



MIDDLE EAST AND
NORTH AFRICA

LEBANON

World Bank Group

COUNTRY CLIMATE AND DEVELOPMENT REPORT

March 2024

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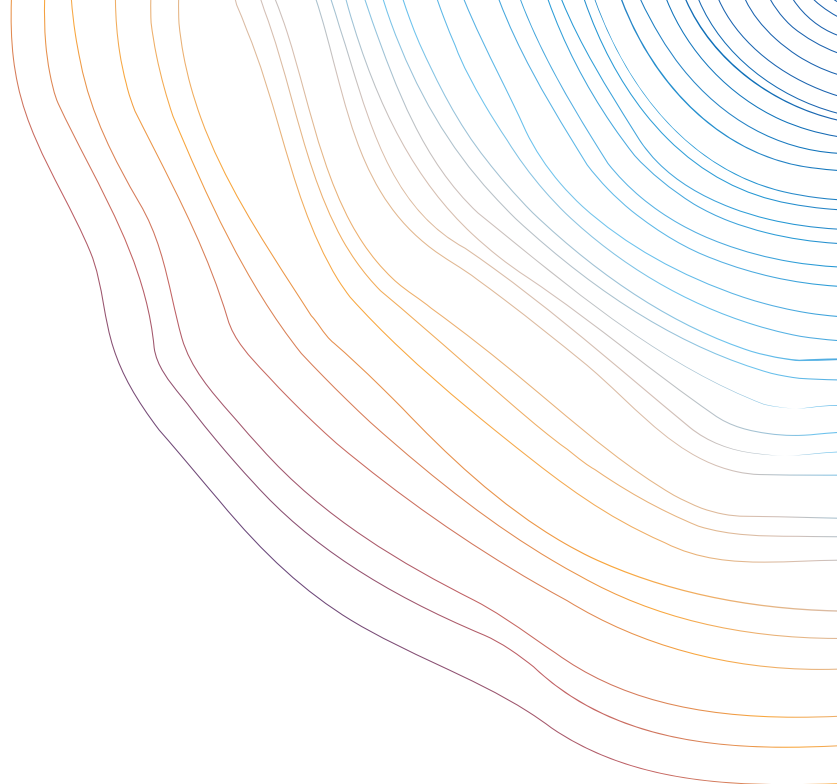
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List of Acronyms

CCDR	Country Climate and Development Report
CO₂	Carbon dioxide
DRE	Distributed Renewable Energy
DO	Distributed only scenario
EDL	Electricité du Liban
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GWh	Gigawatt-hour
LC	Least cost
LCEC	Lebanese Center for Energy Conservation
MoEW	Ministry of Energy and Water
NDC	Nationally Determined Contribution
NPV	Net present value
NRW	Non-Revenue Water
RCP	Representative Concentration Pathway
tCO₂	Tonnes of carbon dioxide

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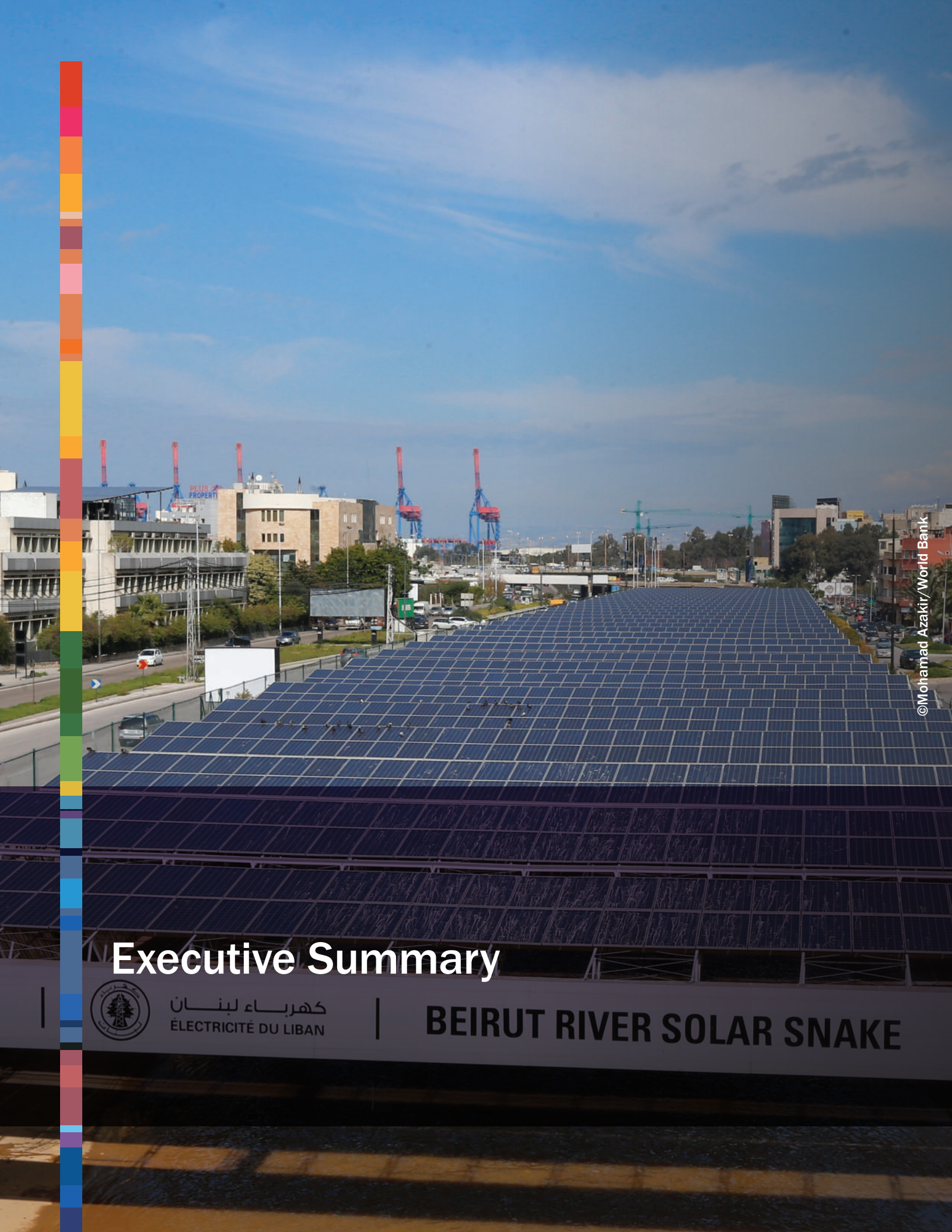
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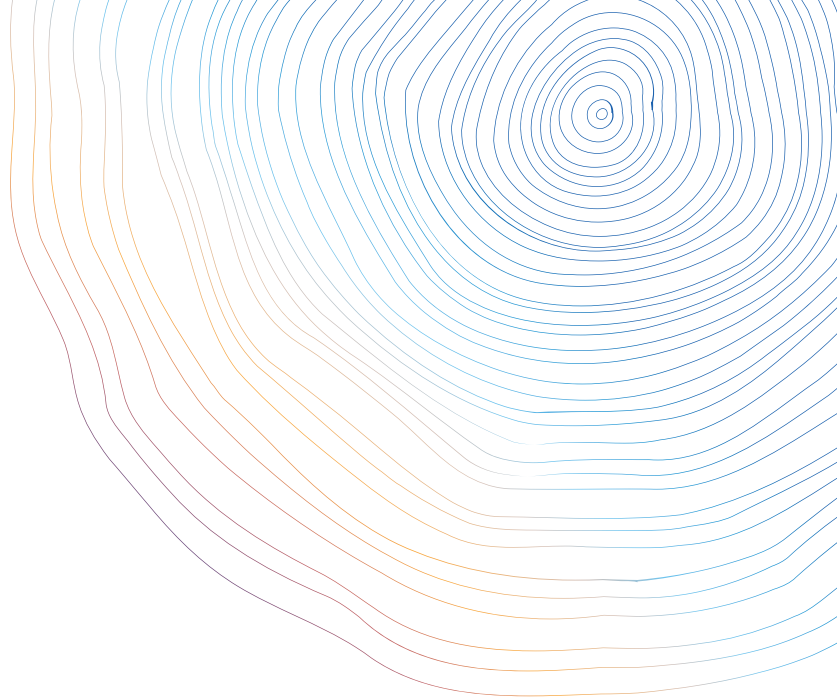
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Executive Summary



كهرباء لبنان
ÉLECTRICITÉ DU LIBAN

BEIRUT RIVER SOLAR SNAKE



EXECUTIVE SUMMARY

The Lebanon Country Climate and Development Report (CCDR) aligns the country's short-term recovery needs with resilient, low-carbon, long-term development, building on quantitative modeling-based analytics, existing research and country diagnostics, and extensive stakeholder consultations to study the effects of climate change on Lebanon's recovery and development objectives. Two macroeconomic baseline scenarios—a business-as-usual “muddling through” scenario and a broad reforms-based recovery scenario—underline the report's findings. The first assumes continuation of inaction on reforms,¹ absence of fiscal space, and a banking sector that is incapable of providing financing to the private sector. The recovery scenario assumes that macro-fiscal reforms will be adopted that will gradually ease financing constraints and increase fiscal space.

1 The reforms are predicated on a new, credible exchange rate and monetary framework; comprehensive bank restructuring that addresses balance sheet impairments, restores liquidity, and adheres to sound global practices of bail-in solutions based on a hierarchy of creditors (starting with bank shareholders) that protect small depositors; a medium-term fiscal strategy to restore debt sustainability; and key structural and sector-level reforms to enhance governance.

The CCDR analysis has six key messages:

Message 1: Lebanon is among the countries least prepared to face climate change; its limited adaptive capacity, exacerbated by the ongoing economic and financial crisis, is the primary source of its vulnerability to climate change.

Lebanon has among the poorest scores in climate readiness of all Middle Eastern and North African countries (just ahead of Yemen), reflecting limited capacity to adapt to climate change on all levels. In 2022, Lebanon ranked 161 out of 192 countries in terms of readiness to face climate change according to the Notre Dame Global Adaptation Initiative Country Index.² Its vulnerability to climate change stems not only from its exposure to climate risks (see Message 2 below), but also from its inability to adapt, which is driven by infrastructure deficits and weak institutions. The ongoing economic crisis is weakening the country's human, natural, and physical capital, eroding its already limited capacity to adapt to climate change. In 2019, it plunged into one of the worst economic and financial crises in modern history (World Bank 2021a). Gross domestic product (GDP) has contracted by close to 40 percent since 2018, erasing more than 15 years of economic growth. The steep economic contraction and severe deterioration in basic service provision have increased unemployment, poverty and brain drain. Overall and youth unemployment rates have increased by about 18 and 24 percentage points, respectively. The economic crisis is also weighing on Lebanon's natural capital; inadequate wastewater and solid waste systems, which are among the public services that the financial crisis has most affected, are accelerating environmental degradation.

Climate change in Lebanon will result in more frequent extreme weather events, warmer temperatures, and greater rainfall variability. The average temperature is expected to be 1.7°C to 2.2°C higher by 2040 than the 1980 to 2005 average, which will result in more frequent heatwaves, with the number of days hotter than 35°C occurring more often, reaching 22 to 25 days by 2040. Rainfall, including its intensity and duration, has varied significantly year to year, increasing surface run-off and decreasing rainfall infiltration into the soil.

Message 2: Climate change impacts that are covered in this report are projected to reduce Lebanon's growth potential by up to 2 percent annually by 2040 and impede service provision, especially in water and energy, hindering key growth sectors such as agriculture and tourism.

Macroeconomic modeling of Lebanon's climate change effects indicates a considerable decrease in economic activity of 1.1 percent to 2.0 percent of real GDP annually by 2040. Initiating climate adaptation now will support Lebanon's long-term recovery. Damage from flooding, lower crop yields, a decrease in water supply, and lower labor productivity (affected by heat)—Lebanon's most important climate change damage channels—is significantly greater (reaching -2 percent) under the worst-case global scenario (representative concentration pathway 8.5), highlighting the urgency of climate action to limit damage in all of these areas, particularly agriculture.

It is projected that climate change will decrease water availability by up to 9 percent by 2040 (and up to 50 percent during the dry season) and induce significant losses in key recovery-driving sectors, particularly agriculture (up to US\$250 million per year) and tourism (up to several hundred million

2 These data are from the Notre Dame Global Adaptation Initiative Country Index (database), Notre Dame, IN (accessed in November 2023), <https://gain-new.crc.nd.edu/country/lebanon>.

dollars per year), threatening livelihoods. The combined effects of higher temperatures and lower precipitation would also decrease the number of snow days by 6 to 9 days in 2030 and 38 to 50 days in 2050. In the agricultural sector, it is projected that combined climate change effects will decrease the yield of irrigated crops by 0.3 percent to 8.7 percent and of rainfed crops by 3.5 percent to 7.5 percent. Annual financial losses for rainfed and irrigated crops due to increased temperature and rainfall may reach US\$250 million per year. The decrease in the number of snow days mentioned above poses a direct threat to winter tourism, and in the summer, the likely increase in the frequency of forest fires threatens Lebanon's growing eco-tourism sector. It is projected that economic losses in tourism due to climate change will be approximately US\$75 million per year. Climate change impacts on tourism could result in job losses of approximately 2 percent in agriculture, transport, and trade and 13 percent in accommodations.³

In terms of mitigating GHG emissions, continuation of the status quo in Lebanon's power sector will increase costs, emission, and fuel imports, both in U.S. dollar terms and as a share of GDP. Since the beginning of the economic crisis in 2019, costly highly polluting diesel generators operating outside the legal framework have been the primary source of electricity. Lebanese households have learned to navigate and adapt to multiple crises, but the "generator economy" is becoming too expensive for consumers. In 2020, the average cost of private diesel generation was US\$0.60 per kilowatt-hour. Driven by security-of-supply concerns and price signals (after the removal of foreign exchange-induced fuel subsidies), deployment of standalone solar and hybrid systems has grown in recent years. From 2023 to 2040, under a muddling through scenario, costs and emissions are higher and demand for electricity is 16 percent lower than under a recovery least-cost (recovery-LC) scenario). While fuel costs under a muddling through scenario account for more than 78 percent of annual system costs, fuel costs decline to less than 54 percent of total costs by 2040 under a recovery-LC) scenario.⁴

Message 3: Decarbonizing Lebanon's power sector generates a triple dividend, reducing economic costs by 41 percent and emissions by 43 percent and improving macro-fiscal outcomes.

Decarbonizing Lebanon's power sector would help address its external fiscal imbalances while reducing emissions and achieving economic gains, such as more jobs. Investment in low-cost (and low-carbon) electricity generation is essential for Lebanon's economic recovery. Continuing the status quo (dominance of fossil fuel-based power generation and lack of sector reforms) would result in higher electricity costs, fuel imports, and emissions, which would slow economic growth. In contrast, if reforms were to be adopted in line with a recovery-LC scenario paved by sizeable investments in utility-scale solar energy and limited investments in natural gas generation, the impact would be significant, resulting in more affordable electricity, 41 percent lower costs, and 43 percent lower carbon dioxide (CO₂) emissions, accompanied by less air pollution. If steps are taken toward recovery, it is expected that, by 2030, generation of approximately 4.2 GW in solar energy will decrease the cost of electricity by 60 percent and meet growing demand. Although the primary motivation for policies to expand renewable energy and promote energy efficiency is to reduce costs, increase electricity supply, and improve fiscal outcomes and consumer affordability, slower emissions growth and more job opportunities are additional benefits. With investment needs of US\$5.9 billion in generation by 2040, recovery-LC is predicated on a financially viable power sector, unlocked through sector reforms and private investments, and on public investments needed to manage a grid with high penetration of

3 Source: Lebanon CCDR modeling result.

4 The recovery-LC scenario assumes that macro-fiscal stabilization occurs in the short term (12–18 months) and that the sector begins structural reform as outlined in the Ministry of Energy and Water's policy plans. Under this scenario, the first new centralized power plant would enter service in 2027 to meet rising demand.

variable renewable electricity. Comparing the investments proposed under recovery-LC with a scenario under which emissions decline from 2023 levels to net zero by 2050 shows that recovery is compatible in the next decade with a long-term net zero target.

Beyond the power sector, promoting electrification of public transport and improving solid waste management present opportunities to advance the development and climate agendas simultaneously. Together, the transport and solid waste sector generated 31 percent of Lebanon's greenhouse gas (GHG) emissions in 2019 (25 percent and 6 percent, respectively). Phased deployment of 4,000 electric minibuses and 2,000 electric buses would reduce annual road transport carbon emissions by 1.0 tonnes of CO₂ equivalent (5.4 percent) in 2040. Approximately US\$900 million in net present value is needed. A significant share of the carbon abatement would result from a modal shift from cars, so reforms to improve the service quality of public transport will be essential. Adopting principles of integrated solid waste management (e.g., circular economy, resource efficiency, waste hierarchy) will not only help address important sector challenges, but also reduce GHG emissions and alleviate serious environmental and public health impacts.

Message 4: Increasing Lebanon's capacity to adapt to climate shocks depends on how quickly it recovers from its current crisis and invests in adaptation measures (especially in the water, agricultural, tourism, and transport sectors)

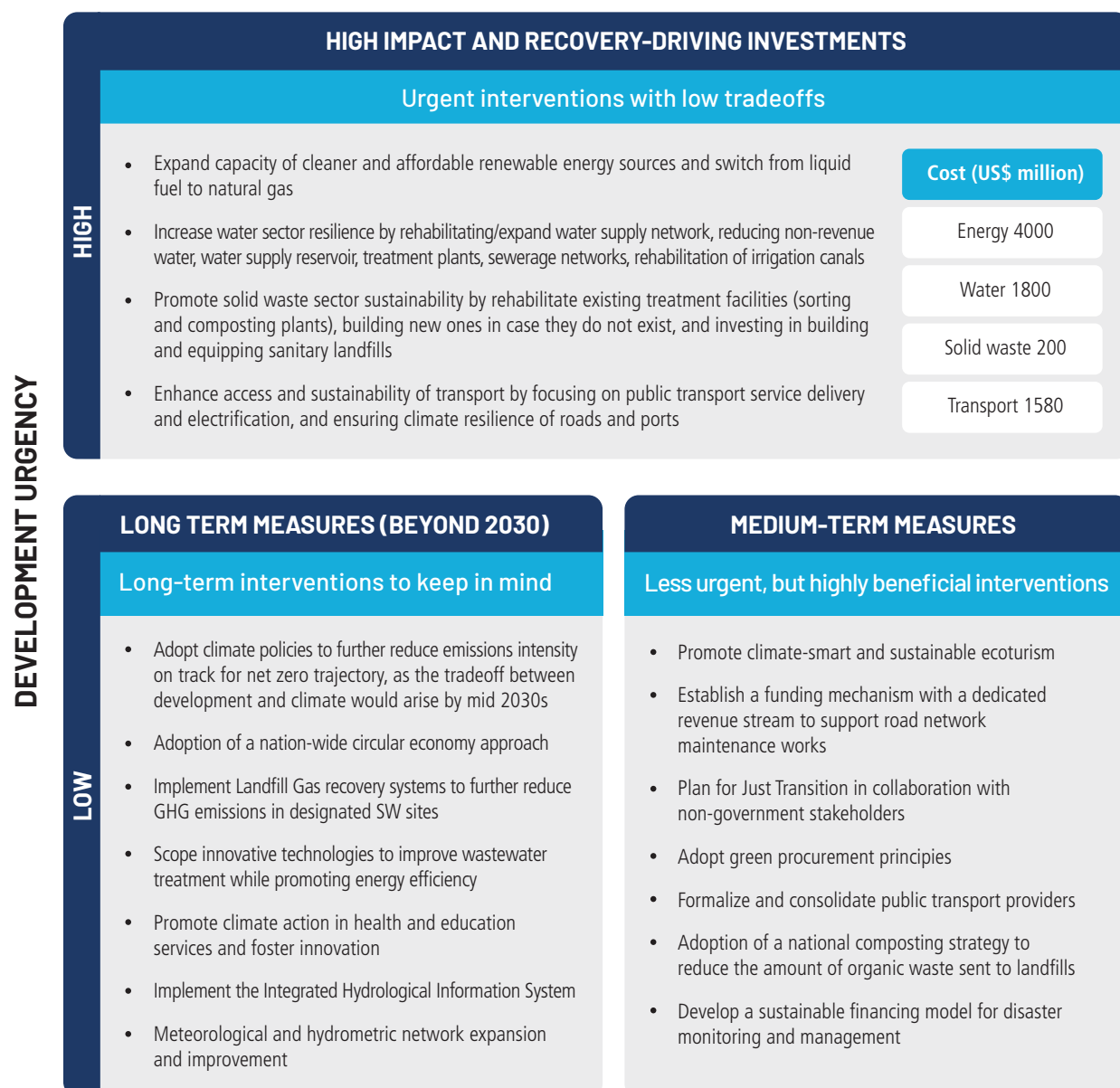
In the short to medium term, the extent of damage from extreme weather events will depend on how quickly Lebanon can exit its current crisis. Its capacity to adapt to acute climatic stresses will be greater under the recovery scenario, especially in the case of flooding; stress tests show more damage to the government's fiscal balance and debt-to-GDP ratio if floods occur under the muddling through scenario. Floods are also expected to have a larger and longer-lasting impact on economic output under the muddling through scenario because lower overall productivity will be lower, and reliance on capital stock for production will be greater. Under the recovery scenario, Lebanon's economy is expected to be more resilient to potential climate shocks in the short term and climate damage in the long term.

Building adaptive and resilience capacity, against climatic shocks, especially in the water, agricultural, tourism, and transport sectors, will support Lebanon's recovery and protect livelihoods. In the absence of appropriate strategies and accompanying structures, and given Lebanon's natural landscape, groundwater characteristics combined with the projected reduction in snowpack accumulation and other climate-driven losses will make it difficult to benefit during the dry season (April–September) from the abundant water resources of the wet season (October–March). Therefore, it is essential to identify techniques that can be used to store water during the wet season to be used during the dry season and to reduce current drinking water and irrigation water distribution losses. Similarly, adaptation measures in agriculture and tourism are needed to protect these vulnerable sectors and the livelihoods they support. Some of the key proposed measures include catalyzing climate-smart investments in agri-food value chains by providing technical and financial support to farmers and agribusinesses and ensuring water availability by increasing water use efficiency in irrigation and investing in water harvesting systems. In tourism, enhancing public sector capacity to assess climate risks and enforce environmental and broader ecotourism standards will increase resilience, biodiversity, jobs, and economic benefits to communities. A road network analysis reveals that Lebanon's road assets are highly vulnerable to climate impacts, with 54 percent exposed to landslides, which damage infrastructure assets, disrupting transport of goods and mobility of people. Lebanese ports and airport are also exposed to sea level rise and would benefit from mitigation measures to increase their resilience.

