

02

Lebanon's vulnerable populations and economic crisis

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National overview

Lebanon is a parliamentary democratic republic with a unitary system of government [2] and an estimated population of 5.9 million people. Nestled along the Mediterranean coast, Lebanon has considerable variations in its climate, population distribution and terrain, ranging from coastal areas to mountainous regions [3]. It is bordered by two countries, Syria to the north and east and Israel, which Lebanon does not recognise as a state, to the south. Its political and security landscape continues to be shaped by its relations with its neighbours [4].

The diverse population seen today in Lebanon is a result of a myriad of socio-ethnic and religious groups based in the geographic region and three significant waves of migration to the country over the course of the last century. The migration of Armenians fleeing the Ottoman massacres in 1915, the displacement of Palestinians who fled during the establishment of the State of Israel in 1948 and 1967, and the displacement of Syrians since the onset of the Syrian Civil War in 2011 have each influenced contemporary Lebanon's intricate socio-ethnic landscape [5].

The diversity of the Lebanese population played a considerable role in Lebanon's fifteen-year civil war (1975-1990), during which a range of ethno-religious and political factions and subsequent militias came into conflict regarding the country's governance. At the onset of the civil war, the majority in Lebanon's coastal cities were comprised by Christians and Sunni Muslims, Southern Lebanon and the Beqaa Valley were populated by predominantly Shia Muslims, and the country's mountainous regions were comprised of Druze and Christians [6]. ●

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Vulnerable and displaced populations in Lebanon

Lebanon is not a signatory to the 1951 Refugee Convention nor its 1967 Protocol. This means that the legal status of migrants and refugees is determined by Lebanese laws and regulations [7] and that refugee status is not assigned to individuals who might otherwise qualify for it under international law and the definition of the United Nations [8]. This has significant implications as Lebanon hosts the highest number of displaced people per capita and per square kilometre globally [5]. Estimates suggest that, of the country's total population of 5.9 million, 1.5 million are Syrians, 180,000 are Palestinian [9] and an additional 156,000 are of Armenian descent [5].

The following terms are employed to refer to those who have sought refuge in Lebanon [9]:

- "Persons displaced from Syria", which includes Palestinian refugees from Syria as well as registered and unregistered Syrian nationals.
- "Displaced Syrians" refers to Syrian nationals, including those born in Lebanon to displaced Syrian parents.
- "Palestine refugees from Lebanon (PRL)" refers to 180,000 persons living in 12 camps and across urban and rural settings in Lebanon.
- "Palestinian refugees from Syria (PRS)" refers to 31,400 persons across Lebanon who migrated from Syria.

Beyond those who have been displaced, an estimated 2,100,000 Lebanese nationals are deemed "vulnerable" and require humanitarian assistance. The types and numbers of vulnerable populations living in Lebanon according to the LCRP are shown in Table 2. Whilst the LCRP estimates that 180,000 PRLs are resident in Lebanon, the total number of UNRWA-registered Palestine refugees in Lebanon was more than 489,000 as of March 2023 [10]. As registration with UNRWA is voluntary and deaths and emigrations often remain unreported, UNRWA estimates that not more than 250,000 PRLs currently reside in Lebanon. ››

TABLE 2

The total population of Lebanon and its vulnerable populations as reported in the Lebanon Crisis Response Plan [9].
**UNRWA estimates that up to 250,000 PRLs reside in Lebanon.*

		PEOPLE	%
TOTAL POPULATION	TOTAL	***5,900,000***	***100***
VULNERABLE POPULATIONS	VULNERABLE LEBANESE	*2,100,000*	*36*
	DISPLACED SYRIANS	*1,500,000*	*25*
	PALESTINIAN REFUGEES IN LEBANON	*180,000**	*3.1*
	PALESTINIAN REFUGEES FROM SYRIA	*31,400*	*0.5*
	TOTAL	***3,800,000***	***64***

Vulnerable and displaced populations in Lebanon

Lebanon's Armenian population is concentrated in north Beirut, Tripoli, and Anjar in Beqaa. Armenian refugees were granted citizenship in 1932 and have integrated into Lebanese society [11]. Most of Lebanon's current Armenian population is comprised of second- and third-generation individuals who are Armenian-Lebanese.

Neither Palestinians who fled to Lebanon during the establishment of the State of Israel in 1948 nor Palestinians who have migrated to Lebanon since have been granted Lebanese citizenship [12]. Full integration of displaced Palestinians into Lebanese society remains a principal challenge, largely due to the lack of their legal recognition and status. Displaced Palestinians in Lebanon reside predominantly in Beirut and the outskirts of Sidon, Tyre, and Tripoli. Approximately 45% of Palestinians live in the 12 official Palestinian refugee camps in the country [8-10]: Beddawi, Burj Barajneh, Burj Shemali, Dbayeh, Ein El Hilweh, El Buss, Mar Elias, Mieh Mieh, Naher el-Bared, Rashidiyeh, Shatila, and Wavel camps.

Since the start of the Syrian Civil War in 2011, a large number of persons displaced from Syria sought refuge in Lebanon. The number and distribution of displaced Syrians are unknown due to the government's suspension of UNHCR's registration of new arrivals in 2015. Nevertheless, newly-displaced people continued to arrive [5] and recent estimates suggest that around 1,500,000 displaced Syrians live in Lebanon [9].

Syrians live across the country with higher densities in cities such as Beirut, Tripoli, and areas within the Beqaa Valley. Around two-thirds of the Syrian population are settled in the Beqaa Valley and the North of Lebanon. While most displaced Syrians live in urban settings, around 300,000 Syrians live in 6,000 informal settlements throughout the country. ●

Internal displacement in Southern Lebanon

On 7 October 2023 the paramilitary wings of Hamas, the Palestinian political group governing the Gaza Strip, launched a series of coordinated armed incursions into Israel attacking civilians residing in proximity to the Gaza-Israel border. Following Hamas's incursion, a massacre of over 1,000 persons and kidnapping of more than 240 civilians, the Israel-Gaza crisis began and has led to an ongoing severe bombardment by the Israeli Defence Forces (IDF) and the subsequent displacement and killing of Gaza's residents. By March 2024, over 30,000 Gazans are reported to have been killed, with 1.7 million people being internally displaced and the entire population facing crisis levels of food insecurity [15].

Hezbollah, the Shia Muslim political party and militant group based in Lebanon, immediately expressed solidarity with Hamas on 7 October 2023. Subsequent hostilities between Hezbollah and the IDF arose which have included exchanges of live fire along Lebanon's southern border. As of May 2024, over 93,000 people had been internally displaced in the south of Lebanon, with 96% originating from Bint Jbeil, Marjayoun and Tyre districts [16]. Over 1,359 casualties had been reported and 344 deaths as a result of the conflict. At the time of writing, there were concerns regarding the potential for a more extensive conflict between the two parties which would lead to the further displacement of communities. ●

The Lebanese economic crisis and vulnerable populations

Lebanon has grappled with severe economic, political, and social crises since 2019. These stem from the country's unprecedented financial crisis, estimated by the World Bank as one of the ten most severe crises globally since the mid-nineteenth century, and the subsequent currency collapse of the Lebanese Pound (LBP, also known as the Lebanese Lira) [17]. As of February 2023, the Lebanese Pound had lost over 98% of its value since the onset of the crisis in August 2019 [18] with the LBP:USD exchange rate rising from around 1,500:1 to over 89,500:1 in February 2024 [19].

As a consequence the Lebanese population has been severely impacted with many households unable to afford basic necessities. The COVID-19 pandemic and the catastrophic explosion on 4 August 2020, which destroyed much of Beirut's port and surrounding neighbourhoods, have further exacerbated the situation. UNICEF Lebanon has estimated that the ongoing economic crisis in Lebanon pushed approximately 50% of Lebanese nationals below the poverty line [20].

Inflation has further impacted livelihood opportunities and vulnerable people have experienced declining employment opportunities and a reduction in the provision of essential services such as electricity, healthcare, water, and education [21]. The national electricity grid faces frequent rolling blackouts, with communities receiving between one to two hours of public electricity supply daily, and fuel shortages have made it difficult to run backup generators to power healthcare and clean water facilities. Supply chains of food shops, transport service providers, and telecom network operators have also been severely disrupted. The education sector has suffered from the closure of schools, teachers resigning and striking, and lack of access to electricity and the internet, with many schools being predominantly closed since 2020 [22].

With thousands of healthcare workers emigrating from Lebanon, a shortage in medical supplies, and ongoing electricity cuts, the national healthcare system has been struggling to provide adequate services to its citizens and the displaced populations it hosts. Social protection is limited in Lebanon as social security coverage was originally provided exclusively to labour unions, rather than all members of Lebanese society. The National Social Security Fund (NSSF) was established to ensure health security for approximately one quarter of the Lebanese population (1.5 million citizens) [23]. The 2019 financial collapse, however, caused the NSSF's savings to drop from $8.5 billion to $450 million [24]. The NSSF nearing bankruptcy has meant that medical bills and costs of those with social security are not being covered or reimbursed. The only new social assistance programme to arise since the onset of the economic crisis, the Emergency Social Safety Net Project, provided cash transfers to 150,000 households in 2022 [25]. In addition, UNRWA provided more than 524,000 public health consultations to Palestinian refugees through its network of 27 health centres in 2022 and supported 61,000 households with emergency cash transfers [10]. ››

The Lebanese economic crisis and vulnerable populations

A 2023 Human Rights Watch (HRW) report found that the majority of people in Lebanon find it challenging to secure their social and economic rights amidst an intensifying economic crisis, with the most significant impact felt by low-income households. The report sheds light on the high levels of poverty and food insecurity in Lebanon, attributed to political instability, a decline in economic activity, and the escalating costs of living. Almost 70% of surveyed households expressed struggles in meeting basic expenses or falling consistently behind in the preceding year, and 22% of households said that they lacked access to adequate food in the preceding month. At the end of 2021 the United Nations estimated that approximately 3.28 million people, nearly half of the population, had moved into income poverty since the start of the economic crisis in 2019 [25].

Displaced populations in Lebanon face a similar narrative, often confronting additional legal and security challenges. A report by UNRWA in 2022 revealed that the economic crisis has further worsened the already dire situation of Palestinian refugees, increasing both social and financial hardships [26]. The report highlighted that more than 90% of Palestinian refugees in Lebanon are living in extreme poverty compared to 50% in 2018, whilst food insecurity has increased from 65% in 2019 to 89% in 2020. Due to financial constraints for both schools and families there has been a notable increase in education expenses, which has resulted in many families moving their children from private schools to UNRWA facilities [27]. The devaluation of the Lebanese Pound, hyperinflation, fuel and electricity shortages, a scarcity of medicine, and the COVID-19 pandemic have collectively further contributed to a decline in the living conditions of Palestinian refugees [26]. Due to severe funding shortages and operational difficulties, the access and quality of services provided by UNRWA, the leading humanitarian agency for Palestinian refugees, have also been adversely affected.

The Vulnerability Assessment of Syrian Refugees in Lebanon (VASyR), an annual report published in 2022 by UNHCR, UNICEF, and the World Food Programme (WFP), highlighted the sharp increase in food insecurity. Two-thirds of displaced Syrians were unable to buy essential food and items needed for their survival, with 6% being affected by severe food insecurity [28]. Food prices increased by 332% in the year to June 2022 and 94% of Syrian refugee households took on debt to pay for their basic food and non-food necessities: 93% reported food needs as the primary justification for borrowing, followed by rent (46%) and medical expenses (35%). With that, the purchasing power of displaced Syrians has decreased [28]. Following new regulations of the government, Syrian-owned businesses were forced to close, causing many people to lose their livelihoods [29]. Regarding education, the VASyR revealed that only 60% of Syrian refugee children between the ages of 6 and 14 were regularly attending school in 2022, with the rate dropping to 8% attendance for the adolescents at the upper secondary school level [28]. Overall, the competition for limited jobs and resources have exacerbated social tensions among different groups of the Lebanese population [29].

Policy framework for refugees and displaced populations

The policy framework in Lebanon for displaced Syrians and Palestinian refugees is intricate and fragmented, involving various legal categories, authorities, and regulations (see Table 3). Lebanon is not a signatory of the UN Refugee Convention and lacks a clear legal framework for refugees and asylum seekers overall. Though Lebanon has engaged in a series of operational agreements with UNHCR, the policies which are implemented are regularly changed.

Palestinians largely reside in 12 formally-recognised refugee camps. Over the years, these Palestinian camps have become "settlements" and this has discouraged the Lebanese government from establishing similar, formal camps for Syrian refugees due to their perceived permanence. As a result, Lebanon does not provide official refugee camps for displaced Syrians [30], leading them to reside within Lebanese communities or in unrecognised, informal settlements.

Neither Palestinian refugees nor displaced Syrians in Lebanon are granted citizenship, nor do they have the right to own property, or access certain professions. Palestinian refugees are unable to access national public services such as healthcare, education, and social security and instead rely on the provision of services by UNRWA.

TABLE 3

Summary of rights of Palestinian refugees and displaced Syrians.

ASPECT	PALESTINIAN REFUGEES	DISPLACED SYRIANS
RESIDENCY REGULATIONS	*Can apply for Palestinian refugee ID cards.*	*Requires UNHCR registration, passport or ID, no-work pledge or work permit, $200 fee, and housing pledge. Non-registered people need a Lebanese sponsor, passport or ID, notarised pledge, $200 fee, and housing pledge.*
ENTRY RESTRICTIONS	*Visa required for Palestinians from Syria, requires renewal every three months.*	*Ended visa exemptions in 2015. Proof of financial means or hotel reservation required.*
EMPLOYMENT	*Restricted from over 22 professions. Difficulty in obtaining work permits and labour rights.*	*Allowed to work in three sectors: agriculture, construction, and cleaning.*
PROPERTY OWNERSHIP	*Prohibited from owning property since 2001. No legal remedy for expropriation or eviction.*	*Prohibited from owning property.*
MOBILITY	*Restrictions in southern Lebanon camps. Checkpoints and curfews.*	*Official documentation required.*
ACCESS TO PUBLIC SERVICES	*Reliant on UNRWA for healthcare, education, and social security.*	*Dependent on residency status and legal documentation.*

Income levels and access to financial services

The severe economic and financial crisis resulted in a sharp decline in the income level of all of Lebanon's residents, with the nation reclassified by the World Bank from an upper-middle-income country to a lower-middle income country in July 2022 [31]. Since May 2020, Lebanon has been in negotiations with the International Monetary Fund (IMF) for a rescue package to halt the country's further macroeconomic deterioration [32]. In April 2022, a Staff Level Agreement was signed between Lebanon and the IMF for a four-year extended fund facility aiming to restructure the financial sector through enhancing governance and undertaking fiscal reforms. Progress in implementing the agreement has been minimal.

A multi-sectoral needs assessment by REACH and OCHA from March 2024 found that the average monthly income of Lebanese households was $460, with a total average expenditure of $414 of which 17% was spent on electricity [33]. This was insufficient to meet basic needs due to inflation because of the economic crisis [34]. More than 50% of Lebanese people now live in poverty and 23% live in extreme poverty [35]; for displaced Syrians, meanwhile, the case is even worse as the poverty rate has reached 88% and the excessive poverty rate has reached 55% [36]. According to the VASyR, the average monthly income (based on employment, before accounting for other sources of assistance) of displaced Syrians per capita in Lebanon as of 2022 was LBP 410,495 (25% of the Survival Minimum Expenditure Basket, defined as LBP 8,156,858 per household per month in 2022, with an average household of five members) [28]. Although the Palestinian refugees' monthly income is suggested to be higher, it is still below the poverty line and minimum wage. A UNRWA study from 2022 reported that the average monthly expenditure of Palestinian refugees in Lebanon households was LBP 11,300,000 [26].

Lebanese citizens face notable challenges in accessing financial services due to the crisis. In response the Lebanese government has executed several economic changes, including efforts to cut public spending, a new currency exchange system, and capital infusions into the banking industry [37]. The objectives of these initiatives have been to boost access to foreign money, redevelop the banking industry, and enhance financial stability. The Central Bank of Lebanon's planned implementation of capital controls in 2019 resulted in protests [38], with regulations limiting withdrawals and hindering international money transfers.

The Central Bank changed the official exchange rate at the beginning of 2023 and the Lebanese Pound lost significant value in relation to the US Dollar (from 1,500:1 in January 2023 to 89,500:1 in February 2024) [19]. Due to the Lebanese Pound's significantly reduced value on the black market, depositors found it detrimental to withdraw their funds at the official rate. Owing to low stocks of cash, Lebanon's banks impose strict caps on withdrawing dollars – with a maximum withdrawal at a few hundred dollars per week – and have instated blocks on most transfers abroad which leave Lebanese people, many of whom are paid in dollars, in financial hardship [39]. Displaced Syrians and Palestinian refugees in Lebanon, meanwhile, are prohibited from opening bank accounts [40], leading them to rely entirely on cash for their daily needs. The only interactions surveyed displaced persons expressed having with banks was the usage of the Common Card, a card issued by the UN beginning in 2016 to streamline humanitarian assistance [41]. ››

Debt, microfinance institutions and savings groups

A 2019 demand-side analysis of financial service access, usage, and needs amongst crisis-affected communities found that households, both displaced populations and Lebanese nationals, struggle to meet their needs and stabilise their financial lives [42]. Systemic uncertainty and irregular cash flows have led to the widespread use of informal financial solutions such as buying on credit, borrowing from friends and family, and using savings groups. According to the Multi-Sectoral Needs Assessment in 2024, 21% of households reported borrowing money or receiving credit in the last three months with an average amount of unpaid debt of $988 [33]. This was significantly higher than the average debt of $200 in 2022. The primary reason to borrow or receive credit was to buy food (68%), to pay for health care (38%), and to purchase medicines (31%). The main sources of credit were predominantly friends or relatives (79%), followed by supermarkets (20%) and pharmacies (5%).

Differences in economic status stand out as a key barrier to financial inclusion, with Syrian respondents explaining that they are unable to access formal financial services such as banks and insurance due to their status as displaced persons. Informal saving groups, known as *jamaiyas*, have gained popularity amongst Lebanese nationals and displaced community members in Lebanon. Each month the saving group's participants, typically 10-15 people, bring a fixed amount of money (usually between $20-100) and a different group member takes the total amount raised by the group [42].

The microfinance sector began developing in Lebanon in the late 1990s with support from USAID in establishing Lebanon's first three microfinance institutions (MFIs): Al Majmoua, Vitas, and Association du Développement Rural (ADR). Successful microfinance programmes have been launched across Lebanon by many organisations, with different programmes aiming to support distinct groups including low-income households, displaced communities, women, youth, and small business owners.

Due to the challenging financial landscape in the country, and the deteriorating economic situation of borrowers with many struggling to repay their loans and increasingly relying on external aid, the microfinance sector in Lebanon has significantly contracted. MFIs are experiencing difficulties in accessing financing capital due to capital controls, which limit their liquidity and ability to lend, and the currency collapse wiped out much of the asset base. Outside investment into the microfinance sector is currently lacking.

Nevertheless, demand for loans remains high: a number of MFIs reported an increased demand for loans in the past 12 months in productive sectors such as agriculture, manufacturing and trade. A substantial number of small and medium-sized enterprises (SMEs) want to invest in green solutions such as solar panels for electricity, solar installation for irrigation, and solar water pumping. Although some MFIs such as Al Majmoua have begun to provide green energy loans, the low availability of capital to finance such projects – which usually require larger loan amounts – is a great barrier.

An impact study on the economic and COVID-19 crises on microcredit borrowers, published by the Consultation and Research Institute and the Lebanese Microfinance Association in 2020, found that the majority of borrowers did not have bank accounts (73%), lacked NSSF coverage (59%), reside in rural areas, and have an educational attainment that is lower than the national level (68% not reaching secondary level, compared to 55% nationally) [43]. The study also found ››

Debt, microfinance institutions and savings groups

that 30% of borrowers who were active in the summer of 2019 became inactive in the summer of 2020, 19% of whom had to find new, often less stable, sources of income. Between 2019 and 2020, the share of unemployed borrowers in Lebanon increased from 1% to 14%. Between August and December 2019, 17% of businesses closed as a result of the financial crisis. The same study found that of 94% of MFI clients surveyed expressed satisfaction with their MFI, with 77% encouraging other people to take MFI loans.

USAID's LIFE programme supported eight key microfinance organisations by lending capital and offering planning and technical assistance: ADR, Association d'Entraide Professionnelle du Liban, Al Majmoua, Vitas, The Lebanese Cooperative for Development, Emkan, Entrepreneurial Development Fund, and the Makhzoumi Foundation. USAID's assistance expanded the supply of loans to SMEs and reoriented itself around supporting microfinance organisations by lending capital and providing technical management and planning support, facilitating access to reliable and competitive credit. The programme, which ended in 2021, helped provide over 15,000 loans across all regions of Lebanon, created or sustained close to 21,000 jobs (40% of which were filled by women), and almost half of all borrowers were aged 18 to 35. LIFE's support extended beyond the provision of microfinance and offered technical assistance through training, mentoring, and coaching to over 20,000 microenterprises in Lebanon, while providing in-kind support to over 5,000 micro-businesses that were new entrants to the market.

Organisations such as Kiva, which crowdfunds loans to unlock capital for underserved communities in collaboration with local lending partners, have provided loans to small businesses and for personal consumption costs of displaced persons in Lebanon. This has the goal of facilitating self-reliance, autonomy, and building of sustainable livelihoods. Due to the compounded crises, Kiva no longer operates in Lebanon.

Al Majmoua is a Lebanese non-profit MFI and was previously a Kiva field partner. The MFI focuses on supporting micro-entrepreneurs, particularly women, in developing sustainable businesses across the country. It has targeted small-scale entrepreneurs and provided loans to over 400,000 individuals since 1997. Al Majmoua has provided loans to more than 8,500 displaced Syrians, over 80% of which were women [47]. Since the crisis, the number of loans provided to displaced clients has decreased to 1,853 as many Syrians and Palestinians have fallen below the poverty line and are no longer able to take out loans.

In 2022, Al Majmoua launched a green energy loan to support access to renewable energy generation, clean transportation, and energy efficiency measures for businesses and households [49]. Through this programme it disbursed 24 loans totalling $56,000. Its evaluation found that 79% of borrowers were extremely satisfied with the loans and no longer experienced problems; before the loan, in contrast, 64% mentioned the lack of electricity and 27% mentioned very high generator bills as problems. Before the loan, 93% of borrowers had a generator subscription but this decreased to 43%, along with reduced generator bills. Every borrower said they would prefer to choose their own suppliers rather than being limited to specific suppliers as part of the programme. Overall, 60% reported increased quality of life due to uninterrupted electricity access and 40% reported that it had positively affected their productivity.

03

National energy context of Lebanon

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National policy overview

The energy sector in Lebanon represents a significant area of expenditure for the economy, government, and individuals. More than 98% of the country's primary energy is imported, almost all in the form of fossil fuels, which exposes Lebanon to international oil price fluctuations and a high reliance on other countries for its electricity production [9]. Both utility-scale power plants and smaller generator networks rely on diesel to provide electricity and the costs of providing power have increased significantly owing to internal factors, such as the economic crisis, and external events such as the war in Ukraine. In theory Lebanon has a relatively strong policy environment towards renewable energy both in comparison with other countries in the region and around the world [44], but in practice the implementation and potential benefits of these policies have been stymied by the ongoing crises.

