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MINISTRY OF ENVIRONMENT

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LEBANON

FOURTH BIENNIAL UPDATE REPORT ON CLIMATE CHANGE 2021

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Lebanon's Fourth Biennial Update Report the UNFCCC

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Foreword

Since the submission of its last Biennial Update Report (BUR), Lebanon has been the scene of extraordinary circumstances. Yet, since the, the Government of Lebanon with the support of the United Nations Development Programme (UNDP) has submitted its Updated Nationally Determined Contribution with increased ambition and enhanced transparency, developed a climate proofing methodology, improved its climate finance understanding and updated its Greenhouse Gas Inventory and emission reduction analysis as reflected in the present Fourth BUR.

The perseverance of our partners in undertaking these activities and implementing them is undoubtedly related to their strong understanding of how vulnerable the Lebanese economy and the livelihoods of people are, and to their strong belief that through climate action, it is possible to recover from the impacts of a global health crisis, local social unrest, and unprecedented economic crisis. As Lebanon is striving to rebuild and recover from a multitude of crisis, it is embracing the opportunity to shift its economy and society towards a low-carbon and climate-resilient path. The UNDP remains engaged alongside the Lebanese people to support them in responding to the global call for enhanced climate action while putting their businesses, livelihoods and institutions on a sustainable development path.

Celine Moyroud
UNDP Resident Representative


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Foreword

The Fourth Biennial Update Report (BUR) may be the strongest testimony of Lebanon's commitment to its responsibilities under the United Nations Framework Convention on Climate Change (UNFCCC). Despite the deep economic and social crises that the Lebanese people and institutions have been facing, experts and officials have outdone themselves to finish the task. They are driven by their belief and conviction that the more we know, the more Lebanon will benefit from opportunities for recovery and resilience.

Countless stories could be told about the important role of multilateralism in nurturing and empowering the Lebanese people and economy. Tackling climate change is one of them. Today more than ever, the people of Lebanon are sparing no effort in up-scaling renewable energy, increasing food security, enhancing local industrial production, and improving healthcare. The 4th BUR, along with previous and future reports under the UNFCCC articulate the impact of these efforts through continuously updated Greenhouse Gas Inventories, mitigation and vulnerability analysis and tracking support needed and received.

The Ministry of Environment will continue to promote the strong linkages between climate action and sustainable development, and will intensify its efforts in engaging all national stakeholders in this reasoning. We present this BUR as a useful tool to showcase to our international partners our commitment, and to our national partners our perseverance to mainstream climate change in the recovery and reform of Lebanon.

Nasser Yassin, PhD
Minister of Environment

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ACRONYMS

ACE	Action for Climate Empowerment
AFD	Agence Française de Développement
AFDC	Association for Forests, Development and Conservation
AFOLU	Agriculture and Forestry and Other Land Uses
AR	Assessment Report
ARDAC	Assisting Reforestation and forest Development Activities
ARDP	Agriculture and Rural Development Project
BAU	Business-As-Usual
BDL	Banque Du Liban
BEEP	BIM for Energy Efficiency in the Public sector
BRT	Bus Rapid Transit
BTR	Biennial Transparency Report
BUR	Biennial Update Report
CAS	Central Administration of Statistics
CBD	Convention on Biological Diversity
CBIT	Capacity Building Initiative on Transparency
CCXG	Climate Change Expert Group
CC	Cropland remaining Cropland
CD	Cartagena Dialogue
CDM	Clean Development Mechanism
CDR	Council for Development and Reconstruction
CEDAW	Convention on the Elimination of all forms of Discrimination Against Women
CEDRE	Conférence Economique pour le Développement par les Reformes avec les Entreprises
CEDRO	Country Energy Efficiency and Renewable Energy Demonstration for the Recovery of Lebanon
CFL	Compact Fluorescent Lamp
CMU	Cash Management Unit
CNG	Compressed Natural Gas
CoM	Council of Ministers
CS	Cropland converted to Settlement
CTCN	Climate Technology Center and Network
CVF	Climate Vulnerable Forum
DMFAS	Debt Management and Financial Analysis System
DNA	Designated National Authority
DOC	Degradable Organic Carbon
DREG	Decentralized Renewable Energy Power Generation
DREI	Derisking Renewable Energy Investment
EBRD	European Bank for Reconstruction and Development
ECM	Energy Conservation Measures
EDL	Electricité du Liban
EF	Emission Factor
EMEP	European Monitoring and Evaluation Programme
ENS	Energy-Not-Supplied
EPA	Exploration and Production Agreement
EPC	Engineering, Procurement and Construction
ETF	Enhanced Transparency Framework
ESMES	Energy Smart Mediterranean Schools
EU	European Union
FAO	Food and Agriculture Organization
FEV	Fuel-Efficient Vehicles
FF	Forest Land remaining Forest Land
FLRM	Forest Landscape Restoration Mechanism
FOD	First Order Decay
FOLU	Forest and Land Use

ForFITS	For Future Inland Transport Systems
FS	Forest Land converted to Settlement
FSV	Facilitative sharing of views
GBA	Greater Beirut Area
GCF	Green Climate Fund
GDO	Gas Diesel Oil
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEFF	Green Economy Financing Facility
GG	Grassland remaining Grassland
GHG	Greenhouse Gas
GoL	Government of Lebanon
GPG	Good Practice Guidance
GS	Grassland converted to Settlement
GW	Grassland converted to Wetland
GWP	Global Warming Potential
HDV	Heavy-Duty Vehicles
HFO	Heavy Fuel Oil
HPS	High Pressure Sodium
ICA	International Consultation and Analysis
ICAT	Initiative for Climate Action Transparency
ICDF	International Cooperation and Development Fund
ICTU	Information necessary for Clarity, Transparency and Understanding
IMELS	Italian Ministry for the Environment, Land and Sea
ISWM	Integrated Solid Waste Management
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
IPTEC	IPT Energy Center
KCEP	Kigali Cooling Efficiency Programme
KPI	Key Performance Indicators
LA	Level Assessment
LBP	Lebanese Pound
LCA	Lebanon Climate Act
LCEC	Lebanese Center for Energy Conservation
LDV	Light-Duty Vehicles
LEAP	Low Emissions Analysis Platform
LECB	Low Emission Capacity Building Project
LEDS	Low Emission Development Strategy
LEEREFF	Lebanon Energy Efficiency and Renewable Energy Finance Facility
LF	Land converted to Forest Land
LGIF	Lebanon's Green Investment Facility
LLWB	Lebanese League for Women in business
LPA	Lebanese Petroleum Administration
LPG	Liquefied Petroleum Gas
LRI	Lebanese Reforestation Initiative
LS	Land converted to Settlement
LULUCF	Land Use, Land Use Change and Forestry
LW	Land converted to Wetland
MENA	Middle East and North Africa
MCM	Million Cubic Meters
MISCA	Management Information System for Climate Action
MINARET	Model of NEXUS Approach and Renewable Energy Technologies
MMS	Manure Management System
MoA	Ministry of Agriculture
MoE	Ministry of Environment

MoEW	Ministry of Energy and Water
MoF	Ministry of Finance
MoFA	Ministry of Foreign Affairs and Emigrants
MoI	Ministry of Industry
MoIM	Ministry of Interior and Municipalities
MoPWT	Ministry of Public Works and Transport
MoU	Memorandum of Understanding
MPG	Modalities, Procedures and Guidelines
MRV	Measuring, Reporting and Verifying
MRVCE	Measuring, Reporting and Verifying Coordinating Entity
MSW	Municipal Solid Waste
NA	Not Applicable
NAMA	Nationally Appropriate Mitigation Action
NAP	National Adaptation Programme
NC	National Communication
NCLW	National Commission for Lebanese Women
NCV	Net Calorific Value
NDC	Nationally Determined Contribution
NDCSP	Nationally Determined Contribution Support Programme
NE	Not Estimated
NEEAP	National Energy Efficiency Action Plan
NEEREA	National Energy Efficiency and Renewable Energy Action
NFP	National Forest Plan
NGO	Non-Governmental Organization
NHR	Net Heat Rate
NIR	National Inventory Report
NMVOC	Non-Methane Organic Volatile Compound
NO	Not Occurring
ODS	Ozone Depleting Substances
OECD	Organisation for Economic Co-operation and Development
OF	Other land converted to Forest Land
OMSAR	Office of the Minister of State for Administrative Reform
OO	Other land remaining Other land
PA	Protected Areas
PATPA	Partnership on Transparency in the Paris Agreement
PC	Passenger Cars
PCM	Presidency of the Council of Ministers
POP	Persistent Organic Pollutants
PRP	Pasture Range and Paddock
PV	Photovoltaics
QA/QC	Quality Assurance/Quality Control
RPTA	Railway and Public Transport Authority
ROI	Return on Investment
SALMA	Smart Adaptation of Forest Landscapes in Mountain Areas
SAVR	Selection of Adaptive Varieties and Rootstocks
SCF	Sub-national Climate Fund
SDG	Sustainable Development Goal
SEA	Strategic Environmental Assessment
SECAP	Sustainable Energy and Climate Action Plans
SGBL	Société Générale de Banque au Liban
SFOC	Specific Fuel Oil Consumption
SLMQ	Sustainable Land Management in the Qaraoun Watershed Project
SNC	Second National Communication
SOER	State of the Environment Report and Future Outlook
SOP	Standard Operating Procedures

SPV	Special Purpose Vehicle
STG	Steam Turbine Generator
SUV	Sport Utility Vehicles
SWAM	Solid Waste Management
SWDS	Solid Waste Disposal sites
SWH	Solar Water Heaters
TA	Trend Assessment
TACCC	Transparency, Accuracy, Completeness, Comparability and Consistency
TNC	Third National Communication
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UFM	Union for the Mediterranean
UNHCR	United Nations High Commissioner for Refugees
USAID	United States Agency for International Development
USD	United States Dollar
USEK	Holy Spirit University of Kaslik
USFS	United States Forest Service
WSA	Whole School Approach
WUI	Wildland-Urban Interface
WWTP	Waste Water Treatment Plant

I. National Circumstances

I. NATIONAL CIRCUMSTANCES

Lebanon's Fourth Biennial Update Report presents an update of the country's GHG inventory for the period 2016 - 2018, mitigation actions undertaken and/or planned for the period 2016-2018 and an overview of climate change direct and indirect support received for the same period.
However, it is worth noting that while this report is being prepared in 2021, Lebanon's national circumstances changed drastically between 2018 and 2021, due to an unprecedented economic, financial, monetary, banking crises and amidst the global COVID-19 pandemic.

An accumulation of large budget deficits throughout the years has significantly increased the debt-to- Gross Domestic Product (GDP) ratio. Moreover, the Lebanese Pound (LBP) has devalued by as much as 80%, while inflation rates soared, impacting the Purchasing Power Parity of Lebanese citizens. The fact that Lebanon relies on imports for most of its food and energy supplies has aggravated the situation even further. The cost of fuel increased drastically since 2018, which significantly changed the domestic, institutional, and industrial pattern of fuel consumption for electricity and heat generation as well as transport. The COVID-19 pandemic has exacerbated conditions whereby the government-imposed lockdowns that further lowered economic activity.

On August 4th, 2020, an explosion occurred at the port of Beirut which damaged the Port infrastructure, and surrounding area; the cost of damage is estimated between 3.8 and 4.6 billion US Dollars[1]. This further sets back an already struggling economy and has halted a large area of commercial activity and essential services; the consequent physical capital losses of the blast are expected to cause an additional decline in GDP, estimated at 0.4 to 0.6 percentage points (World Bank, 2020a).

Furthermore, Lebanon has been dealing with a crippling humanitarian crisis since 2011 due the displaced Syrian population, which has stretched an already fragile public infrastructure with demands exceeding the capacity of institutions to meet the required needs.

Therefore, for the purpose of reporting obligations under the Fourth Biennial Update Report, and in order to better reflect the circumstances of the year that the GHG inventory covers, **this chapter describes Lebanon's National Circumstances for the year 2018 only.**

1.1 Geographic and climate profile

Lebanon is located on the eastern basin of the Mediterranean Sea and is characterized by a long narrow coastal plain and 2 mountainous areas separated by the Bekaa Valley.
Lebanon has a Mediterranean-type climate characterized by hot and dry summers (June to September) and cool and rainy winters (December to mid-March). Spring and autumn are warm and pleasant. The average annual temperature is 15°C.
Along the coast, summers are hot and humid with temperatures crossing 35°C in August. But due to the moderating effect of the sea, the daily temperature range is narrower than it is inland. January is the coldest month, with temperatures around 5 to 10°C. The mean annual rainfall on the coast ranges between 700 and 1,000 mm. About 70% of the average rainfall in the country falls between November and March and is concentrated during only a few days of the rainy season, falling in heavy cloudbursts or violent storms. Rainfall in inland Lebanon is higher with snow in the mountains than that along the coast.

1.2 Population and social profile

Lebanon's population is estimated to be 5.97 million in 2018, including foreign workers, Palestinian and Syrian displaced (the latter estimated at 968,529). The working age population (15+ years) accounts for around 3.7 million persons and the total labor force participation rate is 48.8% with a large difference between men (70.4%) and women (29.3%). The general unemployment rate is estimated to 11.4% in 2018, with differences observed between women (14%) and men (10%), and with a high rate of 23.3%. among youth (15–24 years old). The public sector share of employment (ministries, public administration, and government-owned institutions) in Lebanon is 14% while the private sector accounts for the remaining 86%.

The estimated total number of households in Lebanon is around 1.266 million. The most common kind of household composition was of 4 persons on average; just 10% of households were composed of only one person.

Lebanon's educational attainment is relatively high compared to the region. Only 2% of residents aged 3 years and above are not enrolled in education and 7% are illiterate. The percentage of residents holding a university degree is 21%, with almost no difference between women and men (CAS, 2020, UNRWA, 2020 and UNHCR, 2020).

In Lebanon, women and men have different socially attributed roles and responsibilities regarding productive, reproductive and community work (related to their gender roles). Lebanon is a patriarchal society where men are generally expected to be the master of the family and women to be responsible for the organization of the house and raising the children. Therefore, the place of women in the social organization, the work force, the economy and the political institutions has a direct impact on their vulnerability to climate change. Indeed, the extent of women's control over resources, their access to technology and financial means, are critical to mitigation and adaptation actions.

Women comprise 51.6% and men 48.4% of the total residential population. Among women of working age, the labor force participation rate is 29.3%. Despite the relatively high degree of gender occupational segregation (index = 43.8%), the proportion of women in managerial positions (28.9%) is roughly in proportion to their overall share in total employment (30.5%). Women benefit from a relative gender equality status when it comes to access to education and jobs, but some legislative aspects undermine their possibility to exercise their rights like men (i.e., impossibility to pass on the Lebanese nationality to foreign husbands and their offspring, unequal rights when it comes to divorce, inheritance or child custody).

Along with the Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW), the Rio Convention, Sendaï Framework on Disaster Risk Reduction and the UNFCCC set a solid ground for Lebanon to implement policies that are in line with gender equality and women's empowerment in climate actions. In addition, Lebanon's constitution mentions the equality between all its citizens.

1.3 Economic profile

Gross Domestic Product (GDP) has been fluctuating in the recent years, due to the economic crisis that Lebanon has been facing since 2019.

In 2018, the nominal GDP stood at USD 54.9 billion and the real GDP growth at nearly -1.9% compared to around 1% in 2017 (Figure 1). The Lebanese economy is service oriented with over 72.2% of GDP

generated from services. Agriculture and Industry contributed to 4.4% and 12% respectively. The remaining 11.4% are revenues from indirect tax returns. (World Bank, 2020a).

Lebanon's fiscal policy coupled with regional instability have restrained the country's economic activity as the public debt to GDP ratio stood at 151% and the budget deficit reached $6.3 billion in 2018, the largest budgetary shortfall of the decade and 70% higher than 2017 budget (Figure 2). Lebanon's vulnerable economy has been further hit by compounded crises, beginning with an economic and financial crisis, followed by COVID-19 and lastly the explosion at the Port of Beirut.

