A PATHWAY TOWARDS A CLIMATE RESILIENT ECONOMY:

LEBANON'S Long Term - Low Emission Development Strategy

2025

LEBANON

This document should be referenced as

MoE/UNDP (2025). A Pathway towards a Climate Resilient Economy: Lebanon's Long-Term Low-Emission Development Strategy (LT-LEDS). Beirut, Lebanon.

UNFCCC focal point

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This product was developed under UNDP's Climate Promise, with generous funding from the governments of Germany, Japan, United Kingdom, Sweden, Belgium, Spain, Iceland, the Netherlands, Portugal and other UNDP's core contributors, and it underpins UNDP's contribution to the NDC Partnership.

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Acknowledgements

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AROHA is an independent NGO established in 2017, based out of Geneva, Switzerland and operating worldwide with a mission statement of averting climate chaos. It operates as a global platform mobilizing support for climate threatened communities and nations as key champions in overcoming a global crisis of the climate.

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The Financial Futures Center (FFC) is an economic and financial research initiative supporting developing countries to catalyze a transformation by optimizing core economic and climate responses together within the real economy.

Global Center on Adaptation

The Global Center on Adaptation (GCA) is an international organization that works as a solutions broker to accelerate action and support for adaptation solutions, from the international to the local, in partnership with the public and private sectors. Founded in 2018, GCA operates from its headquarters in the largest floating office in the world, located in Rotterdam, the Netherlands. GCA has a worldwide network of regional offices in Abidjan, Côte d'Ivoire, Dhaka, Bangladesh, and Beijing, China.

IndyAct

IndyACT is an independent NGO working, since 2007, on climate change and the green economy in the MENA region through policy dialogue and thought leadership. IndyACT has programs on climate change, green economy, circular economy, marine-protected areas, and conservation. IndyACT has developed a green economy vision for Lebanon, named "100% Lebanon", that provides a civil society endorsed roadmap for economic recovery.

Climate Analytics (Technical Advisory Services Supported by Green Climate Fund GCF/2019/C/001)

Climate Analytics is an independent climate science and policy institute with headquarters in Berlin and regional offices across Africa, Australia and the Pacific, the Caribbean, North America, and South Asia. Dedicated to limiting global warming to 1.5°C, Climate Analytics empowers vulnerable nations through science-driven research, policy support, and strategic guidance in international climate negotiations and national planning efforts.

Learning by Doing (LbD)

Learning by Doing (LbD) is an international, multi-disciplinary initiative involving partners from Mexico, South Africa, Lebanon, the Dominican Republic, and the UK, with a regional focus on Latin America and the Caribbean. Funded by Germany's BMU ministry and the International Climate Initiative (IKI), LbD aims to envision and transition to societies compatible with limiting global temperature rise to 1.5–2°C by 2050, illustrating their socio-economic, cultural, and natural features. Implemented by Energeia and CIES, LbD collaborates with academic and civil society partners, including ITAM, the University of Cape Town, Fundacion Popular, IndyAct, and ECLAC.

Energia

Energeia is a research and advisory network that connects economists, policy analysts, financial strategists, and diplomats to advance social policy and climate action. Operating since the early 2000s with a focus on Latin America, Asia, and Africa, Energeia leverages a core team of experts and extensive regional networks to facilitate collaboration among governments, civil society, and the private sector. With a history of pioneering multilateral initiatives, including work with the IADB and World Bank, Energeia provides access to world-class policy and analytical resources.

FOREWORD

Lebanon faces an unprecedented intersection of challenges: climate change, economic hardship, and the aftermath of conflict. These pressures have left a significant toll on our economy, infrastructure, and society, requiring urgent, innovative solutions to rebuild and thrive. The Long Term - Low Emission Development Strategy (LT-LEDS) provides a comprehensive framework to address these challenges, leveraging climate action as a catalyst for economic recovery in tandem with sustainable development. The development of the LT-LEDS actively engaged youths, gender advocates, and NGOs, ensuring that the strategy addresses diverse perspectives and promotes inclusive climate action.

LT-LEDS emphasizes the potential for significant GDP growth through the transition to a low-emission, resilient economy. Whether under reform or no-reform scenarios, the strategy demonstrates measurable economic benefits, including higher disposable incomes, reduced poverty, and job creation by 2050. By fostering investments in renewable energy, sustainable transportation, reforestation, and climate-smart agriculture, the LT-LEDS creates opportunities to drive economic transformation and resilience. The reform scenario accelerates these benefits by unlocking greater economic growth and broader socio-economic gains, while the strategy's flexibility ensures progress under varying fiscal and governance conditions, with reforms maximizing the impact of investments and driving long-term prosperity.

The recent conflict has exacerbated Lebanon's economic vulnerabilities, making recovery efforts particularly challenging. LT-LEDS provides a unique opportunity to integrate climate greening and resilience into recovery and reconstruction, ensuring that investments are sustainable and climate-proof in various sectors. This also creates an opportunity to attract international funding, create quality jobs, and stabilize its economy while addressing long-standing structural challenges.

Implementing the LT-LEDS requires bold action and collective effort. Mechanisms such as the Lebanon Green Investment Facility are critical to scale up climate action and drive economic transformation. The strategy also emphasizes public-private partnerships and international collaboration to ensure that Lebanon's transition is financially viable and socially inclusive.

This document represents more than a climate strategy; it is a climate-print for Lebanon's economic revitalization, and a vision to achieve net-zero by 2050. By aligning economic recovery with low-emission climate resilient development, the LT-LEDS offers a roadmap to build resilience, create economic opportunities, and improve the well-being of all citizens. It is a call to action for stakeholders across Lebanon and beyond to join forces in building a resilient, sustainable, and thriving nation.

Tamara Elzein, PhD

Minister of Environment

FOREWORD

Climate change poses one of the most significant challenges of our time. For Lebanon, the urgency of climate action is amplified by a prolonged economic crisis and the increasing frequency of climate-related shocks. Yet, amidst these challenges, the Long Term - Low Emission Development Strategy (LT-LEDS) emerges as a roadmap for a low-emission, climate-resilient development pathway by 2050. It identifies transformative actions across key sectors—energy, agriculture, transport, and industry—ensuring that climate action is integrated into Lebanon's recovery and development strategies. This strategy aligns with the reforms-oriented vision of the current government and specifically highlights the impact the envisaged reforms that the envisaged reforms can have in leapfrogging Lebanon into a low-carbon climate-resilient thriving economy. Lebanon can unlock tangible economic benefits, including higher GDP growth, higher disposable incomes, job creation, and poverty reduction. By focusing on investments in renewable energy, sustainable transportation, reforestation, and climate-smart agriculture, the LT-LEDS not only creates a pathway for economic transformation and resilience but also complements the government's commitment to structural reforms and sustainable development, even amidst fiscal and governance constraints.

A critical component of the LT-LEDS is its emphasis on innovative financial mechanisms and partnerships to advance Lebanon's climate and economic goals. Central to this effort is the Lebanon Green Investment Facility (LGIF), established by the support of the UNDP and endorsed by the Ministry of Environment in early 2024. The LGIF is designed to play a blended finance facility for Lebanon and mobilize climate finance from private investors to support private sector climate investments in Lebanon. UNDP has, through its Climate Promise 2.0 initiative, provided technical support and advisory services to the LGIF, ensuring its alignment with Lebanon's sustainable development objectives. The LGIF is designed as a blended finance facility (merging concessional loans, guarantees, and grants) to mobilize resources and attract private investors to support private sector climate investments in Lebanon. UNDP continues to provide technical support and advisory services to the LGIF, ensuring its alignment with Lebanon's sustainable development objectives and the Paris Agreement. LGIF offers a transformative solution to green economic recovery, strengthen the private sector, and attract international climate finance, all of which are crucial for resilience and long-term stability. By embedding strong governance and transparency measures, this approach ensures that every investment contributes meaningfully to Lebanon's sustainable development goals.

This strategy would not have been possible without the collective efforts of the Ministry of Environment and the United Nations Development Programme Climate Promise flagship initiative, and the technical input from the International Labour Organization. This strategy also reflects the inclusive and participatory approach adopted in its development: youth groups, gender advocates, and NGOs all contributed to the LT-LEDS, thus ensuring that Lebanon's transition is both equitable and inclusive.

The implementation of the LT-LEDS will require bold actions and innovative solutions, but the potential rewards are substantial. Together, we can transform this strategy into tangible outcomes, ensuring that Lebanon remains on track to achieve its climate commitments while implementing a sustainable and inclusive recovery.

Blerta Aliko

UNDP Resident Representative

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List of Acronyms

AFF	Agriculture, Forestry, and Fisheries
AFOLU	Agriculture, Forestry and Other Land Use
AKIS	Agricultural and Knowledge Information System
BAU	Business-As-Usual
BCR	Benefit to Cost Ratio
BDL	Central Bank of Lebanon
BRT	Bus Rapid Transit
CAS	Central Administration of Statistics
CBA	Cost-Benefit Analysis
CBIT	Capacity-Building Initiative for Transparency
CCDR	Country Climate and Development Report
CEDRE	Conférence Economique pour le Développement par les Réformes et avec les Entreprises
CIP	Capital Investment Programme
CMIP6	Coupled Model Intercomparison Project 6
CPP	Climate Prosperity Plan
CVF	Climate Vulnerable Forum
EDGAR	Emissions Database for Global Atmospheric Research
EDL	Electricité du Liban
EPR	Extended Producer Responsibility
EV	Electric Vehicle
EWEMBI	EartH2Observe, WFDEI and ERA-Interim data Merged and Bias-corrected for ISIMIP
FFC	Financial Futures Center
FTE	Full-Time Equivalent
GCA	Global Center on Adaptation
GCF	Green Climate Fund
GCM	General Circulation Models
GDP	Gross Domestic Product
GEBCO	General Bathymetric Chart of the Oceans
GEM	Green Economy Model
GESI	Gender Equality and Social Inclusion
GHG	Greenhouse Gas
GPP	Green Public Procurement
GPWv4	Gridded Population of the World Version 4
GVA	Gross Value Added
HDI	Human Development Index
HR	Human Resources
HSDI	Heat Stress Duration Index
HVAC	Heating, Ventilation, and Air Conditioning

ILO	International Labour Organization
IPCC	Intergovernmental Panel on Climate Change
ISIC	International Standard Industrial Classification
ISO	International Organization for Standardization
LCCS	Land Cover Classification System
LEDS	Low-Emission Development Strategy
LEV	Lebanon Economic Vision
LGIF	Lebanon Green Investment Facility
LT-LEDS	Long-Term Low-Emission Development Strategy
LULUCF	Land Use, Land-Use Change, and Forestry
MoE	Ministry of Environment
MoF	Ministry of Finance
MSME	Micro, Small and Medium Enterprise
MRF	Material Recovery Facilities
MRV	Measurement, Reporting, and Verification
NAP	National Adaptation Plan
NCD	Non-communicable Diseases
NDC	Nationally Determined Contributions
NGO	Non-Governmental Organization
NMT	Non-Motorized Transportation
NR	No Reform (Scenario)
PV	Photovoltaic
R	Reform (Scenario)
R&D	Research and Development
RCP	Representative Concentration Pathway
SDG	Sustainable Development Goals
SME	Small and Medium Enterprises
SPM	Summary for Policymakers
SSP	Shared Socioeconomic Pathways
TDM	Transportation Demand Management
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
V20	Vulnerable Twenty Group
WBGT	Wet-Bulb Globe Temperature

Executive Summary

Lebanon's Long Term - Low Emission Development Strategy (LT-LEDS) is an economy-wide policy document designed to chart a sustainable pathway for Lebanon's economy, integrating multidimensional considerations to ensure optimal outcomes while addressing the impacts of climate change. Developed in response to Lebanon's commitments under the Paris Agreement, particularly Article 4, paragraph 19, the LT-LEDS represents a comprehensive framework guiding Lebanon's transition to a low-carbon economy by mid-century, aligning national development goals with climate resilience and sustainability.

Lebanon's long term-low emission development strategy builds on existing frameworks and economic models leveraging indigenous energy sources to reduce reliance on imported fuels and recurring costs, while also addressing multifaceted challenges, including severe economic, monetary, and financial crises, exacerbated by geopolitical tensions. With a population of approximately 6.6 million in 2023, including around 2 million refugees and displaced individuals, Lebanon's resources and services are under significant strain. The labour force participation rate stands at 43.4%, with high unemployment rates, particularly among youths and women. Environmental degradation, inadequate infrastructure, and regulatory challenges further compound these issues, underscoring the urgent need for a sustainable development strategy.

The development of the LT-LEDS was guided by two primary processes: the NGO-led 100% Lebanon Vision and the Climate Prosperity Plan (CPP) developed for Lebanon by the Climate Vulnerable Forum, led by the Ministry of Environment and supported by the UNDP Climate Promise 2.0 Project. These processes involved extensive national consultations and integrated modelling exercises to assess the impact of LT-LEDS targets across various policy dimensions under both economic reform and no-reform scenarios. The strategy incorporates a forward-looking approach, balancing climate resilience with economic growth while adhering to Lebanon's commitments under the Paris Agreement and national legislation. Under the reform scenario (LEDS-R), the LT-LEDS emphasizes accelerated implementation through enhanced governance, fiscal measures, and targeted investments, unlocking greater socio-economic benefits. Under the non-reform scenario (LEDS-NR), the strategy's flexibility ensures continued progress, albeit at a slower pace, by leveraging existing frameworks and incremental improvements. This dual approach ensures the LT-LEDS remains adaptable to varying conditions while maximizing long-term economic and environmental outcomes.

As such, the strategy is centered around 3 key figures that define its objectives and outcomes: **Net Zero, GDP impact, and total investment required**. These numbers provide a clear framework for understanding the strategy's goals and the resources needed to achieve them.

1. **Net Zero**: The LT-LEDS sets a target for achieving carbon neutrality by mid-century. By 2050, Lebanon aims to move into negative emissions, reaching -1.8 million tonnes of CO_2eq. without reforms (LEDS-NR) and -1.4 million tonnes with reforms (LEDS-R). This ambitious target aligns with global climate objectives and underscores Lebanon's commitment to reducing greenhouse gas emissions while fostering economic growth.
2. **GDP impact**: The LT-LEDS is projected to have a significant positive impact on Lebanon's GDP. By 2050, GDP is expected to be 42 to 53% higher in the LEDS scenario compared to the Business-As-Usual (BAU) scenario. This growth is driven by investments in renewable energy, sustainable

agriculture, tourism, circular economy, and others, which create new opportunities for economic productivity and job creation. Disposable income per person is also projected to increase significantly, reaching USD 4,932 per person in 2050 in the LEDS-NR scenario, compared to USD 3,365 per person in the BAU-NR scenario.

3. **Total investment required**: The implementation of the LT-LEDS requires substantial financial resources, but the benefits far outweigh the costs. The strategy is expected to generate USD 97.16 billion of cumulative net benefits between 2022 and 2050 for the LEDS-NR scenario. The cost-benefit ratio stands at 2.24 in 2030 (LEDS-NR) and increases to 5.14 by 2050 (LEDS-R), meaning that each dollar invested in the strategy will result in USD 5.14 of economic and societal benefits in the long term, coupled with reforms. The additional real investment required is estimated at USD 12.8 billion, or 4.1% of GDP by 2030, making the LT-LEDS an ambitious yet economically and financially viable strategy.

LT-LEDS provides a clear message: **to achieve a sustainable GDP growth rate, whether through state-led actions or external efforts, a certain amount of investment is required**. These investments directly lead to measurable economic outcomes, including increased GDP, higher disposable income, and reduced poverty levels.

The analysis conducted demonstrates that implementing the LT-LEDS objectives will significantly improve Lebanon's performance across key indicators compared to both a business-as-usual scenario and the current Nationally Determined Contribution (NDC). The table below summarizes the main benefits identified from economic, social, energy, and environmental perspective. These benefits highlight the strategy's potential to drive progress under both reform and non-reform scenarios, with reforms amplifying outcomes and non-reforms ensuring steady advancement.

Table i: Key results from the macroeconomic modelling of Lebanon's LEDS

Thematic area	Key Results
Economic	• The interventions proposed in the LEDS will serve to both reduce the economic burden of climate change and to increase economic productivity by creating new opportunities in the green economy. Cumulative damages from climate change in Lebanon are projected to total between USD 76.4 billion and USD 97.8 billion by 2050, rising from USD 40.6 billion in 2022 as economic growth increases exposure to climate-related risks. In contrast, under the LEDS scenarios, damages are estimated between USD 76.4 billion and USD 90.8 billion. This represents a reduction of 8.3% to 12.2% compared to BAU projections, demonstrating the value of the LEDS scenario in lowering long-term economic losses through targeted mitigation and adaptation efforts. • The disposable income per person would likewise increase significantly to reach USD 4,930 / person in 2050 under the LEDS-NR scenario, compared to USD 3,370 / person in the BAU-NR scenario. • Meanwhile, the share of the population living under the poverty line would decrease by 31% (LEDS-NR, compared to BAU-NR) and 13% (LEDS-R, compared to BAU-R) in the LEDS scenario in 2050. It is worth noting that poverty levels are projected to remain relatively constant in the BAU-NR scenario and decline in the BAU-R case.

Thematic area	Key Results
Social	• Over the 2022-2050 period, unemployment under the LEDS framework is projected to range between 7% and 9.2%, compared to 11.7% to 24.7% in the BAU scenarios, highlighting the power of a green and climate-resilient economy to unlock employment opportunities and drive sustainable growth. • Overall employment creation would increase by 28.1% (LEDS-NR, compared to BAU-NR) compared to the current trajectory in the NR scenario. Jobs will be created particularly in sectors such as renewable energy, agriculture, and the greening of the vehicle fleet. • Over the 2022-2050 period, the LEDS framework demonstrates significant public health benefits, with air pollution-related deaths projected to drop from approximately 5,700 in 2022 to nearly zero by 2050 under both LEDS-NR and LEDS-R scenarios. In contrast, a business-as-usual (BAU) trajectory would continue to cause even more deaths, underscoring the life-saving potential of transitioning to a green and climate-resilient economy.
Energy	• The implementation of the LEDS objectives, notably in terms of renewable energy, energy efficiency, and increased electrification (e.g. of the transportation system) will help decouple economic growth from energy consumption. While energy demand will keep increasing in the BAU-NR scenario, it will plateau in the LEDS-NR scenario at around 151,000 TJ/year, and start decreasing from the mid-2030s, reaching 92,985 TJ/year in 2050. • On the other hand, the energy bill as a share of GDP will be drastically reduced. This cost is projected to represent 18.2% of GDP in 2050 for the BAU-NR scenario; alternatively, it only amounts to 2.7% of GDP in the LEDS-NR scenario in the same year. The measures put forward in the LEDS would, therefore, help reduce the costs of energy for the population and help reduce energy consumption.
Environmental	• Over the 2022-2050 period, the implementation of the LEDS would reduce climate-induced costs by 8.3% to 12.2%, lowering cumulative costs to a range of USD 35.8 billion to USD 39 billion under the LEDS-NR and LEDS-R scenarios, respectively. In contrast, the BAU scenarios would result in significantly higher costs, highlighting the economic benefits of adopting a green and climate-resilient pathway.

The strategy calls for sectoral actions and targeted investments in key sectors such as energy, agriculture, transport, and water, ensuring that each sector contributes to economic growth while addressing sustainability and climate resilience.

- **Energy Sector**: The LT-LEDS prioritizes renewable energy investments, aiming to install 500 MW of solar and wind energy in the short term and expand renewable energy capacity to meet 100% of electricity demand by 2050. Energy efficiency programs targeting a 10% reduction in electricity consumption in public buildings and incentives for Electric Vehicle (EV) purchases are also part of the short-term actions. The long-term goal is to modernize the national grid and phase out fossil fuel power plants, reducing Lebanon's reliance on imported fuels and lowering energy costs.
- **Agriculture Sector**: The proposed strategy includes installing drip irrigation systems on 10,000 hectares of farmland, promoting climate-resilient crop varieties, and training 5,000 farmers in sustainable techniques. Long-term actions aim for 100% adoption of sustainable agriculture practices, increasing domestic food production to meet 75% of national demand, and implementing agroforestry practices on 20,000 hectares of land. These measures will enhance food security and protect agricultural systems from climate-related risks.
- **Transport Sector**: Short-term actions involve establishing Bus Rapid Transit (BRT) systems in major cities, developing 200 km of bike lanes in urban areas, and introducing stringent vehicle emission standards. Long-term goals include developing a national public transport network and electrifying all public transport vehicles, thus reducing greenhouse gas emissions and improving air quality.
- **Water Sector**: The LT-LEDS focuses on implementing integrated water resource management (IWRM) practices, repairing and upgrading water infrastructure to reduce losses by 20%, and conducting national water conservation campaigns. Long-term goals include ensuring reliable and

sustainable water supply, developing large-scale water storage and distribution projects, and achieving 100% wastewater treatment and reuse.

- **Tourism Sector**: The LT-LEDS outlines actions to transform Lebanon's tourism sector into a sustainable and climate-resilient model. Key actions include establishing the National Sustainable Tourism Council, launching a national online platform for sustainable tourism, upgrading infrastructure to eco-friendly options, certifying green tourism destinations, fostering public-private partnerships, enhancing digitalization, achieving net-zero emissions, reviving historic travel routes, and promoting inclusive and marine tourism. This approach ensures economic growth while preserving natural and cultural heritage and mitigating climate impacts.

The LT-LEDS highlights the crucial role of financial institutions in financing Lebanon's transition to a low-emission economy through public-private partnerships and international collaboration. The Lebanon Green Investment Facility (LGIF) serves as a blended climate finance mechanism to attract public and private investments in renewable energy, sustainable transportation, and climate-resilient infrastructure. The strategy identifies significant private sector opportunities, particularly in energy efficiency and sustainable agriculture, supported by green bonds and climate funds. Achieving the transition requires USD 12.8 billion by 2030 (4.1% of GDP), with a Benefit to Cost Ratio (BCR) of 2.24 by 2030, rising to 5.14 by 2050. Debt-for-climate swaps are proposed to repurpose Lebanon's debt toward climate initiatives, unlocking financial resources for sustainable development. The banking sector is expected to drive green financing, integrate climate risk assessments, and build capacity in climate finance. Public-Private Partnerships (PPPs) and international funding, including access to the Green Climate Fund (GCF) and Climate Investment Funds, will be key to mobilizing resources. As per the strategy, in the short term (1-5 years), banks should develop green financing products, establish climate risk assessment frameworks, and support debt-for-climate swaps, as part of the sector's reforms. Over the long term (5-15 years), priorities include scaling up renewable energy investments, supporting green industries, and enhancing financial transparency per Task Force on Climate-related Financial Disclosures (TCFD) standards. The banking sector's contributions will spur economic growth, reduce climate risks, and enhance global competitiveness. Despite challenges such as limited access to international capital and regulatory barriers, Lebanon can leverage green bonds and carbon financing to attract investment. LT-LEDS provides the opportunity to integrate these instruments into national development plans, ensuring climate-proofing measures and green public procurement support economic recovery and sustainability.

In conclusion, the LT-LEDS aims to adopt a practical and targeted approach, prioritizing investments that drive measurable impacts across key sectors such as energy, agriculture, and transport. While investment needs may vary across sectors, the strategy ensures that each contributes to the overarching goals of economic growth, climate resilience, and carbon neutrality. By aligning national policies with global climate objectives, the LT-LEDS provides a clear framework for sustainable development, emphasizing reforms and investments that maximize long-term benefits. Through targeted investments, sectoral reforms, and the integration of climate considerations, the LT-LEDS serves as a roadmap for a prosperous, sustainable, and resilient future for Lebanon.

ملخص تنفيذي

تشكل استراتيجية التنمية المنخفضة الانبعاثات الطويلة الأجل للبنان (LT-LEDS) وثيقة للسياسة العامة على نطاق الاقتصاد ككل، جرى تصميمها لرسم مسار مستدام للنمو الاقتصادي في لبنان، مع مراعاة الأبعاد المتعددة المرتبطة بمواجهة تغيّر المناخ. وتمثل هذه الاستراتيجية التي تمَّ وضعها استجابةً لالتزامات لبنان بموجب اتفاق باريس، خصوصاً ما يتعلق بالمادة الرابعة، الفقرة ١٩، إطاراً توجيهياً يدعم انتقال لبنان نحو اقتصاد منخفض الكربون بحلول منتصف القرن، بما ينسجم مع الأهداف الإنمائية الوطنية ويعزز القدرة على التكيف مع تغير المناخ وتحقيق الاستدامة.

وتستند استراتيجية التنمية المنخفضة الانبعاثات إلى النماذج والأطر الاقتصادية القائمة، مع التركيز على مصادر الطاقة المحلية للحد من الاعتماد على المحروقات المستوردة والتكاليف المتكررة المرتبطة بها. في الوقت ذاته، تسعى الاستراتيجية إلى مواجهة التحديات المعقدة بما في ذلك الأزمات الاقتصادية والنقدية والمالية الحادة التي تتفاقم بفعل التوترات الجيوسياسية.

ومع بلوغ عدد سكان لبنان نحو ٦,٦ ملايين نسمة في عام ٢٠٢٣، من بينهم حوالي مليوني نازح ومشرد، تخضع الموارد والخدمات في لبنان لضغوط هائلة. وتبلغ نسبة مشاركة القوة العاملة ٤٣,٤ ٪، في ظل معدلات بطالة مرتفعة، خصوصاً بين صفوف الشباب والنساء. ويُفاقم التدهور البيئي وضعف البنية التحتية والتحديات التنظيمية من تعقيد المشهد، مما يؤكد الحاجة الملحة إلى استراتيجية تنموية مستدامة وشاملة.

استندت استراتيجية التنمية المنخفضة الانبعاثات وطويلة الأجل للبنان الى نهجين أساسيين هما ١) "رؤية لبنان مئة بالمئة" التي تقودها منظمات غير حكومية و ٢) خطة ازدهار المناخ (Climate Prosperity Plan CPP) التي أعدَّها منتدى البلدان المعرضة لخطر تغير المناخ للبنان (Climate Vulnerable Forum) ، بقيادة وزارة البيئة وبدعم من "مشروع الوعد المناخي ٢,٠ (Climate Promise 2.0)" التابع لبرنامج الأمم المتحدة الإنمائي (UNDP). وقد اعتمد النهجان على مشاورات وطنية موسعة ونماذج متكاملة لتقييم أثر أهداف الاستراتيجية عبر مختلف السياسات وذلك ضمن سيناريويهن محتملين: الإصلاح أو غياب الإصلاح الاقتصادي.

وتتبنّى الاستراتيجية نهجاً استشرافياً، يوازن بين تعزيز المرونة المناخية وتحقيق النمو الاقتصادي، مع التزام الكامل بأهداف اتفاق باريس والتشريعات الوطنية. ففي سيناريو الإصلاح (LEDS–R)، تشدد الاستراتيجية على التسريع في التنفيذ من خلال تعزيز الحوكمة، اعتماد اصلاحات ضريبية واستثمارات مستهدفة، مما يتيح تحقيق فوائد اجتماعية واقتصادية واسعة النطاق. أما في سيناريو غياب الإصلاح (LEDS–NR)، فتعتمد الاستراتيجية على مرونتها لضمان التقدم المستمر، ولو بوتيرة أبطأ، وذلك من خلال البناء على الأطر القائمة والتحسينات التدريجية.

ويضمن هذا النهج المزدوج أن استراتيجية التنمية المنخفضة الانبعاثات تبقى قابلة للتكيف مع مختلف الظروف والسيناريوهات، مع ضمان تحقيق أفضل النتائج الاقتصادية والبيئية على المدى الطويل.

بناءً على ذلك، تتمحور الاستراتيجية حول ثلاثة مؤشرات رئيسية تحدد أهدافها ونتائجها وهي: الوصول إلى صافي الصفر net zero – الأثر على الناتج الإجمالي المحلي، وحجم الاستثمارات الاجمالية المطلوبة. وتقدم هذه المؤشرات إطاراً واضحاً لفهم أهداف الاستراتيجية والموارد المطلوبة لتحقيقها.

١. **صافي الصفر Net Zero**: تضع الاستراتيجية هدفاً يقوم على تحقيق الحياد الكربوني carbon neutrality بحلول منتصف القرن. حيث يسعى لبنان إلى الانتقال إلى انبعاثات سلبية تبلغ –١,٨ مليون طن من مكافىء ثاني أكسيد الكربون في حال غياب الإصلاحات الإصلاحات و–١,٤ مليون طن من مكافىء ثاني أكسيد الكربون في حال تنفيذها. ويتماشى هذا الهدف الطموح مع الأهداف المناخية العالمية ويؤكد على التزام لبنان بالحد من انبعاثات غازات الدفيئة بالتزامن مع دعم النمو الاقتصادي.

٢. **أثر الناتج الإجمالي المحلي**: من المتوقع أن تُحدث استراتيجية التنمية المنخفضة الانبعاثات وطويلة الأجل للبنان أثراً إيجابياً ملحوظاً على الناتج الإجمالي المحلي، حيث يُتوقّع أن يكون أعلى بنسبة تتراوح من ٤٢ و٥٣ بالمئة بحلول عام ٢٠٥٠ مقارنة بسيناريو العمل المعتاد. ويعود هذا النمو إلى استثمارات في الطاقة المتجددة والزراعة المستدامة والسياحة والاقتصاد الدائري وغيرها، مما يعزز الإنتاجية الاقتصادية ويخلق فرص عمل جديدة. كما من المتوقع أن يزداد الدخل المتاح للفرد بشكل ملحوظ، ليبلغ ٤,٩٣٢ دولاراً للفرد بحلول عام ٢٠٥٠ مقارنة بـ ٣,٣٦٥ دولاراً فقط في حال استمرار العمل المعتاد دون إصلاحات.

٣. **إجمالي الاستثمار المطلوب**: يتطلب تنفيذ الاستراتيجية موارد مالية كبيرة، إلا أن الفوائد المرتقبة تفوق التكاليف. ومن المتوقع أن تحقق الاستراتيجية ٩٧,١٦ مليار دولار من الفوائد الصافية المتراكمة بين عامي ٢٠٢٢ و٢٠٥٠ في إطار سيناريو غياب الإصلاح. وتُظهر التقديرات أن نسبة العائد إلى الكلفة ستبلغ ٢,٢٤ في عام ٢٠٣٠ في هذا السيناريو، لترتفع إلى ٥,١٤ بحلول عام ٢٠٥٠ في ظل سيناريو الإصلاح، مما يعني أن كل دولار يُستثمر في الاستراتيجية سيحقق فوائد اقتصادية واجتماعية بقيمة ٥,١٤ دولاراً في المدى الطويل، عند إرفاقه بالإصلاحات اللازمة. ويُقدَّر حجم الاستثمار الحقيقي الإضافي المطلوب بقيمة ١٢,٨ مليار دولار أي ما يعادل ٤,١ بالمئة من الناتج الإجمالي المحلي بحلول عام ٢٠٣٠، مما يجعل الاستراتيجية طموحة، ولكن قابلة للتحقيق على المستويين الاقتصادي والمالي.

تحمل الاستراتيجية رسالة واضحة: **لتحقيق نمو مستدام في الناتج الإجمالي المحلي، سواء عبر إجراءات تقودها الدولة أو جهود خارجية، لا بد من استثمار مالي ملموس**. وتؤدي هذه الاستثمارات إلى نتائج اقتصادية قابلة للقياس مثل زيادة الناتج الإجمالي المحلي وزيادة في الدخل المتاح للأفراد وانخفاض في مستويات الفقر، مما يعزز الأسس الاقتصادية والاجتماعية للتنمية المستدامة.

يُظهر التحليل أن تنفيذ الأهداف الخاصة بالاستراتيجية سيحسن بشكل ملحوظ أداء لبنان عبر مختلف المؤشرات الأساسية بالمقارنة مع سيناريو العمل المعتاد والمساهمة المحددة وطنياً الحالية. ويلخص الجدول أ الفوائد المتوقعة من جوانب الاقتصاد، والمجتمع، والطاقة، والبيئة. وتؤكد هذه الفوائد قدرة الاستراتيجية على دفع عجلة التقدم في كل من سيناريو الإصلاح وسيناريو غياب الإصلاح، حيث تؤدي الإصلاحات إلى تعزيز النتائج، فيما يضمن غيابها تحقيق تقدم أبطأ، ولكن مستقر.

الجدول أ: النتائج الرئيسية المترتبة عن نماذج الاقتصاد الكلي لاستراتيجية التنمية المنخفضة الانبعاثات وطويلة الأجل للبنان

المجال الموضوعي	النتائج الرئيسية
اقتصادياً	▪ ستعمل الاجراءات المقترحة في الاستراتيجية على خفض العبء الاقتصادي لتغير المناخ وزيادة الإنتاجية الاقتصادية من خلال خلق فرص جديدة في الاقتصاد الأخضر. ويقدَّر إجمالي الأضرار المتراكمة من تغير المناخ بما يتراوح بين ٧٦,٤ و٩٧,٨ مليار دولار أمريكي بحلول عام ٢٠٥٠، ارتفاعًا من ٤٠,٦ مليار دولار أمريكي في عام ٢٠٢٢، نتيجة ازدياد التعرض للمخاطر المناخية مع استمرار النمو الاقتصادي. في المقابل، تُقدَّر الأضرار ضمن سيناريوهات استراتيجية التنمية منخفضة الانبعاثات (LEDS) بما يتراوح بين ٧٦,٤ و٩٠,٨ مليار دولار أمريكي، ما يشكل انخفاضاً يتراوح ما بين ٨,٣٪ و١٢,٢٪ بالمقارنة مع سيناريوهات العمل كالمعتاد. مؤكداً فعالية خطة ازدهار المناخ. ▪ كذلك، سيزداد الدخل المتاح للفرد بشكل ملحوظ ليبلغ ٤,٩٣٠ دولاراً للفرد في عام ٢٠٥٠ في إطار سيناريو الاستراتيجية بغياب الإصلاح، بالمقارنة مع ٣,٣٧٠ دولاراً للفرد في إطار سيناريو العمل المعتاد القائم بغياب الإصلاح. ▪ في غضون ذلك، يُتوقَّع أن تساهم الاستراتيجية في تقليص نسبة السكان الذين يعيشون تحت خط الفقر بنسبة ٣١٪ مقارنة بسيناريو العمل المعتاد في حال غياب الإصلاحات، وبنسبة ١٣٪ مقارنة بسيناريو العمل المعتاد في حال تنفيذ الإصلاحات في عام ٢٠٥٠. وتجدر الإشارة إلى أنه من المتوقع أن تبقى مستويات الفقر مستقرة نسبياً في إطار سيناريو العمل المعتاد القائم على غياب الإصلاح وأن تتراجع في حالة سيناريو العمل المعتاد مع الإصلاح.
اجتماعياً	▪ من المتوقع أن تتراوح نسبة البطالة في الفترة الممتدة بين عامي ٢٠٢٢ و٢٠٥٠ بين ٧٪ و٩,٢٪، بالمقارنة مع ١١,٧ و٢٤,٧٪ في إطار سيناريوهات العمل المعتاد، ما يعكس الدور المحوري لاقتصاد أخضر ومتكيّف مع تغير المناخ في تحفيز فرص العمل وتعزيز النمو المستدام. ▪ كما ستزداد وتيرة خلق فرص العمل بنسبة ٢٨,١٪ في سيناريو الاستراتيجية القائمة على غياب الإصلاح، مقارنة بالمسار الحالي لسيناريو غياب الإصلاح، لا سيما في قطاعات حيوية مثل الطاقة المتجددة، والزراعة، والنقل البيئي. ▪ يبرهن إطار الاستراتيجية في الفترة الممتدة بين عامي ٢٠٢٢ و٢٠٥٠ عن تحصيل فوائد ملحوظة على مستوى الصحة العامة، إذ يُتوقع أن تنخفض الوفيات المرتبطة بتلوث الهواء من ٥,٧٠٠ شخص تقريباً في عام ٢٠٢٢ إلى ما يقارب الصفر بحلول عام ٢٠٥٠، في كل من سيناريوي الإصلاح غياب الإصلاح ضمن الاستراتيجية. في المقابل، سيستمر مسار العمل المعتاد في التسبب بمزيد من الوفيات، ما يبرز الإمكانات الحقيقية لإنقاذ الأرواح من خلال التحول إلى اقتصاد أخضر ومتكيّف مع التغير المناخي.
في قطاع الطاقة	▪ سيساهم تنفيذ الأهداف الخاصة بالاستراتيجية، خصوصاً فيما يتعلق بالطاقة المتجددة وكفاءة الطاقة وزيادة الاعتماد على الكهرباء (مثلاً، في قطاع النقل)، في فصل النمو الاقتصادي عن استهلاك الطاقة. وبالرغم من أن الطلب على الطاقة سيظل يرتفع في إطار سيناريو العمل المعتاد القائم مع غياب الإصلاح، إلا أنه سيصل في إطار هذا سيناريو تنفيذ الاستراتيجية في غياب الإصلاح إلى نحو ١٥١,٠٠٠ تيراجول سنوياً، ويبدأ بالانخفاض اعتباراً من منتصف ثلاثينيات هذا القرن، ليبلغ ٩٢,٩٨٥ تيراجول سنوياً في عام ٢٠٥٠. ▪ في المقابل، ستشهد فاتورة الطاقة كنسبة من الناتج الإجمالي المحلي انخفاضاً كبيراً. إذ يُتوقع أن تبلغ هذه النسبة ١٨,٢٪ في عام ٢٠٥٠ في إطار سيناريو العمل المعتاد مع غياب الإصلاح؛ في حين ستنخفض إلى ٢,٧٪ فقط من الناتج الإجمالي المحلي في إطار سيناريو تنفيذ الاستراتيجية في غياب الإصلاح في العام ذاته. وبالتالي، ستؤدي الاجراءات الواردة في الاستراتيجية الى خفض ملحوظ في تكاليف الطاقة للسكان وفي الحد من استهلاك الطاقة.

المجال الموضوعي	النتائج الرئيسية
في قطاع البيئة	▪ سيساهم تنفيذ استراتيجية التنمية المنخفضة الانبعاثات وطويلة الأجل للبنان في تقليص التكاليف الناجمة عن تغير المناخ بما يتراوح بين ٨,٣٪ و١٢,٢٪ في الفترة الممتدة بين عامي ٢٠٢٢ و٢٠٥٠، مما يؤدي إلى خفض التكاليف التراكمية إلى ما بين ٣٥,٨ مليار دولار في إطار سيناريو الاستراتيجية في غياب الإصلاح و٣٩ مليار دولار في سيناريو الاستراتيجية القائمة على الإصلاح. في المقابل، المتوقع أن تسجل سيناريوهات العمل المعتاد تكاليف أعلى بكثير، مما يؤكد على الفوائد الاقتصادية الناجمة عن اعتماد مسار أخضر وقادر على التكيف مع تغير المناخ.

وتدعو الاستراتيجية إلى اتخاذ إجراءات قطاعية واستثمارات مستهدفة في القطاعات الرئيسية مثل الطاقة والزراعة والنقل والمياه، مما يضمن أن كل قطاع يساهم في النمو الاقتصادي بالتزامن مع معالجة الاستدامة والقدرة على مواجهة تغير المناخ.

▪ **قطاع الطاقة**: استراتيجية التنمية المنخفضة الانبعاثات وطويلة الأجل للبنان أولوية للاستثمارات في مجال الطاقة المتجددة، حيث تهدف إلى تركيب ٥٠٠ ميغاواط من الطاقة المنتجة من الشمس والرياح في المدى القصير والعمل على رفع حصة الطاقة المتجددة الى ١٠٠٪ بحلول عام ٢٠٥٠. وتشمل الإجراءات العاجلة أيضاً برامج لتحسين كفاءة الطاقة الهادفة إلى خفض استهلاك الكهرباء بنسبة ١٠٪ في المباني العامة الى جانب تقديم حوافز لاقتناء المركبات الكهربائية. أما على المدى الطويل، فتتمثل الأهداف في تحديث شبكة ا لكهرباء الوطنية والتخلص التدريجي من معامل الكهرباء العاملة على الوقود الأحفوري، مما يحد من اعتماد لبنان على المحروقات المستوردة ويخفض تكاليف الطاقة.

▪ **قطاع الزراعة**: تتضمن الاستراتيجية المقترحة تركيب أنظمة ري بالتنقيط على مساحة ١٠,٠٠٠ هكتار من الأراضي الزراعية، مما يعزز زراعة أنواع محاصيل قادرة على التكيف مع تغير المناخ، بالإضافة إل تدريب ٥,٠٠٠ مزارع في مجال التقنيات الزراعة المستدامة. وتهدف الإجراءات الطويلة الأجل إلى اعتماد ممارسات زراعية مستدامة ١٠٠٪، مما يزيد إنتاج المواد الغذائية المحلية لتلبية ٧٥ بالمئة من الطلب الوطني، وتنفيذ ممارسات الحراجة الزراعية على مساحة ٢٠,٠٠٠ هكتار. وستعزز هذه التدابير الأمن الغذائي وتحصّن الأنظمة الزراعية ضد المخاطر المرتبطة بالمناخ.

▪ **قطاع النقل**: تشمل الإجراءات القصيرة الأجل إنشاء أنظمة حافلات النقل السريع في المدن الرئيسية، وتطوير ٢٠٠ كيلومتر من الخطوط المخصصة للدراجات في المناطق الحضرية، واعتماد معايير صارمة لانبعاثات المركبات. أما الأهداف طويلة الأجل، فتركّز على تطوير شبكة نقل عام وطنية وتحويل كامل أسطول النقل العام الى مركبات كهربائية، مما يساهم في خفض انبعاثات غازات الدفيئة وتحسين جودة الهواء.

▪ **قطاع المياه**: تركز الاستراتيجية على تطبيق ممارسات متكاملة لإدارة موارد المياه وإصلاح وتحديث البنية التحتية لتخفيض الخسائر بنسبة ٢٠٪، والقيام بحملات وطنية لترشيد استهلاك المياه. وتشمل الأهداف الطويلة الحفاظ على استمرارية وموثوقية إمدادات المياه، وتطوير مشاريع كبرى لتخزين وتوزيع المياه ومعالجة مياه الصرف الصحي وإعادة استخدامها.

▪ **قطاع السياحة**: ترسم الاستراتيجية مساراً لتحويل قطاع السياحة اللبناني إلى نموذج مستدام وقادر على التكيف مع تغير المناخ. وتتضمن الإجراءات الرئيسية إنشاء مجلس وطني للسياحة المستدامة، وإطلاق منصة إلكترونية وطنية للسياحة المستدامة، وتحديث البنية التحتية بما يتماشى مع المعايير البيئية، واعتماد وجهات سياحية خضراء. كما تتضمن دعم الشراكات بين القطاعين العام والخاص، وتعزيز التحول الرقمي، وتحقيق صافي انبعاثات صفرية، وإعادة إحياء المسارات السياحية التاريخية، والترويج للسياحة الشاملة للجميع والسياحة البحرية. ويساهم هذا النهج للنمو الاقتصادي مع المحافظة على التراث الطبيعي والثقافي والتخفيف من آثار تغير المناخ.

تُبرز استراتيجية التنمية المنخفضة الانبعاثات وطويلة الأجل للبنان الدور المحوري الذي تؤديه للمؤسسات المالية في تمويل انتقال لبنان إلى اقتصاد منخفض الانبعاثات من خلال تعزيز الشراكات بين القطاعين العام والخاص والتعاون الدولي. ويشكل "مرفق الاستثمار الأخضر للبنان" (LGIF) آلية تمويل مختلط في مجال المناخ تهدف إلى جذب الاستثمارات العامة والخاصة في مجالات الطاقة المتجددة والنقل المستدام والبنية التحتية المتكيفة مع تغير المناخ.

وتحدد الاستراتيجية فرصاً واعدة للقطاع الخاص، خصوصاً في مجالي كفاءة الطاقة والزراعة المستدامة، مدعومة بآليات تمويل مبتكرة مثل السندات الخضراء وصناديق المناخ. وتُقدَّر الحاجة التمويلية للانتقال الى اقتصاد منخفض الانبعاثات بنحو ١٢,٨ مليار دولار بحلول عام ٢٠٣٠ (٤,١٪ من الناتج الإجمالي المحلي) مع نسبة عائد إلى التكلفة بمعدل ٢,٢٤ بحلول عام ٢٠٣٠، ترتفع إلى ٥,١٤ بحلول عام ٢٠٥٠.

كما تقترح الاستراتيجية استخدام أدوات مالية مبتكرة مثل "مقايضة الديون مقابل العمل المناخي"، لإعادة توجيه ديون لبنان نحو تمويل مبادرات مناخية، بما يُعزز التنمية المستدامة. ومن المتوقع أن يقود القطاع المصرفي تمويل هذا التحول ويدمج تقييمات مخاطر المناخ ويبني القدرات في مجال تمويل المناخ.

وستشكل الشراكات بين القطاعين العام والخاص والتمويل الدولي، بما في ذلك الوصول إلى صندوق المناخ الأخضر (GCF) وصناديق الاستثمار في مجال المناخ، عاملاً أساسياً في حشد الموارد. ووفقاً للاستراتيجية، يُطلب من المصارف في المدى القصير (سنة إلى خمس سنوات) تطوير منتجات تمويل خضراء، وإنشاء أطر لتقييم مخاطر المناخ ودعم آليات مقايضة الديون مقابل العمل المناخي، ضمن حزمة الإصلاحات المصرفية.

أما على المدى الطويل (٥–١٥ سنة)، فتركز الأولويات على توسيع نطاق الاستثمارات في مجال الطاقة المتجددة، ودعم الصناعات الخضراء وتعزيز الشفافية المالية وفق معايير الإفصاح المالي المرتبط بالمناخ.