Message 5: Despite stalling implementation of reforms, critical and no-regret investments can still be advanced with limited macro-fiscal impact.

Amid an ongoing and deepening economic crisis, Lebanon has almost no fiscal space, limited institutional capacity, and numerous development challenges, so it is critical to prioritize, and sequence recommended measures and interventions—reflecting their urgency, synergies, and trade-offs—in responding to development and climate needs. The measures recommended in this CCDR, responding to the above-highlighted development and climate needs, are shown in [Figure ES1](#).

Figure ES1: Recommended Policies and Interventions



Aligning Lebanon's recovery with cost-effective climate action between 2024 and 2030 will require that Lebanon invest an estimated US\$7.6 billion in the four key sectors covered in the CCDR (energy, water, transport, solid waste). The capital-intensive energy sector alone requires approximately US\$4 billion in investment to diversify the generation mix toward cleaner, affordable renewable energy sources and to switch from liquid fuel to natural gas. Other critical investments would include more than US\$1.8 billion in the water sector, according to the updated National Water Sector Strategy, to increase water security through additional storage capacity, increase water use efficiency, and restore resilient water services. Approximately US\$200 million is required in the solid waste sector to rehabilitate existing treatment facilities (sorting and composting plants), build new ones where they do not exist, and invest in building and equipping sanitary landfills. In the transport sector, investment needs include new projects to kick-start an effective green public transport system (US\$915 million) and increase transport infrastructure resilience (including roads, bridges, and ports) (US\$665 million). Major transport assets (e.g., Beirut Airport, Port of Beirut, Port of Tripoli) could benefit from climate-driven public-private partnership projects that consider effective green building systems and energy efficiency.

In the short-term (2024–26) and under any scenario, Lebanon needs critical investments in key service and growth-providing sectors that requires a financing envelope of US\$770 million. The recovery and muddling through scenarios examined in this CCDR are meant to illustrate alternative development paths that broadly correspond to reform and no-reform (status quo) scenarios. Although Lebanon could embark on either of these two scenarios, it may end up on a path somewhere in between. Consequently, the Lebanon CCDR also assessed the impact of an urgent financing envelope that responds to key (partial) needs in the four covered sectors in the CCDR (energy: US\$300 million; water: US\$260 million; transport: US\$120 million; solid waste: US\$90 million) even under a muddling through scenario.

The US\$770 million critical investment package will yield a slightly higher real GDP than the muddling through scenario without placing debt on an unsustainable footing. Lebanon cannot afford to delay these much-needed investments. Macroeconomic modeling of the impacts of the priority investments package showed that it would not place debt on an unsustainable footing. The fiscal and debt dynamics can be enhanced by mobilizing private sector financing, reducing the central government's share of total investment spending.

Message 6: Empowering Lebanon's private sector, improving governance, and adopting a whole-of-society approach to climate change are critical for Lebanon's green recovery.

Restructuring the financial sector to regain its intermediation functions and establish dedicated mechanisms for affordable green investments is critical. Empowering Lebanon's private sector to play a bigger role in the economic recovery and supporting the country's climate action requires restructuring the financial sector to restore banks' viability and financial intermediation. The ongoing crisis presents real opportunities for the private sector.

Improved governance, empowered public sector institutions, and a whole-of-society approach to climate change are critical for Lebanon's green recovery efforts and progress on its climate change commitments and ambitions. Effective governance and strong institutions are necessary to coordinate efforts across different sectors and levels of government. In terms of ensuring citizen buy-in and engagement, Lebanon's whole-of-society approach would rest on three pillars: foster **accountability** for implementation of climate change commitments and climate change financing (on budget and off budget); promote **collaboration** among stakeholders to develop and implement a timebound strategic vision to support, mobilize, and harness the impact of multi-stakeholder and stand-alone initiatives for climate change adaptation and mitigation interventions, especially those geared toward a just transition for the most vulnerable groups; and support **direct citizen- and community-led actions** in conjunction with municipal and national guidelines and directives.

Lebanon CCDR Highlights

Main Climate Change Impacts



UP TO 50%

LOWER WATER AVAILABILITY
PROJECTED IN THE DRY
SEASON (APRIL-SEPTEMBER)

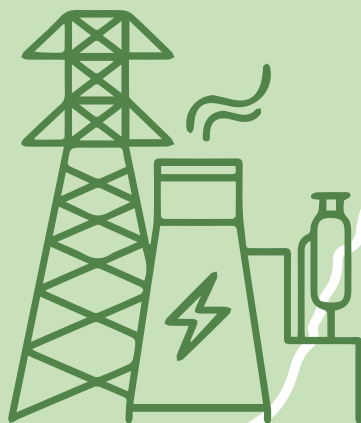


1.1 to 2.0%

PROJECTED ANNUAL
LOSSES TO LEBANON'S
REAL GDP

**DUE TO CLIMATE
CHANGE BY
2040**

Benefits of Decarbonizing Lebanon's Power Sector



41%

LOWER ECONOMIC COSTS



43%

LOWER EMISSIONS

**RESULTING FROM ADOPTING THE CCDR'S
LEAST-COST RECOVERY PATHWAY FOR
LEBANON'S POWER SECTOR, COMPARED
TO THE STATUS QUO SCENARIO.**

Needed Short-term Investments



**US\$ 770
MILLION**

LEBANON'S CRITICAL
SHORT-TERM INVESTMENT
NEEDS BETWEEN
2024-2027



1

Development and Climate Context

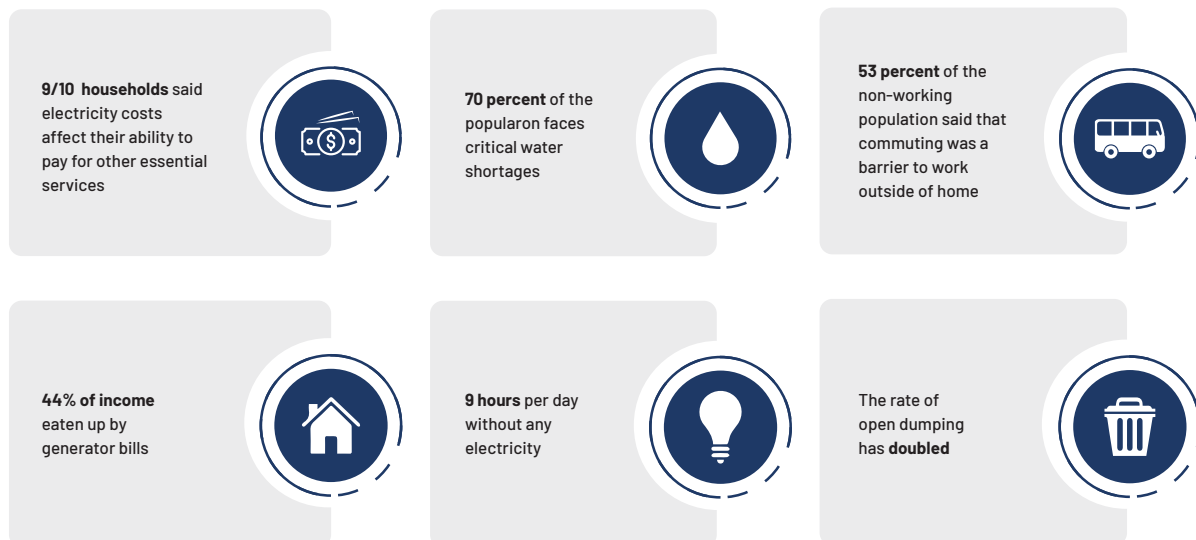
1. Development and Climate Context

1.1 Economic and Social Challenges Amid a Compounded Crisis

Lebanon's economic and financial crisis ranks among the worst globally since the mid-nineteenth century. Between 2018 and 2021, Lebanon's gross domestic product (GDP) fell from about US\$55 billion to US\$23 billion, with GDP per capita plummeting by about 55 percent. According to the World Bank Spring 2021 Economic Monitor, such a rapid contraction is one of the most severe in modern times and is usually associated with conflict or war. Contraction in real GDP has wiped out more than 15 years of development and economic growth. The COVID-19 pandemic; the devastating Beirut Port explosion; and more recently, a food security shock and oil price hike due to the war in Ukraine have compounded the country's economic and financial collapse.

The country continues to face rampant inflation and near-collapse of service provision. The dramatic deterioration in the delivery of many services stems mainly from the collapse of Lebanon's electricity sector. Even before the current crisis, Electricité du Liban (EDL) supplied only 55 percent to 64 percent of Lebanon's electricity needs (approximately 12–14 hours of supply per day on average until 2018) because of a long-standing capacity deficit of up to 1,500 MW. During the crisis, at times, grid service dropped to less than one hour of power per day, with effects on poverty, the economy, the environment, and recovery prospects ([Figure 1](#)). The country's wastewater treatment plants are mostly nonoperational because of the crisis, causing severe difficulties in responding to a nationwide cholera outbreak between late 2022 and June 2023. The transport sector also faces challenges, with deteriorating public transport and road conditions, which hamper mobility, connectivity, and trade; an informal, poorly maintained system exacerbates this.

Figure 1: Costs of Collapsing Basic Services as a Result of the Economic and Financial Crisis



Source: World Bank, Human Rights Watch, and UNICEF.

The steep economic contraction and severe deterioration in basic service provision have increased unemployment, poverty, and the brain drain. The crisis has caused unemployment and youth unemployment rates to increase by about 18 and 24 percentage points, respectively. Gender inequality has increased, with 32.7 percent of women in the labor market unemployed, compared with 28.4 percent of men (CAS 2022). Labor demand has decreased significantly, leading to a decline in overall labor force participation from 48.8 percent in 2018/19 to 43.4 percent in 2022, including some initially unemployed individuals leaving the workforce.

Lebanon hosts an estimated 1.5 million displaced Syrians, in addition to Palestinian refugees and other refugee groups, who deterioration in basic service provision also affects. Lebanon has one of the highest concentration of refugees per capita in the world. The ongoing crisis has increased competition between refugees and host communities for jobs, economic opportunities, and basic services, particularly in lagging regions (Akkar, Bekaa, the south). Access to health care facilities has diminished amid soaring costs. The education sector is also struggling to meet demand, with overcrowded classrooms, inadequate facilities, and limited operational funds. Energy demand is difficult to meet. Approximately 486 MW of additional power generation is necessary to meet the basic needs of displaced Syrians.

The impacts of the economic crisis have also intensified burdens on Lebanon's natural capital. Inadequate wastewater and solid waste systems, which are among the public services that the financial crisis has affected most, are accelerating environmental degradation. Key challenges include the impact on health of air pollution caused by open burning of solid waste, water-borne diseases associated with inadequate wastewater and solid waste management, and impacts on land resources and coastal zones due to open dumping and extensive construction of related infrastructure in coastal zones. Increases in fuel prices have forced citizens to find alternative sources for heating, intensifying illegal logging practices and endangering Lebanon's already fragile forests. Wildfires have increased exponentially, from 343 recorded events in 2019 to 1,077 in 2021.⁵ The rising threat of wildfires poses a dual risk, not only endangering valuable assets, but also affecting tourism, which serves as a crucial socioeconomic safety net, particularly in rural areas.

1.2 Climate Change and Development Challenges

1.2.1. Physical Climate Change Impacts

The average temperature in Lebanon is expected to be 1.7 °C higher than 1980 to 2005 averages by 2040 under the representative concentration pathway (RCP) 4.5 scenario and 2.2 °C higher under RCP 8.5. By the end of the century, temperatures could be 4.4 °C higher.⁶ Projections for precipitation are less certain,⁷ but Lebanon expects to experience net water loss. It is projected that, by 2040, a combination of increases in heat and decreases in precipitation will decrease available water by 5.7 percent under RCP 4.5 and by 9 percent under RCP 8.5.

5 Lebanon CNRS data

6 The Lebanon Council for Scientific Research provided this information for the Lebanon CCDR.

7 Estimation of precipitation change has a higher standard deviation with time because of various factors such as the complexity of the climate system and assumptions made in the models. Rainfall patterns, including intensity and duration, vary significantly year to year, resulting in greater surface runoff and less rainfall infiltration into the soil. Fluctuations in precipitation ranged from 500 mm in 2019 to 900 mm in 2004.

Lebanon's natural capital,⁸ the main economic lever for Lebanon's rural economy, is deeply connected to growth-driving sectors (water, agriculture and forestry, tourism), critical to restoring growth and creating jobs, and highly vulnerable to climate change. Water is vital to Lebanon's social and economic recovery and development, directly affecting sectors that collectively generated 37 percent of Lebanon's exports and 19 percent of employment in 2019.⁹ Water underpins key economic sectors such as industry, agriculture, energy, and tourism. With approximately 20 percent of Lebanese households generating primary or secondary income from the agrifood sector, agriculture is critical to growth and recovery. Agribusiness is the largest industrial subsector of the economy, accounting for more than 17 percent of exports in 2020. Tourism contributed 19.1 percent to the country's GDP in 2019. Since the beginning of the crisis, and despite the impact of the COVID-19 pandemic, the tourism sector has shown great resilience; it was the only contributor to growth in 2021.

It is projected that climate change will induce significant losses in key recovery-driving sectors, particularly agriculture (up to US\$250 million per year) and tourism (several hundred million per year), threatening jobs, incomes, and livelihoods. In the agricultural sector, it is projected that combined climate change effects will decrease the yield of irrigated crops by 0.3 percent to 8.7 percent and of rainfed crops by 3.5 percent to 7.5 percent. Decreases in the number of snow days pose a direct threat to winter tourism. It is projected that direct economic losses in tourism due to climate change will be US\$75 million per year. If tourists shift to another country altogether, total expenditures by tourists, including transport and consumption, could reach US\$500 million of the US\$7 billion being spent before the crises. In summer, the likely increase in the frequency of forest fires threatens Lebanon's growing ecotourism sector. Effects of climate change on tourism could result in job losses across the whole economy of approximately 2 percent in agriculture, transport, and trade and 13 percent in accommodations.

With approximately 20 percent of Lebanese households generating primary or secondary income from agrifood, the sector provides a productive social safety net and has been resilient in generating livelihoods and income for a large share of the poor. Agribusiness is the largest industrial subsector of the economy. Crop production accounts for about 60 percent of agricultural output, and livestock production accounts for 40 percent and provides a critical year-round source of income. The contribution of primary agricultural production to GDP dropped from 3.2 percent (US\$1.77 billion) in 2018 to 1.4 percent (US\$323 million) in 2021, although the sector accounted for more than 17 percent of total exports in 2020 (US\$700 million on average between 2014 and 2020). Lebanon's agrifood exports increased by 51 percent to US\$949 million from 2019 to 2021, primarily driven by a surge in fruit exports, especially grapes. Although domestic agrifood production satisfies only 20 percent of local demand, it provides the largest share of income for poor segments of society and is concentrated in the poorest areas. Host communities and refugees in Lebanon are especially reliant on the agricultural sector for income and food security.

8 Stock of renewable and nonrenewable resources.

9 Source: Observatory of Economic Complexity and ILO

Table 1: Projected losses induced by climate change in key sectors by 2040
(Source: Lebanon CCDR/CNRS data)

Sector	Projected climate change risks and damages
Water	<ul style="list-style-type: none"> It is projected that increases in heat and precipitation will decrease water availability annually by 5.7 percent under RCP 4.5 and 9 percent under RCP 8.5. In the dry season, it is projected that water availability will be 42 percent lower under RCP 4.5 and 54 percent lower under RCP 8.5.
Agriculture	<ul style="list-style-type: none"> It is projected that combined climate change effects will decrease the yield of irrigated crops by 0.3 percent to 8.7 percent and of rainfed crops by 3.5 percent to 7.5 percent. Annual financial losses in rainfed and irrigated crops due to increased temperature and rainfall may reach up to US\$250 million.
Tourism	<ul style="list-style-type: none"> The number of snow days is expected to decrease gradually over time, with 5.9 fewer days in 2030 and 37.7 fewer days in 2050 under RCP 4.5. More-severe loss is projected under RCP 8.5, with 8.6 fewer days in 2030 and 50.1 fewer days in 2050. This poses a direct threat to winter tourism. It is projected that economic losses due to climate change will be up to US\$500 million per year in total consumption by tourists and a loss in jobs of about 13 percent.
Transport	<ul style="list-style-type: none"> It is estimated that landslide and flood damage to roads (cost of rehabilitating assets damaged by these hazards) is US\$1.4 billion.

Source: Lebanon CCDR/CNRS data.

Note: RCP, representative concentration pathway.

Climate change is affecting urban infrastructure, increasing the risk of damage, disruption, and financial costs for cities. Lebanon is highly urbanized, with an estimated 88.9 percent of its inhabitants residing in cities (UN-Habitat and ESCWA 2021). These cities, and most of the population, are primarily located along the coast, which is susceptible to changing precipitation patterns and intensity of storms and, in the long

term, rising sea levels.¹⁰ In Beirut, floods and storms have inundated coastal settlements, buildings, and transport infrastructure; disrupted operation of the Beirut airport; and damaged roads, water networks, and wastewater systems along the coast. A 2020 World Bank study (Beirut Urban Resilience Master Plan) estimated that an urban flood with a recurrence interval of two years (depth 0.13–0.36 m) has the potential to affect more than 100,000 people residing in Beirut. A coastal flood with a recurrence interval of 10 years has the potential to cause significant damage, including to 170 buildings, 6.7 km of roads, and 3 km of sidewalks.

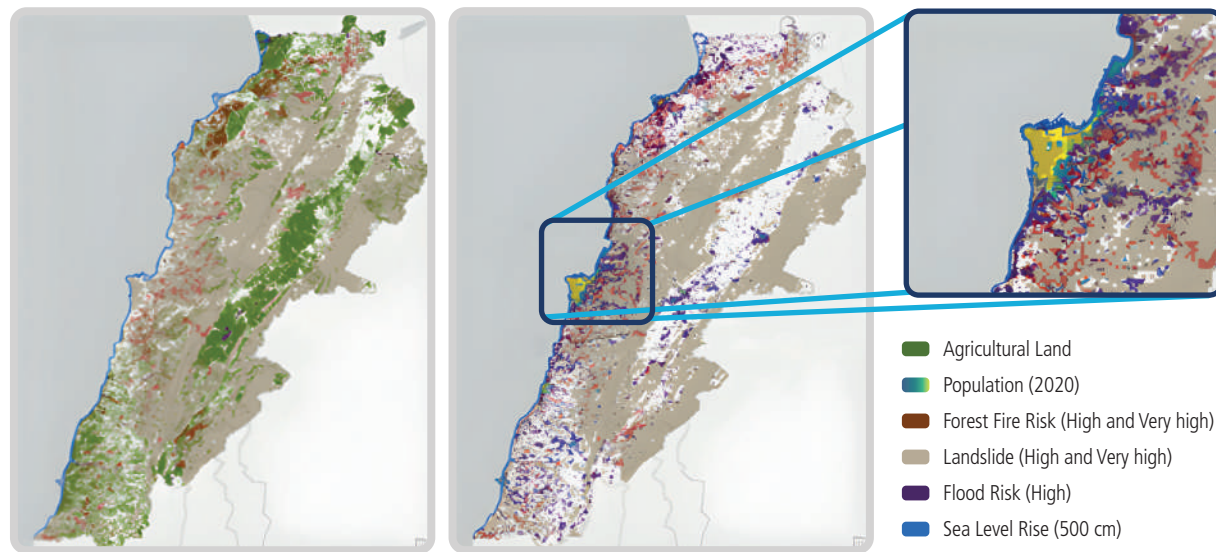
Uncontrolled urban growth, along with unsustainable land management practices, is degrading the country's natural capital, including water, agriculture, and the ecosystem, and limiting economic opportunity. Integrated land management is closely linked to the four key sectors covered in this Country Climate and Development Report (CCDR). There is a lack of clarity on land governance, incomplete overall registration of lands and properties, complex land administration processes, and weak integration across governmental entities. Incomplete land surveying, inadequate map integration among government bodies, and inefficient land administration systems have collectively impacted approximately 65 percent of the country's territory. This has resulted in poorly integrated land use and environmental plans, leading to challenges such as inefficient land utilization, mismanagement of resources, environmental problems, and of informal developments.

The poor-quality housing prevalent in refugee communities tends to be ill equipped to protect against temperature extremes, damaging weather events, and other climate change effects, which increases refugees' vulnerability. It is estimated that 69 percent of refugee families live in residential structures and 22 percent in nonpermanent shelters. For those living in residential structures, housing selected for its affordability often provides substandard living conditions: windows or doors are not sealed against the elements; the roof, walls, or floors let in rain; sanitation services are limited; and electric service is patchy. Forty-three percent of all refugee households experience substandard living conditions in residential structures. Nonpermanent shelters provide little protection against the elements because they are built as temporary solutions but are often used for longer than a decade. Residential structures and nonpermanent refugee shelters are also frequently overcrowded, adding to public health risks when health services are already inadequate (UNHCR 2019).

Vulnerability to climate change in Lebanon is geographically sensitive, with agricultural land and transport infrastructure among the most vulnerable. An area spanning 12.23 km² of agricultural land is notably susceptible to flood hazards, and a substantial agricultural expanse of 715.83 km² faces high to very high landslide exposure. The risk extends to the transport sector, with 41 km of roads at significant risk of flooding and a staggering 3,117 km of roads vulnerable to high and very high levels of landslide hazard. Particularly concentrated in the Mount Lebanon governorate, these risks span 1,393.6 km of roads. Projections reveal a growing concern for human settlements. Sea-level rise is expected to affect densely populated urban areas, with potentially devastating consequences. By 2030, an estimated 11,756 people will be exposed to high flood risks, and it is anticipated that the exposure to high and very high landslide risks will affect 1,848,735 people. These troubling figures underscore the urgent need for comprehensive strategies to mitigate the impacts of these hazards on agriculture and infrastructure.

10 Averaged across the Mediterranean basin, mean sea level rose by 1.4 mm/year during the 20th century and has accelerated to 2.8 mm/year recently (1993–2018) (high confidence), mostly because of global ocean and icesheet dynamics.