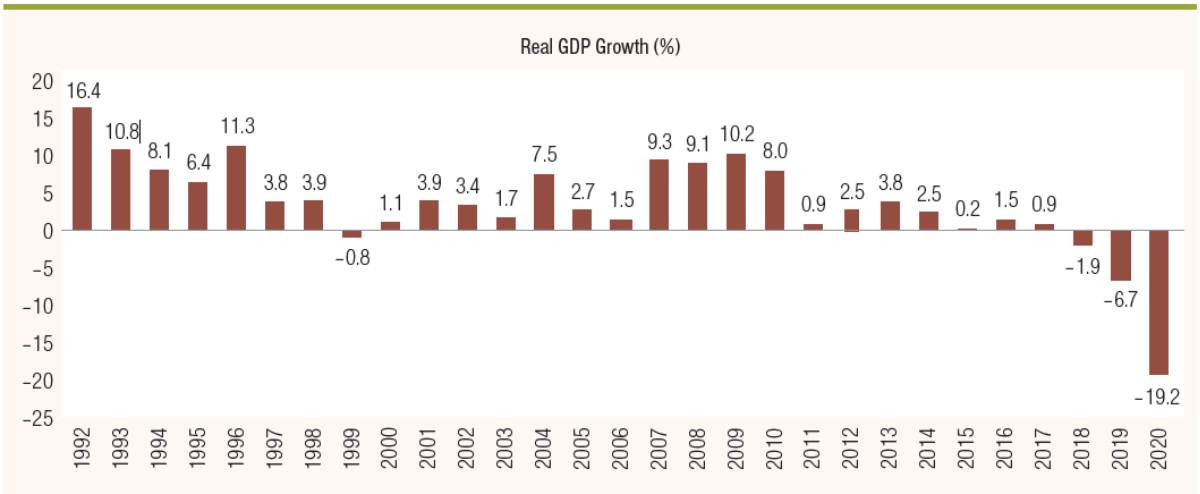


Figure 1: Lebanon's real GDP growth (World Bank, 2020a)

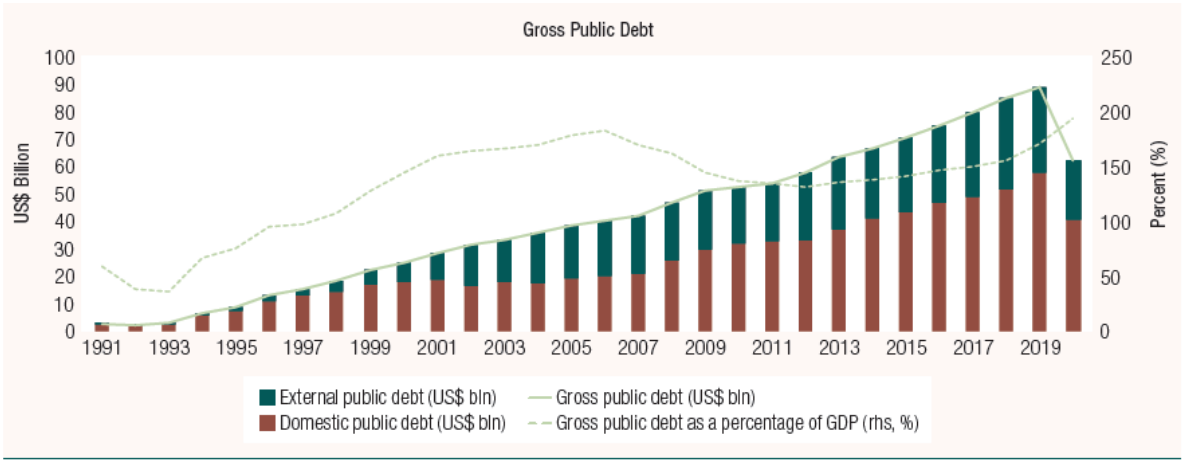


Figure 2: GDP Lebanon's Debt to GDP ratio (World Bank 2020a)

1.4 Sectors Overview in 2018

Water

At a glance

Lebanon's available renewable water resources have dropped below the 1,000 m^3/capita/year threshold that defines water stress.
Total renewable resources estimated at 700 m^3/capita/year
It is estimated that the influx of refugees and displaced increased the national water demand by 8 to 12%.
The total length of **rivers** and streams in Lebanon is 730 km. There are 40 rivers in of which 16 are defined as perennial and the rest as seasonal. All rivers in Lebanon are replenished annually by local precipitation events, which tend to be restricted to around 90 to 100 days between October and April, and to snowmelt.
Currently **water storage** in dams is estimated at of 232.5 MCM (Mainly in the Qaraoun Dam on the Litani River and the Chabrouh Dam). Several dams are under construction and once completed, the static storage capacity at the national level will reach 409 MCM.
Most of the water used to secure domestic supply in Lebanon comes from captured **spring** sources, which are estimated at 5,000 springs across the country and a total annual yield of 1,200 MCM.
Lebanon has two main **aquifers** supplying water to all economic sectors. 50% of irrigation water comes from wells and boreholes, and 80% of the potable water supplied comes from groundwater sources.
There are seven identified **wetlands** in Lebanon that cover a total area of 16 km^2

Annual Water Balance (SOER, 2020)

Source	Amount MCM	
	MoEW/UNDP (2014)	Final Draft 2020 NWSS
Precipitation (including snow)	9,365-6,015	8,600
Evapotranspiration	1,475-1,563	4,500
Surface runoff (excluding spring discharge)	3,807-2,151	2,900[1]
Groundwater to sea	400	1,200[2]
Groundwater recharge	4,116-6,651	

[1] includes losses as rivers to neighbors (700 MCM) and renewable surface water (2,200 MCM)
[2] includes losses to groundwater (700 MCM) and renewable groundwater resource (500 MCM)

Key legislation

Law 221/2000 - Water sector structure
Law 77/2018, amended by law 192/2020 - Water Code
National Water sector strategy (updated), 2020
Nationally Determined Contribution (updated), 2020

Gender analysis

Women are often the main water resource manager at the household level, because of the responsibility they hold for food production and preparation, hygiene, cleaning, washing, waste disposal and care of children and elderly.
This involvement, along with men, should support a better management of water resources at household level and increase access to safely managed water for all. Women as a group should therefore be targeted in awareness and education campaigns on water management and conservation, as they form a key player in ensuring the success of national water strategies and policies

SDG linkages

SDG 6: Clean Water and Sanitation
Optimization of water resources through groundwater recharge and surface storage substantially increases water-use efficiency and can help to protect surface water dependent ecosystems

Energy

At a glance	1 Power utility: Electricité du Liban 7 Thermal power plants and 2 rental barges - 4 power plants operate on Gas Diesel Oil, while the rest and the barges use heavy fuel oil (Grade A and Grade B) 97% of electricity generated through thermal power plants in 2018 3% of electricity generated through renewable energy in 2018 15,214 GWh electricity supply in 2018, including thermal power plants, renewable energy, and electricity purchase 23,089 GWh electricity demand in 2018 10,461 GWh gap between supply and demand
Private generators in Lebanon	Due to load shedding, technical losses and the aging of power plants, Lebanon's electricity sector suffers from frequent shortages from the difference between supply and demand, giving space to the proliferation of privately-owned generators. While some of these generators are located in industrial facilities or in commercial institutions, most of them are spread within neighbourhoods, supplying electricity to residential buildings and small retailers at a monthly fixed subscription fee. There is no information on the numbers of private generators in Lebanon.
Renewable energy	Total installed renewable energy power capacity estimated at 350 MW including 286 MW from hydropower sources, 7 MW from landfill and 56.37 MW from solar power. The cumulative installed decentralized small-scale solar photovoltaic (PV) capacity grew by the rate of 89% per year from 2010 until 2019, reaching a total of 78.65 MWp installed capacity. As for wind energy, which is yet to be used in Lebanon, the government signed three Power Purchase Agreements with private developers for the installation of three wind farms in the northern and mountainous district of Akkar with a total capacity of 227 MW (UNDP, 2019a). This project is currently on hold.
Key legislation	Law 462/2002 and its amendments in 2006 (Law 775), 2014 (Law 288) and 2015 Law 54) - Organization of the Electricity Sector Law 132/2010 - Offshore Petroleum Resources Law CoM Decision 1 dated 21/06/2010 - Policy Paper for the electricity sector Decree 10289/2013- Petroleum Activities Regulations Law 288/2014 - License Independent Power Producers Decree 43/2017 - The Exploration and Production Agreement (EPA) Law No. 84/2018- Strengthening Transparency in the Petroleum Sector Policy Paper for the Electricity sector- (draft update) 2019 National renewable energy action plan 2016-2020 National Energy efficiency Action Plan 2016-2020 Nationally Determined Contribution (updated), 2020
Gender analysis	Women are often responsible for domestic works that require use of energy. Thus, as primary household-energy managers, women have a critical role to play along their male counterparts in the success of implementation of any energy related policy. They should be therefore targeted as a group in awareness and education campaigns. Furthermore, energy and related technologies can play a key role in integrating women into the economy by involving them in new type of activities and helping them acquire new skills.

SDG linkages	SDG 7: Affordable and Clean Energy Energy efficiency: Energy efficiency and related reduction in energy demand and losses can help increase energy security by reducing energy imports in countries that rely on trade for energy supply Renewable energy: Investments in renewables generate modern and sustainable energy services and can increase energy security in countries that rely on imports for energy supply

Transport

At a glance	2,034,501 vehicles registered in 2018 83.5% of the fleet are passenger cars 63% increase in car fleet since 2010 0% customs fees on electric vehicles 20% customs fees on hybrid vehicles 1 national air carrier -Middle East Airlines 1 airport – Hariri Beirut International Airport 5 legal harbors: Beirut, Tripoli, Saida, Tyre and Jounieh. 2,860 fishing boats spread over 44 local harbors
Key legislation	Law 341/2001 and Decree no. 7858/2002, banning the use of private and public cars of diesel engines starting from 15/06/2002 and the use of public buses of 16 to 24 passengers of diesel engines starting from 31/10/2002 Law 243/2012, the New Traffic Law Law 79/2018, article 55 and budget law 144/2019 article 25.c on tax incentives for hybrid and electric cars The master plan land public transport for passengers, 2014 Nationally Determined Contribution (updated), 2020
SDG linkages	SDG 11: Sustainable Cities and Communities Private transport: Reduces air pollution and reduces air quality impact of cities Public transport: Increases public transport, increases sustainable transport and improves road safety due to modal shift (fewer cars) and improved infrastructure

Industry

At a glance	7.6% of the country's GDP in 2018 No update of industrial census since 2007 20% of the local labor force employed in the industrial sector 4,700 industrial firms in Lebanon with 26% manufacturing agri-food products, followed by construction materials (12%) and chemical products (8%). Top five Lebanese industrial exports in 2018 are pearls and precious stones (41%), mechanical machinery (6%), electrical machinery and equipment (5%), plastics (4%), and essential oils and cosmetics (4%). 150% of industries in Mount Lebanon and 18% in Bekaa
Key legislation	Decree 8471/2012 and its related decisions (202/1, 203/1 and 271/1 - 2013) on Environmental Compliance Lebanon Industry 2025: The integrated vision of the Industrial Sector in Lebanon Lebanon SME strategy, a roadmap to 2020, 2014
SDG linkages	SDG 9: Industry, Innovation and Infrastructure Uptake of low emissions energy technologies in industry (e.g. concentrated solar thermal) supports development of sustainable and reliable infrastructure

Waste and wastewater

At a glance	55% of waste disposed in 4 main landfills: 2,500 tonnes per day received at Naameh landfill since 1997 380 tonnes per day received at Tripoli landfill since 1998 150 tonnes per day received at Zahleh landfill since 2002 200 tonnes per day received at Saida landfill since 2013 900 open dumpsites 69% of open dumpsite have fires 15%-20% of waste generated is recycled or composted Industrial waste disposed with municipal waste In Lebanon, there are currently 78 WWTPs that are distributed amongst the regions, amongst which several are not operational. Most of these plants are small in scale and were built by non-governmental organizations through international funding. 24% of the Lebanese population is estimated to be served by primary and secondary wastewater treatment 68% of wastewater is collected, amongst which only 19% undergoes primary or secondary treatment before discharge. 32% of wastewater is discharged in septic tanks or cesspools without treatment It is estimated that the influx of refugees and displaced increased the wastewater generation rate by 8 to 14%
Key legislation	MoE Decisions 1294/2017 and 1295/2017 defined, respectively, the requirements for transport and treatment facilities of hazardous waste Law 80/2018 for the Integrated Solid Waste Management CoM decision number 3/2019 -Roadmap of the Integrated Solid Waste Management Decree 5605/2019 on source sorting of MSW; Decree 5606/2019 on management procedures of hazardous Waste MoE Decision 108/2019 on appointing the ISWM coordination committee; MoE Decision 58/2020 on classification of RDF MoE Decisions 59/2020, 998/2019 and 999/2019 addressing, respectively, storage, generators and transporters of hazardous waste. CoM decision 35 dated 17/10/2012 on the National Strategy for the Wastewater Sector National Water sector strategy (updated), 2020 Nationally Determined Contribution (updated), 2020
Waste crisis of 2015	Lebanon experienced an eight-month-long waste management crisis in 2015 and 2016 that was precipitated by the closure of the Naameh Landfill serving Beirut and Mount Lebanon. The closure of the Naameh landfill had significant impacts on the solid waste management sector in Lebanon, and particularly in the areas that were served by the facility where waste collection services were suspensed for weeks. Since no alternative was readily available and given the limited capabilities for provision of solid waste management services at the municipal level, the government developed an emergency four-year plan in 2016, which selected the sites of Costa Brava and Bourj Hammoud serve as landfill sites to receive waste from Beirut and specified regions in Mount Lebanon for the next four years. The Costa Brava site started receiving waste on August 25, 2016 and the Bourj Hammoud site, on October 8, 2016. the emergency plan also called for the construction of a landfill for Chouf and Aley cazas; and resume investigations for developing waste-to-energy in the country (CoM Decision n°1, dated 12/03/2016, updated 17/03/2016).

Gender analysis	The Policy Summary on Integrated Solid Waste Management does not explicitly mention women participation is not mentioned at local level for household solid waste procedural aspects. Women are often the responsible for the waste management at household level and should be integrated in consultations and implementation programs regarding solid waste management at municipal level.
SDG linkages	SDG 12: Responsible Consumption and Production Contributes to reducing waste generation through prevention, reduction, recycling and reuse Contributes to management of chemicals and all wastes to reduce their release to air, water and soil in order to minimize adverse impacts on human health and the environment

Agriculture

At a glance	4% of Lebanon's GDP in 2018 2% annual growth rate since 2010 5% of total exports, coffee, grapes and potatoes being the most exported products 64% of Lebanese territory covered by agricultural areas 62% of total water demand for irrigation Irrigation water demand expected to keep on increasing and reach 1,050 million cubic meters (MCM)/year by 2030
Key legislation	Ministry of Agriculture Strategy, 2020-2025 Nationally Determined Contribution (updated), 2020
Gender analysis	The MoA strategy includes sex-disaggregated data for the number and age of farmers; insists on women's participation in agriculture projects along with youth, and capacity building for a better inclusion of women. It also mentions the particular vulnerabilities of women to poverty. It does not analyse what role women can play in adaptation actions to climate change.
SDG linkages	SDG 2: Zero Hunger Ensuring sustainable food production systems improves food security

Forestry and other land use

At a glance	13.2% of the total area of the country 10.2% of the Lebanese territory is covered by other wooded land 84% of the Lebanese territory without adequate master plans 1,278 quarries in Lebanon covering an area of 5,267 ha 15 nature reserves 3 biosphere reserves 16 protected forests 18 protected natural sites/landscapes 4 Ramsar sites 5 world heritage sites 15 important bird areas Target to achieve land neutrality by 2030
Key legislation	Decision no. 52/2009, Lebanon's National strategy for forest fire management National Forest Plan (NFP), 2015 to promote the increase in forest cover by 40 million trees by 2020 CoM Decision 42/2017 forming a ministerial committee for developing a master plan for the protection of mountain summits and natural areas

	Decision Number 62/2018, Lebanon's National Biodiversity Strategy and Action Plan 2016-2030 Lebanon's National Action Programme (NAP), 2018 Law 130/2019, New Protected Areas Law Nationally Determined Contribution (updated), 2020
Gender analysis	In Lebanon's National Forest Programme, gender is integrated in all aspects of the document: it includes the women's role and vulnerabilities, especially for low-income communities, the necessity to strengthen women's participation and leadership by integrating them in capacity-building programs and the importance of gender assessments. Gender is also integrated in projects, activities and indicators.
SDG linkages	SDG 15: Life on Land Implementation of sustainable management of forest management to prevent fires and subsequent deforestation

1.5 Education and climate change awareness

Education is linked to access to knowledge and technology and plays a key role for one's involvement in actions related to mitigation and adaptation to climate change. In Lebanon, access to education is equal for men and women and the figures show that women represent more than 50% of the number of students at all levels. However, illiteracy rate is higher for women. The main inequality is between urban and rural areas where higher education is not always available. Therefore, students who want to complete a tertiary degree need to migrate to cities. This can be an obstacle for women in certain families: they might not be authorized to leave the family house before getting married, depending on the social and cultural accepted norms.

A complete strategy on Action for Climate Empowerment (ACE) to accelerate climate solution through education, training and public awareness is yet to be developed in Lebanon. However, several initiatives are well established and have been successful in building capacities and raising climate change awareness among schools, universities and citizens at large. The Ministry of Environment is heavily involved in such activities and is attempting to create an articulation mechanism for all these initiatives. Indeed, the Service of Environmental Guidance of the MoE is enabling communication channels between stakeholders in the education sector (schools and day care) to coordinate environmental education and awareness.

Due to the economic, social and sanitary crisis that Lebanon has been facing, and since new national challenges and priorities have emerged, the momentum for mainstreaming climate change in the education sector has slowed down during the last years.

Engagement of non-state actors in climate action

The Lebanon Climate Act (LCA) was enacted in June 2016. It has been developed by the NGO Green Mind in partnership with the United Nations Development Program (UNDP) and the Banque Du Liban (the Central Bank of Lebanon), and in cooperation with the Federation of Chambers of Commerce, Industry and Agriculture in Lebanon as well as the Lebanese Ministry of Environment (LCA, 2021). The LCA has been established in line with Lebanon's NDC and has a threefold objective:

- to create a network of companies and institutions contributing to climate change efforts;
- to involve and mobilise the private sector in the broader climate change community by giving this stakeholder group a space to showcase and support climate action through initiatives;
- to build partnerships between businesses and non-governmental organisations in key sectors.

LCA members are expected to enhance their company's ability to address climate risks, and *in tandem* comply with environmental regulations and increase market competitiveness in the long term. A guidebook titled 'How to create value from climate change' (or LCA guidebook) has been prepared under this initiative, to steer the process of shifting to sustainable actions and enhancing resource efficiency of business operations, and in turn reduce operational costs and create cost-efficient supply chains (LCA, 2017).