Data from the World Bank states that Lebanon has universal access to electricity, similar to other countries in the region [50]. Whilst electricity connections may be available to all, the duration of the electricity supply is usually very limited. Data for clean cooking was not collected as the use of liquefied petroleum gas (LPG) and electricity for cooking are ubiquitous; as a result, access to clean cooking can be assumed to be practically universal. More of Lebanon's total energy consumption comes from renewable sources than other countries in the region but the country's reliance on fossil fuels for electricity generation means its proportion of renewable energy consumption is below the global average.

According to more recent analysis by IRENA, in 2023 Lebanon's renewable energy share was 11%, with hydropower being the largest renewable energy resource in Lebanon (providing 75% of renewable energy), followed by solar power (20%) and bioenergy [51]. Since 2021, Lebanon has experienced a surge in solar power adoption supported by national and international actors from the private and public sectors, with exceptional growth for domestic installations. In 2020 Lebanon added just 14 MW of rooftop solar but an additional 663 MW was installed in 2022, and the country was estimated to have passed 1 GW of rooftop solar in June 2023 [52].

In support of Lebanon's goal of meeting 30% of national energy consumption through renewable sources by 2030, a range of stakeholders have become involved in scaling up renewable energy. In 2019, USAID launched the $20 million Solar & Renewable Energy Fund to help local businesses across Lebanon install solar systems. In 2022, UNIDO received €3.7 million from the European Union to finance renewable energy projects across the country, focusing on the industrial sector. The increase in domestic installations, meanwhile, has been greatly supported by a scheme led by Lebanon's Banque De L'Habitat in collaboration with the Lebanese Center for Energy Conservation (LCEC) which provides loans to help Lebanese households buy and install solar systems [52]. ●

Governance of the energy sector

The Ministry of Energy and Water (MEW) directs the overall governance of the energy sector in Lebanon, holding the responsibility for the country's electricity, water and oil portfolios [53]. It proposes the rules for the production, transmission and generation of electricity, as well as the safety and environmental conditions and technical specifications for electrical installations [54]. MEW holds overall responsibility for national strategies and planning, as well as for proposing laws and making interconnection agreements with other countries. Most resolutions taken by MEW require the approval of the Council of Ministers (CoM), the executive body of the Government of Lebanon composed of the heads of each ministry.

Lebanon's vertically integrated electricity company, Electricité du Liban (EDL), manages the country's entire electricity sector including generation, transmission, and distribution [53]. EDL controls 90% of the electricity market and serves 1.4 million customers. The private company Electricité de Zahlé (EDZ) has a concession agreement to provide power to the Beqaa region [55] whilst other concession agreements cover distribution in the Jbeil and Bhamdoun areas and for hydropower plants [55]. EDL owns seven major thermal power plants (totalling 2,330 MW), the Kadisha hydropower plant which offers 21 MW of installed generation capacity, and it also imports electricity from Syria. There are five historic independent power producers (IPPs) in Lebanon: four supply hydropower, such as those operated by the Litani River Authority which supply around 200 MW to EDL, and one uses heavy fuel oil, with EDL acting as the single buyer. Owing to its reliance on imported fuel, amongst many other issues, EDL has reported annual deficits of around $2 billion and has been unable to provide quality services to meet electricity demand.

LCEC is a not-for-profit subsidiary of MEW that develops national strategies for energy efficiency and renewable energy deployment [53]. Whilst financially and administratively separate, LCEC acts as the technical arm for MEW and conducts research and assessments across a range of sustainable energy topics including solar photovoltaics (PV), solar water heating (SWH), battery storage, wind energy, and green buildings.

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Electrification policies and the national grid

Significant reforms could enhance electricity provision in Lebanon. In 2002, Law 462 was introduced and included provisions to unbundle the electricity sector, create an Electricity Regulatory Authority (ERA), and liberalise the generation and distribution of power [56]. The ERA would also have the responsibility to grant generation licenses to IPPs and allow private companies to provide electricity to the national grid. These reforms were never enacted by the CoM and so the ERA was never formed.

In 2011 Law 462 was comprehensively revised to address the ongoing gaps in the legislative framework but, once again, the process was never completed. In 2014 Law 288 indicated that the CoM, acting on recommendations from MEW and the Ministry of Finance, could issue licenses for two years; this was extended for a further two years, to 2018, despite no licenses having been issued [53]. In 2019, the Lebanese Parliament enacted Law 129 which allows the Government to enter into agreements for the design, financing, construction and operation of power plants – subject to conditions set by MEW – and allowed conventional power plants to be classified as IPPs, permitting the sale of energy to MEW under long-term power purchase agreements (PPAs) [54].

The National Energy Efficiency Action Plan (NEEAP), originally drafted by MEW and LCEC in 2010, was updated and adopted in 2019 to address the causes of the electricity problems in Lebanon [53]. Amongst others, these issues included:

- Tariffs being fixed since 1994 when oil prices were very low;
- High operating costs of present power plants which rely on heavy fuel oil and diesel;
- High technical losses (16.5%) from the underdeveloped grid and non-technical losses (21%) from illegal connections;
- Uncollected bills, including from public institutions ($1.8 billion) and refugee camps ($444 million); and
- The impact of regional crises, estimated to have cut availability by 500 MW (equivalent to five hours per day) and costing around $150 million in increased private generator use.

Proposed solutions to these issues included grid rehabilitation to reduce technical losses, collecting unpaid bills, installing smart electricity meters, increasing tariffs, and building new generation capacity. However, few of these areas have seen improvements.

Owing to the need to increase power generation, in 2022 the CoM approved a plan from MEW to finance, build and operate two gas-fired power plants in Zahrani and Deir Amar; together they will have a capacity of 825 MW and cost between $500-600 million [54]. In addition, Lebanon has a large untapped potential for renewable energy generation: this has been estimated at a total potential of 34 GW of solar and 5 GW of wind energy generation capacity, of which 5.5 GW and 1 GW respectively would be sited on public land [57].

Lebanon has a large untapped potential for renewable energy generation, estimated at 34 GW of solar and 5 GW of wind energy generation capacity.

EDL and the national electricity crisis

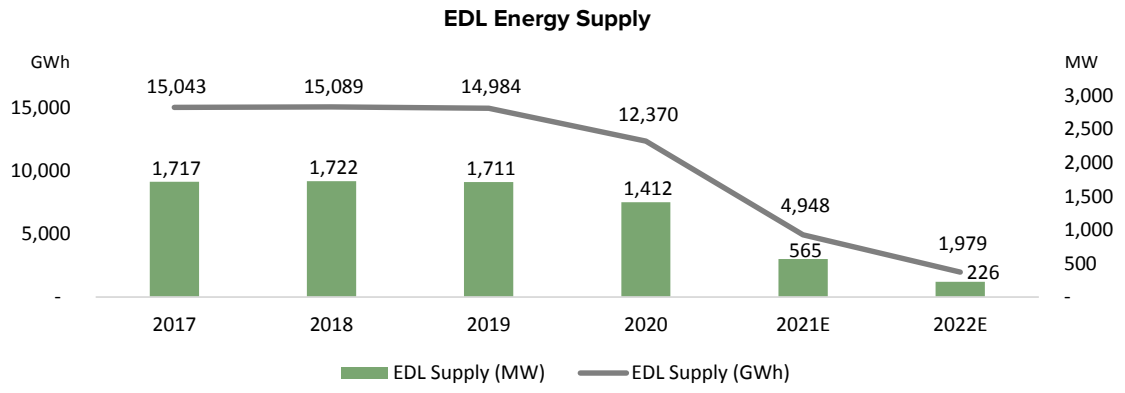
The state electricity company EDL is at the centre of Lebanon's ongoing electricity crisis. Despite being the sole official electricity provider – aside from a concession agreement for the region of Zahlé – the supply from EDL is far less than the demand. The resulting shortfall is compensated mostly by unregulated diesel generators networks owned and operated by private suppliers or, more recently, solar power, or goes unmet.

While EDL should be able to operate autonomously, it falls under the responsibility of MEW and the Ministry of Finance holds financial oversight. EDL's board is controlled by the CoM, the executive body of the Government of Lebanon, the same group that has not enacted the proposed Electricity Regulatory Authority which would allow the reformation of the energy sector and unbundle EDL's monopoly over electricity generation, transmission, and distribution. Without this reform, EDL remains solely responsible with "political interventionism crippling decision making and progress in the sector", in the words of MEW [56]. Allegations of weak governance, mismanagement, and corruption – including a billion-dollar fraud case which resulted in 20 individuals being charged – further impact EDL's ability to operate effectively [58].

These structural and management issues severely limit the amount of electricity that EDL can provide. EDL provided 78% of Lebanon's electricity needs in 2008 but this decreased to just 55-64% (depending on total demand assumptions) in 2018 as a result of "chronic underinvestment in new generation capacity" [59], with electricity rationing reducing the available power from 12-21 hours to less than 3 hours ››

FIGURE 1

The EDL grid capacity and annual energy supply (estimated data for 2021 and 2022) [61].



EDL and the national electricity crisis

per day [58]. The grid has a capacity of 1,800 MW, which falls short of the 2,000-3,000 MW the country needed before the crisis. In 2023, the grid provided only 200-250 MW due to the crippling prices of imported fossil fuels [60]. As many of Lebanon's power plants operate at low efficiency, until 2021 the Government turned to a Turkish company to provide power-generating barges to deliver up to 25% of the country's generation capacity.

These issues have led to EDL running a deficit of $1.5-2 billion per year, accounting for 3.8% of Lebanon's gross domestic product and half of the total fiscal deficit [58]. More than $1.5 billion was spent on the power-generating barges between 2013-21 (not including the cost of fuel, which was provided by the Government) which has been estimated to cost the same as three power plants. EDL is unable to overcome this deficit: tariffs have been fixed at an average of $0.095/kWh since 1994, only around half of the $0.18/kWh it costs to produce and transmit power even before accounting for low rates of (often late) bill collection (estimated at 60-70% of payments [62]), especially from state institutions and refugee camps [59]. This has led EDL further into debt, rather than offering a route out of it.

Both EDL and the electricity sector need significant reform and, whilst there have been many proposals to do so, few have come to fruition. There remains a critical need to strengthen and improve transmission and distribution networks to satisfy present power demand, significant portions of which is still going unmet, and to accommodate future expansions in distributed generation. EDL and its infrastructure will play an important role in adapting to emerging energy solutions, both in terms of technical integration and regulatory approvals.

Until EDL can supply reliable power, people in Lebanon will look to alternative means to access electricity such as diesel generator networks or, increasingly, solar power. The new Distributed Renewable Energy Law, ratified in December 2023, offers an example of how reform may be able to relieve some of the pressure on EDL, but its eventual impact remains to be seen.

The new Distributed Renewable Energy Law was ratified in December 2023 and provides an improved regulatory framework, promising to relieve some of the pressure on EDL.

Diesel generation and distributed renewable energy

As EDL is unable to meet electricity demand through the national grid, private diesel generator operators have established networks to provide electricity in a parallel unofficial market [53]. These private diesel networks are ubiquitous across Lebanon, with an estimated 83% of households receiving power from a neighbourhood generator [58]. Generator operators issue separate bills which are either on a monthly flat subscription rate based on the permitted current that a customer draw at a given time – which is generally preferable for operators, as it it is usually more profitable – or tariffs per kilowatt-hour (kWh) of electricity used which are far higher than those of EDL, usually around $0.30/kWh [59]. The networks are officially unregulated and have seen their prices rise to levels unaffordable for many people in Lebanon [9].

This has led many individuals and organisations to generate their own electricity. Solar PV has become commonplace throughout the country as households and businesses have installed solar PV systems on their roofs at a cost of around $2,000-$7,000, dependent on the system capacity and whether battery storage is included. LCEC estimated that Lebanon passed the significant milestone exceeding 1,000 MW of rooftop solar capacity in June 2023, of which 663 MW was installed in 2022 alone – a clear contrast to the cumulative total of 90 MW at the end of 2020 – and achieved primarily as a result of small-scale rooftop solar installed in response to the worsening energy crisis [52]. LCEC maintains a list of approved solar providers which meet its qualification criteria, which include compliance with national standards and having installed a cumulative capacity of at least 700 kWp, and featured more than 30 companies as of September 2023 [63].

Public institutions have widely adopted solar PV systems to provide reliable electricity as a backup to the EDL grid. Large-scale solar systems have been installed for hospitals around the country to decrease their reliance on diesel generators, whilst schools have used them to reduce electricity costs in the face of increased pressures resultant from offering second shifts to the increased number of children [9]. Water pumping and wastewater treatment plants have also begun to install solar power to alleviate the unavailability of grid power and the high costs of diesel generation.

Despite their prevalence, decentralised solar electricity systems have only recently been included under the country's legal framework. The Distributed Renewable Energy Law [64], which aims to scale up smaller-scale generation, was ratified by the Lebanese Parliament in December 2023 and represents a significant step in scaling up standalone and rooftop solar, offering the potential to also help to unlock renewable energy financing opportunities through the sale of electricity between private actors [65]. Amongst other objectives, the Distributed Renewable Energy Law:

- Approves all forms and applications of net metering, including for single owners and for groups of tenants or owners, as well as virtual net metering, which allows energy producers to sell electricity to the national grid and be remunerated at the end of the fiscal year; and
- Introduces peer-to-peer energy contracts between generators and consumers without needing to pass through the public grid, with the excess able to be sold to the grid through net metering.

The Distributed Renewable Energy Law will require further refinement to clarify its approvals procedures and the role of entities such as EDL, amongst others, but the implementation of this legislation is expected to allow for power to be provided from decentralised systems to the national grid. This can use bi-directional meters which were introduced by EDL in 2011 [65] and allow power producers to sell electricity to their neighbours. These initiatives could increase the amount of generated renewable energy that is able to be used, by providing useful channels for excess power, and offer new mechanisms for those unable to install their own systems to benefit from the reliability provided by local generation. The total potential generation capacity for rooftops in Lebanon has been estimated at 918 MWp across hospitals (33 MWp), education centres (520 MWp), public buildings (224 MWp) and religious buildings (141 MWp).

Solar water heating

Solar water heating (SWH) systems can provide hot water for domestic uses, such as bathing and washing dishes, as well as in social institutions, such as health centres and schools. Like solar PV, SWH uses panels typically installed on the roof of a building to capture energy from the sun but, instead of generating electricity, captures thermal energy.

In the most common type of SWH in Lebanon, called a thermosiphon, water is heated in the SWH panels and rises into a storage tank installed above them. This passive system relies on gravity and so the water taps should be below the SWH system. Pressurised systems, which rely on pumps, are less common in Lebanon but can have tanks at the same level as the SWH system. Forced circulation systems, meanwhile, pump a heat transfer fluid through the panels, where it absorbs heat, and then through a heat exchanger in a water tank, where heat is transferred to potable water.

Between 2010-2020 there were an estimated 28,392 thermosiphon, 17,325 pressurised thermosiphon, and 2,738 forced circulation systems installed in Lebanon by qualified SWH companies (a list of which is maintained by LCEC) [66]. Whilst in 2017-18 the global SWH market started to show growth following a period of decline, the Lebanese market saw a continued decrease in the number of new installations because of the economic crisis, the restructuring of subsidised loans from Banque du Liban in 2017 which caused local banks to stop offering SWH loans for households, and the COVID-19 pandemic.

SWH systems installed in Lebanon between 2010-2020 had an average panel area around 3-4.5 m^2 and a capacity of around 245-260 litres [66]. SWH system costs have decreased both through technological development and local manufacturing in Lebanon; in 2020, the average cost of a typical system (measuring 4.26 m^2 in area and with a capacity of 252 litres) was $1,114, a decrease of 41% since 2010. As most households use electricity for water heating, transitioning to SWH would reduce electricity bills for users [9] and present systems have been estimated to have saved EDL 321 GWh per year of electricity and 181,573 tonnes of CO_{2eq} [66].

SWH can help Lebanon reach its commitment to using renewable energy for 11% of its heat demand by 2030 [66] and has been highlighted as an important energy efficiency measure for buildings [59]. Despite the shrinking market for new installations, SWH systems continue to offer a good opportunity to save money but will likely require financial incentives – such as grants, loans or innovative financing – to increase their uptake [66]. SWH systems are typically more affordable, have higher efficiencies, and require smaller areas than solar PV but, with electricity the priority for many households, water heating may be in competition with electricity generation for limited roof space around Lebanon.

Solar water heaters are relatively affordable, have high energy efficiencies, and require smaller areas than solar PV.

04

Energy needs of vulnerable communities

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Energy in the Lebanon Crisis Response Plan

The LCRP identifies that the energy sector in Lebanon has a significant role to play in improving access to electricity for households and public services which have been affected by the Syria crisis [9]. The LCRP aims to provide electricity services to both Lebanese host community members and displaced people, whilst also minimising the impacts on the environment and on the finances of the Government of Lebanon. To do this it presents four main outcomes:

- Increasing renewable energy production and storage capacity,
- Reducing energy demand through energy efficiency measures,
- Rehabilitating and reinforcing transmission and distribution networks, and
- Enhancing the capacity of MEW to plan, budget and oversee energy sector initiatives.

The LCRP looks to address how improved energy services can support four cross-cutting issues: water, particularly for pumping stations; education, as many public schools have accommodated displaced Syrians through second shifts; health, especially for the provision of essential care services and cold chains; and social stability, to avoid tensions between people and communities over scarce and expensive fuel resources. Each of these has been affected by the ongoing economic and Syrian crises, as well as other factors such as the COVID-19 pandemic.

Despite acknowledging that the issues affect all vulnerable populations in Lebanon, the energy components of the LCRP target only a fraction of vulnerable Lebanese people and displaced Syrians. With 1.5 million people in each of these cohorts, the energy sector outcomes target 406,365 vulnerable Lebanese people (27%) and 272,122 displaced Syrians (18%).

The LCRP does not include Palestinian refugees in Lebanon and Palestinian refugees from Syria living in camps in Lebanon in the energy sector outcomes. The LCRP also notes the government policy that no formal infrastructure should be installed in informal settlements, such as those which host displaced Syrians. It does, however, acknowledge that these settlements require comprehensive assistance for basic services, such as electricity and cooking appliances, and that street lighting could provide a major benefit to both displaced and host communities.

Aiming to put the needs of the most vulnerable first, the LCRP prioritises activities and projects with the highest quantity of affected people who currently do not have sufficient quantity, quality or continuity of services related to electricity. It will implement planned priority projects as part of the government's strategies, focus on areas at high risk of environmental degradation or social stability issues, and focus on groups which may require specific assistance such as female or child-headed households, elderly or disabled persons, and children. Overall, the LCRP targets 332 municipalities, 147 hospitals and healthcare institutions, 864 schools, and four water establishments under its energy focus.

> **"By the end of 2023, all vulnerable populations in Lebanon will have improved and equitable, sustainable access to all forms of electricity."**
>
> – Lebanon Crisis Response Plan 2023

Energy for households and businesses

Households and businesses in Lebanon are heavily impacted by the energy crisis. Whereas before the crisis the average electricity supply was 12 hours per day, a 2023 study by HRW found that the provision from EDL had decreased to only two hours per day. Both the lack of availability of electricity and its irregularity cause issues for households and businesses, which are not able to plan their days because they must shape their tasks around when (or if) electricity is available.

Lucrative networks of unregulated private diesel generator operators, some which serve buildings or entire neighbourhoods, have become the primary electricity source for many households and businesses. Skyrocketing prices of diesel generator bills, further exacerbated by the war in Ukraine and nationwide inflation, have made a stable supply of electricity a great expense for most households and unaffordable for those with lower incomes [58]. In 2021, the government lifted fuel subsidies and began to finance fuel imports at a higher rate than the official exchange rate in an attempt to alleviate fuel shortages [67]. Prices for fuel nearly doubled as a result, with no other form of support being introduced for lower-and middle-income households, increasing the financial pressure on them. The VASyR found that households were spending LBP 406,810 on average in 2022 on electricity from both the grid and private generators, a stark increase from LBP 17,674 for electricity from the national grid and LBP 47,566 for electricity from diesel generators in 2021 [28].

This sharp increase in electricity bills further exacerbates already high levels of inequality [58]. Lower-income households have been found to spend a much higher proportion of their monthly income on generator bills: 88% for households in the lowest-income quintile, compared to 44% for the average household and 21% for the highest-income quintile. Nearly one in four households surveyed by HRW reported having had their electricity shut off due to failing to pay their bills, for diesel subscriptions.

To supplement the availability of electricity, and in addition to the ubiquitous reliance on diesel, 7% of the surveyed population were found to rely on an uninterruptible power source (UPS) and fewer than 2% on solar systems [58]. The need to rely on multiple electricity systems contributes significantly to the high prices that households must pay for electricity. Despite the great expense incurred for alternative sources of electricity to the grid, the HRW study found that Lebanese households go without electricity for a large part of the day (for 9 hours on average), compared to 1.5 hours before the crisis, with significant regional fluctuations [58]. It also found that households in the lowest-income quintile make do without electricity for a longer time (11 hours on average) than households in the highest-income quintile (6 hours).

Rising prices, both for electricity and across the economy, have resulted in almost 90% of surveyed respondents in the HRW study in 2023 reporting that electricity costs have affected their ability to pay for other essential services [58]. Nearly two-thirds of respondents reported not being able to pay for heating within the last year, 37% reported that it affected their ability to keep their homes at a safe temperature, and 34% said that it impacted their ability to cook or heat food. Over 50% say they had not been able to pay for tuition fees or school materials, with over a third saying they were struggling to pay for school meals, and 43% reported having been unable to pay for medicine and other health-related expenses. Two-thirds of respondents said the lack of electricity had meant they were not able to keep food refrigerated or frozen and 47% said that it hindered them from getting sufficient water, as most households rely on electric water pumps.

In addition to the economic impact on households, air pollution caused by heavy reliance on diesel generators has had a detrimental impact on people's health and on the environment [68]. A study by the American University of Beirut found that the rate of carcinogenic pollutants in the atmosphere has doubled since 2017, leading to ››

Energy for households and businesses

higher rates of lung cancer, including in younger patients [69]. The unregulated diesel networks also pose a serious safety risk when faulty or overloaded generators catch fire or explode. Such incidents have significantly increased since the crisis when it became necessary to use generators for longer periods of time.

In response to the national energy crisis, Lebanon has experienced a "solar revolution": the country went from generating almost no electricity from solar in 2010 to having installed 90 MW of installed solar capacity in 2020, surging with the installation of a further 100 MW in 2021 and passing 1,000 MW of rooftop solar alone in 2023 [52], [60]. There has been a significant increase in the demand for privately-installed solar systems in particular as these rooftop systems have the potential to both reduce electricity bills and provide a more stable supply of electricity [68]. Solar water heaters (SWH), which use thermal collectors rather than electricity to heat water for domestic uses, have also become popular with estimates that these systems can reduce household electricity bills by 80% [70].

While the increasing use of solar energy has the potential to be a more sustainable and affordable source of electricity than the current diesel-reliant infrastructure, a lack of clear regulations also carries risks [68]. Systems are often not sized correctly and do not always meet quality standards. Increasing technical capacity and regulatory oversight to ensure systems are optimised and standardised would be crucial to enhance the sustainability of the solar transition.

Although solar installations do not emit toxic emissions or greenhouse gases during use, unlike diesel generators, at the end of their lifecycle they become electronic waste which can be harmful to health and the environment if not disposed of correctly. This burden is likely to fall on those working in waste management, a sector which has notoriously struggled through many crises in Lebanon, with 44% of solid waste in the country being disposed of in open dumps and only 6% reaching recycling facilities [71].