ستُساهم مشاركة القطاع المصرفي في تحفيز النمو الاقتصادي والحد من مخاطر المناخ وتعزيز التنافسية العالمية للبنان. ورغم التحديات القائمة، مثل صعوبة الوصول إلى رأس المال الدولي والعوائق التنظيمية، يمتلك لبنان فرصة للاستفادة من السندات الخضراء وتمويل الكربون لاجتذاب الاستثمارات. وتقدم هذه الاستراتيجية فرصة دمج هذه الأدوات ضمن خطط التنمية الوطنية، بما يضمن اتخاذ إجراءات فعّالة للتصدي لتغير المناخ ودعم المشتريات العامة الخضراء وتحقيق التعافي الاقتصادي المستدام.

في الختام، ترسم استراتيجية التنمية المنخفضة الانبعاثات وطويلة الأجل للبنان مسارًا عمليًا وموجّهًا نحو تحقيق نتائج ملموسة يعطي أولوية للاستثمارات التي تُحدث تأثيرًا قابلاً للقياس عبر مختلف القطاعات الرئيسية مثل الطاقة والزراعة والنقل. وعلى الرغم من تفاوت احتياجات الاستثمار بين هذه القطاعات، تضمن الاستراتيجية مساهمة كل منها في تحقيق الأهداف الشاملة للنمو الاقتصادي والقدرة على التكيف مع تغير المناخ وحيادية الكربون.

وتقدم الاستراتيجية من خلال مواءمة السياسات الوطنية مع الأهداف المناخية العالمية إطاراً واضحاً للتنمية المستدامة، مع التركيز على الإصلاحات والاستثمارات التي تحقق أقصى فائدة على المدى الطويل. كما تشكل هذه الرؤية القائمة على الاستثمارات المستهدفة والإصلاحات القطاعية ودمج الاعتبارات المتعلقة بتغير المناخ، خارطة طريق تقود لبنان نحو مستقبلاً أكثر ازدهارًا واستدامة وقادر على الصمود.

1. Introduction

In accordance with Lebanon's commitments (Law 115/2019) under the Paris Agreement (specifically article 4 (paragraph 19), Lebanon has endeavoured to develop a comprehensive long-term strategy for low greenhouse gas emissions that carries through to mid-century (i.e., 2050). The strategy aims to contribute to achieving the overarching objective of the Paris Agreement: restricting the global temperature increase to well below 2°C, with additional efforts directed towards limiting warming to 1.5°C.

The primary objectives of Lebanon's Long Term - Low Emission Development Strategy (LT-LEDS) is, therefore, to guide national institutions towards long-term low-emission/resilient planning, provide a political message to the international community on Lebanon's direction towards sustainable, low-carbon and resilient development, and integrate national economic development with climate mitigation and adaptation. Moreover, Lebanon plans on synergizing sustainable development and national planning and moving towards the full implementation of the Paris Agreement's Article 2.1.c (making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development) commensurate with national priorities.

To reinforce the interim and long-term targets of the LT-LEDS, a series of national consultations and various integrated modelling exercises were conducted to assess the LT-LEDS targets' impact on policy dimensions, such as economic, social, and the environment. These consultations and modelling exercises highlight the synergies between climate action and policy priorities in key development sectors, such as energy, transport, agriculture, and tourism.

The LT-LEDS for Lebanon draws upon a comparison between a Business-As-Usual (BAU) scenario and climate action scenarios, both aligned with varying levels of ambition. These scenarios are informed by the objectives and targets outlined in Lebanon's 2050 "100% Vision." Lebanon 2050 "100% Vision" is an NGO-led vision that served as an integral element guiding the development of the LT-LEDS; it reflects the nation's aspirations for sustainable growth and climate resilience.

Lebanon's LT-LEDS is instrumental in shaping its sustainable future, without compromising its economic development. The strategy offers a well-defined roadmap for complementing Lebanon's long-term development aspirations with the objectives outlined in its Nationally Determined Contributions (NDCs) and included within the Paris Agreement. It also provides clear and measurable outcomes, through established milestones and indicators, as a tool to monitor progress towards Lebanon's NDC targets, within a wider long-term target, thus allowing for course correction at consecutive NDCs.

The strategy begins with an introduction, setting the stage for Lebanon's Long Term - Low Emission Development Strategy (LT-LEDS) and its alignment with global climate objectives while framing the urgency and rationale for the initiative. **Chapter Two** explores Lebanon's socio-economic and environmental profile, climate change impacts, and challenges such as heat-related risks and productivity losses, alongside greenhouse gas emission trends and the climate policy landscape. **Chapter Three** outlines the development of the LT-LEDS, defining its objectives, core pillars, and the methodological approach for transitioning toward sustainable growth. **Chapter Four** highlights LT-LEDS as an economic opportunity, showcasing its benefits such as improved livelihoods, public health, enhanced energy systems, and compliance with NDC-2020 commitments, emphasizing gender equality and social inclusion. **Chapter Five** focuses on unlocking climate resilience financing through innovative solutions and partnerships. **Chapter Six** provides sector-specific strategies for agriculture, transportation, tourism, and energy, emphasizing actionable pathways and climate-proofed investments supported by mechanisms like the Lebanon Green Investment Facility. In conclusion, **Chapter Seven** addresses the challenges of implementation amid hostilities, and the crucial institutional arrangements required to align financial flows with LT-LEDS goals ensuring its effective implementation and success.

2. National Context

2.1 Profile

In 2023, Lebanon's population was estimated at approximately 6.6 million; Lebanon is characterized by high density per square kilometre; this population estimate includes foreign workers, Palestinian refugees, and an estimated 1.5 million displaced Syrians. The working-age population (15+ years) is about 3.6 million, with a 43.4% labour force participation rate (World Bank, 2024). There is a notable gender disparity, where men's participation is at 67.2%, while women's is a mere 19.7%. The overall unemployment rate is alarmingly high at 29.6%, with women facing higher unemployment rates (32.7%) compared to men (28.4%). Youth unemployment (ages 15-24) is particularly severe at 47.8%. The economic stagnation and political situation have resulted in a continuous increase in unemployment and underemployment, particularly among vulnerable groups, such as women and youth. These figures highlight the significant economic challenges Lebanon has been facing, further exacerbated by the severe economic and financial crisis, which has seen the GDP plummet from USD 55 billion in 2018 to USD 18 billion in 2023 (CAS, 2022; World Bank, 2024).

Employment is predominantly in the private sector (86%), with the public sector employing 14%. Most residents live in major coastal cities, forming around 85% of the population. Furthermore, the fragmented social security system and the rise of informal hiring and employment continue to pose significant obstacles, leaving many workers without adequate protection. Education levels are relatively high, with only 2% of residents aged three and above not enrolled; there is a low 7% illiteracy rate. About 21% of the population holds a university degree, with no significant gender difference (CAS, 2022; ILO, 2023).

Lebanon has been through a severe economic and financial crisis, considered one of the worst since the mid-nineteenth century. Between 2018 and 2023, the GDP experienced a 67% drop per capita, effectively erasing over 22 years of development progress (World Bank, 2024b). The crisis, compounded by the COVID-19 pandemic, Beirut Port explosion (August 4th, 2020), and geopolitical tensions, has led to the collapse of services, particularly in the electricity sector, where grid service in some areas has dropped to less than an hour per day. This poor power supply has significantly impacted poverty rates, equitable access to energy, and recovery prospects. Wastewater treatment plants have mostly become non-operational, complicating responses to nationwide cholera outbreaks in areas with high rates of displaced Syrian nationals. The transportation sector is also struggling; deteriorating public transport and road conditions hinder mobility, connectivity, and trade; water sector inefficiencies result in significant water loss and polluted rivers, posing health risks and reducing agricultural productivity; while poor urban air quality, primarily due to vehicle emissions and diesel generators, adds to health risks (World Bank, 2024a). Environmental degradation has accelerated due to inadequate wastewater and solid waste systems, leading to health issues from air and water pollution. Increased fuel prices have led to illegal logging, consequently endangering forests. The rising threat of wildfires and forest fires impacted tourism, a crucial socioeconomic safety net in rural areas. Additionally, with 89% of the population living in urban areas, particularly along the coastline, urban infrastructure is vulnerable to floods and storms. This vulnerability is mainly due to inadequate infrastructure development and increasing informal settlements from influxes of displaced population. Their settlements lack proper waste disposal, which worsens environmental pollution and health hazards.

The influx of 1.5 million displaced Syrians since 2012, along with Palestinian refugees, has further strained basic services and economic opportunities, especially in regions like Akkar, Bekaa, and the South. Refugees, displaced populations, and Lebanese host communities (who are already suffering from the impacts of a worsening economic crisis) suffer from substandard housing and overcrowding, making

them particularly susceptible to economic shocks and climate change impacts. Water scarcity, exacerbated by climate change, affects agriculture, energy, and tourism, with increased temperatures and rainfall variability reducing crop yields and threatening food security. The energy sector in Lebanon is heavily dependent on private and neighbourhood diesel generators amid the public utility's inability to supply power commensurate with demand.

During the period from 1994 to 2018, most indirect emissions increased, primarily due to rising energy and transport demand, coupled with widespread reliance on private and neighbourhood generators to compensate for the national grid's frequent electricity shortages. However, 2019 witnessed a drop in emissions caused by disruptions in fuel consumption, following the October 2019 protests and ensuing economic crises. Disruptions in fuel consumption were especially felt in electricity generation at industrial and commercial levels. This disruption further increased reliance on a decentralized network of diesel-powered generators, often operated by local businesses and individuals, providing essential power to homes, businesses, and public services. Land management is hindered by incomplete surveys and inefficient official administrative agencies, leading to resource mismanagement and environmental issues.

Additionally, the sectoral and socioeconomic challenges stated above are exacerbated by regulatory and institutional challenges, which hinder effective environmental management on numerous levels:

1. **Insufficient Regulatory Frameworks and Enforcement Mechanisms**: Weak or outdated environmental regulations, coupled with ineffective enforcement mechanisms, hinder the ability to monitor and address environmental issues adequately, especially when it comes to air quality and environmental degradation.
2. **Limited Institutional Capacity and Inter-sectoral Coordination**: Deficiencies in government agencies' capacity to tackle environmental concerns, especially in conflict prone areas where regulatory implementation is needed, compounded by fragmented governance structures, obstruct approaches to better and more efficient environmental management.
3. **Inadequate Public Participation and Resource Constraints**: Lack of meaningful public engagement, awareness, and limited financial resources constrain efforts to address environmental challenges comprehensively.

The near yearlong hostilities that Lebanon faced (between October 2023 to October 2024) resulted in severe macroeconomic impacts. The real GDP net contraction for 2024 is 5.7%, compared to the pre-hostilities estimate of a modest growth of 0.9%[1]. The estimated damage across all sectors is USD 3.4 billion, and a total economic loss is estimated at USD 5.1 billion (sectors such as agriculture: USD 1.1 billion; commerce: USD 1.7 billion; and tourism: USD 1.1 billion, etc.); and an estimated 166,000 jobs have been lost. The impact of the hostilities is expected to be a prolonged downturn due to the compounding damage and losses, coupled with a weak recovery framework. The final cost of damage and losses is in fact much higher than the estimated figure, USD 5.1 billion; the assessment only covered 80% of conflict-affected areas in Lebanon; and sectors such as the electricity, transport, cultural heritage, municipal services, and water have not been fully integrated into the assessment. The losses will have a profound impact on the LT-LEDS implementation, which had been developed prior to the onset of the hostilities.

2.2 Climate Change Impacts: Past, Present, and Future

Impact of Climate Change on Lebanon: A Decade of Losses and Extreme Weather Events

During the period from 1950 to 2020, Lebanon witnessed an increase of 1.6°C in the annual mean temperature, with a particularly steep rise between 1991 and 2020. This warming was consistent across all regions, with annual mean temperatures rising from 14.2°C in 1901 to 15.8°C in 2020. Coastal regions have experienced a slower rate of warming due to the cooling effects of the sea breeze. Concurrently,

[1] Lebanon Interim Damage and Loss Assessment (DaLA) – November 2024. Washington DC. The World Bank.

precipitation patterns have changed significantly, showing a decreasing trend of 0.53 mm per decade from 1950 to 2020, with a slightly less pronounced decrease of 0.35 mm per decade between 1990 and 2020 (MoE/UNDP/GEF, 2022).

These climatic shifts have led to increased variability and extremes in weather patterns. Precipitation has exhibited strong fluctuations, with annual totals dropping to less than 500 mm in years such as 1960-61, 2001, 2010, and 2019, while reaching around 900 mm in wetter years like 1968-1970, 1994, and 2004. The number of Consecutive Dry Days (CDD)—days when daily precipitation is less than 1 mm—has shown a south-to-north gradient, with significantly higher values in the southern part of Lebanon, indicating worsening drought conditions in these areas.

Lebanon has experienced a series of extreme climatic events over the past decade, including severe heatwaves, droughts, and unseasonal rainfall, which have resulted in forest fires, flooding, landslides, and significant damage to infrastructure and communities across various regions (Table 1).

Table 1: Climatic Events in Lebanon (MoE/UNDP/GEF, 2022)

Date	Climatic events
2007	Severe heat waves, where temperatures exceeded the 90th percentile during the summer months. Heat waves reached temperatures above 40°C for five days in June and seven days in July. This led to large local forest fires. Rainfall was also 50% lower that summer.
2008	Well-below-average temperatures and drier-than-average conditions.
2009	Warmer-than-average temperatures prevailed throughout the country, followed by severe rainfall causing flooding.
2010	The average air temperature ranged from 2°C to 4°C higher than normal, with November being very dry. Lebanon received less than 40% of normal precipitation levels. Heatwaves were recorded over the Bekaa Valley (September 2010). In December, an extratropical cyclone brought heavy rainfall and strong winds to the eastern Mediterranean. Along the coast of Lebanon, waves reached ten meters tall.
2011	Temperatures and rainfall levels were normal. Flood damage in the Akkar, Dannieh, and Hasbani area.
2012	Summer was significantly warmer than normal with anomalies between +1°C and +3°C, reaching +4°C. Despite some extreme precipitation events, 2012 was slightly drier than normal, especially during the warm season. Precipitation surplus resulted in a wetter-than-normal winter with rainfall reaching 125% to 140% of long-term mean precipitation, especially in January. Spring was dominated by mostly dry conditions. Lebanon received 50 millimetres less precipitation than normal or 40% of the long-term mean.
2013	The Middle East was +1° to +2°C warmer than normal, including the winter and summer months. In the first days of January, snow, frost, and thunderstorms affected parts of Lebanon and surrounding areas. In March, a heatwave hit with maximum temperatures reaching nearly 40°C. Flash floods were recorded in North Bekaa and East Lebanon (November 2013).
2014	Middle East temperatures were 1°C to 2°C above the long-term mean and annual precipitation was below normal. Lebanon had a dry year with high temperatures and low rainfall. Main frost events in Central and Northern Bekaa Valley and North Lebanon (in March 2014) and heat and water shortages (September 2014).
2015	In the Middle East, temperatures were +1°C to +2°C warmer than the long-term mean. Windstorms and frost were recorded on the coastal areas in South Lebanon (January 2015), snow, wind, and frost in Mount Lebanon (March 2015) and floods of Nahr El Kabir in Akkar area (February 2015).
2016	Heavy rain and snow caused a landslide in Chouf, Mount Lebanon.
2017	Heatwaves and strong winds caused forest fires in several areas in North Lebanon (Akkar).
2018	Snow, heavy rain, and some flooding were observed in Tripoli in February 2018 where it recorded 81 mm of rain in 24 hours. In December 2018, storm “Norma” caused torrential rain, freezing winds, and snow, causing damages to infrastructure, roads, and homes across the country.
2019	Heavy rain caused flooding (December 2019). Heat wave with temperatures in coastal and inland areas exceeding 36.5°C (July 2019).
2020	Heat wave for two weeks in July and August; temperatures reached more than 40°C.

Lebanon, therefore, has suffered significant economic losses due to climate change over the past decades, experiencing substantial reductions in its GDP due to climate-induced damages (CVF, 2020). From 2000 to 2019, **Lebanon's economy was estimated to have lost 5% of its GDP due to climate change**, driven largely by extreme weather events, shifting precipitation patterns, and rising temperatures (CVF, 2020). This loss underscores the urgent need for dedicated funding mechanisms to address and mitigate further loss and damage.

Impact of Climate Change on Lebanon's Economy: Historical Trends and Sectoral Vulnerabilities

Historically, Lebanon's economy has been significantly impacted by climate change, particularly in the agriculture, industry, tourism, and construction sectors.

According to a macroeconomic risk assessment of the impact of climate induced effects on Lebanon's economy (Box 1), agriculture, industry, and construction sectors have been identified as highly sensitive to changes in mean annual temperature and precipitation. Each sector has a specific optimal temperature that maximizes productivity (Table 2). In fact, Lebanon's mean annual average optimal temperature is 16.6°C, beyond which productivity is significantly reduced.

Box 1: Methodology Overview of the Macroeconomic Risk Profile: Understanding Climate Impacts on Lebanon's Economy

The methodology employed in the Macroeconomic Risk Profile for Lebanon involves an advanced econometric analysis that relates GDP per capita to changes in temperature and precipitation over time. This analysis incorporates both direct and indirect climate-related drivers that affect economic output. A critical aspect of this methodology is the comparison between observed economic performance under current climate conditions and a counterfactual scenario where anthropogenic climate change did not occur. This approach allows for the first-ever attribution of economic losses specific to human-induced climate change. It then assesses the economic impacts of climate change under the Paris Agreement-consistent temperature goals: 1.5°C and 2°C global temperature rises.

The econometric model also integrates the concept of an "optimum temperature" for economic performance. In Lebanon, where the climate has warmed beyond this optimum, the negative impacts of temperature increases are particularly pronounced. The model estimates that Lebanon's economy operates sub-optimally under current warming trends, leading to greater economic losses with each degree of temperature rise. The assessment further considers the impacts of changing precipitation patterns, which have exacerbated water scarcity issues, particularly in agricultural regions such as the Bekaa Valley.

Table 2: The optimal temperatures and precipitation levels for each sector

Sector	Optimal Temperature	Optimal Precipitation	Historical Losses (1980-2016)
Agriculture, Forestry, Fisheries (AFF)	16.5°C	78 cm	30% productivity loss with 2°C deviation from optimal temperature.
Industry (excluding Construction)	16.3°C	80 cm	20% productivity losses with deviations from optimal conditions.
Manufacturing	16.2°C	80 cm	Sensitive to both temperature and precipitation deviations.
Construction	15.9°C	73 cm	Loss of 25% of productivity with temperature deviations; most resilient overall.
Services	16.8°C	81 cm	Largest losses from deviations in precipitation levels.
Total Economy	16.6°C	80 cm	Significant GDP loss exceeding 60% during dry years with 40 cm precipitation.

The construction sector operates best at 15.9°C, most likely due to its full exposure to outdoor conditions and the physically demanding nature of its work. It is the least sensitive to temperature deviations, even though it's showing a 25% loss of productivity. The industry sector has experienced a 20% reduction in productivity with a deviation from its optimal temperature. The agriculture sector, with an optimal temperature of 16.5°C, is the most sensitive, experiencing a significant 30% productivity loss with a 2°C deviation from its ideal temperature.

Figure 1 highlights the losses in sectoral gross value-added due to temperature deviations of the sectors between 1980 and 2016.

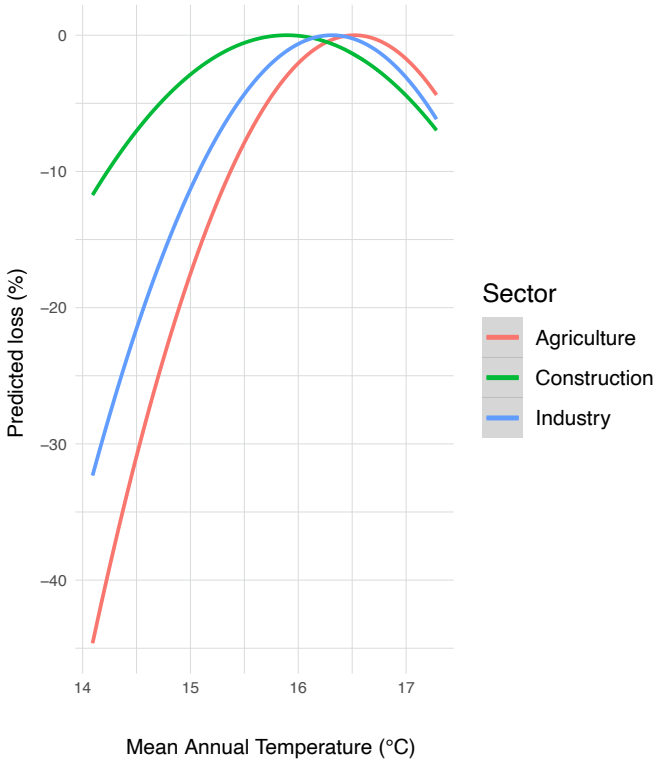

Figure 1: Estimated historical losses in percentage of sectoral gross value-added based on actual historical temperature (1980-2016)

Additionally, precipitation plays a critical role across all economic sectors. The services and manufacturing sectors require slightly higher optimal precipitation levels, 81 cm and 80 cm respectively, to maintain maximum productivity. During particularly dry years, such as when total annual precipitation[2] dropped to 40 cm, Lebanon's overall GDP suffered a dramatic loss exceeding 60% compared to years with optimal precipitation levels of around 80 cm.

Figure 2 provides the losses in GDP across governorates, highlighting the significant economic toll climate change has already exacted on Lebanon.

[2] Total annual precipitation refers to the sum of daily precipitation in one calendar year.

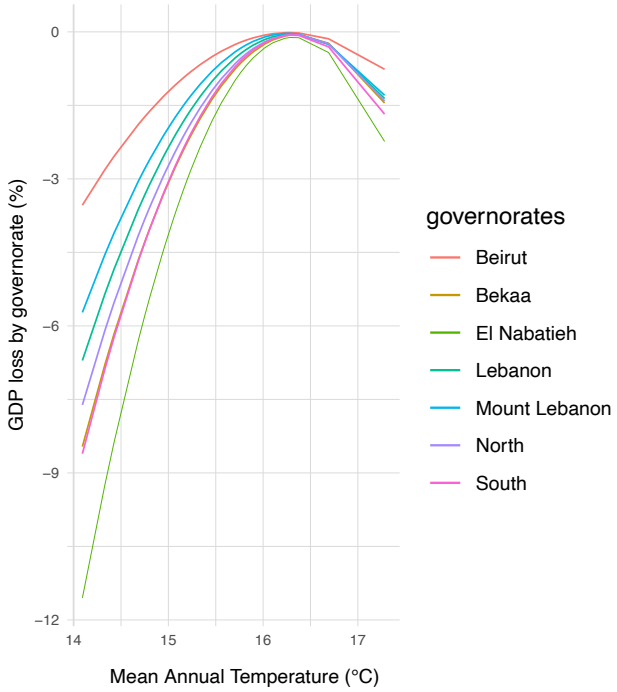

Figure 2: Total GDP loss by governorate due to deviations to output-maximizing sectoral temperature of the agriculture, industry and construction sectors

In terms of climate impacts and their regional disparity in Lebanon, climate change has affected the country's governorates differently, with each region experiencing significant damage due to deviations from optimal temperature and precipitation patterns. Mount Lebanon/Keserwan-Jbeil and Beirut have been among the most affected, with these areas experiencing the largest economic losses due to their high concentration of temperature-sensitive sectors (Figure 3).

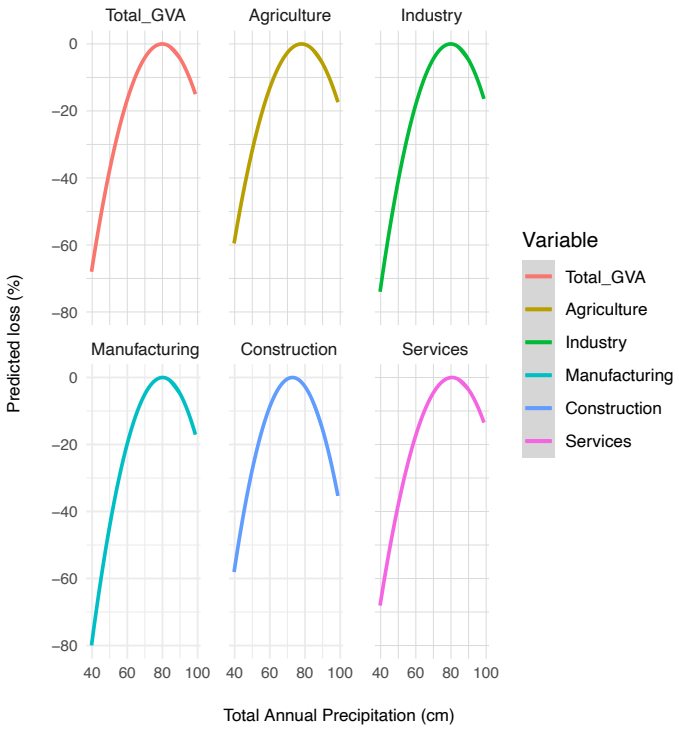

Figure 3: Estimated historical losses in % of sectoral Gross Value-Added (GVA) based on observed historical total annual precipitation (1980-2016)

The Bekaa/Baalbeck-Hermel and North/Akkar Lebanon Governorates, heavily reliant on agriculture, have suffered from decreased crop yields and water shortages, leading to substantial reductions in agricultural output. El Nabatieh has also faced significant economic damage, particularly in the agriculture sector, because of increased drought frequency and reduced water availability.

The cumulative effect of these climate-induced damages has resulted in notable reductions in GDP across these governorates, with each region grappling with the economic toll of ongoing environmental changes (Figure 4).

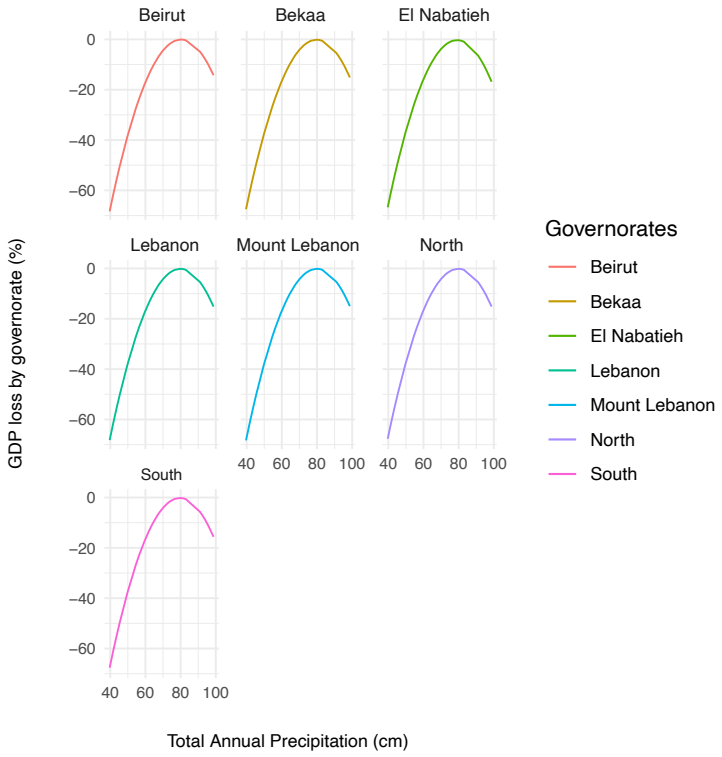

Figure 4: Total GDP loss by governorate due to deviations to optimal sectoral precipitation (1980-2016)

Present Climatic Changes and Their Economic Impact

Lebanon is currently witnessing ongoing and increasingly severe impacts from climate change, especially in the Bekaa, North, and El Nabatieh due to their heavy reliance on agriculture, concurring with the macroeconomics assessment findings (MoE/UNDP/GEF, 2022). The recent mean annual temperature increases of 0.6°C - 0.8°C have already led to noticeable declines in crop yields, especially in high-value crops such as olives, grapes, and other types of fruit. The combination of higher temperatures and reduced precipitation has further strained water resources, leading to critical challenges in water management and agricultural irrigation.

Moreover, Lebanon's coastal regions are grappling with sea-level rise and saltwater intrusion, which threaten both agricultural lands, urban settlements, and the country's tourism sector, which is heavily reliant on coastal cities. Additionally, the tourism sector, which approximately contributes 7% to Lebanon's GDP, faces significant risks due to the shortening of snow seasons, with a 40% reduction in snow residence time, particularly affecting ski resorts at lower altitudes.

The rise in temperature in Lebanon since pre-industrial times has resulted in reduced snow cover and increased river evaporation, posing a threat to the water supply for irrigation. Additionally, the decreased river flows have lowered hydropower potential, further impacting the energy supply.

These cumulative impacts underscore Lebanon's increasing vulnerability to climate change, highlighting the urgent need for comprehensive adaptive measures to mitigate further environmental degradation and economic losses.

Future Climate Projections for Lebanon: Assessing Risks in a 1.5°C and 2°C World

Looking ahead, Lebanon's future under different global warming scenarios[3] shows a stark contrast between moderate and severe impacts.

In terms of temperature impacts, an increase in the number of summer days will add a thermal burden on urban populations and increase energy demands for cooling. Sectors will face significant challenges, necessitating improved resilience to climate extremes. With a 2°C global temperature increase, extreme heat events could double, and at 3°C, they could quadruple (IPCC, 2023). For Lebanon, this means more frequent and prolonged heatwaves and cold spells, with a near fivefold increase in heatwave and drought incidents by mid-century. Table 3 below summarizes Lebanon's projected impacts and risks on different sectors (MoE/UNDP/GEF, 2022).

Table 3: Summary of sectoral climate change impacts in Lebanon (MoE/UNDP/GEF, 2022)

Type of Impact	Climate Stressors	Projected Risks
Reduced water Availability	Increased temperatures Reduced rainfall and snow cover Increased drought incidences Rise in sea level	Altered seasonal water regimes; and a 30% increase in winter floods (up to 30%). Reduced river flows leading to increased strain on limited groundwater sources in the dry season. Increased evaporation of surface water. Increased saltwater intrusion/salinization of coastal aquifers. Annual water availability projected to decrease by 5.7% under RCP 4.5 and 9% under RCP 8.5. Dry season water availability projected to decrease by 42% under RCP 4.5 and 54% under RCP 8.5.
Less snow	Increased temperature Reduced rainfall	The number of snow days is expected to decrease, with 6 fewer days in 2030 and 38 fewer days in 2050 under RCP 4.5, and 9 fewer days in 2030 and 50 fewer days in 2050 under RCP 8.5. Reduced snow cover by 40%. Shifts in snow fall from 1,500 m to 1,700 m by 2050, and to 1,900 m by 2090. Decreased snow residence time from 110 to 45 days.
Less agriculture productivity	Increased temperature Reduced rainfall and snow cover More frequent droughts More frequent heat waves and fewer frost days Sea level rise	Reduced land productivity of irrigated crops by 0.3% to 8.7%. Reduced productivity of rain fed crops by 3.5% to 7.5%. Declined soil moisture (high temperatures / reduced precipitation / higher evapotranspiration) impacting agricultural yields. Migration of mountain fruit production to higher elevations. Decreased crop quality (particularly wine grapes). Increased infestation (fungi and bacterial diseases). Shift in grazing areas and periods for livestock. Increased pumping for irrigation needs.
High energy demand	Increased temperatures	Increased demand on cooling (1.8% increase in electricity consumption for a 1°C increase, and 5.8% for a 3°C increase).
Sea level rise	Increased rise (30-60 cm in 30 years-2mm/ year)	Increased seawater intrusion into aquifers. Increased risk of coastal flooding and inundation. Increased coastal erosion altering coastal ecosystems in natural reserves and elsewhere.
Forests at risk	Increased temperatures	Increased adverse effects on forests suffering from fragmentation, pest outbreaks, forest fires, and harmful practices.

[3] RCP 4.5 represents a stabilization scenario where greenhouse gas emissions peak around 2040 and then decline, reflecting moderate mitigation efforts. In contrast, RCP 8.5 is a high-emission scenario characterized by continued increases in greenhouse gas emissions throughout the 21st century, leading to more severe climate impacts.

Type of Impact	Climate Stressors	Projected Risks
Increase in morbidity and mortality	Increased temperatures More intense and frequent heatwaves Increased extreme weather events	Increased outbreaks of infectious diseases. Increased morbidity and mortality from heat and other extreme weather events. Increased malnutrition from droughts and floods. Increased rates of water-borne, rodent-borne, and vector-borne diseases.
Reduced tourism activities	Increased temperatures More intense and frequent heatwaves Sea level rise Reduced precipitation/snow	Impact on outdoor winter tourism. Shortened skiing season. Increased losses of natural attractions (e.g., public sandy beaches). Increased structural damage to the country's archaeological heritage.

Although the Paris Agreement aims to limit global warming to well below 2°C above pre-industrial levels, while pursuing efforts to limit the increase to 1.5°C, Lebanon will still face a complex mix of potential risks under both a 1.5°C and a 2°C world.

The country's economy faces significant risks from climate change in all its sectors, with potential GDP impacts widely depending on global temperature rise. In a scenario where the world warms by 1.5°C, Lebanon could see moderate economic losses, but if temperatures rise to 2°C or higher, the losses could exceed 20% of GDP[4] (Figure 5).

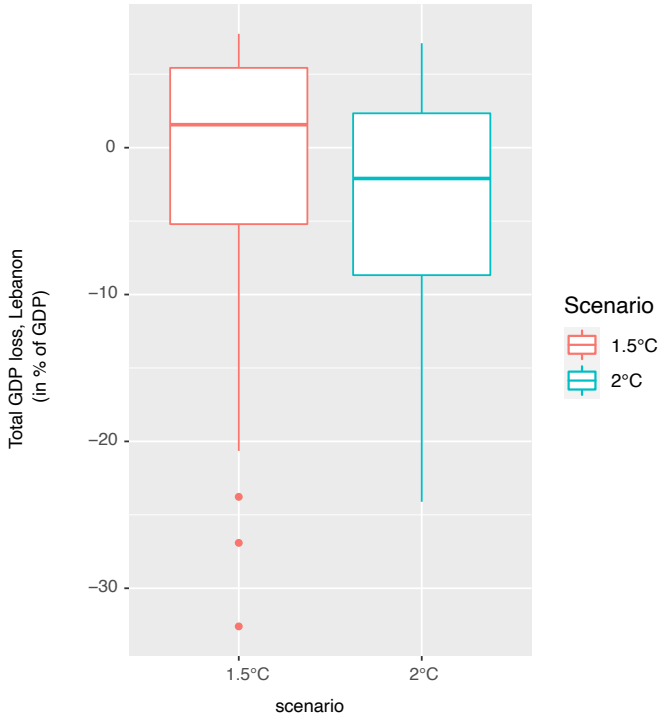

Figure 5: Projected total GDP impact (in %) for Lebanon for 1.5°C and 2°C global warming scenarios[5]

[4] This projection assumes no major changes in the structure of Lebanon's economy, where the current contribution of each sector and governorate remains constant.

[5] Assuming no structural change in the sectoral composition of GDP and economic contribution of government and accounting for temperature and precipitation related effects

Under a 1.5°C global warming scenario, the agriculture sector may experience slight benefits in certain areas due to increased CO_2 fertilization[6]. However, these potential gains are unlikely to outweigh the broader negative impacts; the risk of reduced crop yields becomes increasingly significant, especially for rain fed and irrigated crops. Under a 2°C warming scenario, annual temperatures could increase by 1.2°C - 1.4°C, leading to widespread productivity and financial losses across the agriculture sector; these losses are estimated at USD 512 million annually (World Bank, 2024a). The most affected regions are expected to be Mount Lebanon, the North, and the coast, where agriculture plays a crucial role in local economies (coastal agriculture in Lebanon includes citrus trees, bananas, olive trees, etc.) (Figure 6). The GDP reductions in these areas could range from 2.7% to 10.9%, depending on the severity of warming.

Rising temperatures pose a serious threat to Lebanon's construction and industry sectors, both of which have optimal operating temperatures - 15.9°C and 16.3°C, respectively. Under a 1.5°C global warming scenario, these sectors might face limited disruptions. However, if global temperatures rise closer to 2°C, the impacts become more severe. A projected temperature increases of 1.2°C - 1.4°C would push both sectors beyond their optimal ranges, leading to loss in productivity, exacerbating existing challenges, including labour inefficiencies and increased operational costs, especially in energy-intensive or temperature-sensitive industrial activities.

In the construction sector, regions like Mount Lebanon and Beirut, where construction is concentrated, are particularly vulnerable. Similarly, the industry sector would experience strain, with the North and Mount Lebanon expected to be the hardest hit. This could lead to notable reductions in GDP and broader economic repercussions across the country.

In addition to the direct impacts on agriculture, construction, and industry, Lebanon's energy sector is also expected to face significant challenges due to climate change. Hydropower generation, a key component of Lebanon's energy mix, is projected to decrease by 8% by 2040 and 29% by 2080 due to reduced streamflow.

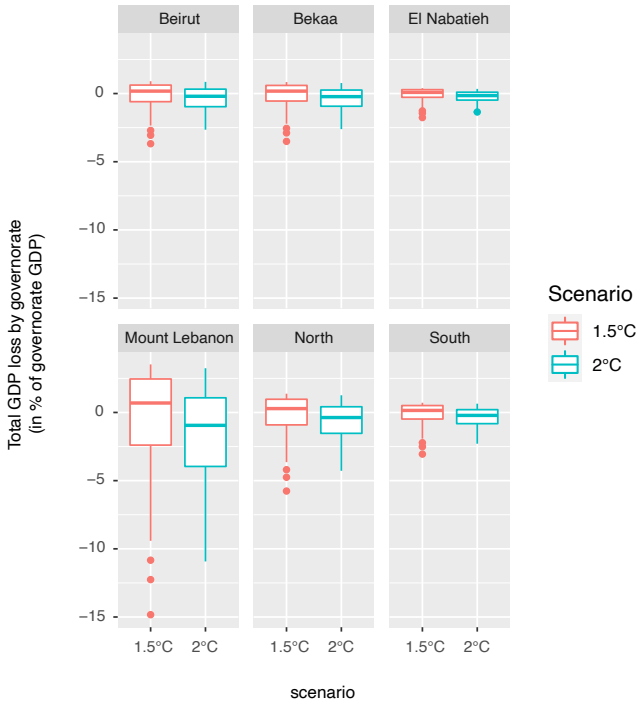

Figure 6: Projected total GDP impact (in %) by governorate for 1.5°C and 2°C global warming scenarios[7]

[6] CO_2 fertilization refers to the process by which increased levels of carbon dioxide (CO_2) in the atmosphere enhance the growth and photosynthesis of plants, potentially leading to higher crop yields

[7] Assuming no structural change in the sectoral composition of GDP *and accounting for temperature and precipitation related effects*

This reduction, coupled with the anticipated rise in energy demands for cooling as temperatures increase, highlights the critical need for infrastructure adaptations and investments in energy efficiency and climate-resilient infrastructure, which will be essential to mitigate the impacts of rising temperatures on Lebanon's economy.

Furthermore, in addition to the projected losses from the agriculture, industry, and construction sectors, which threaten jobs, income, and livelihoods, the tourism industry will also face a significant decline due to shorter skiing seasons and increased heatwaves. The reduction in GDP from fewer tourists is estimated at USD 500 million by 2040 (World Bank, 2024a).

Implementing the LT-LEDS will enable Lebanon to strategically mitigate its climate change impacts by aligning national actions with its NDC commitments; this alignment ultimately contributes to the Paris Agreement's global goals; and it aims to steer away from the projected impacts at 1.5°C and 2°C. This alignment also highlights the need for strategic planning and climate resilience, particularly in vulnerable sectors, to mitigate these projected climate risks. With the agriculture and industry sectors highly vulnerable, Lebanon's future economy, when shifting from a service-oriented to a production-based economy (i.e., agriculture and industry), runs the risk of becoming extremely vulnerable when resilience building in those sectors is not factored in.

2.3 Heat Related Risks – Wet-bulb Globe Temperature

Heat related risks are one of the biggest challenges associated with rising temperatures that, along with many economic losses, result in non-economic permanent losses such as human lives. Extreme heat (e.g., heat waves) are measured in dry-bulb temperature (or simply temperature); however, a wet-bulb

globe temperature (WBGT) (T_W) assessment[8] is needed due to its compound nature of dry-temperature and humidity, especially for Lebanon which receives high moisture levels from the Mediterranean Sea. Annex I explains this assessment's detailed methodology.

Figure 7 indicates the spread of monthly averaged T_W over the decadal average (2000-2009) (blue horizontal lines inside the red boxes), where a prominent variation (vertical axis) in monthly values is found, with December/January and July/August showing the lowest and highest values of T_W respectively.

[8] A fundamental aspect of GHG-induced warming is global-scale increase in absolute humidity. Physiologically, the human body's efficiency of perspiration/evaporation cooling slows in hot and humid conditions, resulting in hyperthermia, heat exhaustion, and stroke. A wet-bulb temperature of 35°C is considered a limit to human tolerance of heat stress (Sherwood and Huber, 2010), while for physical labor (outside activities) a 32°C is established as the upper limit (Coffel et al., 2017). For the purpose of analysis in the LT-LEDS, US National Weather Service criterion – defined as "dangerous" and "extremely" dangerous" – thresholds of 24.6°C and 29.1°C respectively are used.

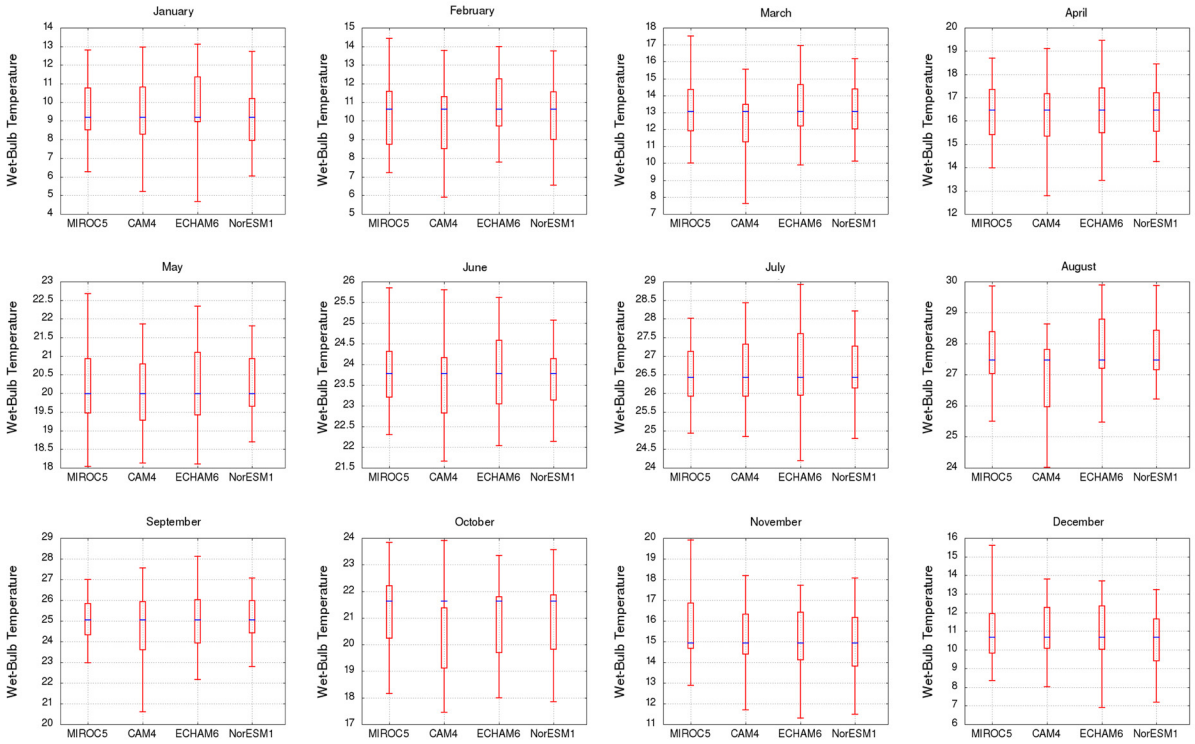

Figure 7: Comparison of the four GCMs against EWEMBI data in the reference period for a monthly scale over Lebanon[9]

Focusing on the four warmest months, Figure 8 indicates the probability of crossing the "dangerous" (T_W = 24.6°C) and "extremely dangerous" (T_W = 29.1°C) thresholds when global temperature rises to 1.5°C and 2°C. June, the coolest summer month, shows a 33% probability of exceeding the dangerous threshold once in a year. In the reference period, which is projected to increase by 48% and 59%, in a 1.5°C and 2°C warmer world respectively, there is a zero probability of crossing the "extremely dangerous" threshold in all three periods. June is followed by September, which shows a much higher exceedance probability. "Dangerous" thresholds in all three time periods, along with some probabilities of crossing the "extremely dangerous" threshold, are highly probable.

The two warmest summer months, July and August, show over 90% exceedance of the probability – even in the reference period that indicates the threat of climate change to Lebanon's population at the present level of warming, which is likely to exacerbate in future warmer worlds. The probabilities of exceeding the "extremely dangerous" threshold during August is 16% under current warming (reference period) trends; this probability increases to 30% and 44% in 1.5°C and 2°C warmer worlds respectively. This possibility can happen even if there is a drastic future reduction in GHG emissions to achieve the Paris Agreement's goal of 1.5°C; the probability of crossing the "extremely dangerous" threshold once in a year will be twice as much as the present levels in Lebanon. Getting to this threshold signifies the importance of carrying out adaptation planning to safeguard against the threat of future heat stress in the country. Alternatively, keeping the global mean temperature rise to 1.5°C, compared to 2°C, would reduce the probability of crossing the "extremely dangerous" temperature by 14%.