In addition, a number of Lebanese municipalities have been engaged in climate action through the formulation and implementation of SECAPs, supported by the EU ClimaMED project. These and other municipalities have joined Covenant of Mayors initiative and have set mitigation targets and adaptation goals to guide their climate action, as presented in Table 1. With the approval of the Sub-national Climate Fund (SCF) project by the GCF, and which Lebanon is one of the beneficiaries, climate financing has become available for municipalities to plan and implement climate action at the local and community levels.

Table 1: Lebanese Municipalities members of the Covenant of Mayors

Municipality	Population	Target /Goal
Kab Elias, Wadi el elm	50,000	Mitigation
Hasbaya	19,000	Mitigation and Adaptation
Baakline	17,000	Mitigation
Jezzine	10,000	Mitigation and Adaptation
Dekwaneh	6,450	NA
Ardeh	5,000	Mitigation
Batloun Shouf	3,650	Mitigation and Adaptation
Menjez	800	Mitigation
Union of Dannieh Municipalities	175,000	NA
Bechmezzine	1,500	Mitigation
Kherbet Rouha	24,800	Mitigation and Adaptation
Kawkaba	2,500	Mitigation and Adaptation
Khreibi	3,200	Mitigation and Adaptation
Moukhtara	950	Mitigation and Adaptation
Kousba	10,000	Mitigation
Jdeideh el Chouf	20,600	NA
Union of eastern Baalbeck Municipalities	35,000	NA
Hammana	7,000	NA

Box 1: Overview of the Sub-national climate fund with the Green Climate Fund

Sub-national Climate Fund (SCF)

The Sub-national Climate Fund is a global project (42 countries, including Lebanon), funded by Green Climate Fund (USD 150 million as concessional equity), Pegasus Capital Advisors, a global private equity impact fund (USD 600 million as commercial equity), with technical assistance from IUCN (USD 28 million as public grant) to finance mid-sized infrastructure projects at a sub-national level (e.g. municipalities, provinces) for mitigating GHG emissions and improving the resilience of local communities in developing countries to the impacts of climate change.

Municipalities or provinces can design and submit projects meeting the following conditions:

- Alignment with Lebanon's NDC
- Commercially viable business model
- Clear climate mitigation component and contribute positively to at least two other SDGs
- Actions have to be at the municipal level (with municipalities and local private sector raising 51% of the investment and enter into a Special Purpose Vehicle (SPV) agreement with the SCF (assets can account towards the 51% of the equity)
- Expected return on investment (ROI) is 13% - but could be lower if the climate benefit is large (as low as 8%) and can vary over time
- Projects are medium-sized (USD 5-75 million/project, with a cap per country at USD 75 million) targeting climate resilient, low-carbon infrastructure and nature-based solutions

1.6 Governance

Lebanon has a democratic political system, with the Parliament as a legislative body, the Council of Ministers as the executive body and the President as the head of state and the commander-in-chief of the Lebanese Armed Forces and security forces.

Box 2: Woman participation in decision-making

Woman participation in decision-making

Participation of women in decision-making processes is still relatively low, though their representation is increasing. The 2021 Government included only 1 woman, while the government of 2020 Government included 6 female Ministers in key sectors such as Justice, Labor, Communication, Defense Ministries in addition to having Mrs. Zeina Akra as Deputy Prime Minister.

The National Commission for Lebanese Women (NCLW), established in 1998 and located under the President of the Republic, is mainly responsible for gender mainstreaming in public administrations through actions and mechanisms enforcing and institutionalizing Gender Focal Points'. In the 2011-2021 national strategy for women in Lebanon prepared by the NCLW, climate change has been mentioned as a "real risk that should be taken seriously and, more importantly, is the responsibility of men and women alike." (objective 9- enhancing the contribution of Women to environmental protection).

In 2017, The Office of the Minister of State for Women's Affairs adopted a National Strategy for Gender Equality (2017-2030), which builds on the existing national strategy for women in Lebanon (2011- 2021). The 12-point strategy includes a specific action area on Environment, which includes the impacts of climate change in magnifying existing inequalities in gender. The strategy calls for the 1) Support of national strategies to ensure gender responsive governance and management of services, including access to affordable and clean energy and climate finance and 2) Support gender-mainstreaming to protect livelihoods of women through disaster and climate risk management. However, this office was disactivated with the 2019 and 2021 governments.

Lebanon is internationally involved in numerous platforms which tackle climate change:

- The Cartagena Dialogue for Progressive Action: the dialogue is an informal space, open to forward-looking countries who support ambitious and expeditious implementation of the Paris Agreement, and who are committed, domestically, to becoming or remaining low carbon. Lebanon hosted the 21st meeting of the Cartagena Dialogue in September 2017 in Beirut, reaffirming its ambitious role in the region.
- The Climate Vulnerable Forum (CVF): this South-South cooperation acts as a voice to accelerate climate action as soon as possible in order to avoid the worst climatic disasters in vulnerable countries. Moreover, Lebanon is part of the V20 (Vulnerable 20 Group) as an economy heavily threatened by the changing climate. Lebanon hosted the MENA regional meeting in May 2015 in Geneva, Switzerland.
- The Partnership on Transparency in the Paris Agreement (PATPA): The Partnership supports international efforts to engage in practical exchanges and political dialogue on climate transparency. The new enhanced transparency system is of particular importance for the Partnership for building up mutual trust, accelerate ambitions, and tracking progress towards the Paris Agreement Goal. Lebanon hosted the 8th Annual Partnership Retreat in Broumana in October 2019, with 65 participants from 40 countries attending.
- The NDC Partnership: the NDC partnership is a coalition of countries and institutions working to mobilize support and achieve ambitious climate goals. Lebanon became a member of the NDC Partnership on 25 March 2019, appointing Focal Points in the Ministry of Environment (MoE) and the Council for Development and Reconstruction (CDR). Moreover, Lebanon sits on the NDC Partnership steering committee, and task force of the NDC financing strategy.
- The Initiative for Climate Action Transparency (ICAT): the ICAT initiative responds to the critical need to support improved transparency and capacity building under the Paris Agreement. The initiative integrates guidance, capacity building and knowledge sharing to engage countries in the use of a common framework to assess the impacts of their policies and actions and report progress, fostering greater transparency, effectiveness and ambition. Lebanon currently sits as a member on the ICAT Advisory Committee.
- The Union for the Mediterranean (UfM): Lebanon is an active member of the Union for the Mediterranean, which is an intergovernmental institution bringing together the European Union Member States and 15 countries from the Southern and Eastern shores of the Mediterranean to promote dialogue and cooperation.
- The OECD Climate Change Expert Group (CCXG): the aim of the group is to promote dialogue and enhance understanding on technical issues in the international climate change negotiations.

1.7 Climate change key legislation and mainstreaming

Lebanon has been a Party to the United Nations Framework Convention on Climate Change (UNFCCC) since 1994 (Law 359/1994), ratified the Kyoto Protocol in 2006 (Law 738/2006), and the Paris Agreement to the UNFCCC (Law 115/2019 and Decree 5599/2019).

No major legislation directly addresses climate change action in Lebanon, other than the Nationally Determined Contribution (NDC), as dictated by the Paris Agreement. Lebanon submitted its first NDC in 2015 and the updated version in 2021.

In 2017, the Ministry of Environment requested to become the coordinator of the NDC committee and received approval from the Council of Ministers (CoM), as per decision 33/2017. The committee is chaired by the MoE and includes nominated representatives from the Ministry of Energy and Water

(MoEW), Presidency of the Council of Ministers (PCM), Electricité du Liban (EDL), Ministry of Public Works and Transport (MoPWT), Ministry of Agriculture (MoA), Lebanese Petroleum Administration (LPA), Ministry of Foreign Affairs (MoFA) and Ministry of Finance (MoF).

The main role of the NDC committee is to follow-up the implementation of all NDC elements. The mandate of the committee also includes:

- Update on the progress of the ministries and institutions' plans and strategies that make up Lebanon's Nationally Determined Contribution (NDC).
- Implement the United Nations Framework Convention on Climate Change (UNFCCC) decisions related to the NDC and related transparency of action and support requirements.
- Assess gaps and needs related to the implementation of sectoral and cross-cutting activities under the NDC and related to the reporting of progress (needs could be financial support, capacity-building support, technology support or technical support).
- Update Lebanon's NDC to move to a more ambitious target every 5 years, with the first update in 2020.
- Find linkages and opportunities to better implement Lebanon's NDC and relevant Sustainable Development Goals (SDGs).
- Ensure that the implementation of Lebanon's NDC respects human rights and gender equality.
- Prepare the report on the NDC progress and communicate it to the Council of Ministers periodically.

Nationally Determined Contribution targets

In compliance with the provisions of the Paris Agreement, Lebanon published its Nationally Determined contribution (NDC) to mobilize international finance and set a long-term strategy to reduce national GHG emissions and improve resilience to negative impacts of climate change. Lebanon has set targets to reduce its GHG emissions by 15% as an unconditional target and 30% as a conditional one by 2030, compared to a Business-as-usual scenario.

In 2020, and in accordance with Articles 4.9 and 4.11 of the Paris Agreement (and Law 115/2019), Lebanon updated its Nationally Determined Contribution to respond to the call for enhancement and to meet the goals of the Agreement. The NDC update put forward an ambitious mitigation target of 20% emission reduction as an unconditional target by 2030. with clear sector- specific objectives and provided more clarity on Lebanon's adaptation guiding principles and priorities (Table 2).

The preparation of the NDC document and its update was led by the Ministry of Environment (MoE) in close coordination with the official NDC committee. The update was based on a series of meetings virtually conducted in 2020 to ensure institutional ownership, public participation and engagement with local communities in a gender-responsive manner. These included meetings with sectoral mitigation and adaptation experts from line ministries to assess where additional ambition in the NDC could be allocated and assess the enhanced adaptation targets, and their appropriateness considering Lebanon's special circumstances. Consultations were also organized with Non-State Actors academic experts, youth, the private sector and civil society organizations. Finally, the results were presented to the official inter-ministerial NDC committee, headed by the Ministry of Environment. Once feedback was received, the NDC was sent to the Council of Ministers for official approval and was submitted in January 2021 to the UNFCCC Secretariat.

Table 2: Lebanon's NDC 2015 vs. 2020

Unconditional targets 2015[2]	Unconditional targets 2020[3]
1. A GHG emission reduction of 15% compared to the Business-As-Usual (BAU) scenario in 2030 (amounting to 6,222 Gg. CO_2eq.). 2. 15% of the power and heat demand in 2030 is generated by renewable energy sources. 3. A 3% reduction in power demand through energy-efficiency measures in 2030 compared to the demand under the BAU scenario.	1. A GHG emission reduction of 20% compared to the Business-As-Usual (BAU) scenario in 2030, (amounting to 7,790 Gg. CO_2eq.). 2. 18% of the power demand (i.e., electricity demand) and 11% of the heat demand (in the building sector) in 2030 is generated by renewable energy sources. 3. A 3% reduction in power demand through energy-efficiency measures in 2030 compared to the demand under the BAU scenario.
Conditional targets 2015[2]	**Conditional targets 2020[4]**
1. A GHG emission reduction of 30% compared to the Business-As-Usual (BAU) scenario in 2030 (amounting to 11,860 Gg. CO_2eq.). 2. 20% of the power and heat demand in 2030 is generated by renewable energy sources. 3. A 10% reduction in power demand through energy-efficiency in 2030 compared to the demand under the BAU scenario.	1. A GHG emission reduction of 31% compared to the Business-As-Usual (BAU) scenario in 2030 (amounting to 12,075 Gg. CO_2eq.). 2. 30% of the power demand (i.e., electricity demand) and 16.5% of the heat demand (in the building sector) in 2030 is generated by renewable energy sources. 3. A 10% reduction in power demand through energy-efficiency in 2030 compared to the demand under the BAU scenario.

[2] GHG emission reductions recalculated as per the 2006 IPCC Guidelines and AR5 GWPs. Numbers reflect rounding.
[3] The unconditional mitigation scenario includes the impacts of mitigation actions which Lebanon can nationally implement, and through international support in the form of loans or other repayable instruments.
[4] The conditional mitigation scenario covers the mitigation actions under the unconditional scenario, as well as further mitigation actions which can be implemented upon the provision of additional international support in the form of grants.

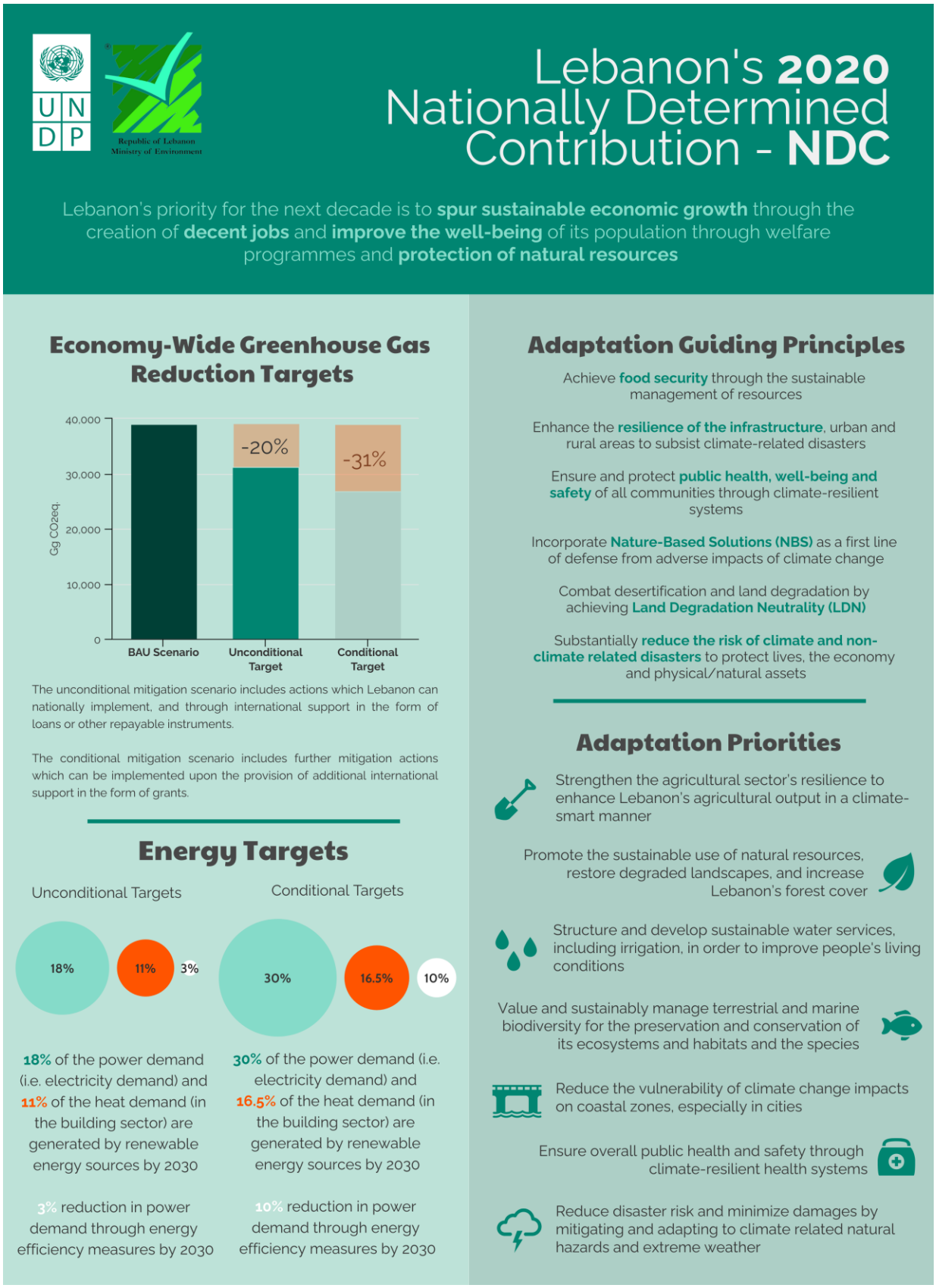


Figure 3: Overview of Lebanon's Nationally Determined Contribution 2020

Table 3: Summary of Information necessary for clarity, transparency and understanding (ICTU) of Lebanon's mitigation part of the NDC update

Reference point	GHG emissions level in the projected BAU scenario in 2030 (mitigation actions implemented after 2011 not taken into account)
Quantifiable information on the reference indicators	GHG emissions level in the projected BAU scenario in 2030: 38,950 Gg CO_2eq.
Target relative to the reference indicator	Economy wide absolute GHG emissions target Single-year target in 2030 Unconditional target: reduce GHG emissions by 20% below the BAU scenario (amounting to 7,790 Gg. CO_2eq. Conditional target: reduce GHG emissions by 31% below the BAU scenario (amounting to 12,075 Gg. CO_2eq.) in 2030
Information on sources of data	Lebanon's Third National Communication (TNC)'s time series analysis, consultations with key stakeholders. The BAU and mitigation scenarios were developed for all sectors using the Low Emissions Analysis Platform (LEAP) software.
Time frame	Lebanon has already begun implementing the actions and activities needed to meet this commitment. It will continue to do so until 2030.
Sectors	Energy, industrial processes and product use, agriculture, forestry and land-use, and waste.
Gases	Carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O).
Assumptions and methodological approaches	Lebanon is accounting for its anthropogenic GHG emissions and removals using the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, and 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (collectively, the "2006 IPCC Guidelines").
IPCC methodologies and metrics	The IPCC 2006 guidelines and parts of IPCC 2013 Wetlands Supplement is being used for estimating GHG emissions and removals. Global warming potentials (GWP) for a 100-year time horizon from the IPCC's fifth Assessment Report (AR5) is being used to calculate CO_2 equivalents.
Fair and ambitious	Considering Lebanon's difficult national circumstances and its regional context as depicted in the national circumstances in this NDC, as well as its low share in global emissions, Lebanon therefore considers the targets put forward in this update as fair and ambitious. Moreover, Lebanon applied the ICTU guidance to this 2020 NDC in order to enhance its clarity, transparency and understanding.