Map 1: Climate Change Risk in Lebanon



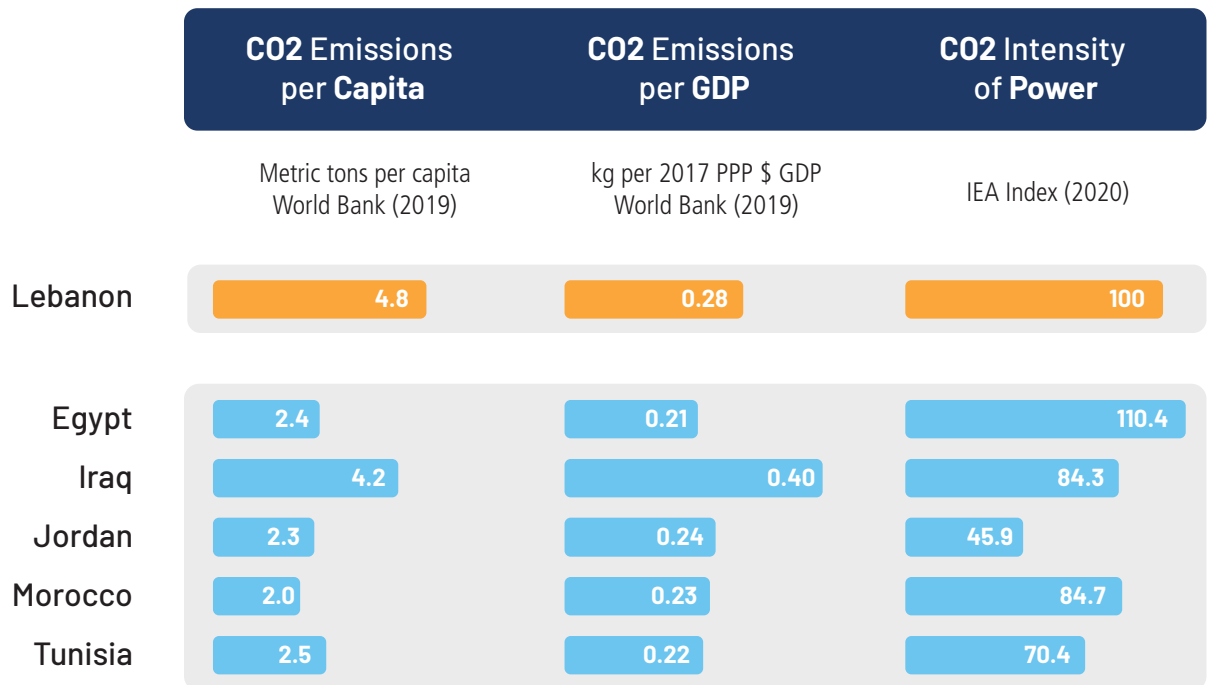
Source: Lebanon CNRS data CCDD team analysis.

1.2.2. Lebanon's Carbon-Intensive Development Model

In 2019, the energy sector was responsible for half of Lebanon's total greenhouse gas (GHG) emissions, making it the largest contributor to GHG emissions and air pollution (50 percent), followed by the transport sector (25 percent), industrial processes (11 percent), and solid waste (6 percent). Lebanon's net emissions in 2019, accounting for carbon dioxide (CO₂) removal from forestry and other land uses, were 27,028 Gg of CO₂ equivalent (CO₂e). The economic crisis and the COVID-19 pandemic temporarily reduced GHG emissions by decreasing economic activity, but the country's reliance on diesel generators for power generation degrades air quality. The transport and solid waste sectors are carbon inefficient, with transport contributing to import bills and air pollution. Carbon emissions from these sectors increased from 20.2 percent in 2001 to 25 percent in 2019, reaching 7.6 tonnes of CO₂ equivalent (MtCO₂e). In the solid waste sector, open dumping and open burning increased significantly, with about 42 percent of waste ending up in open dumps, posing health and environmental risks even before the crisis.

Lebanon's power sector is the greatest drag on its economy and environment. Annual budgetary transfers to EDL, the state-owned power utility, averaged 3.8 percent of GDP over the last decade, accounting for close to half of the country's overall fiscal deficit, but EDL has been chronically unable to provide a reliable supply of electricity. A private (and lucrative) business has emerged to complement EDL's limited supply: private generators. With the economic crisis, the limited supply of power from the grid has dropped further. EDL and private generators generate electricity from brown sources (heavy fuel), which is expensive—in addition to the fiscal cost, energy (mostly fuel) imports contribute to Lebanon's balance-of-payments deficit, and the cost to consumers is among the highest in the Middle East and North Africa—has a large carbon footprint, and is a major source of air pollution.

Figure 2: Emissions in Lebanon and Middle Eastern and North African Country Peers

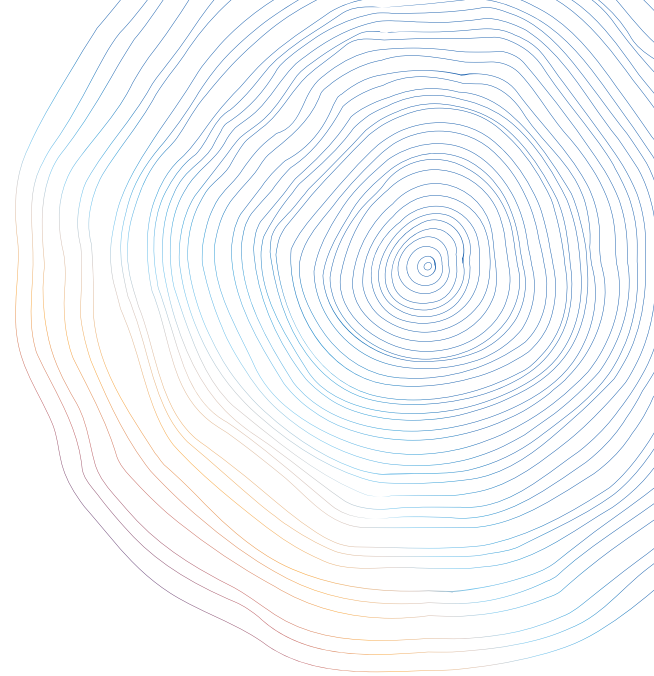


Sources: World Bank and International Energy Agency.
 Note: CO₂, carbon dioxide; GDP, gross domestic product.



2

Climate Commitments, Policies and Engagement







2. Climate Commitments, Policies and Engagement








2.1 Ambitious Climate Commitments and Lagging Implementation

Lebanon's nationally determined contribution (NDC) is designed to align mitigation and adaptation efforts with the country's development and economic recovery needs but requires robust governance action. The 2020 NDC has been revised to include sector-specific activities, prioritizing entry points that are closely linked with economic drivers. According to its 4th National Communication on Climate Change, progress toward Lebanon's mitigation and adaptation targets ([Table 2](#)) requires a series of robust governance actions: improve management practices and increase institutional capacities, provide incentives for action and fiscal reform, strengthen partnerships (including with the private sector and civil society), conduct innovative research and development, integrate and include various stakeholders, especially gender institutions, youth groups, and vulnerable communities, through a comprehensive approach, and increase monitoring and transparency (MoE and UNDP 2023).

Although there is no legislation specific to climate change, sectoral plans have recently incorporated climate adaptation strategies, including the National Agriculture Strategy 2020–25, which is designed to improve climate change adaptation and sustainable management of agrifood systems and natural resources. Climate-related initiatives include increasing access to climate finance and insurance; supporting climate-smart agricultural practices such as conservation agriculture, afforestation, reforestation, and forest management; and encouraging action in the water-energy-food nexus involving smart irrigation, renewable energy adoption, and agricultural waste reuse. The Updated National Water Sector Strategy 2020–2035 discusses the need for integrated water resource management that considers climate change and disaster risk reduction and an integrated hydrological information system to provide meaningful real-time data that account for the impacts of climate change on water resources. The water strategy includes a drought mitigation plan with periodically monitored indicators and early warning systems and introduced a roadmap in May 2022 focused on tariff adjustments, technical enhancements for cost recovery, deficit reduction measures, and legal and institutional reforms to aid in the recovery of the water supply and sanitation sector. The upcoming publication of a low-emissions development strategy will also be integral to supporting mitigation action.

Table 2: Lebanon's Updated Nationally Determined Contribution Mitigation and Adaptation Targets for 2030

MITIGATION		Unconditional (%)	Conditional (%)
	Reduce greenhouse emissions	20	31
	Increase power generated by renewable energy	18	30
	Reduce heat demand in building sector	11	16.5
	Reduce power demand through energy efficiency	3	10

ADAPTATION	
	Strengthen agricultural sector's resilience in a climate-smart manner
	Promote sustainable management and use of natural resources, including sustainable forest management, and restore degraded landscapes
	Sustainable water services, including irrigation
	Value and sustainability manage terrestrial and marine biodiversity
	Reduce vulnerability of coastal zones and urban areas
	Ensure overall public health and safety through climate-resilient health care systems
	Reduce disaster risk and damages by mitigating and adapting to climate-related natural hazards and extreme weather

Several governance challenges hinder management of resources and provision of efficient, sustainable services. In the water sector, the overlap of laws and regulations has created a convoluted institutional framework and diluted accountability and transparency mechanisms. Responsibilities for water resource management are dispersed across ministries and institutions and multiple administrative levels. Many functions overlap, making it easy to avoid taking responsibility for tasks. Coordination

among stakeholders is limited, and reliable data to guide planning, strategy, policy formulation, and prioritization and sequencing of investments are lacking. In the power sector, Parliament ratified a law on distributed renewable energy in December 2023 whose implementation would set the stage for net metering at the individual, building, and community levels. The law allows private distributed generation solutions of up to 10 MW to be deployed and connected to the grid.¹¹ Once enacted and implemented, the law will encourage households and businesses to install grid-connected renewable energy sources and benefit from net metering with EDL. This will provide opportunities for the private sector to invest in clean, affordable generation capacity and sell electricity directly to creditworthy clients, mitigating exposure to EDL risk.

The primary role of the Lebanese Center for Energy Conservation (LCEC), Lebanon’s national energy agency is to promote and develop energy efficiency, renewable energy, and green building initiatives. Its main achievements include its establishment as a reference organization for sustainable energy in Lebanon,¹² successful creation and implementation of national action plans, and development of pioneering projects in the Arab world under the leadership of the Ministry of Energy and Water (MoEW). It needs sustainable funding and the ability to navigate complex partnerships; it receives support from various national and international institutions such as the European Union, Italian Ministry of the Environment and Energy Security, and Central Bank of Lebanon. Ongoing work involves updating the National Energy Efficiency Action Plan and the National Renewable Energy Action Plan to guide energy sustainability efforts.

Despite the issuance of Law 80/2018 on integrated solid waste management, the sector remains riddled with inefficiencies and lack of coordination among stakeholders. Before the crisis, several in-depth assessments were produced to identify relevant mitigation and adaptation options for the waste sector to support the NDC targets, including Nationally Appropriate Mitigation Actions (UNDP 2017). Climate proofing of key development plans included the Capital Investment Program of 2018, which covered proposed solid waste management needs, but these are no longer relevant for the sector and cannot be considered as a basis for decision making. The waste sector is awaiting approval of a cost-recovery law to cover some of its operational costs. Most municipalities spend more than 75 percent of their budgets on collection and disposal of waste, and in some cases, municipalities face large deficits because of these costs.

Disjointed laws and incentive programs promote greener transport, but implementation and legal frameworks are lacking. In 2022, to encourage the use of less-polluting vehicles, the Budget Law (Law 10) reduced customs duties and taxes on eco-friendly vehicles, including hybrid and electric vehicles, imported within three years of enactment of the law. Fully electric vehicles were exempted from customs fees, and hybrid and plug-in hybrid vehicles received a 70 percent reduction in customs fees. Moreover, registration fees for hybrid and electric vehicles were reduced by 50 percent. Absence of recent reliable data, lack of vision, poor planning, limited fiscal space, and the impact of recent compounded crises have hindered development of green, inclusive, affordable, reliable public transport. In the port sector, fixing the current legal vacuum and governance framework present opportunities to increase efficiency and resilience and align with global best practices.

11 The MoEW developed the law with support from the European Bank for Reconstruction and Development and the Lebanese Center for Energy Conservation.

12 The energy scenarios presented in section 3.1 benefitted from consultations with, and data provided by LCEC.

Lebanon has increased its ability to expand social assistance, horizontally and vertically, in response to new shocks, climatic and other. The government has invested in social protection delivery systems by building the Daem¹³ platform, an adaptive social protection system that supports households in the face of climate shocks, with support from the World Bank. Approximately 60 percent of Lebanese households are registered on this platform, making it the most comprehensive social registry in the country. The government is also creating a registry to expand social protection coverage to farmers and provide access to agricultural extension services by improving the Ministry of Agriculture's e-learning platform.

2.2 Climate Change Governance and Citizen Engagement

The ongoing economic crisis has led to the lowest levels of citizen trust in government (8 percent), the legal system (16 percent), and parliament (10 percent) ever measured in Lebanon.¹⁴ Moreover, Lebanon's score of 1.25 on the World Bank regulatory governance indicators (0 = worst performance, 5 = best performance) reflects scant opportunities for public consultation on draft laws and regulations, including those on climate change. Its score of 0.28 (on a scale from 0 to 1) for publicized law and government data on the 2022 World Justice Project's Rule of Law Index also attests to limited transparency. This political stalemate has led to vested interests that discourage competition and constrain entrepreneurship, innovation, and job creation. Weak governance has facilitated high rates of informality and a pervasive shadow economy intricately connected to economic actors and institutions. Lack of trust in government undermines tax revenues, which in turn limits public service delivery, fueling a vicious cycle.

State capacity for climate policy implementation is severely constrained. Lebanon's overlapping crises have contributed to significant levels of staff attrition and absenteeism in the public sector, severely limiting government functions and delivery of public services. The Ministry of Environment was appointed as the official focal point and NDC coordinator, along with an interministerial NDC committee formed in 2017 that the Ministry of Environment chairs and that is yet to be institutionalized through adequate staffing. The ministry has a limited, but technically strong, staff (primarily United Nations Development Program-supported contractors) to oversee and coordinate the country's climate change policies, but this staff is often unable to find counterparts to coordinate with in other ministries because of the lack of civil servants throughout the government.

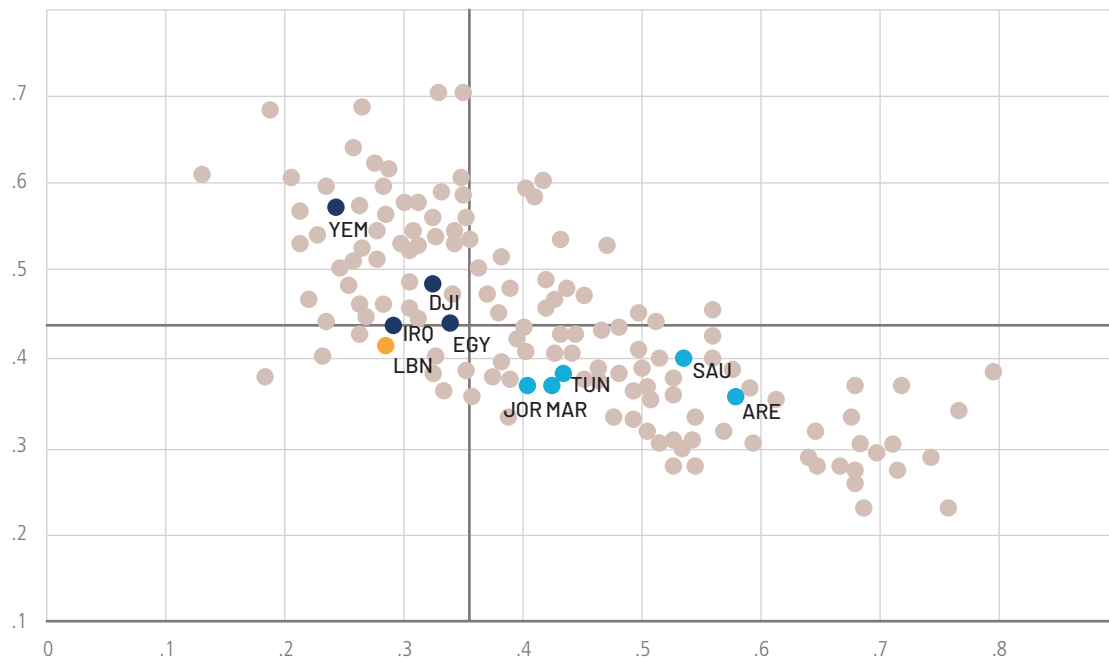
Weak governance has resulted in Lebanon being one of the countries least ready to face climate change in the world, with limited adaptive capacity that the ongoing financial and economic crises have compounded. In 2022, Lebanon ranked 161 out of 192 countries in terms of readiness to face climate change according to the Notre Dame Global Adaptation Initiative Country Index.¹⁵ Lebanon has among the lowest scores in readiness to face climate change of all Middle Eastern and North African countries (just ahead of Yemen), reflecting limited capacity to adapt to climate change on all levels. Its vulnerability to climate change stems not only from its exposure to climate risks, but also from its limited capacity to adapt to these risks, compounded by limited early warning systems and decaying infrastructure (Figure 3).

13 "Daem" means "support" in Arabic.

14 Percentage of citizens saying they have a great deal or a lot of trust in an institution (Alayli 2022, 13).

15 These data are from the Notre Dame Global Adaptation Initiative Country Index (database), Notre Dame, IN (accessed in November 2023), <https://gain-new.crc.nd.edu/country/lebanon>.

Figure 3: Adaptive Capacity Scores (Vulnerability and Readiness for Climate Change): Lebanon and Regional Peers



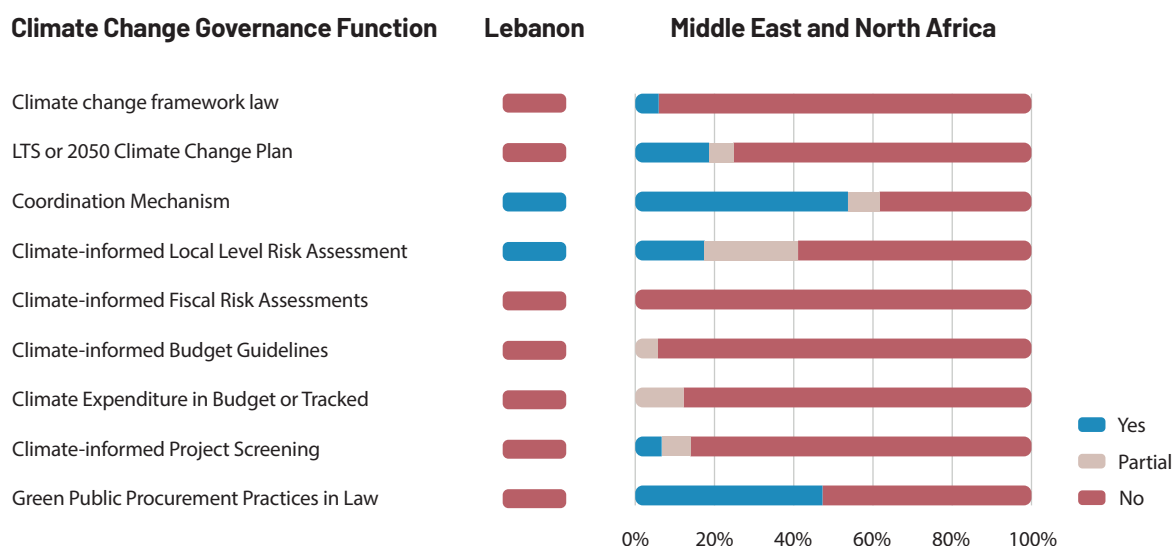
Source: Notre Dame Global Adaptation Initiative Country Index (database), Notre Dame, IN (accessed in November 2023), <https://gain-new.crc.nd.edu/country/lebanon>.

Despite the existence of a coordination mechanism, there is limited coordination on climate change initiatives between national and subnational levels of government. There are no legal requirements for subnational governments to prepare decarbonization and adaptation strategies and plans, although some local governments, such as in Menjez and Jdeidet el Chouf, have prepared sustainable energy action plans. Local administrations formulate local solid waste management plans, which are based on guidelines outlined in the Integrated Solid Waste Management strategy, which the council of ministers must approve and the Ministry of Environment must submit. This strategy should be supplemented with a strategic environmental and social assessment that considers climate co-benefits and aligns with guidance provided by national climate change strategies. In the water sector, although the responsibilities of the MoEW and the regional water establishments have been defined, there are no formal procedures that outline coordination among municipalities with the MoEW and regional water authorities.

Despite its ambitious climate commitments under the Paris Agreement, Lebanon has yet to adopt a systematic, long-term approach to incorporating climate change considerations into policies, processes, and systems. For instance, it has not included climate change considerations in its public finances, identified climate-related fiscal risks, or screened public investments through a climate change lens (Figure 4). Although sustainability and environmental criteria are mentioned in the public procurement law (244/2021), there is no obligation to conduct climate-friendly procurement (also known as green

public procurement),¹⁶ and state-owned enterprises are not obligated to account for climate change in their operations, although the government embarked on public procurement reform in 2019 and voted on a modernized public procurement law (244/2021) using the United Nations Commission on International Trade Law model law. Article 15, Sustainability and Development Policies, requests that, when possible, procuring entities adopt sustainable public procurement to procure sustainable goods and services with a view to minimizing environmental impact.

Figure 4: Status of Major Climate Change–Linked Governance Frameworks: Lebanon and the Middle East and North Africa



Source: Data from 19 countries, collected by World Bank staff in 2021.

Note: Publication of Lebanon's Low Emission Development Strategy is expected in 2024, setting emission reduction targets until 2050.

a. Lebanon's Long Term Strategy is under preparation.

There is considerable potential to capitalize on nonstate actors' growing awareness of climate change challenges. According to the 2022 International Public Opinion on Climate Change survey, nearly one-third of respondents considered climate change a government priority, and approximately 56 percent expressed willingness to participate in organized groups advocating for climate action or were already involved in such efforts. Encouraging initiatives by civil society include the Lebanese Reforestation Initiative, which promotes community-based reforestation efforts, and Arcenciel, a nongovernmental organization addressing hazardous waste management. Collaborative platforms, such as the Lebanon Climate Act and the Lebanese Water Actors Platform, facilitate multisectoral engagement and capacity building for a comprehensive approach to climate

¹⁶ Green public procurement is essential for fostering a supportive environment for green investments and facilitating green recovery, and like many other nations, Lebanon must adopt it to meet climate goals.

policy and action. Additionally, the private sector's voluntary reporting of GHG emissions, supported by the Ministry of Environment's decision 99/1, contributes to development of Lebanon's monitoring, reporting, and verification system.