In addition, solar systems are typically affordable only to higher-income households [68]. The high upfront costs of solar systems, typically costing at least $5,000 for high-quality systems according to estimates, makes them out of reach for many vulnerable households and small businesses. Cheaper systems – starting at around $2,000 to $3,500 [60] – are available but are often substandard and have shorter lifetimes, meaning that low-income households ultimately pay more for lower-quality installations [68]. According to an assessment by Mercy Corps [72], a lack of financial schemes specifically for renewable systems was the key barrier to uptake. Because of the economic crisis, suppliers are less willing to offer instalment payments to purchase the systems. Furthermore, the unequal access to solar energy is also manifested through the fact that many vulnerable households tend to live in rented accommodation and so cannot access solar systems due to the limited availability of (or denial of permission for accessing) rooftop space in overcrowded urban areas.

Small businesses represent 97% of formal businesses in Lebanon and embody the backbone of the economy, spanning the services, manufacturing, and trade and retail sectors. There are over 200,000 SMEs which are mostly family-owned; 91% have fewer than five employees and one in five are owned by women [73]. Around 51% of Lebanon's population rely on small business for their livelihoods [74] in sectors like agro-food processing, manufacturing, construction, retail, cosmetics, and digital services.

These SMEs have also struggled immensely due to the electricity crisis. An assessment by the Near East Foundation (NEF) in 2022 found that 67% of surveyed small businesses were unable to operate normally due to electricity shortages, and 35% reported insufficient water (which also relies on electricity) impacted their operations. Over ››

Energy for households and businesses

half of the surveyed businesses reported having electricity for no more than 3 hours per day. The unreliability of electricity access makes production scheduling challenging because businesses are not always able to complete their services as they get interrupted by blackouts [75].

In addition, the volatility of diesel prices makes it difficult for businesses to forecast and budget for their energy expenses. For this reason, over 50% of the 30 micro-businesses in Beqaa, Baalbek-Hermel and North Lebanon surveyed by the Mercy Corps assessment own a private generator to ensure continuous electricity access [72]. Bills for diesel generator operators have increased up to $1,500 per month and also incur maintenance costs, with spare parts not always being readily available, and the quality of diesel is sometimes poor which can result in damage to equipment. Businesses which rely on diesel subscriptions spend an average of $330 per month and most take efforts to minimise their use of electricity.

Solar installations have become more widespread as enterprises seek to lower their electricity costs. Despite the tangible benefits of a solar system, businesses face similar challenges to households and struggle to make the initial investment due to high upfront costs. The current financial crisis and the collapse of the banking sector has meant that access to finance is rarely available, with microfinance institutions struggling to obtain financing capital due to Lebanon's high risk rating. Solar energy suppliers have also stopped selling systems on credit or offering instalment payments [72]. The inability to access finance means that many businesses cannot keep up their stock for their general operations, which further reduces their profit margins, which in turn impacts their ability to make investments. Uncertainty about the future and the current negative economic prognosis also make SMEs unwilling to take risks and make investments.

Moreover, the sector is characterised by low-quality products which involve high maintenance costs, coupled with inconsistent guidance from suppliers and limited technical knowledge from businesses [72]. Many technicians are familiar with specific brands only and lack more general repair skills. Some suppliers purposefully sell lower-quality products to gain a foothold in the market; this contributes to a great increase in e-waste for which there is currently no adequate disposal mechanism.

According to the Mercy Corps assessment, solar energy is a more viable option for some sectors than others [72]. Retail shops, for example, were found to have the lowest rates of access to solar energy due to space and location issues as they usually are in densely populated areas in shared buildings with limited rooftop space for solar installations. The study found that despite accessing electricity for an average of only 9.7 hours per day, most retail shop owners were unwilling to ››

> "I wish we could get more solar power to replace the generators, but it is a big investment. In these times, we are afraid to make big moves."
>
> – Agro-food processor in Baalbek-Hermel region [72]

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make the costly investment of the solar installation. Instead they were most likely to have a diesel generator subscription, which is perceived as the most cost-effective and hassle-free solution as the subscription fees cover operation and maintenance (O&M) costs.

By contrast, diesel subscriptions were far less common for manufacturers which, owing to their higher power demands, were more likely to have their own source of electricity [72]. Half relied on their own solar installation which they used for an average of 7 hours per day or their private generator which they used for 9 hours electricity. The power-intensive nature of their work means that solar lighting is mostly used for appliances that are unrelated to their production processes: this means that investing in solar energy could be particularly costly for manufacturers. Energy efficiency measures could provide much potential to reduce the energy costs for this sector.

The agro-food industry uses lower-intensity electricity for longer periods of time (an average of 22 hours per day) as a result of demands such as overnight refrigeration [72]. This group was found to often have diversified power sources and use solar installations for an average of 13 hours, with battery storage being common and essential. The Mercy Corps assessment noted that, in this sector, labour costs remain worryingly low which means they currently offset the high energy costs.

In response to the challenges faced by households and small businesses to access reliable electricity, several projects have been implemented:

- With funding from MEW and in collaboration with EDL, LCEC implemented the 3 Million Lamps project to replace three million incandescent lamps with compact fluorescent lamps (CFLs) in approximately one million households, building on a pilot project conducted in Beqaa valley with UNDP [76]. LCEC also developed a standards and testing programme for CFLs and other household appliances.
- LCEC implemented the Solar Water Heater Subsidy Programme, which consisted of 0% interest loans provided by the Central Bank of Lebanon to install solar water heaters with a financial cap of $5,000 [77]. LCEC developed a list of qualified companies to provide their products as part of this scheme.
- NEF and SHEILD Association implemented the Em(power) pilot project in which they supported municipality-level renewable energy solutions in the South of Lebanon which were developed through community consultations.
- USAID launched the $20 million Solar and Renewable Energy Fund to support SMEs with loans for solar installations [78].
- Banque de l'Habitat in collaboration with LCEC launched a scheme to provide loans to Lebanese households and small businesses for solar PV systems [52].

While these programmes illustrate a variety of promising approaches to increase energy access for households and businesses, the need greatly outstrips the support available. In particular, access to financing mechanisms will need to play a key role in making these solutions more affordable to a wider range of households. Quality standards coupled with increased oversight and clear regulation would also be important to support a more fair, sustainable transition to clean energy, rather than the current piecemeal situation in which only higher-income households can access a system and the quality of systems varies greatly. ●

Électricité de Zahlé

In a country afflicted by severe electricity cuts, with residents having to cope with only a few hours of electricity per day, the city of Zahlé in Beqaa Valley stands out as a bright exception [62]. Along with 16 surrounding villages, the city enjoys 24/7 electricity supply provided by the utility Électricité de Zahlé (EDZ).

The company relies on a mixture of discounted power provided by EDL, which it buys from the national grid when it is available, as well as subsidised fuel imports for its own diesel power plant. Tariffs are set by MEW and the company has achieved profitability while being able to provide electricity at rates comparable those of private diesel generator networks. EDZ also has a reliable mechanism to collect almost 100% of its payments; EDL, meanwhile, has a collection rate of around 60-70%, resulting in shortfalls of billions of dollars.

EDZ's business model has worked relatively well but the ongoing economic crisis and rising fuel prices have placed a strain on the company. The increasing unavailability of electricity from EDL has further increased the amount of fuel that EDZ needs to purchase. The power generation technology used by EDZ – high-speed diesel engines – are relatively inefficient, exacerbating fuel usage and costs. Due to these constraints, EDZ now rations the electricity it provides to industrial customers.

Renewable energy provides an opportunity to improve the situation in Zahlé as well as in the rest of Lebanon. Many customers have purchased solar systems, encouraged by a net metering agreement that gives them a discount on their bills in exchange for feeding solar-generated power into the grid. Of the 70 MW produced by EDZ, 11 MW was generated by renewable energy in 2021. For EDZ customers it is relatively cheap to purchase solar installations as the relatively reliable supply of power eliminates the need for batteries.

EDZ has investigated the possibility of a utility-scale solar farm, due to its short-term contract with the government, but ultimately decided against it as the large investment was deemed as too financially risky. Long-term licenses for power producers and a consistent policy framework would greatly support much-needed investments in larger-scale electricity generation.

Despite its successes, there are drawbacks to EDZ's current model such as its reliance on diesel generation and that it diverts scarce central government resources to a city that is relatively well off. Even so, the company provides an interesting example of how a regional utility model can rapidly facilitate high-quality electricity provision alongside the national grid, and without having to wait for much-needed reforms at the national level. With long-term contracts and other reforms, other regional utilities could also attract more investments and improve electricity provision for their customers. ››

Of the 70 MW produced by EDZ, 11 MW was generated by renewable energy in 2021. For EDZ customers it is relatively cheap to purchase solar installations as the relatively reliable supply of power eliminates the need for batteries.

Électricité de Zahlé

In the words of Zahlé residents

The READS Programme conducted qualitative research to learn the perspectives of residents, businesses, and social institutions in Zahlé on EDZ's electricity provision. Overall there were high rates of satisfaction among customers, who were happy with the reliability of EDZ's electricity, and they recognised that they were better off in this regard than in other parts of Lebanon.

This reliability comes with higher costs, however, and interviewees almost universally mentioned the challenges related to the affordability of EDZ electricity. "Despite being satisfied with their services, the accompanying electricity bills are a concern due to their expensive nature. While the consistent power supply is highly appreciated, exploring avenues to make the cost more manageable would be an area of interest for us," said a Zahlé-based resident. People living in Zahlé employ a variety of strategies to reduce their electricity usage: some residents have switched from electricity to gas to power heaters and stoves, while others limited their use of air conditioning, heating, and elevators.

Increasingly, residents are investing in their own solar systems and battery storage. One interviewee described the perceived advantages of these installations: "Some of my neighbours have already installed solar power systems, and they are more privileged than me since they probably enjoy benefits such as reduced electricity costs, increased energy independence, and a more sustainable energy source." Respondents who already have solar with a battery storage tended to agree, with one resident summarising the situation: "On the positive side, having battery storage allows me to store excess energy generated during sunny periods for use during cloudy days or nighttime, providing a more consistent power supply. However, the downside is the recurring cost and effort of replacing these batteries annually, adding to the overall maintenance expenses of the solar system."

For some, the ongoing struggle of paying high electricity bills has made the initial upfront investment in a solar installation even more inaccessible. A school in Zahlé, for example shared that "the primary challenge we face with EDZ is the monthly cost, ranging between $400 to $500. Affordability becomes a hurdle, and while we recognise the potential benefits of solar panels, it's currently beyond our financial reach."

Despite this, with exorbitant fuel prices making solar installations affordable in comparison and awareness of environmental sustainability rising, it is a matter of time before Lebanon's solar revolution takes over Zahlé, supported by its net metering arrangement. Increased energy independence and reduced reliance on fossil fuels are benefits that Zahlé's residents strive for, as in the rest of Lebanon. Just as renewable energy investments are likely to provide significant long-term savings for EDZ, smaller-scale solar installations promise the same for households, businesses, and social institutions in Zahlé.

> We are privileged to have EDZ supplying 24 hours daily while other nearby areas receive only around 2-3 hours daily."
>
> – Resident of Zahlé

Energy for households and businesses

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BARRIER	OPPORTUNITY
Reliance on expensive and unregulated diesel networks which cause significant pollution	Municipal-level solar installations, high-quality smaller-scale solar systems with battery storage, and combining generators with PV and storage solutions
Solar systems are not affordable for most lower-income households and SMEs, and there is a lack of financial schemes for renewable energy systems	De-risking green financial products like credit guarantee funds, solar leasing schemes, instalment payments, subsidies for lower-income households, pooling SMEs to invest in renewable energy
Lack of clear regulatory frameworks for off-grid generation	Develop supportive, enforced government policies and incentives for decentralised generation
Substandard solar PV systems and systems are being installed in an unregulated manner	Enforce quality standards and checks, create a comprehensive list of accredited suppliers
Lack of post-sales services and generation of e-waste	Require suppliers to provide post-sales services, develop and implement e-waste management systems
Risk aversion and lack of consumer awareness	Promote information about cost-value comparisons and energy efficiency measures, affordable energy audits to support businesses in making decisions

Energy for public institutions

The overlapping crises in Lebanon have put an increasing strain on public services and these issues have been compounded by a lack of reliable and affordable energy. In particular, the education and health sectors have been heavily impacted by the high costs and low availability of electricity: these have negatively affected learning environments for young people and compromised the ability of clinics and hospitals to provide high-quality care.

Energy for education

The Lebanese education system has needed to accommodate a large number of displaced Syrian children into the public school network [9]. This influx has strained the operational capacity of the education system and schools responded by providing second shifts to allow a greater number of students each day. The resource requirements and operational costs – including for energy – have increased as a result, whilst other issues have also impacted the sector, including the economic crisis devaluing the salaries of teachers, students continuing to struggle with COVID-related learning loss, and the overall defunding of the public school system.

In 2023 the LCRP reported that an estimated 1.45 million children (around 662,000 Lebanese, 715,000 displaced Syrians, 56,000 Palestinian refugees, and 13,000 migrants) were in need of support for access to education [9]. It estimates that 10% of the 1.2 million Lebanese children of school age do not access any form of education, mostly owing to economic vulnerabilities, and 60% of displaced Syrian children are outside of formal education. Poverty was found to be the main driver of education-related vulnerability across all vulnerable groups, with costs of transport and educational materials affecting enrolment, whilst other factors such as child labour (affecting 31% of Syrian boys and 5% of Syrian girls) and marriage (1% and 7%) mean that children are unable to attend school. A change in policy by the Ministry of Education lifted registration restrictions on displaced Syrian children and was implemented from the 2022-23 school year; this has resulted in an increase in registrations at second-shift schools which mainly serve that vulnerable group. Many barriers to attendance and attainment remain, however.

The LCRP sets out detailed objectives for the education sector which include increasing inclusive access to education, improving teaching and learning through formal and non-formal services, and enhancing governance and management of the sector. It also acknowledges the critical role of energy in education. Schools require electricity to provide a conducive learning environment for all ages, from kindergartens up to tertiary education, through lighting to read and study, computer and internet access for e-learning, administrative tasks, and other key functions. In addition, schools require energy for heating and cooling depending on the season and additionally for cooking, where meals are provided. The LCRP features opportunities for several energy-related measures and targets 864 schools for energy interventions [9], highlighting how implementing energy efficiency programmes can reduce electricity consumption, for example through LED lighting and lighting controls in schools.

In the face of these ongoing issues, many organisations have implemented renewable energy systems for schools, including the following examples:

- The Government of Japan funded ECOSYS, a solar energy provider, to install PV systems at 122 schools across Lebanon, completing the project in March 2021 [79]. The project was divided into lots representing groups of schools in different regions of the county, with four system sizes (6 kWp, 10 kWp, 15 kWp and 20 kWp) in each lot. ››

Energy for public institutions

- Under the EU-funded Energy Smart Mediterranean Schools Network project, in 2021 LCEC released an expression of interest to install solar PV and battery systems in three schools [80]. Separately but under the same project in 2023, LCEC released a request for proposals to retrofit schools with new LED lighting and install grid-interactive solar PV and battery systems in Tripoli, North Lebanon [81]. The systems were required to provide at least 12 kWp of solar PV and 20-30 kWh of battery storage for each school.

- In 2022, UNDP installed a solar PV system at Batloun Public Intermediate School, Mount Lebanon, under the EU-funded CEDRO V project which has been estimated to produce 10 MWh of electricity per year, save 8 tCO_{2eq} annually, and cover more than 70% of the school's energy demand [82].

- The Sustainable Facility Management at Public Schools in Lebanon (SUFA) Project, funded through GIZ Lebanon, aims to keep schools operational through ensuring sustainable electricity access in its targeted areas and to reduce energy consumption, amongst other environmentally-focused goals [83]. As of May 2023, the Project had released a request for proposals through LCEC to provide around 430 kWp of solar PV capacity across 21 schools [84].

- In August 2023, the French government invited solar PV suppliers to submit proposals to equip 56 francophone schools with PV systems [85].

- UNRWA has installed solar PV systems in three of its 64 schools and plans to install renewable energy at a further 12 schools between 2024 and 2026.

Whilst these systems demonstrate the potential for solar system usage for educational institutions, they fall short of the potential 520 MWp capacity estimated to be possible to install on school rooftops around the country [57].

These energy interventions have provided benefits in many schools but the LCRP also highlights how those which already have solar installations now require additional battery capacity owing to the reduced availability of the national grid. It estimates that this would require relatively little funding: around $15,000 to provide solar and batteries, or around $10,000 for batteries where solar PV is already in place. Battery storage could provide electricity during low-generation periods, such as during poor weather or in the evenings, when solar panels alone are unable to supply sufficient levels of power. Batteries can also store power from solar panels which otherwise would go to waste, for example during weekends or holiday periods when schools are not in use. This might be limited, however, by space constraints: either for panels, if the available roof area has already been used, or for batteries, which would need a dedicated and secure room in the building.

Over the long run, solar and battery storage systems provide clear and direct benefits through increased power availability and savings on electricity bills. However, these require a significant upfront investment which often cannot be covered through education budgets and makes implementation highly reliant on external donor funding. Large-scale funding from foreign governments and international organisations can have a transformative effect in reaching large numbers of schools under the same project: this could be channelled through government ministries or humanitarian and development organisations, but funding from individual donors and the Lebanese diaspora could also fund systems for specific schools. ››

Energy for public institutions

Energy for health

Alongside the multiple crises affecting the country, the health sector has experienced additional challenges resulting from the COVID-19 pandemic and outbreaks of cholera throughout the country [9]. National pressures, such as the increasing number of vulnerable people and the devalued currency, combined with global issues such as high fuel prices and shortages of medicines, have meant that Lebanese health institutions are under great strain.

Costs have been found to be the greatest barrier for vulnerable populations in accessing healthcare [9]. Lebanese women reported having more difficulty in affording the cost of treatment compared to men (78% and 67%) with many relying on coping mechanisms to mitigate this: 65% of Lebanese switched to substitute or generic medication compared to 49% of displaced Syrians, while both groups relied on rationing existing medication at similar rates (30% and 25% respectively). Issues around the affordability of healthcare are magnified for households with higher health expenditures – such as those with a person with a disability or chronic illness, older people, young children, adolescents, or survivors of sexual and gender-based violence. Reducing expenditure on health was reported by 25% of Lebanese people, 60% of displaced Syrians, and 23% of Palestinian refugees in Lebanon.

As a result, the LCRP focuses on four key outcomes to support the health sector: improved access to primary healthcare, improved access to hospital and advanced referral care, improved preparedness to outbreaks and infectious diseases, and the fundamental rights and access to basic services and information [9]. Similarly to the education sector, the LCRP highlights the importance of energy to the health sector. Health centres require uninterrupted and high-quality electricity to ensure vaccines and other medicines are adequately cooled, to power equipment for critical procedures, and to provide a range of planned and emergency procedures, amongst many other uses. Similarly to schools, hospitals must provide a temperature-controlled environment which is safe for patients, and provide meals.

As health facilities rely primarily on power from EDL, the frequency and duration of blackouts has severely affected their ability to provide essential services to communities. Health centres typically use diesel generators to ensure that power remains available but the high cost of fuel causes further affordability issues for the already resource-constrained healthcare sector. As most funding goes towards covering critical operational expenses there is extremely limited capacity to invest in energy efficiency or renewable energy which typically have high upfront costs. This presents a missed opportunity as investing in these measures would allow for long-term reductions in energy bills. The LCRP estimates solar power can reduce the ongoing costs of running generators by tens of thousands of dollars per year for a typical health centre [9].

Increasingly, the installation of solar systems has become widespread and has helped meet the electricity needs of health centres. However, many facilities do not have access to solar energy yet. For those who do, the limited area for solar panels means that the amount of electricity they are able to generate falls well below the needs, with diesel power continuing to make up the shortfall. More solar energy installations are needed, especially for smaller primary health centres and dispensaries, to ensure that the benefits of renewable energy are available to all.

The LCRP targets 147 hospitals, primary health centres, and other healthcare institutions for energy interventions. It proposes energy audits to identify and implement energy efficiency measures whilst highlighting the limitations of the ››

Energy for public institutions

existing humanitarian aid system: most aid focuses on access to healthcare through subsidisation, but far less support exists to increase the service capacity of hospitals which is severely limited by financial resources. As a result the LCRP advocates for renewable energy systems to reduce fuel costs, thereby increasing available funds for healthcare services and making the healthcare system more resilient. It also acknowledges the scale of the challenge, estimating that energy efficiency and renewable energy measures for a hospital could cost between $10,000 to $100,000.

The installation of renewable energy for public institutions, or the increase in capacity of existing systems, has clear and direct benefits from reducing energy bills. In support of this, international and local organisations have partnered with health centres to provide sustainable electricity, including the following examples:

- In 2022, UNHCR supported the solarisation of 11 health facilities in Beqaa; it also installed solar PV in government hospitals in Tripoli and Halba in North Lebanon, estimated to reduce monthly fuel costs by $41,000 and $29,000 respectively [86].
- In June 2023, UNICEF worked with two companies to complete the solarisation of 150 primary healthcare centres across Lebanon in just 13 weeks using funding from the governments of Germany (through KfW Development Bank) and the United States; it also identified that more than 600 dispensaries still struggle with power cuts and their potential for solarisation was being assessed [87].
- In May 2023, the Ministry of Public Health and UNOPS completed a project to install 266 kWp of solar PV on each of three public hospitals in North Lebanon, Beqaa, and Nabatieh governates, funded as part of a $1.3 million project from the Government of Japan [88].
- UNRWA has installed solar PV systems in seven of its 27 health centres across Lebanon, significantly improving access to power, particularly for essential cold storage for medication and vaccines.

These programmes, amongst others, have demonstrated the viability and advantages of providing locally-generated, renewable electricity to support health services, but many challenges remain in scaling up these initiatives across ››

"The installation of solar systems provides a reliable and environmentally friendly energy solution that alleviates the burden on the national grid while reducing carbon emissions and paving the way for a greener and healthier Lebanon."

– Hicham Fawaz, Head of the Hospitals and Dispensaries, Department at the Ministry of Public Health [90]

Energy for public institutions

the country. A potential solution for many facilities which already have solar systems would be to increase their battery storage capacity; this could maximise their ability to fully utilise the electricity they generate and minimise their reliance on other sources. It would also help mitigate against the unavailability of EDL power and high fuel costs.

A further opportunity would be to combine the energy needs and generation capacities of public institutions. The high electricity usage of hospitals – many of which suffer space constraints on their own rooftops, limiting their solar generation potential – could be supplemented by electricity generation from schools, if such a local network could be established under the new Distributed Renewable Energy Law. A study by the Lebanese Foundation for Renewable Energy and the National Council for Scientific Research explored the case of Rizk Hospital, Beirut, being supplied by 12 education centres within a 1 km radius [89]. It found that supplying electricity through either solar-battery-diesel or solar-diesel systems would significantly reduce costs compared to the baseline diesel-only systems, and either option could have a payback time of less than four years. This could provide significant cost savings for all institutions compared to the heavy reliance on diesel generation [89].

Moving to a private sector-led model could improve the affordability of renewable energy systems by spreading payments over a longer period, rather than a single large instalment. If a health centre and an energy company could enter into a long-term agreement, such as for a loan or power purchase agreement (PPA), then the monthly payments could be comparable to (or ideally less than) present spending on diesel and hence result in cost savings. In addition to potential challenges with the regulatory framework governing such an arrangement, it would require the company to cover the initial cost of purchasing the equipment which may incur its own financing challenges.