Low Emission Development Strategy

Lebanon is preparing its Low Emission Development Strategy (LEDS) with the support of UNDP (Low Emission Capacity Building LECB project and NDC Support Programme NDCSP). The main objectives of the LEDS are to guide national institutions towards long-term low emission planning, provide a political message to the international community on a country's direction towards sustainable, low-carbon and resilient development, integrate national economic development with climate mitigation and adaptation, and synergize sustainable development and national planning.

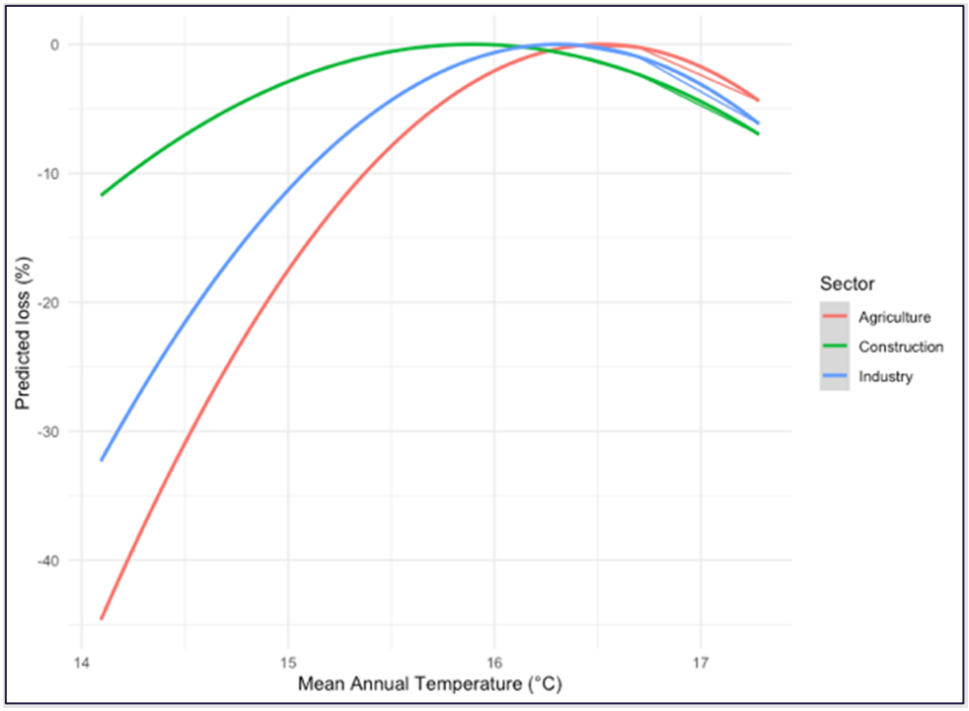
In 2019, Lebanon received from a technical assistance from the Green Climate Fund under the "country programming project for technical advisory services for Lebanon" to develop, amongst other, a long-term strategy for Lebanon. Based on the results of the technical assistance, the LEDS is planned to be finalized by 2021.

Box 3: Summary of Macroeconomic Risk Profile: Lebanon

Macroeconomic Risk Profile of Lebanon

This study is carried out under the Green Climate Fund (GCF) technical advisory service and aims at providing the country a simple model in assessing the economic impacts of climate change under the Paris Agreement-consistent scenarios: 1.5°C and 2°C.
The study is based on a combination of research from existing publications, consultation with the Nationally Designated Authority, and country-specific econometric methods using up-to-date datasets and climate models.

The main results show significant, non-linear impacts to agriculture, industry, and construction in changing climates, with negative impacts even at a 1.5°C global warming, albeit less than at 2°C global warming. Similarly, non-linear impacts are seen for all sectors with respect to precipitation, suggesting that both the lack of and excessive precipitation are detrimental to sectoral growth.

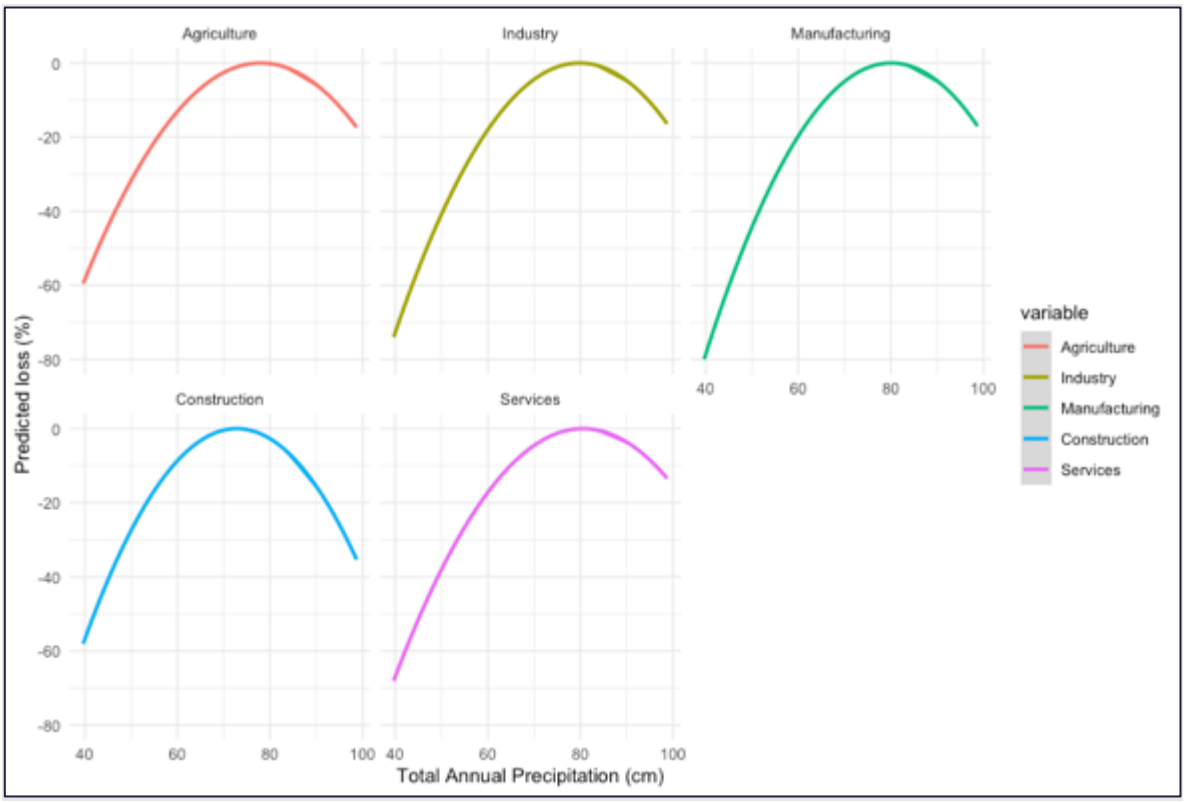


Estimated historical losses in percent of sectoral gross value-added based on actual historical temperature (1980-2016).

Temperature impacts indicate that Beirut is the least vulnerable to temperature changes among the governorates, mainly because of the minimal share of temperature-sensitive sectors to its GDP. On the other hand, Bekaa, North, and El Nabatieh have the highest share, due to the concentration of agriculture in the governorate's GDP. Looking at the impacts of both temperature and precipitation to total governorate GDP, the largest impacts will likely be experienced in Mount Lebanon, followed by the North, and Beirut.
Future impacts are influenced by two main factors: the magnitude of Lebanon-specific climate change under the different global warming scenarios, and the current economic structure of Lebanon. Lebanon's economy is predominantly driven by the services sector with an average share of about 77.8% of the economy, and is resilient to temperature changes. Due to this economic structure and the bottom-up approach of this

analysis, and the optimistic warming scenarios used as climate projections, the overall GDP impact shows lower estimates than other previous studies.

It is important to note that, given the current Nationally Determined Contributions (NDCs) which documents global mitigation efforts, the world is projected to reach 1.5°C warming around 2040, 2.0°C around 2060, and 2.7°C warming by the end of the century. We are currently (2020) at 1.1°C warmer than preindustrial levels.



Estimated historical losses in percent of sectoral gross value-added based on actual historical total annual precipitation. Total annual precipitation refers to the sum of daily precipitation in one calendar year.

Mainstreaming activities

Mainstreaming of climate change a legislative requirement, However, mainstreaming efforts by the Ministry of Environment have been successful in several key initiatives, as presented in Table 4. In addition, efforts to climate-proof upcoming economic plans and reforms are underway to lock climate change in any future projects. A study conducted by UNDP to climate-proof Lebanon's main development plans (Capital Investment Programme, Lebanon Economic Vision and the 3-year development priorities of the Financial Recovery Plan) estimated that an additional 6,671 Gg CO_2eq. can be further reduced by 2030 through climate proofing priority investments and can deliver USD 3.2 for every USD 1 invested in mitigation and adaptation enhancement Figure 4.

Figure 4: Main finding of the climate-proofing Lebanon's development plans (UNDP, 2021)

Table 4: Examples of climate change mainstreaming in sectoral initiatives

Sector/theme	Leading Institutions	Mainstreaming details
Ministerial declaration (decision 1/2021)	CoM	The Ministerial declaration of the Lebanese Government formed in 10/9/2021 included in their action plan the "preparation of a national sustainable strategy" and the "support of a green economy […] and the commitment to the Paris Agreement".
Offshore Petroleum Sector SEA- 2021 update	Lebanese Petroleum Authority	The Government carried out a Strategic Environmental Assessment (SEA) for the Offshore Petroleum Sector in 2012 and updated it in 2021 to take into consideration and abide by Lebanon's NDC targets for 2030.
National Health Strategy, 2021	MoPH	The National Health Strategy 2021 includes a section on climate change and health which proposes a Framework for Strategic Activities on Climate Change and Health. The framework includes "the assessment of the vulnerability of public health sector to climate change" (1.a), and "the development of health system response strategies, plans and projects and integrate them into national health strategies" (1.b).
Ministry of Agriculture Strategy 2020-2025, 2020	MoA	The Strategy includes Pillar 4 "Improving climate change adaptation /sustainable management of agri-food systems and natural resources, includes programmes to "Increase climate change adaptation and encourage related private investment along the agri-food value chains" (4.1), to "Enhance the efficient use of irrigation water and expand the supply of water resources for irrigation"(4.3) and "Encourage and support the use of renewable energy in the agricultural sector" (4.4).
Renewable Energy Outlook: Lebanon 2020-2030, 2020	MoEW-IRENA	Based on the assessment of the potential of Renewable Energy in Lebanon, the target to supply 30% of the electricity mix from renewables by 2030 was adopted in the NDC update.
National cooling plan under Kigali amendments, 2020	MoE	The National Cooling Plan 2050 prepared for Lebanon has taken into account GHG emission reductions potentials in its transition to energy-efficient and low GWP RAC appliances. The plan sets a target to reduce GHG emissions by 4.5 Gg CO_2eq by 2050 from the cooling sector.
National Water Sector Strategy (NWSS), 2020 update	MoEW	The strategy takes into account the impacts of climate change on available water resources in its proposed projects related to water demand management, irrigation and water supply. In addition, it calls for a series of assessment studies and institutional capacity building to improve the quality and quantity of data related to the potential impacts of climate change on water resources and the possible adaptation options. Climate change impacts will also be taken into consideration in the Strategic Environmental Assessment of the Strategy.

National Strategy For Conservation and Management of Plant Genetic Resources for Food and Agriculture in Lebanon 2015 – 2035, 2020	MoA	One the main goals of the strategy is "to promote sustainable utilization of Plant Genetic Resources for Food and Agriculture PGRFA as well as to provide options for adapting to and mitigating climate change and responding to food, feed and other needs"
Standard operating procedures to integrate gender into climate change policies, plans and reports, 2020	MoE	Two sets of standard operating procedures on mainstreaming gender were produced: one aims at integrating gender into policies and strategies in the relevant ministries retroactively and for future policy-making, and one to integrate gender in climate reporting and planning tools such as national communications, BURs, disaster risk management plans, national adaptation plans etc. The developed guidelines cover the entire policy making and reporting procedures from stakeholder involvement and decision making, to data collection, analysis of gaps and barriers, and development of indicators.
Draft Disaster Risk Management strategy, 2020	PCM	The draft strategy includes an objective to reduce disaster risk and minimize damages by mitigating and adapting to climate-related natural hazards and extreme weather
The National Strategy for Women in Lebanon 2011-2021, 2019	National Commission for Lebanese Women (NCLW)	Climate change is included in the strategy under the objectives 9 ("Enhancing the contribution of women to environmental protection") and 11 ("Protecting girls and women in situations of emergency, armed conflict, war and natural disaster"). The document highlights the positive role that women can play along with men to improve social behaviors to mitigate climate change and to adapt to its impacts because of the gender role they hold for household management and education of children to eco-friendly behaviors.

1.8 Gender-responsiveness of climate action

Lebanon has prioritized the gender-responsiveness of climate relevant policies, to ensure optimized implementation of mitigation and adaptation actions. Under the Nationally Determined Contribution Support Programme (NDCSP), the Ministry of Environment and the National Commission for Lebanese Women (NCLW) have put forward a set of Standard Operating Procedures (SOPs) to assist ministries in integrating gender into policies and strategies. The objective of these SOPs is to provide clear steps and actions to integrate gender into climate planning and reporting, including the collection of related data and information. They also include general considerations and background about climate change and gender, an overview of the gender integration process and the main actors to be involved, a step-by-step guide for planning and reporting with related questions and analysis, and concrete examples.

Moreover, the SOPs mandate the establishment of impact assessments which can include indicators such as the increase (%) in women's participation in decision-making related to climate planning and action, the increase (%) in number of women-led organizations in climate related action and the decrease in inequality regarding access to and control over resources.

Several capacity-building sessions were organized for gender focal points in different institutions to enhance awareness on climate change, gender, and their integration into the policy-making process.

Moreover, this exercise has also allowed for improved gender integration in Lebanon's updated NDC, prioritizing it in mitigation and adaptation, as well as listing it as a climate action enabler.

Examples of gender aspects in climate change mitigation and adaptation:

- **Energy:** Energy plays a key role for household needs, education, health care, access to clean water and other services. Energy has a direct impact on women's lives as women are often responsible for domestic work that requires energy and act as primary household-energy managers. Women have a critical role to play alongside their male counterparts in the success of energy related measures.
- **Solid waste:** Gender roles are often clearly defined when it comes to solid waste management. Women are responsible for domestic tasks such as gathering the waste, while men will collect and dispose of it (depending on the region). As both men and women are involved in solid waste management, both need to be part of the solutions the sector seeks. For instance, if women are involved in waste management at the household level, increasing their participation in recycling and designing capacity-building activities can provide opportunities for source reduction as well as increasing re-use and sorting-at-source.
- **Water:** Women are often the main water resource manager at home because of their responsibilities in food production and preparation, hygiene, cleaning, washing, waste disposal and care of children and the elderly. As such, women should be directly involved in decisions regarding water to increase efficiency of water distribution and improve water management by understanding behaviors and practices around water usage.

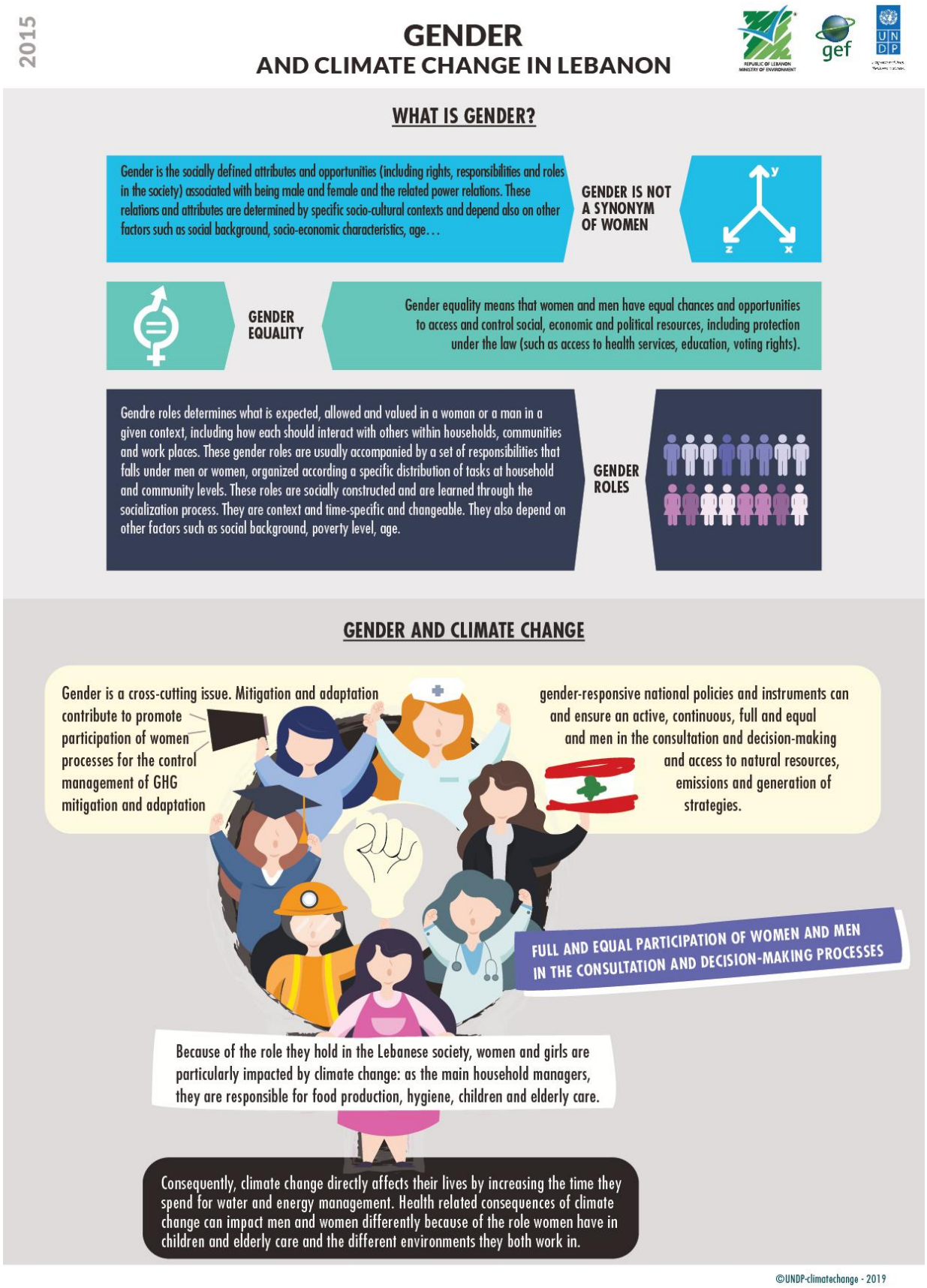


Figure 5: Gender and Climate Change in Lebanon

1.9 Synchronization of NDC and SDGs

In order to synchronize the preparation, update and tracking of Lebanon's NDC, an NDC-SDG assessment was conducted to explore opportunities for complementarity of climate action and sustainable development implementation and support, under the Nationally Determined Contribution Support Programme (NDCSP). The assessment had important implications for Lebanon's NDC update, which merges climate action under the NDC with the SDGs, along with a green and blue economy, leaving no one behind.