In the private sector, the need to reduce costs and address infrastructure shortages continues to drive climate-sensitive approaches. Based on the Green Economy Module of Enterprise Survey (2019), about 16 percent of all firms had adopted at least some energy-efficiency measures. The top measures are improvements to lighting systems (44 percent), waste management (recycling, minimization) (36 percent), heating and cooling improvements (25 percent), machinery upgrades (23 percent), and energy management (21 percent). Most firms that did not implement any environmentally conscious measures reported having other priority investments, which is likely a reflection of the crisis context.



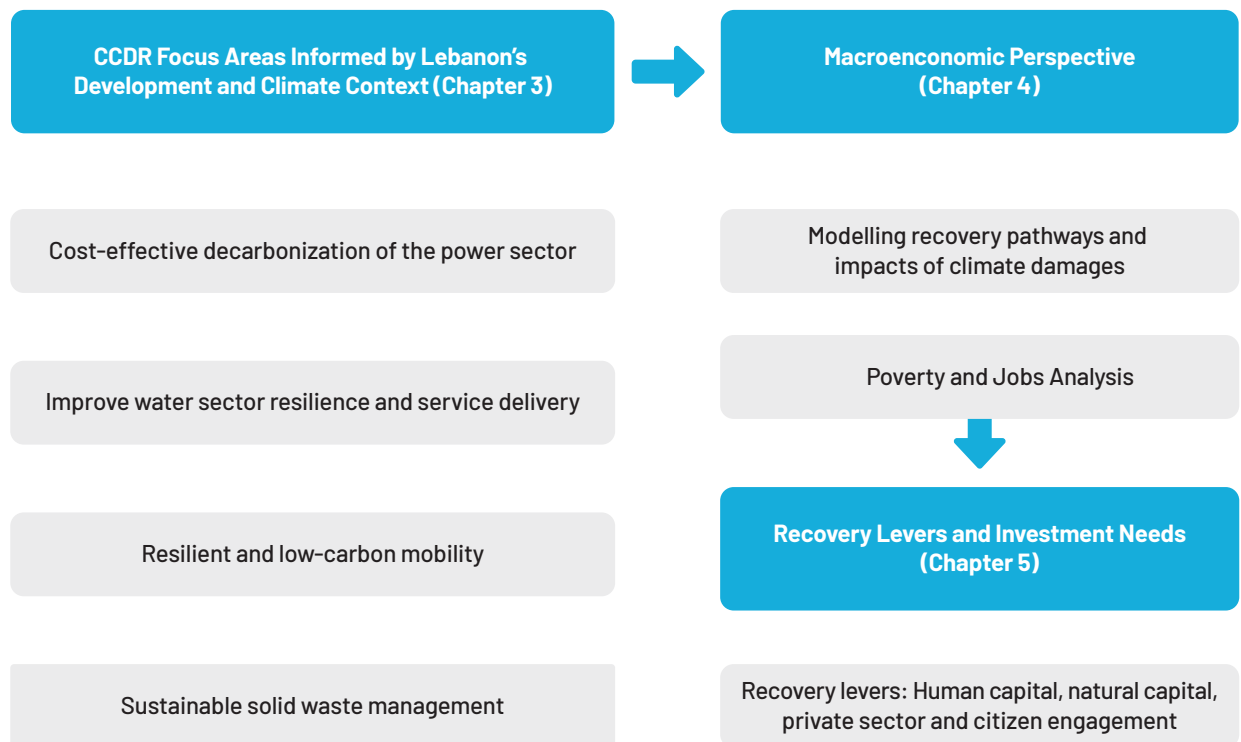
3

Pillars of a Climate-Reponsive Recovery

3. Pillars of A Climate-Responsive Recovery

This CCDR provides a roadmap for climate-responsive recovery and development in four priority sectors: **energy, water, transport, and solid waste**. Selection of these focus areas reflects their contribution to Lebanon's recovery and macro-fiscal stability; their role in reactivating critical services, especially in energy and water; and their relevance to increasing Lebanon's capacity to adapt to climate change. Water is the most vulnerable of these sectors to climate change, and energy, transport, and solid waste contribute more than 80 percent to Lebanon's emissions. Given Lebanon's dire economic situation, this CCDR proposes a level of climate action that is in line with the country's short-term recovery needs and long-term development objectives. The analytical framework shown in [Figure 5](#) builds on sector-level deep dives and has been informed by extensive stakeholder consultations.

Figure 5: Analytical Framework of Lebanon's Country Climate and Development Report (CCDR)

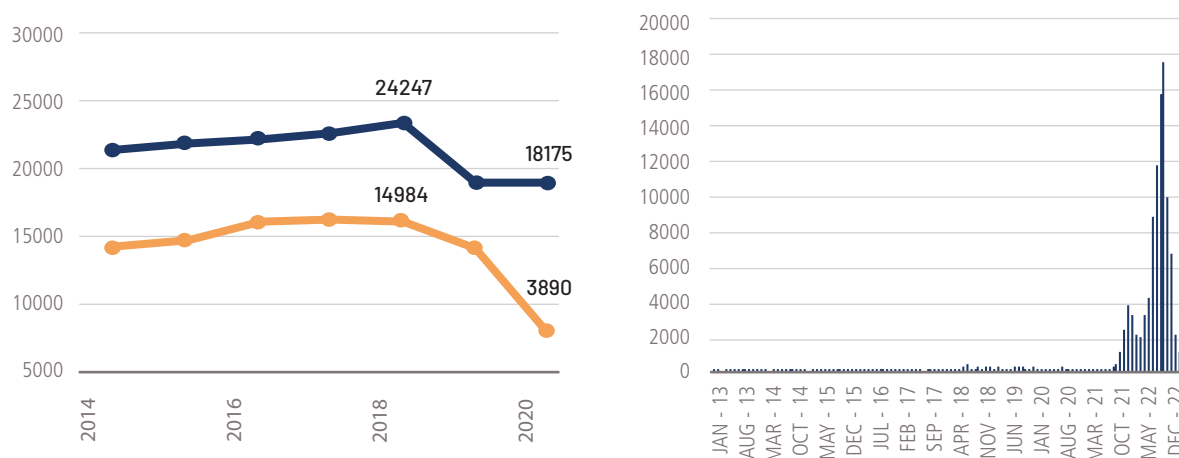


Two proposed scenarios were considered in analyzing the four priority sectors: the muddling through scenario assumes that the economic and financial crisis will drag on and that there will be no macro-fiscal stabilization, whereas the recovery least cost (recovery-LC) scenario assumes that macro-fiscal stabilization occurs in the short term and that the sector embarks on required structural reforms. An additional net zero scenario is considered for the power sector that assumes that emissions decline linearly from 2023 levels to net zero in 2050.

3.1 Cost-Effective Decarbonization of the Power Sector

Since the beginning of the economic crisis in 2019, electricity demand has been primarily met by costly, highly polluting diesel generators operating outside the legal framework. The sector's long-lasting capacity deficit (Figure 6) has enabled diesel generator owners to expand their subscription-based businesses, creating a complex informal economy resistant to regulation and government oversight. Lebanese households have learned to navigate and adapt to multiple crises, but the “generator economy” is becoming too expensive for consumers. With declining supply of electricity from the grid, households have relied on private diesel generators to partially meet their demand. Combined with higher oil prices, this has been financially devastating for Lebanese households. In 2020, the average cost of private diesel generation was US\$0.60 per kilowatt-hour. Driven by security-of-supply concerns and price signals (after the removal of foreign exchange–induced fuel subsidies), imports of standalone solar and hybrid systems skyrocketed. According to LCEC's estimates, standalone solar photovoltaic systems are expected to reach 1,100 MW peak in Lebanon by the end-2023.

Figure 6: (a) Severe and growing gap between EDL's supply and demand (GWh); (b) Solar panel imports to Lebanon 2013-2022 (net tonnes per month)



Source: Electricité du Liban.

Source: World Bank 2023a.

An electricity planning model was used for exploratory energy transition analysis over the 2023–40 period that was designed to identify policy and investment priorities to deliver clean, affordable, and reliable electricity. Aligned with macroeconomic modeling described in Chapter 5, the two primary scenarios were used to assess recovery-compatible decarbonization pathways for the electricity sector. **Under the muddling through scenario, the sector's inability to access foreign currency freely will continue to constrain fuel supply.** Energy consumption will grow very slowly as the country remains in crisis, but grid supply will remain insufficient to meet demand. As EDL regains the ability to collect payments and charge tariffs that cover operating costs—albeit while remaining exposed to foreign exchange risk due to billing cycle delays—it would be able to increase supply through existing thermal capacity. If no new centralized power plants are built starting from 2031, existing EDL capacity will at most serve only 10 percent of demand, which will further increase dependence on diesel generators and stand-alone solar for households and businesses.

Under the recovery-LC scenario, covering 2023 to 2040, the first new centralized power plants (gas fired and solar) would enter service in 2027 to meet rising demand. Until then, EDL's existing capacity, small additions of standalone solar systems, and existing diesel generators would meet demand. To illustrate the merit of advancing

sector reforms, the electricity planning model simulates the impact of prolonged delays in commissioning utility-scale solutions. This sensitivity analysis, distributed only, relies exclusively on grid-connected distributed solutions (solar and wind up to 10 MW each, distributed storage, and distributed ICE generation in addition to household diesel generators and rooftop solar) to meet electricity demand derived from the macroeconomic modeling.

Significant investment in low-cost, low-carbon electricity generation is essential to shift from muddling through to recovery-LC. From 2023 until 2040, muddling through results in higher costs, greater emissions, and 16 percent less demand for electricity, derived from the macro model. In contrast, recovery-LC results in more-affordable electricity. This is the outcome of sizeable new investments in utility-scale solar (to reach 4.2 GW by 2030 and 8.7 GW by 2040) and investments in natural gas generation (to reach 3.2 GW by 2030 and 5.7 GW by 2040) for a total of US\$5.9 billion in investment in power generation capacity by 2040,¹⁷ which will lower the cost of supply by 66 percent and reduce CO₂ emissions by 43 percent, also reducing air pollution (Figure 8). Under the muddling through scenario, fuel costs account for more than 78 percent of annual system costs. With recovery-LC, fuel costs decline to less than 54 percent of total costs by 2040.

Figure 7: (a) Electricity Generation Mix; (b) Electricity Generation Capacity Mix

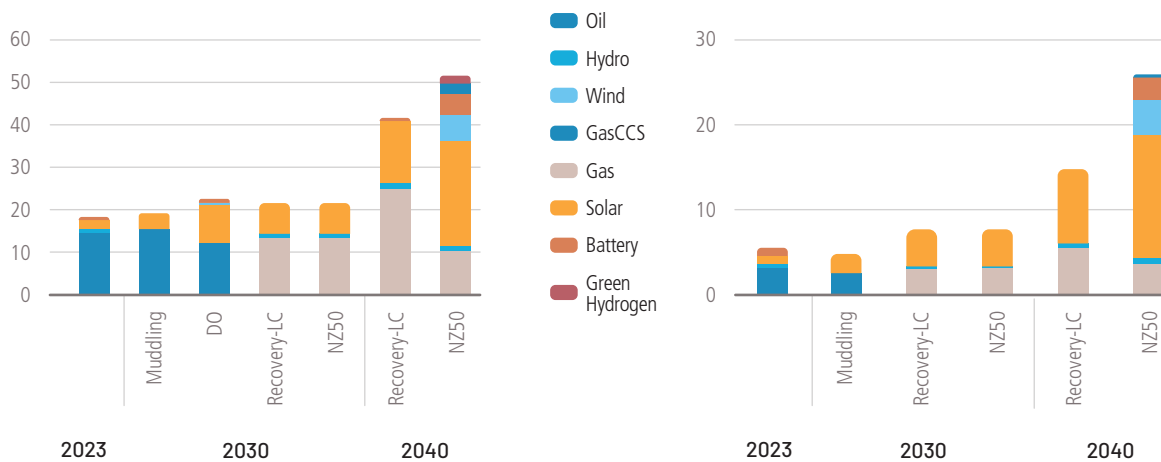
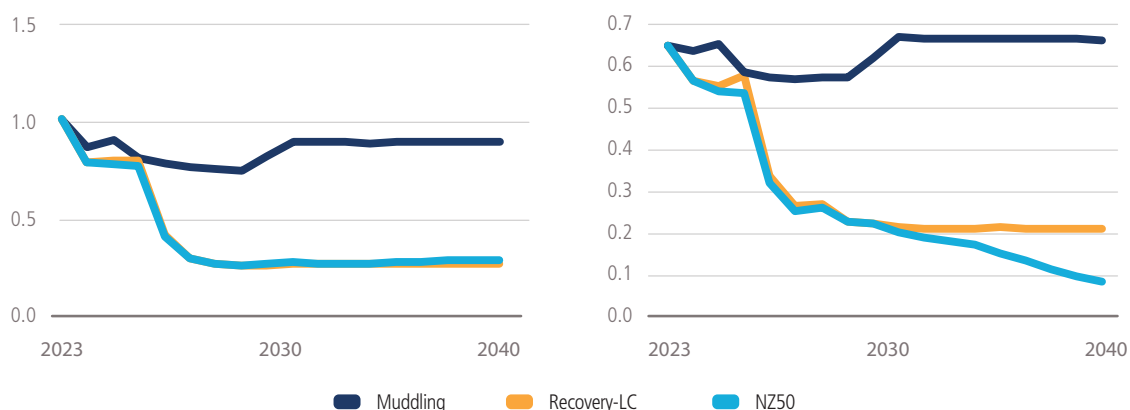


Figure 8: (a) Normalized System Costs per Unit of Electricity Supply; (b) Grid Emission Intensity



¹⁷ Investments are split equally between gas-fired and renewable energy. The costs cited in this CCDD are related to power generation only. Additional investments will be required in the transmission and distribution network.

Access to capital is necessary to move into recovery-LC scenario and secure, affordable electricity. Because recovery-LC relies on capital-intensive solar photovoltaic technology, annualized capital expenditure costs rise to 30 percent by 2040. Securing access to capital at scale will be challenging in the absence of macro-fiscal stabilization. It also underscores the urgency of sector reforms designed to restore the financial viability of the power sector and reduce perceived risks for prospective investors by improving the sector's operational and commercial performance, strengthening the regulatory framework, and enhancing financial transparency and accountability. If such measures are taken to promote recovery-LC, public investment in network strengthening and dispatching will be needed to manage an electricity system with high penetration of variable renewable electricity (32 percent of the generation mix by 2030 and 35 percent by 2040).

Lebanon's 2030 renewable energy target is within reach. According to LCEC, installation of household solar systems increased from 100 MW in 2020 to an estimated 1,100 MW by the end of 2023. Under the recovery-LC scenario, total energy generation from renewables continues to expand as the lowest-cost option for electricity supply. The recovery-LC scenario exceeds Lebanon's conditional NDC target of 30 percent of demand met by supply from renewable sources by 2030 (reaching 42 percent; 38 percent under distributed only), compared with the unconditional target (18 percent) under muddling through (19 percent).

For 2023 to 2030, power sector development according to least-cost planning is compatible with a net zero pathway. Decarbonization of the power sector, notably through solar photovoltaic, is the least-cost option for Lebanon in the foreseeable future. Until 2030, the recovery-LC scenario is fully aligned with the net zero pathway. Under recovery-LC, grid emission intensity declines from 0.63 tCO₂/MWh to 0.23 tCO₂/MWh in 2030.¹⁸

Beyond 2030, climate policies would be required to pursue net zero and further reduce emissions intensity to 0.1 tCO₂/MWh by 2040. In the decade from 2030 to 2040, electricity demand will continue to be primarily met using gas and solar photovoltaic under the recovery-LC scenario, whereas investments in wind and grid-scale battery energy storage,¹⁹ both highly capital intensive, will be important if net zero targets are pursued (**Figure 9b**). Cumulative investment needs for a net zero scenario would be US\$9.3 billion by 2040 (58 percent higher than for recovery-LC), with electricity cost highly contingent on availability of low cost of capital. In the longer term, a net zero economy is predicated foremost on a resilient, financially viable power sector, unlocked through reform actions.

Distributed renewable energy solutions can increase affordability in the short term and expand service provision while power sector reforms take hold (Box 1**).** Without a utility-scale solution in the short term, the distributed-only (DO) sensitivity scenario requires an average of US\$519 million a year of up-front investment in power generation between now and 2030 to meet electricity demand, compared with US\$379 million a year for recovery-LC. With smaller, oil-fired generators structurally costlier than utility-scale gas power plants to maintain grid stability, the cost of generation under distributed only would be 47 percent higher than under recovery-LC by 2030 but still 42 percent lower than under a muddling through scenario. The earlier that structural reforms to mobilize capital at scale are implemented, the faster the sector recovery could embark on a least-cost, sustainable path.

18 Grid emission intensities include private generation.

19 For a total of 4 GW (wind) and 2.7 GW (battery energy storage systems), in addition to 14.8 GW of solar photovoltaic by 2040 under the net zero scenario

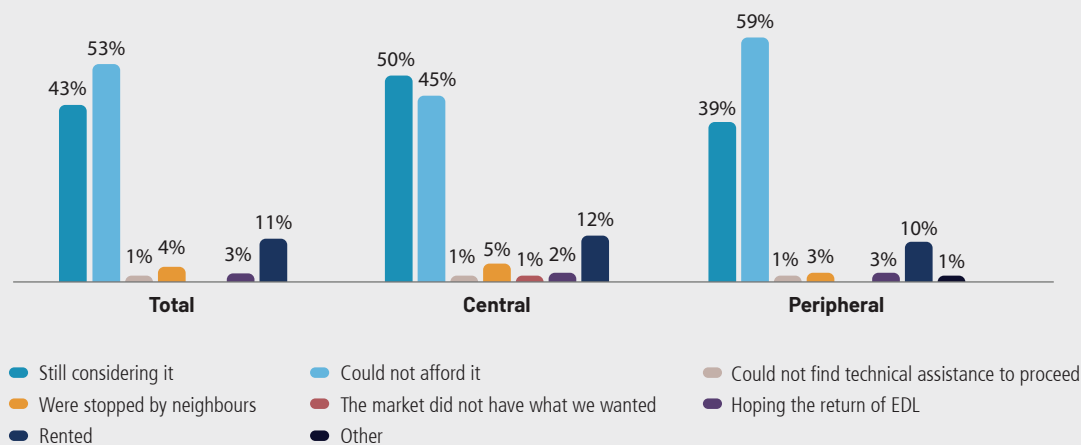
Box 1. Aligning Distributed Renewable Energy Solutions with a Sector Recovery Pathway

Despite a legal vacuum, grid collapse and extremely high fuel costs have kick-started the transition to renewables through scattered bottom-up initiatives. With the increase in reliance on distributed generators, deployment of stand-alone solar photovoltaic systems, including battery energy storage systems, has accelerated in Lebanon to meet part of the demand from households, businesses, buildings, health care facilities, and communities, albeit in the absence of a legal framework for distributed generation operating on parallel distribution networks. Domestic solar systems have become a common sight on rooftops across the country. According to the Lebanese Center for Energy Conservation, 870 MW of standalone solar photovoltaic systems had been installed by January 2023 (compared to 100 MW in 2020). It is estimated that another 250 MW was added in 2023. Although instrumental in maintaining minimum services for wealthier households, critical public services, and economic agents, this approach is gradually reaching its limits: distributed renewable energy (DRE) systems are operating off-grid, deprived of trading, scale, and cost optimization potential; roof space is a binding constraint in urban areas, in particular Beirut, where most of the demand is located; and upfront investment costs, combined with lack of access to financing, exacerbate social inequalities.

Grid-connected distributed systems, if technically enabled, properly structured, and regulated, could support electricity supply and extend service provision in the short term. Small systems (up to 10 MW of photovoltaic, battery energy storage systems,) connected to the grid but distributed across Lebanon closer to load centers can play an important role in the short term to improve services and accelerate energy transition but would not be a substitute for core sector reforms to put the sector back on a financially stable trajectory. The sector reform agenda should include policy and infrastructure designed to use DRE to help the sector improve in the short term. Solar photovoltaic and hybrid systems are currently operating on an off-grid basis in the absence of reliable grid services and EDL's unreadiness to expand net metering and implement peer-to-peer trading. With minimum grid supply secured, reactive power, and adequate dispatching, DRE systems would feed into a functional grid. Operationalization of an appropriate legal framework, in particular the DRE law, would create the conditions needed to mobilize the private sector for deployment of DRE systems in a manner that would help the sector restore services in the short term and recover financially in the medium term. Distributed approaches can reduce system costs in the short term (as opposed to the muddling through scenario) while enabling utility-scale investments in least-cost options through transparent, structured, competitive processes.

Developing new business models for DRE solutions will mitigate some of the social inequalities that Lebanon's energy crisis has created. Concomitantly addressing technical challenges, lack of access to financing, and the regulatory vacuum would be critical to expand DRE solutions in a manner consistent with sector recovery prospects. A recent World Bank (2023) household survey conducted for the CCDR has revealed the socioeconomic trade-offs of Lebanon's energy transition in its decentralized form. On average, private generator subscriptions accounted for 55 percent of total household energy expenditures; households spent an average of US\$77 per month on private generators, which provide on average 16 hours of energy per day according to respondents. Despite generators' high monthly cost, 73.5 percent of respondents considered solar energy to be unaffordable because of the high up-front cost, with an average cost of between US\$2,000 and US\$3,000 and a cost as high as US\$10,000 depending on location and household energy needs. Barriers to adoption of low-carbon solutions such as solar energy and to inclusion are significant because of high up-front costs (Figure B2.1) and nonhome ownership.

Figure B2.1: Barriers to Adoption of Distributed Solar Photovoltaic Energy Systems



Box 2. Prospects for Hydrocarbon

The Eastern Mediterranean's untapped gas reserves have attracted renewed attention, driven by global energy market developments, Europe's intensifying energy crisis since the war in Ukraine, and plans for massive expansion of renewable energy, calling for new energy transport corridors.

Prospects for offshore gas production are unclear and farfetched. In 2018, Lebanon awarded exploration and production rights for Block 4, whose first exploratory drilling reportedly yielded a dry well, and Block 9, whose exploration had started in August 2023. The U.S.-brokered maritime demarcation agreement between Lebanon and Israel, finalized on October 27, 2022, gave new impetus to exploration prospects. Figures reported in the media on the Qana prospect potential are highly speculative, awaiting drilling.