[9] For each of the four GCMs, the red coloured boxes represent the 66% range around the median, whereas whiskers span the minimum and maximum value. The blue horizontal lines represent the averaged decadal value of EWEMBI for each month, while monthly averaged values of 20 members of 10-year simulations for each GCM (200 years per GCMs) are used for the box and whisker plot.

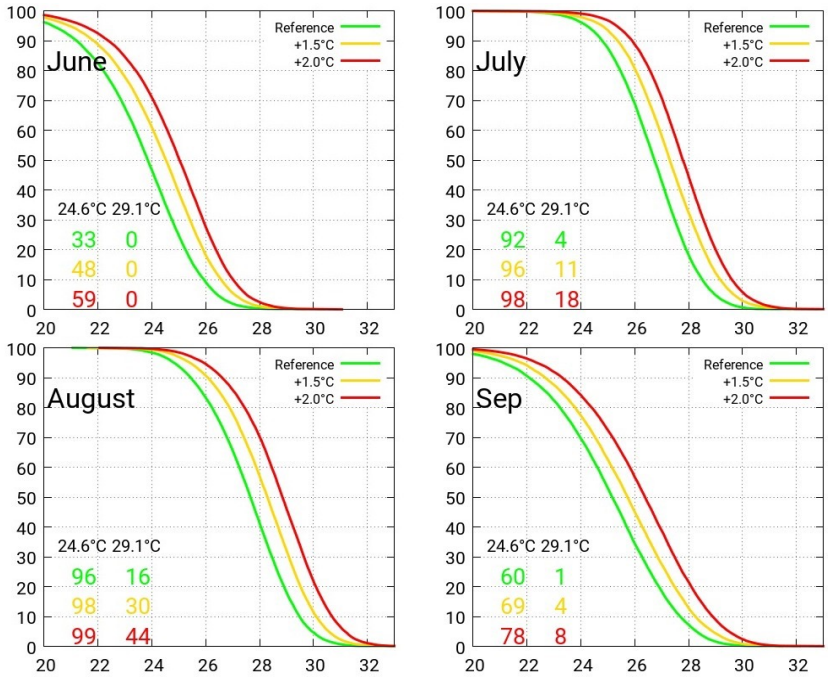

Figure 8: Exceedance Probability (vertical axis) versus Wet-bulb temperature (horizontal axis) curves[10]

The values inside each panel in Figure 8 represent the exceedance probabilities at dangerous (24.6°C) and extremely dangerous (29.1°C) thresholds for reference (green), +1.5°C (gold) and +2.0°C (red) periods.

Figure 9 highlights the Heat Stress Duration Index (HSDI) for Reference (green), 1.5°C (orange) and 2°C (red) worlds for the four GCMs with 20 members, each member with a 10-year simulation. Left and right panels represent the HSDI at the "dangerous" (24.6°C) and "extremely dangerous" (29.1°C) thresholds respectively. The blue horizontal lines represent the ensemble median for each GCM.

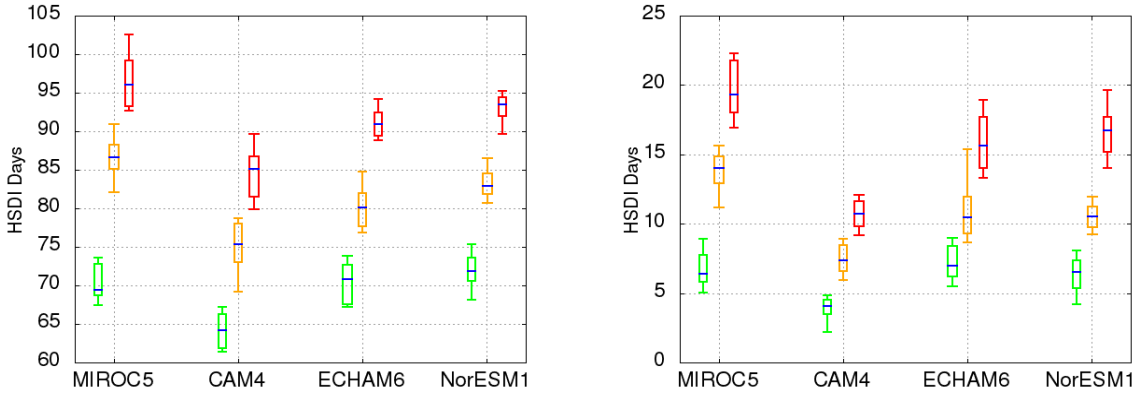

Figure 9: Heat Stress Duration Index (HSDI) for Lebanon

In terms of three consecutive days (or more) of exceedances with a daily maximum T_W (above the defined thresholds) (defined as Heat Stress Duration Index – HSDI), results (Figure 9) indicate a consistent increase. For the "dangerous" threshold (T_W = 24.6°C), there are almost 70 HSDI days per year on average in the reference period, which gradually increase to almost 80 and 90 in the 1.5°C and 2°C warmer worlds. Similarly, there are five HSDI days on average for the "extremely dangerous" threshold (T_W = 29.1°C) in the reference period, which increases to more than 10 and 15 in the 1.5°C and 2°C warmer climates respectively.

[10] Based on an ensemble of four GCMs (CAM4, ECHAM6, MIROC5, NorESM1) with 20 members, where each member has 10-year simulations in Lebanon.

The increase in the number of HSDI days, even in a 1.5°C warmer world, highlights the need to take appropriate adaptation measures in Lebanon; it also signifies the reduced impacts of heat stress at the 1.5°C level compared to the higher-level warming of 2°C.

In terms of population exposure to HSDI events, Figure 10 shows the exposure of around two million and 0.35 million person-days for "dangerous" and "extremely dangerous" thresholds respectively in the Reference period. An additional 0.1 and 0.2 million person-days for "dangerous" and 0.1 and 0.3 million person-days exposures are expected with the 1.5°C and 2°C warmer worlds respectively.

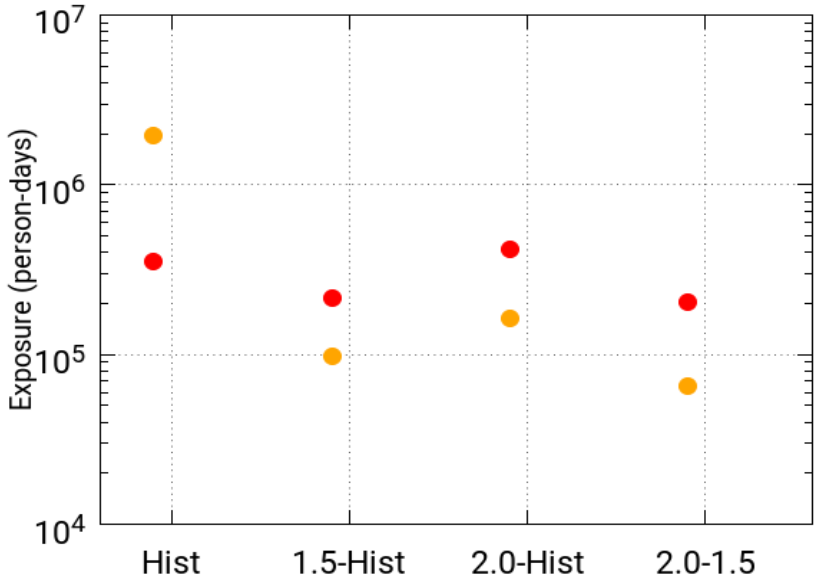

Figure 10: Lebanese Population exposure to HSDI [11]

In this context, addressing the labour market implications of heat stress becomes even more urgent. The lack of economic resilience in Lebanon complicates the task of ensuring a just transition that safeguards the rights and livelihoods of workers, particularly sectors such as agriculture and construction, where exposure to heat stress is high. In fact, to characterize the prevailing environmental conditions for work in Lebanon, the monthly average maximum WBGT and monthly average maximum temperatures are used. For more details on the approach, refer to **Annex II.**

Figure 11[12], below, illustrates the quarterly average maximum temperatures across Lebanon (reference historical period (1985-2014). The third quarter (Q3: July – September) indicates particularly high temperatures across Lebanon (almost all regions experiencing average maximums above 28°C); these high temperatures are likely to pose significant heat stress risks, especially inland where temperatures are consistently extremes.

[11] Figure 10 highlights population exposure to HSDI events in mean number of person-days per year, which considers population values at 2010 levels for "dangerous" (24.6°C) (orange) and "extremely dangerous" (29.1°C) (red) HSDI thresholds. (N.B. vertical axis is in log-scale.)

[12] The following section presents the findings of the forthcoming report written by Andreas Flouris (University of Thessaly and University of Ottawa), Leonidas Ioannou (Jožef Stefan Institute), Konstantinos Mantzios (University of Thessaly) and published by the International Labour Organisation.

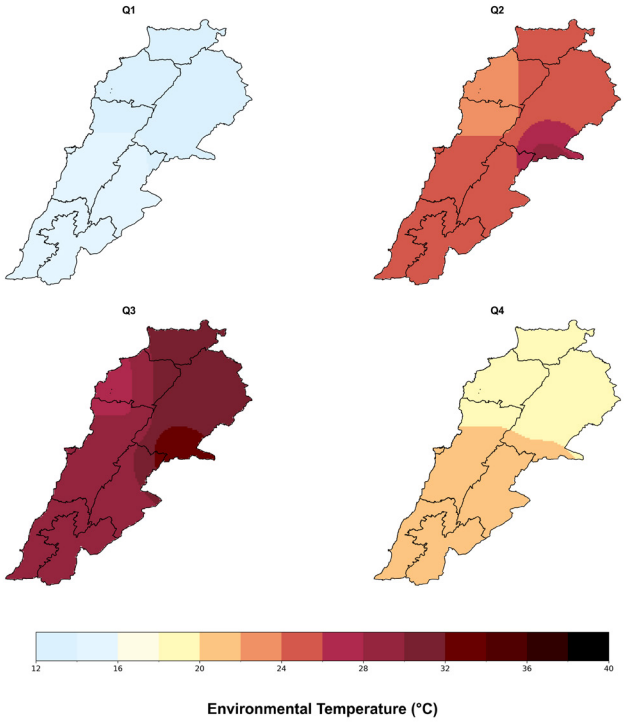

Figure 11: Quarterly average maximum temperatures across Lebanon[13]

WBGT observed maximum temperatures across Lebanon. Figure 12 indicates that during Q2 (April – June), Lebanon experiences a WBGT of 20.5°C and 28.5°C, marking the beginning of heightened heat stress risks, particularly for outdoor workers. Q3 represents the peak heat stress period, where across the country, WBGT values exceed 32°C with the East and North-East experiencing values of WBGT up to 34.5°C.

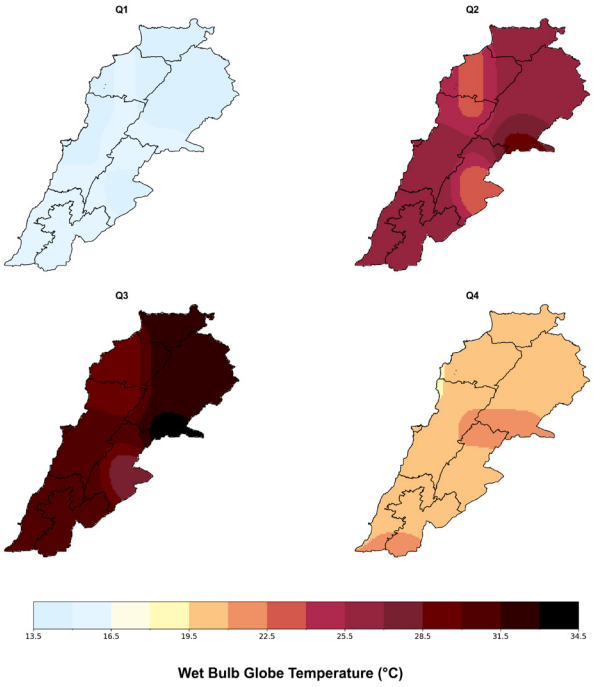

Figure 12: Quarterly average maximum WBGT across Lebanon[14]

[13] During the reference historical period (1985-2014)

[14] During the reference historical period (1985-2014)

The Q2 and Q4 periods also require attention since WBGT values during these quarters remain high enough to pose moderate risks, particularly in areas with vulnerable workers.

Under future climatic scenarios, and given Lebanon's dependency on agriculture production, including sectors such as wine and citrus products, the projected shifts in temperature and precipitation patterns, water resources, amid fragile infrastructure and ecosystems, are likely to disrupt key economic activities. Assuming a range of 3°C to 8°C temperature rise, Lebanon is faced with significant health impacts and with a severely reduced capacity to perform manual labour; these impacts and reduced capacity are a result of unmanageable heatwaves, water shortages, and disruption of daily life and agricultural systems that are expected at the higher end of the results.

For WBGT, and till the end of this century (Figure 13), Lebanon will face increases of 2°C to 3.5°C in many regions. Inland and southern regions of Lebanon are projected to experience the most significant WBGT increases toward the end of the century. Without strong global climate mitigation (i.e., SSP3-7.0 and SSP5-8.5) by the end of the century, Lebanon could witness WBGT rises of over 5°C, which would lead to significant heat-health impacts, as well as drastic reductions in the capacity to perform manual labour. These projections emphasize the importance of implementing adaptation strategies to mitigate the impacts of rising heat levels in Lebanon.

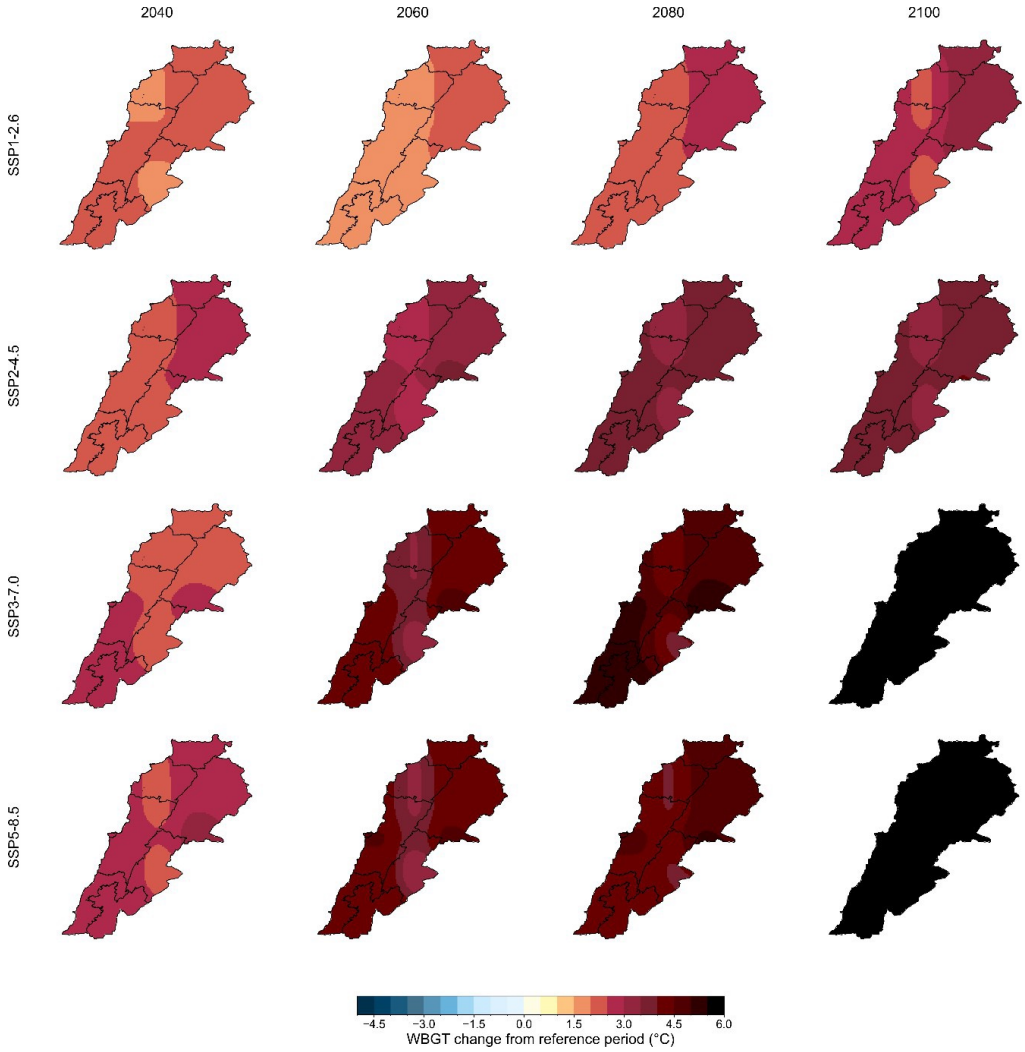

Figure 13: Change in the average maximum WBGT in Lebanon[15]

[15] Compared to the reference historical period (1985-2014) across the different SSPs and at different time points during this century

2.4 Loss of Productivity by Sector of Activity – Impacts of Heat Stress

The impact of heat stress on Lebanon's labour market is significant, with varying degrees of productivity loss across key sectors, particularly during the peak summer months. In terms of economic impacts, the reduced work hours caused by the exposure of workers to heat stress during 2023 is estimated to be USD 1.36 billion of GDP (Figure 14). The concentrated GDP loss in Beirut and Jounieh illustrates Lebanon's economic dependency on services, where tourism, hospitality and retail are concentrated in these two regions, in addition of both being coastal areas, and therefore particularly vulnerable to heat stress, especially when considering the broader infrastructural challenges. The services sector's share of the GDP loss due to heat stress constitutes 87.2%, followed by transport and trade (8.1%) with the rest of the sector's share being 4.7% collectively. With projected climate impacts, productivity losses are expected to reach 25% for low-intensity work and as high as 40% in high-intensity work by 2100, reflecting the severe impact of climate change and heat stress on productivity.

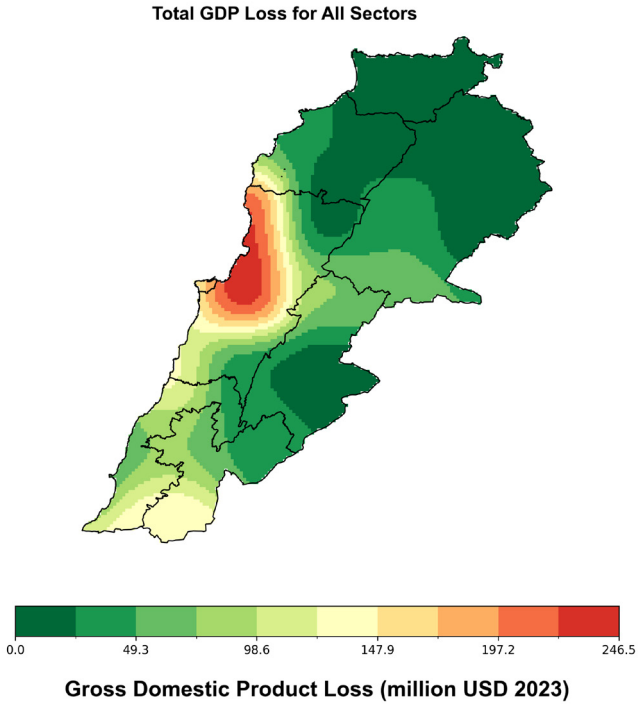

Figure 14: Loss of GDP (proxied from work hours lost) across Lebanon during 2023 for all sectors

The analysis using data for 2023 reflects a seasonal pattern where the highest impacts occur in Q3, mirroring the period of most intense heat. In agriculture, the loss was particularly severe in Q3, with over 3,300 Full-Time Equivalent (FTE) jobs lost due to heat stress. This sector is highly susceptible to heat due to the outdoor nature of the work, which exposes workers directly to high heat stress. Annual losses reached nearly 6,000 FTE jobs, underscoring the need for interventions in agricultural work conditions to prevent recurring losses during hot periods. According to the ILO data (ILO, 2024), Lebanon has already faced productivity losses in agriculture and construction sectors between 10-20% in high-intensity work, and 1-10% in low and moderate-intensity work in the period extending from 1985 to 2014.

The construction sector also experienced notable losses, peaking at 7,166 FTE jobs in Q3. With a total of nearly 13,000 FTE jobs lost over the year, this sector shows the cumulative impact of prolonged exposure to high heat exposure. Similarly, manufacturing saw steady impacts, particularly in Q3, with total annual FTE job losses amounting to 11,318. This reflects the compounding effects of heat in indoor manufacturing environments where cooling measures may be limited, particularly in cases where protective equipment may be required and/or the work is physically demanding.

The services sector, Lebanon's largest contributor to GDP, was also significantly affected, with 72,000 FTE jobs lost throughout the year. The sector's high losses in Q3 (34,491 FTE jobs) underscore the widespread effect of heat stress, which not only affects direct outdoor workers but also indoor jobs through discomfort and increased health risks.

Transport and trade sectors saw FTE job losses surpassing 7,000 annually, with Q3 again being the most impacted quarter, demonstrating how heat stress can disrupt logistics, delivery, and trade operations.

The manufacturing, mining/quarrying, services, transport and trade sectors have already incurred around 8% productivity losses. In low-intensity work, no significant changes are anticipated during this century under future climatic scenarios, where significant heat stress impacts are expected, ranging between 10 to 26% losses by 2100, underscoring the impact of high heat exposure and the need for adaptation measures.

Overall, across all sectors, the total FTE job losses in Lebanon due to heat stress in 2023 amounted to 110,000 jobs, or 7% of total jobs in Lebanon, a significant indicator of the challenges that rising heat stress poses to the labour market. These results highlight the urgent need for adaptive policies, such as regulated work-rest cycles, access to cooling measures, and the integration of heat mitigation into occupational safety standards, to safeguard worker productivity and health in Lebanon.

All sectors have already witnessed an estimated 8-11% work time loss during the period extending from 1985 to 2014, where the agriculture and construction sectors having experienced the highest work time loss. Under future climatic conditions, work time loss increases gradually, reaching 26% by end of the century for agriculture and construction sectors, and up to 16% for manufacturing, mining/quarrying, services, transportation and trade.

Overall, in Lebanon, productivity losses are directly linked to work intensity, with high-intensity work across all industries facing the greatest projected losses under all scenarios. Although the impact on moderate and low-intensity work is less severe, even these activities will experience productivity declines, particularly under higher- emission scenarios, highlighting the pervasive impact of rising heat levels. It is also clear that vulnerability is unequal since agriculture and construction show the highest productivity losses due to heat stress, reaching as high as 43% by the end of the century. Manufacturing, mining/quarrying, services, transportation, and trade sectors are also heavily impacted, but to a lesser degree. The above emphasizes the need for targeted adaptation strategies, particularly for high-intensity labour, to mitigate productivity losses in the context of increasing heat levels and climate change impacts.

2.5 Lebanon's GHG Emission Profile

In 2022, Lebanon emitted 20,968 Gg CO_2eq. (as total emissions), which is a 31% decrease from 2019 (calculated as 30,189 Gg CO_2eq.); this drop is mainly due to a significant decrease in energy-related emissions. The economic crisis that started in 2019 exacerbated electricity supply problems, with extended power cuts due to the government's inability to secure fuel for power plants and ensure proper maintenance and upgrades of an already fragile infrastructure. An 85% decline in electricity production was observed between 2019 and 2022: with EDL electricity generation plummeting to 2,138 GWh in 2022 (EDL, 2023). This decrease was mainly due to the halt of some power plants (i.e. Jiyeh and Zouk thermal power plants, Hrayche power plant), and a gradual reduction in the reliance on power rental barges that came to a complete halt in 2022.

Nevertheless, the main contributor to greenhouse gas emissions in Lebanon remains the energy sector (including transport) with 77% of GHG emissions, followed by industrial processes (12%) (Figure 15).

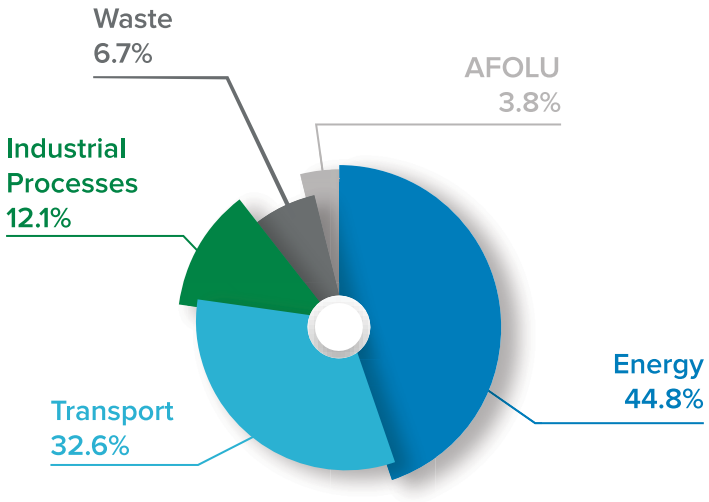

Figure 15: Lebanon's national greenhouse gas inventory by category in 2022

Transport emissions constitute around 32.6% of total emissions; this sector remained an important contributor to emissions with 6,663 Gg CO_2eq. in 2022, mainly due to passenger cars gasoline consumption.

The industrial processes sector accounted for approximately 12% of total emissions with 3,021 Gg CO_2eq. in 2022. These emissions have seen fluctuations due to varying levels of industrial activity and changes in production processes. Key contributors include cement production and emissions from F-gases.

The AFOLU sector contributed 3.8% of GHG emissions, with 778.3 Gg CO_2eq. in 2022. These emissions arise from activities such as enteric fermentation in livestock, agricultural soil management, and deforestation. CO_2 removals from forestry and land use change amounted to -1,474 Gg CO_2, bringing Lebanon's NET emissions to 19,491 Gg CO_2eq. Emissions from this sector are influenced by agricultural practices, land-use changes, and forest management policies.

The waste sector contributed 6.7% of Lebanon's total GHG emissions, with emissions estimated at 1,805 Gg CO_2eq. in 2022. Emissions primarily result from solid waste disposal on land and wastewater treatment, due to the anaerobic decomposition of organic waste in landfills and the treatment of municipal and industrial wastewater. Efforts to improve waste management practices and increase recycling rates are essential for reducing emissions from this sector.

Historically, Lebanon's GHG emissions steadily increased, nearly tripling since 1994, with an average annual growth of 6%. However, this trend shifted significantly following the events of 2019 and the subsequent financial economic crisis. By 2022, total GHG emissions had decreased by 32% compared to 2019, largely due to the COVID-19 pandemic and decrease in economic activity post 2019. These factors significantly reduced energy-related emissions, which had long been the dominant contributor to Lebanon's total GHG output.

The time series of emissions in Figure 16 shows a considerable growth in the CO_2eq. total emissions since approximately 2008; they are dominated by an increase in energy sector emissions. Between 1994 and 2022, the energy sector, including transport, remained the largest source of GHG emissions, contributing between 66% and 77% of the total.

Over time, emissions experienced periodic declines, notably in 2007, 2010, and after 2019. The 2007 drop was attributed to damage from the July 2006 war, which impaired the electricity distribution network and caused power plants to operate below capacity. In 2010, a shift to natural gas at the Deir Amar plant, along with increased hydropower production, further reduced emissions. However, the most significant decrease occurred after 2019 due to the civil unrest and economic collapse that the country has been witnessing.

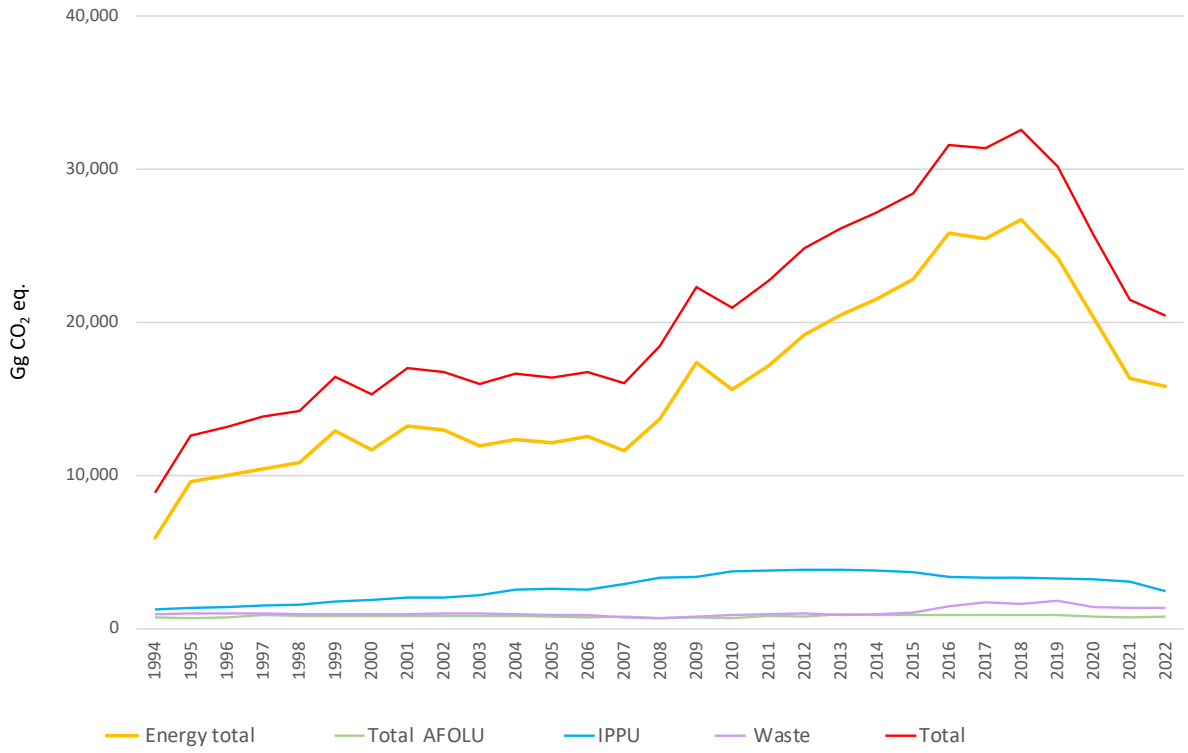

Figure 16: Trend in total and sectoral GHG emissions 1994-2022

2.6. Lebanon's Climate Policy landscape

Lebanon ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1994 through Law 359, the Kyoto Protocol in 2007 by virtue of Law 738, and the Paris Agreement in 2019 by virtue of Law 115. The country submitted its Nationally Determined Contribution (NDC) (Figure 17) in 2015 and updated it in 2021, increasing its mitigation targets and identifying additional adaptation priorities (MoE/UNDP/GEF, 2021).

Figure 17: Lebanon's Nationally Determined Contributions in its updated 2021 NDC

The updated 2021 NDC (MoE, 2021) provides additional information on the mitigation targets that contribute to Lebanon's sustainable development. Additionally, as per paragraph 11 of Article 7 of the Paris Agreement, Law 115/2019 and paragraph 11 of Decision 9/CMA.1, the adaptation priorities in the updated NDC correspond to (c) National adaptation priorities, strategies, policies, plans, goals, and actions of the Annex of Decision 9/CMA.1 (Further guidance in relation to the adaptation communication, including, inter alia, as a component of nationally determined contributions, referred to in Article 7, paragraphs 10 and 11, of the Paris Agreement and Law 115/2019). Therefore, the adaptation priorities reported in the updated NDC constituted part of Lebanon's first Adaptation Communication in accordance with paragraph 10 of Article 7 of the Paris Agreement and Law 115/2019 (MoE/UNDP/GEF, 2021).

To bridge Lebanon's economic recovery efforts with its climate commitments, it is essential to incorporate climate-proofing measures into national development plans. By doing so, Lebanon can align its growth strategies with sustainable practices, ensuring resilience to climate change impacts while advancing its economic goals.

Therefore, in addition to Lebanon's international commitments and obligations to the UNFCCC, Lebanon's national development plans, including the Financial Recovery Plan (MoF, 2020), Lebanon Economic Vision (LEV) (McKinsey, 2018), and Capital Investment Programme (CIP) (CEDRE, 2018), were developed

to address economic challenges and promote growth. However, these plans (or similar plans developed in the future) must align with Lebanon's climate commitments, necessitating climate-proofing policies to ensure sustainable development.

Overall, climate-proofing policies are an essential component of a low emission development strategy, since they help ensure that development is both environmentally sustainable and resilient to the impacts of climate change. By integrating climate proofing into national development plans and policies and adding an additional layer of climate considerations to the implementation of these development plans, Lebanon can take meaningful steps towards achieving its climate goals, while also promoting economic growth and development.

In fact, climate-proofing the above-mentioned development plans highlights the economic benefits of integrating climate mitigation and adaptation measures, with a return on investment of USD 3.2 for every dollar invested, and an overall additional benefit of USD 5.4 billion for a USD 1.7 billion cost. Key sectors requiring enhanced interventions include energy, transport, water, and irrigation. Promoting renewable energy, sustainable land use practices, and resilient infrastructure development are essential for achieving Lebanon's climate goals (UNDP, 2021).

2.7 Exploring Opportunities: The Need for a Long Term - Low Emission Development Strategy (LT-LEDS)

The development of Lebanon's Long Term - Low Emission Development Strategy (LT-LEDS) is essential to comply with the Paris Agreement (Article 4.19). Additionally, from a sustainable recovery approach, developing and implementing a Long Term - Low Emission Development Strategy (LT-LEDS) with a focus on climate considerations can address Lebanon's plethora of challenges and present numerous opportunities for long-term sustainable development:

1. Economic and Financial Growth: By integrating climate considerations into the LT-LEDS, Lebanon can build a sustainable economy, reduce reliance on diesel generators, and create new job opportunities in burgeoning green sectors.

2. Job Creation and Workforce Development: Transitioning to a low-carbon economy opens doors to green jobs, particularly in renewable energy, energy efficiency, and sustainable agriculture, enhancing employment prospects and boosting the labour market.

3. Urban Infrastructure Enhancement: The LT-LEDS can drive improvements in urban infrastructure resilience against climate-related hazards, upgrade buildings and infrastructure, and enhance water management practices, leading to safer and more efficient cities.

4. Support for Vulnerable Populations: Prioritizing climate-resilient housing and infrastructure in refugee camps can significantly improve living conditions and food security for refugees and host communities, fostering social stability.

5. Environmental Restoration and Protection: Promoting sustainable land management practices through the LT-LEDS can protect and restore natural capital, support ecosystem restoration projects, and mitigate environmental degradation.

6. Energy Security and Sustainability: Advancing energy conservation, efficiency, and the use of renewable energy sources can reduce greenhouse gas emissions and enhance energy security, making Lebanon less dependent on imported fossil fuels.

7. Improved Land Management and Governance: Strengthening land tenure rights, promoting participatory land use planning, and enhancing coordination among government agencies can lead to better land management and more effective governance.

By embracing climate considerations in development planning, Lebanon can seize these opportunities to build a sustainable and resilient future, addressing economic, environmental, and social challenges while fostering growth and stability.

3. Development of Lebanon's Long Term - Low Emission Development Strategy (LT-LEDS)

In 2025, Lebanon will submit its second set of Nationally Determined Contributions (NDCs) as part of the Paris Agreement framework, demonstrating its commitment to addressing climate change and reducing greenhouse gas emissions. This submission offers an opportunity to revise and strengthen climate goals, strategies, and policies, aligning them with Lebanon's evolving socio-economic and environmental priorities.

Lebanon's Long Term - Low Emission Development Strategy (LT-LEDS) is crucial in this process, ensuring sustainable and resilient growth by integrating climate considerations into economic planning. This strategy promotes investment in green technologies, renewable energy, and sustainable infrastructure, fostering innovation and creating new economic opportunities. As Lebanon prepares for its second NDC submission, the LT-LEDS will shape the country's development path and help achieve its climate goals.

3.1 Defining Lebanon's Long Term - Low Emission Development Strategy (LT-LEDS)

Lebanon's Long Term - Low Emission Development Strategy (LT-LEDS) is a strategic roadmap that envisions the transition to a low-carbon economy. It incorporates essential institutional, economic, technological, and social changes required for this transition. The strategy outlines a clear path towards reducing greenhouse gas emissions, while promoting economic growth and enhancing resilience to climate change impacts.

The LT-LEDS incorporates two main elements: an NGO-led ambitious 100% Lebanon Vision for 2050, which sets clear objectives and targets; and the Climate Prosperity Plan (CPP)[16] pathways, which simulates the impacts of various policies, such as the NDCs, on Lebanon's economy.

Together, these components form a comprehensive framework guiding Lebanon towards sustainable development and climate resilience. The LT-LEDS is designed to integrate long-term economic development with environmental sustainability; it helps in positioning Lebanon to achieve its Nationally Determined Contributions (NDCs) under the Paris Agreement by pushing for the global goal of limiting temperature increases to well below 2°C, with efforts to limit warming to 1.5°C. By adopting a low-emission development scenario for Lebanon, the LT-LEDS, as a strategy, emphasizes the importance of integrating climate resilience into all aspects of national development planning.

3.2 Objective of the LT-LEDS

The primary objectives of Lebanon's LT-LEDS include:

1. **Guide National Institutions:** Provide a clear framework for national institutions to engage in long-term low emission planning and implementation.

2. **Political Commitment:** Send a strong political message to the international community about Lebanon's commitment to sustainable, low-carbon, and resilient development.

3. **Integrate Economic and Climate Goals:** Harmonize national economic development with climate mitigation and adaptation strategies.

[16] The CPP assessment outlines a comprehensive approach for Lebanon's transition to a sustainable and resilient economy, focusing on renewable energy, infrastructure modernization, sustainable transportation, and socio-economic resilience to climate change impacts based on modeled projections conducted through GEM Model. The document is unpublished.

4. **Synergize Sustainable Development**: Align sustainable development goals with national planning and ensuring that climate action supports broader resilience development objectives.

5. **Provide short and long-term actions**: Provide short and long-term actions for sustainable development in key sectors, including agriculture, energy, tourism, and transportation.

6. **Design LT-LEDS financial delivery mechanisms:** Introduce a robust set of financing mechanisms as an essential outcome of the LT-LEDS to ensure its effective implementation and enhance Lebanon's resilience to climate change.

3.3 Elements and Pillars of LT-LEDS

Elements:

The LT-LEDS is structured around two elements: "100% Lebanon Vision for 2050" and Lebanon's Climate Prosperity Plan Pathways Assessment. Three main pillars were identified, each encompassing specific objectives and targets to guide Lebanon towards its long-term climate and development goals.

The objectives guiding the LEDS scenarios and outcomes are based on the 100% Vision for Net-Zero by 2050, an NGO-led initiative designed to steer Lebanon's development across economic, social, environmental, and institutional sectors. It involves all relevant stakeholders; and it aligns international commitments such as the Paris Climate Agreement and the United Nations Sustainable Development Goals; moreover, it promotes holistic development and efficient resource allocation through an inclusive and consultative process. The "100% Vision" focuses on a green recovery approach with sector-specific objectives (Table 4); it is validated by extensive consultations with national stakeholders from various sectors, where specific climate change mitigation and adaptation needs were identified. These consultations aimed to understand sectoral challenges and to develop objectives aligned with Lebanon's climate goals by 2050. Detailed targets under these objectives are further elaborated in **Annex III.**

Table 4: Lebanon's Vision 2050: Sectoral Objectives

	Description
Pillar 1: Lebanon in transition	
Objective 1	Financing maximized renewable energy and grid modernization potential and connectivity
Objective 2	Sustainable transportation
Objective 3	Accelerated transition and modernization through re-skilling and training
Pillar 2: Climate finance for prosperity	
Objective 4	Shifting sustainable debt through conversion and attrition of capital to climate projects
Objective 5	Carbon Financing Hub to value blue carbon, soil carbon, forest carbon, etc.
Objective 6	Financially protect the economy and livelihoods
Pillar 3: Climate- resilient Lebanon	
Objective 7	Developing domestic food and commercial markets
Objective 8	Green and resilient built environment
Objective 9	Building resilience to heat-related diseases

In addition to the "100% Lebanon Vision for 2050", Lebanon's CPP outputs were further integrated as an element of developing the LT-LEDS.

Climate Prosperity Plans (CPPs) are national assessments that enable socio-economic development by decoupling[17] economic growth from greenhouse gas emissions and enhancing resilience to climate-related shocks. Lebanon's CPP aims to highlight how sustainable economic development through renewable energy, modernized infrastructure, sustainable transportation, increased climate project funding, and enhanced food production and ecosystem resilience can be achieved under different scenarios using the Green Economy Model (GEM) to simulate and compare the impacts of various policies and scenarios (Box 2). More details on the GEM Methodology are included in **Annex IV.**

Box 2: Green Economy Model (GEM) approach for CPP development

The Green Economy Model (GEM) is a comprehensive tool used to analyse the economic, social, and environmental impacts of Lebanon's Climate Prosperity Plan (CPP), helping identify the most effective strategies to meet climate goals. By incorporating detailed climate data, extended damage estimates, co-benefits of climate action, and numerous policy options, GEM simulates various scenarios to forecast the outcomes of different policies and investments. The model integrates socio-economic and environmental dynamics at the country level, highlighting how different forms of capital, whether built, social, human, or natural interconnect and contribute to sustainable development.

Using System Dynamics methodology, GEM provides a holistic approach to development planning, emphasizing the importance of feedback loops to understand the reinforcing and balancing effects of policies. These feedback mechanisms help policymakers realize the short-term benefits and potential medium-term challenges of different strategies, promoting sustainable consumption and decoupling economic growth from resource use. GEM also evaluates externalities such as greenhouse gas emissions, air pollution, and water use, providing a thorough economic valuation that supports the creation of resilient, well-balanced policies. In the CPP context, GEM's capabilities have been enhanced to include additional climate impacts and resilience options, enabling a comprehensive economic and financial assessment of climate action to support Lebanon's sustainable development objectives.

Pillars:

Lebanon's Long Term - Low Emission Development Strategy (LT-LEDS) is anchored in nine nationally prioritized objectives, grouped into three pillars: **Lebanon in Transition, Climate Finance for Prosperity, and Climate-Resilient Lebanon**. These pillars focus on maximizing renewable energy, sustainable transportation, debt repurposing, carbon financing, financial protection, domestic market development, and resilience to climate impacts, guiding Lebanon's 2050 Vision for sustainable development and reaching 100% Net-Zero in terms of emissions.

Pillar 1: Lebanon in Transition

Lebanon aims to transition its economy to a green, low-carbon path by transforming the energy and transportation sectors, harnessing renewable energy, modernizing grid infrastructure, increasing energy efficiency, and shifting to electric and non-fossil fuel vehicles. This transition will create future-oriented jobs and foster innovation, ensuring the workforce is re-skilled and prepared for new roles in a sustainable economy in transition.

- **Maximized Renewable Energy and Grid Modernization**: Achieve 90-100% renewable energy for power demand and 75% for heat demand by 2050. Enhance energy efficiency to reduce energy demand by 30% by 2040.
- **Sustainable Transportation**: Transition to 90-100% electric or non-fossil fuel vehicles by 2050. Promote public transportation and non-motorized transport infrastructure.
- **Re-skilling and Training**: Ensure 75% of new jobs are supported by re-skilling and training programs aimed at future industries.

[17] Refers to the concept of achieving economic growth without a corresponding increase in the consumption of natural resources or environmental degradation. In other words, it means creating an economy where prosperity and development do not rely on the exploitation or depletion of resources such as fossil fuels, minerals, and water.

Pillar 2: Climate Finance for Prosperity

Lebanon will mobilize innovative financing mechanisms, such as debt-for-climate swaps and carbon finance, to support its climate ambitions, while ensuring financial protection against climate risks through early warning systems and schemes for the most vulnerable populations.

- **Sustainable Debt and Climate Projects**: Double the available financing envelope for climate projects through mechanisms, such as debt-for-climate swaps by 2045.
- **Carbon Financing Hub**: Increase forest cover to 30% by 2035 through reforestation and participation in carbon markets. Implement early warning systems to enhance ecosystem resilience.
- **Financial Protection**: Extend financial protection against climate-related disasters to 100% of the population living in poverty by 2035.

Pillar 3: Climate-Resilient Lebanon

The third pillar focuses on building socio-economic resilience to climate change by developing domestic food markets; consequently, domestic food markets enhance food security. They enhance food security by supporting sustainable local industries and reinforcing the built environment with nature-based solutions to protect coastlines, secure water supplies, and strengthen forest ecosystems. Additionally, the health system will be fortified to minimize heat stress impacts and ensure access to water, while raising awareness on heat-related diseases.

- **Domestic Food and Commercial Markets**: Achieve 75% domestic production of national food and beverage consumption by 2045 and ensure 90-100% of farming outputs come from sustainable practices by 2050.
- **Green and Resilient Built Environment**: Deploy nature-based solutions to enhance resilience to fire, flood, and coastal erosion in 90-100% of risk areas by 2045.
- **Resilience to Heat-Related Diseases**: Protect 100% of workers from extreme heat, including those in the informal economy, by 2045.