Under the synchronization exercise, the mitigation and adaptation strategies that constitute Lebanon's NDC were matched with the different Sustainable Development Goals (SDGs) sub-targets, using the SDG Climate Action Nexus tool (SCAN-tool), developed under the umbrella of the NDC Support Cluster. This tool identifies the climate mitigation and adaptation actions that may impact specific SDG targets.

By linking 12 strategies with the 169 SDG sub-targets, the main findings showed a high rate of synchronization between climate action and sustainable development in Lebanon, making the achievement of SDG 13 (Climate Action) an enabler for the implementation of other SDGs. It was also found that a large number of linkages were made with non-environment SDGs, such as SDG 3 (Good Health and Well-Being) and SDG 8 (Decent Work and Economic Growth), among others.

For each strategy/sector (energy, waste, transport, water, biodiversity, industry) a guidance document was produced to showcase the primary SDG linkage, along with other important linkages, based on the tool's matching properties. Moreover, the guidance document recommended further possible linkages with SDGs, to be taken up in the next policy-making cycle. Examples of linkages include:

- Agriculture is a primary source of income and employment in rural areas reaching up to 25% of the labor force and representing 80% of its GDP. Socio-economic stability can be maintained for low-income workers through introducing more sustainable agricultural processes that reduce environmental impact, increases resiliency, and uses water and land resources more efficiently (SDGs 1, 2, 6 and 12).

- Renewable energy technologies such as hydro, solar and wind power, can greatly reduce greenhouse gas emissions and greatly reduce premature deaths from air pollutants. Deploying cleaner energy sources that enable the phasing out of diesel generators can therefore, have a significant impact on SDGs 3.4 and 3.9 which relate to achieving more positive health outcomes by reducing harmful pollutants.

- Mass transit strategies can reduce transport cost as part of the household budget by providing public transit as an alternative to car ownership, which could potentially positively impact low-income families (SDG 1) and household income (SDG 4). Further, mass transit that aims to increase mobility and accessibility can greatly improve access to jobs and income potential and provide more equitable access to other important places such as schools, hospitals, and shopping (SDG 10).

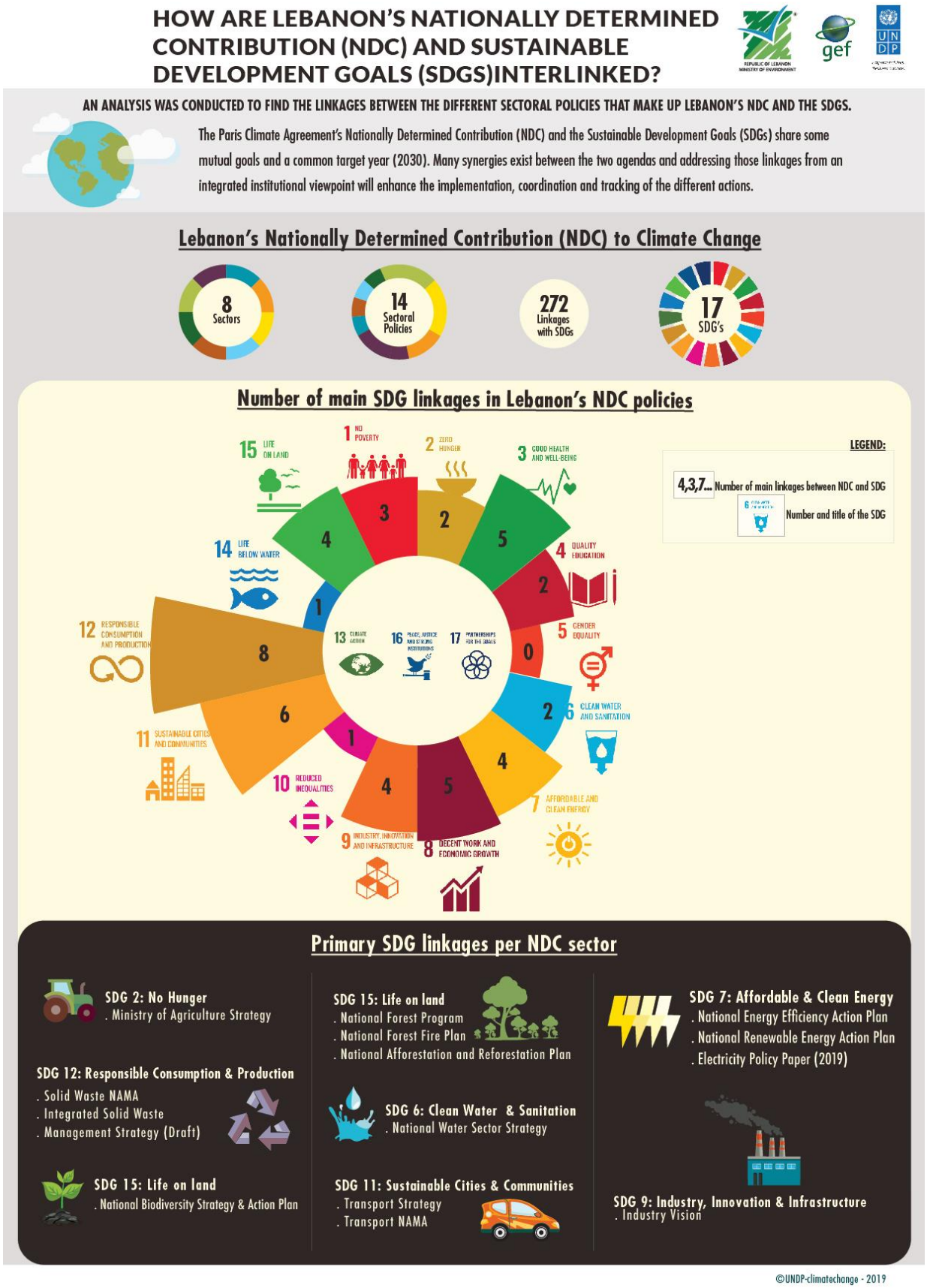


Figure 6: Interlinkages between Lebanon 's NDC and SDG

II. Institutional Arrangements Related to MRV

II. INSTITUTIONAL ARRANGEMENTS RELATED TO MRV

2.1 Institutional arrangements for the preparation of Biennial Update reports

In Lebanon, the Ministry of Environment (MoE) is the national focal point for climate change and is also the focal point of the following climate change related international organizations (in addition to the UN Organisations, such as UNDP, UNEP, FAO, WHO, World Bank, UNHABITAT, UNICEF, etc.):

- United Nations Framework Convention on Climate Change (UNFCCC)
- The Adaptation Fund
- NDC Partnership
- Green Climate Fund (GCF)
- Climate Technology Centre and Network (CTCN)
- Climate Vulnerable Forum (CVF)
- Cartagena Dialogue for Progressive Action (CD)
- Partnership on Transparency in the Paris Agreement (PATPA)
- Initiative for Climate Action Transparency (ICAT)
- Union for the Mediterranean (UfM)

A climate change team, supported by multilateral funds, works under the Service of Environmental Technology at the Ministry of Environment, and is responsible amongst other, for the preparation and submission of the Biennial Update Report, and the participation in the international consultation and analysis (ICA) and Facilitative Sharing of Views (FSV) processes.

Box 4: Mandate of the climate change team at MoE

- Prepare Biennial Update Reports and National Communications,
- Prepare and update of Nationally Determined Contributions along with implementation follow up,
- Develop climate change policy (i.e., Low-Emission Development Strategy, financial incentives),
- Follow-up and lead on institutional arrangements to enhance national climate action, finance and transparency,
- Follow-up on mainstreaming climate change in national sectoral policies, strategies and institutions including energy, water, transport, agriculture, forestry, solid waste, wastewater, oil and gas, finance, gender, sustainable development, education, research, disaster risk, cities, etc.
- Establish linkages and synergizing work with other international conventions such as the United Nations Convention to Combat Desertification, the UN Convention on Biological Diversity, the Sendai Framework for Disaster Risk Reduction, the Montreal Protocol on Ozone Depleting Substances, and its Kigali amendments, the Agenda 2030 for Sustainable Development, etc.
- Follow-up on international climate change negotiations,
- Coordinate regional and international climate change related projects,
- Assume the role of focal point to the UNFCCC, Green Climate Fund, Adaptation Fund, Global Environment Facility, Climate Technology Center and Network and Intergovernmental Panel on Climate Change.

Accordingly, the Ministry of Environment was responsible for coordinating the preparation of Lebanon's first, second, third and fourth Biennial Update report, with the support of the Global Environment Facility (GEF), and the collaboration of the United Nations Development Programme (UNDP).

In order to prepare and submit BURs on a continuous basis, institutional arrangements have been put in place according to the following elements:

1- GHG inventory: The Ministry of Environment is the lead compiler of the GHG inventory. Various Lebanese ministries such as the Ministry of Energy and Water, the Ministry of Agriculture, the

Ministry of Interior and Municipalities, and research institutions such as the Institute for Environment at the University of Balamand and the IPT Energy Centre, are mainly involved in the provision of activity data and other parameters for the preparation and validation of the GHG inventory. More details are provided under section 2 of this report.

2- Information on mitigation actions: The Ministry of Environment is the entity responsible to report the progress of the sectoral mitigation efforts undertaken in the country. The needed information is shared in a tabular format to relevant institutions, local experts, international agencies working in Lebanon and the private sector to be as exhaustive as possible in mapping national activities. However, the absence of proper institutional arrangements complicates the involvement of other institutions such as Council of Development and Reconstruction, Ministry of Public works and transport, Ministry of Industries, Central Bank and Central Administration of Statistics and hinders the completeness and accuracy of the exercise.

3- Constraints and gaps and related financial, technological, and capacity building needs and support needed and received: Information related to sectoral constraints, gaps and needs are collected through stakeholders' consultations and bilateral meetings with key experts, in addition to a desk review of relevant national reports, plans and strategies that identify and report similar information. A validation exercise is also undertaken with representatives of donor agencies and international organization to ensure no omission of activities. However, the absence of proper institutional arrangements to involve local communities, municipalities and the private sector hinders the completeness and accuracy of the exercise.

Through the Capacity Building for Improved Transparency (CBIT) project, Lebanon envisages to establish an MRV Coordinating Entity (MRVCE) and a network of partners to enhance the role and engagement of ministries and agencies not only in the preparation of the GHG inventory, but also in collecting data and information for other sections of the BUR.

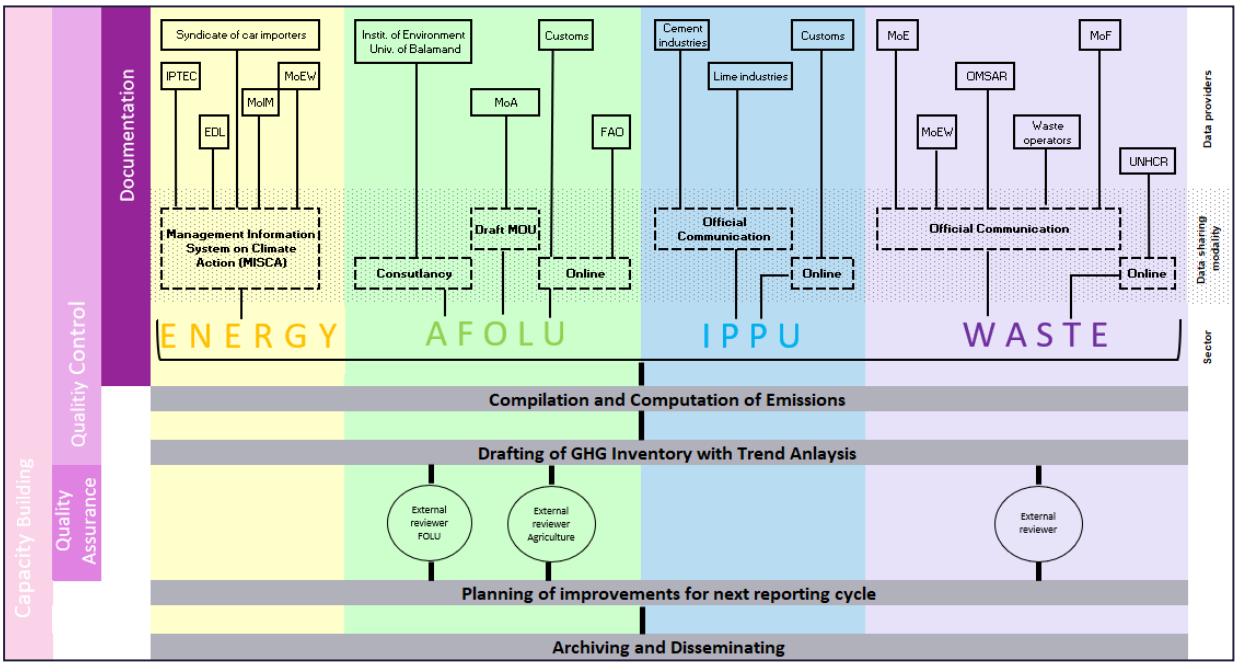
2.2 GHG Inventory System

Lebanon has produced three National Communications (NC) (submitted in 1999, 2011 and 2016) and three Biennial Update Reports (BUR), submitted in 2015, 2017 and 2019, each containing a national Greenhouse Gas (GHG) inventory. The last GHG inventory, reported as part of Lebanon's 3rd BUR, covers a time series from 1994-2015 and was compiled using the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories and using the IPCC software version 2.54.

The GHG inventory is an integral part of the BUR3/4NC project funded through the Global Environment Facility's (GEF) enabling activity and managed by the United Nations Development Programme (UNDP) in Lebanon. The Government of Lebanon (GoL) through the Ministry of Environment (MoE) provides in kind support for the project. The overall coordination of the project is handled by the climate change office, which is part of the Service of Environmental Technology at MoE. The Ministry is the institution responsible for the preparation and submission of BURs and National Communications to the United Nations Framework Convention on Climate Change (UNFCCC).

The GHG inventory compilation team is located at the climate change office and is financed on a project basis. The retention of the compilation team therefore depends on the ability to continue finding international funding. The compilation team is supported by sectoral experts (transport, FOLU, wastewater) recruited on a needs basis as well as external reviewers (IPPU, waste, AFOLU). Activity data is collected by the Ministry of Environment - Climate Change Office through data sharing

requests with relevant institutions. Intensive stakeholders and key data holders consultations are conducted during the process, building on existing institutional arrangements.



IPTEC: IPT Energy Center; EDL: Electricite du Liban; MoIM: Ministry of Interior and Municipalities; MoEW: Ministry of Energy and Water; MoA: Ministry of Agriculture; MoU: Memorandum of Understanding; FAO: Food and Agriculture Organization; MoE: Ministry of Environment; OMSAR: Office of the Minister of State for Administrative Reform; MoF: Ministry of Finance; UNHCR: United Nations High Commissioner for Refugees.

Figure 7: GHG Inventory preparation process for the inventory of 2018

During the GHG inventory preparation process, attempts to abide by a pre-defined GHG inventory cycle have been compromised by various delays in access to funding, access to data, or enabling political environment. These delays affect the approach of data collection, which is mostly undertaken on an ad-hoc manner (as opposed to having a restrained data collection phase) and decrease the time spend and efforts invested in improving methodologies, data validation, Quality Assurance/ Quality Control (QA/QC) and uncertainty analysis. **Uncertainty assessment** has been carried out for this inventory based on the 2006 IPCC guidelines.

Standardized **documentation and archiving** templates have been used to capture methodologies and data, expert judgements and assumptions, recalculations and improvements made as well as reported issues and potential improvements.