If oil or gas is discovered, its commercial potential would need to be appraised. The Lebanese offshore environment is characterized by deep water and complex geology. Lebanon does not have any tangible natural gas infrastructure, and its economy has few forward linkages for natural gas. Petrochemicals, plastics, and fertilizers are imported. Piped gas is not used for cooking, heating, or heavy industry. The discovery of oil or gas would leave the electricity sector as the sole anchor customer for the domestic market, which would require Electricité du Liban to be creditworthy. Gas exports, through pipeline(s) or liquefied natural gas, would come with high infrastructure and transport costs and require regional collaboration.

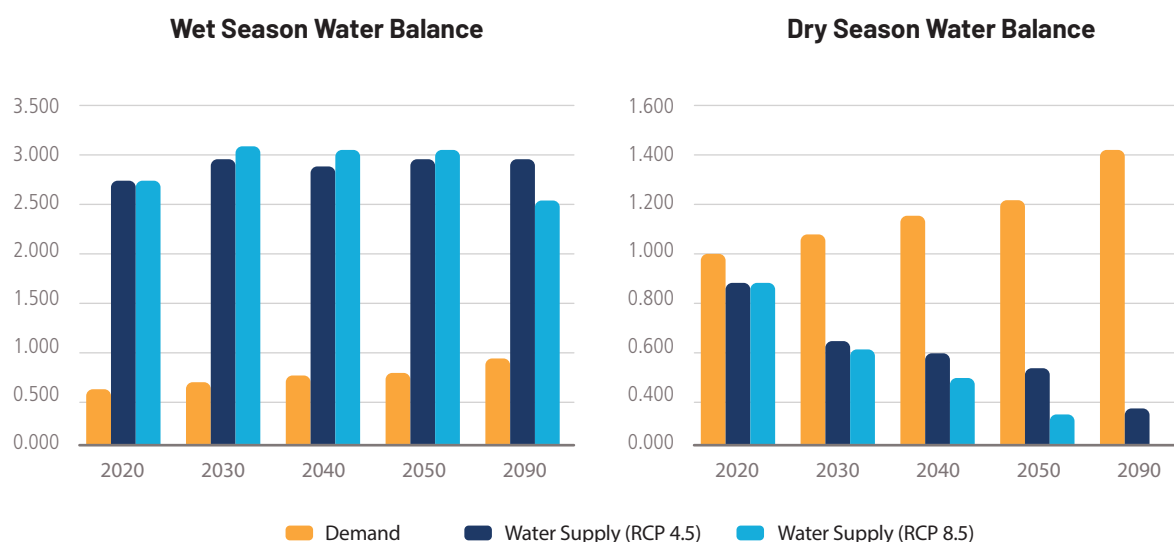
Gas exports could help address Lebanon's fiscal and monetary challenges, but empirical evidence reveals that discovery of resource windfalls adversely affect countries with weak institutions and poor governance. Thus, an adequate legal and regulatory framework, including a sovereign wealth fund, should be established to protect the country's hydrocarbon revenue stream for future generations.

3.2 Building Climate-Adaptive Capacity in the Water Sector

3.2.1. Impact of Climate Change on the Water Sector

In the absence of climate adaptation action, it is projected that Lebanon will face a significant reduction in yearly water availability by 2040, with estimates ranging from 5.7 percent to 9 percent. Precipitation ranges from 700 to 1,000 mm along the coastline to 1,600 mm in inland mountain areas. Per capita renewable water resources are estimated at around 848 cubic meters annually. Precipitation is among the highest in the Middle East and North Africa, and annual average water resources exceed demand, but approximately 70 percent of annual average precipitation falls during the wet season (November to March), with a significant gap between demand and availability of water during the dry season. This gap is expected to grow, and model projections suggest that climate change will result in water availability during dry seasons declining by up to 50 percent by 2040 (Figure 9). The projected reduction in snowpack accumulation, increase in evaporative losses, presence of karstic groundwater resources, and lack of infrastructure will decrease the availability of wet-season water and make it difficult to store to use during the dry season. Availability of accurate measured data for the water sector is limited in Lebanon, so it is essential to analyze impacts based on available data and assumptions about the seasonal gap between water supply and demand and to identify appropriate interventions that can mitigate these imbalances and increase resilience under the recovery scenarios.

Figure 9: Lebanon's Water Balance During the (a) Wet and (b) Dry Seasons



The persistence of weak governance, compounded by the economic crisis, undermines the capacity of the water sector to respond to the impacts of climate change. The water sector faces significant governance challenges that impede effective resource management and delivery of sustainable water services. Despite adoption of integrated water resource management principles, progress is considerably slower than the regional average. Complex legal frameworks and regulations have resulted in a convoluted institutional structure, diminishing accountability and transparency. Responsibilities for water management are fragmented across ministries and administrative levels, leading to overlap of responsibilities and lack of accountability. Coordination among stakeholders is deficient, and there is a notable absence of reliable data for informed planning, strategy development, policy formulation, and investment prioritization. Prolongation

of the crisis will exacerbate the sector's limitations by preventing new investments in basic service delivery and the storage capacity needed to build resilience to projected climate change in the long term. The renewable water resource diminished from more than 2,000 cubic meters per capita in the 1960s to less than 660 cubic meters per capita in 2020. The "Muddling through" scenario in the water sector will have serious consequences that are highlighted in [Table 3](#).

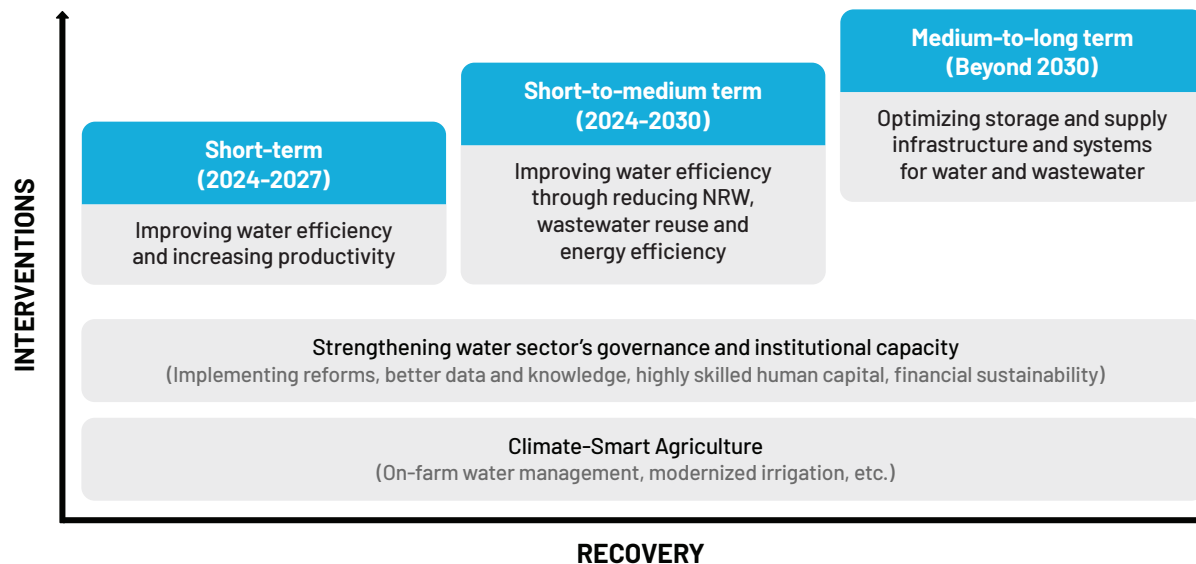
Table 3

Characteristics	Impacts
<ul style="list-style-type: none"> Limited infrastructure to store water and bridge the seasonal gap in the availability of water. The operations of most of the country's about 75 wastewater treatment continue to be hindered by the high costs of energy and limited sewerage networks connectivity. The institutional capacity for building resilience to climate change is limited at the level of the water utility and the ministry. Tariffs are too low to cover operation and maintenance costs for existing infrastructure, address the high share of non-revenue water, the brain drain of human capital and lack of technical capabilities. The continuous brain drains of the human capital within the Water Establishments. 	<ul style="list-style-type: none"> More than 70 percent of the population face critical water shortages and an increasing cost of supply. Increases in the cost of water for the extremely income vulnerable groups. Poor quality of services undermines the willingness of the population to pay, while the increase in the cost of basic goods and services means that many are unable to pay. Increased prevalence of, and inability to control, water borne diseases, as seen with the outbreak of cholera in October 2022

3.2.2. Pillars of a Resilient Water Sector

Under a recovery scenario, there are a number of opportunities to increase the resilience of the water sector and reduce vulnerability to climate change. The updated National Water Sector Strategy of 2020 identified a series of prioritized investments of more than US\$1.8 billion that must be made to increase water security in Lebanon. These investments mainly address infrastructure improvements needed to increase water use efficiency and adaptive capacity while supporting a series of institutional reforms to ensure adaptive governance and build resilience. Given the constraints of the economic crisis, these investments must be prioritized, starting with a series of relatively low-cost, no-regret measures to increase water use efficiency, reduce non-revenue water (NRW), and increase financial sustainability within the sector ([Figure 10](#)). Low-cost, high-impact investments in rehabilitation and construction of water supply and sanitation networks, water supply and wastewater treatment plants, new storage, and irrigation canals must be made for Lebanon to address risks to the water sector associated with climate change described above.

Figure 10: Pathway Toward Climate-Resilient Recovery of Lebanon's Water Sector



3.2.3. Increasing Water Efficiency and Productivity and Climate-Smart Agriculture

Increasing the availability of water while increasing efficiency by reducing NRW can provide short-term, no-regret benefits for water establishments. In the short term (2024–27), increasing water availability, especially in greater Beirut, is critical for service delivery. For instance, the MoEW determined that approximately 240 million more cubic meters of water volume will be needed in 2035 in greater Beirut to meet demand. A series of targeted interventions to reduce NRW and construct water storage reservoirs could reduce the deficit to approximately 50 million cubic meters. The water supply network in greater Beirut reaches 90 percent of households, which are facing water shortages and limited hours of water supply of about 3 hours per day during the summer. The Greater Beirut Water Supply Project is designed to supply an additional 250,000 cubic meters per day. In the short to medium term (2024–30), investments by the water establishments to reduce NRW (physical and economic losses through monitoring, billing, and collection; targeted infrastructure improvements) to increase the water efficiency of the water establishments. The NRW baseline is not available, so a NRW reduction roadmap must be prepared that includes an assessment of a NRW reduction baseline and define based on the assessment the need to rehabilitate, replace existing water supply networks, and define the reduction objectives. Data on NRW at water enterprises is limited because no monitoring tool has been implemented to monitor physical losses, and appropriate technologies have not been deployed to control commercial losses. In addition, the financial stability of the water enterprises must be ensured; NRW reduction can help design need-based water allocation to different areas and sectors. A focus on energy-efficient investments, such as in renewable energy, can also help ensure continued operation of water treatment plants and water and wastewater pumping stations. Several wastewater treatment plants are proposed in the National Water Sector Strategy 2020, but implementation would require proper diagnosis of the existing nonfunctioning wastewater treatment plants before investing in new ones. Tested strategies to upscale systems should be integrated into existing investments.

Increasing water efficiency by increasing the productivity of water use, particularly in the agricultural sector, will be critical to increasing the resilience of the water sector in the face of climate change. About 45 percent of Lebanon's croplands depend upon basin and furrow irrigation, which is highly inefficient. Under current irrigation conditions, considering network losses, irrigation efficiency is approximately 50 percent to 60 percent. Better on-farm water management would build resilience into food systems, especially in the

Bekaa, where high-value food is produced. Modern irrigation systems provide climate-resilient solutions in the short and long term. For modern, pressurized, on-farm irrigation systems to operate at their highest performance level, irrigation water supplies must be reliable and predictable. This is typically not a problem in areas where groundwater resources are readily available. Modernizing such systems is likely to require adding on- or off-farm storage, depending on system characteristics and design. Structural reforms and institutional strengthening of water establishments and water user organizations must accompany any adaptation of irrigation delivery systems to a changed climate and economic environment.

3.2.4. Optimizing Storage and Supply Infrastructure and Systems

Increasing storage capacity and optimizing how it is used will be critical in adapting to projected changes in water availability. This includes building surface water storage and improving management of natural storage, particularly groundwater resources, to help adjust to the projected decrease in water during the dry season and the increase in intensity of precipitation events (which may be complex given the karst nature of aquifers). This will be particularly important given the fast-diminishing snow cover, which will exacerbate the problem beyond management by 2030. The 2020 National Water Sector Strategy outlines an ambitious plan to nearly double built storage capacity to 409 million cubic meters to meet growing demand for drinking water, irrigation, and hydropower. Additional infrastructure may be required to facilitate the transfer of water to major demand centers and meet the projected gap. Climate change is also expected to have significant implications for groundwater recharge through complex impact pathways that will require better data to ensure adaptive management that can account for future changes. Without adequate storage, resilient supply systems, and adaptive management, Lebanon will face new challenges in securing sufficient water of suitable quality to sustain resilient growth and development.

3.2.5. Providing Financial Sustainability

Ensuring financial sustainability is necessary to ensure water security and resilience services. Funding agencies can provide temporary assistance, but long-term sustainability of the water sector will depend on organizational efficiency and reliable revenue streams. Ensuring financial sustainability and transparency of water establishments will be critical to improving performance. The guidelines used for internal organization and monitoring of water enterprises should be reviewed and restructured. Reforms such as those supported under the World Bank—financed Greater Beirut Water Supply Project focused on ensuring that entity audits are undertaken on a timely basis can help identify entry points for strengthening short-term gains and longer-term outcomes and could be extended to the other three water establishments with the understanding that each faces a different financial and operational situation.

Developing data and knowledge management systems will be key to ensuring integrated water resource management and adaptive capacity to respond to changing circumstances. For an integrated system, it is essential that data on the nature of the resource and the efficiency of water services, including users, supply, demand, NRW, waterways, storage, and groundwater resources, are accurately gathered. National and basin-level water accounts are needed to record the level and use of water and to understand the nature and impact of changes. Water abstractions from public and private wells are not measured regularly or continuously, with approximately 100,000 private, unlicensed, unregistered wells at the national level, according to MoEW data. Lack of data on withdrawals from these unregistered wells makes it difficult to determine the national water balance and integrated management efforts. There are also no large-scale data on water withdrawals or actual consumption. The MoEW is working on an integrated hydrological information system that could be a strategic tool for this purpose. Water quality assessment should also be made part of water knowledge management because it helps address service provision and health challenges.

3.3 Resilient and Low-Carbon Transport

3.3.1. Ensuring Resilience of Mobility by Building Back Better

Lebanon's road assets are highly vulnerable to climate impacts, with 54 percent exposed to landslides, which damage infrastructure assets and thereby disrupt movement of goods and people. The road network in Lebanon is exposed to considerable climate risk. Network climate risk exposure analysis suggests that road assets are substantially more exposed to landslide hazards than flood hazards, with 54 percent of assets exposed to high landslide risk. When floods and landslides damage road assets (direct risks) they also have an economic impact by disrupting and rerouting traffic (indirect risks). The direct risk of damage to roads from landslides and floods (cost of rehabilitating the assets damaged by these hazards) is estimated to be a total of US\$1.4 billion. [Map 2a and b](#) shows exposure to floods and landslides. Several corridors play more critical roles than others in terms of potential impact on overall network performance; the north-south corridor connecting coastal cities and the east-west corridors connecting inland regions and Beirut are critical ([Map 2c](#)).

Map 2: (a) Normalized System Costs per Unit of Electricity Supply; (b) Grid Emission Intensity

(a) Road Segments Exposed to Severe Flood



(b) Road Segments Exposed to Landslide Hazards



(c) Road Segments with High Economic Criticality



With limited fiscal space, road assets can be designed and managed better, prioritizing rehabilitation of road segments exposed to high risk, at a cost of approximately US\$465 million. This involves ensuring climate and disaster resilience at the design stage through proper drainage systems, adequate slope stabilization, and robust structural support to withstand climate hazards and introducing a climate-aware road asset management system to prioritize road maintenance projects and investments, considering climate risks and network resilience. Disruptive technologies such as nondestructive structure inspection solutions and mechanisms to collect road asset defect reports from users and stakeholders could be assessed and introduced to increase the efficiency and effectiveness of this system. A funding mechanism with a dedicated revenue stream to support road network maintenance would also ensure financial sustainability and reduce maintenance backlogs in the long run, optimizing lifecycle asset costs.

The tragic Port of Beirut explosion underlines the urgent need to build back better and provides an opportunity to increase port resilience. The explosion traumatized the sector and exposed its weaknesses and inability to predict, identify, and respond to external risks. The slow recovery is expected to intensify the burden on the economy, and opportunity costs are high given recent port developments in the Eastern Mediterranean, especially that the Port of Beirut lost the transshipment market to its competitors around the Mediterranean in 2020. Rebuilding the port presents an opportunity to build back better, relying on four building blocks: a new governance structure established in a port sector law based on the landlord port model; efficient, modern customs and trade processes addressing lack of transparency and security; open, transparent bidding processes that encourage private sector participation in reconstruction and operation of the port; and good-quality infrastructure that is dependent on a countrywide vision for the port sector and a revised masterplan for the port. The new masterplan should assess climate and disaster hazards (e.g., from rising seawater levels, coastal erosion) and incorporate design and engineering measures to build resilience, as well as renewable energy and energy efficiency. It should also consider blue ports principles to plan for a green recovery, regain competitiveness in the global maritime market, and promote socioeconomic development in Lebanon. Special attention should also be paid to the redesign of simplified, standardized, digitalized processes and procedures supported by adoption of port governance and border management reforms. Reconstruction of a modern, efficient port is key for Lebanon's social and economic recovery and development.

3.1.2. Moving Toward a Greener, More-Inclusive Transport Sector

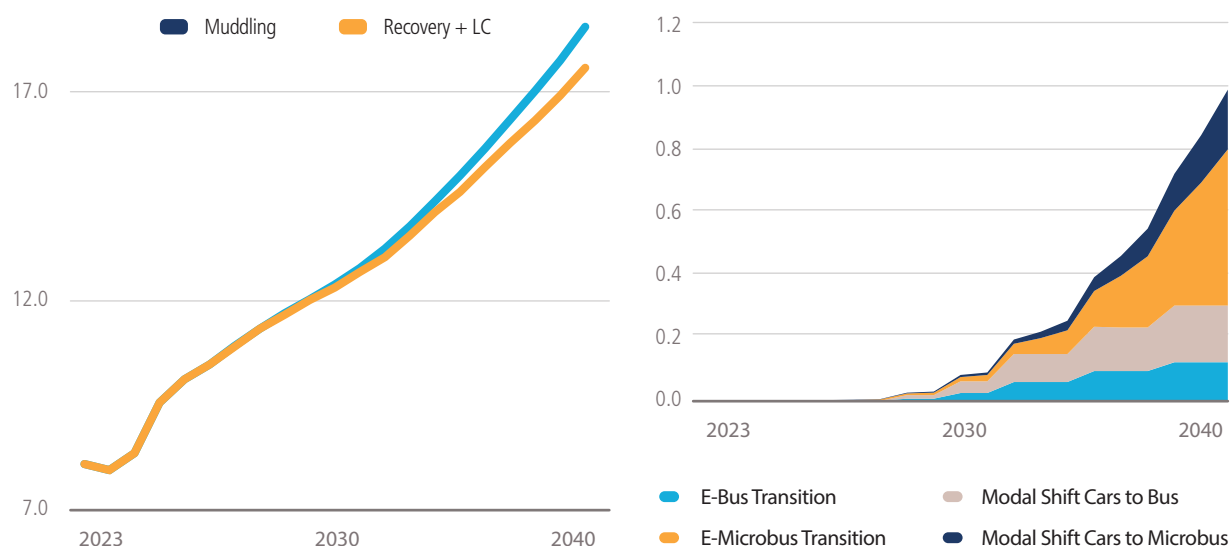
Amid increasing poverty, enhancing public transport to provide a more affordable, greener transport alternative to private cars is critical for Lebanon's recovery. The transport sector accounted for 25 percent of the country's fuel consumption, mostly gasoline and diesel, in 2018, which contributed to Lebanon's high fuel import bills, air pollution, and economic inefficiency. The sectors' shares of carbon emissions increased from 20.2 percent in 2001 to 25 percent in 2019, reaching 7.6 MtCO₂e. Land transport relies on carbon-intensive modes of transport, presenting opportunities for a green recovery. A survey conducted in Beirut in 2022 revealed that 75 percent of respondents never use public transport.²⁰ Enhancing carbon-efficient public transport would provide a more affordable way to access vital services and employment while encouraging a shift away from private modes of transport and reducing emissions. Enhancing public transport is a key priority. To inform public transport planning and decision making, data must be collected on existing public transport demand, supply, and willingness to pay. Then a sound legal and institutional framework for good sector governance must be created; a strategic vision for the sector prepared; service providers formalized and consolidated; the system organized into lines; infrastructure such as stations, depots, and pedestrian and cyclist access infrastructure invested in; gender considerations addressed; and service quality monitored. This would help provide an affordable, well-organized, safe, accessible, reliable public transport system for all, particularly the most vulnerable, reducing household transport expenditures and increasing access to services and employment for all.

For a country like Lebanon, the energy transition presents an opportunity to switch to renewable energy—powered electric vehicles after having improved public transport. The key barriers to electric mobility include the current insufficient electricity supply, the composition of the energy mix, the macro fiscal status, lack of an institutional and policy framework to support the transition to electric mobility, and lack of charging infrastructure. Once the barriers are addressed and the country has a capable, resistant energy grid, replacing existing vehicles with electric ones can help reduce emissions, but merely replacing cars and not focusing on public transport would be a missed opportunity. In the meantime, electric micro-mobility can support the transition to more sustainable mobility. For example, public transport stops and stations may become e-mobility hubs where shared electric two-wheelers can be rented out for last-mile trips.

20 The survey was conducted as part of a World Bank study titled "Ten-thousand Steps in Her Shoes: The Role of Public Transport in Women's Economic Empowerment – Evidence from Egypt, Jordan, and Lebanon."