BARRIER	OPPORTUNITY
High cost of fuel for diesel generators	Install solar PV systems with battery storage
High upfront costs of solar PV systems and batteries	Leverage grant funding from international and governmental donors, including the diaspora and other private entities. Establish PPAs between health centres and private companies, paying for electricity through cost savings from reduced diesel consumption
Different amounts of electricity generated and consumed by each institution Limited space for rooftop installations and battery storage systems	Establish a network to combine public institutions, transferring excess electricity from one facility to one in need of more power

Energy for water and sanitation

Access to water, sanitation, and hygiene (WASH) services – including the provision of safe water for domestic purposes and the treatment of wastewater – is limited throughout Lebanon. Nearly 2.8 million people face challenges in accessing sufficient quantities of water for drinking, sanitation and domestic use whilst WASH-related needs have increased by more than 25% since 2022 in all 26 districts of the country [9]. As with other public services, the country's overlapping crises has increased the pressure on Lebanon's water infrastructure: alongside water shortages, limited capacity has resulted in public health risks including widespread cholera outbreaks, environmental damage from uncontrolled discharge of pollutants, and increased tensions between communities.

A lack of reliable electricity severely limits the functions of WASH facilities. Across the WASH sector around 70-80% of electricity consumption is used by water pumping and distribution, such as to deliver water to communities, with the remainder needed in wastewater plants to remove contaminants and pollutants to make water safe to reuse or dispose of in the environment [91]. EDL is the main electricity source for 87% of water supply facilities across the country and, when only a few hours of power are available per day, these facilities must either suspend operations or rely on diesel generators for backup power [92]. High cost of fuel places a significant burden on organisations' balance sheets and limits the duration of operation, ultimately affecting the supply of water for communities and often forcing them to rely on other sources, such as trucked water.

Limited access to WASH affects all vulnerable groups. A study by Human Rights Watch, published in 2023, highlighted some of the water challenges faced by households as a result of the lack of electricity [58]. Most households that were surveyed relied on electric pumps to provide water in their homes with nearly half reporting that blackouts affect their ability to receive water; amongst these, 85% said that this happened either once per week or almost every day. The proportion of Lebanese households which reported not having sufficient water to cover at least one basic need increased from 20% in 2021 to 32% in 2022, whilst for PRL households this increased from 19% to 44%; meanwhile displaced Syr- ››

> "In July 2022, 79% of Lebanese agreed with the statement that 'The presence of so many Syrian refugees in Lebanon today is placing too much strain on Lebanon's resources, like water and electricity', with more than 90% of agreement in Beqaa, Beirut and the North Governorates."
>
> – Lebanon Crisis Response Plan 2023

Energy for water and sanitation

ian households reported having insufficient or barely sufficient water for washing or domestic purposes increased from 33% to 56% [9].

There are many issues relating to providing sustainable long-term solutions to informal settlements, including for water services, and as of 2022 water is trucked into 45% of informal settlements [92]. Decreasing funds allocated to WASH services in informal settlements has meant that the provision of water has been limited to just 7.5 litres per person per day, well below the standard of 35 litres to cover drinking, cooking, hygiene, and domestic needs. The ability of organisations to remove sewage in informal settlements has been similarly diminished. Whilst water-related issues manifest differently between and within communities, the LCRP acknowledges the need to support equitable and dignified access for all vulnerable communities and promotes equal access to services to reduce the risk of resource-based tensions.

MEW is the government body responsible for water in Lebanon: it leads the WASH sector at the national level, which is coordinated by UNICEF and World Vision and supported through thematic groups. Lebanon has four Water Establishments (WEs) covering separate regions (Beirut and Mount Lebanon, North Lebanon, Beqaa, and South Lebanon) which are responsible for both drinking water and wastewater treatment. WEs do not receive funding from the central budget and so must rely on tariffs to recoup their costs; a combination of low tariffs and low rates of collection, exacerbated by the weakening currency, means that expenses outweigh revenues [92] and, according to their financial reports, three WEs were experiencing severe deficits in 2022 [9].

WEs, alongside other public services and refugee camps, were identified by MEW in 2022 as a key institution that must repay their overdue electricity bills in order to stabilise the finances of the electricity sector [56]. A study by the American University of Beirut, based on available data, found that the North Lebanon Water Establishment ran a deficit of $15.3 million to EDL across the years 2016-2020, whilst the Beqaa Water Establishment owed $5.6 million for 2017 alone and the South Lebanon Water Establishment owed $6.1 million for 2018 [91]. The five-year Water Sector Recovery Plan, put forward by MEW in 2022, highlights the need for the ratification of key water policies to reform and support the WASH sector, with key investments and cost-recovery plans as critical components.

Programmes which support the transition to local renewable energy have been identified as key components to strengthen the WASH sector. Derived from MEW's plans and strategies, the LCRP recommends that the water and energy sectors collaborate to reduce the reliance on the national grid and fossil fuels through implementing renewable energy projects and gravity-fed systems where feasible [9]. Similar recommendations have been made by the WASH sector which also highlighted the need for support from the Government, especially for loans, and the wider donor community [92]. Amongst others, some of the projects to support water pumping and sanitation systems to transition to renewable energy which have been implemented around Lebanon include:

- The Lebanon-Water Project, implemented by DAI and funded by USAID, invested $800,000 to build a solar-powered pumping station for the Beqaa Water Establishment in 2019 [93]. The system provides 24-hour water services to 21,000 residents of Ghazzeh and saves an estimated $60,000 per year in fuel costs.

- In 2021, UNHCR and the René Moawad Foundation inaugurated a 545 kWp solar system for the Qobayat water station which supplies clean water to 20 villages in Akkar [94]. Before the installation the water supply was sub- ››

Energy for water and sanitation

ject to strict rationing, with power supplied for only six hours once per week. The new solar system, which cost $87,000, provides water to around 25,000 residents and is estimated to save the North Lebanon Water Establishment at least $5,000 per month.

- In 2023, UNHCR and INTERSOS, an Italian non-governmental organisation (NGO), implemented a 162-panel solar system at the Saab well in Choueifat, Aley, operated by the Beirut and Mount Lebanon Water Establishment [95]. The system supplies water to 40,000 Lebanese people and 5,000 displaced Syrians living in the Choueifat el Qobbah and Choueifat el Oumara neighbourhoods and is estimated to save the WE more than $28,000 per year.

- The same partnership, also in 2023, implemented a 248-panel solar system to provide drinking water to 80% of the residents of Damour village. The project reached around 6,000 Lebanese people and 1,500 displaced people and reduced the monthly fuel costs by 50%.

- In July 2023 the Government of Japan and UNOPS launched a project to provide renewable energy and energy efficiency measures for water pumping stations and public hospitals in Nabatieh and Beqaa Governates [90]. The project aims to reduce operational costs for WEs, lower the reliance on diesel generators in the absence of national grid electricity, and support further investment in renewable energy.

- UNRWA has installed solar-powered water pumping at 13 installations associated with Palestinian refugee camps.

Whilst these projects represent valuable steps forward towards increasing the uptake of renewable energy for water pumping and sanitation in Lebanon, many barriers remain. One is that the electricity consumption of water facilities varies greatly which has a significant impact on system design. For energy security reasons, a renewable energy system might be designed to provide enough power to satisfy high levels of usage on a low-generation day, for example a cloudy day in the winter. This means that there can be significant amounts of overgeneration – and therefore energy wastage – on days with lower electricity demand or sunnier weather. Facilitating net metering, through which electricity could be sold to other consumers or provided to the EDL grid, could utilise this electricity and increase the overall availability of the network for other users.

READS workshop participants highlighted additional concerns about access to water services, describing how the provision of water has been negatively impacted by high fuel prices, making water more costly to pump into homes, and that the lack of government oversight on the cleanliness of water could be a public health concern. Climate change is exacerbating the scarcity of water in some regions, such as Bint Jbeil in the south of the country, caused by the wastage of river and spring water. These issues are felt around Lebanon but more acutely in certain regions: participants shared that water policies and regulations are weaker, or less strictly enforced, in remote areas, whilst water wells are scarcer altogether in mountainous regions. Illegal infringements on the main water networks cause an unequal distribution of water resources across the country and increase the strain on the network.

As with almost all applications of renewable power, providing decentralised electricity solutions to water facilities comes with a high initial capital cost. The price of system components such as solar panels are subject to import taxes which increase costs and exacerbate the currency issues of buying goods on the international market. The costs vary significantly depending on the ››

Energy for water and sanitation

scale of the systems but offer clear long-term financial savings on operating expenses.

As an alternative option to overcome high initial costs, partnerships between the private sector and WEs or municipalities could help to scale up sites with renewable energy systems. Public-private partnerships could be developed to spread the costs of systems over a longer term for the operators of water facilities, whilst companies could gain a steady revenue stream from recurring payments. These could also be integrated with O&M agreements to ensure the long-term efficacy of the renewable energy infrastructure. This would need to be supported by a reliable income for the facilities, such as through tariff reform or improved collection rates, and strong legal agreements to safeguard the longevity of such arrangements.

Tariff structures burden both WEs and EDL, as water tariffs are fixed, so WEs operate at a loss following the devaluation of the Lebanese Lira as they cannot recoup their costs from customers. Meanwhile low electricity tariffs mean that, when power is available, the price is too low for EDL to recoup its costs from WEs for their electricity usage, further negatively affecting EDL's finances. Following the increase in the electricity tariff to $0.27/kWh in late 2022, this has increased grid electricity costs for WEs but it is hoped that this would help support the overall financial health of both sectors [91].

At the policy level, either (or both of) the energy sector or WASH sector could support the integration and scaling up of renewable energy assets into WASH. Providing distributed and decentralised power to facilities, especially those in more remote locations, could both increase the availability and reliability of power as well as reduce costs. These benefits would be passed on to all community members through the increased availability of water services and to WEs and municipalities through reduced electricity bills.

BARRIER	OPPORTUNITY
High cost and unavailability of diesel fuel lead to water shortages	Solarisation of water pumping and gravity-fed projects through grant funding, blended finance, or public-private partnerships, leverage savings on electricity bills
Poor wastewater infrastructure leads to disease outbreaks and pollution	Solarisation of wastewater treatment to improve services, increase government monitoring and oversight
Low collection rates leads to low revenue and underfunded infrastructure	Invest in improved collection mechanisms
Illegal infringements on main water networks leads to high production costs and reduced revenue	Stricter enforcement of regulations, financial or in-kind support to most vulnerable households

Energy for food and agriculture

The agricultural sector in Lebanon has been severely impacted by the economic crisis but continues to provide a large share of jobs and income, especially in rural areas and for poorer households. The agri-food sector generates primary or secondary income for around 20% of households and 26% of industrial establishments operate in this sector, the largest share of any kind [96]. Farming households typically have small-scale land plots, with 87% below two hectares, and lack post-harvest facilities and links to wider value chains. Around 60% of Lebanon's 900 cooperatives are in the agriculture sector: most are inactive or relatively weak, but the stronger cooperatives offer services to their members (such as equipment to process crops) as well as many more farmers in the region.

Lebanon has a diverse range of climatic zones that are suitable for a wide variety of crops, representing 60% of agricultural output, whilst livestock production represents 40% [96]. Irrigation is widely used across the country: around three quarters of Lebanon's arable land is irrigated and agriculture consumes 56% of total water supplies, with the volume of water necessary being expected to increase by 10% between 2020 and 2035. Irrigation systems around the country are in disrepair and in need of rehabilitation which has led to wastewater, an estimated 92% of which goes untreated, causing contamination and health risks.

The agri-food sector is one of the three sectors in which displaced Syrians are legally permitted to work. It is their second-highest employment area, behind construction, with 24% of displaced and working Syrians with a regular job employed in the sector [96]. Of these, 34% work in Akkar and 36% in Beqaa; even before the Syrian Civil War, in 2011 Syrians made up 54% and 90% of the agricultural workers in these regions respectively. Working conditions for both Lebanese and displaced Syrians are typically poor and the sector has high levels of informal employment for daily workers, low wages, and child labour. Women constitute around 35% of the agricultural workforce, mainly in informal roles and family-related labour, typically responsible for manual tasks such as planting and harvesting [97].

The agriculture sector has been heavily affected by global price rises. In August 2022, the high cost of fuel was the second most common shock cited by agricultural households (87%) after high food prices (90%) [96] and causes a great impact as energy for agriculture is dependent on diesel (70%) and gasoline (30%) [98]. Fuel is required for operating machinery in fields (such as for planting and harvesting) and for post-harvest processing, as well as for transport, and the high reliance on diesel and gasoline drives up prices to the end consumers. A lack of cold storage – either through the absence of facilities, the high costs of operating them, or the unavailability of electricity from EDL – creates spoilage and wastes otherwise viable products [99]. This also affects other areas of the agri-food sector, such as the fishing industry.

Renewable energy therefore offers an attractive solution for businesses in the agriculture and food sectors to reduce their costs, and its use is encouraged by the Government's National Agriculture Strategy for 2020-25, especially at the farm level [100]. Considering the high proportion of vulnerable Lebanese and displaced Syrians working in the agri-food sector, improvements in energy provision and the subsequent cost savings could be put towards improving working conditions for some of the country's most vulnerable people.

Solar power can be used to pump water for irrigation and to power post-harvest machin- ››

Energy for food and agriculture

ery as a direct replacement for diesel generation, or as a supplement to the low availability of grid power from EDL. The BASATINE project, for example – a collaboration between six NGOs including Mercy Corps, Al Majmoua, and Berytech Foundation – supported micro-loans for solar irrigation for vulnerable farmers, finding that these resulted in both high satisfaction for borrowers as well as high returns on investment [72]. The Water and Energy for Food programme, meanwhile, partnered with Al Majmoua to provide green financing and technical assistance to farmers [101]. Through this renewable energy companies, such as Green Essence, were able to provide end-user financing mechanisms at lower risk for farmers to access solar irrigation [102].

While solar irrigation can provide a vital opportunity to improve crop yields and support vulnerable communities, increased pumping can lead to overexploitation of groundwater. Some NGOs have implemented solar irrigation for agricultural applications without the knowledge or approval of MEW which could result in long-term water scarcity in the future. Conducting resource assessments and coordinating between government, NGOs, and community groups could mitigate this risk while still benefitting from the advantages of sustainable energy for irrigation.

When coupled with battery storage, renewable energy can provide reliable power for cooling rooms and storage facilities; this can extend the lifetime and maintain the quality of products, especially for more sensitive foods such as fish. A recent assessment found that agro-food businesses require electricity for the longest durations of any type of SME, more than 21 hours per day on average, for refrigeration and cooling, but at comparatively low power levels [72]. It also found that these businesses were most likely to have access to multiple sources of electricity including the grid, diesel generators, solar and, to a lesser extent, batteries.

Whilst renewable energy can provide long-term savings, most agri-food businesses are unable to invest in these solutions owing to their limited access to finance to cover the upfront expenses [96]. Cooperatives, meanwhile, have varying levels of capacity; although some may be able to coordinate the purchase of new equipment through contributions from members, many more would require external support and financing. For both businesses and cooperatives in the agri-food sector, assistance – for technical matters, longer-term financing, and project management – would likely be required from renewable energy companies or independent entities, such as NGOs, to guide the transition to sustainable power.

BARRIER	OPPORTUNITY
High costs and unavailability of fuel	Solar PV systems with battery storage, supported financially by external organisations and contributions from cooperatives
Absence of cold storage of facilities and high costs of operating them	Roll out solar freezers or refrigerators through results-based financing schemes

05

Stakeholders and energy projects

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Overview of stakeholders in Lebanon

Sustainable energy in Lebanon is delivered through a wide variety of stakeholders, each with their own mandates, projects, and objectives. Through the LCRP, a focus has been brought to providing electricity services to particularly vulnerable populations across the country in an environmentally sustainable and financially viable manner. Some organisations operate across the country or internationally, whilst others focus on issues in specific regions. As many displaced Syrians live in settlements that are deemed legally informal, the formal provision of electricity is particularly difficult to implement.

A wide variety of non-profit actors work on the topic of sustainable energy. These include international and local NGOs, which often have a strong focus on minimising the financial burden of electricity provision to address cross-cutting energy-related issues including for water and sanitation, education, health, and social stability between different communities residing within the country. Private companies provide sustainable energy technologies, especially solar PV, both to individuals and for larger-scale projects for companies, industries, and cooperatives. These efforts are often supported by municipal governments, NGOs, finance institutions, and other actors.

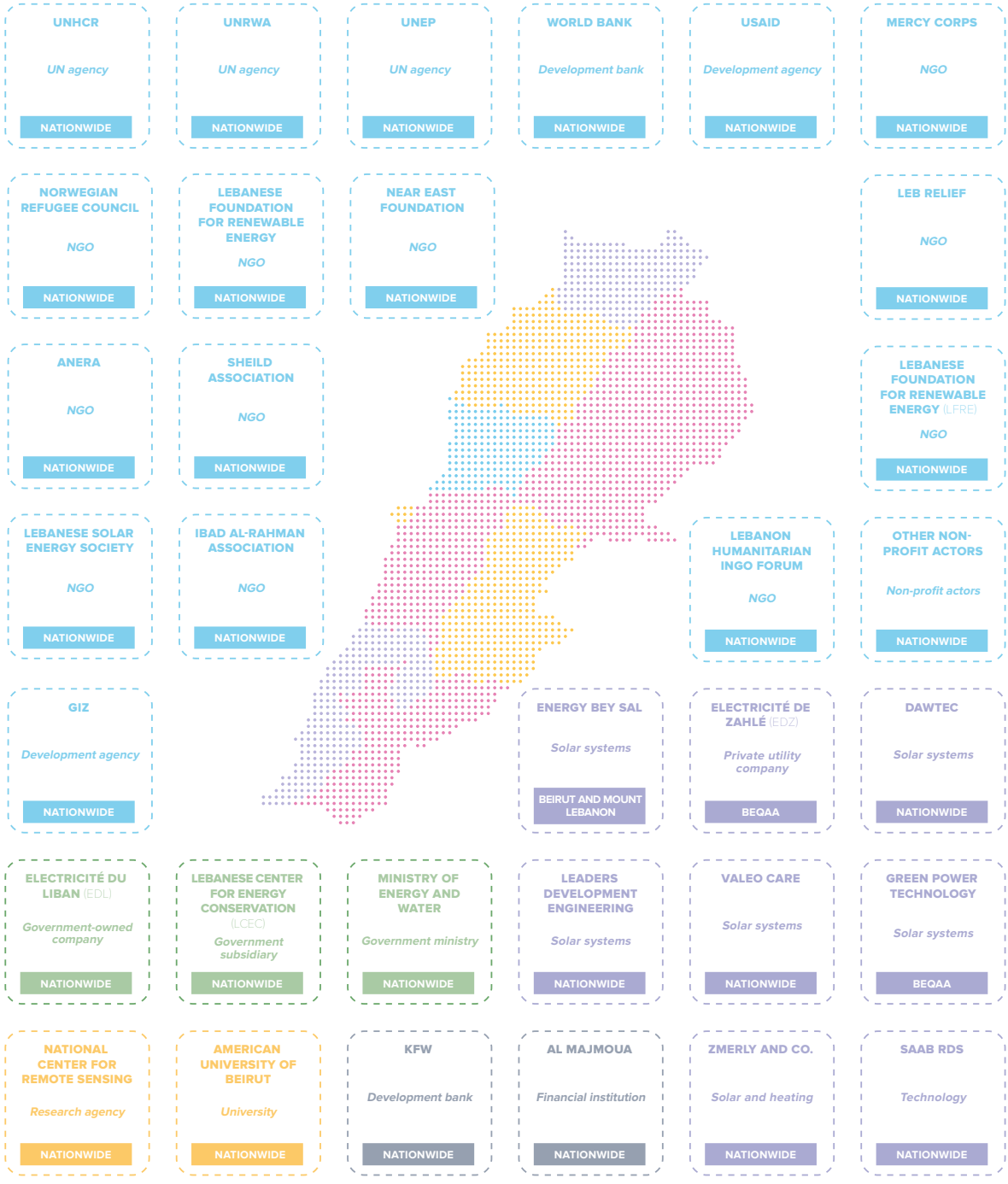
The stakeholders working in Lebanon can be classified into broad categories:

- **Government agencies** with mandates and responsibilities defined by the Government of Lebanon.
- **Non-profit sector** comprised of humanitarian, development, and community-based organisations, which typically address specific issues and include UN agencies operating across the world, international NGOs with projects in Lebanon, local NGOs working across the country or in certain areas, and smaller scale community-based organisations.
- **Private sector companies** which offer energy products or services on a commercial basis.
- **Financial institutions** which offer loans and other financial services to community members to support the acquisition of energy solutions.
- **Other organisations** such as research institutions which focus on issues that are related to energy.

This section provides a short summary of the most relevant organisations working towards providing sustainable energy in Lebanon, their work, and relevant partnerships. It also provides deep dives into specific projects and organisations. The directory of stakeholders included in this section intends to be extensive but not exhaustive.

The LCRP lays a focus on how to provide electricity services to vulnerable populations in an environmentally sustainable and financially viable manner.

Overview of stakeholders in Lebanon



Stakeholder directory

GOVERNMENT

MINISTRY OF ENERGY AND WATER (MEW)

Government ministry

NATIONWIDE

The **Ministry of Energy and Water (MEW)** is responsible for overseeing the operations related to electricity, oil, and water resources as well as promoting renewable energy sources such as solar, wind, and geothermal. **MEW** holds overall responsibility for national energy strategies and planning as well as the technical specifications for electrical installations. Most resolutions taken by **MEW** require the approval of the Government of Lebanon's executive body, the Council of Ministers (CoM).

LEBANESE CENTER FOR ENERGY CONSERVATION (LCEC)

Government subsidiary

NATIONWIDE

The Lebanese Center for Energy Conservation (LCEC) is a non-profit organisation within **MEW** that develops national strategies for renewable energy and energy efficiency. **LCEC** is financially and administratively separate from **MEW** but acts as its technical arm and conducts research on a range of renewable energy technologies and related topics. **LCEC** has partnered with many organisations on renewable energy projects, for example the Solar Water Heater Subsidy Programme, the 3 Million Lamps Programme, and the Beirut River Solar Snake [104].

ELECTRICITÉ DU LIBAN (EDL)

Government owned company

NATIONWIDE

Electricité du Liban (EDL) is Lebanon's vertically-integrated electricity company that has generated, transmitted and distributed electricity since 1964. **EDL** operates seven major thermal power plants, totalling more than 2 GW, and is responsible for 90% of the country's electricity production, transmission and distribution activities [105]. Insufficient investment, outdated infrastructure, the economic crisis, and political instability have all contributed to negative impacts on its production plants and resulted in severe load shedding [106].

Stakeholder directory

NON-PROFIT SECTOR

UNHCR

UN agency

NATIONWIDE

The **Office of the United Nations High Commissioner for Refugees (UNHCR)** is a UN agency that provides protection and assistance to refugees, asylum-seekers, and stateless persons in Lebanon [107]. **UNHCR** coordinates the protection response for all refugees in Lebanon with the government, UN agencies, and local and international partners. It works with partner agencies to maximise efficiency and minimise duplication in the delivery of humanitarian programmes including for protection, shelter, basic assistance, social stability, livelihoods, energy and water, education, health, and food security.

UNRWA

UN agency

NATIONWIDE

The **United Nations Relief and Works Agency (UNRWA)** for Palestine Refugees in the Near East is a UN agency that supports the relief and human development of Palestinian refugees. The Agency's services encompass education, healthcare, relief and social services, camp infrastructure and improvement, microfinance, and emergency assistance [108]. In Lebanon, **UNRWA's** protection response focuses on providing assistance to Palestine refugees through a multi-dimensional approach. This includes the identification and referral of vulnerable individuals facing protection risks; the coordination and delivery of mental health and psychosocial support services; child protection; monitoring and reporting on cross-border movements; and advocacy for Palestine refugees' rights [109].