3.4 Methodology for Developing the LT-LEDS Scenarios and Pathway

Two overarching simulations are considered, under which different scenarios are modelled: One scenario entails macroeconomic challenges continuing in the coming years, **No Reform simulation (NR)**; and another is characterized by a stronger economic reform scenario, **the Reform simulation (R)**:

- **No Reform simulation**, where no economic reforms are implemented: A simulation where current policies and practices remain unchanged, leading to the **continued trajectory of existing environmental and economic trends** without additional interventions for sustainable development or climate resilience.
- **Reform simulation**: Envisioning a Lebanon where reforms have been effectively implemented and the fiscal situation has improved, although it was not until 2024 when Lebanon's was able to access international capital markets; moreover, the banking sector's solvency will not be fully restored until the following decade. The reform simulation anticipates that Lebanon will **successfully complete debt restructuring in 2025**, leading to an improved sovereign credit rating and reduced borrowing costs. This, in turn, would enable Lebanon to tap into international markets and benefit from a decrease in its cost of borrowing post-restructuring. The Reform simulation complements the World Bank's Country Climate and Development Report (CCDR) for Lebanon's recovery scenario[18] (World Bank, 2024a).

[18] The CCDR entails a set of macro-fiscal reforms that aim to ease financing constraints and improve fiscal space, facilitating significant investments in key sectors such as energy, water, transport, and solid waste management.

Given Lebanon's uncertain macroeconomic outlook, it is crucial to use two different baseline simulations in the LT-LEDS analysis. Indicators such as energy demand and emissions are closely linked to GDP, meaning that shifts in the economy will have an impact on the scale of efforts and investments needed for emissions reductions, such as expanding transport electrification and increasing renewable energy generation. By considering multiple baseline scenarios, we can provide a more thorough assessment of the required investments and the range of potential outcomes. Considering multiple baseline scenarios ensures that our strategies are resilient and adaptable to changing economic conditions (Table 5).

Three main scenario pathways are considered in the development of Lebanon's LT-LEDS (Figure 18): a Business-As-Usual scenario (BAU), the Nationally Determined Contribution (NDC) scenarios for both conditional and unconditional targets, and the Low-Emission Development Strategy (LEDS) Scenario.

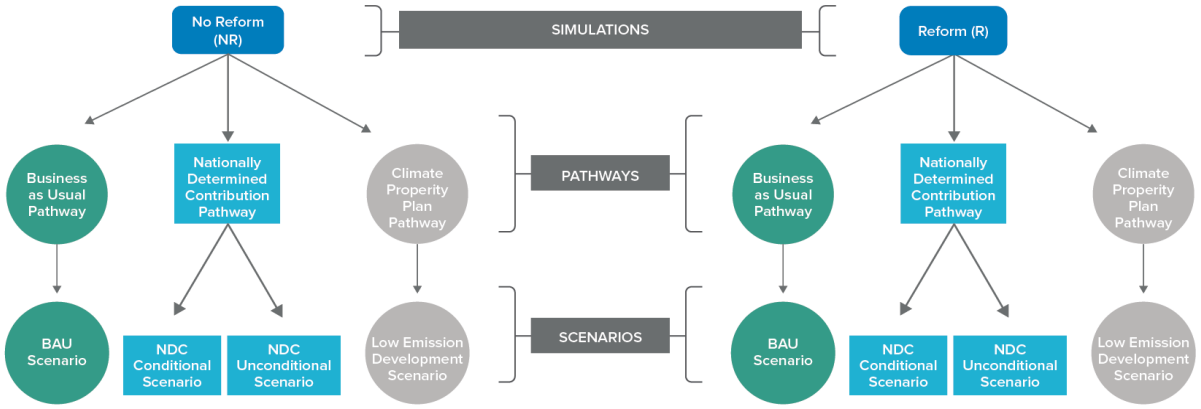

Figure 18: Three main scenario pathways considered in the development of Lebanon's LT-LEDS

1. Business-As-Usual (BAU) Scenario

The BAU scenario represents the status quo with **no implementation of any climate action, including measures stated in Lebanon's Nationally Determined Contributions (NDCs)**. In this scenario, no measures for climate resilience or transition are implemented beyond what currently exists in practice. It reflects a future where the nation's policies and actions remain unchanged, following historical patterns and conventional practices. This scenario essentially portrays the consequences of inaction, where existing trends and behaviours persist, potentially leading to increased vulnerability to climate change impacts and lost opportunities for sustainable development.

2. Nationally Determined Contribution (NDC) Scenarios: conditional and unconditional

The NDC scenarios align with the country's official climate commitments as outlined in its Nationally Determined Contribution updated and submitted in 2021. It represents a structured approach to addressing climate change, incorporating measures to reduce sectoral emissions and enhance climate resilience. **The NDC scenarios demonstrate a country's dedication to meeting its international climate obligations by implementing policies and initiatives outlined in its official 2021 NDC document**. This scenario emphasizes a proactive response to climate change, seeking to reduce emissions and adapt to a changing climate in accordance with globally agreed targets.

This scenario has two sub-scenarios: conditional, where the implementation of NDCs is contingent on international support, and unconditional, which would not rely on external support that Lebanon has pledged to achieve independently utilizing its own resources and capabilities.

3. Low-Emission Development (LEDS) Scenario

The LEDS scenario stands out as an ambitious and transformative pathway toward climate prosperity. In this scenario, the **country maximizes its utilization of domestic renewable energy resources, stimulates**

electrification, and fosters a transition to a greener and more sustainable economy. Simultaneously, it employs comprehensive climate resilience and nature-based solutions to safeguard the country against the adverse impacts of climate change. The LEDS scenario represents a holistic strategy, focusing on economic growth, job creation, and environmental stewardship, with the aim of ensuring long-term sustainability and prosperity. It exemplifies a forward-thinking and integrated approach to climate action, aiming to build a resilient and low-carbon future.

Table 5: Summary of the modelled LT-LEDS scenarios

	Scenario Name	Scenario abbreviation	Description
Simulation 1: No reforms	Business-As-Usual - (No Reform)	BAU-NR	The climate inaction scenario, in a context of weakened economic reform and performance.
	Unconditional NDC - (No Reform)	NDC-U-NR	The scenario reflects the impact of unconditional NDC targets, in the context of weakened economic reform and performance.
	Conditional NDC - (No Reform)	NDC-C-NR	The scenario reflects the impact of conditional NDC targets, in a context of weakened economic reform and performance.
	LEDS - (No Reform)	LEDS-NR	The scenario reflects the impact of the LEDS targets, in a context of weakened economic reform and performance.
Simulation 2: Reforms	Business-As-Usual - (Reform)	BAU-R	The climate inaction scenario, in a context of heightened economic reform and performance.
	Unconditional NDC - (Reform)	NDC-U-R	The scenario reflects the impact of unconditional NDC targets, in a context of heightened economic reform and performance.
	Conditional NDC - (Reform)	NDC-C-R	The scenario reflects the impact of conditional NDC targets, in a context of heightened economic reform and performance.
	LEDS - (Reform)	LEDS-R	The scenario reflects the impact of the LEDS targets, in a context of heightened economic reform and performance.

An exhaustive description of the three scenarios BAU, NDC (conditional and unconditional), and LEDS is detailed in **Annex V**.

4. Results: LT-LEDS as an economic opportunity for Lebanon

The Long Term - Low Emission Development Strategy (LT-LEDS) scenarios brings positive economic advantages and enhanced prosperity for Lebanon across multiple sectors, including the economy, livelihoods, transport, public health, and energy. These scenarios aim to drive significant economic growth and stability by reducing energy costs, mitigating climate-related damages, and fostering sustainable investments.

The LEDS is a competitive economic development strategy. It achieves a Benefit to Cost Ratio of 5.14 by 2030. It stands out as a competitive economic development strategy at the national level; it offers a unique approach in addressing the pressing issue of climate change. **It recognizes that climate action and economic prosperity are not mutually exclusive but can, in fact, be mutually reinforcing.**

The LEDS stimulates economic growth (GDP up to 53% higher than BAU by 2050) and job creation (28.1% higher than BAU, with four million people employed by 2050) both by reducing costs of climate change (resilience) and by increasing productivity (transition).

The LEDS generates economic growth and job opportunities through a dual strategy. On one hand, it mitigates the economic burdens associated with adapting to climate change, reducing the costs incurred due to climate-related disasters. On the other hand, it enhances economic productivity by accelerating the transition to a green economy.

The LEDS, due to high expectations for climate resilience, creates a strong synergy with transition investments. It distinguishes itself by setting ambitious targets for climate resilience, which creates a robust synergy with transition investments.

Investment levels are the highest for the LEDS scenario (close to 4% of GDP by 2030), since it envisions significant investments, making it a comprehensive and proactive strategy to address climate change. By earmarking substantial funds, the LEDS ensures that it has financial resources to make a significant impact.

The investments are economically viable (with USD 97.2 billion of net benefits by 2030). The investments are not just ambitious, but economically and financially viable as well. The LEDS stands as a credible and practical approach to climate prosperity, both from an investment and development point of view.

Funding options are available; a balance between public and private sources should be pursued. While public funding plays a critical role, the LEDS also advocates for a balanced approach that leverages private sector investments.

4.1 Economics

With the implementation of the Low Emission Development Strategy (LEDS) scenario, **real GDP[19] growth** could increase from 0.91% to 2.4% per year if no reforms are implemented (LEDS-NR) and from 3.1% to 4.4% per year under the reform simulation (LEDS-R).

These results demonstrate that even without reforms, shifting from a BAU approach to a LEDS strategy would lead to a significant positive impact on GDP growth, increasing it by 164% compared to the BAU scenario without reforms (Figure 19). Similarly, under the reform simulation, adopting a LEDS approach in

[19] Real GDP measures the value of all goods and services produced within an economy, adjusted for inflation, to reflect changes in the quantity of output over time.

addition to implementing reforms would further boost GDP growth by 40.2% compared to the BAU scenario with reforms.

Additionally, in Lebanon's context and considering the economic crisis and unprecedented inflation over the past years, it's important to also consider **nominal GDP**[20], which is projected to increase from USD 22.5 billion in 2022 to USD 59.8 billion by 2050 without any reforms under the BAU-NR scenario. With reforms, these values will increase to USD 112.6 billion and even up to USD 160.2 billion by 2050 under a LEDS reform scenario.

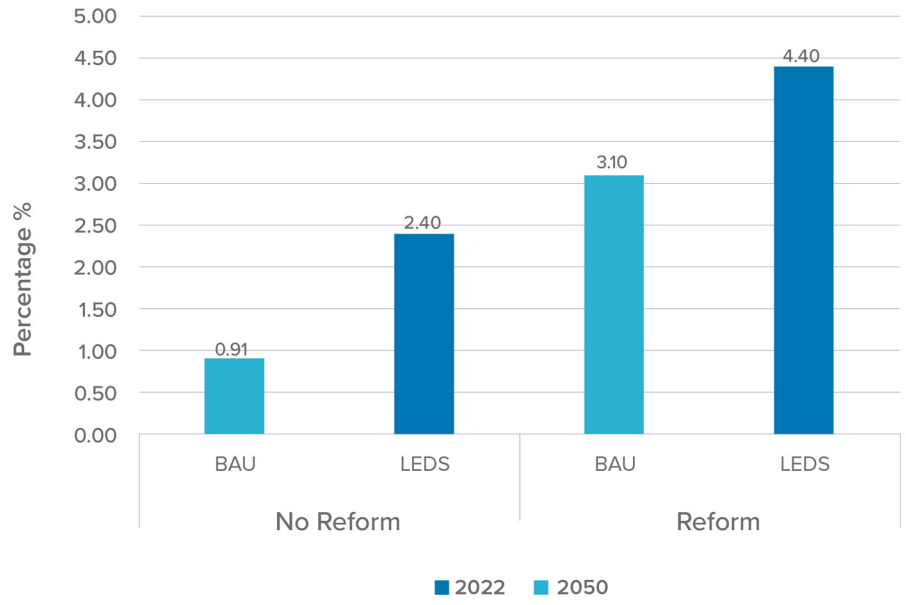

Figure 19: Real GDP growth (in %) projected from 2020-2050

With no reforms, real **disposable income per capita**[21] is projected to decline from USD 3,560 per person in 2022 to USD 3,370 per person in 2050 under no reforms. The implementation of LT-LEDS measures will increase the real disposable income per capita to a significantly higher level of USD 8,205 per person by 2050 (Figure 20). This underscores the substantial economic advantages and enhanced growth potential brought about by the LT-LEDS's strategic approach to climate prosperity, with an increase of 39.5% compared to the BAU-R Scenario. This highlights the critical importance of adopting the LT-LEDS measures since they offer substantial economic benefits; they also significantly boost growth potential, leading to a far higher increase in real disposable income per capita compared to other scenarios.

The Low-Emission Development Strategy for Lebanon will also reduce poverty levels and improve people's well-being; there will be a reduction in the share of the population below the poverty line by 31% compared to the BAU scenario. In the BAU scenario the number of people living below the poverty line was expected to increase over time (Figure 21). This highlights the LT-LEDS's complementary role of alleviating poverty and improving the well-being of a significant portion of the population. The LT-LED not only promotes sustainable economic growth, but it also significantly reduces poverty levels.

[20] Nominal GDP measures the value of all goods and services at current prices, without adjusting for inflation, which can distort comparisons across different time periods.

[21] Disposable income: Amount of money that a person or family has left after paying their taxes. It is the portion of income that can be spent on the necessities of life, like food and rent, as well as on discretionary items, leisure activities, and investments.

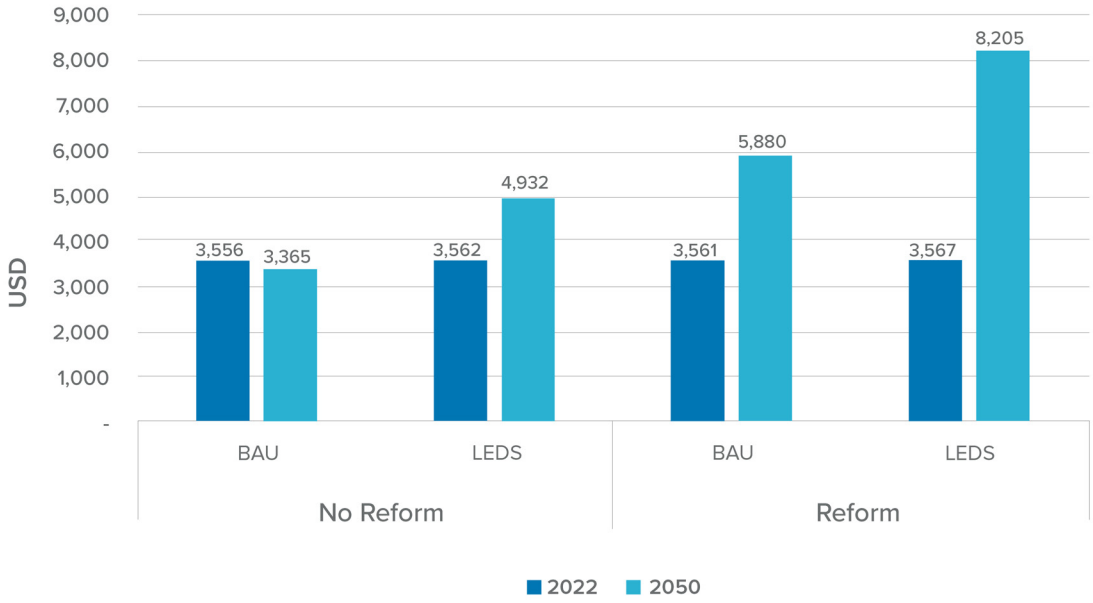

Figure 20: Real disposable income per capita by 2050

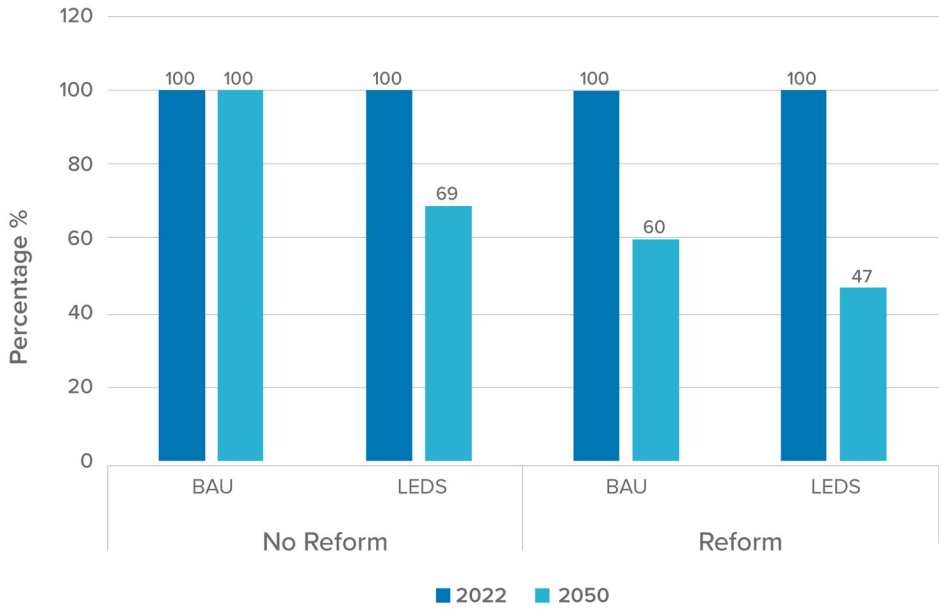

Figure 21: Percentage of people living under the poverty line under the LEDS Reform and No Reform scenarios

Box 3: Why is the LEDS scenario not leading to further reductions in poverty when reforms are applied?

The apparent contradiction between LEDS-R and LEDS-NR arises from a misunderstanding of how different scenarios and their projections are modelled and interpreted, especially taking into consideration the uncertainties in the BAU scenario. In the Business-As-Usual - No Reform scenario, the total number of people living below the poverty line is expected to increase over time. This scenario assumes no significant policy changes or reforms are implemented, leading to high variability and uncertainty in macro-economic parameters. Consequently, the baseline estimation for the population under the poverty line is subject to significant variation.

Conversely, in the LEDS-NR scenario, even without reforms, the number of people living below the poverty line is predicted to decrease significantly, by 31%. This reduction highlights the effectiveness of the LT-LEDS in alleviating poverty and improving overall well-being, driven primarily by sustainable development practices and climate resilience measures. However, when considering the LEDS-R scenario, the reduction in poverty is projected to be 13% by 2050. Although this seems lower than the LEDS-NR scenario, it underscores the additional impact that economic growth and policy reforms in the BAU-R scenario have on reducing poverty. The combined effect of economic growth under BAU-R and the complementary role of LT-LEDS interventions will result in a notable reduction in poverty.

Therefore, the higher percentage reduction in the LEDS-NR scenario compared to the LEDS-R scenario **can be attributed to the interplay between baseline uncertainties in the BAU-NR scenario and the added benefits of reforms in the BAU-R scenario**. In essence, while LEDS-NR demonstrates a strong standalone impact on poverty reduction, the LEDS-R scenario reflects a more balanced and sustainable approach, integrating both economic growth and reform-driven interventions to achieve a comprehensive reduction in poverty.

4.2 Livelihoods

The Low-Emission development scenario highlights a transformative shift towards a more sustainable and equitable economic landscape, leading to a boost in social stability and productivity alongside a decrease in unemployment rates. This transition not only curtails unemployment rates, but it also facilitates the creation of diverse green employment opportunities in renewable energy, sustainable agriculture, and eco-friendly infrastructure development, as industries pivot towards sustainable practices and technologies.

Although the overall increase in total employment from 3.9 to 4 million is marginal, **the LEDS scenario demonstrates a significant reduction in unemployment rates from 24.7% to 9.2%, which can be further reduced to 7% with appropriate reforms, driven by the rise in green jobs** (Figure 22, Figure 23). This improvement is largely due to the projected increase in GDP under the LEDS scenario, strategic land use for agriculture, and the ambitious implementation of transition and adaptation interventions, all of which contribute to substantial job creation and economic growth.

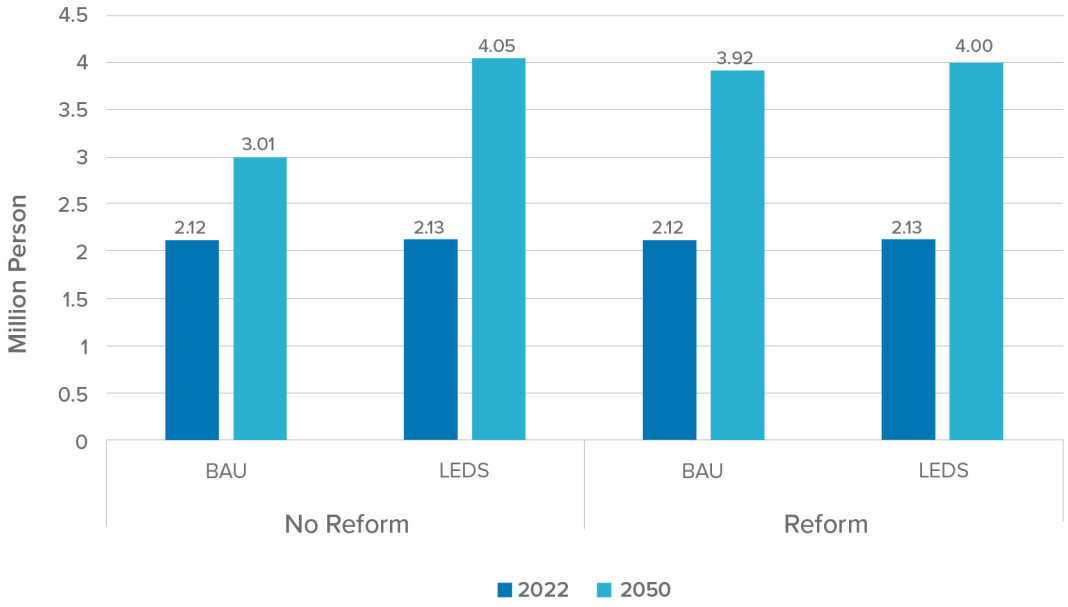

Figure 22: Total employment by 2050 for the BAU and LEDS scenarios

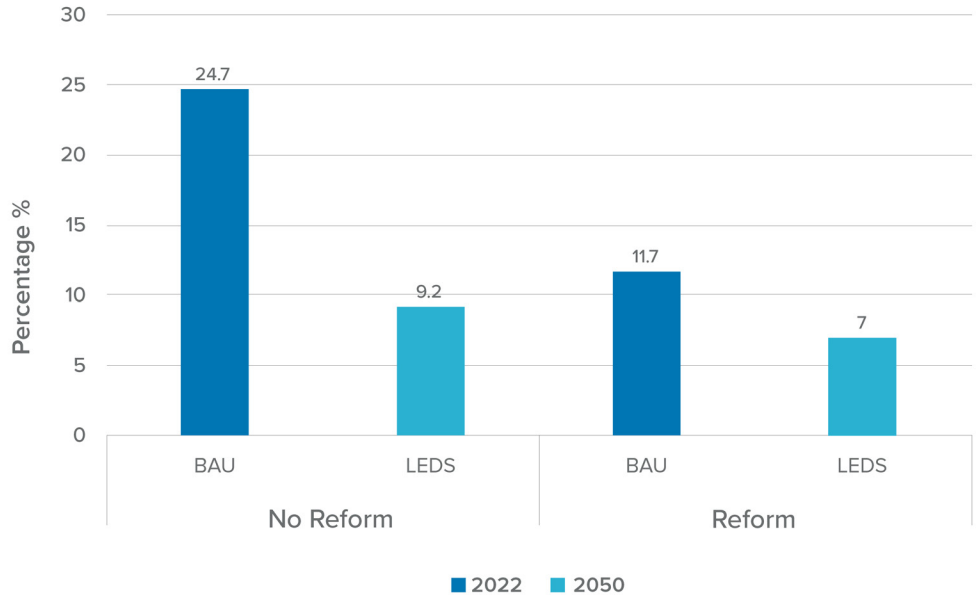

Figure 23: Unemployment rate by 2050 for the BAU and LEDS scenarios

This transition creates diverse green employment opportunities in renewable energy, sustainable agriculture, and eco-friendly infrastructure development, as industries adopt sustainable practices and technologies. **The LEDS scenario shows a substantial rise in green jobs, from 44,720 to 109,080 jobs by 2050 without reforms to 118,610 with reforms** (Figure 24). Furthermore, the LEDS scenario sees the share of green jobs rise from 1.14% to 2.96% with reforms by 2050, roughly doubling the proportion compared to the baseline. This significant increase highlights the LEDS' effectiveness in promoting environmentally sustainable employment. These new jobs are expected to emerge notably in renewable energy and sustainable agriculture, with additional employment in greening the vehicle fleet later in the period (Figure 25).

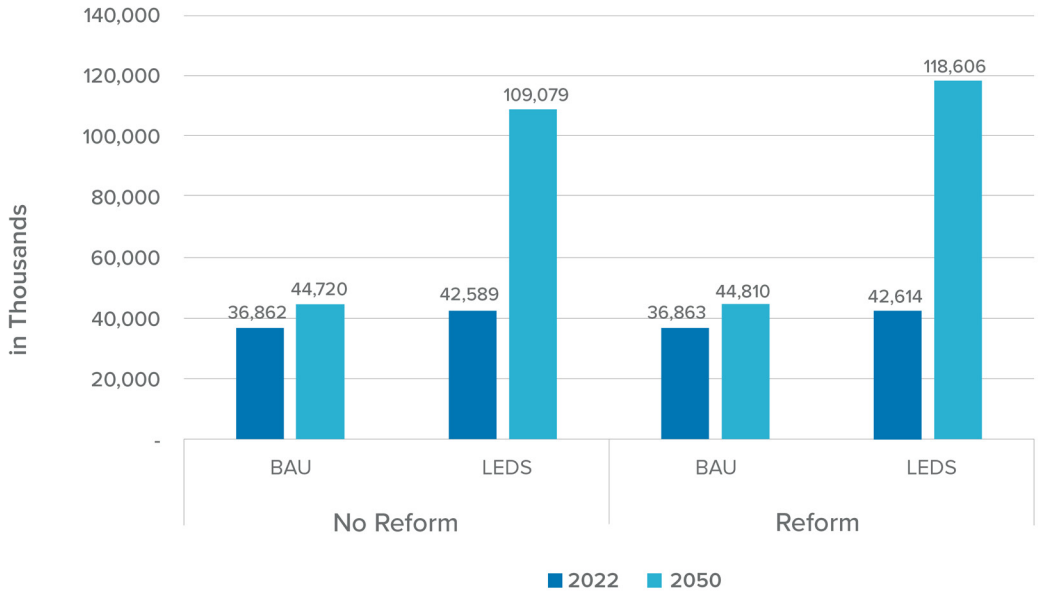

Figure 24: Number of green jobs by 2050 for BAU and LEDS scenarios

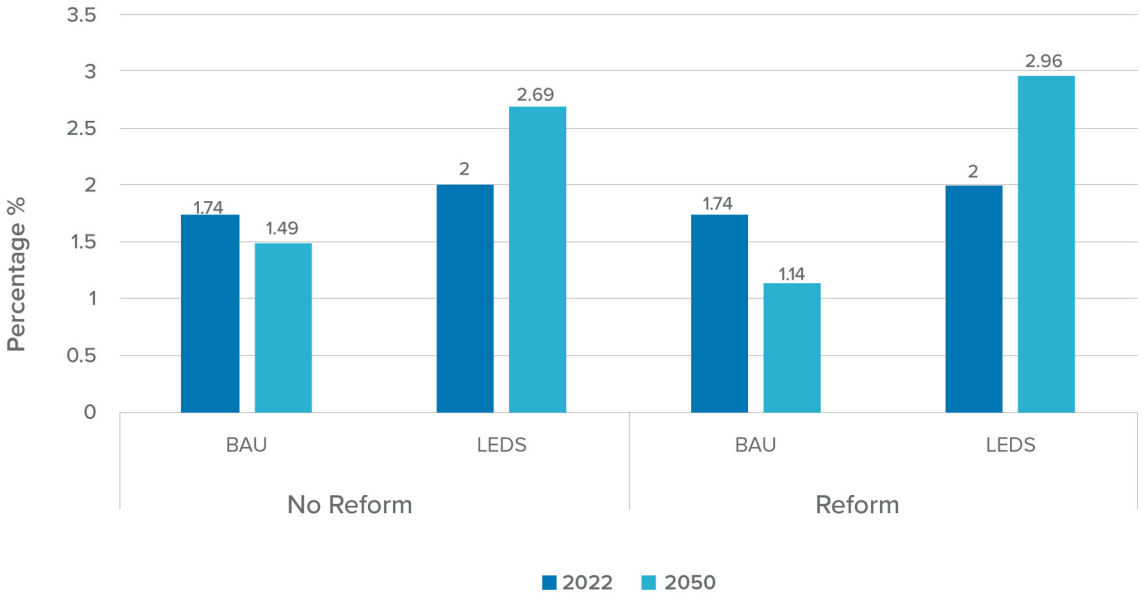

Figure 25: Share of Green Jobs out of total employment by 2050

4.3 Public Health

The LEDS scenario presents a brighter public health outlook in addition to social improvements, with reduced mortality and morbidity rates stemming from cleaner energy production and improved environmental practices. Total annual deaths from ambient and indoor air pollution are projected to increase up to 11,438 people (BAU-R) in 2050, due to higher air pollution under Business-As-Usual conditions. However, due to a projected increase in GDP, optimized population policies, improved energy efficiency, and the widespread adoption of renewable energy sources, **the LEDS scenario demonstrates a remarkable improvement in air quality, with the total annual deaths from indoor and ambient air pollution declining to close to zero by 2050 and saving around 11,000 lives** (Figure 26).

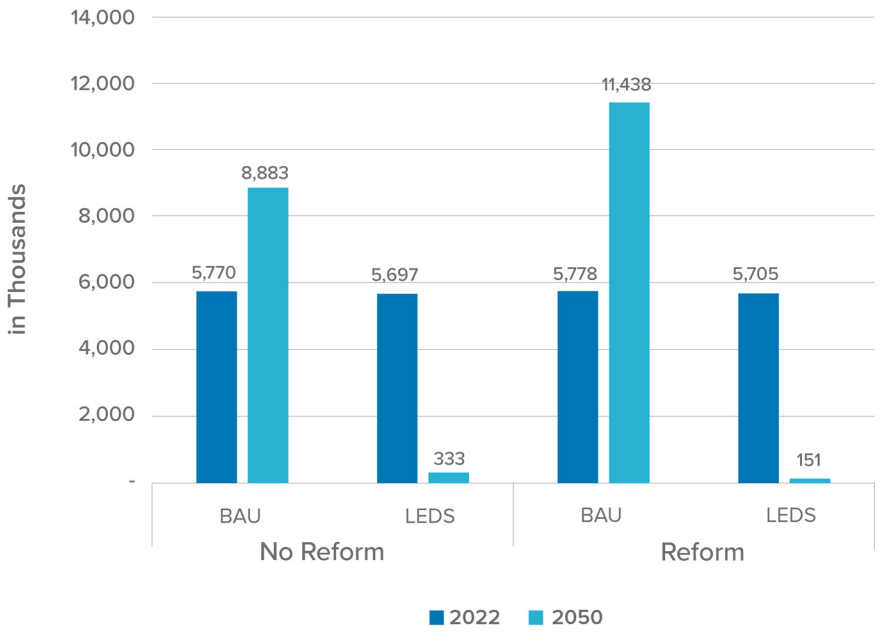

Figure 26: Total deaths by air pollution by 2050 for the BAU and LEDS scenarios

In addition, the adoption of Non-Motorized Transport (NMT) is estimated to decrease the incidence of Non-Communicable Diseases (NCDs) reaching 24% by 2050 under the LEDS scenario; in comparison, there is a 13% decrease under the BAU scenario. This significant health improvement in the LEDS scenario is driven by its ambitious policies and investments in the installation of alternative transport infrastructure in urban areas, fostering healthier lifestyles and reducing the burden on public health.

4.4 Energy

Under the LEDS scenario, energy consumption is substantially reduced, from 202,490 TJ under BAU to 92,990 TJ in 2050 (Figure 32) (LEDS-NR) and to 143,790 TJ (LEDS-R). The reform scenario (LEDS-R) shows higher energy consumption compared to the NR scenario (LEDS-NR) because it incorporates a faster and broader scale of economic growth, higher levels of industrial activity, and increased electrification, which drive higher energy demand despite the efficiency measures in place. This reduction is driven by several key factors within the LEDS, including higher GDP, optimized power generation policies, improved energy efficiency, and increased electrification, all of which contribute to a more sustainable and energy-efficient future.

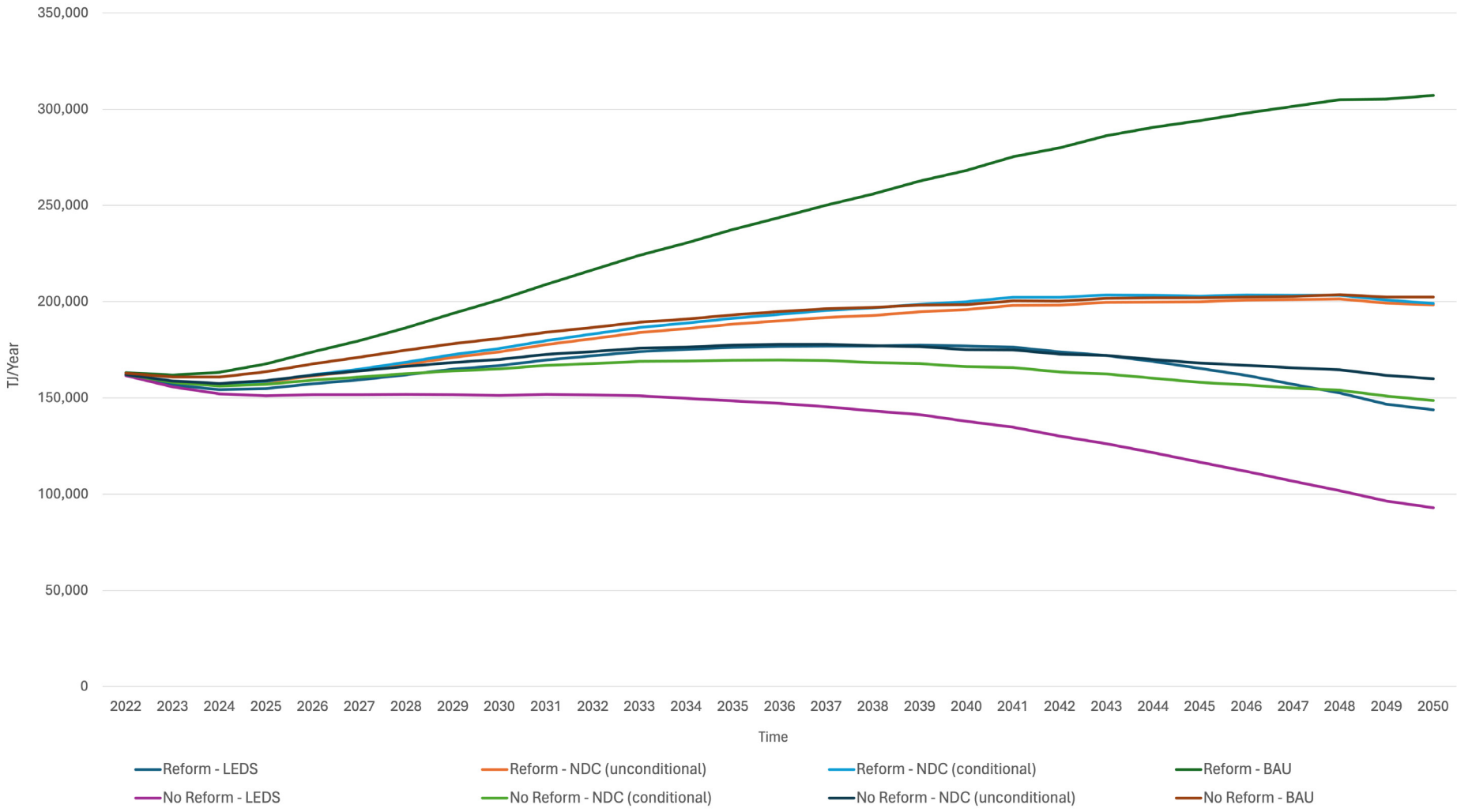

Figure 27: Final energy consumption. BAU, NDC and LEDS scenarios, Simulation NR, and R

The energy bill[22] **as a share of GDP is also expected to decrease from 18.2% (BAU-NR) and 15.5% (BAU-R) dropping down as low as 2.7% (LEDS-NR) and 2.4% (LEDS-R) in 2050** (Figure 27). This substantial reduction is driven by several key factors within the LEDS, including the higher GDP generated by the LT-LEDS and the comprehensive efforts to reduce the country's total energy expenditure.

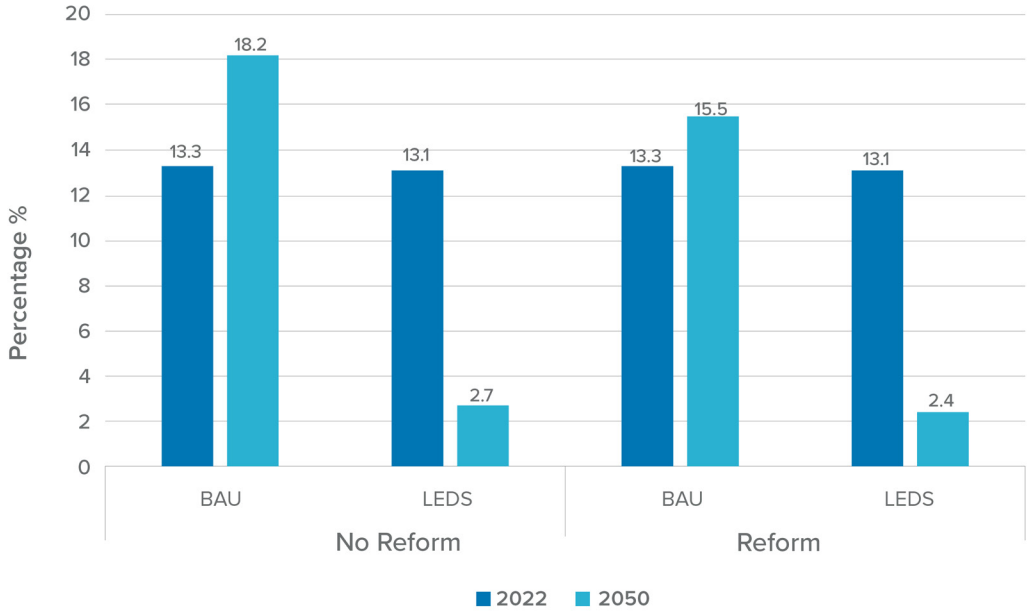

Figure 28: Percentage of the energy bill in GDP by 2050 for the BAU and LEDS scenarios

The indicator of the energy bill as a share of GDP reflects the efficient and sustainable utilization of energy resources in the LEDS, contributing to economic prosperity and environmental responsibility. As a result, under the BAU-NR scenario, the energy affordability index experiences a slight increase, diminishing from 0.84 in 2022 to 0.54 in 2050 (Figure 28). In contrast, in the LEDS scenario, the energy affordability index sees a more significant improvement, reaching 3.46 in 2050. This indicates **a substantial improvement in energy affordability for the population within the LEDS**.

In terms of total energy generated, Figure 29 shows a substantial increase in electricity generation from 2022 to 2050 across all scenarios, emphasizing the impact of strategic reforms. The LEDS scenario, particularly with reforms, emerges as the most effective approach, projecting electricity generation to exceed 40 million MWh/year by 2050, compared to just under 30 million MWh/year in 2022. This significant growth contrasts sharply with the BAU scenario, where electricity generation is expected to increase from around 18 million MWh/year in 2022 to about 25 million MWh/year by 2050 without reforms, and slightly higher with reforms. The NDC scenarios, both conditional and unconditional, show moderate increases, reaching between 30 to 35 million MWh/year with reforms. The data highlights that the LEDS scenario, by far, offers the most substantial boost in electricity generation. This demonstrates the critical importance of adopting LEDS combined with robust reforms to maximize energy production and meet future demand sustainably. Prioritizing the LEDS pathway is therefore crucial to achieving both economic growth and environmental goals.

[22] The total expenditure a country incurs for importing or producing energy resources within a specific period. It's a key indicator of economic performance, impacting businesses, households, and competitiveness. Analyzing it relative to GDP shows energy intensity, efficiency efforts, and reliance on imports.

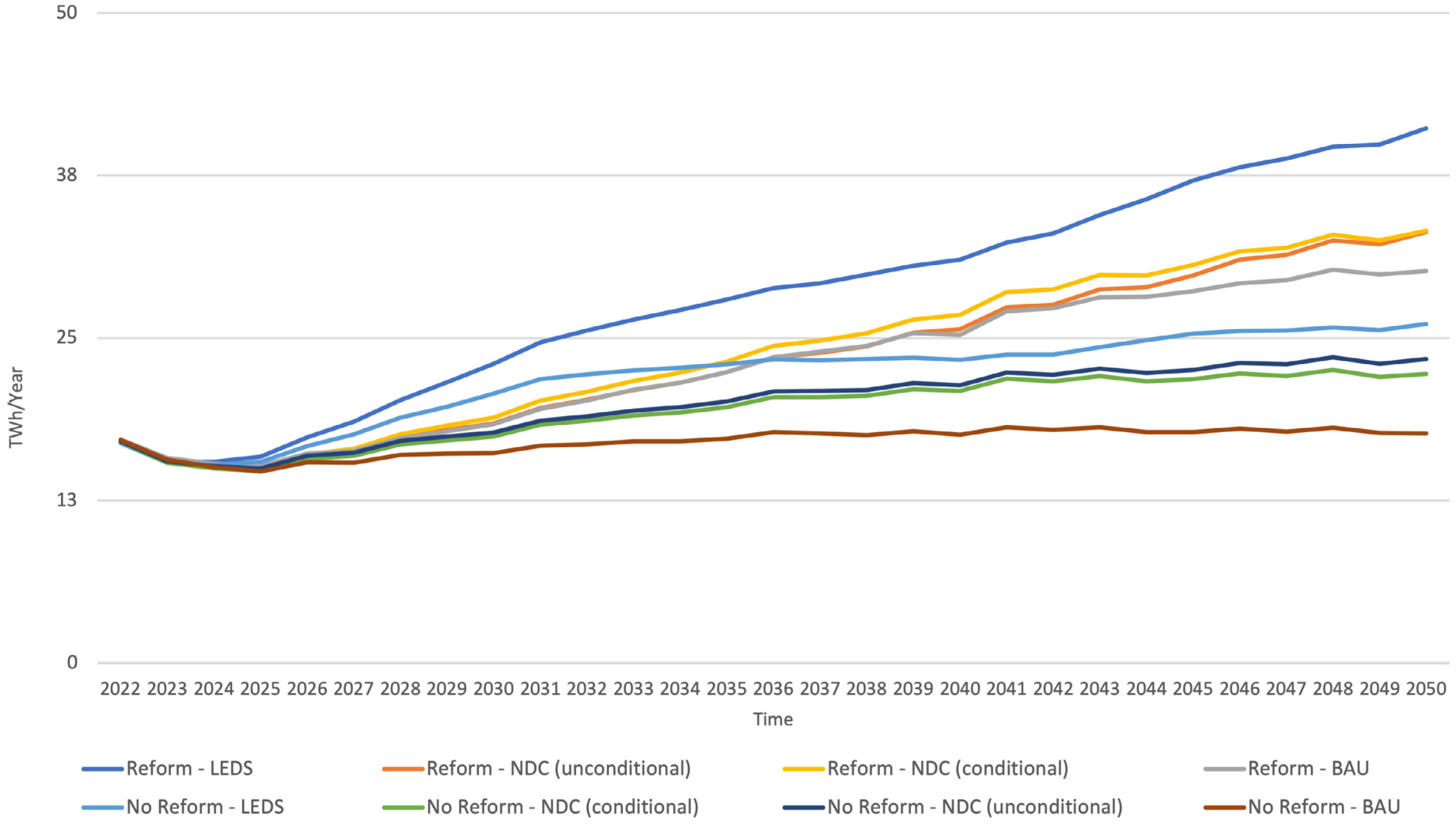

Figure 29: Annual electricity generation, BAU, NDC, and LEDS scenarios, Simulation NR and R

4.5 Transport

In the LEDS scenario, there is a significant increase in ambitions for vehicle electrification, leading to an increase of the total electricity demand resulting in demand reaching 13,910 TJ or 3,864 GWh (LEDS-NR) and 20,210 TJ or 5,614 GWh (LEDS-R) in 2050. In the Nationally Determined Contribution (NDC) scenario, the total number of low carbon vehicles is estimated to be 400,483 vehicles by 2050. **However, within the LEDS scenario, the adoption of low carbon vehicles is significantly higher, with a total of 838,055 (LEDS-NR) and 1.22 million (LEDS-R) vehicles in the year 2050** (Table 6). Table 7 reflects on the types of low-emission vehicles in both LEDS scenarios.

Table 6: Number of low-emission vehicles in various scenarios

	No Reform (NR)			Reform (R)		
Scenario	**2030**	**2040**	**2050**	**2030**	**2040**	**2050**
NDC	118,835	257,851	400,483	128,476	333,514	581,904
LEDS	286,642	398,341	838,055	309,860	515,275	1,217,359

Table 7: Number of low-emission vehicles per type in the LEDS scenarios

	No Reform (NR)			Reform (R)		
Vehicle type	**2030**	**2040**	**2050**	**2030**	**2040**	**2050**
Plug-in hybrid	100,325	139,419	293,319	108,451	180,346	426,075
Hybrid	42,996	59,751	125,708	46,479	77,291	182,604
Electric	143,321	199,170	419,027	154,930	257,638	608,679

Lebanon's transportation demand is projected to expand significantly by 2050, primarily due to demographic and economic growth. To accommodate this growth, an integrated and well-planned transportation network is essential. This network should cater to the diverse needs of administrative and social services, economic development, educational establishments, and recreational activities.