Projected growth in road-based transport CO₂ emissions warrant focusing on electrifying the transport fleet (buses and minibuses), with a significant share of emission abatement potential from the modal shift from cars coming from service quality improvements. Enhancing public transport, including implementing bus electrification pilots in 2025 and increasing the use of electrical vehicles until 2040 could reduce annual road transport CO₂ emissions by 5.4 percent, from 18.7 MtCO₂e (muddling-through scenario) to 17.7 MtCO₂e (recovery + low-carbon transition) (Figure 11a). About 37 percent of the abatement would be attributed to a modal shift from private cars to public transport. An ambitious goal of electrifying 50 percent of new minibuses by 2040 (aggregate fleet size of up to 4,000 in phases with operation and maintenance costs) would involve around US\$370 million in net present value in private investment along with measures to achieve financial and economic utilization of the technologies. Fleet electrification would require availability of a stable, reasonably priced power supply, proper operational planning, and modern fare collection systems with tariff regimes that enable cost recovery and required returns to private investment. Uptake of electric buses in phases, to reach procurement of 500 buses by 2035 (aggregate fleet size of up to 2,000 in phases with operations and maintenance costs) would require around US\$530 million in net present value; public or private investment; and measures to enable technical, financial, and economic utilization of the technologies. The additional annual demand for electricity from electric buses and minibuses would be on the order of 400 GWh in aggregate, insignificant compared to the 2040 generation capacity of more than 43 TWh (Recovery-LC scenario), conditional upon connectivity to the distribution grid with needed capacity and operational stability.

Figure 11: (a) Road Transport Emission Projections; (b) Carbon Dioxide Emissions Savings From Electrifying Bus and Minibus Fleet



3.4 Sustainable Solid Waste Management

Solid waste is responsible for 60 percent of Lebanon's total waste emissions; improving solid waste collection, treatment, and management is critical for mitigating GHG emissions. The Fourth National Communication reported that emissions from activities related to generation and treatment of solid waste and wastewater in 2019 accounted for approximately 6 percent of Lebanon's total GHG emissions (1,805 Gg CO₂e); the waste sector (covering solid waste and wastewater) is the fourth-largest contributor to GHG emissions after energy (50 percent), transport (25 percent), and industrial processes (11 percent). It also estimated that 90 percent of GHG emissions from the waste sector are methane emissions, the remaining emissions being mainly nitrous oxide (7.75 percent), and that the solid waste sector alone accounts for approximately 75 percent of

total methane emissions. It also estimated that the solid waste sector accounts for more than 60 percent of total waste emissions, which are mainly methane emissions resulting from anaerobic and semi-anaerobic decomposition of the organic fraction of waste disposed of on land, whereas most nitrous oxide emissions are from wastewater treatment and discharge from domestic and industrial sources.

Improving solid waste collection, treatment, and management is also a priority to address urgent environmental and public health concerns. Approximately 70 percent of dumpsites have fires, posing health and safety threats to local populations and contributing to climate change through GHG emissions and black carbon, a highly potent, short-lived climate pollutant (MoE and UNDP 2017). An ongoing World Bank (2023b) assessment has indicated that waste treatment capacities are barely covering 8 percent of total waste. Although total waste generation has fallen by about 25 percent since 2018, limited amounts of waste are diverted from disposal. A World Bank assessment estimated that the share of waste disposed of in sanitary landfills and open dumps increased from 77 percent in 2018 to 99 percent in 2023. The rate of open dumping has almost doubled since 2018, with about 42 percent of waste ending up in open dumps and subject to open burning (Table 4) (World Bank 2023b).

Table 4: Waste Disposal Practices in 2018 and 2022

	Waste generated (tons/day)	Waste disposed (tons/day)	Share of waste disposed out of total waste generation (%)	Share of waste disposed of in sanitary landfills out of total waste (%)	Share of waste disposed of in open dumps out of total waste (%)
2018	7,342	5,674	77.3	55	22
2022	5,600	5,528	98.7	57	42

Source: World Bank 2023b.

Establishing a clear groundwork for covering the operational costs of waste services is essential for securing the financial sustainability of the sector. After the financial crisis in 2019, with its attendant currency devaluation and lack of public funding for costly daily operations, the solid waste sector experienced a severe deterioration in level of service along the waste chain. Several avenues are being explored to enhance cost recovery, including optimizing operational costs along the value chain based on local master plans at the level of the solid waste service zones; adjusting the basis of public budget allocations for treatment and disposal to allow continued functioning of solid waste treatment and disposal facility operators; pursuing cost recovery based on the draft cost recovery law that is being discussed with members of parliament and local authorities; and obtaining targeted international support to respond to the critical status of the sector, including from the displaced population.

Adopting the principles of integrated solid waste management (including adopting needed reforms and taking a circular economy approach) will help respond to sector challenges while reducing GHG emissions. The Ministry of Environment prepared a roadmap for the solid waste sector for 2023 to 2026, identifying priority reforms and intervention for the recovery of the sector. The roadmap builds upon on-going initiatives and provides guidance to help achieve sustainable recovery of the sector, which can be done by increasing the capacity of the central government and local authorities to manage the sector, establishing a basis for cost recovery and adequate public financing for operational costs, and adopting climate-smart technologies (e.g., closing open dumpsites, increasing composting rates, reactivating methane recovery operations, revisiting waste-to-energy options). To allow comparison across technologies, the potential for GHG mitigation technologies was assessed on a per ton of input basis, based on a life-cycle assessment.

A case study at the level of a solid waste service zone confirmed that additional capital investment of US\$31.5 million could reduce GHG emissions by 50 percent, which makes the investment costs of the climate-smart scenario equivalent to those of the muddling through scenario when GHG emission costing is factored in. To gain a more in-depth understanding of mitigation potential in the waste sector, two service zones were studied: the Beirut-Matn Service Zone and the Zahle Service Zone. The proposed alternatives included a comprehensive method for enhancing the current waste management system, including the collection system, recovery, treatment, and disposal, and as such includes methane recovery from landfills as well as energy production from recovered methane and other waste-to-energy options such as anaerobic digestion. The analysis of the two service zones considered investment options aimed at optimizing operating costs. It was identified that the required implementation of cost recovery measures and adjustments of public allocations for the sector are essential to meet these objectives. The targets adopted for land disposal, which will be further validated as part of the national solid waste strategy, did not account for the cost of land.

In the case of the Beirut-Matn Service Zone, the additional investment costs needed for the recovery scenario are US\$58 million over 15 years and are fully justified because they are equivalent to the cost of emissions averted of approximately US\$68 million (Table 5). The actual cost of solid waste management is expected to significantly increase when environmental degradation is factored into baseline, as will be done in a World Bank analysis in 2024, which will further confirm the feasibility of the climate-smart option. The results of such assessments allow decision makers to make informed choices about development of solid waste plans and identification of fiscal requirements to respond to the national NDC targets while providing basic services, which presents a major challenge at the national level.

Table 5: Cost Comparison of Muddling Through and a Recovery Scenarios for Beirut-Matn Service Zone

Parameters	Muddling through scenario	Recovery least cost scenario
Waste generated (NPV 2025–40 at 4%) (tonnes)	4,214,079	4,214,079
Waste collected by the informal sector (tonnes)	105,346	105,346
Waste collected (NPV 2025–40 at 4%) (tonnes)	4,108,733	4,108,733
Waste landfilled as % of generated (%)	73	50
Additional capital investment, not discounted (US\$ million)	0	31.54
Greenhouse gas emissions (NPV 2025–40 at 4%) (CO ₂ e)	1,555 Gg	713 Gg
Net emissions averted (NPV 2025–40 at 4%) (CO ₂ e)		842 Gg
Net emissions averted (NPV 2025–40 at 4%) (US\$ million) ^a		68.54
Total cost without accounting for emissions (NPV 2025–40 at 4%) (US\$ million)	107.93	165.59
Total cost with accounting for emissions (NPV 2025–40 at 4%) (US\$ million)	107.93	97.05

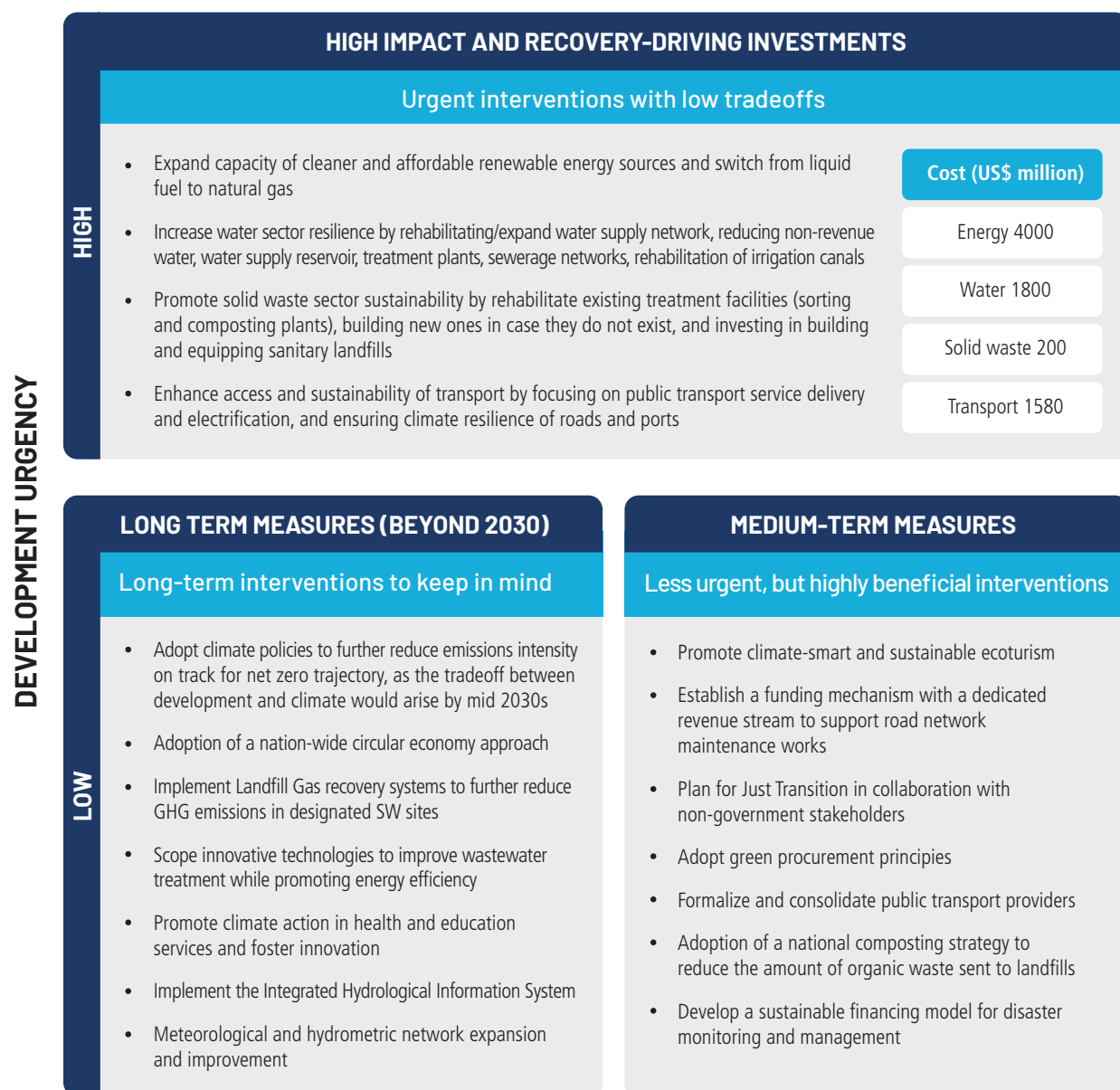
Note: CO₂e = carbon dioxide equivalent; GHG = greenhouse gas; NPV = net present value.

a. High-Level Commission on Carbon Prices 2017.

3.5 Recommendations and Investment Needs

Amid a deepening economic crisis, Lebanon has almost no fiscal space, limited institutional capacity, and numerous development challenges; therefore, it is critical to prioritize and sequence recommended measures and interventions—reflecting their urgency, synergies, and trade-offs—in responding to development and climate needs. The recommended measures of this CCDR, responding to the above-highlighted development and climate needs, are shown in [Figure 12](#). The recommended measures of this CCDR, responding to the above-highlighted development and climate needs, are shown in [Figure 12](#).

Figure 12: Country Climate and Development Report Recommended Policies and Interventions



The costs of aligning Lebanon's recovery with cost-effective climate action between 2024 and 2030 in the four key sectors covered in the CCDR (energy, water, transport, solid waste) are estimated at US\$7.6 billion. The capital-intensive energy sector alone requires approximately US\$4 billion in investment to diversify the generation mix toward clean, affordable, renewable energy sources and switch from liquid fuel to natural gas. Other critical investments include more than US\$1.8 billion in the water sector, according to the updated National Water Sector Strategy, to increase water security through additional storage capacity, increase water use efficiency, and restore resilient water services. This can be achieved by focusing on short-term, no-regret measures to ensure water efficiency by reducing NRW or using energy efficiency in supplying water and by mobilizing financing for new investments of about US\$400 million to increase water supply by gravity, including low-income neighborhoods and irrigation canals, while preparing for development of additional storage capacity. Approximately US\$200 million is required for the solid waste sector to rehabilitate existing treatment facilities (sorting and composting plants), build new ones where needed, and build and equip sanitary landfills. Investment needs in the transport sector include new projects to launch an effective, green public transport system (US\$915 million) and increase transport infrastructure resilience (e.g., roads, bridges, ports) (US\$665 million). Major transport assets (e.g., Beirut Airport, Port of Beirut, Port of Tripoli) could benefit from climate-driven public-private partnership projects that consider effective green building systems and energy efficiency.



4

Macroeconomic Perspective

4. Macroeconomic Perspective

4.1 Lebanon's Macro Fiscal Realities

For more than four years, Lebanon has been facing the most devastating multipronged crisis in its modern history. Since the onset of the economic and financial collapse in 2019, the Lebanese pound has lost more than 98 percent of its value. Triple-digit inflation and currency depreciation show no sign of abating, inducing a pervasive and growing dollarized cash-based economy. Inflation averaged 171.2 percent in 2022 and is projected to reach about 231 percent in 2023 (World Bank 2023a). Inflation is highly regressive, disproportionately affecting the poor and vulnerable, especially because basic goods, including food items, are the primary drivers of overall inflation.

Public finances have all but collapsed, prompting an acute collapse in public service delivery. In the absence of immediate measures of fiscal consolidation and initiation of debt restructuring in the context of a comprehensive crisis resolution plan, a passive approach to fiscal policy continues to drive a near-complete collapse of public finances. The primary spending downturn has severely hindered public service delivery, and the collapse in revenue generation has impeded wage corrections to offset the dramatic erosion of public sector wages, allowances, and pensions driven by inflation. The fiscal deficit was 2.9 percent of GDP in 2022. It is estimated that revenues have declined from an already low 13.1 percent of GDP in 2020 to 6.1 percent in 2022, one of the lowest rates globally. An increase in total expenditures (including off-budget spending) more than offset revenues (World Bank 2022a).

Financial losses in the banking system exceed US\$72 billion, equivalent to more than three times GDP in 2021 (World Bank 2022a). Combined losses stem from a public sector in default; a central bank holding the largest negative reserves position in the world; and an oversized, insolvent banking system. As early as November 2019, the financial sector introduced discretionary and informal capital controls to conserve liquidity and capital as depositors struggled to access the full value of their pre-crisis deposits. A complicated multiple exchange rate system was put in place, governed by ad hoc Central Bank circulars in lieu of a new monetary exchange rate framework grounded in the full realization of financial losses. The severe shortage of foreign currency and rationing of depleted foreign currency reserves has quickly translated into acute shortages and supply shocks in crucial imports, ranging from medications to fuel supplies.

Lebanon's faltering infrastructure is a drag on economic growth, potential output, and total factor productivity. Capital expenditures have declined markedly in the post-civil war reconstruction period and have amounted to less than 2 percent of GDP since 2001. As a result, capital stock declined to less than 50 percent of GDP since 2010, leading to significant disinvestment. As highlighted in the 2022 Public Finance Review, investment expenditures were not sufficient for maintenance and adequate service provision. The persistently low capital expenditures exacerbated Lebanon's longstanding and severe infrastructure deficiencies in the water, solid waste, electricity, and transport sectors. The current infrastructure to store water and bridge the seasonal gap in availability of water is limited, with per capita water storage in dams of 38.97 cubic meters per capita, similar to Jordan and much less than Algeria, Egypt, Morocco, or Tunisia. The total storage of 0.233 billion cubic meters is equivalent to approximately 6 percent of surface water availability, versus the regional average of 91 percent. Increasing storage capacity and securing water is essential for irrigation to safeguard food security and for water supply to increase water availability during the dry season. After the onset of the financial crisis in 2019, inadequate provision of public services, a staple of Lebanon's post-war economic model, gradually escalated to public service non delivery. Lebanon's decaying infrastructure has reduced total factor productivity and potential growth, and disinvestment has reduced economic growth.

4.2 Two Possible Futures

The assessment of the macroeconomic impacts of selected climate change damage and actions is based on simulating their effects under two distinct (and diverging) futures for the country—the muddling through (business as usual) and recovery scenarios. In this section, the baseline macroeconomic simulations of the muddling through and recovery scenarios are presented. (The baseline scenarios exclude energy transition.) The simulations were conducted under extreme uncertainty and are subject to revision. Therefore, the estimated real, fiscal, and debt indicators are only illustrative. In the next section, energy transition (or lack thereof) is incorporated into the macroeconomic simulations, and the differences in the impact of a muddling through versus a recovery scenario on different variables, particularly on the energy transition, and climate adaptation are highlighted. The macroeconomic simulations are conducted with the help of a macrostructural country model developed by the World Bank (MFMod).²¹

The muddling through scenario is predicated on continuation of the status quo of lagging and inadequate macro-fiscal reforms. Lack of reforms adversely affects fiscal and external stances. Lack of fiscal space, coupled with an impaired banking sector that is incapable of performing its financial intermediation functions and an inability to tap into international capital markets because of the sovereign default, implies that funding for capital expenditures and, consequently, the energy transition and climate adaptation, is lacking. Financing constraints lead to anemic economic growth, and climate-related financing is scarce in the next decade. Under this scenario, it is assumed that a restructuring of the sovereign debt is not completed before 2030. Despite debt restructuring, the yields on Lebanon's bonds do not fall drastically, and the country slowly regains limited access to international financial markets.²² The debt restructuring, which is accompanied by lingering apprehension in international credit markets regarding the country's creditworthiness and borrowing capacity, does not yield a marked appreciation in the exchange rate.

Under the muddling through scenario, GDP growth is subdued over the next two decades. It is assumed that gradual, albeit limited, improvement in electricity provision by the central utility (EDL) enhances the business-enabling environment and supports the traditional drivers of growth—tourism and services. The improvement in electricity provision, coupled with a marginal increase in private and government consumption, helps sustain average real GDP growth rates of 2.0 percent from 2020 to 2030 and 1.6 percent from 2030 to 2040. An increase in investment, which increases to its pre-crisis level, leading to an accumulation in the capital stock, sustains the growth rate in real GDP.

Despite the inadequate macro-fiscal reforms, ad hoc revenue measures (e.g., adjustments to customs duties, income tax, and the exchange rate used for collecting EDL and telecom tariffs) will lead to a gradual, albeit modest, improvement in fiscal revenues. Starting from a low base from 2010 to 2020, it is projected that fiscal revenues will average 16.2 percent of GDP from 2020 to 2030 and 18.5 percent from 2030 to 2040. Despite the increase in fiscal revenue, it is projected that the overall budget will remain in deficit as expenditures rise more rapidly than revenue collection. Lebanon's weak external position is expected to persist amid continuing dependence on imports and a less-than-commensurate increase in exports. The decline in the economy's total income and GDP per capita from 2020 to 2030 will lead to a decrease in imports and an average current account surplus of 4.4 percent. Export competitiveness will continue to be inhibited as the tradable sector does not fully exploit the benefits of a weaker exchange rate owing to persistent structural bottlenecks and a weak institutional and volatile political environment.²³ As a result, it is projected that the current account will be in a deficit of 12.7 percent from 2030 to 2040.

21 MFMOD is a customizable hybrid-macrostructural model with neoclassical long-run closure and Keynesian short-run features.

22 Cruces and Trebesch (2013) provide evidence that, depending on the extent of investor losses, sovereign yields can remain high after a restructuring and that countries may face continued exclusion from credit markets.

23 A detailed analysis of the causes of the lack of an external lift is offered in World Bank (2021b).

The recovery scenario assumes that adequate reforms are underway, indicating that the financing constraint is less binding owing to improved fiscal space. Nonetheless, Lebanon continues to be deprived of access to international capital markets until 2024, and the banking sector's solvency is not entirely restored in the next decade. Under this scenario, it is assumed that Lebanon completes a debt restructuring in 2025 that improves its sovereign credit rating. Lebanon is able to tap into international markets, and the cost of borrowing decreases after the restructuring. The macroeconomic scenarios embed the costs of the energy transition.

Under the recovery scenario, higher investment rates, which support economic growth, reverse the depletion of human and physical capital. As investment increases, and the capital stock ultimately surpasses its precrisis levels, real GDP growth accelerates from 2.9 percent from 2020 to 2030 to 4.7 percent from 2030 to 2040. In tandem, total factor productivity is expected to increase owing to an increase in power supply by EDL and enhancements in the business-enabling environment. It is projected that total factor productivity growth turns positive in 2026 and averages 1.0 percent from 2027 to 2040. An increase in private and government consumption and stabilization of private sector activity amid a gradual easing in political tensions leads to the acceleration in real GDP growth. The economy will continue to be services oriented, and the traditional drivers of growth (travel services and the services sector in general) will be the main sources of growth. Moreover, integration of a niche agricultural sector into regional and global value chains; a transition from low to high value-added activities in agriculture, tourism, industry, health care, and education; greater integration into the knowledge economy; and digitalization of government services will buoy economic growth.

The debt restructuring and fiscal and economic reforms will yield sufficient fiscal space for capital expenditures. For instance, reforms of the tariff structure, improvements in revenue collection, and maintenance of the grid will allow EDL to increase the power supply. This scenario also assumes gradual improvement in revenue collection so that the ratio of revenues to GDP gradually returns to near-precrisis levels. Although fiscal revenues are expected to remain at 23.7 percent of GDP by 2040 under the recovery scenario, the overall fiscal balance will continue to register a deficit of 2.5 percent of GDP in 2040 as the rise in expenditures outstrips the increase in revenues. On the external side, real GDP growth will stimulate demand for imports, leading to a current account deficit of 24.8 percent by 2040 under the recovery scenario. These dynamics reflect Lebanon's continued dependence on imports, as in the precrisis period.