Quality Assurance (QA) and Quality Control (QC) measures were undertaken for the activity data, emission factors and parameters following the recommendations and IPCC 2006 GL. The adoption of the standardized documentation sheets upstream allowed a significant improvement in the tracking of methodological changes, data sources, assumptions, necessary improvements and recalculations. QC roles and responsibilities were clearly allocated, both general and category-specific QC measures were defined and applied, sectoral QA was undertaken and outcomes of QA/QC were documented. Quality assurance for the GHG inventory was performed through an external review by a UNFCCC reviewer.

By adopting this approach, the inventory compilation team intended to bring significant improvement on both the implementation and reporting of QC procedures, while balancing quality control requirements, improved accuracy and reduced uncertainty against requirements for timeliness and cost effectiveness. MRV of mitigation actions and policies.

Currently Lebanon has no specific methodology for monitoring the progress of actions described. Sectoral experts with recruited to collect information on mitigation activities being undertaken in the energy, transport and wastewater sectors and consultations with project proponents and main stakeholders helped identify mitigation actions being implemented or being planned. However, this exercise is not undertaken on a systematic and regular basis and linkages between sectoral policies and actions and climate change are still not well clarified. Indeed, institutionalized communication and reporting channels are crucial to avoid double counting, assign specific activities to specific plans and/or commitments, and identify the multitude of actors working on mitigation actions beyond the sectoral actors. For example, the private sector and municipalities are responsible for a significant part of emission reduction, however, due to the unavailability and scattering of relevant data, their activities are not completely covered under this reporting exercise. The current approach to assessing impacts of mitigation actions does not allow filtering through different levels of information to identify cluster of information including emission reduction impact.

Based on the above, tracking mitigation actions accurately and comprehensively has become an important need to better assess emission reduction progress against committed targets and the impact of mitigation action on the wide economy. Lebanon plans to enhance the robustness and institutionalization of reporting mitigation actions through 2 main workstreams:

Mapping of planned and implemented activities through the NDC Partnership:

Lebanon became a member of the NDC Partnership in 2019, and as the main focal point, the Ministry of Environment has coordinated with several ministries to develop sectoral Partnership Plans (PPs) for the energy, transport, waste, water and wastewater, agriculture, and forestry sectors. These plans will present Lebanon's priorities related to climate change actions in a framework that allows tracking progress against results. It will therefore present new and planned climate action work as well as ongoing projects and programs, including sectoral barriers and needs with corresponding enabling technical and financial assistance activities.

The Partnership Plans are being re-evaluated by respective ministries to reflect the recent national circumstances before being shared with the NDC Partnership partners in order to mobilize support.

Institutionalized tracking of activities through the Capacity Building Initiative on Transparency (CBIT):

As part of the proposed CBIT project, a Measuring, Reporting and Verifying Coordinating Entity (MRVCE) is planned to be established with the responsibility to develop a long-term transparency strategy which will be a strong reference point for all stakeholders in planning their activities when it comes to reporting, capacity-building and institutional arrangements. Under the proposed project, the MRVCE is expected to set up a cross-cutting system that tracks GHG emissions, mitigation and adaptation actions, support received and needed, and capacity building needs.

More specifically, and according to the CBIT project document, the MRVCE is planned to undertake the following tasks:

- Tracking the implementation of Lebanon's NDC through regular national stock take towards achieving the NDC goals, and the implementation and enhancement of the transparency framework.

- Tracking progress of climate policies through the development of progress indicators, the quantification of emission reduction potential from policies and strategies and through building capacities of partner agencies on tools and methodologies to collect the necessary data to quantify

- Assessing impacts and analyze the progress of mitigation, adaptation and means of implementation.

- Tracking climate finance through the development of progress indicators on support received and through the design of appropriate institutional arrangements for the MRV network of partners to enhance information sharing.

- Assisting partner agencies in identifying support needed for mitigation and adaptation actions.

However, since the CBIT approval is still pending, no concrete steps have been undertaken for the establishment of the MRVCE.

Capacity building is much needed at the national level to improve monitoring and reporting of sectoral mitigation activities. Lebanon identifies the MRV for mitigation actions as a priority area for capacity building, not only to set up a transparency baseline and an MRV system but also to support national institutions to develop indicators and track and report progress on mitigation actions.

Lebanon is committed to improve data collection and management over time, and to formalize institutional arrangements that support the long-term collection, analysis and reporting of information on mitigation actions and efforts to explore co-benefits in more details.

Table 5: Capacity building needs related to MRV, as identified during the ICA 2020

Capacity Building Needs	Planned improvements
Setting up a transparency baseline	Perform a baseline assessment of Lebanon's GHG inventory, mitigation actions, and climate finance reporting. The transparency strategy (mentioned below) will take into consideration the results of the baseline assessment, to be able to identify the extent of support and capacity-building needed. Support requested though CBIT project.
Establishment of an MRV Coordination Entity MRVCE and network of partners	Envisioning the establishment of an MRVCE and an MRV network of partners with robust information flows, and clear roles and responsibilities The MRVCE is planned to develop a long-term transparency strategy which will be a strong reference point for all stakeholders in planning their activities when it comes to reporting, capacity-building and institutional arrangements. The MRVCE will also be responsible to set up a cross-cutting system that tracks GHG emissions, mitigation and adaptation actions, support received and needed, and capacity building needs. Support requested though CBIT project.
Establishment of a National Transparency Strategy	Envisioning a high-level transparency strategy to be adopted by the government, build upon existing experts and coordination mechanisms. The strategy acts as a short-term, medium-term and long-term roadmap to guide the government in enhancing its climate reporting. Existing committees such as the NDC committee will be engaged. Support requested though CBIT project.
Development of indicators to track progress of mitigation actions	Capacity-building to the institutions which are responsible for the implementation of mitigation strategies will be provided. The aim is to empower stakeholders to move towards evidence-based decision-making, through the development of indicators which will track the progress of mitigation actions. Support requested though CBIT project.
Inclusion of mitigation actions related to other gases such as F-gases	No planned improvement

2.3 MRV of support needed and support received

Currently, no single entity is responsible for tracking and reporting on climate change projects and related expenditures in Lebanon. The MoE has attempted to identify and track climate change related activities across the years and their related financing, however limited information was available to estimate the overall support that Lebanon is receiving for climate action.

Key data sources in Lebanon do not or only partially provide detailed descriptions of climate action. Information related to a project's aims or outputs is in many cases only available through its title. This hinders the possibility of identifying the specific project activities that are related to climate adaptation or mitigation, and their nature (capacity building, implementation, etc.).

As part of the proposed CBIT project, the MRV Coordination Entity is planned to set a mechanism to track climate change finance flows, through its network or partners or through a regular donor coordination process. In addition, the update and operationalization of the Monitoring Information System of Climate Action (MISCA) platform will facilitate the exchange of data between Ministries, among which financial flows.

Technical support ad capacity building is much needed in Lebanon in order to collect and report information on support received in a systematic and sustainable way. Nationally endorsed definitions on finance, capacity building and technology transfer are required to provide a common understanding of what should be considered when tracking support, both for the purposes of international reporting as well as for national decision-making processes. There is also a capacity building need to harmonise data from all sources (i.e., include all the actions implemented by private and public stakeholders), to estimate climate impacts of groups of actions and to avoid double counting of overlapping mitigation actions .

Support should target all involved stakeholders, as described in Table 6, to ensure an inclusive and complete reporting mechanism for climate finance flows. The establishment of an MRVCE is becoming essential to create a momentum and set the first bases of an MRV system.

Figure 8 presents a general system design that can be adopted by the MRVCE to (1) set up data sharing modalities with data providers, (2) review, compile, analyse and archive collected information, (3) report the information on support received to the UNFCCC, NDC committees tracking implementation.

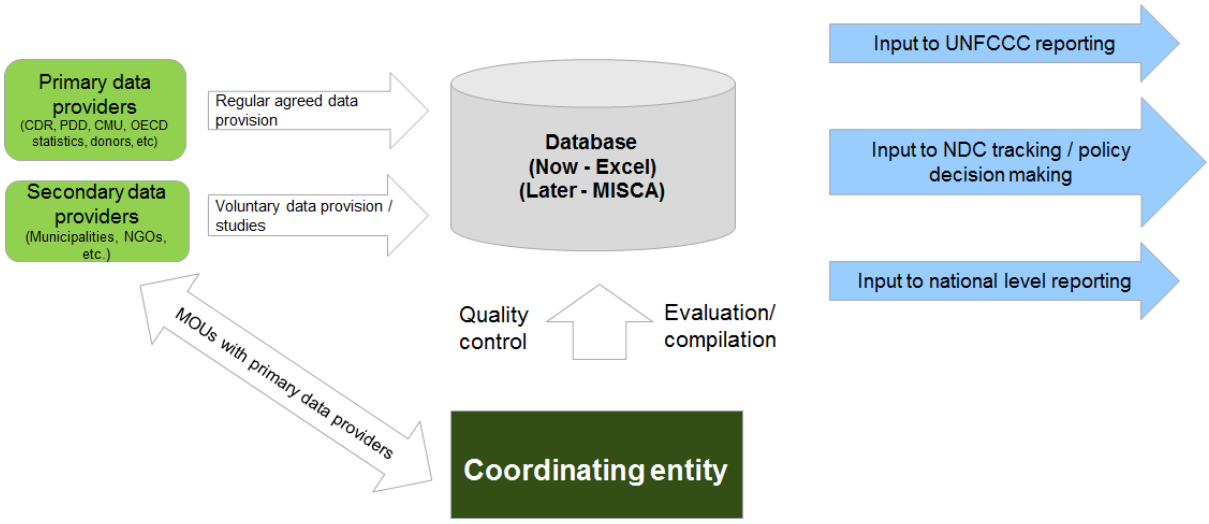


Figure 8: Suggested basic structure of MRV of finance system

Table 6: Key Stakeholders for tracking and reporting climate finance flows

Stakeholders	Potential role in climate finance reporting	Gaps and constraints
Cash Management Unit (CMU) at the Ministry of Finance	Reports information on related cash grants received by Lebanon public institutions	No reporting of Non-cash grants such as technical support, capacity building support or technology transfer
Public Debt Department at the Ministry of Finance	Reports related loans received by the Lebanese Government through the Debt Management and Financial Analysis System (DMFAS)	No details on the technical aspect and content of the loan to establish climate relevance or not. Only captures loans received by the Lebanese government
Expenditure Unit at the Ministry of Finance	Reports domestic finance flow based on the expenditure of governmental institutions	No details on the technical aspect of the expenditure to establish climate relevance or not
Ministerial budgets	Reports information on public expenditure on relevant project in a disaggregated form	Not publicly available for all ministries
Council for Development and Reconstruction	Reports technical and financial details on grants and loans managed by CDR through the JD Edwards data management system Reports cash and non-cash support received Reports information disaggregated per sector	Only reports on project implemented by CDR Different classification of information than MoF system
Ministry of Environment	Reports technical and financial details on support received through specific climate change and environmental funds (Adaptation Fund, Green Climate Fund, Global Environment Facility, etc.)	
Council of Ministers	Reports on loans and grants have been released in the official gazette	Information not easily searchable as it is scanned and included as pictures in the archiving system
UN agencies and international organizations	Report on technical and financial information related to grants received directly to international organizations	Information scattered across agencies Funds not accounted for in the Lebanese public sector
Municipalities	Report financial and technical information related to grants received directly to Municipalities	Grants are not registered by the cash CMU or the CDR.
Non-Governmental Organizations (NGOs)	Report financial and technical information related to grants received directly to NGOs	Grants not captured by any government agency.
Investment Development Authority of Lebanon	Reports Foreign Direct Investments	

III. National Greenhouse Gas Inventory

III. THE NATIONAL DIRECT AND INDIRECT GREENHOUSE GAS INVENTORY OF 2018

3.1 Methodology

The inventory of Greenhouse Gas (GHG) emissions in this report covers the year 2018, with a recalculated time series for 1994-2018 when needed. The inventory was prepared based on the 2006 IPCC Guidelines, and using the IPCC software version 2.54, including analysis of key categories, uncertainties and generation of trends. The inventory is in line with UNFCCC Decisions 17/CP.8 and 2/CP.17. To the extent possible, the inventory implemented the provisions of decision 18/CMA.1 on modalities, procedures and guidelines for the transparency framework. Emissions of Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O) were estimated and reported in Gg CO_2eq. (1,000 tonnes). The following sectors are covered: 1. Energy (including transport), 2. Industrial Processes and Product Use (IPPU), 3. Agriculture Forestry and Other Land Use (AFOLU) and 4. Waste.

To estimate the GHG emissions, tier 1 methods were mostly applied using default emission factors, with activity data being derived from national sources, international organizations and other literature as identified in each sector. Proxy data, interpolations, extrapolations and estimations based on expert judgments were used in cases where data was unavailable.

Tier 2 methods were used to estimate emissions from cement manufacturing, product uses as substitutes for Ozone Depleting Substances (F-gases), road transport (for CH_4 and N_2O), solid waste disposal on land and wastewater treatment and discharge, while approach 3 was adopted for the representation of land use areas in some subcategories of AFOLU. More details on categories covered and tiers used are presented in section 3.9.

In order to allow the aggregation and total overview of national emissions, emissions of CH_4 and N_2O were converted to CO_2 equivalent using the IPCC Fifth Assessment Report's (AR5) Global Warming Potential (GWP) values based on the effects of greenhouse gases over a 100-year time horizon.

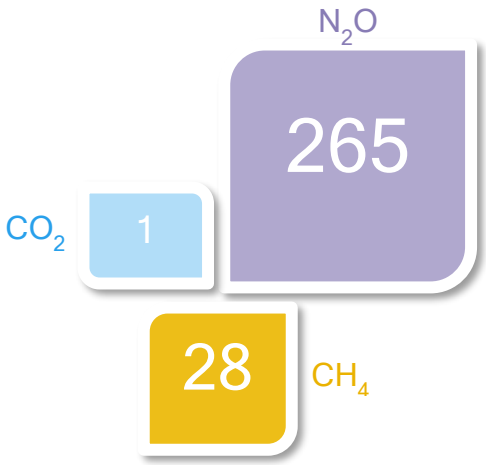


Figure 9: Global Warming Potential (IPCC, 2014)

For indirect greenhouse gases, CO, NO_x, NMVOC and SO_x have been calculated using the EMEP/EEA 2019 tier 1 methodology for all categories, except for transport where Tier 2 technology-specific methodology was used. SO_2 emissions from transport were calculated based on the regulatory limit of sulfur content in fuels.

3.2 Results

In 2018, Lebanon emitted 32,472 Gg CO_2eq. (as total emissions) with the most significant greenhouse gas being carbon dioxide, primarily produced from the burning of fossil fuels. The main contributor to greenhouse gas emissions is the energy sector (including transport) with 82% of GHG emissions, followed by industrial processes (10%). CO_2 removals from forestry and land use change amounted to -3,205 Gg CO_2, bringing Lebanon's NET emissions to 29,266 Gg CO_2eq.