4.6 Environment

4.6.1 Forestry

Concerning environmental indicators, forest cover experiences a positive change, with forested land totalling 146,850 hectares in 2050 compared to 121,410 hectares in 2050 under BAU conditions, which was witnessing a decline in forested areas (Figure 30).

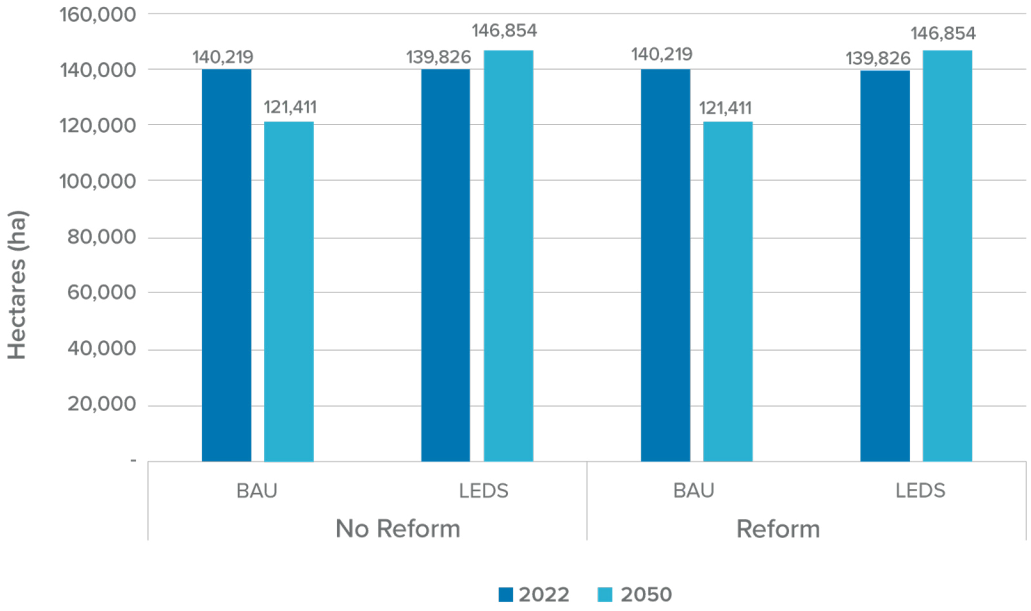

Figure 30: Forest cover by 2050 for the BAU and LEDS scenarios

4.6.2 Water

Through improvements in water efficiency, which includes measures to reduce water consumption in residential, industrial, and agricultural sectors, Lebanon's total water demand, under the LEDS-NR scenario, is expected to decrease by 3.3% compared to the BAU scenario (from 2,016 to 1,949 million m^3 per year) by 2050 (Figure 31), thus decreasing the pressure from population growth, economic development (measured by GDP growth), and expansion of agriculture land.

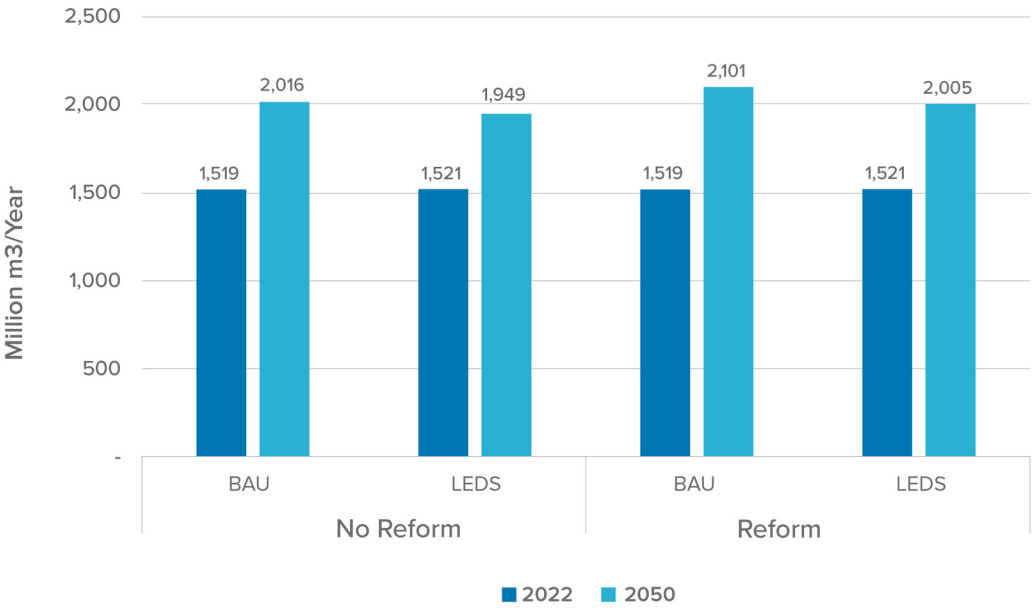

Figure 31: Total water demand by 2050 for the BAU and LEDS scenarios

Similarly, the promotion of water-saving technologies, reduction of water wastage, and responsible water consumption in households and industries under a LEDS scenario can lead to a 50% decline in residential water demand from 1,100 million m^3 under BAU to 550 million m^3 per year in 2050, and a 22.8% decline in industrial water demand, reaching 54 million m^3 per year by 2050, compared to 59 million m^3 under BAU conditions.

Agriculture is the only sector that will witness an increase in water demand to 1,350 million m^3 per year by 2050 under LEDS (compared to 850 million m^3 under BAU scenario) due to the increase in domestic agricultural production in addition to population growth, land use changes, and shifts in diet, despite improvements in water use efficiency within the agricultural sector.

In general, the LEDS aims to ensure the sustainable use of water resources by optimizing water usage across sectors, thereby mitigating the strain on water supply systems, and preserving the availability of water for residential, industrial, and agricultural needs while ensuring economic growth.

4.6.3 Built Environment

Cumulative damages from climate change in Lebanon are projected to increase sharply over time. As shown in Figure 32, damages in 2022 are estimated at USD 40.6 billion across all scenarios. However, by 2050, these damages rise substantially reaching USD 79.6 billion under the No Reform (BAU-NR) scenario and USD 97.8 billion under the Reform (BAU-R) scenario. This upward shift highlights the growing economic burden of climate change if no significant mitigation measures are taken. Even with reforms, the increase to USD 90.8 billion (LEDS-R) suggests that reforms alone are not enough without a comprehensive low-emission strategy. These differences underscore the importance of both reforms and aggressive emissions reductions to curb future economic losses.

In terms of coastal flooding, results of the analysis for Beirut and the impact of sea level rise on urban buildings can be found in Figure 33.

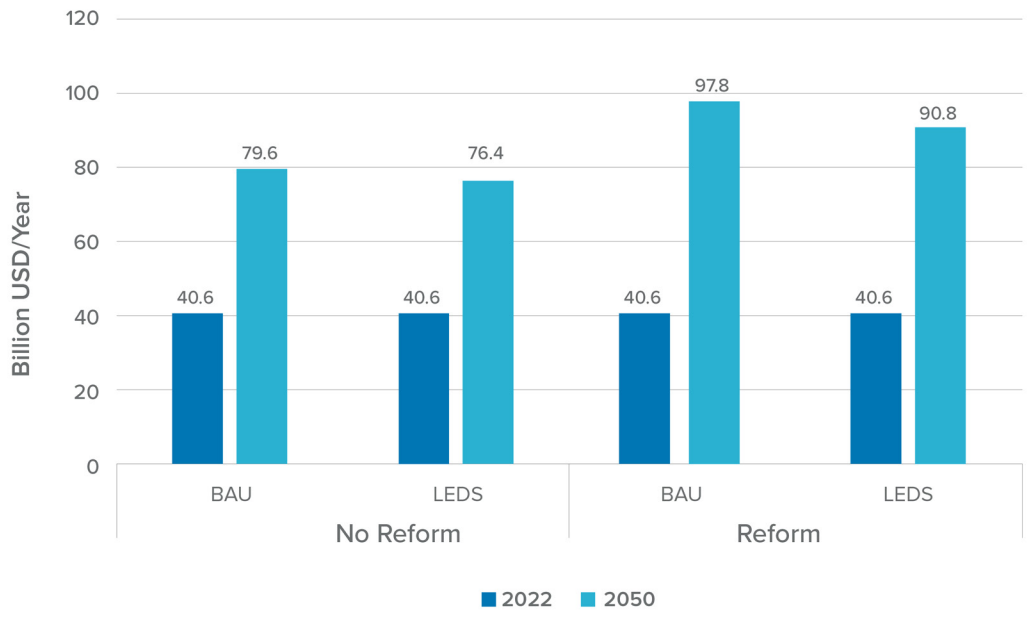

Figure 32: Cumulative climate change damages the BAU and LEDS scenarios for 2022 and 2050

In terms of submerged buildings across the Lebanese coastline, approximately 1,027 buildings in Lebanon are projected to be submerged under the Business-As-Usual (BAU) scenario by 2050, with this number rising to 1,719 buildings by 2100.

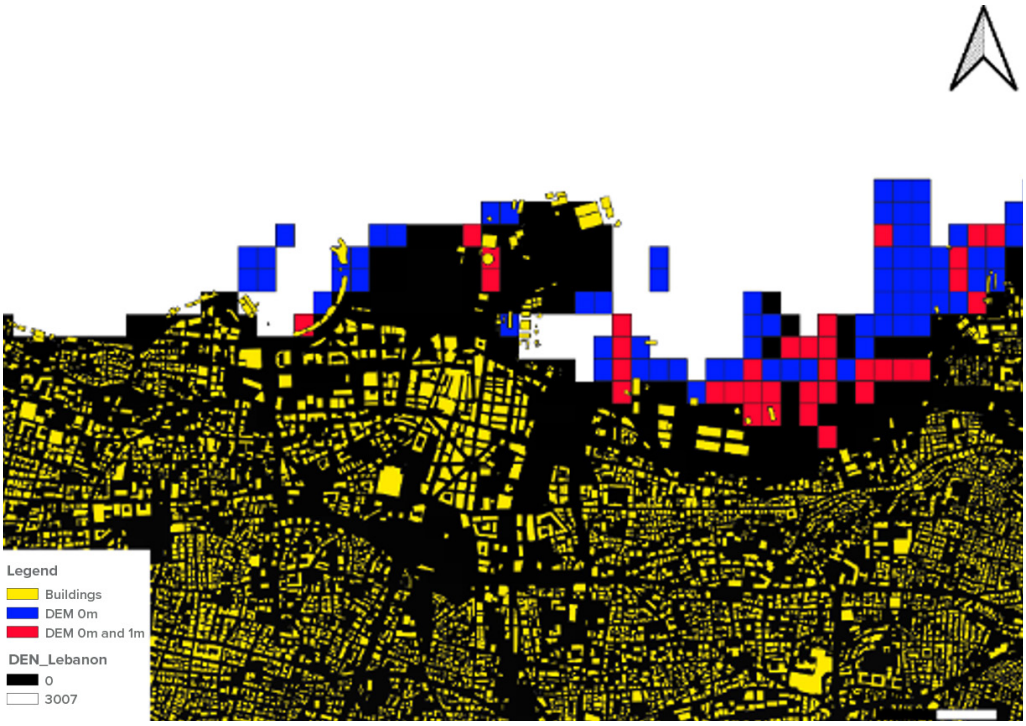

Figure 33: Coastal flooding analysis for Beirut

4.7 Lebanon's CO_2 Projected Pathway Scenarios: LEDS as the Optimal Solution

Although insignificant at the global level, Lebanon's GHG emissions have historically grown by 7% per year, mainly driven by increased energy demand in energy and transport. Under current circumstances, and even with reforms, emissions are expected to double by 2050, reaching up to 40.5 million tonnes (BAU-R), highlighting the unsustainable path of continuing current practices without meaningful changes. Consequently, Lebanon's NDC in 2021 was the first attempt to design plans and policies that help in reducing emissions. In fact, implementing the NDC unconditional scenario forecasts a decrease to 10.2 million tonnes by 2050, and even more to 6.9 million tonnes under the conditional scenario, showcasing the country's efforts towards mitigating climate change (Figure 34).

In contrast, the NDC (Nationally Determined Contributions) scenarios, both conditional and unconditional, already show positive steps towards reducing CO_2 emissions. Under the NDC-Conditional scenario, emissions are projected to decrease to 6.9 million tonnes without reforms and to 8.0 million tonnes with reforms by 2050. Similarly, the NDC-Unconditional scenario forecasts a reduction to 10.2 million tonnes without reforms and 8.7 million tonnes with reforms by 2050. These projections indicate that Lebanon is on track to achieve significant emission reductions under its current NDC commitments, showcasing the country's efforts towards mitigating climate change (Figure 34).

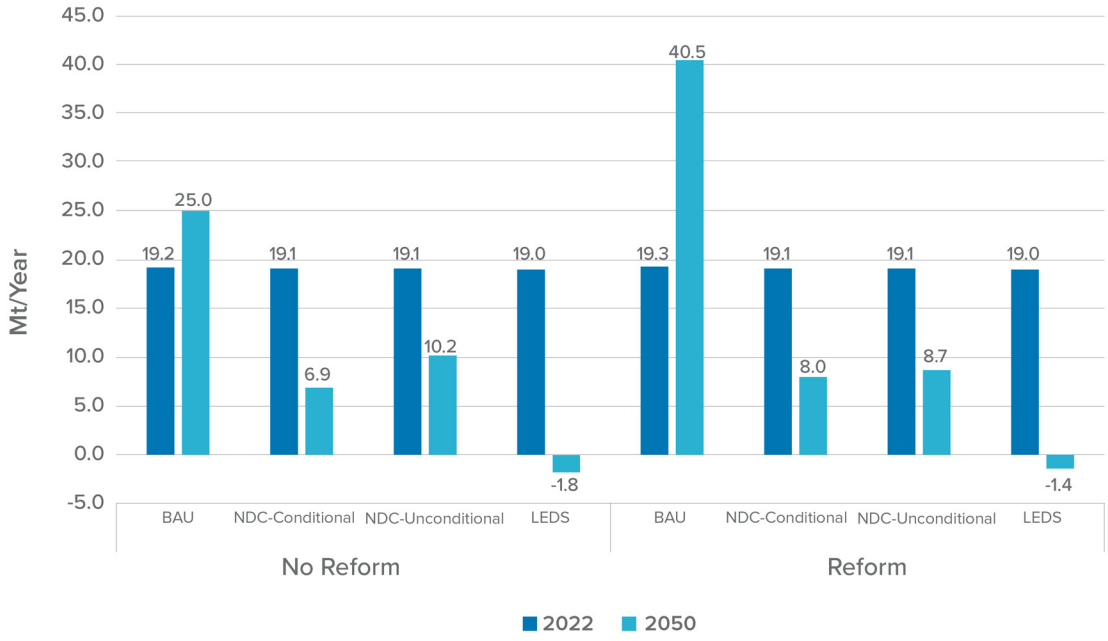

Figure 34: Annual CO_2 eq. emissions for the BAU and LEDS scenarios for 2022 and 2050

However, a trend analysis from 2022 to 2050 for all projected pathways shows that the LEDS scenario presents an even more ambitious and effective pathway for CO_2eq. reduction. Under the LEDS scenario, emissions not only decline, but they reach a net negative status, with -1.8 million tonnes of CO_2eq. without reforms (LEDS-NR) and -1.4 million tonnes with reforms (LEDS-R) by 2050 (Figure 35). This transition to a net sink—where the removal of greenhouse gases from the atmosphere exceeds the emissions produced—demonstrates the superior effectiveness of the LEDS approach.

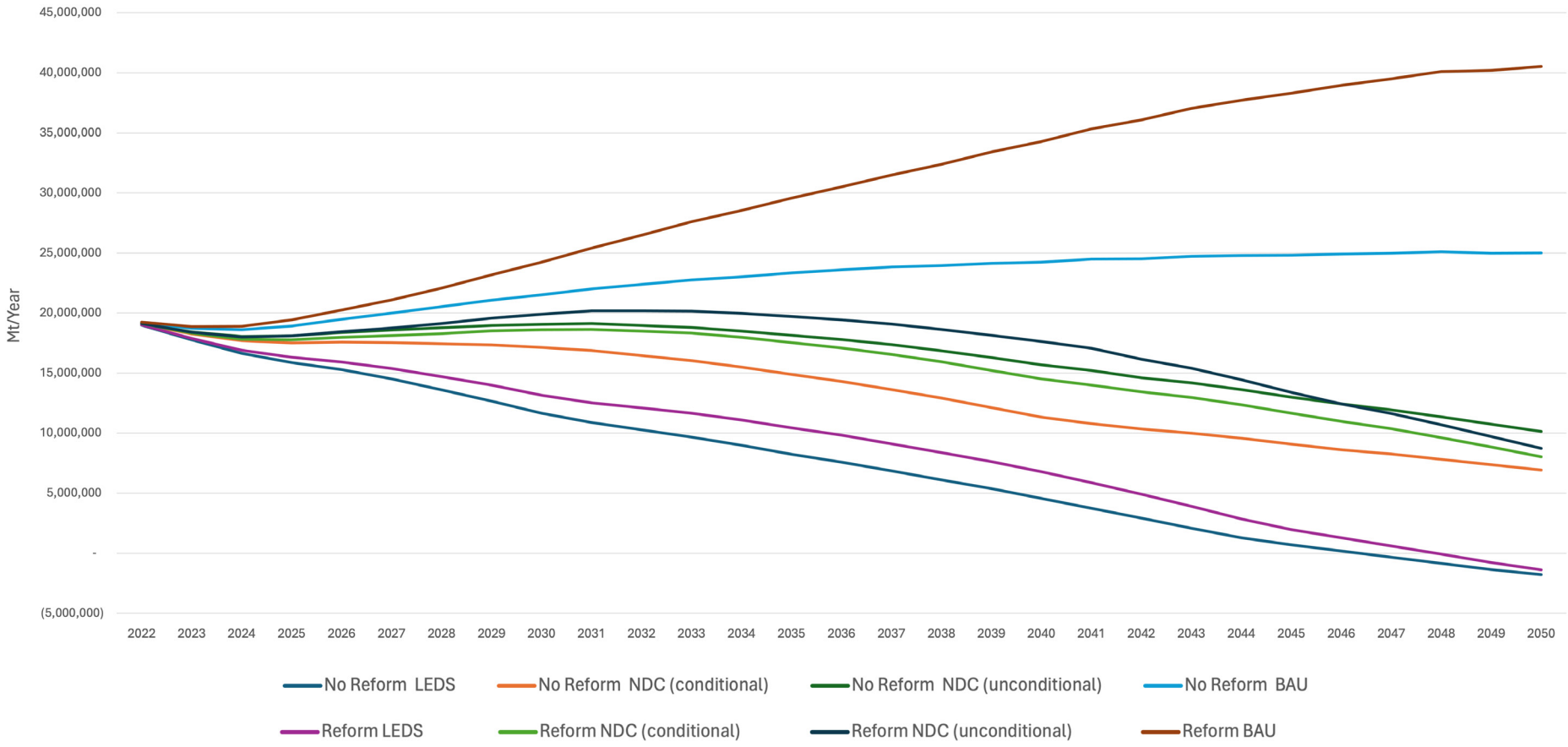

Figure 35: Trend of annual CO_2 eq. emissions for the BAU and LEDS scenarios from 2022 to 2050

The dramatic reduction in emissions under the LEDS scenario is driven by a combination of factors, namely higher economic growth (GDP), strategic population policies, enhanced energy efficiency, increased electrification, widespread adoption of renewable energy sources, and comprehensive, bold policy measures across multiple sectors. Compared to the NDC scenarios, which already show a commendable reduction in emissions, the LEDS approach offers a more aggressive and successful strategy for achieving even greater reductions, positioning Lebanon as a leader in climate action and sustainability (Table 8). This highlights the critical importance of adopting the LEDS pathway to maximize CO_2 reductions and move towards a sustainable, low-carbon future.

Table 8: Evolution of GHG emissions, different scenarios, for both Reform and No Reform simulations

No Reform (NR) (in million tonnes)				Reform (R) (in million tonnes)		
Scenario	**2030**	**2040**	**2050**	**2030**	**2040**	**2050**
BAU-NR	21.51	24.23	25.01	24.24	34.26	40.53
NDC (unconditional)	19.05	15.69	10.15	19.89	17.62	8.73
NDC (conditional)	17.13	11.34	6.92	18.60	14.52	8.04
LEDS	10.88	4.57	-1.78	13.14	6.78	-1.37

4.8 Benefits of Implementing the LEDS Scenario: Unlocking Sustainable Growth

To fully grasp the benefits of implementing the LEDS scenario, it is crucial first to understand Lebanon's current progress in meeting its Nationally Determined Contributions (NDCs) and Sustainable Development Goals (SDGs). Evaluating where Lebanon currently stands with its commitments provides a baseline for measuring the potential impact of adopting the LEDS approach. By assessing progress towards reducing greenhouse gas emissions, enhancing sustainable practices, and achieving socio-economic targets, identification of gaps and opportunities can be achieved. This foundational understanding enables strategically planning the LEDS implementation to build on existing efforts, optimize outcomes, and ensure a more sustainable and resilient future for Lebanon.

4.8.1 Lebanon's NDC-2020 compliance and SDG Co-Benefits:

Assessing NDCs and considering equity principles helps in understanding their compliance with the Paris Agreement's temperature goals. Therefore, the assessment integrates equity considerations, historical emissions, and Lebanon's capabilities (GDP or Human Development Index, HDI) to assess the fairness of its NDC's emission reduction targets[23] (AROHA/CVF, 2023).

Key components of the assessment include:

1. Emissions Envelope of Responsibility: Considers cumulative emissions from 1950 or 1990 to 2100.
2. Capability Allocation: Wealthier countries (higher GDP or HDI) are allocated more responsibility for negative emissions.
3. Equity Framework: Evaluates countries' fair share in limiting global warming to 1.5°C, using IPCC scenario groups.
4. Traffic Light System: Classifies countries' NDCs into **green (compliant), orange (near compliant), and red (non-compliant)** based on their alignment with the Paris Agreement.

[23] The Traffic Light Assessment (TLA) report developed and published by CVF, evaluates the compliance of countries' Nationally Determined Contributions (NDCs) with the Paris Agreement's temperature goals and equity principles.

The assessment uses a fair share approach combining historical responsibility and capability to allocate global positive and negative emissions. The assessment excludes LULUCF emissions and focuses on direct emissions.

In the Lebanese context, the following conclusions are drawn when assessing compliance with the Paris Agreement based on its NDC targets:

1. **Emission Reduction Targets**: Lebanon's NDC targets are aligned with the Paris Agreement's 1.5°C goal. However, its implementation towards reaching its target requires significant improvements.

2. **Current Emissions**: Lebanon, along with other vulnerable countries, has relatively low per capita emissions and contributes a minor share to global emissions.

3. **Equity Compliance**: Lebanon's NDCs reflect efforts to meet its fair share of global emission reductions, considering its economic and developmental context.

4. **Global Context**: Vulnerable countries collectively contribute a small fraction of global emissions, but they are crucial in the global effort to combat climate change due to their high vulnerability to its impacts.

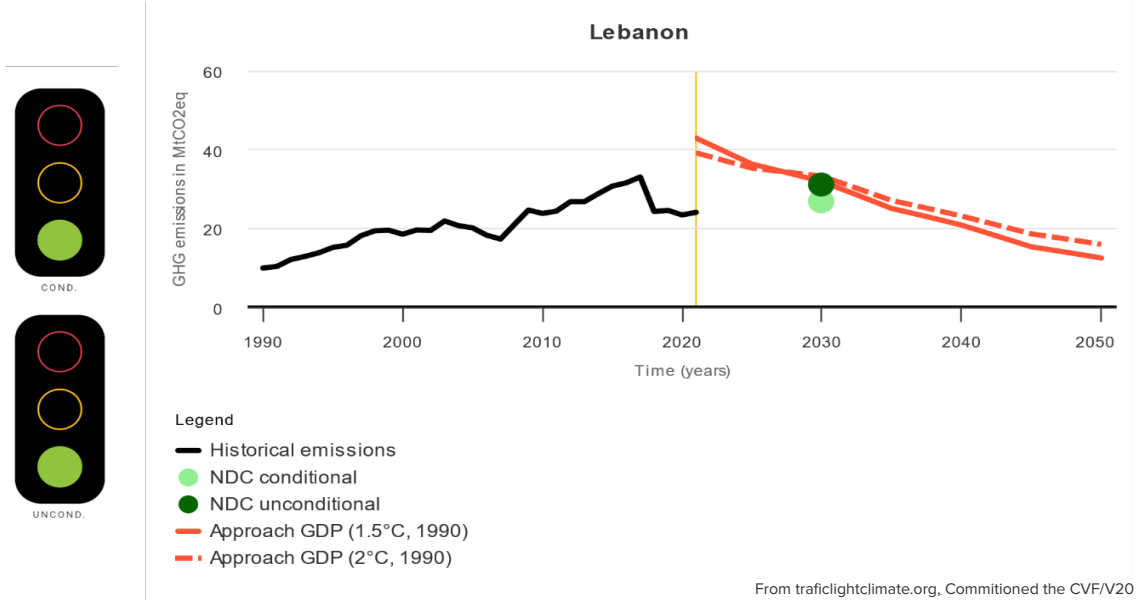

Figure 36: Lebanon's classification as per the CVF Traffic Light Assessment

For Lebanon, the assessment highlights the need for:

- **Enhanced International Support**: Financial and technological assistance to achieve its NDC targets.
- **Strengthening NDC implementation**: To move towards full compliance with the Paris Agreement.
- **Continued Monitoring**: Regular assessment and adjustment of targets based on updated climate data and international commitments.

In terms of classification, Lebanon has been assigned green (Figure 36), indicating that Lebanon's NDC targets are compliant with the Paris Agreement's temperature goal and equity principles, implying equitably derived consistency with limiting warming to just below 2°C. Countries in this category are doing their fair share to adhere to the Paris Agreement goals.

The implementation of LEDS scenario measures will, likewise, serve to stimulate progress towards the achievement of the Nationally determined contributions (NDCs), and, in turn, bring Lebanon closer toward contributing to the global Sustainable Development Goals achievement. The figure below, produced

based on the LEDS scenario, illustrates this progress relative to the BAU-NR scenario, which is particularly important for SDG 3 (Good health and well-being), with a 38.1% boost to progress by 2030, SDG 2 (Zero hunger), a 34.3% boost to progress by 2030, and SDG 7 (affordable and clean energy), a 24.6% boost to progress by 2030 (Figure 37).

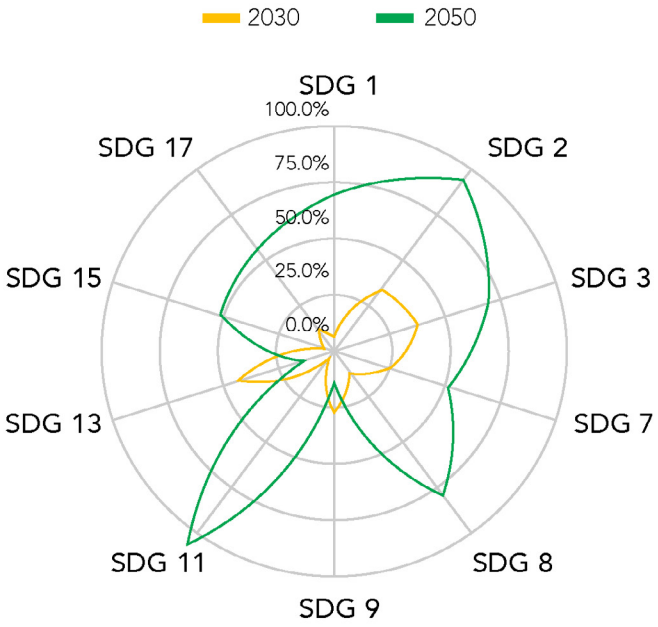

Figure 37: SDG progress in the LEDS-NR scenario, 2030/2050

The model also demonstrates that the implementation of the proposed measures will contribute to helping Lebanon achieve the Sustainable Development Goals (SDGs) by boosting progress towards the realization of these objectives. The LEDS-NR scenario shows that progress will be made towards SDG 3 (Good health and well-being), with a 38.1% boost to progress by 2030, SDG 2 (Zero hunger), with a 34.3% boost to progress by 2030, and SDG 7 (affordable and clean energy), with a 24.6% boost to progress by 2030. Table 9 below summarizes the projected progress.

Table 9: Boost to progress towards SDG achievement (LEDS-NR scenario)

	2030	2050
SDG 1 (no poverty)	6.4%	37.8%
SDG 2 (zero hunger)	34.3%	69.0%
SDG 3 (good health and well-being)	38.1%	94.4%
SDG 7 (affordable and clean energy)	24.6%	69.4%
SDG 8 (decent work and economic growth)	11.6%	51.2%
SDG 9 (industry, innovation and infrastructure)	27.5%	79.8%
SDG 11 (sustainable cities and communities)	4.0%	13.9%
SDG 13 (climate action)	43.2%	106.4%
SDG 15 (life on land)	4.0%	13.9%
SDG 17 (partnerships for the goals)	11.6%	51.2%

4.8.2 Gender Equality and Social Inclusion (GESI) in Lebanon's LT-LEDS:

Lebanon recognizes that gender equality is not only a human right but also a prerequisite for sustainable development, aligning with global frameworks such as the Paris Agreement, the 2030 Agenda for Sustainable Development (SDG 5), and the Lima Work Program on Gender. As part of its climate strategy, Lebanon has started integrating gender-responsive policies across its initiatives, ensuring inclusive participation and equitable access to resources.

However, a gender analysis conducted in 2020 by the Ministry of Environment, with the support of UNDP, highlighted how significant gender and social inequalities still persist. These inequalities are especially visible when it comes to access to land, resources, education, and economic participation in the energy and waste sectors[24]. The analysis includes the lack of gender-disaggregated data, except in agriculture, limiting the effectiveness of gender-informed policies.

Lebanon's National Adaptation Plan (NAP) incorporates gender-responsive strategies by emphasizing inclusive stakeholder engagement and capacity-building programs at national and local levels. Collaborating with the National Council for Lebanese Women (NCLW), the NAP promotes gender-balanced representation in consultations and sectoral policies, establishing key entry points for gender inclusion in climate adaptation.

The Climate Change Capacity Building Initiative for Transparency (CBIT) builds on the NAP's efforts, focusing on strengthening institutional capacities to implement Lebanon's enhanced transparency framework. CBIT ensures that GESI considerations are integrated into policy consultations, data collection methodologies, and transparency strategies. This ensures the equitable participation of women in institutional arrangements, reinforcing gender-responsive climate governance.

Lebanon also committed to the gender-responsive just transition pledge, launched at COP28 in Dubai. This pledge emphasizes addressing intersecting inequalities faced by marginalized groups, including women in rural areas, indigenous communities, and persons with disabilities. It advocates secure land rights, education in climate-smart practices, access to funding, and gender-responsive budgeting, ensuring climate policies actively address gender disparities.

Gender-responsive budgeting plays a critical role by allocating financial resources equitably to address the specific needs of women and marginalized communities in adaptation, mitigation, and resilience-building efforts. This approach prioritizes investments in women-led initiatives, renewable energy projects that create jobs for women, and climate-smart agriculture programs tailored to women's roles in resource management.

By aligning GESI principles with its LEDS approach, Lebanon ensures that women and vulnerable populations actively participate in, and benefit from, the country's transition to a net-zero and climate-resilient future. Through inclusive governance, stakeholder engagement, and gender-responsive policies, Lebanon is building a sustainable and equitable climate future that addresses the diverse needs of all its citizens.

The integration of the GESI principles into the objectives and targets used to develop the LEDS scenario are elaborated further in **Annex VI.**

4.8.3 Macroeconomic and Cost and Benefit Implications of the LEDS Scenario

The macroeconomics and Cost-Benefit Analysis (CBA) shows that pursuing the objectives of the LEDS scenario will improve Lebanon's performance on a significant number of indicators compared to a Business-As-Usual situation; this is true even compared to a situation representing the implementation of its current NDCs. Additionally, it exhibits the values of the boost delivered to each indicator by LEDS

[24] UNDP, MoE (2020). Gender analysis report: Addressing gender and social inequalities in Lebanon's energy and waste sectors. https://climatepromise.undp.org/sites/default/files/research_report_document/undp-ndcsp-lebanon-gender-analysis-report.pdf?utm_source=chatgpt.com

interventions, for LEDS-NR (compared to BAU-NR) and LEDS-R (compared to BAU-R). of the boost delivered to each indicator by LEDS interventions, for LEDS-NR (compared to BAU-NR) and LEDS-R (compared to BAU-R).

Implications for economic growth and employment

The LEDS scenario demonstrates its long-term viability as a sensible economic development strategy. By 2030, in the short term, it generates a Benefit to Cost Ratio (BCR) of 2.24 (LEDS-NR) and 2.29 (LEDS-R), which means that for every USD invested in the LEDS, when using the BAU-NR, 2.24 USD in system-wide benefits are realized. On the other hand, by 2050, the BCR increases to 5.14 (LEDS-NR), signifying that for each USD invested, when using the BAU-NR, USD 5.14 in economic and societal benefits are generated.

These BCR values underscore the effectiveness and economic soundness of the LEDS, with increasingly positive returns over time, making it an effective choice for sustainable and prosperous long-term development.

Table 10 below outlines the CBA indicators related to Lebanon's investments in transition and mitigation measures, as well as resilience and adaptation efforts, from 2022 to 2050. The investments in transition and mitigation efforts, which encompass sectors such as power generation, energy efficiency, and sustainable agriculture, are projected to total USD 8.6 billion by 2030 and USD 14.087 billion by 2050. Meanwhile, investments in resilience and adaptation strategies - covering areas like flood protection, drip irrigation, and urban greening - are estimated at USD 2.1 billion by 2030 and USD 4.2 billion by 2050. The total investment required for these initiatives amounts to USD 12.7 billion for the period 2022-2030, increasing to USD 21.3 billion by 2050.

Table 10: Cost-Benefit Analysis (CBA), 2022-2050, Simulation NR

CBA Indicator	Unit	2022-2030	2022-2050
Investments in transition/Mitigation[1]	USD billion	8.613	14.087
Investments in resilience/Adaptation[2]	USD billion	2.149	4.205
Contingency payments	USD billion	2.010	3.104
Investment required	**USD billion**	**12.772**	**21.396**
Total avoided cost	**USD billion**	**19.643**	**60.158**
Total added benefits	**USD billion**	**8.951**	**49.802**
Net integrated benefits	**USD billion**	**15.821**	**97.159**
Ratio avoided cost to investment		1.54	2.81
Ratio added benefits to investment		0.70	2.33
Ratio avoided cost and added benefits to investment		**2.24**	**5.14**
Net investment	**USD billion**	**10.058**	**17.277**

[1] Power generation, transmission line, industrial Carbon Capture projects, energy efficiency, fuel switch, livestock management, land-based intervention, sustainable agriculture, electrified and non-Motorized transportation, waste management.

[2] Flood protection, drip irrigation, road networks, drainage system, net shading, retrofitting, livestock adaptation, greening urban areas, and water infrastructure.

Beyond these positive sectoral outcomes, the LEDS scenario presents a compelling investment opportunity for Lebanon. Under a no reform scenario (LEDS-NR), investments would amount to USD 12.8 billion, approximately 4% of the GDP by 2030. Although ambitious, this strategy is both economically and financially viable, projecting USD 97.16 billion in cumulative net benefits between 2022 and 2050 for LEDS-NR. This underscores the attractiveness of the LEDS approach, not just for environmental reasons, but as a sound economic strategy.

In terms of economic impact, the total avoided costs- representing the savings from reduced damage and losses due to climate change- are projected to reach USD 19.6 billion by 2030 and significantly rise to USD 60.1 billion by 2050. Added benefits, which capture the additional positive outcomes from these investments, amount to USD 8.9 billion by 2030 and USD 49.8 billion by 2050. The net integrated benefits, combining both avoided costs and added benefits, are estimated at USD 15.8 billion for the short term (2022-2030) and a substantial USD 97.1 billion over the long term (2022-2050).

The cost-benefit analysis further highlights that benefits would already outweigh costs within this decade, with the cost-benefit ratio standing at 2.24 in 2030 (LEDS-NR). This positive trend is expected to strengthen over time, with the ratio increasing to 5.14 by 2050 (LEDS-NR), indicating that each USD invested in the LEDS scenario will yield USD 5.14 of benefits in the long term. These figures suggest that climate action and economic prosperity are not mutually exclusive, but rather mutually reinforcing. Moreover, there are substantial financing opportunities, particularly in the private sector, which could support the successful implementation of LEDS scenario measures.

In general, while the required investment is higher under the BAU-R scenario due to increased energy demand, capital accumulation, and greater climate vulnerability, the LEDS scenario demonstrates larger benefits. This is due to higher avoided costs and added benefits, making the LEDS strategy a viable and desirable economic development strategy under various economic conditions. The table clearly illustrates that adopting the LEDS scenario not only supports sustainable development, but also promotes economic resilience and growth, highlighting its potential as the best path forward for Lebanon.

5. Unlocking Climate Resilience and Net-Zero Financing

Lebanon's climate finance vision involves securing funding from public, private, and international sources to implement the Long Term - Low Emission Development Strategy (LT-LEDS). This finance vision supports climate change mitigation, adaptation, and low-carbon development, enhancing sustainable growth and integrating climate actions into national policies. The UNFCCC Cancun Agreement (2010) commits to providing predictable and adequate funding to developing countries, attracting additional resources as a result. As climate change intensifies risks, climate finance reduces environmental and economic losses and addresses climate-induced problems.

The LEDS scenario outputs and its path forward are clear: Their targets are defined, covering the key areas of economic and climate action. If properly implemented, these actions will launch Lebanon onto a more prosperous trajectory, delivering greater socio-economic benefits for its people, instead of remaining on the current path-based development model.

To implement plans and activities to reach a Low-Emission Development in Lebanon by 2050, significant additional real investments are needed compared to the BAU (Business-As-Usual) scenario. In the LEDS scenario, there's a significant increase in total additional real investment compared to Business-As-Usual (BAU) cases. As presented in Figure 38, by 2030, this extra investment reaches USD 12.1 billion in one scenario (LEDS-NR) and USD 12.84 billion in another (LEDS-R); and by 2050, it goes up to USD 44.29 billion (LEDS-NR) and USD 50.94 billion (LEDS-R).

These investments are driven by ambitious policy initiatives aiming for a more sustainable and climate-resilient economy, alongside substantial investments in adaptation measures to tackle climate change challenges. As a percentage of GDP, the additional real investment under LEDS is substantial, representing 4.1% and 3.9% of GDP by 2030 in the two scenarios. Although this percentage slightly decreases by 2050, it remains significant, at 2.4% and 1.9% of GDP respectively (Figure 39).

Lebanon's transportation demand is projected to expand significantly by 2050, primarily due to demographic and economic growth. To accommodate this growth, an integrated and well-planned transportation network is essential. This network should cater to the diverse needs of administrative and social services, economic development, educational establishments, and recreational activities.

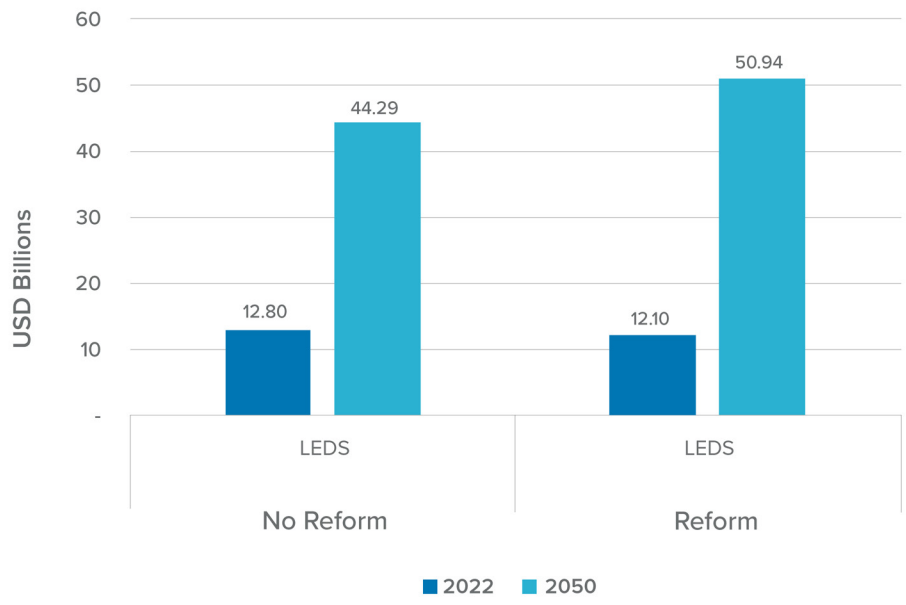

Figure 38: Additional real investment in USD billions for transition and climate resilience, BAU, NDC, and LEDS scenarios

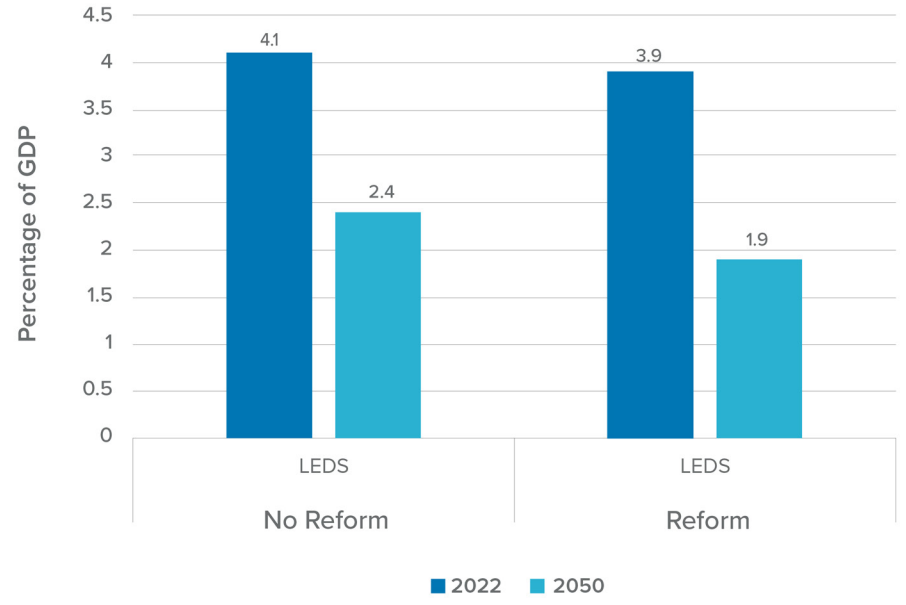

Figure 39: Additional real investment as percentage of GDP in transition and climate resilience as a share of GDP, BAU, NDC, and LEDS scenarios

Lebanon already has a set of development-oriented potential projects identified, which are aligned with the objectives set out in the LT-LEDS; Lebanon will, therefore, contribute to achieving the set targets, especially when climate proofing is properly integrated. These potential projects denote 44 transition projects[25], representing a value of USD 6.90 billion, and 39 resilience[26] projects, representing a value of USD 4.92 billion[27]. These projects cover sectors such as renewable energy, water and waste management, sustainable agriculture, forestry, and biodiversity conservation. The table below (Table 11) summarizes these elements.

Table 11: Overview of active and planned projects

Project type	Number of projects	Value (USD billions)
Transition	44	6.90
Resilience	39	4.92
Total	**83**	**11.83**

Gaps also exist, notably in the areas of health, coastal protection, urban resilience, and transitioning off the vehicle fleet. The full funding of these projects, as well as the development of concrete projects to meet the targets in need of implementation, represents the next step in realizing the LT-LEDS. Furthermore, the Lebanese government has conducted a comprehensive climate-proofing review of its wider project portfolio, identifying how planned projects can be enhanced to include a resilience-building element (UNDP, 2021). These also represent interesting investment opportunities.

Accordingly, Lebanon calls on the support of its international partners since the country has demonstrated a clear, ambitious vision of a future where development and commitment to the planet go hand in hand. This vision is worth approximately USD 51 billion; and it is backed by a strong will. **The LT-LEDS is therefore a strong signal to the international community: Lebanon has a plan and is committed to developing its key sectors in a green sustainable manner**. Annex VIII lists the short-term projects (worth USD 11.83 billion) that will make a positive contribution to achieving the objectives of LT-LEDS.

Transition and resilience projects reflected in Annex VIII cover a multitude of sectors including agriculture, tourism, circular economy, energy, and transport. Considering the role they play regarding GHG emissions in Lebanon, further assessment on how best to climate-proof these sectors were carried out to provide sectoral objectives, targets, and a way forward towards a net-zero future.

[25] Refer to projects that aim to shift economic activities, infrastructure, or policies toward more sustainable, low-carbon, and climate-resilient practices.

[26] Refer to projects designed to enhance the ability of communities, ecosystems, or infrastructure to anticipate, absorb, recover from, and adapt to climate-related shocks and long-term environmental changes.

[27] Not all transition and resilience projects have an indicated value.