UNEP

UN agency

NATIONWIDE

The **United Nations Environment Programme (UNEP)** is a UN agency that works to promote sustainable development and the protection of the environment worldwide [110]. **UNEP** has been active in Lebanon since 2006 and, in 2021, **UNEP** partnered with UNDP to further support Lebanon's prioritisation of mitigating environment and climate issues, improving coordination on environmental programs, promoting resource mobilisation, and enhancing knowledge sharing and joint advocacy for people and planet [111].

WORLD BANK

Development bank

NATIONWIDE

The **World Bank** is an international financial institution that provides loans and grants to developing countries for capital programmes and has been active in Lebanon since 1948 [20]. As of October 2022, the **World Bank's** total commitment in Lebanon amounted to $1.5 billion, consisting of 20 active projects (loans and grants) covering a range of sectors, including water, transport, education, health, poverty targeting, social safety nets, food security, environment, and SMEs.

Stakeholder directory

NON-PROFIT SECTOR

USAID

Development agency

The United States Agency for International Development (USAID) provides humanitarian and development assistance to Lebanon and has been involved in several energy projects [112]. Since 2012, **USAID** has implemented more than 41 solar energy projects in 70 Lebanese towns and villages that benefitted over 460,000 residents. In 2023, **USAID** launched the $20 million Solar and Renewable Energy Fund which will provide financing to Lebanese businesses to purchase and install solar systems in order to reduce costs, boost productivity, and protect Lebanese jobs.

NATIONWIDE

MERCY CORPS

NGO

Mercy Corps is a global, non-governmental humanitarian aid organisation present in over 40 countries around the world that strives to alleviate suffering, poverty and oppression by helping people build safe, productive and just communities [113]. **Mercy Corps** has operated in Lebanon since 1993 and has worked on programmes that promote economic growth and opportunities, while also responding to emerging emergencies in the country. This encompasses interventions such as skills training and development, agriculture, cash assistance, and support to Lebanese SMEs and markets. **Mercy Corps** Lebanon has supported Lebanese SMEs to conduct energy audits and adopt solar energy solutions. As a result of this support the SMEs reported a 70% reduction in their monthly energy payments, growing profits, and supported a 40% increase in the number of employees.

NATIONWIDE

NORWEGIAN REFUGEE COUNCIL (NRC)

NGO

The **Norwegian Refugee Council (NRC)** is an independent humanitarian organisation which helps people forced to flee and those affected by displacement. **NRC** specialises in six areas: food security, education, shelter, legal assistance, protection from violence, and water, sanitation and hygiene. **NRC** is a determined advocate for displaced people, promoting and defending displaced people's rights and dignity in local communities, with national governments and in the international arena. **NRC's** work also includes energy interventions, providing energy access to public schools, health clinics, pumping stations, youth centres, and water facilities in various regions of Lebanon. **NRC** also focuses on improving public service provision and governance, conducting energy auditing and efficiency studies for schools, urban and rural residential areas, heating systems, and developing task-specific energy solutions [114].

NATIONWIDE

Stakeholder directory

NON-PROFIT SECTOR

LEBANESE FOUNDATION FOR RENEWABLE ENERGY (LFRE)

NGO

NATIONWIDE

The **Lebanese Foundation for Renewable Energy (LFRE)** is an NGO which brings together experts from across the Lebanese energy landscape including businesses, academics, and NGOs. **LFRE** has published studies on the most cost-effective energy mix for the country, focusing on renewable sourcing and its potential in reducing electricity costs. **LFRE** has collaborated with the **American University of Beirut** on green energy policy and has worked extensively with the National Council for Scientific Research on mapping potential sites for solar and wind generation.

IBAD AL-RAHMAN ASSOCIATION

NGO

NATIONWIDE

The **Ibad Al-Rahman Association** is a faith-based, non-profit, non-governmental, non-political organisation. It has been actively involved in several projects aimed at promoting sustainable energy solutions in different regions of Lebanon including PV solar training in Beirut and Beqaa, LED bulb distribution in Beirut, Mount Lebanon, Beqaa, and North governorates, and the installation of PV systems for houses in Beqaa. The capacities of some of its installations include 130 kW in Beirut, 20 kW in a school in North, 20 kW at a site in Mount Lebanon, 68 kW for water pumping in Beqaa, and installation of solar water heating in Mount Lebanon.

LEB RELIEF

NGO

NATIONWIDE

Leb Relief is a non-political, non-religious, non-profit NGO offering essential services to Lebanon's most vulnerable communities, including displaced people and Lebanese nationals. It works in collaboration with local authorities, UN agencies and international NGOs, including partnerships with organisations such as **UNICEF**, **UNOCHA**, Department of Foreign Affairs and Trade (Australia), **WFP**, IRC, DRC, EV-MADAD, and Expertise France [115]. Its areas of coverage include the North Governorate, for example in Minieh-Danniye with a solar farm of 154 kW for pumping station in Beshtayeh; Akkar Governorate, with a solar system for the Halba TVET institute; and Tripoli, in which the organisation provided support for SMEs with solar systems.

Stakeholder directory

NON-PROFIT SECTOR

ANERA

NGO

Anera, founded in 1968, is a US-based non-governmental aid organisation that provides humanitarian and development aid to the West Bank, Gaza Strip, Lebanon and Jordan. In Lebanon the organisation's work extends across the country, including the North, Akkar, Beirut, Mount Lebanon, Beqaa, and South regions. The organisation has equipped more than 100 social institutions with solar PV systems, including health centres, schools and kindergartens, vocational training centres, and community centres. **Anera** has also begun working on wastewater treatment and is planning a pilot project to solarise water pumping. The NGO runs a youth programme aimed at enhancing employability preparedness, encouraging the young to give back to their communities. Through the programme, young people participate in a curriculum which teaches them about renewable energy, how to conduct needs assessments, and design solutions with community leaders. Through this programme solar streetlights have been installed and programme participants have been linked with job opportunities in the energy sector.

NATIONWIDE

SHEILD ASSOCIATION

NGO

SHEILD – Social, Humanitarian, Economical Intervention for Local Development – is a Lebanese association working for the best interest of the Lebanese community. **SHEILD's** interventions range from addressing social, financial, health and education-related access issues and disparities. **SHEILD** works to bring relief to Lebanon's population, particularly those who have suffered and/or are still suffering from war or the absence of governmental health and social care and protection. **SHEILD** functions through both direct assistance programmes and community-based interventions to enhance human rights and social awareness, financial conditions, and protection. The organisation follows a participatory approach which involves local stakeholders and authorities in a system of coordination to assess needs and implement programs responding to these needs. **SHEILD's** main partners are **WFP**, **UNHCR**, **NEF**, **UNDP**, IOM, ILO, WHH, Mission East, NPA, and ACTED. **SHEILD** partnered with **NEF** as part of the Em(power) project which, to date, has developed five solar projects for Bani Hayyan, Baraashit, and Tebnin municipalities, as well as the fisherman cooperative of Sarafand and agricultural cooperative of Loubieh [116]. In partnership with **UNHCR**, **SHEILD Association** has implemented several solar-powered water pumping systems in Nabatieh and the South Governorate, including in Maarakeh (in 2024), Srifa (2023) and Borjshamali (2022) [117].

NATIONWIDE

NEAR EAST FOUNDATION (NEF)

NGO

The **Near East Foundation (NEF)** is an NGO dedicated to advancing innovative, sustainable, community-led economic and social development across the Middle East, Africa and the Caucasus. Its main focus is supporting vulnerable communities to generate safe and sustainable income through financial and non-financial services. In Lebanon, **NEF** implemented the Em(power) project in collaboration with **SHEILD**, through which the organisations worked with communities and municipalities to identify energy and water access problems and solutions through a community consultation process [118]. Its focus regions included Sarafand, Bani Hayyan, Loubieh, Tebnin, and Baarachit. Some of the energy solutions it supported include solar street lighting for the port in Sarafand, solar-powered water filtration systems for drinking and non-drinking water, and solar-powered pumps for agricultural production.

NATIONWIDE

Stakeholder directory

NON-PROFIT SECTOR

LEBANESE SOLAR ENERGY SOCIETY (LSES)
NGO

NATIONWIDE

The **Lebanese Solar Energy Society (LSES)**, based in Beirut, was established in 1980. Its members are involved professionally and academically in promoting the use of solar and renewable energy [119]. **LSES** has been involved in activities and projects related to solar and renewable energy which aim to promote their use. The NGO also provides training on PV systems, energy audits, and energy efficiency.

GIZ
Development agency

NATIONWIDE

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH is a German international cooperation agency that has been supporting Lebanon's economic and social development for more than 40 years [120]. **GIZ** works in partnership with the government of Lebanon, civil society organisations, and the private sector to implement projects in various sectors, including economic development and employment, education, security, reconstruction, and peace. **GIZ** has been working in Lebanon since 1975 and has implemented more than 200 projects in the country. **GIZ's** current portfolio in Lebanon includes projects that aim to support the country's economic recovery, create job opportunities, improve vocational education and training, promote sustainable energy, and enhance social stability.

LEBANESE FOUNDATION FOR RENEWABLE ENERGY (LFRE)
NGO

NATIONWIDE

The **Lebanese Foundation for Renewable Energy (LFRE)** is a locally-run foundation dedicated to revolutionising Lebanon's energy landscape. Through reconsidering how Lebanon produces, delivers and consumes energy, **LFRE** is developing a new energy model that leverages Lebanon's 300 sunny days a year, as well as wind and hydropower potential. With an aim of providing 24-hour electricity access, **LFRE** is devoted to protecting public health and the environment and developing a local energy industry. **LFRE** intends to rapidly increase the construction of wind and solar plants, upgrade national hydro-sourced energy production, increase job opportunities, and build new run-of-river hydropower plants across the country. **LFRE** is dedicated to planning that is centred around sustainable development and creating a virtuous cycle to promote agriculture, agro-industries and eco-tourism.

Stakeholder directory

NON-PROFIT SECTOR

LEBANON HUMANITARIAN INGO FORUM (LHIF)

NGO

NATIONWIDE

The Lebanon Humanitarian INGO Forum (LHIF) is an informal, independent coordinating body comprised of 65 INGOs which work to address the needs of vulnerable individuals, families, and communities throughout Lebanon. Formed in 2012 to provide a common platform for advocacy among INGOs responding to the Syrian Crisis in Lebanon, **LHIF** is funded by the Swedish International Cooperation Agency (SIDA), Swiss Cooperation Office in Lebanon (SDC), European Commission in Beirut (ECHO) and the Lebanon Humanitarian Fund (LHF). The purpose of **LHIF** is to facilitate the work of its member organisations by efficiently and effectively addressing key issues of common interest, supporting informed decision-making, and advocating with a unified voice to influence policy and decision making.

OTHER NON-PROFIT ACTORS

Non-profit actors

NATIONWIDE

Other humanitarian and development organisations working on issues aligned with energy and the environment in Lebanon include: **International Renewable Energy Agency (IRENA), United Nations Development Programme (UNDP), United Nations Children's Fund (UNICEF), International Committee of the Red Cross (ICRC), United Nations Industrial Development Organization (UNIDO), United Nations Office for Project Services (UNOPS), United Nations Economic and Social Commission for Western Asia (ESCWA), United Nations Population Fund (UNFPA), United Nations Entity for Gender Equality and the Empowerment of Women (UN Women), United Nations Human Settlements Programme (UN-Habitat), United Nations Office for Disaster Risk Reduction (UNDRR), United Nations Educational, Scientific and Cultural Organization (UNESCO), United Nations Volunteers (UNV), United Nations Office on Drugs and Crime (UNODC), United Nations Framework Convention on Climate Change (UNFCCC), World Vision,** and other community-based organisations and faith-based organisations.

Stakeholder directory

PRIVATE SECTOR

ELECTRICITÉ DE ZAHLÉ (EDZ)

Private utility company

Electricité de Zahlé (EDZ) is a privately-owned energy provider and distributer based in Zahlé, Beqaa, operating across approximately 250 km^2. **EDZ's** core activities include generating and dispersing electricity through medium and low voltage networks, serving residential, commercial, industrial, and agricultural sectors. **EDZ** provides ongoing energy access for more than 55,000 subscribers in Zahlé and 17 neighbouring towns, with a network spanning 1,390 circuit kilometers and an installed capacity of 269 MVA. It relies on renewable hydroelectric power from the Bardouni River, ensuring a stable and uninterrupted electricity supply. Key partners include the Centre Culturel Français (CCF) in Zahlé, with whom **EDZ** collaborates on initiatives like higher education scholarships for students to pursue advanced studies in France.

BEQAA

ENERGY BEY SAL

Solar systems

Energy Bey, founded by Lebanese engineers, is a company focusing on enhancing the quality of solar system installation and energy supply in Lebanon. Partnering with international suppliers, **Energy Bey** specialises in solar system engineering, contracting services, and supplying solar energy products. **Energy Bey** provides renewable energy technologies, including PV panels and lithium batteries, and works with Lebanon's construction sector to support the implementation of building-integrated solar PV. **Energy Bey's** operations prioritise quality installations and reliable after-sales support.

BEIRUT AND MOUNT LEBANON

LEADERS DEVELOPMENT ENGINEERING

Solar systems

Leaders Development Engineering is a Lebanese company which has implemented more than 70 solar systems in various locations across Lebanon including Beirut, Mount Lebanon, and Beqaa in collaboration with **Mercy Corps**. The company has also partnered with **World Vision** to install 10 wastewater treatment systems in central Beqaa which are powered by solar systems. Furthermore, the company has recently completed two notable solar projects with **World Vision** in Jbail and Qousaaya which involved the installation of more than 600 solar panels for boreholes.

NATIONWIDE

Stakeholder directory

PRIVATE SECTOR

GREEN POWER TECHNOLOGY

Solar systems

BEQAA

Green Power Technology is a Lebanese company that was established in 2011 to bring renewable energy access to local communities. The company's projects are concentrated in Lebanon, with some activities in Saudi Arabia. To date, **Green Power Technology** has installed solar pumping systems in the Qaa area (1.5 MW for agriculture) and solar systems at the Kabelias public market (1 MW), Riyak Hospital (1.2 MW), and Zahlé public parking (200 kW). **Green Power Technology's** total installed capacity in Lebanon currently stands at around 9 MW. **Green Power Technology** has also developed and installed off-grid systems for schools, houses and supermarkets, as well supported the rehabilitation of medium voltage networks for 27 villages in West Beqaa [122].

DAWTEC

Solar systems

NATIONWIDE

DAWTEC is a Lebanese energy consultancy, design and implementation company that has been active in Lebanon since 2003. **DAWTEC** specialises in solar thermal and solar electricity systems. The company has a manufacturing line for innovative products which focuses on a solar water heating system and two architectural products relating to solar thermal and solar street lighting technologies, all suitable for residential and commercial applications.

ZMERLY AND CO.

Solar and heating

NATIONWIDE

Zmerly and Co. is a Lebanese company focused on providing solar heating solutions. Its services include installing PV systems for residential, educational, commercial, and public facilities. The company specialises in solar water heaters, solar heating with floor heating, heat pumps, and smart controllers. **Zmerly and Co.** offers design, consultancy, and installation services. The company houses Zmerly Academy, a centre that provides training on heating and solar thermal systems.

SAAB RDS

Solar systems

NATIONWIDE

Saab Research and Development Systems (RDS) is a Lebanese company dedicated to advancing renewable energy solutions, particularly solar systems [123]. Since its establishment in 2019, the company has completed over 150 projects and has installed more than 2400 panels, resulting in a cumulative power installation of over 3 MW. Specialising in solar and battery equipment, consultation, and system sizing, **SAAB RDS** offers solutions for commercial, industrial, agricultural, and residential needs. **SAAB RDS** aims to support energy independence amongst individuals and communities while reducing costs and environmental impact.

Stakeholder directory

PRIVATE SECTOR

VALEO CARE

Solar systems

NATIONWIDE

Valeo Care is a Lebanese contracting company with operations spanning the installation and maintenance of diverse solar systems such as on-grid, off-grid, and hybrid systems, alongside solar pumping systems and solar streetlights. **Valeo Care** is active across all regions of Lebanon, with a significant emphasis on catering to NGOs.

AK ENERGY

Solar systems

NATIONWIDE

AK Energy is a private company specialising in solar panel installation and the deployment of solar photovoltaic, solar thermal, and solar electric equipment. **AK Energy** is involved in activities ranging from the installation and maintenance of critical infrastructure like gas, water, plumbing, heating, ventilation, and air conditioning (HVAC) systems to sustainable energy initiatives. **AK Energy** is involved in the construction of solar power plants, PV cells, and mobile solar power stations. The company is dedicated to advancing environmentally responsible solutions such as solar space heating systems and solar water boilers and offering consulting services by renewable energy specialists.

GREEN ESSENCE

Solar systems

NATIONWIDE

Green Essence was founded in 2008 and provides renewable energy solutions to the domestic, commercial, industrial, and agricultural sectors. **Green Essence** has installed on- and off-grid solar PV systems for schools, markets, and hospitals, as well as for water pumping. The company has also implemented solar water heating systems and heat pumps for agricultural applications.

Stakeholder directory

FINANCIAL INSTITUTIONS

KFW

Development bank

KfW is a German development bank that has supported Lebanon's economic and social development for more than 40 years [124]. **KfW** works in partnership with the Government of Lebanon, civil society organisations, and the private sector to implement projects including for economic development and employment, education, security, reconstruction, and peace. **KfW** has worked on projects related to renewable energy, for example the Employment through Labour-intensive Infrastructure Measures Programme which aims to support displaced Syrians and vulnerable Lebanese by creating job opportunities. The financing contribution for Phases I and II of the project was approximately EUR 12 million, and a third phase of the project is planned for 2024. The programme is part of the German Federal Ministry for Economic Cooperation and Development's employment campaign in the Middle East.

NATIONWIDE

AL MAJMOUA

Financial institution

Al Majmoua is a microfinance institution, established in 1997, which provides access to finance, financial literacy and non-financial services such as entrepreneurship, social entrepreneurship trainings and business development services to SMEs with a focus on women-led and youth-led businesses [125]. It has a presence across Lebanon and offers loans up to $20,000, subject to the availability of funding for loan capital. **Al Majmoua** has partnered with Berytech, an entrepreneurship support organisation, on the Water and Energy for Farmers programme to develop a green financing loan product and is seeking funding to create a sustainable green financing fund for SMEs. Under a new project funded by the Regional Development and Protecion Program, **Al Majmoua** will support green energy investments of SMEs and is currently exploring new potential for energy financing with ILO and **Mercy Corps. Al Majmoua** is a long-term partner of many UN agencies and international organisations and has received financing from stakeholders including the IFC, the European Investment Bank, the Dutch Development Bank (FMO), the French Development Agency (AFD), and has been a Kiva field partner for more than 10 years before the start of the compounded crisis in Lebanon.

NATIONWIDE

Stakeholder directory

OTHER ORGANISATIONS

NATIONAL CENTER FOR REMOTE SENSING

Research agency

NATIONWIDE

The **National Center for Remote Sensing** has partnered with the **Lebanese Foundation for Renewable Energy** and **American University of Beirut's** Issam Fares Institute to undertake assessments on land resources, hydrological impact, environmental and social impact, natural disasters, and renewable energy [126]. The **National Center for Remote Sensing** is involved in mapping potential lands for solar, wind, and hydropower resources, mapping public land, creating business models, integrating renewable energy with agriculture, the mapping rooftops of medical, educational, public buildings, hydrological assessment for large-scale PV systems, and data analysis for renewable energy projects.

AMERICAN UNIVERSITY OF BEIRUT

University

NATIONWIDE

The **American University of Beirut** is a private, independent university chartered in New York with its campus in Beirut. The university's interdisciplinary research on energy policy examines the intersection of energy and security in the Middle East region and encompasses a wide range of fields, including renewable energy, energy systems analysis, energy efficient buildings, environmental systems modelling, and water resources engineering [127]. The university helps inform policy makers and the public on the challenges and opportunities of the shift towards alternative energy sources in the region and focuses on overall capacity building [128].

Sustainable energy projects

Anera Lebanon: Solarising community facilities and youth training programmes

US-based organisation Anera was founded in 1968 and works in Palestine, Lebanon, and Jordan, with some cross-border work to provide humanitarian assistance in Syria. Sustainable energy has long been a significant concern and priority for Anera and the organisation's leadership has implemented a policy to equip its buildings with solar PV systems. This proved to be highly beneficial when the energy crisis in Lebanon and the failure of the national grid became increasingly severe, highlighting the urgent need for more decentralised, renewable energy systems.

Since 2017, Anera has incorporated sustainable energy solutions in its health-related programmes by solarising health centres. Without a reliable electricity supply, health centres struggle to maintain their operations and provide essential services which are reliant upon refrigeration and cold chains, like vaccine and medication storage. Anera responded to this need first by equipping health centres with solar PV systems before expanding into providing such systems to other social institutions such as community centres, vocational training centres, schools, and more recently wastewater treatment plants.

Initially Anera worked closely with a small group of existing partners but has increasingly received requests for partnership and support in installing solar systems from a range of community groups and facilities. A fire brigade in Beirut, for example, which also runs a small health centre to treat wounds and burns, requested Anera's support with solarising the centre to improve its operational capacity. Another request came from the blood bank of the Lebanese Red Cross in Tyre to install a solar system to reduce their energy expenses, which were exorbitant as it heavily relied on diesel generators. Anera also built two solid waste recycling centres in Beqaa Valley which are powered by solar energy.

Anera has now solarised over 100 social institutions. Most systems are operational and more are under development. Each installation is grant-funded on a project basis and, as of late 2023, Anera Lebanon had secured funding for the solarisation of further health centres and the youth training centres that it runs.

While the on-site installation of the solar system is usually a quick and straightforward process, the assessment phase for each site is more time-intensive and can vary significantly depending on the size of the community facility, ranging from a few days to a few weeks. The next step is the procurement through qualified suppliers, during which the project is tendered out before being implemented by the selected company under the supervision of Anera's engineers. Approvals are required from the local authority to install solar panels on rooftops, but so far this has not raised issues.

The most significant challenge in installing solar systems is usually the lack of space for a system of the required size, for example when the roof is not large enough or if there are complications because the building is rented or co-owned. Wherever possible, and where space allows, Anera installs solar systems with ››

Sustainable energy projects

battery storage (only rarely using diesel-hybrid systems) and ensures that the systems can be connected to the national grid.

Anera ensures that all projects are implemented in a participatory manner and that the community facility takes ownership of the solar system. The recipient facility is involved in all steps of the assessment, procurement, and installation process. Memoranda of understanding and cooperation agreements are signed to ensure community facilities take on the responsibility of the systems and understand the need to cover ongoing O&M costs.

Renewable energy systems have come into high demand and key benefits highlighted by community facilities with them are having improved access to electricity and cost savings achieved by transitioning away from diesel. Anera's monitoring, evaluation and learning system gathers information on cost savings and how these are reinvested and has found that savings on electricity bills more than cover the O&M costs. Close attention is paid to using only high-quality technologies and components and their end of life is considered from the outset: for example, the agreements also include the responsibility of the partner to replace the batteries when necessary and dispose of them in an environmentally responsible way.

Anera considers the replacement or reduced usage of diesel generators a great achievement of its work, estimating that 75% of the facilities that installed a solar system have now stopped using their diesel generator, and that the other 25% have significantly reduced their usage – from around 18 hours to just 3-4 hours per day. In addition to its work on decentralised solar systems for community facilities, Anera has been exploring the potential of solarising water pumping in villages in remote areas for domestic and agricultural purposes. A pilot project is being planned: three wells have been selected in the South of Lebanon, one in a Palestinian refugee camp and two in Lebanese villages.