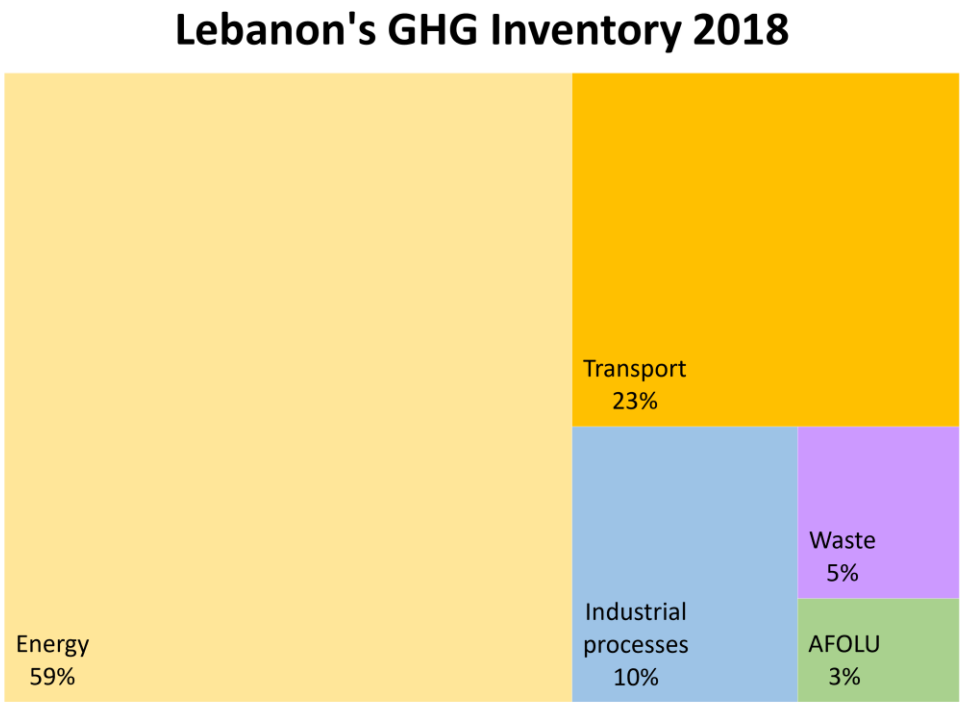


Figure 10: Lebanon's national greenhouse gas inventory by category in 2018

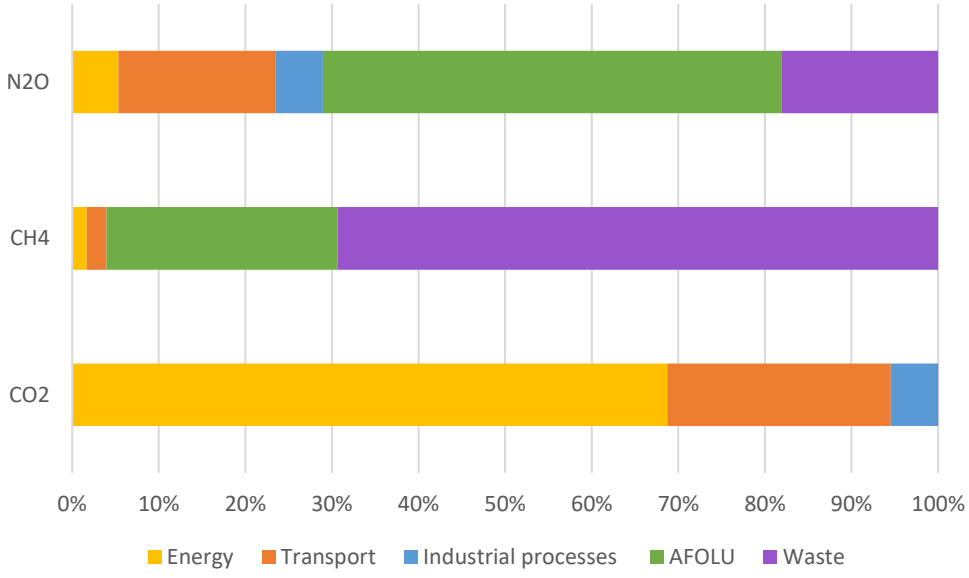


Figure 11: Lebanon's national greenhouse gas inventory by gas in 2018

Table 7: Lebanon's GHG emissions and removals for 2018 per gas and category

Greenhouse gas source and sink categories	CO_2 emissions/ removals Gg	CH_4 Gg	N_2O Gg	CH_4 Gg CO_2eq.	N_2O Gg CO_2eq.	F-gases Gg CO_2eq.	Total emissions Gg CO_2eq.	Net emissions Gg CO_2eq.
Total National Emissions and Removals	**24,772.19**	**69.28**	**2.77**	**1,939.83**	**732.83**	**1,821.17**	**32,472.69**	**29,266**
1 - Energy	**26,452.47**	**2.75**	**0.65**	**76.91**	**171.90**		**26,701.27**	
1.A - Fuel Combustion Activities	26,452.47	2.75	0.65	76.91	171.90		26,701.27	
1.A.1 - Energy Industries	10,193.24	0.40	0.08	11.27	21.32		10,225.82	
1.A.2 - Manufacturing Industries and Construction	4,977.25	0.18	0.04	5.17	9.77		4,992.19	
1.A.3 - Transport	7,226.63	1.60	0.50	44.72	132.91		7,404.25	
1.A.4 - Other Sectors	4,055.36	0.56	0.03	15.75	7.90		4,079.01	
2 - Industrial Processes and Product Use	**1,499.41**		**0.15**	**-**	**40.15**	**1,821.17**	**3,360.73**	
2.A - Mineral Industry	1,498.75	NA	NA	NA	NA	NA	1,498.75	
2.A.1 - Cement production	1,496.82	NA	NA	NA	NA	NA	1,496.82	
2.A.2 - Lime production	0.75	NA	NA	NA	NA	NA	0.75	
2.A.3 - Glass Production	NO	NO	NO	NO	NO	NA		
2.A.4 - Other Process Uses of Carbonates	1.18	NA	NA	NA	NA		1.18	
2.B- Chemical Industry	NO	NO	NO	NO	NO	NA		
2.C - Metal Industry	NO	NO	NO	NO	NO	NA		
2.D - Non-Energy Products from Fuels and Solvent Use	**0.66**	NA	NA	NA	NA		0.66	
2.D.1 - Lubricant Use	IE	NA	NA	NA	NA			
2.D.2 - Paraffin Wax Use	**0.66**	NA	NA	NA	NA		0.66	
2.D.3 - Solvent Use	NE	NA	NA	NA	NA			
2.E- Electronics Industry	NO	NO	NO	NO	NO	NA		
2.F - Product Uses as Substitutes for ODS						1,821.17	1,821.17	
2.F.1 – Refrigeration/ Air Conditioning	NA	NA	NA	NA	NA	1,821.17	1,821.17	
2.F.2 - Foam Blowing	NO	NO	NO	NO	NO	NO		
2.F.3 - Fire Protection	NE	NE	NE	NE	NE	NE		
2.F.4 - Aerosols	NO	NO	NO	NO	NO	NO		
2.F.5 - Solvents	NO	NO	NO	NO	NO	NO		
2.G - Other Product Manufacture and Use			0.15		40.15		40.15	
2.G.1 - Electrical Equipment	NE	NE	NE	NE	NE	NE		
2.G.2 - SF_6 and PFCs from Other Product Uses	NO	NO	NO	NO	NO	NO		
2.G.3 - N_2O from Product Uses	NA	NA	0.15	NA	40.15	NA	40.15	
2.G.4 - Other	NE	NE	NE	NE	NE	NE		
3 - Agriculture, Forestry, and Other Land Use	**(3,205.56)**	**18.50**	**1.46**	**517.97**	**387.95**		**907.03**	
3.A - Livestock	NA	18.49	0.42	517.80	112.16		629.97	
3.A.1 - Enteric Fermentation	NA	14.96	NA	418.99	NA		418.99	
3.A.2 - Manure Management	NA	3.53	0.42	98.81	112.16		210.98	

3.B - Land	(3,194.40)	NA	NA	NA	NA		(3,194.40)
3.B.1 - Forest land	(2,026.06)	NA	NA	NA	NA		(2,026.06)
3.B.2 - Cropland	(1,220.25)	NA	NA	NA	NA		(1,220.25)
3.B.3 - Grassland	NE	NE	NE	NE	NE		NE
3.B.4 - Wetlands	NE	NE	NE	NE	NE		NE
3.B.5 - Settlements	51.91	NA	NA	NA	NA		51.91
3.B.6 - Other Land	NO	NO	NO	NO	NO		NO
3.C - Aggregate sources and non-CO_2 emissions sources on land	1.11	0.01	0.94	1.04	275.79		277.06
3.C.1 - Emissions from biomass burning		0.01	0.00	0.17	0.09		0.26
3.C.2 - Liming	NO	NA	NA	NA	NA		
3.C.3 - Urea application	1.11	NA	NA	NA	NA		1.11
3.C.4 - Direct N_2O Emissions from managed soils	NA	NA	0.69	NA	182.59		182.59
3.C.5 - Indirect N_2O Emissions from managed soils	NA	NA	0.26	NA	67.61		67.61
3.C.6 - Indirect N_2O Emissions from manure management	NA	NA	0.09	NA	25.49		25.49
3.D Other							(12.27)
3.D.1 - Harvested Wood Products	(12.27)	NA	NA	NA	NA		(12.27)
4 - Waste	**25.87**	**48.03**	**0.50**	**1,344.95**	**132.84**		**1,503.66**
4.A - Solid Waste Disposal		21.30		596.52	-		596.52
4.B - Biological Treatment of Solid Waste		2.07	0.12	58.05	31.15		89.21
4.C - Incineration and Open Burning of Waste	25.87	3.73	0.07	104.36	17.78		148.01
4.D - Wastewater Treatment and Discharge		20.93	0.32	586.02	83.91		669.92
Memo Items				0.00	0.00		0.00
International Bunkers	**923.50**	**0.02**	**0.03**	**0.45**	**6.78**	**0.02**	**930.73**
1.A.3.a.i - International Aviation	807.07	0.01	0.02	0.16	5.98	0.01	813.21
1.A.3.d.i - International water-borne navigation	116.43	0.01	0.00	0.29	0.80	0.01	117.52

3.3 Key category analysis

According to the IPCC definition, a key category is one that is prioritized within the national inventory system because its estimate has a significant influence on a country's total inventory of direct GHGs in terms of the absolute level of emissions, the trend in emissions, or both. Total emissions from the key categories amount to 95% of the total emissions included in the inventory. Key categories for Lebanon are determined with Approach 1 described in Volume 1, Chapter 4 of the 2006 IPCC Guidelines.

Several sub-categories have been identified as key in the analysis, with CO_2 being the main gas and the energy sector being the main key category. Both the trend and Level Assessments of key categories are undertaken using approach 1, for all sectors, with and without LULUCF. A list of all key categories is presented in Table 8, Table 9, Table 10 and Table 11.

Table 8: Key categories by level assessment (LA) for 2018 evaluated with LULUCF (Approach 1)

	IPCC Category	GHG gas	Cumulative share LA (%)
1.A.1	Energy Industries - Liquid Fuels	CO_2	29%
1.A.3.b	Road Transportation	CO_2	51%
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CO_2	66%
1.A.4	Other Sectors - Liquid Fuels	CO_2	78%
3.B.1.a	Forest land Remaining Forest land	CO_2	84%
2.A.1	Cement production	CO_2	88%
3.B.2.a	Cropland Remaining Cropland	CO_2	92%
4.A	Solid Waste Disposal	CH_4	94%
4.D	Wastewater Treatment and Discharge	CH_4	95%

Table 9: Key categories by trend assessment (TA) for 2018 evaluated with LULUCF (Approach 1)

	IPCC Category	GHG gas	Cumulative share TA (%)
3.B.1.a	Forest land Remaining Forest land	CO_2	19%
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CO_2	36%
1.A.1	Energy Industries - Liquid Fuels	CO_2	53%
3.B.2.a	Cropland Remaining Cropland	CO_2	64%
2.A.1	Cement production	CO_2	74%
1.A.4	Other Sectors - Liquid Fuels	CO_2	83%
4.A	Solid Waste Disposal	CH_4	87%
3.A.1	Enteric Fermentation	CH_4	90%
1.A.3.b	Road Transportation	CO_2	92%
4.D	Wastewater Treatment and Discharge	CH_4	94%
3.A.2	Manure Management	CH_4	95%

Table 10: Key categories by level assessment (LA) for 2018 evaluated without LULUCF (Approach 1)

	IPCC Category	GHG gas	cumulative share LA (%)
1.A.1	Energy Industries - Liquid Fuels	CO_2	33%
1.A.3.b	Road Transportation	CO_2	56%
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CO_2	73%
1.A.4	Other Sectors - Liquid Fuels	CO_2	86%
2.A.1	Cement production	CO_2	91%
4.A	Solid Waste Disposal	CH_4	93%
4.D	Wastewater Treatment and Discharge	CH_4	95%

Table 11: Key categories by trend assessment (TA) for 2018 evaluated without LULUCF (Approach 1)

	IPCC Category	GHG gas	cumulative share TA (%)
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CO_2	25%
1.A.1	Energy Industries - Liquid Fuels	CO_2	49%
2.A.1	Cement production	CO_2	63%
1.A.4	Other Sectors - Liquid Fuels	CO_2	75%
4.A	Solid Waste Disposal	CH_4	81%
3.A.1	Enteric Fermentation	CH_4	86%
1.A.3.b	Road Transportation	CO_2	89%
4.D	Wastewater Treatment and Discharge	CH_4	91%
3.A.2	Manure Management	CH_4	93%
4.C	Incineration and Open Burning of Waste	CH_4	94%
3.A.2	Manure Management	N_2O	96%

3.4 Trend analysis

Over the period 1994 – 2018, total GHG emissions increased by approximately 3-fold, with the energy sector remaining the largest contributor of GHG emissions in Lebanon (Table 12). The contribution of the energy sector to total emissions has remained relatively the same over the time series, with a share ranging between 66% to 82% of total emissions.

Table 12: Trend in GHG inventory (in Gg) for the time series 1994-2018 with year-to-year percent change

	Total emissions Gg CO_2eq.		Net emissions CO_2eq.	
1994	8,919.69		5,882.66	
2000	15,274.58	-7%	12,153.64	-9%
2001	17,007.99	11%	13,665.03	12%
2002	16,740.49	-2%	13,397.63	-2%
2003	15,934.83	-5%	12,691.59	-5%
2004	16,622.69	4%	13,312.83	5%
2005	16,360.50	-2%	13,189.85	-1%
2006	16,688.21	2%	13,586.80	3%
2007	15,981.50	-4%	12,757.39	-6%
2008	18,396.76	15%	15,209.76	19%
2009	22,264.57	21%	19,119.62	26%
2010	20,874.10	-6%	17,730.18	-7%
2011	22,625.49	8%	19,563.48	10%
2012	24,756.87	9%	21,820.27	12%
2013	26,035.98	5%	22,759.04	4%
2014	27,060.87	4%	23,740.96	4%
2015	28,316.33	5%	25,004.95	5%
2016	31,428.69	11%	28,249.69	13%
2017	31,231.43	-1%	28,026.43	-1%
2018	32,472.18	4%	29,267.18	4%
Average year-to-year % change		**6%**		**7.6%**

Table 13: Trend of emissions during the period 1994-2018 (in Gg)

	Total GHG emissions	Energy	Industry	AFOLU (without LULUCF)	AFOLU (with LULUCF)	Waste
1994	8,920	5,919	1,275	747	-2,290	978
2018	32,472	26,701	3,361	907	-2,297	1,504
% change 1994-2018	264%	351%	164%	21%	0%	54%
% change average yearly	6%	5%	4.3%	1%	0.32%	2.5%

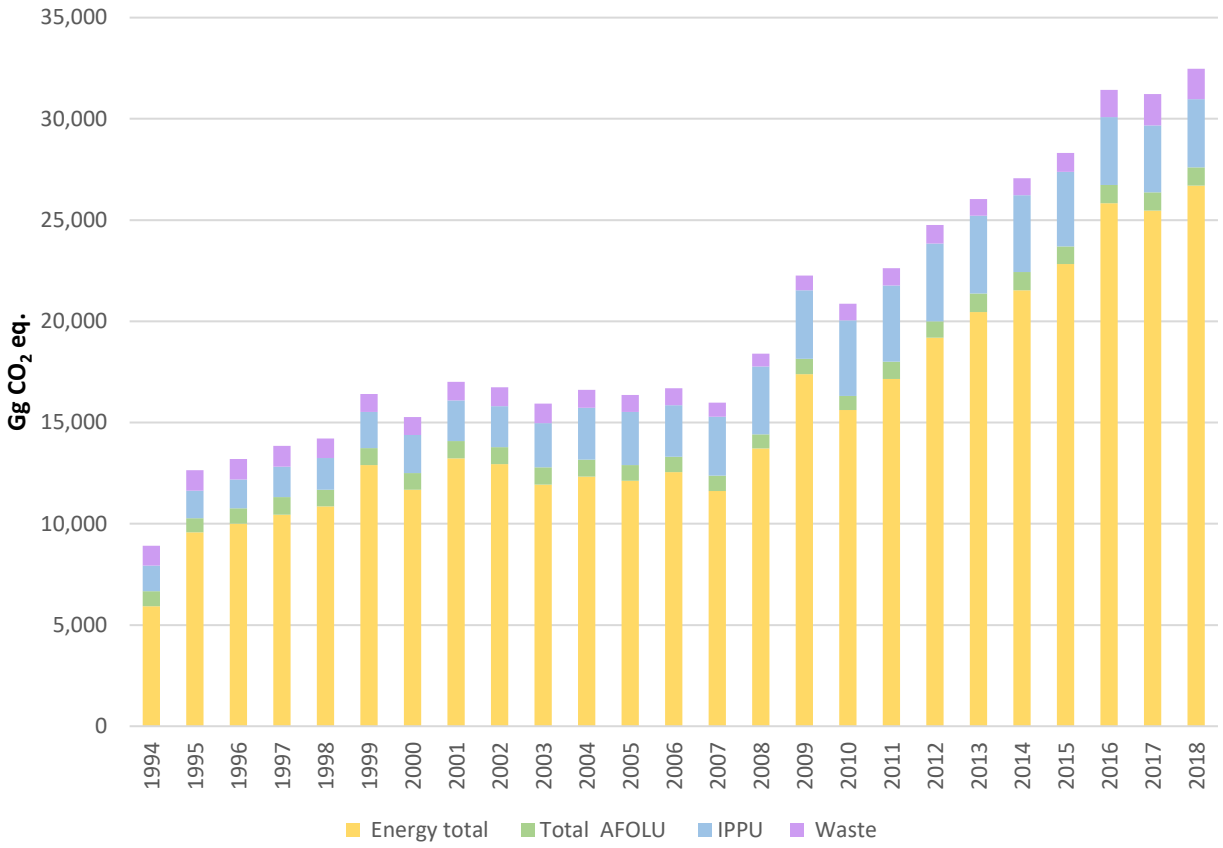


Figure 12: Trend in GHG emissions including share of emissions per sector for the period 1994-2018

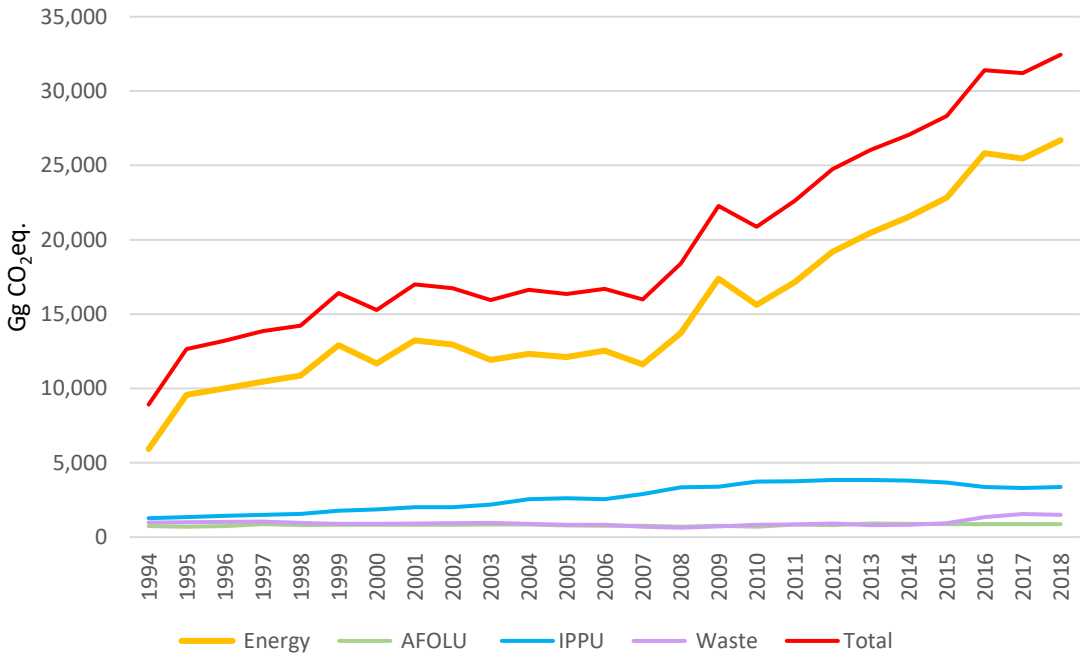


Figure 13: Trend in total and sectoral GHG emissions 1994-2018

Lebanon's GHG emissions are increasing at an average rate of 6% every year, which lead to a significant increase in emissions since 1994. As shown in Figure 13, the trend of increase in total GHG emissions closely follows the trend of emissions from the energy sector. This significant growth in emissions reflects the growing demand for electricity, due in part to the changing socio-economic conditions and to the expansion of the national grid. In fact, the sharp increase noticed between the 1994 and 2000 emissions is due to the increase in gas/diesel oil consumption that accompanied the installation and operation of 4 thermal diesel power plants (the Baalbeck, Tyre, Beddawi and Zahrani) during this period.