6. Climate-Proofing and Financing Lebanon's Key Sectors

To climate-proof sectors that are projected to be major emitters or the most vulnerable in the future such as energy, tourism, agriculture, and transport, the Long Term - Low Emission Development Strategy (LT-LEDS) serves as a comprehensive roadmap, integrating strategic investments to enhance climate resilience and foster a green transition. Based on a participatory approach adopted under the Lebanon 100% Vision, a climate-proofing roadmap for key sectors is proposed below. By targeting key sectors with coordinated actions, the strategy aims to position Lebanon for a sustainable and prosperous future, driving economic growth, enhancing quality of life, and ensuring environmental sustainability.

6.1 2050 A Highly Performing Resilient Agriculture Sector

Developing a low emission climate resilient approach for the agriculture sector in Lebanon over a relatively long-term period (for 2050) is very challenging. The volatility of the political situation in Lebanon and the recurrent socio-economic crisis cuts short any attempt for implementation of existing strategies. Yet, the reforms required for agriculture need to address the root problems that restrain agriculture.

A new approach should be adopted to achieve a high-performing agriculture sector by 2050, with an emphasis on fostering young skilled entrepreneurs, preserving land from fragmentation, promoting technological innovation in water use, valorising climate-smart plant and animal genetics, adopting sustainable production systems, securing profitable markets, and encouraging behavioural change across the industry. These objectives can be achieved through the following actions:

1. Young skilled entrepreneurs and farmers lead the sector

The aging farmer population in Lebanon, hindered by physical limitations and outdated practices, struggles without youth engagement in agribusiness. Youth reluctance stems from the industry's low cost-effectiveness, market uncertainties, and lack of social safety nets. Solutions include updating agricultural education and vocational training to align with market needs, integrating modern technologies, and enhancing infrastructure. Capacity building for farmers, fostering research and development, supporting start-ups, and strengthening farmer associations are also essential to revitalize the sector and attract young talent.

2. Agriculture arable land is preserved from fragmentation and change of usage

To achieve a performant agriculture system by 2050, preserving agricultural assets and resources is crucial. This involves revising inheritance laws to ensure fair land distribution among heirs and facilitating the transfer of lands to active farmers by prohibiting the division of agricultural parcels below a certain size and establishing compensation mechanisms. Strategic land use planning and regulations are necessary to conserve arable lands, which include creating land capability maps, designating protected agriculture zones, and deploying infrastructure to reach arable lands. These steps aim to preserve fertile lands, improve infrastructure efficiency, and support the sustainable development of Lebanon's agriculture sector.

3. Water efficient harvesting and use through innovative techniques are secured

A cross-cutting goal, updating water laws and water infrastructure, and on-farm practices remain crucial for agricultural development. Implementing non-conventional water harvesting technologies is essential to meet the growing water demand, yet adoption is hindered by water quality issues, outdated distribution systems, and management inefficiencies. Climate change necessitates evolving legal frameworks for water user associations and management. Efficient irrigation systems, such as drip

irrigation with climate-based scheduling, are vital but challenged by outdated laws and a lack of agricultural credit systems. A comprehensive approach is needed to promote efficient irrigation and sustainable water management.

4. Performant and climate-smart plant and animal genetic material is valorized

Lebanon aims to balance native and climate-smart landraces to enhance production and meet market and climate challenges. This includes establishing legal and operational frameworks for property rights, national registries, and updated laws, involving academic and research institutions, private nurseries, and international agencies. The promotion of imported climate-smart breeds focuses on those that do not compete with local varieties and meet food safety standards; these breeds are supported by incentives and effective extension services. This comprehensive strategy ensures Lebanon's agriculture sector is equipped to navigate future challenges and maximize its potential.

5. Sustainable agriculture production systems are adopted

Sustainable agriculture focuses on profitability and resource efficiency, reducing reliance on fossil fuels, labour, and heavy machinery. Key practices include reducing GHG emissions, valorizing agricultural waste, and minimizing irrigation and space use. Financial support should shift to evaluate the sustainability and impact of various agricultural systems such as organic farming, conservation agriculture, agroforestry, and climate-smart crop rotations. These systems should be included in education and training, supported by renewable energy initiatives and biodegradable materials. Legal and organizational frameworks should promote innovation with incentives and effective dissemination strategies, while capacity-building services must continually integrate new technologies.

6. Profitable markets are secured

Lebanon's agriculture sector faces issues such as inconsistent quality, chaotic traceability, and lack of transparency, affecting local and export markets. Since the dissolution of the fruit and vegetable bureau in the 1980s, exports have been opportunistic. To address this issue, key measures include empowering farmers, improving market governance, and reestablishing export boards for major value chains. Strengthening farmer associations, implementing transparent regulations, and developing traceability systems are essential. Strategies will focus on institutional reforms, public-private partnerships, and meeting international standards through modernized infrastructure and food quality control labs.

7. Behavioural change is promoted

The relationship between agriculture and society is evolving due to factors such as aging farmers and smaller property sizes as a result of inheritance divisions. These changes result in three scenarios: status quo with non-qualified labor managing farms, modernization with digital techniques, and the rise of agriculture entrepreneurs. Socio-economically, women will play a bigger role, enhancing gender equity and job creation. Food consumption changes will increase locally processed and artisanal foods. The value chain will diversify with direct farmer-to-consumer sales and agro-tourism. Rural energy production will shift towards fuel wood and agricultural residues. Climate change will impact commodity prices, altering international trade and market preferences. Modernizing agricultural production by reduced chemical inputs and water use needs to be the way forward.

In conclusion, the outlined objectives aim to reshape Lebanon's agriculture sector into a resilient, sustainable, and inclusive entity poised to thrive in the face of evolving challenges and opportunities. Figure 40 summarizes this proposed multifaceted approach, encompassing various actions targeting different aspects of the agriculture landscape.

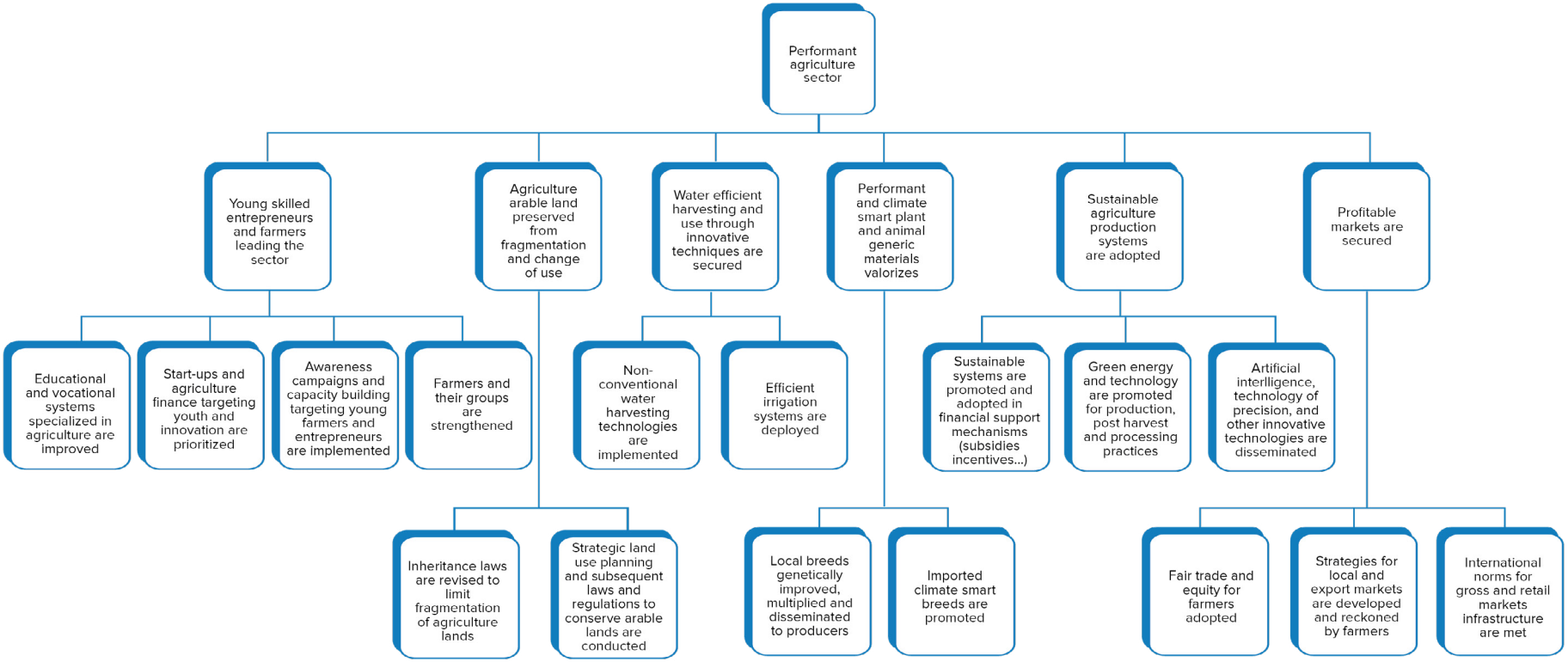

Figure 40: A multifaceted approach for a performant agricultural sector, encompassing various actions targeting different aspects of the agriculture landscape

6.2 2050 Climate-adapted and Responsible Tourism

To ensure the sustainable development of Lebanon's tourism sector, a tiered approach should be followed focusing on concrete actions rather than strategic outlines. This approach needs to be in line with the outcomes and targets of the 2050 Long-Term Low Emission Development Strategy (LEDS), divided into immediate, short-term, and long-term actions.

Immediate Actions (1-2 Years):

1. Establish the National Sustainable Tourism Council (NSTC) with representatives from various ministries, private sector stakeholders, and environmental and cultural groups, with clear roles, responsibilities, and authority to implement and oversee sustainable tourism policies.

2. Launch a national online platform for sustainable tourism to share data, facilitate collaborations, and promote green suppliers and projects, including tools to measure emissions and provide decarbonization solutions.

3. Initiate awareness and training programs through developing educational programs for local communities, tourism operators, and government officials, promoting youth involvement through a Youth Ambassadors program.

4. Transform basic infrastructure into sustainable ones such as reliable and accessible transportation networks within major tourism destinations adapted to eco-friendly options, namely electric vehicles, biking paths, and pedestrian pathways.

5. Strengthen the Ministry of Tourism to ensure efficient operations with a clear mandate, encourage and monitor ISO standards, and implement a high-performance HR system.

Short-Term Actions (2-5 Years):

1. Transform villages, towns, and ancient cities into certified green tourism destinations and promote eco-friendly accommodations and attractions.

2. Foster public-private partnerships to boost economic value through sustainable practices and develop fiscal incentives to support SMEs and local artisans involved in tourism.

3. Implement sector-specific climate actions, tailored for various tourism sectors such as tour operators, accommodations, and transportation, focusing on reducing emissions through green construction, energy efficiency, waste management, and sustainable procurement.

4. Enhance digitalization and smart technology use to reduce emissions and improve efficiency in tourism operations. Develop virtual reality experiences to attract tourists interested in sustainable practices.

5. Expand green transportation infrastructure through developing long-distance, eco-friendly transportation systems such as an eco-friendly railway network or speed boat routes connecting coastal cities. Improve connectivity between Beirut airport and major tourist destinations.

Long-Term Actions (5-15 Years):

1. Achieve Net-Zero emissions by 2050 by continuously decarbonizing tourism activities and infrastructure and implementing advanced technologies and innovations.

2. Revive and expand historic travel routes including rail connections with neighbouring countries. Promote cross-border tourism with eco-friendly options.

3. Promote inclusive and accessible tourism, ensuring that all facilities and services are accessible to people with disabilities, and develop tourism programs that cater to diverse groups.

4. Enhance marine and coastal tourism by creating protected marine areas. Promote activities like diving and underwater archaeology in collaboration with international organizations for marine conservation projects.

5. Monitor, evaluate, and adjust plans to evaluate the effectiveness of sustainable tourism initiatives, regularly updating the action plan based on feedback and best practices.

By implementing such a strategic and tiered approach, Lebanon can transform its tourism sector into a model of sustainability, boosting the economy, while preserving its natural and cultural heritage and mitigating future climate change impacts.

6.3 2050 Resource-Efficient and Circular Material Systems

By 2050, Lebanon's material management system will fully transition into a circular economy, reducing GHG emissions, eliminating waste, and minimizing resource extraction. This transformation will support local industries, create green jobs, and promote environmental sustainability. Full material recirculation, zero landfilling, and a significant reduction in toxic chemicals used in production will be achieved, aligning Lebanon with global climate targets and the Paris Agreement.

This can be achieved through a strategic approach of 1) establishing robust regulatory frameworks and aligning with international standards to drive material circularity and climate compliance, 2) transitioning towards a circular economy model by optimizing material flows, resource recovery, and sustainable production, while 3) ensuring long-term sustainability and competitiveness through promoting sustainable industrial practices and strengthening local industries and 4) building capacity and economic value through green jobs, innovation, and entrepreneurship.

To reach a resource efficient and circular material model by 2050, a set of short term and long-term actions are proposed in Table 12 in line with the LEDS vision and targets.

Table 12: Action plan for resource management

Action	Target	Description
Short-Term Actions (1-5 years)		
Material Waste Diversion	50% waste diversion from landfills by 2030	Implement national waste separation programs for households and industries. Build decentralized recycling and composting centres. Launch public awareness campaigns.
Promote Circular Business Models	30% increase in circular businesses	Provide financial and technical support for circular startups. Develop incentives for repair, refurbishment, and upcycling, including reverse logistics systems.
Extended Producer Responsibility (EPR)	EPR laws for plastics and electronics by 2028	Enforce EPR laws that make producers responsible for product lifecycles. Set up take-back schemes for product reclamation and recycling.
Develop Material Recovery Facilities (MRFs)	Establish MRFs by 2028	Build decentralized material recovery facilities in industrial zones. Foster industrial symbiosis by encouraging industries to reuse waste as raw materials.
Reduce Toxic Chemicals in Production	30% reduction in toxic chemicals by 2030	Implement regulations to phase out toxic chemicals. Support industries transitioning to safer, non-toxic materials.
Long-Term Actions (5-15 years)		
Full Material Recirculation	100% material recovery by 2050	Expand reverse logistics and repair services. Invest in advanced recycling infrastructure and lifecycle tracking of materials for complete recirculation.
Decarbonize Waste and Industry	80% reduction in GHG emissions by 2050	Introduce carbon pricing for waste-intensive industries. Promote waste-to-energy solutions such as biogas production. Ban landfilling and incineration by 2045.

Action	Target	Description
Long-Term Actions (5-15 years)		
Promote Sustainable Production	90% adoption of eco-design by 2040	Mandate eco-design standards to ensure product reusability and recyclability. Support sustainable product development, particularly in key sectors like agriculture and food.
Strengthening Governance and Circular Economy Policies	Full policy integration by 2040	Develop comprehensive circular economy legislation. Build institutional capacities to manage material flows in line with international standards.
Build a Circular Economy Innovation Hub	Establish Lebanon as a circular leader by 2045	Invest in R&D for sustainable materials and waste recovery. Foster public-private partnerships to establish circular economy industrial parks and innovation hubs.

6.4 2050 Powering a Sustainable Future

Transitioning Lebanon to a 100% renewable energy system by mid-century, and achieving Lebanon's LEDS scenario in terms of energy, will enhance sustainable socio-economic development, energy security, and place people at the core of the energy sector. Given the country's dependence on fossil fuel imports, shifting to renewables will reduce reliance on volatile imported fuels, enhancing economic stability.

Achieving climate neutrality by 2050 through renewable energy integration, primarily solar, wind, and geothermal, will lower energy costs, ensure equitable electricity provision, and sustain economic growth. Solar energy will be dominant due to its abundance and cost-effectiveness; wind and hydropower will play a significant role until geothermal becomes viable post-2030. Energy system electrification and aggressive efficiency measures are crucial, alongside expanding the grid and enhancing regional interconnectivity by 2030. Interim targets for 2030 are essential to foster political commitment and address challenges early on, especially with an expected rise in electricity demand due to the planned electrification of the transport sector.

By 2030, key targets should include the installation of up to 4.6 GW of on-grid renewable energy capacity. Contributions from various sources such as small and utility scale photovoltaics, hydropower, wind, and biogas, which will complement electricity generated through new combined cycle gas turbine power plants are necessary. Additionally, new buildings should be required to install solar water heaters or solar PV systems, where feasible. Sector-specific decarbonization plans, including targets for the transport, agriculture, and construction sectors, should be developed to support emissions reduction.

By 2050, Lebanon's electricity demand is expected to flatten as a result of aggressive energy efficiency measures after 2040. Heat pumps should dominate the heat generation industry, with ground-source heat pumps being installed in large commercial and industrial facilities such as hotels. Additionally, all water pumps for irrigation, drinking water, and wastewater treatment should be required to operate on solar PV systems with storage. Industries should be mandated to use hybrid renewable energy systems, incorporating wind, solar, and biogas with storage. Special economic zones should also be established across industrial and rural areas, powered by a mix of solar, wind, and energy storage systems.

To achieve this 2050 vision for Lebanon's energy sector, four strategic objectives should be met, as described in Table 13. Strengthening governance and legal frameworks, building a new electricity model, ensuring long-term sustainability and cost-competitiveness, building capacity and economic value are essential to ensure a successful and efficient transition.

Table 13: Objectives and priorities for Lebanon to reach Net-Zero by 2050 under the LEDS scenarios

Strategic Objectives	Priorities
Strategic Objective I: Strengthen governance and frameworks	Priority 1: Securing political will
	Priority 2: Strengthening and aligning policies
	Priority 3: Restructuring related institutions
	Priority 4: Engaging the private sector
	Priority 5: Electrifying sectors
	Priority 6: Expanding grid and connectivity
Strategic Objective II: Build a new electricity model	Priority 7: Storing energy
	Priority 8: Distributing the load and electric power generation models
	Priority 9: Increasing energy efficiency and system flexibility
	Priority 10: Guaranteeing good value for money
	Priority 11: Diversifying sources and technologies against a defined timetable
Strategic Objective III: Ensure long-term sustainability and cost-competitiveness	Priority 12: Building the financial capacity for investments in clean infrastructure
	Priority 13: Reducing siting and design barriers
	Priority 14: Engaging citizens and local communities
	Priority 15: Eliminating potential conflicts with future independent power providers
	Priority 16: Building local market capacity
Strategic Objective IV: Build capacity and create economic value	Priority 17: Promoting innovation and entrepreneurship
	Priority 18: Carbon pricing
	Priority 19: Developing special economic zones powered by clean technologies

6.5 2050 Low Carbon and Accessible Transportation

Achieving sustainable transport in Lebanon requires a well-designed transportation system that minimizes time and resource use, while prioritizing non-motorized modes such as walking and cycling for health benefits, safety, and emission reduction. Accessibility and safety are key, ensuring equitable and opportunities for all, especially marginalized groups. Transportation plays a critical role in social cohesion; the expansion of Lebanon's transportation demand requires an integrated approach that caters to the needs of different sectors and stakeholders. This plan should focus on enhancing public transportation, improving road safety, and promoting the use of low-carbon transport options. It should involve institutional reforms, capacity building, and stakeholder engagement for effective implementation and monitoring.

Achieving Lebanon's LEDS modelled vision for the transportation sector requires a gradual transition to using private cars less for short travel distances and to increasing electrification in terms of annual passenger-cars and light-duty vehicles. This strategic approach for transportation should include the following plans:

1. Developing integrated policies and programs: Lebanon needs to develop a functional set of laws, regulations, policies, and tax reforms that drive a holistic approach to transportation. This includes investment in public works, mass transit systems, ticketing policies and fees, and alternative modes of transportation. It also requires the establishment of an organizing authority for the sector and the strengthening of institutional capacities to implement and monitor the implementation of such policies.

2. Balancing Priorities: The challenge lies in managing limited resources, while addressing both current and future travel demands. This requires prioritizing investments, incorporating innovative, low-emission technologies and services, and developing a long-term financing mechanism to cover transportation infrastructure expenses. Encouraging effective public-private partnerships is also essential for building, renovating, operating, and managing transportation facilities.

3. Addressing cross-cutting issues: Any transportation strategy must consider equity, accessibility, urban design, and social integration. It must also stay abreast of global trends, particularly in Electric Vehicle (EV) technology. Additionally, a transportation strategy should be closely linked to urban planning, energy, waste management, and agriculture, which requires updating environmental guidelines and policies to minimize harm to the ecosystem; additionally, there needs to be a focus on waste generation implications from transitioning to electric vehicles and the potential to integrate biofuels into circular economy strategies.

4. Strengthening and promoting alternative modes: The primary focus should be on strengthening non-motorized modes of transport namely biking and walking, followed by mass public transport, car sharing programs, motorcycles, and taxis.

5. Implementing Transportation Demand Management (TDM): A key aspect of the strategy is reducing the length and frequency of trips. TDM includes creating pedestrian areas, favouring sidewalks, and developing infrastructure for non-motorized modes. It can also encourage decentralized family-run shops and promote a street-life culture.

6. Changing attitudes: The strategy should also aim at changing social behaviour towards private cars, making alternative modes more appealing and convenient. This includes dedicated lanes for public transport and metered parking.

7. Electrification of transportation: The electrification of transportation is gaining momentum globally as Electric Vehicles (EVs) become increasingly dominant in markets. Lebanon must prepare for this transition by establishing the necessary infrastructure such as fast-charging stations to support the growing adoption of EVs.

8. Exploring alternative fuels: Alternative fuels such as hydrogen, biodiesel, and methane gas hold significant potential. Lebanon should explore integrating these technologies into future plans to assess their role in decarbonizing the economy.

For this purpose, the action plan for transportation reform in Lebanon should aim to enhance economic and environmental goals through immediate and long-term solutions. By 2030, the plan should target urgent actions such as planning public land transport development, contracting private sector services, improving service quality, identifying necessary routes, integrating public transport with soft modes, and developing a national electrification strategy, with specific milestones set for achieving these goals by 2050.

6.6 Synergies and Intersection of Key Sectors

Lebanon's LEDS Scenario highlights the critical intersections between various sectors that can drive sustainable development. The integration of sustainability principles across agriculture, energy, tourism, and transport sectors is essential for the successful transition to a low-carbon, circular economy (Figure 41).

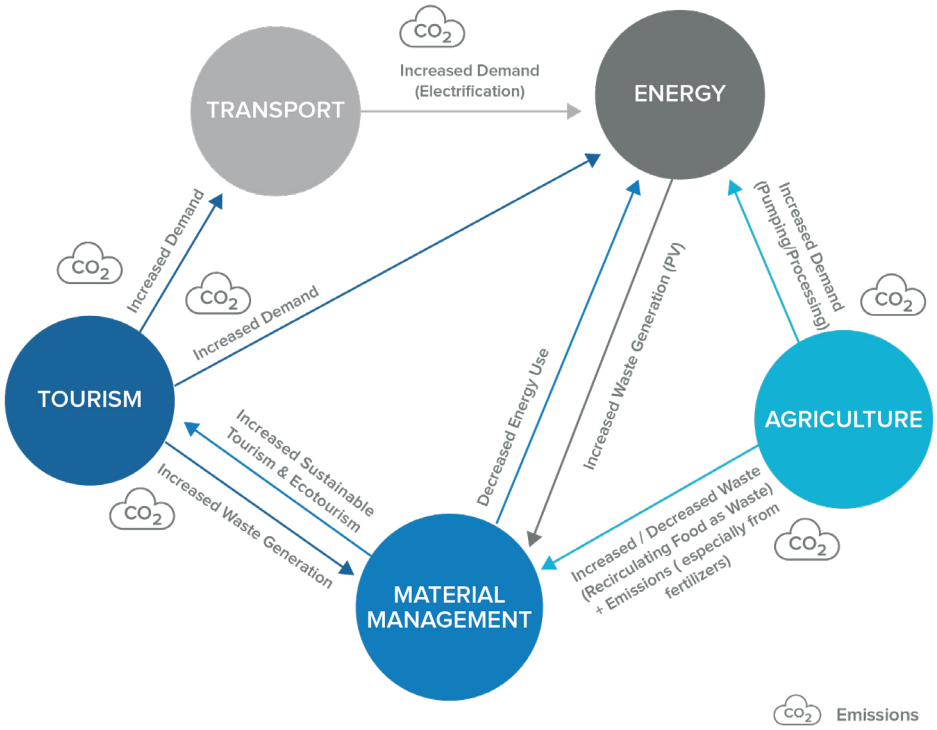

Figure 41: Intersections between sectors for a successful transition to a low carbon, circular economy

The key intersections between these sectors, emphasizing their synergies and potential benefits within the context of Lebanon's LT-LEDS are:

1. Decreased demand and consumption of energy

Energy Requirements for Green Industries - Developing local industries focused on repair, reuse, up-cycling, and recycling (collectively known as recirculation) requires additional energy resources. However, locally repairing and refurbishing products can be significantly less energy-intensive than manufacturing new products or recycling imported goods. This approach can lead to a net reduction in energy consumption, especially when the products being refurbished or repaired were originally produced in Lebanon. This emphasizes the importance of local production and maintenance for energy efficiency.

Energy in Construction - Renovating existing buildings instead of constructing new ones can substantially reduce the embodied energy associated with extracting and processing raw materials such as cement and stone. This practice supports energy conservation and minimizes environmental degradation, contributing to broader sustainability goals outlined in the LEDS scenario.

Waste Management - Composting food waste and transforming agricultural waste into new raw materials or biogas production can reduce the demand on traditional energy sources, substitute the reliance on fossil fuel, and significantly reduce greenhouse gas emissions.

2. Changes in waste generation and practices

Electrification of transport and renewable energy transition -The shift towards Photovoltaics (PVs) and electric bikes is a crucial step in Lebanon's decarbonization efforts. This transition will increase the usage of batteries and other PV equipment, necessitating robust systems for refurbishing and recycling these components at their end-of-life stage. Establishing local industries for the refurbishment and recycling of PV and battery equipment not only reduces waste, but also creates green jobs, supporting the local economy and reducing environmental impacts.

Sustainable and Responsible Tourism - Implementing sustainable materials management and recirculation practices can significantly benefit the tourism sector. Sustainable tourism practices, such as reducing disposable plastic usage, providing refill alternatives, and using biodegradable cleaning products, can reduce the environmental footprint of tourism activities. These practices also create local green jobs, contributing to the economy and enhancing the overall tourist experience by promoting environmental stewardship.

Enhanced Productivity and Local Food Security - Increasing agricultural productivity and ensuring local food security require additional volumes of high-quality compost. Composting organic waste enriches the soil, enhances fertility, and leads to better crop yields. This practice supports a circular economy by returning nutrients to the soil, reducing the need for synthetic fertilizers, and promoting sustainable agricultural practices, all of which are crucial for achieving the targets set in the LEDS scenario. In addition, composting diverts organic waste from landfills, where it would otherwise produce methane—a potent GHG.

3. Increased transport demand

Local vs. International Transport - The production and distribution of "Mouneh" products (traditional Lebanese preserved foods) within Lebanon can increase local transport activities and generate additional emissions. However, this increase in local transport can displace international transport associated with importing similar goods. The net effect on energy consumption and emissions depends on the balance between local and international transport. Additionally, increased local transport is necessary for the recirculation and refurbishment of various materials and products, contributing to the local economy while reducing the environmental impact of long-distance transportation.

The intersection of sectors such as energy, agriculture, transport, and tourism is crucial for advancing sustainable development in Lebanon. Adopting practices like refurbishing and recycling PV equipment, promoting local repair and reuse industries, renovating buildings to reduce embodied energy, and composting organic waste can lead to significant environmental and economic benefits. Enhancing agricultural productivity through composting and encouraging sustainable tourism further contributes to this goal. These integrated approaches reduce energy consumption and GHG emissions, while fostering local green job creation, supporting a resilient and sustainable economy aligned with Lebanon's low emission development scenario.

6.7 Sectoral Actions Towards Implementing the LT-LEDS

The action plan for Lebanon's Long Term - Low Emission Development Strategy (LT-LEDS) brings together the outputs of the various sectors assessed, including energy, transport, agriculture, tourism, while cross-cutting water and public health sector ramifications.

This action plan fits into the implementation of the LT-LEDS by providing targeted, actionable steps that align with the overall strategic goals of transitioning to a low-emission and climate-resilient economy.

Table 14 illustrates the alignment of Lebanon's LT-LEDS targets with both short-term and long-term actions, demonstrating a coherent vision for achieving the 100% renewable energy goal by 2050. The goals are considered as complementary to the investment needs identified in the macroeconomics assessment results in Macroeconomic and Cost and Benefit Implications of the LEDS Scenario section.

Table 14: Short-term and long-term actions to reach Lebanon's LT-LEDS targets

Sector	LT-LEDS Targets	Short-Term Actions (1-5 Years)	Long-Term Actions (5-15 Years)
Energy	Achieve 90-100% renewable energy for power demand by 2050; enhance energy efficiency to reduce energy demand by 30% by 2040	Install 500 MW of solar and wind energy; implement energy efficiency programs targeting a 10% reduction in electricity consumption in public buildings	Expand renewable energy capacity to meet 100% of electricity demand by 2045; modernize the national grid by 2040; phase out fossil fuel power plants by 2045
Transportation	Transition to 90-100% electric or non-fossil fuel vehicles by 2050; promote public transportation and non-motorized transportation infrastructure	Establish Bus Rapid Transit (BRT) systems in major cities; develop 200 km of bike lanes in urban areas; introduce stringent vehicle emission standards	Develop a national public transportation network by 2040; electrify all public transportation vehicles by 2045; implement comprehensive urban mobility plans by 2035
Agriculture	Achieve 100% adoption of sustainable agriculture practices by 2040; increase domestic food production to meet 75% of national demand by 2045	Train 5,000 farmers in sustainable techniques; install drip irrigation systems on 10,000 hectares of farmland; promote climate-resilient crop varieties	Achieve 100% adoption of sustainable agriculture practices by 2040; increase domestic food production to meet 75% of national demand by 2045; implement agroforestry practices on 20,000 hectares of land by 2040
Water	Ensure reliable and sustainable water supply by 2045; achieve 100% wastewater treatment and reuse by 2040	Implement integrated water resource management (IWRM) practices; repair and upgrade water infrastructure to reduce losses by 20%; conduct national water conservation campaigns	Ensure reliable and sustainable water supply by 2045; develop large-scale water storage and distribution projects by 2040; achieve 100% wastewater treatment and reuse by 2040
Tourism	Develop and promote eco-tourism sites; ensure all major tourist sites are climate-resilient by 2040	Develop and market eco-tourism sites; upgrade infrastructure in key tourist destinations to be climate-resilient; train tourism operators in sustainable practices	Promote inclusive and accessible tourism; revive and expand historic travel routes; create protected marine areas and promote activities like scuba diving and underwater archaeology by 2040
Material Management	100% material recovery by 2050; eliminate landfilling; minimize resource extraction	Launch waste separation programs, recycling centers, and composting; promote circular businesses and enforce EPR laws for plastics and electronics; establish Material Recovery Facilities (MRFs)	Achieve full material recirculation with advanced recycling and repair services; adopt 90% eco-design standards by 2040; implement waste-to-energy solutions and eliminate landfills by 2045; launch a circular economy innovation hub by 2045
Public Health	Ensure all public health infrastructure is resilient by 2040; provide universal access to climate-resilient healthcare services by 2045	Upgrade healthcare facilities to be climate-resilient; conduct nationwide health awareness campaigns on climate-related diseases; develop robust health surveillance systems	Ensure all public health infrastructure is resilient by 2040; provide universal access to climate-resilient healthcare services by 2045; implement preventive healthcare programs by 2040

To implement Lebanon's LT-LEDS successfully, the roadmap requires a clear alignment of sectoral actions with national policies, robust governance frameworks, and coordinated efforts across energy, transport, agriculture, tourism, and water sectors. Achieving these targets demands short-term investments alongside long-term commitments to ensure sustainability and resilience. Financing efficiently towards the existing identified developed projects in the pipeline or mainstreaming the short- and long- term priorities into upcoming projects, will be crucial for implementing the strategy's goals and ensuring Lebanon's transition to a low-emission and climate-resilient economy.

6.8 Financing the LT-LEDS: Vehicle for Implementation

Lebanon faces high capital costs and a fragmented financial landscape, thereby limiting the availability of affordable green funding. Without adequate financing, achieving the ambitious targets outlined in the roadmap remains unattainable. This gap underscores the need for innovative financial solutions that not only lower the cost of capital but also attract both public and private investment.

Key financial requirements include public and private funding, international climate finance, and innovative mechanisms such as green bonds and carbon pricing. Public-private partnerships are essential in attracting investments. On the other hand, concessional loans and grants can unlock funds for large-scale renewable energy projects, sustainable transport systems, and climate-resilient agriculture.

Establishing funding mechanisms with local and international organizations is crucial in involving the government, the private sector, banks, investors, multilateral development banks, development finance institutions, and international financial institutions.

Additionally, the government plays a vital role in encouraging private investments and securing guarantees for high-risk climate investments. Public-private partnerships are essential in fostering private investments. Lebanon's climate finance vision focuses on scaling up climate finance, attracting investments, while achieving sustainable, climate-resilient development.

6.8.1 Climate-proofed Public Procurement System: Integrating Green Public Procurement (GPP) into Lebanon's Climate Policy Framework

In alignment with Lebanon's Long Term - Low Emission Development Strategy (LT-LEDS), the Public Procurement (PP) system must be reformed to prioritize Green Public Procurement (GPP). Since public procurement constitutes a significant portion of national expenditure, it presents a key leverage point for fostering sustainable economic practices and addressing climate challenges. By adopting GPP, Lebanon can promote sustainable consumption and production, enhance environmental resilience, and accelerate its transition toward a low-carbon economy.

Green Public Procurement as a Central Policy Driver

GPP ensures that government contracts prioritize environmentally friendly and climate-positive goods and services. Public sector agencies, through GPP, can become market catalysts, encouraging private suppliers to align with sustainability principles. The integration of GPP into Lebanon's procurement system must be approached through mandatory frameworks that emphasize:

- Energy-efficient solutions: Procurement of energy-efficient infrastructure (e.g., LED lighting systems, green buildings).
- Renewable energy investments: Prioritizing solar, wind, and hybrid power systems in energy procurement projects, in line with LEDS targets of achieving 100% renewable electricity generation by 2050.
- Sustainable materials and supply chains: Favouring recycled, non-toxic, and eco-certified materials in construction and operations, reducing the environmental footprint.

Lebanon's Public Procurement Law 244/2021 already encourages sustainable procurement practices. However, climate-specific procurement standards—such as lifecycle carbon analysis or emissions-based screening of bids—are still absent from the framework. Reform is essential to make climate-smart procurement the default in all tenders and public contracts, ensuring alignment with Lebanon's 2050 climate neutrality goals.

Aligning Public Procurement with LEDS and Green Policies

The transition toward GPP must reflect best practices from international models where public spending is climate screened. The LT-LEDS roadmap calls for systemic investments in renewable energy, sustainable transportation, and green infrastructure, making public procurement a key tool to drive these transformations. Public procurement processes should integrate technical scoring criteria that favour:

- Zero-emission solutions: This includes electric vehicles, sustainable public transport systems, and energy-efficient buildings.
- Low-impact production methods: Contracts should prioritize goods and services produced with minimal carbon and resource footprints, consistent with Lebanon's commitment to circular economy practices.

These measures will not only lower emissions but also incentivize domestic producers and suppliers to align with sustainable standards. Requiring climate-friendly supply chains will improve Lebanon's competitiveness in global markets that focus on environmental and social governance (ESG) criteria.

Mandating Climate Conditions and Reforming the Procurement Framework

A critical reform element involves embedding mandatory green procurement clauses into Lebanon's public procurement processes. To ensure consistency, public procurement policies must:

- Mandate climate-friendly procurement for all large-scale infrastructure and service contracts, particularly in energy, transportation, and public health sectors.
- Standardize climate-smart criteria across agencies, such as requiring lifecycle carbon footprint assessments for construction projects or renewable energy certifications for suppliers.
- Monitor compliance through procurement audits that evaluate the environmental impact of procured goods and services. Monitoring is supported by climate-tracking mechanisms integrated into Lebanon's monitoring systems under the LT-LEDS.

Reform is not only justified, but necessary to align public spending with Lebanon's Nationally Determined Contributions (NDCs) under the Paris Agreement. Without such measures, Lebanon risks missing critical climate goals, limiting its ability to attract green finance and international investments. Implementing mandatory green procurement standards will also bolster access to financing from global climate funds that increasingly prioritize sustainability in public expenditure frameworks.

Benefits of Green Procurement for Lebanon's Climate and Economy

Green public procurement will serve as a key pillar of Lebanon's sustainable development strategy, generating multiple co-benefits:

- Reduced carbon footprint: Prioritizing GPP will significantly lower emissions across public operations and infrastructure projects.
- Green job creation: The focus on renewable energy and energy efficiency will stimulate employment in emerging green sectors, helping Lebanon achieve its employment targets under the LT-LEDS scenario.
- Economic savings through resource efficiency: Procuring energy-efficient technologies will reduce energy costs across public institutions, helping mitigate the financial burden on the public sector.
- Resilience to climate impacts: Incorporating climate resilience into procurement practices will enhance infrastructure durability and reduce future climate-related risks.

For Lebanon to achieve its 2050 net-zero emissions goal, **public procurement reform must position GPP as one of the cornerstones of its economic and environmental strategies**. The integration of mandatory GPP criteria across all public procurement processes will ensure that public spending aligns with Lebanon's climate ambitions, supporting the transition to a sustainable, resilient economy. **Public agencies must lead by example, making green procurement the default standard, reinforcing private sector alignment, and fostering an inclusive green recovery across the country**. The reform process, guided by the LEDS' scenario, will establish a robust, climate-proofed procurement system, securing long-term prosperity and environmental protection for Lebanon's future generations.

6.8.2 Financial Institutions' Role in LT-LEDS Implementation

Commercial and investment banks, and the Central Bank of Lebanon (BDL) should play a pivotal role in ensuring that the financial system supports Lebanon's transition toward a low-emission and climate-resilient economy. Climate change presents both physical risks (such as extreme weather events) and transitional risks (stemming from shifting carbon policies), both of which can disrupt financial markets, increase credit risks, and complicate monetary policy. To align financial operations with Lebanon's Long Term - Low Emission Development Strategy (LT-LEDS), banks should emphasize stress testing and internalizing climate risks within their policies and operations.

Stress Testing for Climate Resilience

The sector should aim to strengthen the resilience of financial institutions by mandating climate-related stress tests. These tests assess how portfolios may be affected by both immediate physical risks and long-term policy changes, such as carbon taxes or emission regulations. Integrating climate scenarios into stress testing frameworks ensures that banks (and insurers) can better understand and mitigate vulnerabilities; this integration ensures stability even in the face of economic shocks caused by climate events or shifts in energy policy. The results will drive adjustments to lending practices and asset allocations. These adjustments promote a resilient financial sector that can withstand future climate-related disruptions, while in parallel allocating capital to climate-positive and resilient investments.

Internalizing Climate Risks into Financial Supervision

Climate risks must be embedded into the financial sector's operations and supervisory frameworks and align investments with green and sustainable projects by:

- **Incentivizing Green Finance**: Offering favourable capital ratios for loans targeting renewable energy, sustainable infrastructure, and low-emission sectors.
- **Rebalancing Portfolios**: Steering investments toward low-carbon assets to avoid the risk of stranded investments due to evolving climate policies.
- **Modulating Monetary Policy**: Incorporating climate variables into inflation forecasting to address both supply shocks (e.g., crop failures) and policy-driven inflation (e.g., carbon pricing).

By embedding stress testing and internalizing climate risks into financial supervision, banks ensure they can adapt to climate challenges while maintaining stability, fostering a more resilient economy. Incorporating climate-aware monetary policy adjustments will also address inflation volatility caused by disruptions in food and energy prices or the introduction of carbon taxes. Financial institutions should refine inflation models to account for climate impacts and provide favourable refinancing terms for green projects.

Gradually, financial institutions can transition toward offering preferential loans and, as the Lebanese markets mature, expand to exclusively provide financial instruments for climate-positive projects. Rigorous climate stress testing will enable banks to access blended financing and technical support, encouraging further green investments. This synergy between monetary policies, financial supervision, and climate finance enhances Lebanon's capacity to mitigate risks, mobilize private investments, and drive the transition toward a low-emission economy.

6.8.3 Lebanon Green Investment Facility (LGIF)

The Lebanon Green Investment Facility (LGIF) emerges as a strategic response to this challenge, offering a concessional financing model tailored to Lebanon's needs. Concessional financing, achieved through grants, loans, and guarantees with favourable terms, is key to overcoming the high financing costs currently obstructing green investments. LGIF is built for purposes, to attract capital from International Finance Institutions (IFIs) and private investors to create blended financial instruments. These tools reduce investment risks and incentivize private investors to participate in projects that would otherwise

be financially unviable. This structure ensures that investments in renewable energy and energy efficiency become more feasible, unlocking the potential for large-scale decarbonization.

LGIF is meticulously designed to adhere to strategic objectives that ensure its effectiveness and scalability:

1. Establishment in a Credible Jurisdiction: Ensuring high standards of legal structuring instils investor confidence and provides robust legal protection for stakeholders.

2. Scalable Structure: This allows LGIF to expand its capacity to channel increasing amounts of capital towards impactful projects as it attracts more investment.

3. Sound Governance: Transparent governance practices are crucial for maintaining investor trust and supporting the fund's scalability.

4. Strategic Partnerships: LGIF acts as a platform to build a robust network of partners, fostering collaborative co-investments and strategic partnerships to amplify its reach and impact.

The LGIF fills a crucial gap in Lebanon's financial landscape by addressing the high cost of capital and the lack of affordable credit for eligible sustainable projects. Furthermore, LGIF aligns with Lebanon's NDC targets and sustainable development priorities, ensuring that these investments generate both environmental and social benefits.

Additionally, economic sustainability is a critical consideration for LGIF. By adhering to sustainable investment principles, the fund aims to generate positive returns for investors, while driving environmental change.

Endorsed by Lebanon's Prime Minister at COP28, LGIF plays a pivotal role in integrating climate considerations into Lebanon's national development strategy. Beyond offering financial support, LGIF employs impact measurement tools to track emissions reductions, environmental progress, and social outcomes, ensuring accountability and effectiveness. By addressing the barriers of high financing costs and fragmented funding sources, LGIF not only mobilizes the capital needed to implement the roadmap but also creates a sustainable investment framework that attracts further private sector engagement.

Lebanon's Long Term - Low Emission Development Strategy (LT-LEDS) aims to transform the economy by fostering climate resilience, reducing greenhouse gas emissions, and aligning national development with sustainability goals. However, high capital costs and limited access to affordable financing pose significant barriers to achieving these objectives. To bridge these financial gaps, the LGIF aims to offer concessional financing, leveraging a blend of grants, loans, and guarantees. This structure reduces financial risks and attracts private sector investments in sectors where profitability and sustainability are often at odds. With IFIs, private sector, and public-private partnerships, LGIF ensures that Lebanon can mobilize the resources necessary to unlock the potential of implementing the LT-LEDS roadmap.

7. The Climate Print for Lebanon's Future

As Lebanon embarks on the journey of implementing its Long Term - Low Emission Development Strategy (LT-LEDS), several key actions are required to ensure success. The following outlines the necessary steps, stakeholders' roles, and the overall strategic approach moving forward.

Achieving Adaptation, Resilience, and Carbon Neutrality: Lebanon's Long Term - Low Emission Development Strategy (LT-LEDS) aims to position the nation on a pathway toward climate neutrality by 2050. Central to this vision is the integration of climate resilience and adaptation measures across all sectors, ensuring that vulnerable communities and ecosystems are protected from climate impacts. Nature-based solutions, such as reforestation, sustainable agriculture, and water resource management serve as foundational pillars for increasing resilience and reducing emissions. Investments in nature-based solutions will enhance Lebanon's resilience, while contributing to emissions reductions. Additionally, measures will be embedded in the National Adaptation Plan (NAP) ensuring that climate risks are systematically addressed and that vulnerable communities including women and marginalized populations are protected from the impacts of climate change.

In terms of achieving carbon neutrality by 2050, achieving this ambitious target will require sustained efforts across all sectors focusing on renewable energy, energy efficiency, sustainable transportation, and reforestation. As Lebanon develops, it must embrace technological innovations and capitalize on the economic opportunities arising from the green transition driving job creation; at the same time these opportunities must ensure that women and marginalized groups benefit from the green transition.

Leveraging Finance and Investment for Climate Action: Financing the LT-LEDS is essential in unlocking Lebanon's sustainable development potential. Key initiatives include operationalizing the Lebanon Green Investment Facility (LGIF) to attract investments, utilizing public-private partnerships, and accessing international climate finance through channels such as the Green Climate Fund (GCF) and other multilateral institutions. The public sector must also take proactive steps in issuing green bonds and in creating blended finance platforms to mobilize capital at the required scale. Gender-responsive budgeting will further ensure inclusive climate action, channelling resources toward projects that empower women and benefit vulnerable populations.

A climate-proofed public procurement system (GPP) is integral to this strategy. Green public procurement will prioritize energy-efficient solutions, renewable energy investments, and sustainable infrastructure projects, ensuring public spending aligns with climate objectives. Mandating GPP standards across ministries will establish Lebanon as a leader in sustainable public spending, enhancing environmental resilience, at the same time reducing costs over the long term. In parallel, Lebanon's central bank monetary policy will take a climate-risk centric approach concurrently signalling commercial and investment banking sector policy requirements for stress testing and gradual phase-out of climate-negative investments and services.