4.3 Macroeconomic Assessment of Lebanon's Adaptive Capacity

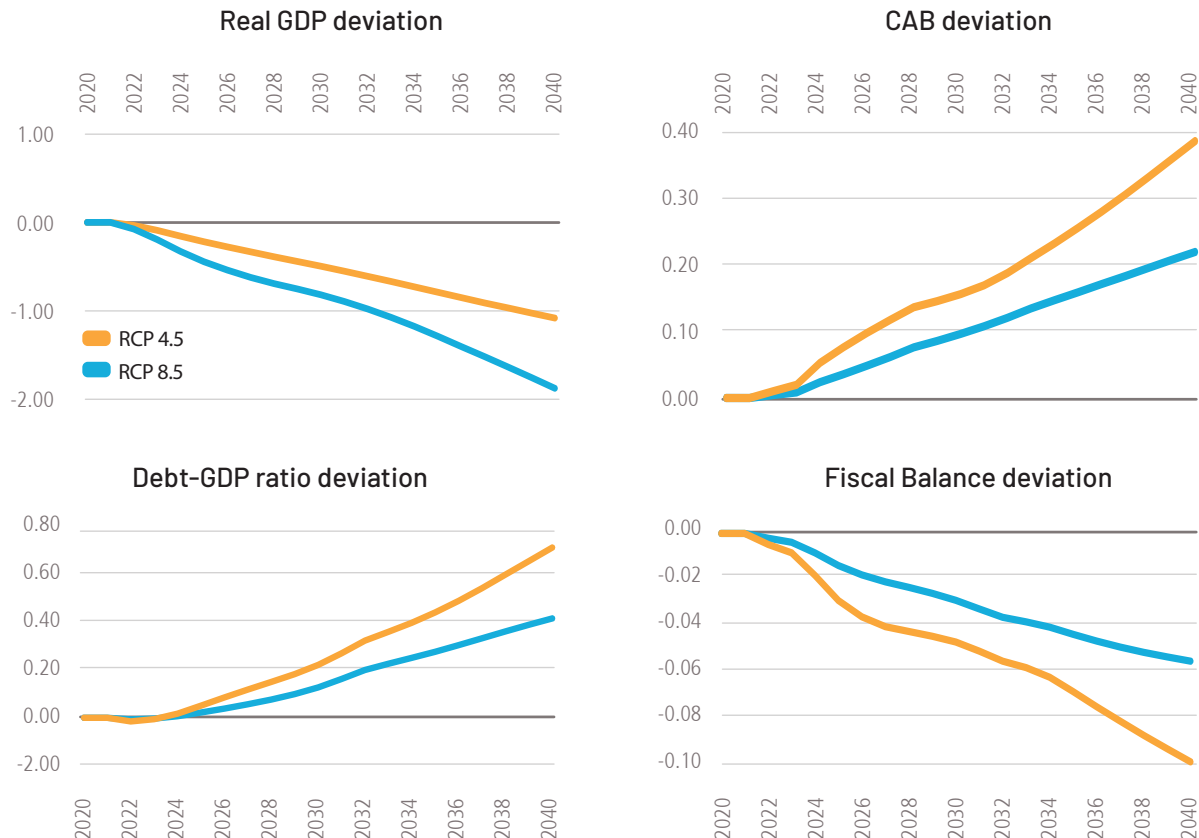
It is estimated that climate shocks (flooding, crop failure, water scarcity) will result in 1.2 percent lower GDP by 2040 than at baseline under the RCP 4.5 climate scenario and 2 percent lower under the RCP 8.5 climate scenario. These shocks are expected to worsen the government's fiscal balance and increase the debt-to-GDP ratio (Figure 13). Of the climate shocks analyzed, lower crop yields pose the greatest risks to economic growth in Lebanon, followed by heat impacts on labor productivity. Higher levels of investment will make the economy more resilient to climate shocks that damage capital stock such as flooding. The recovery and muddling through baselines (section 4.2) include different assumptions about agriculture's share in production over the projection period: a constant share (6 percent) under recovery and a slightly higher share (7 percent) under muddling through. These are conservative assumptions, and it is possible that, on a muddling through pathway, service sectors such as tourism and hospitality would shrink further, and agriculture would take a larger share of the economy. Such an outcome would make the Lebanese economy more vulnerable to climate shocks, affecting mainly the agricultural sector by reducing the water supply and crop yields. It is also possible that, on a recovery pathway, labor will be able to move from rural to urban areas, and labor force participation will increase in sectors greater higher labor productivity, such as services.

The muddling through and recovery baselines are both subject to the following climate stress tests, using a rolling impact (moving window) between 2024 and 2030; this implies that a certain shock is simulated for each year in year t , tracing out the impact of the shock over consecutive years:

- Flooding—calibrated to a 1-in-100-year shock that is expected to reduce the capital stock by 0.033 percent or decrease GDP by 0.14 percent
- Crops—calibrated to a 10 percent decrease in crop yields lasting for one year²⁴
- Water—calibrated to a 10 percent reduction in water supply in one year, with the assumption that water accounts for one-third of inputs in agricultural production

Because agriculture accounts for a small share of economic activity under both scenarios, the impact on overall GDP from crop and water shocks is small.

Figure 13: Deviations in (a) Real GDP, (b) Current Account Balance, (c) Debt-to—Gross Domestic Product (GDP) Ratio, and (d) Fiscal Balance under the Muddling Through Scenario

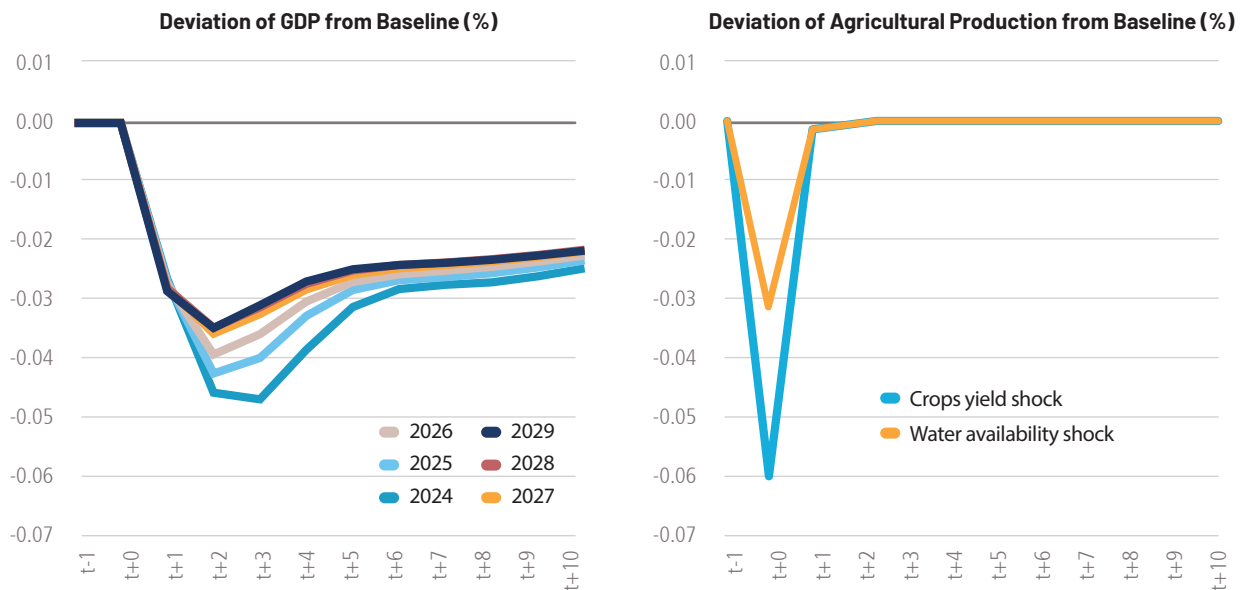


Note: CAB = Current Account Balance.

24 This is a hypothetical “maximum” assumption. Based on RCP modeling, the yield decrease from the decrease in rainfall rate and increase in temperature fluctuates between 0.3 percent and 7.9 percent for irrigated crops and between 3.8 percent and 7.5 percent for rainfed crops

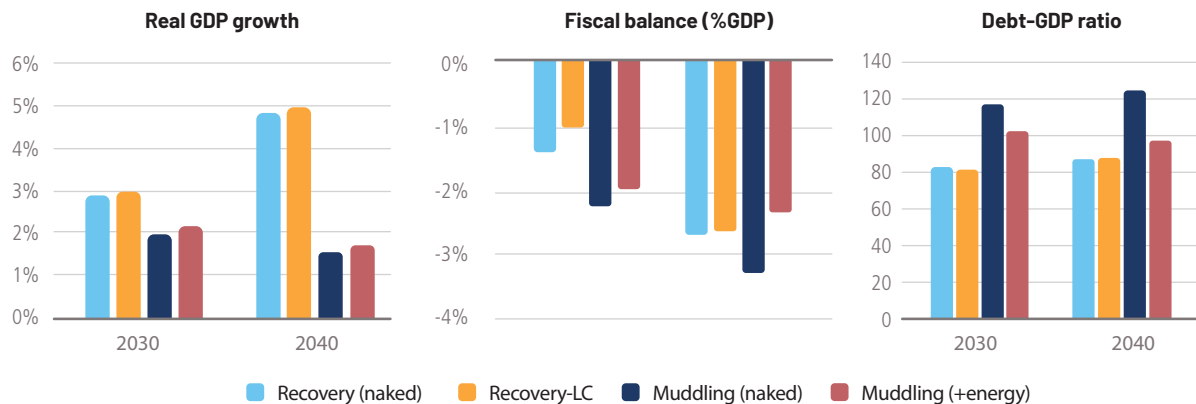
Under the muddling through scenario, floods are expected to have a larger, longer- lasting impact on economic output than under the recovery scenario (Figure 14). because of two main differences: under muddling through, productivity levels are lower, and as such, a larger proportion of economic activity relies on the capital stock; and less investment is available to repairing the capital stock damaged in floods. This means that it takes longer for the economy to recover from a flood under the muddling through scenario. Because the economy recovers faster under the recovery scenario (with total factor productivity and investment returning to precrisis levels), the economy will be more resilient to flooding shocks.

Figure 14: (a) Impact of flooding shock on GDP; (b) Impacts of water scarcity shock and crops yield shock on agricultural output under the “Muddling through” scenario.



A muddling through scenario will have serious consequences for the water sector. More than 70 percent of the population would face critical water shortages and increasing cost of supply. Modeled as a productivity shock, the reduction in crop yields and water supply both lower the level of output for the same inputs of capital and labor, reducing agricultural output by 6 percent and 3 percent, respectively (Figure 15). The water-agriculture nexus in Lebanon is strong, as discussed above, and the financial losses per year of rainfed and irrigated crops due to an increase in temperature and rainfall may reach US\$250 million per year. The irrigation sector faces challenges that limit adaptive capacity, including deficiencies in existing infrastructure, weak water governance, and institutional uncertainty over water rights and operational responsibilities.

Figure 15: (a) Real Gross Domestic Product (GDP) Growth in the Studied Scenarios, (b) Fiscal Balance, (c) Debt-to-GDP Ratio



4.4 Macroeconomic Implications of Lebanon's Energy Pathways

The recovery-LC scenario (which includes the energy transition results) yields lower operating expenditures, lower emissions, and a smaller share of fuel imports relative to GDP, paving the way for more diversification toward crucial imports. It also yields better macroeconomic outcomes than the muddling through-energy scenario (integrating the energy transition results into the muddling through scenario), whose lower investment levels decrease productive capacity through capital stock. Not only does the energy transition under the recovery-LC scenario lead to substantive gains in real GDP, improving debt dynamics, but also results in more fiscal space, allowing for investment in least-cost technology.

Lebanon's energy transition will be fiscally painful in the short term but will bring notable gains in real GDP in the long term. Comparing the macro-fiscal baseline scenarios laid out in section 4.2 with those that include energy transition shows that real GDP growth is, on average, greater with energy transition (Figure 15a) and is projected to be, on average, 0.2 percentage points higher under the recovery-LC scenario. The average gain in real GDP growth under the muddling through-energy scenario is slightly lower but still significant; it is projected that real GDP growth will be 0.2 percent larger during 2020 to 2030 and 0.1 percent larger during 2030 to 2040 under the muddling through-energy scenario than under the baseline scenarios. The gains in real GDP growth when the energy transition is undertaken can be ascribed to a boost in economic activity from energy sector investment.

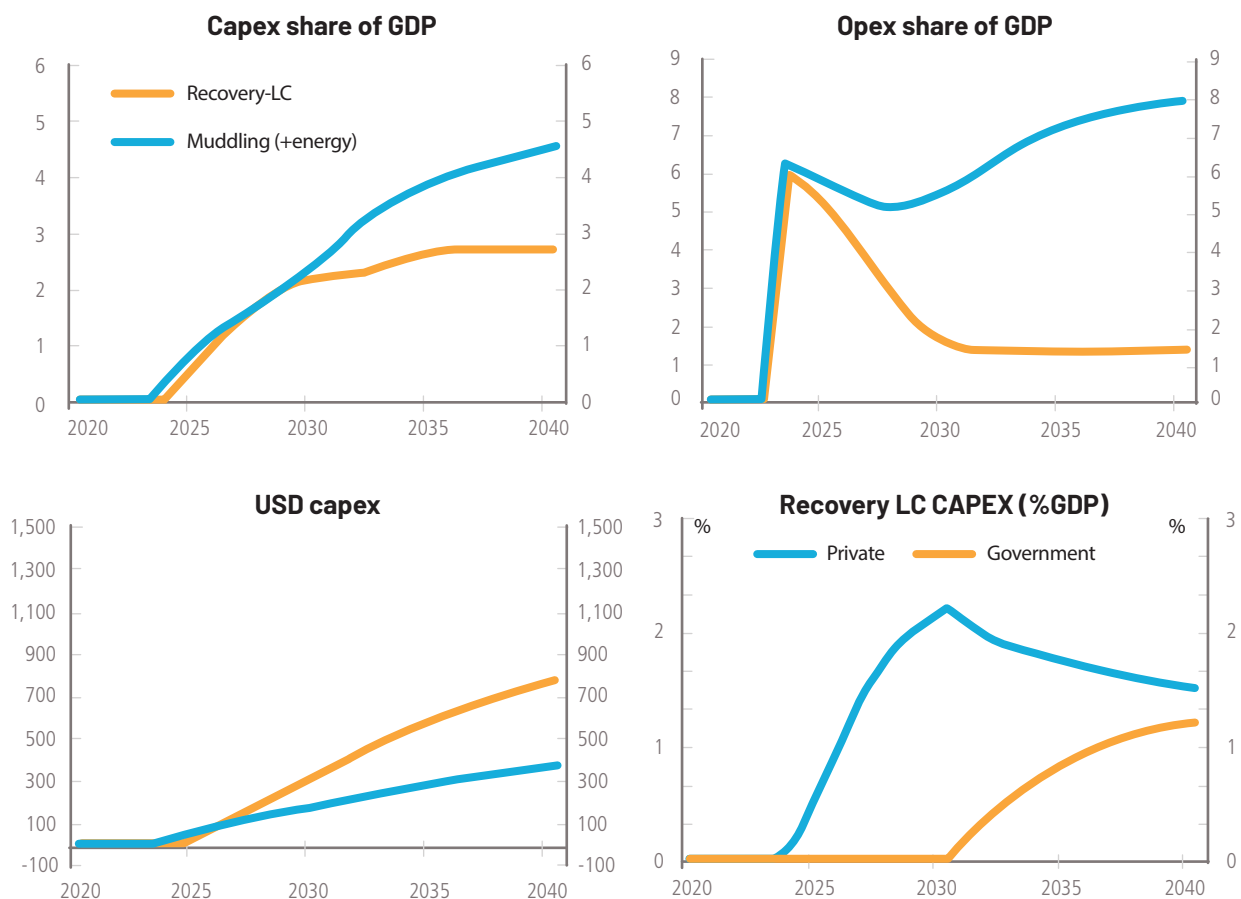
The recovery-LC scenario creates fiscal space, allowing for more investment in least-cost technology than under the muddling through-energy scenario. In line with Lebanon's precrisis fiscal imbalances, fiscal deficits are projected under the recovery and muddling through-energy pathways. Nonetheless, owing to higher revenue collection, the fiscal deficit will be narrower under recovery-LC scenario (Figure 15b). The resulting fiscal space will enable private and public investment in the power sector and least-cost technology investments, leading to a larger capital stock and greater productive capacity under the recovery scenario than under the muddling through-energy scenario.

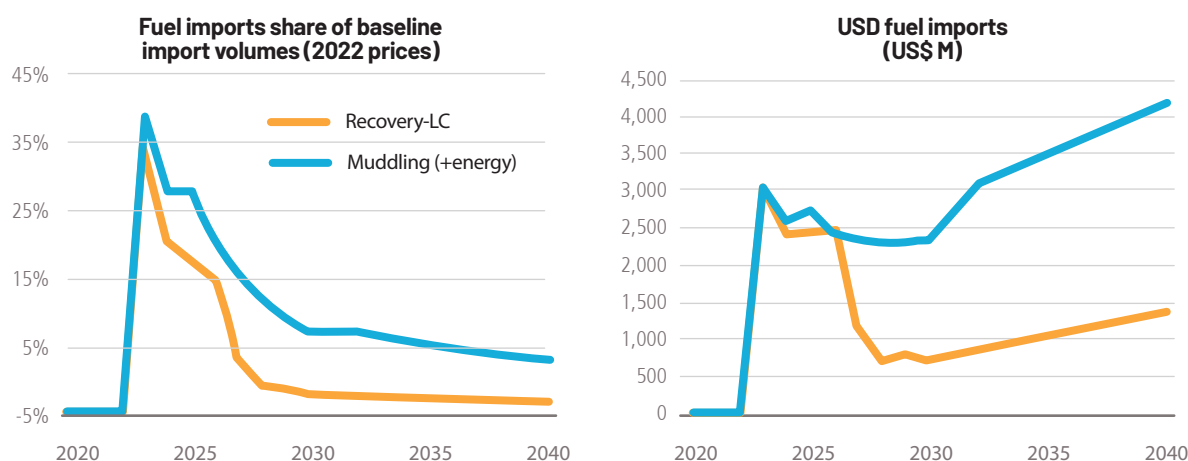
The energy transition will improve debt dynamics. It is projected that the debt-to-GDP ratio declines considerably under the recovery-LC scenario. Whereas Lebanon's debt burden will continue to be substantial under the muddling through-energy scenario, the debt overhang is markedly lower under the recovery-LC scenario (Figure 15c), and it is projected that the debt-to-GDP will fall to 86.5 percent by 2040 under the recovery-LC scenario and remain at 96.2 percent in 2040 under the muddling through-energy

scenario. Therefore, debt dynamics will be slightly better under the recovery-LC scenario. Without the energy transition, the debt-to-GDP ratio under muddling through will surpass 120 percent in 2040. The marked decline in debt-to-GDP ratio under the recovery-LC pathway can be ascribed to lower overall and primary fiscal deficits, external debt, and debt servicing costs, alongside larger GDP. The lower debt-to-GDP ratio due to the energy transition can be ascribed to energy sector investments.

Although capital expenditures as a share of GDP is broadly similar under the muddling through and recovery baseline scenarios, operating expenditures as a share of GDP are much lower under recovery-LC (Figure 16a and b). In U.S. dollar terms, capital expenditures will be considerably lower under a muddling through-energy scenario (Figure 16c). Capital expenditures as a share of real GDP is roughly the same proportion of economic activity under both scenarios because of the weaker exchange rate and smaller economy under the muddling through-energy scenario. Given the shrinking size of the economy in a muddling through scenario, any small U.S dollar capital expenditure is significant for the domestic economy. Amid the energy transition, it is assumed that the private sector pays for the entirety of the investment in power generation and that the government finances an increasing share from 2030 onward under the recovery-LC scenario (Figure 16d).

Figure 16: (a) Capital Expenditures and (b) Operating Expenditures as a Share of Gross Domestic Product (GDP) under Muddling Through-Energy and Recovery-Least Cost (LC) Scenarios; (c) Capital Expenditures under Muddling Through-Energy and Recovery-LC Scenarios; (d) Capital Expenditures as a Share of GDP of the Private and Public Sectors under Recovery-LC Scenario, (e) Fuel Imports as a Share of GDP under Muddling Through-Energy and Recovery-LC Scenarios; (f) U.S. Dollar Fuel Imports under Muddling Through-Energy and Recovery-LC Scenarios





Another notable downside of the muddling through-energy scenario is larger fuel imports—in U.S. dollar terms and as a share of GDP (Figure 16e and f). The difference between the muddling through and recovery-LC scenarios is striking in 2023. Although fuel imports are the same in U.S. dollar terms in 2023 under both energy transition scenarios, the lower exchange rate and smaller economy exacerbate the scale of reliance on fuel imports in the muddling through-energy scenario. For the recovery-LC pathway, fuel import requirements account for approximately 21 percent of GDP in 2023, or 33 percent of projected import volumes for that year. Despite narrowing in 2030, the difference in fuel imports between the recovery-LC and muddling through scenarios remains significant in 2030—3 percentage points relative to GDP and 9 percentage points in its of import volumes.

4.5 Macroeconomic Impact of Critical Short-Term Investments

In the short-term (2024–26) and under any scenario, Lebanon urgently needs investment in key service and growth-providing sectors, with a financing envelope of US\$770 million (Table 6). Although Lebanon could embark on either of the two scenarios, the reality could be somewhere in between. Consequently, the Lebanon CCDR assessed the impact of an urgent financing envelope that responds to key (partial) needs in the four sectors covered in the CCDR (energy, water, transport, solid waste) (Table 6). In view of the severe lack of service provision in the energy and water sectors, these two sectors will receive most of the financing (~39 percent and 34 percent of the total investment envelope, respectively). In the energy sector, a priority would be to increase the low-cost supply (mix adequacy) and the readiness of the grid and EDL for high penetration of variable renewable electricity (grid reliability, operational and commercial efficiency). The transport sector would receive about 15.5 percent of total financing and the water sector approximately 11.6 percent. It is assumed that 80 percent of the financing will be nonconcessional and 80 percent would consist of capital expenditures.