These costs savings are particularly significant given the extremely high price of diesel and its low availability during the economic crisis, further exacerbated by the Israel-Gaza crisis. The conflict's spillover into the South of Lebanon has highlighted the great need for more decentralised renewable energy systems to provide power to schools and other community facilities which – at the time of writing – provide shelter to internally displaced people. Anera's work in Gaza, meanwhile, which installed solar-powered water filtration systems in schools and kindergartens to provide safe drinking water using a reverse osmosis mechanism, has proved to be life-saving for the people who have taken shelter in these buildings in the crisis.

While Anera's work is currently entirely grant-funded, the organisation is looking into forms of blended finance. Its goal is to increase its funding through gaining access to impact investment bonds or loans: this would enable work on a larger scale, such as at the village or town level, to provide decentralised renewable energy systems to whole communities and thereby also have a greater environmental impact. The biggest challenge Anera faces is to obtain the right scale of funding, which is difficult given the many competing priorities such as the ongoing emergency in Gaza and the severe economic crisis in Lebanon. Given the high impact of decentralised energy systems, Anera hopes to receive more support.

Anera has also operated a youth programme for over a decade with the objectives of empow- ››

Sustainable energy projects

ering young people, supporting employability preparedness, and community development sensitisation, all of which aim to support young people in thinking about how to give back to the local community. The programme works with young people to introduce them to environmental and gender issues through a broad curriculum which includes topics such as renewable energy, forestry, and water efficiency to help their communities become more sustainable.

Participants receive coaching on how to conduct needs assessments and design solutions with community leaders and members that will improve life in their communities, supported by a small fund for projects. One activity as part of the youth programme is the installation of solar streetlights; this has an important protection component and is reported to have decreased the number of harassments on the streets. As part of the vocational training, Anera refers the programme participants to job opportunities and encourages the uptake of green jobs, for example in the solar industry, as much as possible. Anera also runs courses on solar system installation and maintenance, as well as water efficiency measures, each of which could help young people take the lead on scaling up renewable energy in Lebanon in the future.

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Sustainable energy projects

Em(power) by the Near East Foundation (NEF) and SHEILD Association: Helping vulnerable entrepreneurs adapt to the energy crisis

To address the heavy impact of the economic and energy crises on vulnerable communities, in October 2022 NEF launched the one-year Em(power) project in collaboration with SHEILD Association. This had the goal of developing energy solutions for entrepreneurs in Nabatieh (Marjayoun and Bint Jbeil districts) and South Governorates (Saida district).

Frequent power outages and water shortages have affected the productivity of businesses which have needed to rely on privately-sourced water and energy or to go without them. Accordingly, the Em(power) project sought to identify cost-effective and equitable solutions to improve energy reliability for entrepreneurs to overcome these shortages. It also aimed to identify locally relevant, sustainable, and scalable strategies for more sustainable energy access, business continuity, and resilience.

Project locations in rural areas in the South of Lebanon were selected because these districts have historically received less funding from donors and other entities. The project team therefore believed that the proposed work would have a greater impact there, compared to in larger urban areas, given the relatively limited resources available to pilot these solutions. The extensive network and technical knowledge of implementing partner SHEILD, an NGO based in the South of Lebanon, was a key asset in the pilot and provided key guidance on location selection.

To develop these solutions, NEF and SHEILD conducted extensive community consultations involving key informant interviews and focus group discussions with stakeholders from a range of sectors. Based on their needs and existing assets, these stakeholders were challenged to identify potential energy and water interventions that could sustainably improve livelihoods and make use of limited resources. The project design originally focused on supporting cooperatives and individual businesses; however, findings from consultations quickly revealed that entire communities, not only specific groups within them, needed solutions to address power and water shortages.

The communities proposed 90 projects of relevant sizes during the consultations. Using predefined selection criteria, the NEF team first created a longlist of eligible projects and then, after assessing their feasibility through site visits, a shortlist of 14 potential projects. NEF then conducted a more intensive technical assessment of the shortlisted projects to verify their feasibility and to refine the budget, timeframe, number and profile of beneficiaries, and to establish links to livelihoods, sustainability, and ability to address social and environmental challenges as part of the intended impact. The technical assessment also ensured that the do-no-harm principle was met and that each proposed solution was as cost effective as possible. ››

Sustainable energy projects

Five initiatives were selected and implemented across five municipalities:

1. Cooperative of fishermen in Sarafand: solar streetlights were installed in the port area to enhance safety and improve operations;

2. Barasheet municipality: solar water pumping was implemented to improve agricultural practices and mitigate the threat of drought;

3. Bani Hayyan municipality: solar-powered water filtration was installed to improve access to clean water and support an agricultural cooperative and community facilities;

4. Tebnine municipality: solar-powered water filtration was provided for clean water and to allow community members to invest in other essential needs and business growth;

5. Agriculture cooperative in Loubieh and Rhzez: solar-powered water filtration was implemented to improve access to clean water for a food processing factory and mill, as well as for residents and businesses.

Most projects cost between $10,000 and $15,000, whilst one cost just $6,500. In a few instances, municipalities made voluntary contributions of between $1,000 and $2,000 to the renewable energy projects which, given their limited resources and lack of funding from the central government, is a strong signal of their commitment to project completion and sustainability. Donations were also collected from members of the public and diaspora. The project team prioritised working with municipal partners that had demonstrated their dedication to enhancing wellbeing in their communities and to making the most of investments into their infrastructure.

The projects implemented by the Em(power) pilot provided important benefits to vulnerable communities, directly improving livelihoods and business viability, while also improving health outcomes, enhancing access to services, and reducing greenhouse gas emissions. Some of the solar installations developed and implemented by the Em(power) project have supported people who were internally displaced by the spillover into Lebanon of the Israel-Gaza crisis that began in October 2023.

One key lesson was that it was more cost effective and impactful to develop solutions at the village level, benefitting underserved rural areas and municipalities, instead of directing support to individual SMEs. While many SMEs would ››

Streetlights in the port of Sarafand.

©Near East Foundation

Sustainable energy projects

prefer individual energy access (for example through individual solar systems), this approach is generally more costly. Instead, it proved more cost effective to support clusters of SMEs, such as cooperatives or associations, which can also share O&M costs. Another finding was that there was low appetite to take on loans or energy-as-a-service models, potentially reflecting concerns about the ability to pay back loans or a lack of trust in new financial systems.

There remains significant unmet demand for renewable energy projects, as evidenced by the many projects that were proposed during the community consultations but were unable to be implemented under the Em(power) pilot. Rich information gathered through the community consultations, field visits, and outreach has provided valuable data for subsequent phases of the programme. Sharing the assessment questions with consultation participants ahead of the discussion was found to be very effective, allowing them to be well prepared and ensuring that consultations included diverse individuals and perspectives.

A high level of cooperation with the selected municipalities was critical to the success of the initiatives. The Em(power) project supported municipalities by building capacity and supporting locally relevant investments, and in return municipalities demonstrated their buy-in through contributions of funds, labour, property, and other assets. Careful engagement with unions of municipalities and municipal governments was essential to ensuring a transparent selection of interventions, sustainability planning, and local prioritisation of investments. Future initiatives could place more emphasis on cost sharing and in-kind contributions from public sector stakeholders.

NEF promoted important sustainability considerations as key components of the projects. These included a one-year warranty period provided by suppliers, cost sharing, and site preparation by some municipalities to distribute the financial responsibility and creating linkages with existing O&M processes. Critical to the success of every intervention was that the specific needs and solutions were identified by the community members which ensured that the project was aligned with their priorities and preferences. Involving local community members in all decision-making processes was successful in fostering a sense of collective ownership and commitment to the projects.

The Em(power) project's decentralised and adaptable model makes it highly replicable across different contexts and provides the flexibility to respond to the specificities of each community. The tools and methodologies developed by NEF can easily be replicated in different communities to identify high-impact investments in energy reliability. The initiatives supported by the project offer valuable insights and highlight the importance of contextually appropriate, flexible solutions to socio-economic challenges.

Sustainable energy projects

Enhancing night-time operations at Sarafand's Port

Sarafand's port was a hub of night-time activity but faced significant challenges. The primary issue was the lack of electricity to illuminate the port and the local fishermen's work at night was dangerous due to frequent collisions of boats in the dark. In addition, essential tasks such as net clearing, hook preparation, and the marketing and selling of catch were burdensome and inefficient. This situation not only endangered the fishermens' safety but also severely restricted their working hours and income potential.

In response to these conditions, the fishermen's union engaged in community consultations through the Em(power) project implemented by NEF and SHEILD. With support from the project team, the union developed a sustainable solution which promised to revolutionise the port's operations through the installation of solar-powered lighting.

The project brought about immediate and significant improvements. The once-dangerous environment became a safer workplace, reducing the risk of accidents. The new lighting system extended the fishermen's working hours, allowing them to engage in their fishing activities and post-fishing tasks more efficiently and safely. This enhancement not only improved their catch but also enabled them to participate more effectively in early-morning markets, increasing their economic gains. ››

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Sustainable energy projects

The impact of the NEF initiative went beyond infrastructural improvements and it empowered the fishermen's community, fostering a sense of progress and possibility. A member of the cooperative shared how the fishermen expressed profound gratitude for the changes and looked forward to future collaborative endeavours: "The Near East Foundation really listened to our struggles. Now, with the solar lights, it's a game-changer. Our workplace is safer, and we can actually see what we're doing. No more stumbling in the dark."

The cooperative hopes for future projects, such as equipping their boats with solar systems for lighting which would further improve their fishing operations, especially during deep-sea expeditions in complete darkness. "Fish are more active at night and that's when we want to be out there. Our personal batteries couldn't keep up and it was frustrating. The solar lights have extended our fishing hours and now we can utilise the market more effectively."

The NEF-supported initiative at Sarafand's port provides an example of how targeted, community-focused interventions can significantly enhance the working conditions and livelihoods of local communities. By addressing a fundamental need for lighting the project not only improved the fishermens' safety and efficiency but also paved the way for sustainable and prosperous fishing practices, highlighting the power of collaborative efforts in community development.

"Before the solar-powered lights, our nights at the port were filled with risks and challenges. With no electricity, it was like navigating through the unknown. Collisions were frequent, and the darkness made our work unsafe. It was a tough time for all of us. Those solar-powered lights didn't just illuminate the port; they illuminated our lives. We can work longer hours, clear our nets more efficiently, and sell our catch with pride. It's not just about the lights; it's about the possibilities they brought." – Fisherman in Sarafand

Sustainable energy projects

Solar energy in Bani Hayyan municipality

Characterised by its traditional Lebanese architecture and beautiful natural landscapes, the town of Bani Hayyan in the Nabatieh Governorate of southern Lebanon is known for its rich history and cultural heritage. Similar to towns across the country, Bani Hayyan faced water and electricity shortages.

Before its engagement with NEF, Bani Hayyan's municipality spearheaded two major projects. The first was a solar pumping project for its water well which aimed to reduce the municipality's dependence on expensive and polluting diesel generators to extract water. The previous method of supplying water to the town's 4,000 residents, using a 330 kVA diesel generator, cost roughly $500 per day and put a significant strain on the municipality's finances. Moreover, the environmental impact of diesel combustion negatively affected community health.

Owing to the inability of the South Lebanon Water Establishment to provide water to the community, the Bani Hayyan municipality stepped in, driven by a deep commitment to the wellbeing of their community. They recognised the urgent need for a sustainable solution that would not only address the immediate water crisis but also set a precedent for future energy use.

In early 2023, with the widespread support of its residents, the municipality successfully secured approximately 300 solar panels. These panels, combined with an agricultural electricity inverter, provide roughly 130 kW of power for the management and extraction of water from the artesian well. Notably, this green initiative was funded through the generous financial contributions of the Bani Hayyan residents without other sources of funding, illustrating a commendable community effort towards environmental responsibility and resource management. “Our solar project not only tackled the water crisis efficiently but also shifted us towards sustainable energy. The residents' contributions were instrumental, reflecting a community united for positive change,” said Yehya Mohsen Jaber, the mayor of Bani Hayyan.

Having navigated the challenges of the water crisis, the Bani Hayyan municipality turned its attention to a second pressing issue: the electricity crisis. Its residents, like many in the country, were burdened with paying two electricity bills, one to EDL and another for generator subscriptions provided by the municipality. Recognising this financial strain and the high cost and operational challenges of managing these generators, the municipality sought to install solar energy systems in most homes in the area.

This ambitious undertaking was funded entirely through community contributions and a two-year instalment plan. Each participating household determined their specific energy needs. The financial contribution from each house was structured with residents paying approximately $100 to $200 per month based on the number of panels they chose to install. This personalised approach ensured that the transition to solar energy was not only environmentally friendly but also financially accessible and tailored to the individual needs of each household. It empowered homeowners by eventually transferring ownership of the systems to them, and reallocated funds previously used for generator subscriptions. The success of this project hinged on this reinvestment, which not only eased the financial burden on the municipality and its residents but also promised to make the solar systems the property of the homeowners after full payment within two years. ››

Sustainable energy projects

After initiating the solar systems project, the Bani Hayyan municipality encountered a new challenge. Completely phasing out diesel generators would not be feasible due to the power needs of several essential facilities and public centres in the town, including the water purification station, public gardens, recreational centres, an agricultural cooperative, a football field, and a cultural club – all integral to the community's wellbeing.

In response, the municipality engaged with the non-profit SHEILD Association to explore solutions for these critical areas. Supported by NEF and with technical support and grant funding through the Em(power) pilot project, SHEILD Association addressed the electricity and water needs of these community facilities by installing a 12 kW solar system to power a water filtration system. This initiative aimed to provide free access to clean water for all inhabitants of Bani Hayyan and neighbouring villages, serving around 4,000 people living in and around the municipality. The primary objective of the solar-powered water filtration project was to address the critical issue of water scarcity and contamination, aiming to prevent the community from relying on unreliable or polluted water sources.

By reducing the risk of waterborne diseases, and improving the overall quality of life, this project served as a cornerstone for community well-being. Beyond using the solar-generated electricity to power the water filtration facility, power was extended to community facilities when the water facility was not being used. These social institutions were able to generate income by hosting events, attracting visitors, and supporting local businesses. The health clinic was also able to reduce healthcare expenses for residents of the community. This holistic approach showcases the collaborative efforts supported by NEF, fostering opportunities for employment, skills development, and economic activities within the community.

Moreover, the solarisation of the water filtration system yielded significant cost savings and operational improvements. The elimination of diesel generators resulted in an almost complete reduction in operating costs, allowing for the allocation of funds to other community facilities benefiting from solar-powered electricity. The increased operating hours of the water filtration system, from two to six hours per day, led to a substantial rise in filtered water production, from 3,000 to 10,000 litres per day. Community facilities, including the cultural centre, public garden, sports club, and clinic, experienced a boost in electricity availability from one to four hours per day.

The grant funding for this solar system through the Em(power) pilot was instrumental, especially considering the municipality's limited budget, which was insufficient to cover basic services like waste management and collection. Building on the successful collaboration, the municipality is now exploring ways to further enhance its energy management and support the community. This project involves the installation of on-grid inverters, which could allow for the effective use of excess solar energy by feeding it back into the town's electricity grid. The goal is to make the most of the solar energy generated in Bani Hayyan and to allow households and facilities to receive credits on their electricity bills for their contributions to the grid, which could be used to offset their consumption at other times. According to the mayor, “this innovative project aims to benefit the less privileged and local facilities, demonstrating our commitment to inclusive energy solutions.” ●

Sustainable energy projects

The rise of solar energy in Lebanon through a private sector lens

The solar industry in Lebanon has experienced exponential growth. While this presents a key opportunity for a green transition, energy companies in Lebanon must navigate a variety of issues in this nascent sector.

One example of a solar energy company is Green Power Tech, which has implemented over 10 MW of solar energy projects in the Beqaa Valley since 2016. Significant projects include the installation of solar systems at Riyak Hospital, Zahlé Municipality parking lot, and a substantial agricultural project in West Beqaa for Kaz'un farm. Green Power Tech finds projects in the agricultural sector particularly interesting, such as solar-powered irrigation systems, due to their immediate and tangible benefits to farmers. By replacing expensive and often unreliable energy sources with solar power, farmers can irrigate their crops more consistently, leading to better yields and improved livelihoods. This immediate benefit is not only financial but also contributes to the stability and sustainability of local agricultural practices.

The market for smaller-scale installations, such as those for households, has become much more crowded; this has driven down the profit margins for solar companies and made them less attractive. Some companies, including Green Power Tech, instead prefer to focus on large-scale installations, such as those for factories and solar farms, for their financial and technical viability. These larger systems can help drive down operating costs for clients which can bring increased profits or allow businesses to expand their operations. “Our clients now pay only half the bills they used to pay to EDZ. And some only pay around 10% of what they used to pay before our project installation,” said Mohamad Dayeh, co-founder of Green Power Tech. This also comes with environmental benefits where solar power offsets electricity from the fossil fuel-powered grid or from diesel generators, estimated by Green Power Tech to be around 500 gCO_{2eq} for every 1 kWh of solar electricity, with continuous advancements in solar panel efficiency, energy storage solutions, and smart grid technologies enabling further progress.

Green Power Tech's collaboration with local communities and businesses in Lebanon involves direct engagement and consultations with local entities during the planning stages of solar energy projects. This engagement is crucial for understanding specific energy needs and ensuring that projects meet these requirements effectively. The planning process incorporates local input to optimise the design and implementation of solar systems, considering factors such as the local climate, geography, and infrastructure. Green Power Tech also hires local workers, providing job opportunities within the community and helping to build a skilled local workforce.

Within this nascent sector, solar companies are confronted with a variety of challenges. Green Power Tech highlights that regulatory hurdles are a primary concern as solar installations require the acquisition of permits and approvals from government bodies like MEW. This process often involves complex technical documentation ››

Sustainable energy projects

and compliance with strict regulatory standards. Additionally, projects that involve feeding electricity back to the grid require agreements with utility companies, such as EDZ or EDL, to manage the interchange of electricity. Local municipalities also play a significant role, as their approval is crucial, especially for larger installations or in areas with numerous existing installations.

Financial risks are another major challenge, with companies often bearing significant investment risks to finance projects with equity. Delayed payments from clients can place great financial burdens on solar companies. In addition, the market in Lebanon is influenced by non-technical factors like religion, politics, and corruption, which can impact the fairness and viability of securing projects. The presence of many unregistered solar companies, due to a lack of regulatory oversight, further intensifies these challenges.

Many stakeholders will have critical roles in advancing Lebanon's solar energy sector. Government involvement will be important, especially in establishing a stable and transparent regulatory framework and offering incentives for the growth of renewable energy, such as tax breaks or financial subsidies. International donors and organisations will also be pivotal in providing grants, technical support, and capacity-building efforts to strengthen the sector. Together these could facilitate access to more attractive financing options, including low-interest loans and customised funding solutions, to enhancing the feasibility and execution of further projects. Engaging the community and raising public awareness are fundamental in encouraging the adoption of sustainable energy solutions. Forging partnerships with educational and research institutions, meanwhile, is an important investment for fostering innovation and cultivating a workforce skilled in renewable energy technologies. All these factors will be critical to support solar energy companies in their central role in providing reliable and affordable electricity solutions to clients across the country. ●

"When transitioning to a solar system for agriculture, the beauty lies in the shift from daily payments for gasoline and fuel to harnessing the power of the sun. With the solar system in place, there's no need for daily expenses; as the sun rises, irrigation begins, eliminating the daily cost." – Mohamad Dayeh, Co-founder of Green Power Tech

06

Potential high-impact projects

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Overview of the design process

Effective long-term solutions cannot be implemented in isolation. Close coordination among stakeholders and fostering learning between different organisations is essential to use resources as efficiently as possible and to scale up existing work. Designing potential energy interventions collaboratively – bringing together the experience and expertise of many different stakeholders – can help to identify the most impactful areas of programming as well as the potential barriers and enablers that will affect its implementation.

In support of this, the READS workshops featured a session in which groups of diverse participants came together to learn about each other's work and co-design potential high-impact projects, building on experience from existing interventions. Each group focused on a different energy issue with the goal of outlining a viable project opportunity that would directly address some of the greatest issues currently faced by vulnerable communities in Lebanon.

By involving a range of stakeholders in the collaborative co-design process, the project concepts aim to address the barriers and gaps that the participants identified as the most pressing. They draw on approaches that have already been piloted that show potential to be either replicated in different regions or scaled up.

Following these initial designs and augmented with elements of others that were identified as viable project opportunities through existing pilot projects or in previous studies and surveys, these ideas have been further developed into the project concepts presented in this section. These summaries provide an outline of the potential project including:

- The proposed location and scale,
- The project activities and potential implementation partners,
- Enablers and barriers which could affect its realisation, and
- How these projects link to previous work through replication and scaling.

The estimated costs of the projects are included as a guide and will vary significantly depending on their scale and complexity. The project concepts are designed to be a starting point to further develop interventions, scope out potential partnerships, attract investment, and ultimately increase access to sustainable energy.

The READS workshop featured a co-design session for stakeholders to develop viable, high-impact projects to increase access to sustainable energy for their specific area.

Important considerations for project design

There are considerable differences between the lived reality of different populations across the country. Variations in the amount of existing infrastructure, levels of economic activity, distances to towns, culture, and local needs and priorities will determine what kinds of interventions would have the greatest effect in increasing sustainable energy in each location. Interventions that benefit entire communities as opposed to individual groups should be prioritised as they allow for a variety of energy needs to be met in a cost-effective way and ensure that no one is left behind.

A one-size-fits-all approach will not be able to account for these nuances. Before beginning any of these projects, further research and detailed assessments at the local level will be necessary to better understand the specific and unique situations on the ground. Such assessments should also be independent, objective, and afforded appropriate time and resources to best develop long-term implementation plans. These should be done with community representatives and other stakeholders which best understand their energy needs and are therefore best positioned to shape the proposed interventions.

Many of the project concepts aim to use market systems to better integrate the private sector in the provision of sustainable energy across Lebanon, especially for communities with specific vulnerabilities. Decentralised electricity generation and energy efficiency measures should be promoted across the country to enhance the availability of electricity. Local solar companies should be supported to conform with national and international product standards to ensure quality for customers. All companies and organisations which implement sustainable energy technologies should facilitate ongoing and independent evaluations to assess their benefits to the user, not just under laboratory or ideal conditions, to monitor their continued usage and long-term benefits.

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Community involvement

Community members should be involved from the outset when designing sustainable energy interventions as they best understand their own energy needs and priorities. Community members are particularly well-placed project partners owing to their networks and knowledge of the context, and so should have leading roles to play in the design and implementation of interventions. Some potential opportunities to involve the community include:

- Working with community groups and a range of leading figures to gather input on design of intervention plans, and to advocate for sustainable solutions with other stakeholders and within their communities,
- Consulting with different community segments during the design phase of interventions and for delivery model development, such as through focus group discussions, co-design workshops and community mapping interventions, whilst coordinating with other organisations to minimise overlap,
- Hiring and training community members as technicians, sales agents, and community mobilisers,
- Involving or creating cooperatives to oversee and manage community-wide or public projects and their locations, and
- Direct collaboration with humanitarian and development actors, the private sector, and other organisations for project planning, management, auditing and other key activities.

Gender mainstreaming

Sustainable energy interventions could have different implications for women and men. This can be exacerbated when decision makers, typically men, may have different priorities when it comes to energy to women with regards to domestic responsibilities. Considering these differences and the effects they may have during both the design and implementation of energy projects can allow them to better meet the needs of all community members and promote gender equality. Gender mainstreaming will vary depending on individual contexts and communities but could be integrated into projects by:

- Using single-gender focus groups during initial scoping phases to identify gender-specific concerns,
- Targeting equal opportunities for training and employment for both women and men,
- Increasing opportunities for training and employment for women in roles that are traditionally seen as “men’s work”,
- Identifying employment opportunities for women which are compatible with family, childcare or household responsibilities, for example near to their homes,
- Scheduling engagement events at convenient times of the day and/or provide stipends to avoid conflicting with childcare responsibilities and allowing mothers to participate, and
- Collecting gender-disaggregated monitoring and sales data.