Measurement, Reporting, and Verification (MRV): A Measurement, Reporting, and Verification (MRV) system is essential to monitor Lebanon's progress toward LEDS targets. This platform will collect real-time data on emissions, adaptation initiatives, and climate projects, ensuring transparency and accountability. By leveraging MRV tools, Lebanon can refine its climate policies based on emerging trends and align future Nationally Determined Contributions (NDCs) with global goals. Digital MRV platforms will further integrate sectoral data on energy consumption, GHG emissions, and mitigation metrics, reinforcing transparency in tracking progress. By digitalizing data collection and integrating the MRV platform into the LEDS governance framework, Lebanon can ensure transparency and accountability in tracking its climate targets.

Stakeholder Engagement and the Role of Municipalities: Municipalities will play a crucial role in advancing Lebanon's climate goals through local-level development and stakeholder engagement. Local governments, supported by community-based organizations, are well-positioned to implement decentralized climate solutions, such as small-scale renewable projects and climate-smart agriculture. Developing structures and frameworks for social dialogue between governments, workers' and employers' organizations can help maximize the economic and social opportunities from climate action, as well as implement the plans and strategies more effectively. Creating platforms for public-private dialogue and stakeholder consultations will foster collaboration among national agencies, local authorities, and civil society, ensuring broad-based support for climate action.

Raising awareness through educational campaigns and capacity-building initiatives will further empower citizens to participate in Lebanon's green transition. Inclusive governance frameworks and ensuring gender-balanced participation will guarantee that diverse voices, especially those of marginalized communities, youths, and persons with disabilities are included in the decision-making process.

Social Protection and the Creation of Decent Work Conditions: Lebanon, in order to safeguard worker health, will have to create a robust framework for managing climate-induced impacts such as heat stress, particularly in highly vulnerable sectors such as agriculture, construction, and manufacturing. Establishing national heat stress guidelines, ensuring decent work conditions (e.g., protection framework for heat stress in the working environment), along with continuous monitoring and risk assessment protocols in workplaces, and integrating a decent work agenda into climate adaptation efforts are important in building societal resilience and facilitate a just transition for all. Social protection schemes can increase the robustness of the labour market as well as facilitate mobility amongst workers as labour markets transition and change towards environmental sustainability.

Institutional Strengthening and Establishing a Legal Framework: In addition to its investment needs to ensure implementation, Lebanon's Long Term - Low Emission Development Strategy (LT-LEDS) requires a robust institutional framework. Led by the Ministry of Environment (MoE), climate-related governance would be strengthened through a proposed climate change law, which aims to consolidate various climate initiatives, establish clear roles, and align national efforts with the Paris Agreement. This law would create an Inter-Ministerial Climate Change Council, chaired by the MoE and involving key ministries, to coordinate strategies such as the LEDS, Nationally Determined Contributions (NDCs), and National Adaptation Plans (NAPs). The Council would work closely with the NDC committee, to oversee NDC updates and ensure alignment with national development goals, and that the outcomes of the LT-LEDS are integrated and reflected in the subsequent iterations of the NDCs.

Additionally, the law would integrate adaptation measures into sectoral plans, fostering climate resilience through the NAP and ensuring seamless coordination between the LEDS framework and national policies. Governance would include the NDC Committee, expanded to monitor sectoral strategies and guide policy adjustments, and task forces from the CBIT project to engage non-state actors and international partners.

7.1 Challenges to Financing and Implementing the LT-LEDS Amid Hostilities

The hostilities between October 2023 and October 2024 have introduced profound challenges to the financing and implementation of Lebanon's Long Term - Low Emission Development Strategy (LT-LEDS). These difficulties extend beyond financial constraints, encompassing institutional, structural, and operational barriers that hinder progress toward achieving the strategy's objectives.

Securing the climate finance necessary for LT-LEDS has become increasingly challenging in the current geopolitical and economic context. Lebanon's weakened fiscal standing, compounded by the economic losses stemming from the hostilities, has undermined its ability to access international climate finance mechanisms and other multilateral funding sources. Heightened risk perceptions among international

investors have reduced Lebanon's attractiveness for private sector involvement, which is critical for the blended financing models envisioned in the LT-LEDS strategy.

Institutional and governance challenges also present significant barriers to both financing and implementing the LT-LEDS. Fragmented governance structures and insufficient inter-agency coordination hinder the integration of LT-LEDS goals into broader policy and recovery frameworks. The hostilities have disrupted public administration capacities, particularly in conflict-affected areas, reducing the ability of institutions to plan, manage, and monitor long-term projects. Additionally, Lebanon's technical and institutional capacity to develop bankable climate projects aligned with international funding criteria remains limited. This capacity gap undermines the country's ability to leverage global climate finance mechanisms effectively.

The LT-LEDS must be actively integrated into post-conflict recovery planning to align long-term low-emission goals with the urgent need to rebuild. **Recovery strategies should incorporate LT-LEDS priorities** to ensure that rebuilding efforts advance sustainable development, rather than solely addressing immediate humanitarian and infrastructural needs. Embedding the strategy into recovery planning provides a critical opportunity to utilize rebuilding as a catalyst for low-emission development, avoiding the risk of sidelining LT-LEDS actions until economic stability is restored. By aligning recovery efforts with LT-LEDS, Lebanon can create a foundation for climate-resilient growth, simultaneously addressing the immediate needs of the post-conflict period.

Implementation of LT-LEDS is further constrained by disruptions to key sectors such as energy, transport, and agriculture, which are foundational to the strategy's success. The ongoing hostilities have delayed an already existing need for critical reforms, as well as investments needed for scaling renewable energy, transitioning to sustainable transportation, and adopting climate-smart agricultural practices. The strategy's emphasis on sectoral transformation requires stable institutional and economic conditions, which the current context fails to provide. Furthermore, the absence of an integrated monitoring and evaluation framework complicates the tracking of progress and the identification of implementation bottlenecks.

To overcome these challenges, it is imperative to prioritize the operationalization of mechanisms such as LGIF to streamline the flow of climate finance. Simultaneously, strengthening institutional capacity to manage and implement LT-LEDS projects, ensuring alignment with recovery strategies, and enhancing coordination among key stakeholders are critical to advancing both the financing and implementation of the strategy. Addressing these issues is vital not only for mitigating the immediate impacts of the hostilities, but also for maintaining Lebanon's commitment to its climate and development goals in the long term.

By aligning institutional governance, financial mechanisms, and policy frameworks with climate goals, Lebanon will unlock the capital needed to achieve its 2050 vision. Through coordinated efforts Lebanon's LT-LEDS will position the country as a regional leader in sustainable development. Lebanon can demonstrate how climate action can drive economic growth and social well-being.

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Annexes

Annex I: Methodology – Heat Stress Related Risks[28]

Heat related risks are considered to be one of the biggest challenges associated with rising temperatures that, along with many economic losses, result in non-economic permanent losses such as human lives. Dry-bulb temperature (or simply temperature) is generally used as an indicator of heat extreme, such as heat waves. Although most of the climate change research has so far focused on the extremes associated with the dry-bulb temperature (such as incurring damages to agriculture, ecosystems, infrastructure and overall economic growth), assessments of moist temperature change remain limited. A fundamental aspect of greenhouse-gas-induced warming is a global-scale increase in absolute humidity. Physiologically speaking, a human body can tolerate high levels of dry-bulb temperature through perspiration/evaporation cooling, provided humidity levels remain low. However, the efficiency of perspiration/evaporation cooling slows in hot and humid conditions, and the body may become unable to maintain a stable core temperature. As a result, illnesses, such as hyperthermia – including heat exhaustion and stroke – will spread.

In order to gauge the potential impacts of moist heat on humans, Wet-bulb temperature (T_W) and Wet Bulb Globe Temperature (WBGT) are used as combined measures of temperature and humidity. These assessments are based on physiological studies with a long history of use in different fields (athletics, military, and workplace safety). Studies have shown impacts to have increased over the past decades due to global warming.

The indicator T_W is generally defined as the temperature that an air parcel would attain if cooled at a constant pressure by evaporating water within it until saturation. T_W always remains less or equal to T (dry bulb temperature), and higher values of T_W imply hot and humid conditions. In the context of climate change, T is an easily understandable concept for a layman, but T_W is not a commonly used notion. A region having a very high T value may not have a high T_W value and vice versa.

Despite the fact that physiological attributes of the human body and its tolerance to heat is distinct in different regions of the world, various matrices and thresholds are used to quantify the impact of wet bulb temperature. For instance, a T_W of 35°C is considered a limit of human tolerance to heat stress, as evaporation cooling at and beyond this limit becomes significantly less effective (Sherwood and Huber, 2010)[29]. This threshold seldom occurred in historical climate records (Raymond et al., 2019[30]; Schär, 2016[31]). For physical labor or demanding outside activities, a T_W of 32°C has been established as an upper limit beyond which such activities may not be safely conducted (Coffel et al., 2017)[32]. In another study, the 84th percentile of daily T_W is considered as an optimal wet-bulb temperature where the heat-related mortality risk shows lowest value (Ahmadalipour and Moradkhani, 2018)[33].

[28] The heat stress numbers for this report are from the forthcoming report by the ILO Lebanon 2024: Country Report with Just Transition Input to the Climate Prosperity Plan authored by Andreas Flouris (University of Thessaly and University of Ottawa). The following section outlines the methodology of said study of which selected findings are included as a basis for the LT-LEDS.

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For this study however, we use criterion from the U.S National Weather Service (USNWS) that defines "dangerous" and "extremely dangerous" thresholds of 24.6°C and 29.1°C respectively, having been widely used in earlier studies (Kang et al., 2019)[34].

Data and Methods

The HAPPI experiment is specifically designed to study the differences in impacts of climate change at 1.5°C and 2°C above pre-industrial levels, and has been employed in a range of recent studies including on changes to the hydrological cycle, tropical seasonality, and crop production (Doll et al., 2018[35]; Faye et al., 2018[36]; Saeed et al., 2018a[37] ; Schleussner et al., 2018[38]). Three time periods (Reference 2006-2015, 1.5°C and 2.0°C above pre-industrial) are considered under HAPPI, each spanning 10 years. Here we use a set of four HAPPI GCMs (ECHAM6, MIROC5, CAM4-2degree and NorESM1) that have been bias corrected to improve the representation of regional features with ISI-MIP2b bias correction methodology using the EWEMBI (EartH2Observe, WFDEI and ERA-Interim data Merged and Bias -corrected for ISIMIP) dataset (Lange, 2017)[39]. This bias correction method demonstrated to lead marked improvement, not only in the mean, but also in the extremes for all the models as well as for the ensemble (Saeed et al., 2018b)[40]. In total, 20 ensemble members per GCM are bias corrected, which sums up 800 years of daily data. Bias correction is carried out for historical, as well as, two future time periods for the two variables, i.e., maximum temperature and relative humidity.

Daily wet-bulb temperature (T_W) is calculated based on the empirical equation developed (Stull, 2011)[41] and used for the region in past applications over the Middle East (Ahmadalipour and Moradkhani, 2018). This equation is based on air temperature and relative humidity:

$$T_W = T[0.151977(RH + 8.313659)^{1/2}] + (T + RH) - (RH - 1.676131) + 0.00391838\,(RH))^{3/2}(0.023101RH) - 4.686035$$

where T_W, T and RH denote wet-bulb (°C), dry bulb (°C), and relative humidity (%). T_W can be calculated for any air temperature, and here annual maximum near-surface air temperature is considered for the calculation of T_W (Ahmadalipour and Moradkhani, 2018). We then calculate T_W for all the 20 bias corrected ensemble members of four GCMs as well as EWEMBI data that is employed here as proxy observation.

Validation

As explained in the previous section that a state-of-the-art bias correction technique is applied to eliminate biases in the GCM simulations. However, this bias correction was conducted at a global scale and therefore it is important to evaluate the performance of each model against the observations over Lebanon.

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40 Saeed, F., Bethke, I., Lange, S., Lierhammer, L., Shiogama, H., Stone, D. A., et al. (2018b). Bias correction of multi-ensemble simulations from the HAPPI model intercomparison project. Geosci. Model Dev. Discuss. 2018, 1–23. doi:10.5194/gmd-2018-107.

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Exceedance Probabilities

In order to calculate the probabilities of crossing different T_W values in the reference, as well as in the two future warmer worlds, we construct a time series by taking the spatial average over T_W for Lebanon and calculate the highest annual value of T_W for each of the years across the whole ensemble. We then rank the time series so that the highest value receives a rank of 1 (Makkonen and Makkonen, 2006)[42]. For each value in the time series, the exceedance probability (p) is calculated as:

$$p_i = \frac{m_i}{(n+1)}; for i = 1.....n$$

where m is the rank (rank 1 given to the highest value) and n represents the number of years in the ensemble. Here we pool the data of all the four GCMs, which provides 800 values for each year, sufficient enough to calculate the mentioned probabilities.

Heat Stress Duration Index (HSDI)

While exceedance probabilities provide an indication of crossing certain T_W thresholds once in a year for different climates, the HSDI serves as a more stringent measure that indicates total number of days exceeding a certain threshold in a year. Here a Heat Stress Duration Index (HSDI) is defined as exceedance of a daily maximum T_W continuously for three days or more above certain thresholds.

Population Exposure to HSDI

In addition to the total number of days satisfying the HSDI criteria, the total number of HSDI events provides an additional angle to the heat stress extremes. For example, a continuous streak of eight days above a certain threshold will give one HSDI event; however, two separate events of three days each will result in six HSDI days. For weather prediction purposes, the event with eight days is most likely to be predicted because of its intense nature as compared to the two short duration HSDI events of three days each. In order to capture this behaviour, we use HSDI events for population exposure.

Population exposure is obtained by first multiplying the ensemble mean of HSDI events (for all the four GCMs with a total of 800 years) considering the 2010 population estimates for each grid box, and then by adding values of all the grid boxes for Lebanon at both the “dangerous” and “extremely dangerous” thresholds. It should be noted that the exposure is given in terms of accumulated person-days which implies that a single individual within a particular grid box may be subjected to multiple HSDI days.

42 Makkonen, L., and Makkonen, L. (2006). Plotting Positions in Extreme Value Analysis. J. Appl. Meteorol. Climatol. 45, 334–340. doi:10.1175/JAM2349.1

Annex II: Methodology – Heat Stress and Labor

A1. Environmental, Productivity, and Work Time Loss Indicators

A1.1 Choice of Environmental Indicators

To characterize the prevailing environmental conditions for work, this report uses the monthly average maximum temperature and the monthly average maximum WBGT. The rationale for using these indicators and at this time constant is provided below:

- The temperature (i.e., air temperature) is the benchmark used by weather and climate experts and organizations, particularly when referring to the general population. The working environment is complex, often involving high humidity, low wind, and exposure to thermal radiation from the sun and/or other sources such as machinery. Therefore, when used alone, temperature cannot fully characterize the working environment[43].
- The most well-known and commonly adopted indicator used by scientists and occupational health and safety professionals to evaluate heat stress in the workplace and its effects on health and productivity is the WBGT[44]. The WBGT considers temperature, humidity, wind speed, and thermal radiation. Moreover, the guidance derived from WBGT considers work intensity and personal protective equipment. A recent series of large-scale multi-country evaluations of all the available indicators found that the WBGT is the most effective for evaluating the risk of heat-related illnesses for people who work in the heat[45].
- The monthly average maximum values were used in this analysis as they are most appropriate for characterizing the working environment because they are typically observed between 12:00 and 14:00, a time period where most of the working population is at their workplace.

[43] Ioannou, L.G., et al., Indicators to assess physiological heat strain - Part 3: Multi-country field evaluation and consensus recommendations. Temperature (Austin), 2022. 9(3): p. 274-291.and the 97.5th percentile represents the value below which 97.5% of the data falls.

[44] Ioannou, L.G., et al., Indicators to assess physiological heat strain - Part 3: Multi-country field evaluation and consensus recommendations. Temperature (Austin), 2022. 9(3): p. 274-291.

NIOSH, Criteria for a recommended standard: occupational exposure to heat and hot environments, B. Jacklitsch, et al., Editors. 2016, Centers for Disease Control and Prevention. National Institute for Occupational Safety and Health. U.S. Department of Health and Human Services: Cincinnati, OH, USA.

ISO, ISO 7243:2017 — Ergonomics of the thermal environment - Assessment of heat stress using the WBGT (wet bulb globe temperature) index. 2017, International Organization for Standardization: Geneva, Switzerland.

ACGIH, Heat stress, TLVs and BEIs: threshold limit values for chemical substances and physical agents & biological exposure indices, ACGIH, Editor. 2020, ACGIH: Cincinnati.

[45] Ioannou, L.G., et al., Indicators to assess physiological heat strain - Part 3: Multi-country field evaluation and consensus recommendations. Temperature (Austin), 2022. 9(3): p. 274-291.

Ioannou, L.G., et al., Indicators to assess physiological heat strain - Part 1: Systematic review. Temperature (Austin), 2022. 9(3): p. 227-262.

Ioannou, L.G., et al., Indicators to assess physiological heat strain - Part 2: Delphi exercise. Temperature (Austin), 2022. 9(3): p. 263-273.

Flouris, A.D., et al., Working in a warming world: Translating thermal physiology to policy-relevant information. Temperature (Austin), 2022. 9(3): p. 223-226.

A1.2 Calculation of WBGT

For the calculation of the WBGT, the Liljegren[46] approach was adopted because it is considered the most accurate method when calculating WBGT from meteorological data[47]. The ambient temperature, relative humidity, and wind speed data required for the calculation of WBGT were obtained from the relevant historical and SSP datasets. Wind speed was corrected for height above the ground using previous methodology[48]. Solar radiation was estimated[49] for the midday of the middle day of each month using the geolocation (longitude and latitude) of each grid cell, while correcting for cloud coverage using published literature[50]. For indoor conditions, solar radiation was considered negligible, while wind speed was kept constant at 1 m/s, since this velocity is more indicative of the occupational settings where some air movement is generated by workers while they walk or move in the worksite[51]. Indoor temperature and humidity were estimated as a function of outdoor conditions[52]. Similarly, for the mining industry, underground temperature[53] and humidity[54] were estimated as a function of surface conditions.

A1.3 Calculation of Productivity

Productivity was calculated using the Hothaps method[55], a function frequently used to assess workability, which was developed based on empirical data from two studies.

A1.4. Calculation of Work Time Loss

Work time loss was calculated using a recently introduced function linking WBGT and the time that workers allocate to work- and non-work-related activities during their work shift. The function has been developed based on field experiment data that included detailed monitoring of hundreds of work shifts from different industries across >10 countries[56].

A1.5 Calculation of Full-Time Equivalent Jobs Lost

Assuming that a worker takes (the minimum of) 14 days leave of absence in any given year and s/he follows a typical work schedule of 5 days/week for 8 hours/day, there are (365 - 14) · (5 / 7) · 8 = 2006 potential working hours annually. The full-time equivalent jobs lost due to heat stress were calculated as the difference between the available hours of work and the estimated hours of work when the work time loss due to heat stress (see A1.4) was considered.

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46 Liljegren J.C., Carhart R.A., Lawday P., Tschopp S., Sharp R. Modeling the Wet Bulb Globe Temperature Using Standard Meteorological Measurements. Journal of Occupational and Environmental Hygiene. 2008/09/18 2008;5(10):645-655.

47 Lemke B., Kjellstrom T. Calculating Workplace WBGT from Meteorological Data: A Tool for Climate Change Assessment. Industrial Health. 2012;50(4):267-278.

48 Masters, G. M., Renewable and efficient electric power systems. John Wiley & Sons: 2013.

49 Khatib T., Elmenreich W. Modeling of photovoltaic systems using Matlab: Simplified green codes. John Wiley & Sons; 2016

50 Kasten F., Czeplak G. Solar and terrestrial radiation dependent on the amount and type of cloud. Solar Energy. 1980/01/01. 1980; 24(2): 177-189.

51 Lemke B., Kjellstrom T. Calculating Workplace WBGT from Meteorological Data: A Tool for Climate Change Assessment. Industrial Health. 2012;50(4):267-278.

52 Lee K, Lee D. The relationship between indoor and outdoor temperature in two types of residence. Energy Procedia; 2015, 78: 2851-2856.

53 Yi, X., Ren, L., Ma, L. et al. Effects of seasonal air temperature variation on airflow and surrounding rock temperature of mines. Int J Coal Sci Technol; 2019, 6: 388– 398.

54 Yasidu, Umali M., Fujii, Yoshiaki, Kodama, Jun-ichi, Fukuda, Daisuke, Maneya, George J., Dandadzi, Johnson, Dassanayake, Anjula B. N., Influences of Water Vapor on Roof Fall Accidents in Selected Underground Coal Mines in Malawi, Advances in Civil Engineering; 2019, 5350686.

55 Kjellstrom T, Lemke B, Otto M, Hyatt O, Dear K. Occupational heat stress: contribution to WHO project on “Global assessment of the health impacts of climate change” which started in 2009. https://climatechip.org/sites/default/files/publications/TP2014_4_Occupational_Heat_Stress_WHO.pdf. 2022–11-14.

56 Ioannou L.G., Foster J., Morris N.B., Piil J.F., Havenith G., Mekjavic I.B., Kenny G.P., Nybo L., Flouris A.D. Occupational heat strain in outdoor workers: A comprehensive review and meta-analysis. Temperature (Austin). 2022; 9(1): 67-102.

A2. Shared Socioeconomic Pathways

The present report used the IPCC Sixth Assessment Report[57] scenarios assessing the projected temperature outcomes based on the framework of the Shared Socioeconomic Pathways (SSPs). The SSPs are climate change scenarios of projected socioeconomic global changes up to 2100 and their code names were created from the SSP on which they are based (SSP1-SSP5) combined with the expected level of radiative forcing in the year 2100 (1.9 to 8.5 W/m^2). This results in the scenario names provided in Table A2.

Table A2: Shared Socioeconomic Pathways in the IPCC Sixth Assessment Report

SSP	Scenario	Estimated warming (2041-2060)	Estimated warming (2081-2100)	Very likely range in °C (2081-2100)
SSP1-2.6 (Sustainability Pathway)	**Low GHG emissions** CO_2 emissions cut to net zero around 2075	1.7	1.8	1.3 – 2.4
SSP2-4.5 (Middle of the Road Pathway)	**Intermediate GHG emissions** CO_2 emissions around current levels until 2050, then falling but not reaching net zero by 2100	2.0	2.7	2.1 – 3.5
SSP3-7.0 (Regional Rivalry Pathway)	**High GHG emissions** CO_2 emissions double by 2100	2.1	3.6	2.8 – 4.6
SSP5-8.5 (Fossil-fueled Development Pathway)	**Very high GHG emissions** CO_2 emissions triple by 2075	2.4	4.4	3.3 – 5.7

Note: The IPCC Sixth Assessment Report also includes SSP1-1.9 which foresees very low GHG emissions (i.e., CO_2 emissions cut to net zero around 2050), resulting in estimated warming of 1.4°C by 2081 – 2100. This scenario was not tested in the present report to reduce length and because it was considered too optimistic. Key: GHG = greenhouse gas.

A3. Datasets and Methodology

The present report includes a collection of global datasets from recognized sources, including historical and projected data on population counts, global terrain elevation, climate, emissions, economic activity and demographics. Each dataset had different resolutions and formats, requiring resampling. The resampling process involved various methods with the target resolution set to 15 arc minutes (0.25 degrees, 1440 longitude x 720 latitude) using Python-based tools. This ensured consistent alignment across datasets for accurate merging and analysis.

A3.1 Population Datasets

Historical population data from the GPWv4 dataset[58], covering the years 1990, 1995, 2000, and 2005, was obtained at a 15 arc-minute resolution. This dataset was already aligned with the target resolution and contained important information related to grid cells, including country mapping and land-water areas, and it was used as the reference dataset for subsequent analysis.

[57] IPCC (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. V. Masson-Delmotte, P. Zhai, A. Pirani et al. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, Intergovernmental Panel on Climate Change.

[58] Center for International Earth Science Information Network - CIESIN - Columbia University, Gridded Population of the World, Version 4 (GPWv4): Population Count, Revision 11. 2018, NASA Socioeconomic Data and Applications Center (SEDAC): Palisades, New York.

Population projections datasets, based on the Shared Socioeconomic Pathways (SSP) scenarios SSP1, SSP2, SSP3, SSP4, and SSP5 were obtained[59]. These projections were originally available at a resolution of 7.5 arc minutes (0.125 degrees 2880 longitude and 1440 latitude) and required resampling to 15 arc minutes. The process was performed using the rasterio library, applying the "Resampling.sum" method to aggregate population data across the new grid cells[60]. After resampling, datasets for rural, urban, and total populations were merged for the years 2010 to 2100, in 10-year increments.

A3.2 Global Terrain Dataset

The global terrain data from the GEBCO terrain model[61] was used. The data was initially provided at a resolution of 15 arc seconds (86400 longitude and 43200 latitude), and it was averaged into 15 arc-minute grid cells. During this process, negative values representing undersea topography were excluded, focusing only on land elevations for merging with climate data.

A3.3 Climate Datasets

The CMIP6 climate historical and projection datasets, with a resolution of 0.625 x 0.9375 (384 longitude and 289 latitude)[62], along with the Gridded Monthly Climate Projection Dataset from the IPCC AR6 Interactive Atlas, at a resolution of 60 arc minutes (360 longitude x 180 latitude, 1 degree)[63], were downloaded using the CDSAPI library. Monthly data from the "UKESM1-0-LL" model was gathered for the following experiments: Historical, SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5. The historical dataset spans 1984 to 2014, while the projection data covers 2020 to 2100. Specifically, near surface air temperature and near surface specific humidity were obtained from the CMIP6 datasets and monthly means of daily wind speed, maximum temperature, and total cloud cover percentage were obtained from the IPCC AR6 datasets. All datasets were resampled to a 15 arc-minute resolution using the nearest latitude and longitude. Relative humidity was calculated using specific humidity and air temperature[64].

A3.4 Demographic Dataset

Hybrid gridded demographic dataset was obtained at resolution of 290 latitude by 720 longitude[65]. This dataset contains fractional percentages for various age ranges, spanning from 5 to 65 years old. The data includes both historical and projected population distributions, covering the period from 1950 to 2050.

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59 Jones, B. and B.C. O'Neill, Spatially Explicit Global Population Scenarios Consistent with the Shared Socioeconomic Pathways. Environmental Research Letters, 2016.

Jones, B. and B.C. O'Neill, Global One-Eighth Degree Population Base Year and Projection Grids Based on the Shared Socioeconomic Pathways, Revision 01. 2020, NASA Socioeconomic Data and Applications Center (SEDAC): Palisades, New York.

60 Gillies, S. and et al., Rasterio: geospatial raster I/O for Python programmers. 2013, Mapbox.

61 GEBCO Bathymetric Compilation Group. The GEBCO_2023 Grid - a continuous terrain model of the global oceans and land. 2023, NERC EDS British Oceanographic Data Centre NOC.

62 Copernicus Climate Change Service (C3S). CMIP6 climate projections, in Climate Data Store (CDS). 2021.

63 IPCC (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. V. Masson-Delmotte, P. Zhai, A. Pirani et al. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, Intergovernmental Panel on Climate Change.

Iturbide, M., J. Fernández, J.M. Gutiérrez, and et al., Implementation of FAIR principles in the IPCC: the WGI AR6 Atlas repository. Scientific Data, 2022. 9: p. 629.

Copernicus Climate Change Service (C3S). Gridded monthly climate projection dataset underpinning the IPCC AR6 Interactive Atlas, in Climate Data Store (CDS). 2023.

64 Lawrence M.G. (2005). The Relationship between Relative Humidity and the Dewpoint Temperature in Moist Air: A Simple Conversion and Applications. Bulletin of the American Meteorological Society; 86(2): 225-234.

65 Chambers, J., Hybrid gridded demographic data for the world, 1950-2020 (1.0), in Zenodo. 2020.

A3.5 Land Cover Dataset

The 2022 C3S Land Cover dataset (v2.1.1)[66] at 300-meter resolution was downloaded via the CDSAPI library, using LCCS class values to identify urban areas (class 190). A binary mask was created, assigning 1 to urban areas and 0 to others, and added to the dataset. The data was then resampled to a 15 arc-minute resolution by summing the urban area cells using xarray's coarsen method[67]. A final dataset was produced with country-level details via geographical mapping, calculating each country's percentage of urban area grid-by-grid.

A3.6 Greenhouse Gas Emissions Datasets

Greenhouse gas emissions data were downloaded from the EDGAR datasets[68] and divided across four sectors (agriculture, mining, manufacturing, /trade). For the agriculture sector, emissions from agricultural soils and enteric fermentation were included. For the mining sector, methane emissions from natural gas extraction and processing were taken into account. For manufacturing, emissions from chemical processes, industrial combustion, iron and steel production, solvent use, oil refining, and waste incineration were accounted for. For transport and trade emissions from aviation (landing and takeoff), road transportation, railways, pipelines, and off-road transport were included. Each sector's emissions were aligned by latitude and longitude, summed, and resampled to a 15 arc-minute resolution. The emissions were then merged into a single dataset, indexed with sectoral and country-level details via geographical mapping. Finally, a new dataset was created to quantify each country's percentage contribution to emissions within each sector, calculated grid-by-grid.

A3.7 GDP Dataset

Country-level economic data on the structure of value added was downloaded from the World Bank's "World Development Indicators" for 2023[69]. The dataset contains the contributions of various sectors, including agriculture, industry (including construction), manufacturing, and services, to each country's GDP, expressed as a percentage of GDP for each sector.

A3.8 Employment Dataset

Economic activity dataset was obtained from ILOSTAT[70] to sum employment data across different economic sectors and gender. The 14 variables were divided into six sectors as follows: agriculture (ISIC rev.4 A), mining (ISIC rev.4 B), manufacturing (ISIC rev.4 C), construction (ISIC rev.4 F), and transport-trade, (ISIC rev.4 H, J). All remaining activities were grouped under the services sector, which includes: utilities (ISIC rev.4 D, E), wholesale, and retail trade; repair of motor vehicles and motorcycles (ISIC rev.4 G), accommodation, and food service activities (ISIC rev.4 I), financial and insurance activities (ISIC rev.4 K), real estate; business and administrative activities (ISIC rev.4 L, M, N), public administration, and defense (ISIC rev.4 O), education (ISIC rev.4 P), human health and social work activities (ISIC rev.4 Q), and other services (ISIC rev.4 R, S, T, U).

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66 Copernicus Climate Change Service (C3S). Land cover classification gridded maps from 1992 to present derived from satellite observation, in Climate Data Store (CDS). 2019.

67 Hoyer, S. and J. Hamman, xarray: 1. Arias P, Bellouin N, Coppola E, et al. Technical Summary. In: Masson-Delmotte V, Zhai P, Pirani A, et al, eds. Climate Change 2021: The Physical Science Basis Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press (In Press); 2021. labeled arrays and datasets in {Python}. Journal of Open Research Software, 2017. 5(1).

68 EDGAR Community GHG Database v8.0: CO_2, CH_4, N_2O, and F-GASES, in European Commission, Joint Research Centre (JRC) and International Energy Agency (IEA). 2023.

69 The World Bank. World Development Indicators - GDP and Sector Value Added, in World Bank national accounts data, and OECD National Accounts data files. 2024, Washington, DC, USA.

70 International Labour Organization (ILO). Employment by sex and economic activity -- ILO modelled estimates, Nov. 2023 (thousands) -- Annual, in ILO Modelled Estimates (ILOEST) Database. 2023, ILO, Geneva, Switzerland.

A3.9. Sector Distribution

We used two datasets to calculate the distribution of each sector on each grid cell: urban area land cover data (providing the percentage of urban area per grid cell) and emissions data (including sectoral emission percentages). For the agriculture, mining, manufacturing, and transport/trade sectors, we used sectoral emission percentages from the above-mentioned emissions dataset as the distribution parameter within the grid cells; while for the services and construction sectors, we applied urban area percentages.

Next, using the employment dataset (with gender-specific employment counts), we calculated the number of male and female workers in each sector for each grid cell based on sectoral employment data and the contribution percentage from emissions or urban area. This process was repeated for all six economic activity sectors, with the final dataset containing an estimated number of male and female workers per sector, indexed by latitude, longitude, sector, and country.

Similarly, for each grid cell, using the above-mentioned GDP dataset, we calculated GDP by sector of economic activity based on the percentage contribution from emissions or urban area. This process was also repeated for all six sectors, producing a final dataset containing the estimated GDP in USD millions, indexed by latitude, longitude, sector, and country.

Annex III: Objectives and Targets for the 100% Lebanon Vision

Result indicator	#	Description	Timeframe				
			2030	2035	2040	2045	2050
Objective	**1**	**Financing maximized renewable energy and grid modernization potential and connectivity**					
Description		Sustainably exploit the full potential of national renewable energy resources to minimize reliance on energy imports, optimize energy efficiency, as well as increase grid connectivity.					
Target	1.1	30% of electricity demand and 16% of heat demand (in building sector) is met through RE.	X				
		60% of power demand and 30% of heat demand (in building sector) is met through RE (electricity demand)			X		
		90-100% of power demand and 75% of heat demand (in building sector) is met through RE (electricity demand)					X
Target	1.2	50% of the workforce in the energy sector has access to up-skilling training to transition into clean energy and waste to energy jobs	X				
		90-100% of the workforce in the energy sector has access to up-skilling training to transition into clean energy and waste to energy jobs			X		
Target	1.3	50% of the country's grid infrastructure has been upgraded, increasing efficiency, disaster resilience and renewable energy supply		X			
		100% of the country's grid infrastructure has been upgraded, increasing efficiency, disaster resilience, and renewable energy supply				X	
Target	1.4	Measures are deployed to enhance energy efficiency resulting in a 3% reduction in energy demand	X				
		Measures are deployed to enhance energy efficiency resulting in a 10% reduction in energy demand		X			
		Measures are deployed to enhance energy efficiency resulting in a 30% reduction in energy demand			X		
Objective	**2**	**Sustainable transportation**					
Description		Support the transition towards a RE-based, resilient mobility network, promoting sustainable lifestyles and sustainable mobility.					
Target	2.1	Promotion of electric mobility and non-fossil fuel vehicles (NFFVs)	X				
Target	2.2	Replacement of old and inefficient vehicles gradually with battery electric vehicles and other NFFVs (20% of newly registered vehicles)		X			
		Replacement of old and inefficient vehicles gradually with battery electric vehicles and other NFFVs (40% of newly registered vehicles)			X		
		Replacement of old and inefficient vehicles gradually with battery electric vehicles and other NFFVs (60% of newly registered vehicles)				X	
		Replacement of old and inefficient vehicles gradually with battery electric vehicles and other NFFVs (90-100% of newly registered vehicles)					X
Target	2.3	Switch 50% of heavy freight transportation to electric rail		X			
		Switch 70% of heavy freight transportation to electric rail			X		
		Switch 90-100% of heavy freight transportation to electric rail					X
Target	2.4	Switch 20% of new truck registrations and 30% of LCVs to electric powertrains		X			
		Switch 30% of new truck registrations and 40% of LCVs to electric powertrains			X		
		Switch 40% of new truck registrations and 50% of LCVs to electric powertrains				X	

Result indicator	#	Description	Timeframe				
			2030	2035	2040	2045	2050
Target	2.4	Switch 50% of new truck registrations and 75% of LCVs to electric powertrains					X
Target	2.5	50% of public transportation is electrified		X			
		75% of public transportation is electrified			X		
		100% of public transportation is electrified				X	
Target	2.6	10km of bike lanes integrated into relevant roads in 10 key urban locations		X			
		50% of relevant roads include bike/alternative transportation lanes			X		
		70% of relevant roads include bike/alternative transportation lanes				X	
		90% of relevant roads include bike/alternative transportation lanes					X
Target	2.7	Promotion of non-motorized transportation in key urban centers	X				
		Share of non-motorized transportation increases to 20% of all road trips		X			
		Share of non-motorized transportation increases to 30% of all road trips			X		
Target	2.8	Promotion of use of public transportation in key urban centers	X				
		Increase the share of daily trips taken using mass public transportation by 20%		X			
		Increase the share of daily trips taken using mass public transportation by 30%			X		
		Increase the share of daily trips taken using mass public transportation by 40%				X	
		Increase the share of daily trips taken using mass public transportation by 50%					X
Objective	**3**	**Accelerated Transition and Modernization Through Re-skilling and Training**					
Description		Promote sustainable economic transformation by incentivizing & leveraging local opportunities for climate resilient & green jobs, and training of the population to increase jobs and decrease poverty.					
Target	3.1	30% of new jobs supported by re-skilling and training for industries of the future		X			
		75% of new jobs supported by re-skilling and training for industries of the future			X		
		90% of new jobs supported by re-skilling and training for industries of the future				X	
Target	3.2	Set up a green entrepreneurship incubator to support young entrepreneurs, foster MSME sectors, enable local climate solution-making and create sustainable job opportunities	X				
		Incubated projects represent 1% of GDP by volume of commercial revenue		X			
Objective	**4**	**Shifting sustainable debt through conversion and attrition of capital to climate projects**					
Description		Repurpose and reduce the debt of Lebanon through debt-for-climate swaps, shifting the debt towards climate-smart investments and improving debt sustainability.					
Target	4.1	Increase available financing envelope for climate projects by 10% through debt-for-climate swaps		X			
		Increase available financing envelope for climate projects by 30% through debt-for-climate swaps			X		
		Increase available financing envelope for climate projects by 100% through debt-for-climate swaps				X	

Result indicator	#	Description	Timeframe				
			2030	2035	2040	2045	2050
Objective	**5**	**Carbon Financing Hub to value blue carbon, soil carbon, forest carbon, etc.**					
Description		Maximize access to carbon financing to support investment efforts while supporting conservation & ecosystem services for multi-industries (agriculture, industry, tourism etc.).					
Target	5.1	Projects representing 100,000 tonnes of CO_2 activated through carbon financing	X				
		Projects representing 200,000 tonnes of CO_2 activated through carbon financing		X			
Target	5.2	Reforestation including participation in carbon markets to increase forest cover in Lebanon up to 30%		X			
Target	5.3	Deployment of early warning systems and implementation of measures to increase ecosystems resilience to reduce forest fire damages by 30%	X				
		Deployment of early warning systems and implementation of measures to increase ecosystems resilience to reduce forest fire damages by 60%		X			
		Deployment of early warning systems and implementation of measures to increase ecosystems resilience to reduce forest fire damages by 90-100%			X		
Target	5.4	Increase in conservation areas and corridors and habitat enrichment to achieve 30% of total protected marine and terrestrial areas each	X				
Objective	**6**	**Financially protect the economy and livelihoods**					
Description		Promote risk informed investment and enable progressive coverage of financial/social protection including insurance for all core climate and disaster risk (fires, erosion damage, agricultural losses, etc.) and protect and increase livelihood options.					
Target	6.1	Extend financial protection including through risk transfer against climate related disasters for 70% of the population living in poverty	X				
		Extend financial protection including through risk transfer against climate related disasters for 100% of the population living in poverty		X			
Objective	**7**	**Developing domestic food and commercial markets**					
Description		Reduce import burden and strengthen local industries to boost the resilience of the economy, with a specific focus on strengthening national food systems, enhancing food security and improving nutritional value by incentivizing domestic production and boosting sustainable beverage, fresh produce and high-nutrient and high-protein industries.					
Target	7.1	25% increase in production in domestic food and beverage, including fresh produce and high nutrient and protein food stocks, with an emphasis on plant crops		X			
		50% of national food and beverage consumption is domestically produced			X		
		75% of national food and beverage consumption is domestically produced				X	
Target	7.2	50% of the population consume largely plant-based		X			
		75% of the population consume largely plant-based			X		
		90-100% of the population consume largely plant-based				X	
Target	7.3	Launch of a program to promote sustainable farming practices in 10-15 key areas	X				
		Program to promote sustainable farming practices is expanded country-wide		X			
		50% of the national farming outputs come from sustainable farming				X	
		90-100% of the national farming outputs come from sustainable farming					X
Target	7.4	50% of building insulation materials are sourced and produced domestically from sustainable materials		X			

Result indicator	#	Description	Timeframe				
			2030	2035	2040	2045	2050
Target	7.4	75% of insulation materials are sourced and produced domestically from sustainable materials			X		
		100% of insulation materials are sourced and produced domestically from sustainable materials				X	
Target	7.5	50% of agricultural inputs such as sustainable fertilizers are sourced and produced domestically		X			
		75% of agricultural inputs such as sustainable fertilizers are sourced and produced domestically			X		
		90-100% of agricultural inputs such as fertilizers are sourced and produced domestically				X	
Target	7.6	Through programs promoting sustainable and green tourism infrastructure and offers, green/eco-tourism tourism represents 10% of Lebanon GDP		X			
		Green/eco-tourism tourism represents 20% of Lebanon GDP			X		
Target	7.7	The up-cycling industry represents 15% of all industrial production		X			
		The up-cycling industry represents 30% of all industrial production			X		
		The up-cycling industry represents 50% of all industrial production				X	
Target	7.8	Implementation of incentivization measures to foster the development of a circular economy	X				
		20% of all production is integrated within the circular economy		X			
		50% of all production is integrated within the circular economy			X		
		70% of all production is integrated within the circular economy				X	
		90-100% of all production is integrated within the circular economy					X
Objective	**8**	**Green and resilient built environment**					
Description		Climate-proof the built environment and the economy by leveraging nature-based solutions and increasing resilience through both soft and hard engineering, leveraging local materials to increase build affordability.					
Target	8.1	Nature-based solutions to enhance forest resilience to fire risk, flood protection, and minimize coastal erosion are piloted in 10-15 risk areas	X				
		Nature-based solutions to enhance forest resilience to fire risk, flood protection, and minimize coastal erosion are deployed in 50% of risk areas		X			
		Nature-based solutions to enhance forest resilience to fire risk, flood protection ,and minimize coastal erosion are deployed in 75% of risk areas			X		
		Nature-based solutions to enhance forest resilience to fire risk, flood protection, and minimize coastal erosion are deployed in 90-100% of risk areas				X	
Target	8.2	Water management projects leveraging nature-based and infrastructural solutions are piloted in Beirut	X				
		Water management projects leveraging nature-based and infrastructural solutions are active in all major cities		X			
		Water management projects leveraging nature-based and infrastructural solutions are active across all key at-risk urban and rural areas			X		
Target	8.3	Water efficiency and sustainable water use projects are piloted in Beirut	X				
		Water efficiency and sustainable water use projects are active in all major cities		X			

Result indicator	#	Description	Timeframe				
			2030	2035	2040	2045	2050
Target	8.3	Water efficiency and sustainable water use projects are active across all key at-risk urban and rural areas			X		
		25% of roofs in major urban centers are cultivated as biodiversity touchpoints and/or used for green energy production		X			
		50% of roofs in major urban centers are cultivated as biodiversity touchpoints and/or used for green energy production			X		
		100% of roofs in major urban centers are cultivated as biodiversity touchpoints and/or used for green energy production				X	
Target	8.4	75-100% of new buildings in at-risk coastal areas are erected at elevation above ground level to increase flood protection	X				
Target	8.5	25% of existing built structures on the Beirut coastline are flood-protected	X				
		50% of existing built structures on the Beirut coastline are flood-protected		X			
		Flood protection of existing built environment programs active on 50% of the at-risk inhabited coastline			X		
		Flood protection of existing built environment programs active on 75% of the at-risk inhabited coastline				X	
		Flood protection of existing built environment programs active on 100% of the at-risk inhabited coastline					X
Objective	**9**	**Building resilience to heat-related diseases**					
Description		Implement preventative measures to minimize the negative impacts of heat stress on the public and workers' well-being and productivity, harnessing nature-based solutions.					
Target	9.1	25% of workers protected from extreme heat, including workers in the informal economy	X				
		50% of workers protected from extreme heat, including workers in the informal economy		X			
		75% of workers protected from extreme heat, including workers in the informal economy			X		
		100% of workers protected from extreme heat, including workers in the informal economy				X	
Target	9.2	75%-100% of new buildings are equipped with insulation (using locally sourced materials) and high-efficiency HVAC		X			
Target	9.3	25% of existing built structures in capital and high density areas are equipped with insulation (using locally sourced materials) and high-efficiency HVAC			X		
		50% of existing built structures in capital and high density areas are equipped with insulation (using locally sourced materials) and high-efficiency HVAC					X
Target	9.4	100% of the population has access to safe and affordable water sources		X			
Target	9.5	Education campaign on rehydration regimes and heat stress prevention is deployed across 90-100% of urban and rural areas	X				
Target	9.6	The share of accredited public and private hospitals reaches 50%			X		
		The share of accredited public and private hospitals reaches 75%				X	
		The share of accredited public and private hospitals reaches 90%					X

Annex IV: The GEM Model

The Green Economy Model (GEM) enabled a comprehensive analysis of the economic, social, and environmental impacts of Lebanon's Climate Prosperity Plan (CPP), identifying the most effective strategies for achieving climate goals. GEM integrates socio-economic and environmental dynamics with natural capital at the country level. Enhancements to GEM for the CPP include detailed climate data, broader climate change damage estimates, co-benefits of climate action, and numerous policy options for resilience. Designed to inform sustainable development policymaking, GEM forecasts the outcomes of various policies and investments over the medium and long term. It promotes an inclusive, robust, and resilient outlook by illustrating how built, social, human, and natural capitals interconnect. Feedback loops in GEM help promote sustainable consumption and decouple economic growth from resource use. Applied in over 50 countries, GEM includes sectors such as population, food supply, economic activity, employment, health care, education, energy, emissions, water pollution, and climate trends, providing economic valuations for several externalities. In the CPP context, GEM includes additional climate impacts and resilience options, enabling a comprehensive economic and financial assessment of climate action. Built using System Dynamics (SD) methodology, GEM aids holistic development planning, informing policy formulation and creating resilient strategies by highlighting both short-term benefits and medium-term challenges. Overall, GEM's application in the CPP demonstrates its capability to integrate multiple dimensions of sustainable development for robust policy and investment decisions.