Table 6: Short-Term Priority Investment Envelope and Financing Assumptions

Sector	2024	2025	2026	Total	Financing		Imports		Capital stock	
					Noncon- cessional financing (%)	Concessional financing and grants (%)	(%) Domestic spending (%)		Capital expendi- tures (%)	Operating expendi- tures (%)
Energy	100	100	100	300	80	20	80	20	80	20
Water	80	80	100	260	80	20	50	50	95	5
Transport	40	40	40	120	80	20	20	80	90	10
Solid waste	30	30	30	90	80	20	80	20	80	20
Total				770						

Although it is expected that financing constraints will ease upon completion of a sovereign debt restructuring, Lebanon cannot afford to delay these much-needed investments. It should mobilize revenues by overhauling its tax policy and system. More specifically, the authorities can significantly enhance revenues in a progressive manner (without placing the burden on wage earners) by ending the overly favorable treatment of wealth, capital gains, and property taxation.²⁵ These additional revenues could be earmarked for sectoral investments, but they are likely to be insufficient, so the authorities should strive to unlock private sector financing through private-public partnerships. The high required rates of return, amid a sovereign default, could make it difficult to mobilize private sector financing. Nonetheless, the country risk premium may decrease and make private sector investments viable if the authorities embark on a comprehensive crisis-resolution plan and initiate structural reforms.

The US\$770 million priority investment package will yield a slightly larger, albeit still small, increase in real GDP than the muddling through pathway without placing debt on an unsustainable footing. In the first year, the investment package will amount to approximately 1.4 percent of GDP under the muddling through pathway. Although approximately 60 percent of expenditures will be on imports, the domestic component (40 percent) of capital expenditures and operating expenditures will increase economic activity in a sustained manner.^{26, 27} More specifically, real GDP is expected to increase by 0.3 to 0.4 percentage points in 2024, 2025, and 2026. The increase in real GDP will continue through 2040. Under the assumption that the government will fully finance the investment package, the fiscal deficit would be projected to increase by around 1.3 percentage

25 See World Bank (2023c) for specific recommendations on mobilizing revenues in a progressive manner.

26 The improvements to real GDP are permanent because of capital spending (which accounts for approximately 86 percent of the total), boosting the productive capital stock.

27 Whereas the total percentage of spending on imports under the investment package is around 60 percent, the percentage of imports versus domestic spending differs across sectors. For instance, the assumption is that 80 percent of expenditures for the solid waste and energy sectors would be on imports, whereas 50 percent and 20 percent of the spending for the water and transport sectors, respectively, would be on imports.

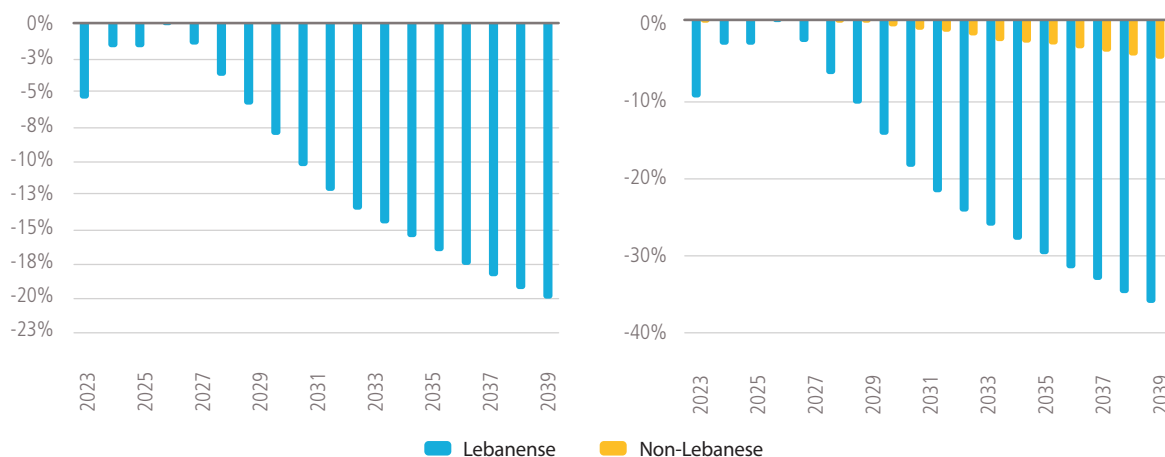
points (relative to GDP) in 2025 and 2026 and by 0.3 and 0.4 percentage points in 2030 and 2040 relative to the muddling through pathway.²⁸ Moreover, the debt-to-GDP ratio would be projected to increase by 1.4, 2.0, and 2.7 percentage points in 2024, 2025, and 2026, respectively. The increase in the debt-to-GDP ratio would persist in 2030 and 2040, increasing by 2.2 percent and 3.5 percent, respectively. The investment package would not, by itself, place debt on an unsustainable footing. The fiscal and debt dynamics can be enhanced by mobilizing Private sector financing, thereby lowering the central government's share of total investment spending.

4.6 Poverty and Jobs Assessment of the Recovery Scenario

From 2023 to 2040, the recovery scenario (inclusive of the energy transition) is expected to result in a lower incidence of extreme poverty than the muddling through scenario. The greatest impact is seen in 2040, with extreme poverty expected to be about 20 percentage points lower than under the muddling through scenario (Figure 17a). The poverty analysis uses 2018/19 Labor Force Survey data, with imputed consumption expenditures derived from a common set of explanatory variables found in the 2011/12 Household Budget Survey.²⁹ The analysis compares the difference in poverty outcomes under the recovery-LC and muddling through scenarios between 2023 and 2040.

Lebanese nationals would experience more of the reduction in poverty than nonnationals, who tend to have much higher and deeper levels of poverty, with improvements insufficient to raise them over the poverty line (Figure 17b). By 2040, Lebanese nationals could anticipate as much as a 37 percentage point greater drop in extreme poverty incidence than under the muddling scenario, whereas nonnationals would see, at most, a 7 percentage point greater decline. Nationals and nonnationals are expected to benefit from a greater reduction in the poverty gap (Figure 17b) under the recovery scenario than under the muddling through scenario. Even though nonnationals do not experience a decline in the incidence of extreme poverty to the same extent as their Lebanese counterparts (Figure 17b), they at least move closer to the poverty line, reducing the severity of the poverty they experience.

Figure 17: (a) Real Gross Domestic Product (GDP) Growth in the Studied Scenarios, (b) Fiscal Balance, (c) Debt-to-GDP Ratio



²⁸ Furthermore, the projected fiscal surplus in 2024 would become a deficit.

²⁹ A passthrough of 0.75 from per capita income growth to per capita consumption is assumed, along with various assumptions under each scenario about growth in the Consumer Price Index; nominal GDP growth; and the shares of agriculture, services, and industry in GDP until 2040

Adopting the recovery pathway in the power sector would increase labor demand by 10 percent more than the muddling through scenario. The main drivers of this difference are private and public sector expenditures. Investment in electricity generation increases demand for labor. Following a pathway toward the NDC targets with photovoltaic installations by 2030, installation projects and operation and maintenance of existing and new renewable energy installations increase employment. It is estimated that 20,000 jobs will be created across all sectors under the recovery-LC scenario, assuming a more or less constant sectoral employment structure. Social resilience is also expected to be enhanced under the recovery scenario, with the incidence of extreme poverty 20 percentage points lower than under the muddling through scenario by 2040, benefitting Lebanese nationals and nonnationals. Although replacing diesel generation with renewable energy will result in job losses, fewer jobs will be lost than those created under a clean energy transition. The net jobs outcome of the recovery-LC scenario in the power sector will therefore be positive, albeit not for all workers. Because most jobs in the diesel sector are informal, displaced workers may need government support such as social assistance to make up for labor earnings loss.

Improving solid waste management also has positive implications for jobs. Almost 6,800 workers are employed in the sector, including water supply, sewerage, waste management, and remediation activities, according to the Labor Force and Household Living Conditions Survey 2018/19 (ILO 2019). Current efforts in the solid waste sector to implement the Sorting at Source Decree 5605/2019 and establish drop-off centers offer additional job opportunities. With approximately 1,000 tons/day of recyclables available across the country and considering current efforts to establish drop-off centers and operationalize treatment facilities, waste recycling can not only optimize climate benefits through waste diversion, but can also include workers in increasingly formalized value chains by providing access to equipment, skills, and tools to increase the value of their activity and the prices paid for their work.



5

The Way
Forward

5. Recovery Levers

Green, resilient, inclusive recovery in Lebanon requires that reforms be implemented, governance improved, human capital developed, natural capital protected, the private sector empowered, and a whole-of-society approach to climate change adopted.

5.1 Reforms as Key Enablers of Recovery

Addressing the ongoing political crisis and implementing key sector reforms are critical for Lebanon's economic recovery. Achieving a broad political settlement is imperative to create an enabling environment for reforms and regain the trust of citizens and donors, whose engagement is required for a strong economic recovery. At the top of the reform agenda are the structural macro-fiscal reforms that are predicated on a new and credible exchange rate and monetary framework; comprehensive bank restructuring, addressing upfront balance sheet impairments, restoring liquidity, and adhering to sound global practices of bail-in solutions based on a hierarchy of creditors (starting with bank shareholders) that protects small depositors; a medium-term fiscal strategy to restore debt sustainability; and key structural and sector-level reforms to improve governance.

Implementation of a long-overdue reform agenda, particularly in the energy sector, should be started immediately to enable a sustainable recovery process. In the power sector, which has a sizable impact on Lebanon's fiscal and current account positions, the most urgent reforms primarily pertain to the operational performance and financial sustainability of the EDL but also to transparency in financial reporting and cash management and establishment of an electric regulatory authority. This is in line with priorities outlined in the government's policy statement that was approved in March 2022 and is still pending implementation. Taking advantage of ongoing bottom-up renewable energy uptake would require a functional grid and an adequate, effective regulatory framework, as envisioned in the draft law on distributed renewable energy. Although reform outcomes may take time to materialize, reform actions must start immediately, with a steadfast commitment over the medium term. Under all scenarios, public investment in strengthening the electricity network and operational systems will be needed to manage a grid with increasing amounts of variable renewable energy.

Reforms in the water sector, crucial for enhancing resilience and mitigating climate change vulnerability, should focus on strategic investments in data, adaptive infrastructure, and institutional changes. In light of economic constraints, low-cost, high-impact measures must be prioritized, addressing water use efficiency, NRW reduction, and financial stability. These efforts should be integrated into a broader enabling environment, recognizing the need for sustained, long-term investments in water supply and sanitation networks, treatment plants, and irrigation canals. Anticipatory steps for large capital investments in new storage are essential, ensuring readiness for a conducive environment towards these large investments. This comprehensive approach is imperative to prepare the water sector for climate change given economic limitations.

5.2 Training the Workforce for a Sustainable Future

Transitioning to a sustainable economy necessitates education at all levels and addressing gender skill bias. Lebanon's economic recovery landscape is diverse, encompassing various roles from construction and transport to experts and engineer. For example, utility-scale photovoltaic projects require a variety of expertise, including legal, real estate, tax, engineering, logistics, environmental, and health and safety. Skills specific to photovoltaics and universal skills such as drivers and loading staff are essential. Lebanon's small size minimizes geographic barriers for skilled workers to be hired in the country, although wind energy demands complex skills

such as specialized vehicle operation, crane use, and intricate wind measurement. Manufacturers often send expert teams to countries lacking local wind farm knowledge. It is crucial to remain agile in skill development, because new requirements may emerge. Transitioning to a sustainable economy necessitates introducing the concepts of circular economy, climate change, and biodiversity to students. Vocational training enhances skills for various sustainable roles. Universities must integrate sustainable development into all disciplines and forge partnerships with the private sector. Gender-aware training is essential to using the untapped potential of female workers, given the disparities in skill distribution and employment opportunities.

5.3 Integrated Land Management

Improving land management practices is essential to safeguarding the country's natural capital and minimizing climate impacts. Expanding and ensuring the upkeep of land information systems and cadastral maps would provide a baseline for development of informed, integrated plans across the country, safeguarding the country's natural capital and preventing urban sprawl. Strengthening institutional coordination between ministries responsible for land use related to urbanization, climate, biodiversity, and food security—horizontally and vertically—is recommended for enhanced coordination. Considering land degradation and environmentally damaging practices, applying economic instruments such as taxes, fees, and charges more broadly would not only provide the government with needed capital, but would also promote use of sustainable practices. Finally, it is estimated that between 20 percent and 25 percent of Lebanon's territory is government owned, which could provide much-needed capital for resolving revenue loss and repaying government debts.

5.4 Climate-Smart Agriculture

Investing in climate-smart agriculture increases resilience to climate shocks and export competitiveness. As described in Chapter 1, climate change increases the vulnerability of the agrifood system through impacts on increasingly scarce water and land resources and the prevalence of pests and diseases; there is thus an urgent need to increase adaptability to climate change and sustainable management of agrifood systems and natural resources. This can be achieved through a comprehensive approach involving several key measures, including improving natural resource quality by reducing water and soil pollution, sustainably managing the soil to combat desertification and sequester carbon, and supporting climate-smart investments in agrifood value chains. It also includes measures to ensure water availability by increasing irrigation efficiency and using water harvesting systems; promote access to climate-resilient crop varieties; enhance livestock management and health; adopt renewable energy and circular economy practices; and improve disaster risk management systems such as drought monitoring, early warning, and integrated pest management.

5.5 Sustainable and Eco-Tourism

Tourism in Lebanon, particularly ecotourism, offers significant climate and social benefits, making it a potential avenue for sustainable development through public-private partnerships, but there is no strategic framework, and climate change considerations are crucial for future plans. The sector's success depends on preserving natural resources, diversifying income sources for rural communities, and enhancing their resilience to climate change. Climate change threatens Lebanon's rich biodiversity, especially in its forests, which could affect tourism. Challenges facing ecotourism in Lebanon include overdevelopment, pollution, inadequate infrastructure, and limited support for small businesses. Addressing these challenges requires tailored marketing, collaboration, training, and sustainable practices, making ecotourism a key contributor to Lebanon's environmental and economic well-being.

5.6 Modernization of Hydrometeorology and Early Warning Systems

Modernization of hydrometeorology and early warning systems is crucial for addressing the challenges that climate change poses and preserving natural capital. A modern hydrometeorology system with advanced monitoring technologies and predictive modeling can provide accurate, timely information, supporting a long-term strategic response to climate risks and informed decisions based on real-time data. Given that effective management of natural resources requires accurate data on precipitation, river flows, soil moisture, and more, the modernized hydrometeorology system helps monitor and manage natural resources sustainably, preventing overextraction and ecological degradation. This is particularly important as changes in precipitation patterns affect water availability for ecosystems and human consumption.

5.7 Private Sector and Green Financing

Although the country's financing constraints are expected to ease upon completion of a sovereign debt restructuring, Lebanon cannot afford to delay much-needed investments in its water, energy, transport, and solid waste sectors. It should use increasing revenue by overhauling its tax policy and system. More specifically, the authorities can increase revenues in a progressive manner (without burdening wage earners) by ending the overly favorable treatment of wealth, capital gains, and property taxation.³⁰ Although this additional revenue could be earmarked for sectoral investments, it is unlikely to be sufficient. Therefore, the authorities should strive to unlock private sector financing through private-public partnerships. The high required rates of return, amid a sovereign default, could make it difficult to mobilize private sector financing, but the country risk premium may decrease and make private sector investments viable if the authorities embark on a comprehensive crisis resolution plan and initiate structural reforms.

5.7.1. Private Sector

Coping measures used during the crisis, such as reducing financial liabilities and focusing on exports and growth of innovative start-ups. Present opportunities for generating climate co-benefits, particularly in renewable energy adoption, but prerequisites such as banking sector restructuring, greater access to finance, and legislative support must be met for sustainable private sector mobilization. Energy efficiency and water conservation are also areas of potential climate action, but they require significant reforms and investment. Clean technology start-ups in Lebanon are already working on innovative solutions in areas such as waste sorting, vertical farming, electric vehicle software, and renewable energy optimization. These technologies are in increasing demand, especially in energy-intensive sectors. Leveraging success stories from clean technology start-ups could accelerate growth of a green start-up ecosystem in Lebanon.

To create a more-coherent, more-effective approach to greening the private sector in Lebanon, government action is essential. The government should consider establishing a national strategy, potentially assigning specific ministries to oversee and promote green initiatives, including research and development and skills development. Leveraging the Climate Change Coordinating Committee for public-private dialogue and implementing an eco-labeling program that assesses businesses' environmental impact and sustainable practices could further encourage and facilitate private sector engagement in climate action.

30 See World Bank (2023c) for recommendations on mobilizing revenues in a progressive manner.

5.7.2. Financial Sector and Green Financing

If the financial sector (as well as private sector) is to be involved in climate action it must be restructured to restore banks' viability and financial intermediation. The financial sector is almost fully nonfunctional, and cash based, with an insolvent banking sector and limited financial capacity of microfinance institutions. Given that climate-related factors can have significant implications for financial institutions and supervisory authorities in the medium and long term, climate-related and environmental considerations must be integrated into a forward-looking framework for rebuilding the financial sector.

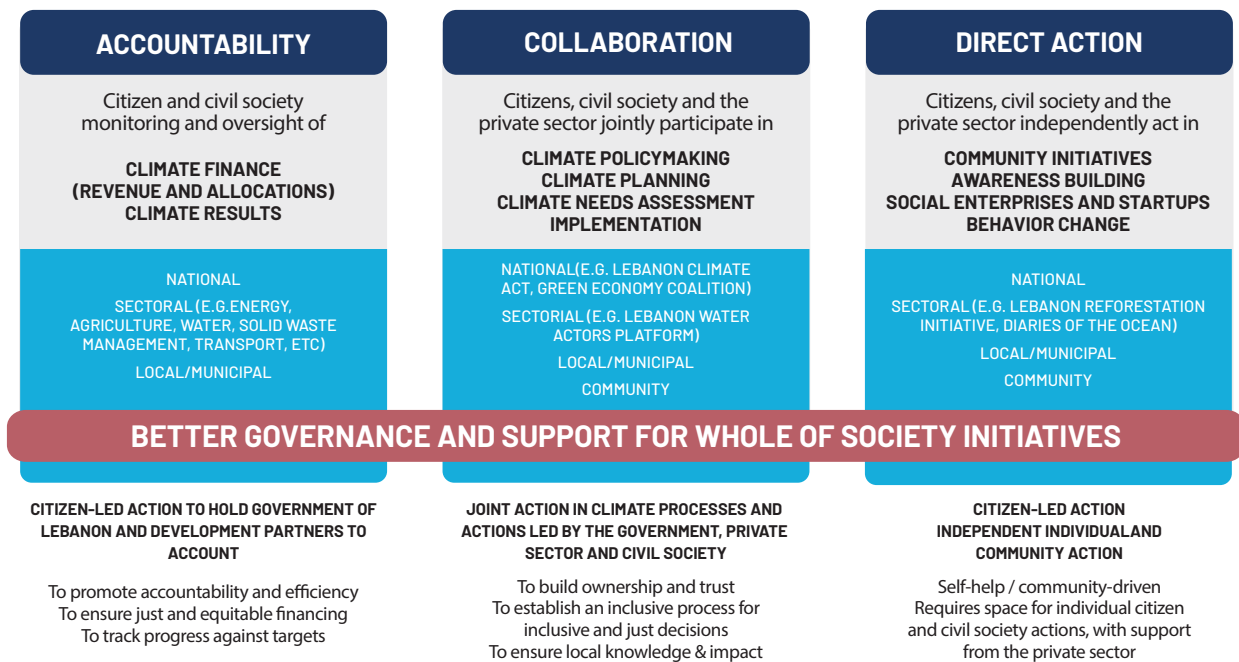
Lebanon has a set of tools to increase its access to innovative green financing. Lack of fiscal space, limited private sector investment capacity, and limited funding from multilateral institutions because progress in key reforms is insufficient will impede mobilization of green finance. In this challenging situation, it is essential to undertake crucial reforms such as restructuring the banking sector and enhancing public sector capabilities. In addition, innovative approaches must be developed to attract green financing. For example, risk-mitigating instruments can aid green financing but depend on overall economic recovery; a reliable platform with strong governance is needed to support green investments, including diaspora contributions; there are promising opportunities for green financing, particularly for farmers through index insurance and digital financial technologies; and microfinance institutions can play a vital role in climate action, but their capacity has declined, hindering green financing. Lebanon should explore results-based climate finance to meet ambitious NDC targets.

There are several medium-term recommendations to improve green financing. The Banque du Liban, Capital Markets Authority, and Insurance Control Commission, in cooperation with a third-party partner, should develop and implement a comprehensive capacity-building program for their staff and financial institutions on climate risks and opportunities and put in place strategies and tools for risk management. The Banque du Liban, Capital Markets Authority, and Insurance Control Commission should develop and adopt a joint strategy for greening the financial sector that covers climate risk management and mobilization of green finance. The Capital Markets Authority should adopt a capital market development strategy that includes green financial instruments such as green bonds and sustainable investment funds. The Insurance Control Commission should promote climate insurance products, including agricultural and catastrophe insurance. The government of Lebanon should assign a public authority to develop a disaster risk financing and insurance strategy.

5.8 Improving Governance and Adopting a Whole-of-Society Approach to Climate Action

Undertaking holistic public sector reforms and adopting a whole-of-society approach to climate change are critical for Lebanon's green recovery efforts and progress on its climate change commitments and ambitions. Business as usual whereby central and local government institutions revert to their precrises state will no longer be sufficient. A whole-of-society approach, which would rest on three pillars—foster accountability for implementation of climate change commitments and financing (on and off budget), with a focus on transparent public financial management and green public procurement and tracking and publicizing progress on NDC commitments and results; support collaboration to create a time-bound strategic vision for climate change initiatives, with a focus on a just transition for vulnerable groups; and support direct action by citizens and community-led actions in conjunction with municipal and national guidelines and directives—is needed to support Lebanon's focus on public sector and governance reforms (Figure 18).

Figure 18: Outlining Lebanon's Whole-of-Society Approach to Climate Change



Moving forward, and with the possibility of accessing climate financing, accountability is extremely important. Under the recovery scenario, whereby the private sector, government, and civil society will have access to climate change finance, there will be increasing concerns regarding how resources are being channeled and used for climate change action and the greater public good. Specific recommendations include:

- Establishing time-bound action plans involving various stakeholders (government entities, businesses, civil society, development partners)
- Promoting civil society engagement in climate policy and budgeting, with access to data and feedback mechanisms at national, ministry, and municipal levels
- Providing fiscal and technical support for local climate initiatives without reinforcing socioeconomic disparities; sharing best practices
- Introducing a youth climate ambassador program and volunteer initiatives as part of education
- Increasing the knowledge capacity of journalists and parliamentarians to understand climate issues thus enhancing their role in the whole-of-society climate approach

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