Inclusivity strategies

Achieving sustainable energy for all requires understanding and meeting the needs of every member of the community. Amongst vulnerable populations in Lebanon, some people may require different considerations to access sustainable energy, for example if they have a disability. Including these people in project design, and offering strategies for their inclusion during implementation, can mean that energy interventions meet their needs more effectively. Some inclusivity considerations could include:

- Holding focus groups with people with specific vulnerabilities to ensure an intervention will be accessible to them and meet their needs, and
- Including people with disabilities in trainings and employment opportunities whilst accommodating any specific needs.

Project concepts

MUNICIPAL-SCALE SOLAR PLANTS FOR VILLAGES

1/2

LOCATION

Beqaa governorate (pilot stage)

Villages and municipalities in rural areas across the country (scale up stage)

BACKGROUND

In parallel to the EDL grid, in some areas the provision of electricity is managed by municipalities which sell electricity from large-scale diesel generators to customers under a tariff structure. As an alternative, large solar plants could provide power to entire villages and could enhance the quantity and quality of electricity available to a municipality. This would reduce the reliance on – or potentially allow the replacement of – the existing diesel generators. Impact investments, donations from the diaspora and blended finance could be used to cover the high initial investment costs, with the municipality repaying costs through income generated from selling electricity. This could also be combined with a revolving fund to seed further investments in other systems.

ACTIVITIES

Scope and select sites

Conduct needs assessment in selected municipalities to size systems

Gain permissions and regulatory agreements

Explore viable business models, including establishing a revolving fund leveraging blended financing, lease-to-own models, green impact bonds, etc.

Procure equipment

Install systems

ENABLERS

Could be used in parallel with EDL grid

Potential to use existing networks and distribution infrastructure but replace generators

Benefits of project extend to entire communities, as opposed to small-scale solutions targeting individual facilities

Working with individual municipalities requires just working with one centralised party as opposed to multiple private individuals who operate diesel generators

Municipalities may offer a lower-risk option for external investors (compared to private companies) and may be able to leverage funding from the diaspora through credible leadership

Municipalities in rural areas often own much land which would be required for the installations

Potential for climate financing through replacing fossil fuel generation with renewables

BARRIERS

Requires large-scale investment and financing

Requires metering and bill payment systems

Distribution network may require upgrading or replacement

Requires battery storage to provide power at night

Municipalities might be pressured against transitioning from diesel by parties with vested interests

Potential space constraints limiting system size for municipalities in (peri-)urban areas

Project concepts

PROJECT REACH AND TIMELINE

10 villages
One year per plant
$6 million ($600,000 per solar plant)

FURTHER INFORMATION

Studies estimate that diesel usage could be decreased by approximately 75% but would likely remain as a backup or to be used at night or for increased electricity use during the winter. As the cost of generating electricity would likely be lowered through the transition from diesel to solar power, these cost savings could be passed on to customers as reduced tariffs or paid into a revolving fund to finance future systems. As an alternative, a company could install and operate a solar system under a build-operate-transfer mechanism: the company would implement the system and receive payments from customers for a given number of years, after which the ownership would transfer to the municipality. Bundling projects could unlock opportunities for lower-cost financing.

REPLICATION & EXPANSION

Anera is conducting a scoping study to assess the potential of this solution

STAKEHOLDERS AND ROLES

Non-profit organisation to provide technical and financial assistance to municipalities

Private company to install, operate and maintain the system

Financial institution to provide commercial financing

Government authorities to provide permitting

SCALABILITY

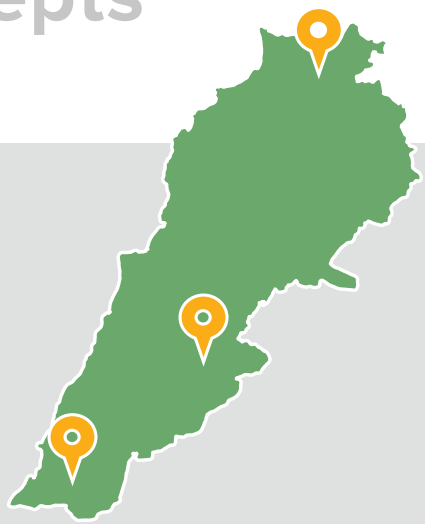
High: The need for a reliable, more affordable electricity supply is immense across the country. A revolving fund model could be piloted with a small number of villages which could then be replicated in other regions.

MUNICIPAL-SCALE SOLAR PLANTS FOR VILLAGES 2/2

Project concepts

SOLAR WATER HEATING AND RENT REDUCTION

1/2



LOCATION

Low-income and vulnerable households in rural areas in Beqaa, North and South governorates

BACKGROUND

Households in Lebanon have been deeply affected by the economic crisis through rising prices, including for rent and energy. Heating water is typically done using electricity but solar water heater (SWH) systems are also popular as they can provide a lower-cost alternative. People living in rented accommodation, who often include more vulnerable households, may not have access to SWHs if their landlords do not want to cover this expense or deny permission for the tenant to purchase and install the system. An organisation could provide SWH to vulnerable people living in rented accommodation with an agreement that the landlord would eventually own the system if they offered a two-year rent reduction to their tenants, allowing these tenants to benefit from both rent and energy bill reductions. Alternatively, a scheme could be offered to landlords leasing accommodation to vulnerable households in which SWH are sold at a subsidised rate to be paid back in instalments. Landlords would qualify for the subsidy if they signed an agreement with their tenants to reduce the rent for a specified amount of time as well as passing along energy bill savings.

ACTIVITIES

Conduct needs assessment among tenants and landlords

Calculate and mediate appropriate SWH subsidies and corresponding rent reductions

Draft contracts and legal agreements

Install SWHs with a warranty to cover repairs and maintenance

Conduct follow-up monitoring to ensure rent reductions are in place throughout the agreed timeframe

ENABLERS

SWHs are widely available and many are manufactured in Lebanon

Opportunity to use renewable energy to offset present electricity-intensive heating methods

Reduces electricity demand and reliance on EDL or diesel generators

Cost savings could be reinvested in further energy efficiency measures

Many vulnerable households are reliant on rented accommodation

BARRIERS

Low ability to pay of households

Requires monitoring to ensure tenants continue to receive rent reductions

Requires agreements with individual landlords and tenants

Limited roof space in densely-populated areas and apartment blocks

Competition for space with solar PV installations

Requires conflict-sensitive selection that takes social cohesion issues into account

Saturation in some areas and preference for solar PV systems

Project concepts

PROJECT REACH, TIMELINE AND BUDGET

10 municipalities with 200 SWH systems each

One year

$2 million

FURTHER INFORMATION

SWH systems can provide hot water for domestic applications such as bathing and washing dishes. Lebanon has a relatively strong domestic SWH manufacturing capacity but installations have slowed since the economic crisis. SWHs typically cost less and use less roof space than solar PV but require some internal work to connect to water storage tanks, and might not be possible to install in apartment blocks.

REPLICATION & EXPANSION

Replicates work implemented in Jordan by NRC, Practical Action and UNHCR under the Renewable Energy for Refugees Project

STAKEHOLDERS AND ROLES

Landlords and tenants to request/give permissions and pay for SWH installations

Companies to provide, install and maintain SWHs

NGOs to support subsidy scheme and to manage legal agreements between parties

SCALABILITY

Moderate: The market for SWH may be saturated in some areas and be affected by the growing market for solar PV systems. However, SWHs can be a cost-effective solution and the project could be scaled to meet demand.

SOLAR WATER HEATING AND RENT REDUCTION 2/2

Project concepts

SOLAR FOR WATER SYSTEMS WITH SMART METERING FOR EXCESS ELECTRICITY

1/2

LOCATION

Agricultural areas in North, West Beqaa, Baalbek-Hermel, and South governorates

BACKGROUND

Water facilities run by water establishments – for pumping for domestic or agricultural applications, filtration, treatment, or other uses – typically use large amounts of electricity when in operation. Most of these rely on electricity from EDL, if available, or on costly diesel generators. Solarising water facilities can both increase the quality and quantity of water services by providing reliable electricity, and typically cost less than diesel generation. Owing to their usage patterns, water facilities would likely not use all of the electricity they generate every day and so excess electricity could be sold on to other community facilities as "off-takers" to enhance their own supply. Smart meters could be used to measure the consumption of other social institutions to issue bills and generate income.

ACTIVITIES

Assess the design of a solar system which could meet the needs of the water facility and additionally the potential excess generation that could be used by off-takers

Conduct assessment of full costs of system, including distribution networks to nearby facilities and smart meters

Investigate and implement water and energy efficiency measures to reduce wastage

Align system planning with new regulatory frameworks on distributed renewable energy

Coordinate with municipal government and social institutions to assess the viability of off-taker connections

Procure and install electricity system, network and smart meters

Develop and implement O&M plan

Monitor electricity usage by off-takers, issue bills and collect payments

ENABLERS

Potential for large-scale solar installation to benefit from economies of scale

Supports water services as a basic need for all community members for both domestic and productive purposes and avoiding health risks associated with using unclean water

Water facilities could have seasonal excess generation that could be passed on to other off-takers which may otherwise not have access to solar energy

Agricultural areas with much public land and high levels of solar irradiance would particularly benefit from the solarisation of water facilities

Could be financially backed by municipalities

New distributed renewable energy law supports the sale of electricity to nearby off-takers

BARRIERS

Requires smart metering to measure consumption by off-takers

Large upfront investment in solar equipment and smart meters

Long-term management of energy consumption may require a dedicated entity to administrate

New legal frameworks may be complicated to navigate

Requires coordination with other similar interventions

Potential for over-exploitation of water resources, further exacerbating shortages

Project concepts

PROJECT REACH, TIMELINE AND BUDGET

10 locations (each with communities of around 10,000 people)

One year

$1.5 million

FURTHER INFORMATION

Water pumping can take place whenever solar generation is available and, once enough has been pumped into water storage tanks, any subsequent energy generation could be used for other purposes. Different types of water facilities have different electricity needs and so the solar system design and amount of excess power available will vary. Existing power distribution networks may require refurbishment or replacement which could be costly but necessary. For some applications, such as pumping for agriculture, water efficiency measures could reduce the overall electricity requirement.

REPLICATION & EXPANSION

Replicates system supported by NEF and SHEILD in Bani Hayyan municipality with additional component of smart meters which potentially enables opportunities for blended finance

Similar systems have been installed in rural areas of Beqaa

STAKEHOLDERS AND ROLES

Water establishments to authorise and oversee the system implementation, including smart meter monitoring and billing

Companies to design, install and maintain electricity systems and networks

NGOs to provide technical support for system design and to identify and manage relationships with potential off-takers

SCALABILITY

High: Replicable across many locations around Lebanon. Savings on electricity costs and payments from off-takers could be used to repay a credit facility, allowing scale-up to other locations.

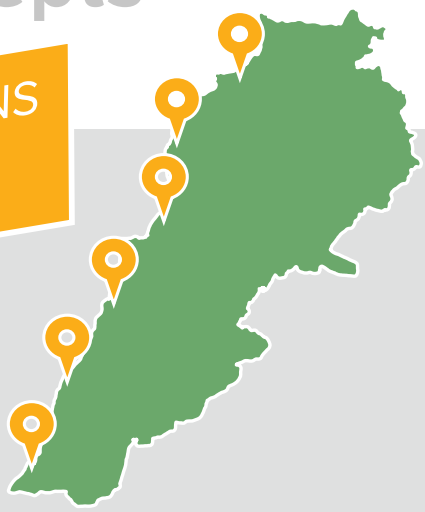
SOLAR FOR WATER SYSTEMS WITH SMART METERING FOR EXCESS ELECTRICITY

2/2

Project concepts

SOLAR INSTALLATIONS FOR THE FISHING INDUSTRY

1/2



LOCATION

Villages along the Mediterranean Coast

BACKGROUND

Fishing in the Mediterranean Sea is a key economic activity in coastal areas of Lebanon. Fishing is often conducted at night when fish are more active: to avoid working in complete darkness, and the hazards that come with this, lighting is required on boats as well as in the ports to process the catch. A lack of cold storage can compromise the quality of the catch by the time the boat returns to port or reaches the sales point, with electricity being able to support refrigeration and ice production for portable ice chests to take on boats. The existing cooperative frameworks could manage communal infrastructure, such as electricity systems and ice production facilities, and handle payments from members to ensure their maintenance.

ACTIVITIES

Work with existing cooperative organisations and their management structures

Assess the requirements for cold storage to meet the needs of the co-operatives

Assess the potential for small-scale lighting and/or refrigeration systems on boats for use at sea

Agree management and maintenance plans, including payments for O&M and replacement parts, with co-operative management and members

Design solar-powered lighting system to illuminate the port area

Install solar-powered lighting, provide communal refrigerators and ice making machines

Implement maintenance and management plans through cooperatives

ENABLERS

Cooperative members could pay a contribution to finance systems as well as monthly fees for system maintenance to reduce reliance on grant funding

Small solar-powered freezers/ fridges are increasingly common and could operate on boats

BARRIERS

Systems will require battery storage given that most operations are at night-time

Requires coordination and collection of monthly contributions via cooperative from members with limited capacity to pay

Requires local permission for equipment installed in public or common-access areas

Ongoing costs and responsibilities for maintenance and battery replacement

Project concepts

PROJECT REACH, TIMELINE AND BUDGET

10 ports and fishing cooperatives

Six months

$500,000

FURTHER INFORMATION

System costs will vary dependent on needs and location, but could be $20,000 to $50,000 based on the costs of the project at the port of Sarafand. It would be crucial to develop an O&M plan and budget for the communal equipment before installation. This should delineate clear roles and responsibilities to ensure that the systems are well-maintained in the long-term.

Cold storage on boats could be facilitated through thermally-insulated ice chests which are filled with ice at the port, or through on-board solar-powered refrigeration systems. The former would likely be more affordable for smaller boats, whilst the latter could be suitable for larger vessels with adequate space, potentially under a battery-swap model with some or all equipment costs covered by individual users.

REPLICATION & EXPANSION

Replicates the initiative in the port of Sarafand supported by NEF and SHEILD Association

Solar-powered refrigeration and ice-making projects have supported fishing communities in Kenya, Senegal, and Indonesia, amongst others

Solar-powered lighting on boats has been piloted in Tanzania

Solar power for ports and battery-swap models for boats have been implemented in Gaza

STAKEHOLDERS AND ROLES

Cooperatives to oversee the implementation of the equipment and management structures

Members of cooperatives to pay for lighting and cold storage services

NGOs to assist in community engagement and technical designs

Companies to design and install equipment

Municipalities and/or port operators to grant permissions for equipment installation

SCALABILITY

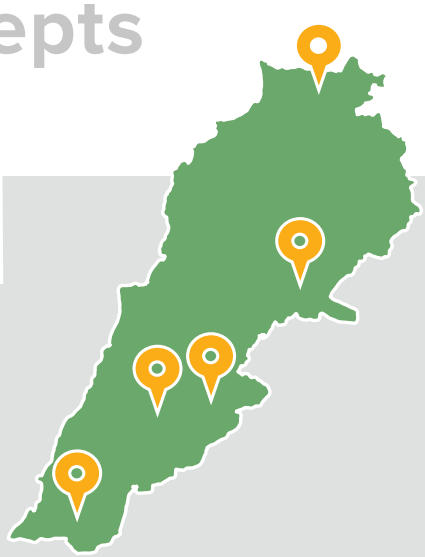
High: Similar projects could be implemented with cooperatives across the country. Multiple ports could be bundled together for economies of scale on similar types of equipment.

SOLAR INSTALLATIONS FOR THE FISHING INDUSTRY 2/2

Project concepts

SOLAR SYSTEMS FOR AGRICULTURAL COOPERATIVES

1/2



LOCATION

Rural areas of Nabatieh, Beqaa, Baalbek-Hermel, North, and South governorates

BACKGROUND

Agricultural cooperatives consist of groups of farmers who work together to achieve economies of scale, collective agreements, and increased negotiating power. Small producers who combine their resources can also access equipment and facilities that might otherwise be unattainable for single operations, including their electricity source. Each cooperative could obtain a solar system to have reliable access to electricity to power their equipment and operations, enhancing their productivity. This would allow them to power a range of specialised equipment and to better schedule their production. Additional benefits could also be extended to local households or communities, such as the provision of water.

ACTIVITIES

Identify and work with agricultural cooperatives to understand their needs and the types of equipment that would be most beneficial

Gather feedback from the wider communities to assess the potential co-benefits of a solar energy system

Reach agreements with cooperatives to decide how the solar system would be managed and financed, and roles and responsibilities for long-term O&M

Work with companies to design, procure and install the solar system and (if necessary) new machinery

Train cooperative members on usage and maintenance of solar PV system and new appliances

Collect payments from cooperative members to fund long-term O&M

ENABLERS

Small-scale projects with potential for high direct impact

Increases incomes and improves resilience to economic and energy shocks for vulnerable workers

Could be implemented within existing cooperative structures

Could replace diesel generation, where used

Includes straightforward applications of solar power for water filtration and pumping

Potential cost savings whilst providing important services to farmers and agri-food businesses

BARRIERS

Bureaucratic challenges of cooperative financing, such as the inability to take on loans without government approval

Cooperatives may operate under different management structures, requiring unique agreements for each one

Heavy historic reliance of cooperatives on grants and limited experience with investing

Switching to solar power may require new equipment or refurbishment of existing machinery

Risk of groundwater overexploitation and need for strict enforcement of regulations

Project concepts

PROJECT REACH, TIMELINE AND BUDGET

20 agricultural cooperatives
One year
$400,000 (around $20,000 per cooperative)

FURTHER INFORMATION

Agricultural cooperatives could focus on one or many applications of electricity. This could include access to water (such as pumping, filtration, or treatment) or equipment for processing produce (such as milling, food preservation, or honey extractors). Providing a reliable source of power could improve operations for cooperative members, whilst its stability (without voltage fluctuations) would help to avoid damage to equipment. Agricultural uses of electricity could provide anchor loads for other applications, such as selling power to local off-takers such as households at a subsidised tariff or powering water stations. Long-term support structures may need to be integrated into the cooperative management to ensure the longevity of the electricity systems.

REPLICATION & EXPANSION

Builds on work conducted by NEF and SHEILD Association under the Em(power) project

STAKEHOLDERS AND ROLES

Cooperatives to oversee the implementation and management of solar systems

Members of cooperatives to pay for electricity services

NGOs to assist in community engagement and technical designs

Companies to design and install equipment

SCALABILITY

Moderate: Cooperatives tend to be fairly small-scale. Similar projects could however be implemented with cooperatives in rural areas across the country.

SOLAR SYSTEMS FOR AGRICULTURAL COOPERATIVES 2/2

Project concepts

SOLAR SYSTEMS FOR HEALTH CENTRES AND SCHOOLS

1/2

LOCATION

Villages and municipalities in rural areas of Lebanon

BACKGROUND

Health centres and schools provide critical public services for communities across Lebanon. Impacted by the energy crisis, there have been efforts to provide solar power to these facilities to reduce their reliance on unreliable grid electricity or expensive and polluting diesel generation. A revolving fund could be established through which community facilities could apply for financing to support solarisation. This fund could provide concessional loans to the facilities which would be paid back using savings from the reduced usage of diesel. Alternatively, a development impact bond could provide a larger amount of upfront financing and donors could take on the responsibility of repaying the loan and interest.

ACTIVITIES

Conduct needs assessment and identify relevant facilities

Establish application process for facilities

Review applications and undertake technical and financial assessments of systems

Align planning and installation with new regulatory frameworks on distributed renewable energy

Procure and install solar systems

Design and implement energy efficiency measures to reduce wastage

Develop and implement O&M plan and budget with clear roles and responsibilities

Repay loan over two-year period using savings from reduced expenditure on diesel fuel

ENABLERS

Potential to address essential needs for public services across the country

High costs of diesel make decentralised solar a more financially viable solution and savings could be redirected towards providing other services

Many health centres and schools have already installed solar systems but many more remain

Relatively large solar installations which are more attractive to the private sector

BARRIERS

Large upfront investment required whilst community facilities have very limited resources

Requires skills and training on long-term O&M and battery replacements (where used) to maintain the benefits of solar power

Project concepts

PROJECT REACH, TIMELINE AND BUDGET

200 institutions

Two years

$5 million

FURTHER INFORMATION

Health centres require reliable electricity to store vaccinations and medication, as well as to power medical equipment. Schools, many of which are doing double-shifts to support displaced Syrian children, require electricity for lighting, cooling and heating as well as to power ICT equipment. Many of these projects have focused on providing solar to health facilities and schools through one-off projects or independent sources of funding. Establishing a long-term revolving fund, through which repayments from one facility can fund new equipment for the next, could provide more and ongoing opportunities to tap into long-term financing. Facility managers should be trained in the O&M of these systems, and a budget for this would also need to be included from the outset, potentially covered by the diesel fuel savings.

REPLICATION & EXPANSION

Replicates work done by many organisations, such as Anera

Several large-scale projects have been grant-funded by international donors

STAKEHOLDERS AND ROLES

Donors to partner with private investors to establish revolving fund or development impact bond and provide capital or repay loans

Private investors to provide initial capital for equipment

Companies to design and install solar systems, and to provide O&M training to community facility employees

NGOs to manage financing disbursal and provide technical support to community facilities

Community facilities to apply for financing, manage design and installation process, and fund O&M measures

SCALABILITY

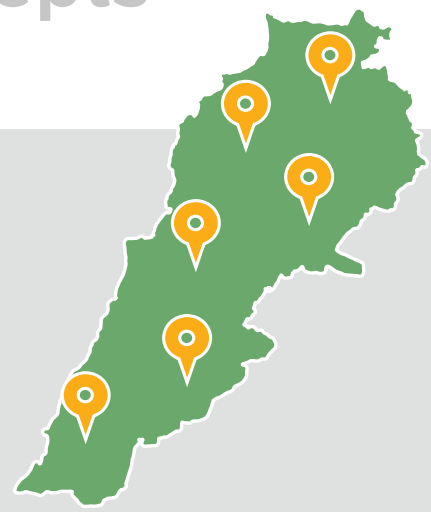
High: Replicable across many locations around Lebanon. Savings on diesel costs could be used to repay credit into a revolving fund, allowing scale-up to other locations. Additional investments into the fund would expand its reach.

SOLAR SYSTEMS FOR HEALTH CENTRES AND SCHOOLS 2/2

Project concepts

VOCATIONAL AND RE-TRAINING PROGRAMMES

1/2



LOCATION

In cities and towns across Lebanon

BACKGROUND

Lebanon's solar revolution has demonstrated the growth potential of the renewable energy sector. It also highlights the great need for a skilled workforce for O&M, energy efficiency measures, and e-waste management systems. Vocational training and re-training opportunities in renewable energy, energy efficiency, and water management measures can equip people with skills and certifications to pursue a career. While such training opportunities are available to some, scaling up the number of skilled workers will help to support these growing industries.