The Green Economy Model (GEM) offers an integrated representation of socio-economic and environmental dynamics, and the natural capital that supports them, at a country level. To ensure that the CPP analysis is comprehensive, considers climate risks, relevant investment options, and produces a wide range of the avoided costs and added benefits generated by climate action, several changes and additions have been made to GEM0F[71]. These can be grouped into four categories: (i) the integration of detailed climate data, (ii) the estimation of a more extended list of climate change damage and assumptions for reconstruction, (iii) the integration of a variety of co-benefits of climate action, and (iv) the addition of several policy options for climate resilience.

GEM is designed to inform policy making towards sustainable development. It allows forecasting and assessing the outcomes of various policies and investments in relation to medium- and long-term national development targets. By offering a systemic approach, GEM forecasts the outcomes of action and inaction across sectors, actors, dimensions of development and over time. Furthermore, GEM enables the formulation of policies and investment packages that result in a more inclusive, robust, and resilient outlook for the country. At the same time, by means of co-creation, GEM supports the creation of a better understanding of the co-benefits associated with sustainable policies and investments, including climate action, under different climate scenarios.

Figure 47 presents the generalized underlying structure of GEM. Figure 48 presents instead a sub-system diagram of the model. The former shows how four key capitals (built, social, human, and natural) are interconnected, and how they contribute to shaping future trends across social, economic, and environmental indicators. Specifically, feedback loops can be identified that are reinforcing (R), in all areas pertaining to economic growth and social development. These are driven by investments and knowledge creation, and enabled by the availability of natural capital, which, if not properly managed, can constrain economic growth (hence the balancing loops -(B)- identified in the diagram). Policies can be implemented to promote sustainable consumption and production, decoupling economic growth from resource use (also through education and behavioural change), to mitigate the exploitation of natural capital and generate stronger and more resilient green growth.

[71] In a reinforcing loop, a change in one direction is compounded by more change. Under a reinforcing loop, policies or shocks that move a variable in one direction transmit through the system in a way that leads to further increases in such variables over time. For example, money in a savings account generates interest, which increases the balance in the savings account and earns more interest. Balancing loops, in contrast, counter change in one direction with change in the opposite direction.

GEM has been applied to more than 50 countries and was designed to include all key sectors that are relevant for future development; for instance, the context of low carbon development is one factor that is included. Additionally, other factors include: population, food demand and supply, land use and land cover, economic activity (via the use of national accounts), employment, access to health care, education, energy demand and supply, air emissions, water pollution, and climate trends. The model also provides an economic valuation for several externalities, including GHG emissions (social cost of carbon), air pollution, wastewater, waste, traffic-related impacts (e.g. accidents, noise), the opportunity cost of water (from savings in the agriculture sector), and biodiversity.

In the context of the Climate Prosperity Plan (CPP) project, GEM has been equipped with several additional climate impacts, and with more than 20 additional climate resilience options, now coupled with an equal amount of transition investments. This allows for the creation of a complete economic and financial assessment of climate action (built on physical indicators and summarized in a Cost Benefit Analysis) for both transition and climate resilience.

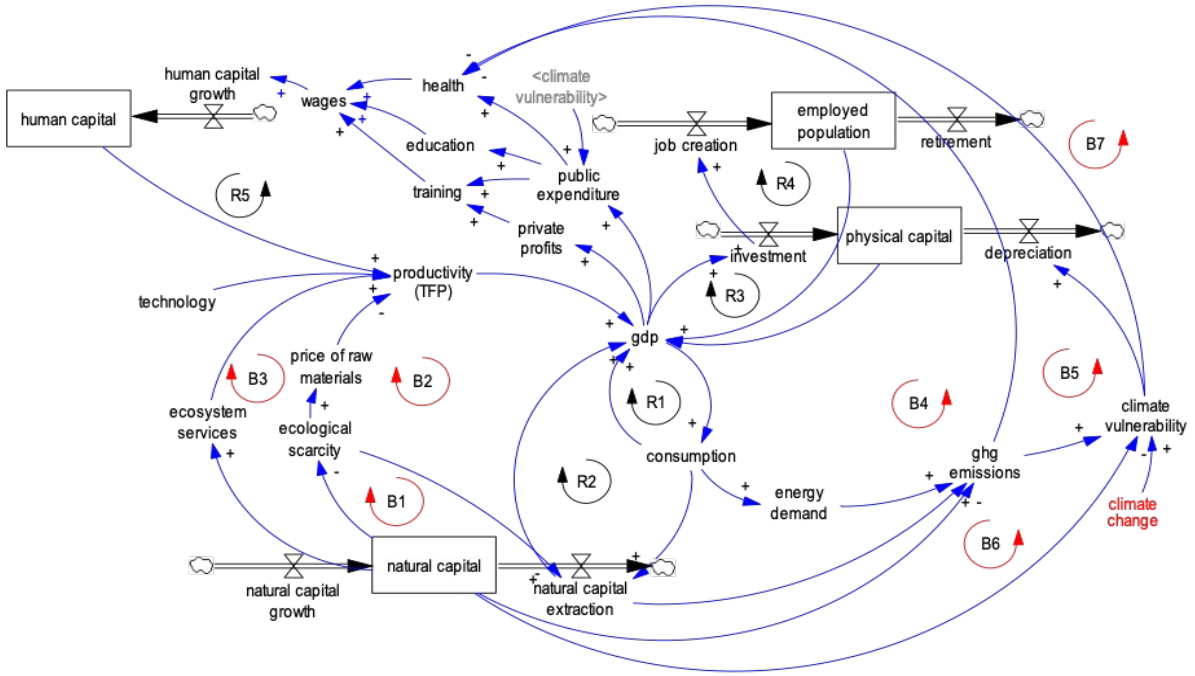

Figure 47: Overview of the Green Economy Model (GEM)

GEM is built using the System Dynamics (SD) methodology, serving primarily as a knowledge integrator. SD is a form of computer simulation modelling designed to facilitate a comprehensive approach to development planning in the medium to long term. SD operates by simulating differential equations with "what if" scenarios, explicitly represents stocks and flows (critical to estimate climate change impacts on infrastructure, and how such impacts accumulate over time to affect economic productivity, among other indicators), can integrate optimization and econometrics, and support model coupling (e.g. in conjunction with spatially explicit models, sectoral models for energy and the economy).

The purpose of using SD for the development and application of GEM is not to make precise predictions of the future, nor to optimize performance; rather, GEM applications are used to inform policy formulation, forecasting policy outcomes (both desirable and undesirable) and leading to the creation of a resilient and well-balanced strategy. Such an approach is consistent with the thinking framework of policymakers, who weigh sets of outcomes on the basis of political, technical, and institutional preferences in choosing policy packages.

All GEM applications include four key capitals (physical, human, social, and natural) as interconnected via the explicit representation of feedback loops (reinforcing or balancing). Policies can be implemented to

strengthen growth (reinforcing loops, e.g. investments in physical capital accumulate capital stock, which, other things equal, increases output potential, production, aggregate demand, including investment, further increasing, capital, and output); or curb change (e.g. by strengthening balancing loops). In the context of climate action, we generally find that transition investments directly stimulate new growth, while investments in climate resilience reduce costs and free up resources, thereby enabling new growth indirectly.

Among the many feedback relationships represented by GEM, there are two that are worth highlighting, considering how central they are for explaining the connectedness of climate, environmental and socio-economic outcomes, which is, in turn, central for the design of robust development policies. The first one refers to impacts on what mainstream models refer to Total Factor Productivity (TFP). TFP in the model is impacted by technology, infrastructure (e.g. the road network and access to electricity), energy productivity (i.e. considering the cost of energy as a ratio of GDP), air pollution, weather (e.g. temperature), and extreme weather events. As a result, investments in energy efficiency and renewable energy, to cite two examples, both reduce energy consumption and spending (possibly resulting in higher GDP) and reduce air pollution (also possibly resulting in higher GDP, but via a different channel). The second one refers to a feedback loop that governs linkages between climate, environment (including policies), and the socio economy. This feedback loop considers the availability of natural resources and impacts of land cover change on ecosystem service provisioning, which goes on to affect economic activity, as well as access to natural resources. These dynamics are represented via the use of feedback loops in the model, resulting in circular relations that may highlight the simultaneous emergence of short-term benefits and medium-term challenges, or vice versa, depending on the scenarios simulated.

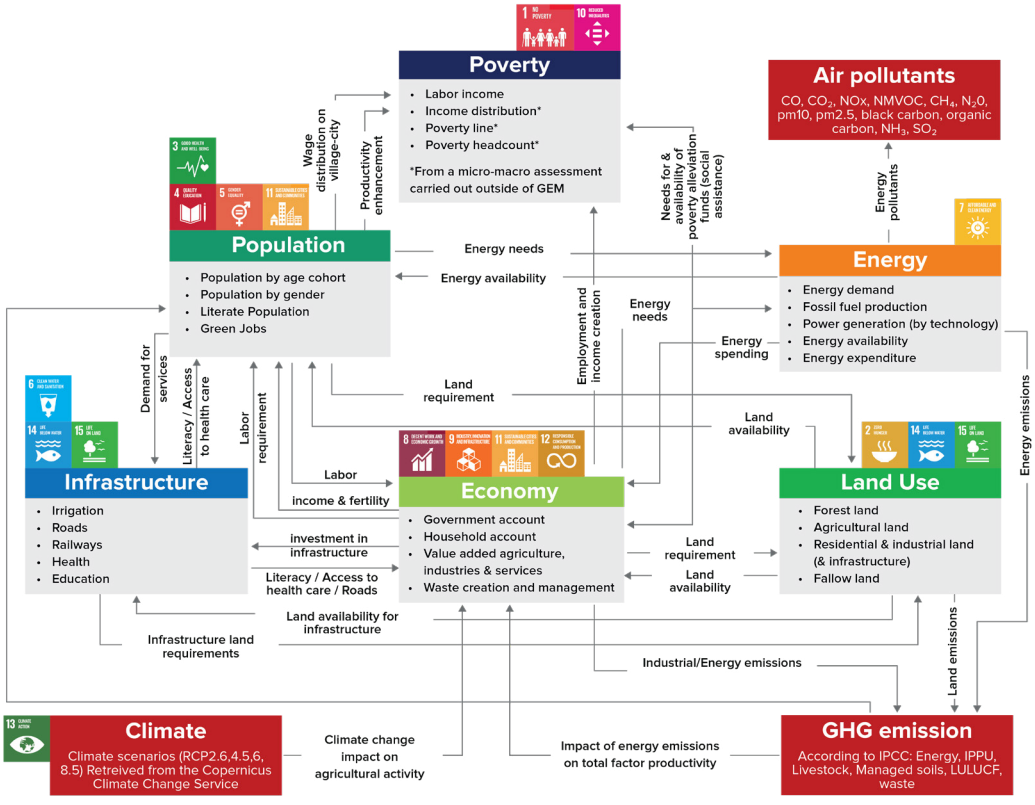

Figure 48: Sub-system diagram presenting the key sectoral components of the Green Economy Model (GEM)

Overall, GEM provides a holistic approach to understanding the connections between climate, environment, and socio-economic outcomes, helping policymakers design effective policies for sustainable development.

Annex V: Description of the Three Scenarios: BAU, NDC (conditional and unconditional), and LEDS

The three modelled scenarios outline Lebanon's projected development pathways options: Business-As-Usual (BAU), Nationally Determined Contribution (NDC), and the Low-Emission Development Strategy (LEDS). The BAU scenario represents a continuation of current policies and practices, maintaining the status quo without additional climate action. In contrast, the NDC scenarios, both conditional and unconditional, align with Lebanon's commitments under the Paris Agreement, implementing structured climate measures to reduce emissions and enhance resilience. The most ambitious pathway, the LEDS, envisions a transformative approach towards achieving climate prosperity through comprehensive investments in renewable energy, sustainable transportation, workforce re-skilling, and resilient infrastructure. Each scenario presents a distinct strategy for Lebanon's climate and economic future, highlighting varying degrees of commitment, innovation, and integration in addressing the pressing issue of climate change. Key elements of each scenario: BAU, NDC (Conditional and Unconditional), and LEDS are as such:

Business-As-Usual (BAU) Scenario

The BAU scenario maintains current policies and practices without any climate action, or implementation of national climate policy, reflecting the status quo. Its key elements include:

a) **No New Measures**:

a. Continuation of existing policies and practices without implementing new climate resilience or mitigation strategies or actions.
b. Reliance on historical patterns and conventional practices.

b) **Economic and Energy Trends**:

a. Energy demand and greenhouse gas emissions continue to increase.
b. Economic activities follow historical trends, with no significant shifts towards sustainability.

c) **Infrastructure and Development**:

a. Infrastructure development continues as per current plans without integrating climate resilience.
b. Limited or no investment in renewable energy or energy efficiency.

d) **Vulnerability to Climate Change**:

a. Increased vulnerability to climate change impacts, such as extreme weather events, sea-level rise, and temperature increases.
b. No additional measures to enhance climate resilience or mitigate climate risks.

Nationally Determined Contribution (NDC) Scenarios

The NDC scenarios align with Lebanon's climate commitments under the Paris Agreement, representing structured approaches to addressing climate change. They include:

a) **Unconditional NDC (NDC-U)**:

a. **Climate Commitments**: Implementation of climate measures that Lebanon commits to without requiring international financial support.
b. **Focus Areas**:
    i. Adoption of renewable energy technologies.
    ii. Implementation of energy efficiency programs.
    iii. Development of climate-resilient infrastructure.

b) **Conditional NDC (NDC-C)**:

a. **Climate Commitments**: Implementation of climate measures contingent on receiving international financial support and other resources.

b. **Focus Areas**:

i. More extensive adoption of renewable energy technologies.

ii. Enhanced energy efficiency programs.

iii. Broader development of climate-resilient infrastructure.

c) **Specific Measures**:

a. Policies to reduce greenhouse gas emissions across various sectors.

b. Initiatives to enhance climate resilience, including infrastructure improvements and adaptation strategies.

d) **Integration with Global Goals**:

a. Alignment with international climate agreements and targets.

b. Collaboration with global partners to achieve climate objectives.

Low-Emission Development Strategy (LEDS) Scenario

The LEDS scenario represents an ambitious and comprehensive strategy for achieving climate prosperity. Its key elements include:

a) **Maximized Renewable Energy and Grid Modernization**:

a. Significant investments in renewable energy sources (e.g., solar, wind).

b. Modernization of the national power grid to improve efficiency and connectivity.

b) **Sustainable Transportation**:

a. Promotion of electric vehicles and development of supporting infrastructure.

b. Enhancement of public transportation systems.

c. Development of infrastructure for non-motorized transport (e.g., cycling, walking).

c) **Accelerated Transition and Modernization Through Re-skilling and Training**:

a. Re-skilling and training programs for the workforce to adapt to new green jobs.

b. Support for green entrepreneurship and innovation.

d) **Financial Protection of the Economy and Livelihoods**:

a. Implementation of financial safety nets and insurance mechanisms to protect against climate-related risks.

b. Development of economic strategies to support climate resilience.

e) **Developing Domestic Food and Commercial Markets**:

a. Promotion of local, sustainable food production to enhance food security.

b. Support for sustainable commercial practices and industries.

f) **Green and Resilient Built Environment**:

a. Construction of energy-efficient buildings and resilient infrastructure.

b. Integration of nature-based solutions to enhance resilience (e.g., green roofs, urban green spaces).

g) **Building Resilience to Heat-Related Diseases**:

a. Public health initiatives to address the impacts of extreme heat.
b. Development of infrastructure to mitigate heat stress (e.g., high-efficiency HVAC systems, green spaces).

h) **Comprehensive Investment Strategy**:

a. Mobilization of significant financial resources for green and resilient infrastructure projects.
b. Engagement of both public and private sectors to fund climate initiatives.

i) **Integrated Approach to Climate Action**:

a. Holistic strategy that combines economic growth, environmental sustainability, and social well-being.
b. Focus on long-term sustainability and prosperity through coordinated climate actions.

Each scenario represents a different approach to addressing climate change, with the BAU scenario maintaining the status quo, the NDC scenarios implementing structured climate commitments, and the LEDS scenario pursuing an ambitious, integrated strategy for climate resilience and economic growth.

Annex VI: Gender Action Entry Points

#	Result indicator	Description	Gender Actions
1	**Objective**	**Financing maximized renewable energy and grid modernization potential and connectivity**	
	Description	Sustainably exploit the full potential of national renewable energy resources to minimize reliance on energy imports, optimize energy efficiency, as well as increase grid connectivity	
1.1	Target	90-100% of power demand and 75% of heat demand (in building sector) is met through RE (electricity demand)	
1.2	Target	90-100% of the workforce in the energy sector has access to up-skilling training to transition into clean energy and waste to energy jobs, of which, 40% are women	▪ Develop advocacy campaigns to encourage women to work in the energy sector ▪ Develop enabling policies for women to work in the energy sector ▪ Conduct trainings for the prevention of sexual harassment in the energy sector
1.3	Target	100% of the country's grid infrastructure has been upgraded, increasing efficiency, disaster resilience, and renewable energy supply	
1.4	Target	Measures are deployed to enhance energy efficiency resulting in a 30% reduction in energy demand	
2	**Objective**	**Sustainable transportation**	
	Description	Support the transition towards a RE-based, resilient mobility network, promoting sustainable lifestyles and sustainable mobility	
2.1	Target	Promotion of electric mobility and none-fossil fuel vehicles (NFFVs)	
2.2	Target	Replacement of old and inefficient vehicles gradually with battery electric vehicles and other NFFVs (90-100% of newly registered vehicles)	
2.3	Target	Switch 90-100% of heavy freight transportation to electric rail	
2.4	Target	Switch 50% of new truck registrations and 75% of LCVs to electric powertrains	
2.5	Target	100% of public transportation is electrified	
2.6	Target	10km of bike lanes integrated into relevant roads in 10 key urban locations	▪ Conduct consultations with women and women's rights organizations to identify the locations and the lanes that would be the safest for them to use.
		90% of relevant roads include bike/alternative transportation lanes	
2.7	Target	Promotion of non-motorized transportation in key urban centers	

#	Result indicator	Description	Gender Actions
		Increase the share of daily trips taken using safe, mass public transportation by 30%	▪ Ensure safe accessibility to mass public transportation for all (women, children, and the disabled) (i.e. ramps, seats dedicated to pregnant women, seats dedicated for the elderly, space for wheelchair, space for strollers) ▪ Ensure proper reporting mechanisms for harassment incidents on board of public transportation vehicles ▪ Conduct awareness campaigns around the above mentioned reporting mechanisms targeting the most vulnerable populations ▪ Ensure that the cost of public transportation tickets is affordable to the most vulnerable communities
2.8	Target	Promotion of use of public transportation in key urban centers	
		Increase the share of daily trips taken using mass public transportation by 50%	
3	**Objective**	**Accelerated Transition and Modernization Through Re-skilling and Training**	
	Description	Promote sustainable economic transformation by incentivizing & leveraging local opportunities for climate resilient & green jobs, and training of the population to increase jobs and decrease poverty	
3.1	Target	90% of new jobs supported by re-skilling and training for industries of the future	▪ Encourage women to participate in the green workforce through advocacy campaigns and dedicated training and educational programs.
3.2	Target	Set up a green entrepreneurship incubator to support young entrepreneurs, of which 50% are female, foster MSME sectors, enable local climate solution-making and create sustainable job opportunities	▪ Encourage young women entrepreneurs to grow their businesses and focus on green solutions
		Incubated projects represent 1% of GDP by volume of commercial revenue	
4	**Objective**	**Shifting sustainable debt through conversion and attrition of capital to climate projects**	
	Description	Repurpose and reduce the debt of Lebanon through debt-for-climate swaps, shifting the debt towards climate-smart investments and improving debt sustainability	
4.1	Target	Increase available financing envelope for climate projects by 10% through debt-for-climate swaps	
		Increase available financing envelope for climate projects by 30% through debt-for-climate swaps	
		Increase available financing envelope for climate projects by 100% through debt-for-climate swaps	
5	**Objective**	**Carbon Financing Hub to value blue carbon, soil carbon, forest carbon, etc.**	
	Description	Maximize access to carbon financing to support investment efforts while supporting conservation & ecosystem services for multi-industries (agriculture, industry, tourism etc.)	
5.1	Target	Projects representing 200,000 tons of CO_2 activated through carbon financing	
5.2	Target	Reforestation including participation in carbon markets to increase forest cover in Lebanon up to 30%	▪ Ensure the participation of women in reforestation projects and mobilize youth to participate
5.3	Target	Deployment of inclusive early warning systems and implementation of measures to increase ecosystems resilience to reduce forest fire damages by 90-100%	▪ Make sure that the measures are inclusive in their nature and are able to target different audiences and communities according to their different needs, without exacerbating or creating inequalities.

#	Result indicator	Description	Gender Actions
5.4	Target	Increase in conservation areas and corridors and habitat enrichment to achieve 30% of total protected marine and terrestrial areas each	
6	**Objective**	**Financially protect the economy and livelihoods**	
	Description	Promote risk informed investment and enable progressive coverage of financial/social protection including insurance for all core climate and disaster risk (fires, erosion damage, agricultural losses etc.) and protect and increase livelihood options	
6.1	Target	Extend financial protection including risk transfer against climate related disasters for 100% of the population living in poverty	
7	**Objective**	**Financially protect the economy and livelihoods**	
	Description	Promote risk informed investment and enable progressive coverage of financial/social protection including insurance for all core climate and disaster risk (fires, erosion damage, agricultural losses etc.) and protect and increase livelihood options	
7.1	Target	50% of national food and beverage consumption is domestically produced	▪ Provide support to women-led SMEs across the Agrofood, industry, and tourism sectors: provide incentives to encourage women-led SMEs to grow and provide them with technical support on how to become more sustainable and eco-friendlier. Also, support them in lowering their carbon footprint, as it will help them trade internationally as well.
7.2	Target	50% of the population consume largely plant-based	
7.3	Target	Launch of a program to promote sustainable farming practices in 10-15 key areas	
		Program to promote sustainable farming practices is expanded country-wide	
		50% of the national farming outputs come from sustainable farming	
7.4	Target	100% of insulation materials are sourced and produced domestically from sustainable materials	
7.5	Target	75% of agricultural inputs such as sustainable fertilizers are sourced and produced domestically	
7.6	Target	Through programs promoting sustainable and green tourism infrastructure and offers, green/eco-tourism tourism represents 10% of Lebanon GDP	
		Green/eco-tourism tourism represents 20% of Lebanon GDP	
7.7	Target	The up-cycling industry represents 50% of all industrial production	
7.8	Target	Implementation of incentivization measures to foster the development of a circular economy	
		90-100% of all production is integrated within the circular economy	

#	Result indicator	Description	Gender Actions
8	**Objective**	**Green and resilient built environment**	
	Description	Climate-proof the built environment and the economy by leveraging nature-based solutions and increasing resilience through both soft and hard engineering, leveraging local materials to increase build affordability	
8.1	Target	Nature-based solutions to enhance forest resilience to fire risk, flood protection, and to minimize coastal erosion are deployed in 90-100% of risk areas	
8.2	Target	Water management projects leveraging nature-based and infrastructural solutions are active across all key at-risk urban and rural areas	▪ Projects of that nature allocate 15% of their budgets to gender equality
8.3	Target	Water efficiency and sustainable water use projects are active across all key at-risk urban and rural areas	▪ Mobilize women to become advocates in their communities for water efficiency and sustainable water use
		50% of roofs in major urban centers are cultivated as biodiversity touchpoints and/or used for green energy production	▪ Urban farming/ train women on urban farming
8.4	Target	75-100% of new buildings in at-risk coastal areas are erected at elevation above ground level to increase flood protection	
8.5	Target	Flood protection of existing built environment programs active on 100% of the at-risk inhabited coastline	
9	**Objective**	**Building resilience to heat-related diseases**	
	Description	Implement preventative measures to minimize the negative impacts of heat stress on the public and workers' well-being and productivity, harnessing nature-based solutions	
9.1	Target	100% of workers protected from extreme heat, including workers in the informal economy	
9.2	Target	75%-100% of new buildings are equipped with insulation (using locally sourced materials) and high-efficiency HVAC	
9.3	Target	50% of existing built structures in capital and high-density areas are equipped with insulation (using locally sourced materials) and high-efficiency HVAC	
9.4	Target	100% of the population has access to safe and affordable water sources	
9.5	Target	Education campaign on rehydration regimes and heat stress prevention is deployed across 90-100% of urban and rural areas	
9.6	Target	The share of accredited public and private hospitals reaches 90%	

Annex VII: Overview of Modelling Outcomes Across Scenarios

	Simulation 1 - No Reform (NR)		Simulation 2 - Reform (R)		Boost delivered by the LEDS scenario	
	BAU-NR	LEDS-NR	**BAU-R**	**LEDS-R**	**LEDS-NR (compared to BAU-NR)**	**LEDS-R (compared to BAU-R)**
Real GDP (2050, USD billion)	40.5	61.9	**76.2**	**108.4**	**+52.9%**	**+42.2%**
Nominal GDP (2050, USD billion)	59.8	91.5	**112.6**	**160.2**	**+52.9%**	**+42.2%**
Average real GDP growth rate (2022-2050, %)	0.9	2.4	**3.1**	**4.4**	**1.5% (LEDS gain)**	**1.3% (LEDS gain)**
Real disposable income per capita (2050, USD/person)	3,370	4,930	**5,880**	**8,205**	**+46.6%**	**+39.5%**
Share of the population under the poverty line (2050, %)	Due to high variability in certain macro-economic parameters, the estimation of the baseline for population under the poverty line is subject to uncertainty, and projections are therefore subject to variation. A diminution of the share of the population under that line is however predicted in the LEDS scenarios				**-31%**	**-13%**
Carbon credit value (2050, USD million)	0	17.9	0	**17.9**	**NA**	**NA**
Additional real GDP generated from climate insurance payouts (2050, %)	0	3.6	**0**	**3.1**	**+3.6%**	**+3.1%**
Total employment (2050, million people)	2.3	2.93	**3.9**	**4**	**28.1%**	**2.1%**
Unemployment rate (average 2022-2050, %)	24.7	9.2	**11.7**	**7**	**-62.9%**	**-39.9%**
Number of green jobs (2050, number of people)	44,720	109,080	**44,800**	**118,610**	**+143.9%**	**+164.7%**
Share of green job in total employment (2050, %)	1.5	2.7	1.1	3	+81.1%	+159%
Total annual deaths from ambient and indoor air pollution (2050, number of people)	8,880	333	11,440	451	-96.3%	-96.1%
Total energy consumption (2050, TJ)	202,490	92,990	307,130	143,790	-54.1%	-53.2%
Energy bill as share of GDP (2050, %)	18.2	2.7	15.5	2.4	-95%	-95.9%
Energy affordability index (2050, index (2022 = 0.84))	0.54	3.46	0.58	3.71		
Annual electricity generation (2050, TWh/year)	17.7	26.1	30.2	41.1	+47.6%	+36.5%
Share of power generated by renewable capacity (2050, %)	3.2	100	3.1	100	+3009%	+3132%
Annual GHG emission levels (2050, million tonnes)	25.01	-1.78	40.5	-1.4	-107.1%	-103.4%
Cumulative climate damages (2022-2050, USD billion)	39	35.8	57.2	50.2	-8.3%	-12.2%
Forest cover (2050, hectares)	121,410	146,850	121,410	146,850	+21%	+21%
Total water demand (2050, million cubic meters)	2,020	1,950	2,101	2,005	-3.3%	-4.6%

Total additional real annual investment, compared to BAU (2030, USD billion)	0	1.05	0	1.68	NA	NA
Total additional real investment as share of GDP, compared to BAU (2030, %)	0	4.1	0	3.9	NA	NA
Average public adaptation and transition investment (2022-2050, USD million/year)	720.6	1,840	811	2,110	+154.77%	+160.24%
Additional annual private adaptation and transition investment compared to BAU (2030, USD million/year)	0	367.8	0	388.2	NA	NA
Ratio avoided cost and added benefits to investment (2022-2030)	NA	2.24	NA	2.29	NA	NA

Annex VIII: Transition and Resilience Projects

	Target #	Secondary target #	Name	Source	Inv. amount (millions)	Currency	Project type
Transition Projects	**Maximizing the financing of renewable and resilient energy systems**						
	1.1		Metn - Al Manzoul Hill lake: Construction of dam and hill lake (0.4MCM) including water treatment plant and transmission line from the lake to reservoirs of Zaarour and Aintoura	Government of Lebanon, "Capital Investment Program" (April 2018)	15.30	USD	Renewable energy (hydro)
	1.1		Hydro power plants (331.5 MW)	Government of Lebanon, "Capital Investment Program" (April 2018)	264.10	USD	Renewable energy (hydro)
	1.1		Geothermal Plant of 1.3MW	Government of Lebanon, "Capital Investment Program" (April 2018)	5.00	USD	Renewable energy (geothermal)
	1.1		Hydro power plants (141.5 MW)	Government of Lebanon, "Capital Investment Program" (April 2018)	112.73	USD	Renewable energy (hydro)
	1.1		Geothermal Plant of 15 MW	Government of Lebanon, "Capital Investment Program" (April 2018)	52.70	USD	Renewable energy (geothermal)
	1.2		Greater Tripoli Basin Wastewater Networks	**EIB Website**	115.56	USD	Waste and energy management
	1.2		Al Ghadir Wastewater	**EIB Website**	157.68	USD	Waste and energy management
	1.2		Kesrwan Water and Wastewater Project	**EIB**	226.80	USD	Waste and energy management
	1.2		Greater Beirut Wastewater	**EIB**	167.40	USD	Waste and energy management
	1.2		South Lebanon Wastewater	**EIB**	108.00	USD	Waste and energy management
	1.2		Construction of Wardaniye Water Treatment Plant to serve Awwali project.	Government of Lebanon, "Capital Investment Program" (April 2018)	37.00	USD	Waste and energy management
	1.2		Solid Waste Management to cover all Lebanon including collection, sorting, treatment and landfill sites.	Government of Lebanon, "Capital Investment Program" (April 2018)	1,400.00	USD	Waste and energy management
	1.3		LV Network Upgrade	Government of Lebanon, "Capital Investment Program" (April 2018)	56.00	USD	Grid modernization
	1.4	1.2, 1.3	Energy Efficiency Telecom Lebanon	**EIB Website**	54.00	USD	Energy efficiency
	1.4		Transmission Master Plan Project (High Importance)	Government of Lebanon, "Capital Investment Program" (April 2018)	223.63	USD	Grid modernization
	1.4		Transmission Master Plan Project including Infrastructure at KSARA Substation (Mid Importance)	Government of Lebanon, "Capital Investment Program" (April 2018)	253.69	USD	Grid modernization
	Sustainable economic transformation						
	3.1	3.2	Identify value chains and green jobs based on the local market's supply and demand of SCP services in the industrial sector	Ministry of Industry & Ministry of Environment, "Sustainable Consumption and Production Action Plan for the Industrial Sector" (2015)	0.25	USD	Green job creation
	3.1		Develop the appropriate educational and awareness tools for promoting SCP approaches in the industrial sector at the level of the consumers	Ministry of Industry & Ministry of Environment, "Sustainable Consumption and Production Action Plan for the Industrial Sector" (2015)	0.40	USD	Capacity-building

	Target #	Secondary target #	Name	Source	Inv. amount (millions)	Currency	Project type
Transition Projects	3.2		Develop the legal framework & promote certification and eco-labeling in the industrial sector in line with SCP approaches	Ministry of Industry & Ministry of Environment, "Sustainable Consumption and Production Action Plan for the Industrial Sector" (2015)	0.25	USD	Capacity-building
	Developing domestic food and commercial markets						
	7.3		Encourage and support the use of renewable energy in the agricultural sector	Ministry of Agriculture, "Lebanon National Agriculture Strategy 2020-2025" (July 2020)	5.00	USD	Sustainable agriculture
	7.3	7.4, 7.6	Promote and upscale the transfer of SCP approaches within industries	Ministry of Industry & Ministry of Environment, "Sustainable Consumption and Production Action Plan for the Industrial Sector" (2015)	0.05	USD	Capacity building
	7.4		Implement recommendations of Sustainable Public Procurement Action Plan	Ministry of Industry & Ministry of Environment, "Sustainable Consumption and Production Action Plan for the Industrial Sector" (2015)	0.25	USD	Capacity building
	Water and waste management						
	8.3		Expansion of Dbayeh Water Treatment Plant to increase supply.	Government of Lebanon, "Capital Investment Program" (April 2018)	5.10	USD	Wastewater management
	8.3		Expansion of Laat Treatment Plant and related networks in Baalbek Caza	Government of Lebanon, "Capital Investment Program" (April 2018)	6.70	USD	Wastewater management
	8.3		Wastewater collection networks and treatment plants in North Bekaa	Government of Lebanon, "Capital Investment Program" (April 2018)	65.30	USD	Wastewater management
	8.3		Wastewater collection networks and treatment plant in the Eastern part of Zahle	Government of Lebanon, "Capital Investment Program" (April 2018)	34.70	USD	Wastewater management
	8.3		Expansion of wastewater collection networks within Zahle city	Government of Lebanon, "Capital Investment Program" (April 2018)	11.30	USD	Wastewater management
	8.3		Wastewater collection networks and treatment plants in the South of Central Bekaa	Government of Lebanon, "Capital Investment Program" (April 2018)	83.30	USD	Wastewater management
	8.3		Expansion of the networks in the Qaraoun Lake region (West Bekaa)	Government of Lebanon, "Capital Investment Program" (April 2018)	4.00	USD	Water management
	8.3		Sour 2 (Remaining part of the coast of Sour city and internal and rural areas)	Government of Lebanon, "Capital Investment Program" (April 2018)	90.00	USD	Water management
	8.3		Halloussie (Halloussiye, Hmairi, Halloussiye el Fawqa)	Government of Lebanon, "Capital Investment Program" (April 2018)	7.50	USD	Water management
	8.3		Srifa (Srifa, Bafliyé, Kalaat Maroun, Neftakhiyé, Niha and Deir Kifa)	Government of Lebanon, "Capital Investment Program" (April 2018)	12.00	USD	Water management
	8.3		Ouadi Slouqi (Froun, El-Qoussair, Mazraat Azzi, Ghandouriyet, Qantara, Deir Siriane, Aadchit, Taybet, Aadayssé, Rabb Et-Tlatine, Ouadi Slouqi, Talloussa, Kabrikha, Bany haiyane, Borj qalaouiyé, Touline, Khirbet Selm, Jmaijmé, Majdel Selm, Markaba)	Government of Lebanon, "Capital Investment Program" (April 2018)	53.00	USD	Water management
	8.3		Deir Mimas (Deir Mimas, Houra and Kfar Kila)	Government of Lebanon, "Capital Investment Program" (April 2018)	8.00	USD	Water management

	Target #	Secondary target #	Name	Source	Inv. amount (millions)	Currency	Project type
Transition Projects	8.3		Sarafund (Coastal part between Qasmiye river in the south and Zahrani river in the north, up to to Zrariye, Insar, En Nmaïrîyé and Deïr ez Zahrâni)	Government of Lebanon, "Capital Investment Program" (April 2018)	105.00	USD	Water management
	8.3		Braiqea (Braiqea, Qsaibet, Qaaqaaiyet Ej-Jisr, Jaouharie, Kfar Djal, Aadchit, Mayfadoun, Choukine, Jibchit, Harouf and Aabba	Government of Lebanon, "Capital Investment Program" (April 2018)	35.00	USD	Water management
	8.3		Nabatiye Part II (Kfar Jaouz, Zibdine, Kfar Roummane, El Midane, Nabatiye el Faouqa, Nabatiye el Tahta, El Bayad, Es Serail, El Aaqide, Kfar Tibnit, Aali et Taher and El Manzale)	Government of Lebanon, "Capital Investment Program" (April 2018)	48.00	USD	Water management
	8.3		Nabaa el Tasseh (Mazraat Biyad, Houmine el Faouqa, Jarjouaa, Aarab Salim, El Louaize, Mlikh, Aaramta and Kfar Houne)	Government of Lebanon, "Capital Investment Program" (April 2018)	28.00	USD	Water management
	8.3		El Aaichiyeh - Rayhan (Rayhan, Sejoud, Nabi Sejoud and El Aaichiyeh)	Government of Lebanon, "Capital Investment Program" (April 2018)	6.00	USD	Water management
	8.3		Zilaya (Zilaya, Qelaya, Aain Et-Tiné, Yohmor, Sohmor, Libbaya, Maydoun and Dellafi)	Government of Lebanon, "Capital Investment Program" (April 2018)	15.50	USD	Water management
	8.3		Wastewater projects	National Water Sector Strategy	2,502.35	USD	Wastewater management
	Others						
	-		Pilot Industrial Zones	**The Strategic Plan for the Development of the Industrial Sector and its Executive Mechanisms (July 2020)**	130.00	USD	Industry
	-		Combating pollution of the Qaraoun Lake	Ministry of Industry & Ministry of Environment, "Sustainable Consumption and Production Action Plan for the Industrial Sector" (2015)	144.30	USD	Pollution reduction
			Lebanon Green Investment Facility	UNDP; MoE	250.00	USD	Multisectoral Mitigation
	Transition Projects Total				**6,900.84**	**USD**	
Resilience Projects	**Accelerated transition and modernization through re-skilling and training**						
	3		Lebanon Roads and Employment Project	**EIB/World Bank**	385.00	USD	Job creation
	3.1	5.3	Develop and implement an action plan to strengthen institutional, technical and administrative public capacities in forest sector	**Ministry of Agriculture, "Lebanon National Forest Program 2015-2025", (January 2015)**	1.00	USD	Capacity building
	3.2		Put in place a sustainable management plan for the development of the socio-economic values of Wood and NWFP	Ministry of Agriculture, "Lebanon National Forest Program 2015-2025", (January 2015)	0.33	USD	Capacity building
	3.2		Develop an action plan to support small entrepreneurs on Wood and NWFP in rural areas and villages	Ministry of Agriculture, "Lebanon National Forest Program 2015-2025", (January 2015)	0.79	USD	Capacity building
	Forestry						
	5.2	5.4	Identify key priority areas for reforestation and afforestation based on priority criteria, delineate them and perform surveys on communities preferences	Ministry of Agriculture, "Lebanon National Forest Program 2015-2025", (January 2015)	0.30	USD	Reforestation

	Target #	Secondary target #	Name	Source	Inv. amount (millions)	Currency	Project type
Resilience Projects	5.2	5.4	Conduct reforestation activities on nationwide level based on endorsed partnerships and protocols	Ministry of Agriculture, "Lebanon National Forest Program 2015-2025", (January 2015)	120.00	USD	Reforestation
	5.2		Update forest legislation to be aligned with national priorities, national strategies, policies and actions plans.	Ministry of Agriculture, "Lebanon National Forest Program 2015-2025", (January 2015)	0.09	USD	Reforestation/legislation
	5.2		Design and put in place a participatory approach for the engagement of neighboring communities based on forest functions	Ministry of Agriculture, "Lebanon National Forest Program 2015-2025", (January 2015)	0.05	USD	Community forest management
	5.2		Set in place an award system for best management practices in public and private forests.	Ministry of Agriculture, "Lebanon National Forest Program 2015-2025", (January 2015)	0.05	USD	Forest management
	5.3	5.4, 5.2	Develop an integrated national monitoring program on forests and rangelands	Ministry of Agriculture, "Lebanon National Forest Program 2015-2025", (January 2015)	0.03	USD	Forest management
	5.3		Mitigate the effect of climate change on vulnerable forest ecosystems	Ministry of Agriculture, "Lebanon National Forest Program 2015-2025", (January 2015)	0.53	USD	Forest management
	5.3		Land Degradation Neutrality of Mountain Landscapes in Lebanon	**GEF**	21.88	USD	Land degradation management
	5.4	5.3 ,5.2	LB: Biodiversity Conservation through NRM at Yammouneh	**World Bank Website**	1.00	USD	Biodiversity
	5.4	5.3, 5.2	Demarcation, classification and registration of forest and other wooded lands	Ministry of Agriculture, "Lebanon National Forest Program 2015-2025", (January 2015)	0.33	USD	Forest management
	5.4	5.3, 5.2	Develop a national communication strategy on forests and rangelands	Ministry of Agriculture, "Lebanon National Forest Program 2015-2025", (January 2015)	0.17	USD	Forest management
	5.4	5.2	Establish an effective network of forest trees nurseries	Ministry of Agriculture, "Lebanon National Forest Program 2015-2025", (January 2015)	0.28	USD	Forest management
	5.4		Develop an action plan to identify alien and invasive species and apply preventive and corrective measures	Ministry of Agriculture, "Lebanon National Forest Program 2015-2025", (January 2015)	0.35	USD	Forest management
	5.4		Ensure effective management in protected forests for biodiversity conservation	Ministry of Agriculture, "Lebanon National Forest Program 2015-2025", (January 2015)	15.09	USD	Forest management
	5.4		Collect, conserve and disseminate traditional and local knowledge, innovations and practices related to biodiversity conservation	Ministry of Agriculture, "Lebanon National Forest Program 2015-2025", (January 2015)	0.50	USD	Biodiversity
	5.4		Develop and apply national schemes on sustainable rangelands management	Ministry of Agriculture, "Lebanon National Forest Program 2015-2025", (January 2015)	0.44	USD	Landscape management
	Financial protection						
	6.1		Create enabling conditions for the development of agricultural insurance also to mitigate the impacts of natural disasters	Ministry of Agriculture, "Lebanon National Agriculture Strategy 2020-2025" (July 2020)	5.00	USD	Financial protection
	Developing domestic food and commercial markets						
	7.3	7.5	Support the adoption of good agricultural practices and good livestock management	Ministry of Agriculture, "Lebanon National Agriculture Strategy 2020-2025" (July 2020)	25.00	USD	Sustainable agriculture
	7.3	7.5, 7.1	Increase climate change adaptation and encourage related private investment along the agrifood value chains	Ministry of Agriculture, "Lebanon National Agriculture Strategy 2020-2025" (July 2020)	50.00	USD	Sustainable agriculture

	Target #	Secondary target #	Name	Source	Inv. amount (millions)	Currency	Project type
Resilience Projects	7.3	7.5	Promote sustainable use of natural resources (soil, pastures, forests and forests, fisheries)	Ministry of Agriculture, "Lebanon National Agriculture Strategy 2020-2025" (July 2020)	20.00	USD	Sustainable resources management
	7.3	7.5	Strengthen the efficiency and effectiveness of the Agricultural and Knowledge Information System (AKIS)	Ministry of Agriculture, "Lebanon National Agriculture Strategy 2020-2025" (July 2020)	15.00	USD	Sustainable agriculture
	Sustainable water management						
	8.3	8.2, 9.4	Water supply projects	National Water Sector Strategy	1,589.89	USD	Water management
	8.3	8.2	Irrigation projects	National Water Sector Strategy	1,143.34	USD	Water management
	8.3		Enhance the efficient use of irrigation water and expand the supply of non-traditional water resources for irrigation	Ministry of Agriculture, "Lebanon National Agriculture Strategy 2020-2025" (July 2020)	30.00	USD	Water management
	Access to water						
	9.4	8.3, 8.5	Greater Beirut Water Supply Project (Awwaly conveyance project) - Phase 1 - Tunnel and Transmission lines	Government of Lebanon, "Capital Investment Program" (April 2018)	197.00	USD	Water access
	9.4	8.3	Upgrade of water systems in Greater Beirut to enable supply from Awwali project.	Government of Lebanon, "Capital Investment Program" (April 2018)	100.00	USD	Water access
	9.4	8.3	Additional Financing for the Greater Beirut Water Supply Project	**World Bank Website**	90.00	USD	Water access
	9.4	8.3	LB- Greater Beirut Water Supply	**World Bank Website**	370.00	USD	Water access
	9.4	8.3	Improvement of water supply system in the caza of Jbeil and construction of wastewater networks for the coastal area of Jbeil and associated treatment plant	Government of Lebanon, "Capital Investment Program" (April 2018)	38.00	USD	Water access
	9.4	8.3	Water supply projects in the villages of south Akkar from Hrar and Qabiit reservoirs	Government of Lebanon, "Capital Investment Program" (April 2018)	83.80	USD	Water access
	9.4	8.3	Rehabilitation of water supply systems in West Bekaa and the villages east of Zahle - packages 1, 2 and 3, rehabilitation/ improvement of water supply systems in Qoblias, and construction of water supply systems for Dhour Zahle, Twayti, Maalaka, karak, Qaa el Rim, Hzarta and the industrial city.	Government of Lebanon, "Capital Investment Program" (April 2018)	51.20	USD	Water access
	9.4	8.3	Water Supply Project -Phase 3 (construction of reservoirs, transmission and distribution lines from Taybe treatment plant, wazzani water, and groundwater wells in the region). Additional water works in Jebel Amel - caza of Bint Jbeil.	Government of Lebanon, "Capital Investment Program" (April 2018)	51.20	USD	Water access
	Others/general						
	-	7.6, 8.2	Program for Economic & Urban Resilience Lebanon	**EIB Website**	108.00	USD	Economic resilience
	-		Lebanese Highways II	**EIB Website**	162.00	USD	Infrastructure
			Lebanon Green Investment Facility	UNDP; MoE	250.00	USD	Multisectoral Resilience
	Resilience Projects Total				**4,927.62**	**USD**	
	Total Transition and Resilience Projects				**11,828.46**	**USD**	

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