ACTIVITIES

Establish partnerships with TVET institutes

Implement existing curricula or develop new, specialised training plans

Develop and manage application process for students

Offer tailored training courses for each sector

Connect with relevant companies, NGOs and other organisations to offer on-the-job experience and placements

Provide certification and recognised qualifications to help graduates find relevant jobs

ENABLERS

Equips people with specialised qualifications in growing industries

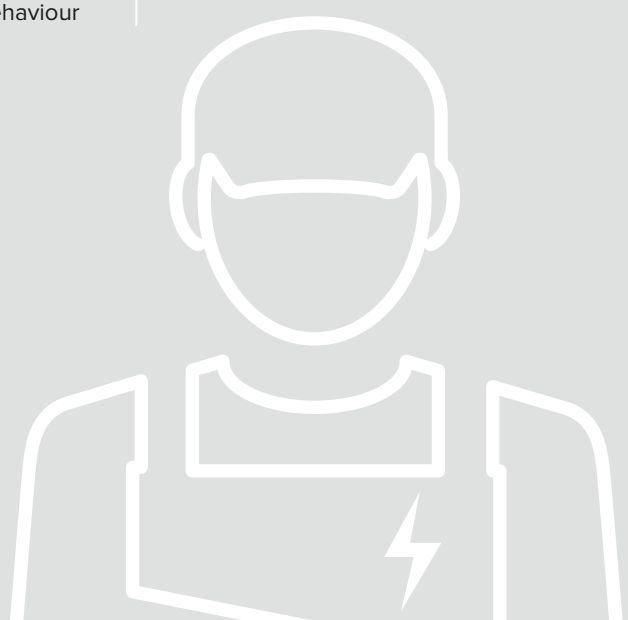
Raises environmental awareness and promotes behaviour change

BARRIERS

Relies heavily on grant funding

Current employment opportunities remain limited but are expected to grow

Some vulnerable groups face restrictions on the industries in which they can work



Project concepts

PROJECT REACH, TIMELINE AND BUDGET

10 locations

Two years

$500,000

FURTHER INFORMATION

Training courses can benefit both people who want to obtain new qualifications and beginning their careers, and people who want to transition into another sector (for example people working with diesel generator networks). Courses could go beyond teaching technical skills and include project development skills, for example how to conduct energy assessments, complete regulatory processes, and develop business models. The curriculum could also include instruction on other environmental issues, such as forestry and water management.

REPLICATION & EXPANSION

Replicates work done through the Renewable Energy for Refugees project by NRC in Jordan

Replicates work done by Anera's youth programme in Lebanon

STAKEHOLDERS AND ROLES

NGOs to establish partnerships with TVET institutions and support participants in applying

TVET institutions to provide courses and certifications

Companies and NGOs to provide opportunities for training and pathways to employment

SCALABILITY

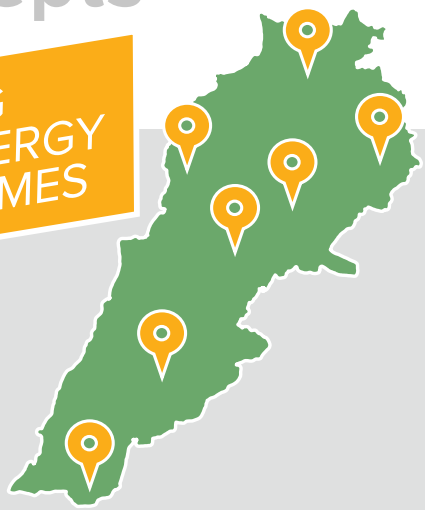
Moderate: Replicable across many locations in Lebanon in collaboration with established TVET institutions, but is heavily reliant on grant funding and reaches a limited amount of people.

VOCATIONAL AND RE-TRAINING PROGRAMMES 2/2

Project concepts

BLENDED FINANCING FOR RENEWABLE ENERGY INVESTMENTS FOR SMES

1/2



LOCATION

Nationwide

BACKGROUND

Small and medium-sized enterprises (SMEs) across Lebanon face electricity shortages, high bills, and unreliable access to power. Investments in renewable energy equipment can provide reliable power whilst also offering short timelines for returns on investment. Many SMEs, however, face challenges in covering the high upfront costs of equipment as longer-term financing schemes are typically unavailable. A financial institution could overcome this blockage by providing the initial investment for an SME to obtain quality solar equipment which would then pay off the loan in instalments. Grant funding could support the financial institution in providing the financing capital for this scheme, as well as de-risking the loans, and could facilitate the financial institution in providing favourable low- or no-interest loans to the SMEs.

ACTIVITIES

Establish a list of pre-approved suppliers of quality-assured renewable energy equipment to participate in financing scheme

Disseminate information about the advantages of solar equipment and cost-benefit analysis for SMEs and promote the scheme

Design financing schemes to offer long-term payment options for SMEs at affordable interest rates

Develop additional opportunities for lower-interest or subsidised loans for vulnerable SMEs

Use payments from SMEs to provide financing for future loans to ensure the longevity of the programme

Monitor and evaluate the affordability, payment rates, and impact of the loans to ensure the financing is both affordable for SMEs and provides the benefits of renewable power

ENABLERS

Short payback period when replacing diesel costs with solar power

Applicable to SMEs across many sectors

BARRIERS

Relies on grant funding for initial loan capital

Uncertainty due to the economic crisis limits ability to repay loans

Limited roof space for solar equipment in densely-populated areas

Project concepts

PROJECT REACH, TIMELINE AND BUDGET

2500 SMEs
Three years
$20 million

FURTHER INFORMATION

Different SMEs have a variety of electricity needs and this would be reflected in the types, capacities, and costs of renewable energy systems they would require. The loan repayment amounts would need to vary depending on the type and size of business and would require careful management and monitoring to ensure SMEs can make payments without causing additional financial burdens.

REPLICATION & EXPANSION

Similar to the USAID-funded Solar & Renewable Energy Fund which provides financing for SMEs in Lebanon to access renewable power

STAKEHOLDERS AND ROLES

Financial institutions to offer and manage loans

Donors to provide initial capital for loans

NGOs to provide business mentorship and awareness raising to SMEs

Renewable energy equipment suppliers to provide high-quality equipment, warranties, and maintenance

SCALABILITY

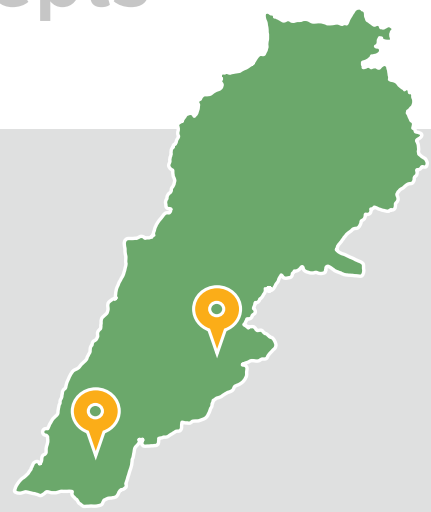
High: Replicable throughout Lebanon and for many types of SMEs.

BLENDED FINANCING FOR RENEWABLE ENERGY INVESTMENTS FOR SMES 2/2

Project concepts

EM(POWER) II

1/2



LOCATION

Beqaa governorate
South governorate – scale up to implement larger projects than in Em(power) I

BACKGROUND

Under the original Em(power) project, a community consultation process identified specific opportunities to increase the electricity supply for municipalities. Through a combination of interviews, focus group discussions, technical assistance, and assessments, five projects were implemented. In the initial pilot of this project, the amount of funding allocated to each project was relatively small, limiting the amount and type of energy solutions that could be implemented. If this were to be scaled up, both in terms of number of projects as well as the budget allocated per project, more municipalities could develop and realise a sustainable energy solution which would have a transformative effect on their communities.

ACTIVITIES

Identify community members to take part in consultations

Hold focus group discussions and semi-structured interviews

Evaluate submitted proposals

Compile shortlist of viable projects

Undertake site visits and assessment of shortlisted projects

Score and select projects

Procure and install solutions

Develop an O&M plan along with roles and responsibilities and financing structures

ENABLERS

Community consultation process is very flexible, adaptable and can be replicated across the country

The consultation process is relatively low-cost

Community-led initiatives tend to be more sustainable due to increased ownership of the project

Solutions at the municipal level benefit entire communities

BARRIERS

Potentially heavily reliant on grant funding

Selection bias of projects may mean that similar projects are funded which do not necessarily benefit the most vulnerable communities

Project concepts

PROJECT REACH, TIMELINE AND BUDGET

20 large-scale projects ($50,000 each)
Two years
$1 million

FURTHER INFORMATION

The Em(power) project had initially intended to target individual SMEs but found that entire communities were facing similar water and energy shortages, and that it was more cost-effective to develop municipal-level solutions. Working with municipalities was also beneficial in terms of having one representative actor to coordinate with and also that has access to land which can be used for solar installations. Identifying individual municipalities which were very proactive and committed to enhancing their communities' welfare was key to the sustainability of the projects, as well as their community-led design and ownership. The need for these community-driven solutions is great, as illustrated by the long list of other project proposals received by NEF and SHEILD.

REPLICATION & EXPANSION

Scales up NEF and SHEILD's Em(power) pilot project, potentially replicating it in a different region of the country

STAKEHOLDERS AND ROLES

NGO to lead on community mobilisation, community consultations, and evaluation and selection of projects

Municipalities to engage in consultations and develop project proposals

Donors to provide grant funding

SCALABILITY

High: The community consultation methodology can be replicated across the country and is relatively low-cost. The full cost of the project depends on the amount of grant funding which needs to be allocated. Still, relatively small projects can have a transformative effect on entire municipalities.

EM(POWER) II
2/2

07

Conclusions

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Key issues for energy access

Lebanon has been experiencing one of the most severe economic and energy crises in recent history. The country's heavy reliance on imported fossil fuels, coupled with chronic underinvestment and management issues of EDL, means that the national grid provides only around two hours of electricity per day. Networks of unregulated, private diesel generators have sprung up to bridge the gap, but their high tariffs place a great financial strain on households and businesses which are already struggling due to the severe economic crisis.

Electricity shortages affect all aspects of life in Lebanon. Households and businesses struggle with the unreliability of the electricity supply, being unable to plan their daily activities due to the frequent outages. High electricity bills represent a crippling burden, particularly for lower-income households. Water pumping and water treatment needs for both domestic and agricultural purposes have become exorbitantly expensive, with small businesses naming water shortages as one of the key factors hindering their productivity. The unavailability of power affects the provision of essential services by community facilities. Some, like health centres, usually have diesel generators for backup or are increasingly adopting solar systems, whilst others such as schools often lack an alternative power source. The productivity of the agriculture and fishing industries is also hindered due to electricity and water shortages limiting their ability to produce, process, and store food.

A "solar revolution" offers the potential to support a transition to a more reliable and sustainable energy source, with Lebanon experiencing a steep rise in demand for solar systems. Whilst this has increased renewable energy production, high upfront costs for solar installations, limited ability to pay by lower-income households, the circulation of substandard products, and a lack of regulation pose challenges and further exacerbate inequalities within Lebanese society.

The Government of Lebanon has acknowledged the significant role of the energy sector in improving the lives of the country's most vulnerable populations, both through access to electricity for households and in support of vital public services. The recent passing of the Distributed Renewable Energy Law promises to support the much-needed expansion of alternative electricity sources. Stakeholders from the government, humanitarian and development organisations, the private sector, and local communities are implementing projects aimed at improving energy access for households, businesses, and community facilities. Whilst these are growing, both in number and impact, they require more investment and coordination to scale up to meet the challenge of providing sustainable access to energy for Lebanon's vulnerable populations.

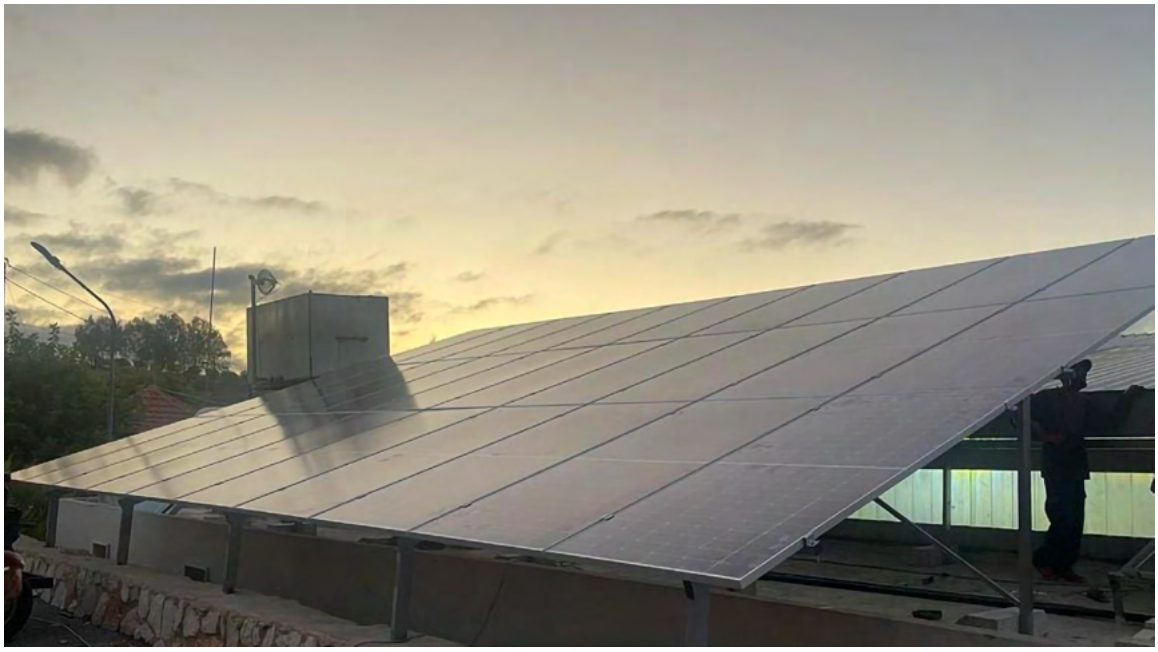
Solar PV systems and solar water heaters have become increasingly popular and widespread across the country. Beyond supporting individual households, businesses, and community facilities to gain access to renewable energy technologies, there are great opportunities for municipal-level solutions to play an important role in significantly enhancing access to sustainable electricity by addressing the needs of entire communities in a cost-effective way. They also provide the benefit of working with a single stakeholder (as opposed to many individuals) which often have large amounts of land at their disposal that can be used for installations. Lebanon also harbours much potential for investments in utility-scale renewable energy systems alongside improvements to both the infrastructure and management of EDL. A variety of solutions will be necessary to enhance reliable access to sustainable electricity across the country. ●

The road to sustainable energy for vulnerable communities

Improving access to reliable and sustainable energy will require a concerted effort from stakeholders across Lebanese society. Companies, humanitarian and development organisations, government departments, municipalities, and many others will need to provide support for sustainable energy interventions, and the involvement of community members in the design of solutions will be critical to ensure that projects meet the needs of vulnerable groups.

The READS workshops brought together a diverse range of stakeholders to co-design potential high-impact projects. Whilst these are presented as individual opportunities – and would each merit investment and implementation on their own – rolling out coordinated interventions addressing several sectors could have a truly catalytic effect on increasing sustainable energy access as a whole.

Acknowledging this, and the work of other initiatives, the roadmap below presents a vision of how access to sustainable energy in Lebanon could develop in the short, medium, and long term. Coordination among different stakeholders will be central to achieving progress, which could be greatly supported by the new Distributed Renewable Energy Law which lays the regulatory foundation to achieve this goal. ››



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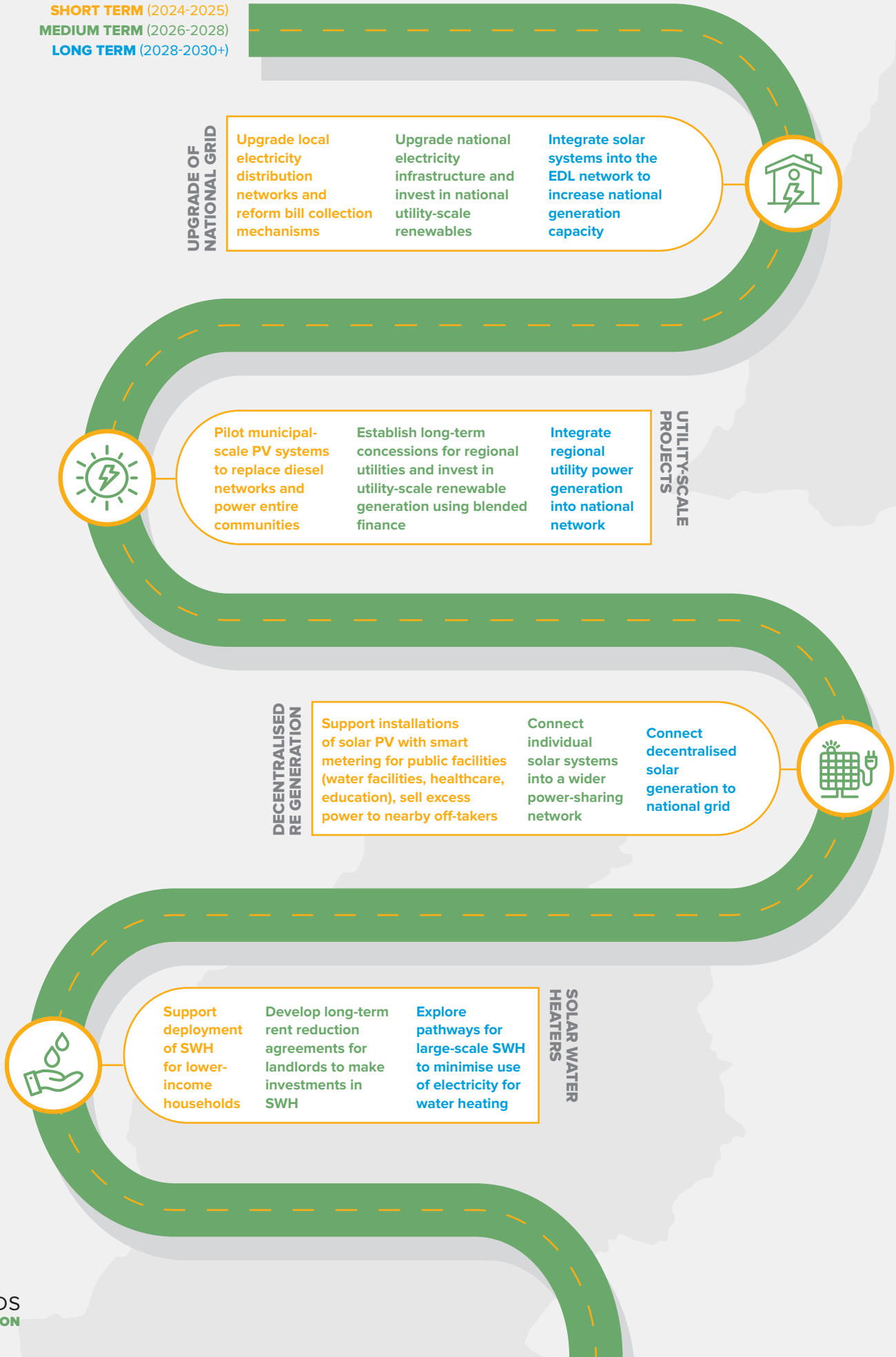
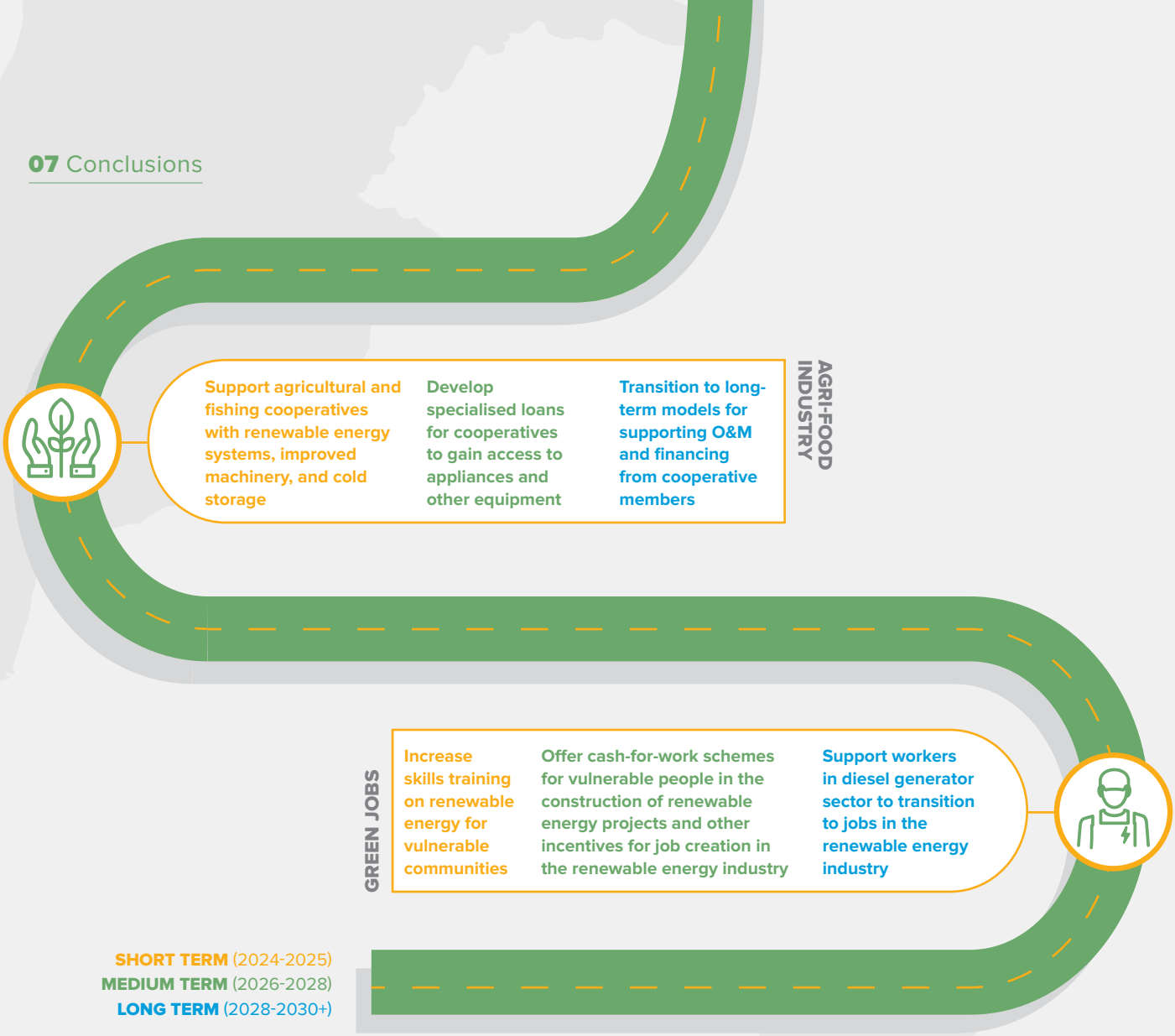
SHORT TERM (2024-2025)
MEDIUM TERM (2026-2028)
LONG TERM (2028-2030+)





The challenge is huge and achieving access to affordable, sustainable, and reliable electricity for vulnerable populations in Lebanon faces many obstacles. It is compounded by the severe economic and energy crises, the Israel-Gaza crisis with internal displacement in Southern Lebanon, and the ongoing war in Ukraine. These same factors highlight the immense benefits in investing in renewable energy systems to reduce Lebanon's reliance on fossil fuels. By investing in decentralised sustainable energy alongside improvements to the national grid, Lebanon can continue its "solar revolution" to bring back more reliable, affordable and sustainable electricity access to its residents to improve their lives and livelihoods. ●

By investing in decentralised sustainable energy alongside improvements to the national grid, Lebanon can continue its "solar revolution" to bring back more reliable, affordable and sustainable electricity.

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