However, emission growth did not follow a stable trend, as it witnessed 2 detectable drops in 2007 and 2010 in addition to one significant increase in 2009. The drop in the emission trend in 2007, mainly driven by a similar drop in gas diesel oil import is an indirect result of the July 2006 war where significant damage to the road network and electricity infrastructure was inflicted. Indeed, due to the impairment of the electricity distribution network, it was impossible to distribute all the electricity produced and consequently thermal power plants were operating at partial load during the year 2007. The rehabilitation of the infrastructure extended over 2 years, and it was not until 2009 that power plants started to run on full capacity again, hence explaining the peak in GHG emissions in 2009. As for the decrease in emissions observed in 2010 which is proportional to the decrease in gas/diesel oil import, it is mainly caused by 1) the use of natural gas in the Deir Amar plant in 2010 thus consuming 40% less diesel oil, 2) the increase in hydropower production by 34% from 2009 to 2010 and 3) the decrease in production of the Tyre plant (consuming 30% less gas diesel oil).

The trend in total emissions for the time-series 1994-2018 is also influenced by increase in emissions from the transport sector by a factor of 5.7 reaching 7.4 million tonnes CO_2eq. (7,400 Gg CO_2eq.) in 2018, mainly due to the increase in the vehicle fleet by a factor of 5 during the same period.

The trend in emissions from Industrial Processes and Product Use (IPPU) also witnessed an increase during the period 1998-2018 (average +37%), due to the addition of emissions of F-gases which were calculated for the first time in this BUR4 submission, as presented in Figure 14.

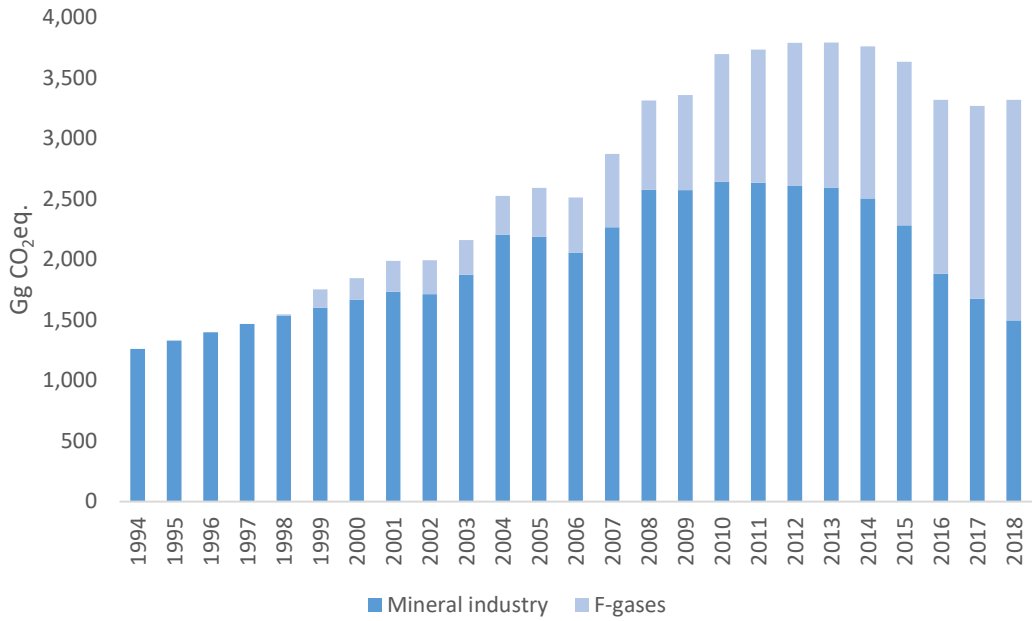


Figure 14: Trend of emissions from Industrial Processes and Product Use

3.5 Uncertainty assessment

Decision 17/CP.8 (UNFCCC-COP 8, 2002), encourages non-Annex I Parties to the UNFCCC to provide information on the level of uncertainty associated with inventory data and their underlying assumptions, and to describe the methodologies used, if any, for estimating these uncertainties. Accordingly, Lebanon has calculated the uncertainty of its national inventory and is for the first time, reporting the results in this 4th BUR.

The IPCC 2006 Guidelines define uncertainty as 'the lack of knowledge of the true value of a variable that can be described as a probability density function characterizing the range and likelihood of possible values". Uncertainty depends on the analyst's state of knowledge, which in turn depends on the quality and quantity of applicable data as well as knowledge of underlying processes and inference methods.

Uncertainty analysis is a key component both of National GHG Inventory and National Inventory Systems and an element of good practice in national greenhouse gas inventory development. It helps to prioritize improvements of future inventories and to guide decisions on methodological choice (IPCC, 2000). In the inventory, quantitative measures of the uncertainty are performed by estimating the 95 percent confidence interval of the emissions and removals for individual categories, the total inventory and the inventory trend.

Uncertainty estimates are done at different inventory levels (from inputs data, to the national annual estimates of emissions or removals, and emissions or removals trends) using appropriate methods based on the IPCC Good Practice Guidances (IPCC, 2000; 2003), and the IPCC 2006 Guidelines (IPCC, 2006). Sectoral Experts investigated the uncertainty parameters coming under their field of work

In the BUR4, the uncertainty analysis performed includes all categories of emissions and removals reported in the 2018 National Greenhouse Gas Inventories for the three relevant direct GHGs CO_2, CH_4 and N_2O. The analyses do not include the emissions of HFCs, PFCs, and SF6 reported. The uncertainty analysis

was performed following the estimation of emissions and removals for all categories evaluated and the overall inventory for 2018, and prior to carrying out the identification of key categories.

The estimated overall uncertainty total inventory reached 12% in 2018, with the corresponding uncertainty in trend 1994-2018 estimated to 171%. Details of uncertainty calculation are presented in Annex I.

Uncertainties for the input data in this report were initially associated to the following main general sources:

a) Direct determination of estimation parameters,

b) Model outputs,

c) Activity data gathered for the inventory from national sources,

d) Estimation parameters and activity data obtained from published references including the IPCC

e) Expert judgment

The activity data and its uncertainties are classified into four general types and about twenty subtypes (according to the inventory sector) with its corresponding identification numbers.

I. National activity data gathered from national data providers and other sources including reports and national published references.

II. International data sources: Basically, obtained from international agencies and organizations, selected from national GHG inventories of other countries, international published references etc.

III. IPCC activity data. Data provided in the IPCC Guidelines (1996 and 2006) and the IPCC Good Practice Guidances (2000 and 2003).

IV. Other activity data. Obtained from other sources or estimated using expert judgment.

The uncertainty values for the activity data used in this report were obtained mainly from the general types I (54%), II (16%) and IV (29%) above (this last basically derived from expert judgment). Similarly, the estimation parameters used in the inventory and its uncertainties were classified into four general types and about twenty subtypes with its corresponding identification numbers.

I. Country-specific estimation parameters obtained from international and national peer reviewed journals, reports, measurement and monitoring data, academy/research institutions etc.

II. International estimation parameters obtained from international peer-reviewed journals, international agencies and organizations, taken from other recognized international methodologies or national inventory reports etc.

III. IIPCC estimation parameters (basically default values) provided in the IPCC Guidelines (1996 and 2006), the IPCC Good Practice Guidances (2000 and 2003) and the IPCC EFDB.

IV. Other estimation parameters. Obtained from other sources or estimated using expert judgment.

The uncertainty values for the estimation parameters used in this report mostly (67%) correspond to the default uncertainty values provided in the IPCC Good Practice Guidance 2000 and 2003 and the 2006 IPCC Guidelines (Type III). A 31% was taking (or they helped select the default IPCC recommended value) from international sources, fundamentally national GHG inventories of other countries (Type II).

For some categories and estimation parameters in which the IPCC Guidelines and Guidances suggest wide uncertainty ranges especially towards the upper bound, a comparison was made with uncertainty ranges reported in the National Inventory Reports submitted in 2018 by several non-Annex I Parties as support for

the selection of the range to be used in the analysis. However, the suggested default IPCC ranges of uncertainty only were modified in some estimation parameters which are quite different from the uncertainty ranges mostly used in other inventories (especially the upper bound) or appear to be too high or too low.

In most of the inventory categories assessed in this inventory, the Tier 1 approach was applied, mainly based in the simple expression 1 (using only one single value for activity data and estimation parameter). For these categories the combined uncertainty for the GHG emission or removal was estimated directly from the uncertainty values for the activity data and estimation parameter.

Once the uncertainties in the categories were determined, they were combined to provide uncertainty estimates for the inventory year 2018 as a whole and for the overall inventory trend over time. That combination was performed based on the simple error propagation equations. These uncertainty calculations were undertaken with a spreadsheet tool prepared according to the Approach 1 as outlined in the IPCC Good Practice Guidances (2000 and 2003) and the 2006 IPCC Guidelines.

3.6 Recalculations

According to the IPCC 2006 guidelines, it is good practice to recalculate historic emissions so that the entire time series of emissions when errors in the estimates are identified and corrected with the availability of new activity data or emission factors and when there is methodological changes or refinements, which is the case of Lebanon.

In BUR4, slight recalculations were made, specifically in transport where the activity data related to the fleet was updated for the time series 1994-2018 given the availability of new values and in the IPPU sector where new data related to the emission of F-gases and the use of Nitrogen in the medical sector were added.

The recalculation had no significant impact on the total emissions of Lebanon, with an average change of -0.4% over the time series. The main changes occurred in the IPPU sector, with a change of 24% between the time-series presented in the BUR3 and the one in BUR4, which was however countered by an average decrease of -4% in the energy emissions over the time-series (Figure 15 and Table 14).

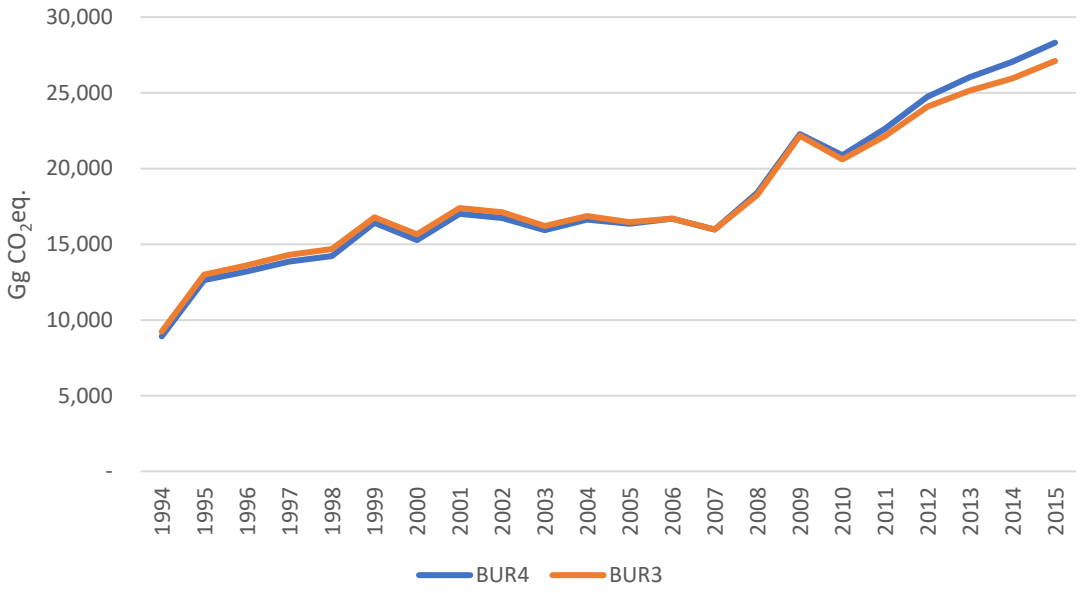


Figure 15: Impact of recalculation undertaken in the BUR4

Table 14: Impact of recalculation on the Lebanese GHG inventory

	Total GHG emissions (Gg CO_2eq.) *			
	BUR4	**BUR3**	**Difference**	**% Change**
1994	8,916.69	9,233.38	-316.69	-3%
1995	12,640.19	12,998.57	-358.37	-3%
1996	13,207.01	13,612.10	-405.09	-3%
1997	13,854.32	14,302.67	-448.35	-3%
1998	14,219.39	14,688.49	-469.10	-3%
1999	16,414.58	16,781.82	-367.25	-2%
2000	15,274.58	15,660.21	-385.62	-2%
2001	17,007.99	17,383.10	-375.12	-2%
2002	16,740.49	17,106.35	-365.86	-2%
2003	15,934.83	16,210.33	-275.50	-2%
2004	16,622.69	16,862.88	-240.19	-1%
2005	16,360.50	16,463.46	-102.95	-1%
2006	16,688.21	16,694.74	-6.53	0%
2007	15,981.50	15,970.34	11.16	0%
2008	18,396.76	18,256.67	140.09	1%
2009	22,264.57	22,167.27	97.30	0%
2010	20,874.10	20,605.47	268.63	1%
2011	22,625.49	22,154.60	470.88	2%
2012	24,756.87	24,100.43	656.44	3%
2013	26,035.98	25,150.24	885.75	4%
2014	27,060.87	25,953.74	1107.12	4%
2015	28,316.33	27,107.65	1208.68	4%
Average change for the time series.				-0.39%

3.7 Comparison between the sectoral approach and the reference approach

According to the IPCC 2006 guidelines, carbon dioxide emissions from the energy sector should be calculated using both the reference and the sectoral approach. The reference approach is based on detailed data on primary energy consumption, which leads to the calculation of apparent consumption of fuel and to the consequent calculation of emissions, while the sectoral approach is based on a detailed disaggregation of energy consumption by sector and fuel for the calculation of CO_2 emissions.

The Reference Approach and the Sectoral Approach often have different results because the Reference Approach a top-down approach using a country's energy supply data and has no detailed information on how the individual fuels are used in each sector. Typically, the gap between the two approaches is relatively small (5% or less) when compared to the total carbon flows involved.

In Lebanon, carbon dioxide emissions for the energy sector are calculated according to the two methodologies. In the reference approach, stock change was only considered for Energy Industries (fuel oil and gas/diesel oil) where stock data was made available for each power plant. For other fuels, stock change was not taken into consideration due lack of data. Therefore, it was assumed that all fuel imported are consumed within the same calendar year.

As shown in Table 16, the difference between the 2 approaches in 2018 is 1.46%. The existing difference results mainly from:

1) transport activity data where the amount of gasoline and diesel consumed in 2018 are the main source of the gap between the 2 approaches,

2) the difference between the emission factors (reference approach uses carbon content of fuel whereas the sectoral approach uses CO_2 emission factor).

Table 15: Energy emissions using the reference approaches for 2018

Fuel (in Gg)	Production	Imports	Exports	International Bunkers	Stock change	Actual CO_2 Emissions (Gg CO_2)
Motor Gasoline		1,986.4				5,988.10
Jet Kerosene		263.76		263.76		-
Gas/Diesel Oil		3,426.14			-590.72	12,376.64
Heavy Fuel Oil		2,047.97		36.6		6,353.69
LPG		204.37				609.65
Bitumen		105.56				-
Lubricants		43.1				-
Petroleum Coke		438.94				1,511.24
TOTAL						**26,839.31**

Table 16: Difference between reference and sectoral approach

	CO_2 emissions (Gg)	% Difference
Reference approach	26,839.31	1.46%
Sectoral approach	26,452.46	

3.8 Indirect GHG emissions

Lebanon reports its indirect emissions under this Fourth Biennial Update report for the period 1994-2018, using sectoral activity data and the European Monitoring and evaluation Programme EMEP 2019 emission factors (EMEP, 2019). The role of carbon monoxide (CO), nitrogen oxides (NO_x) and non-methane organic volatile compounds (NMVOC) is important for climate change as these gases act as precursors of tropospheric ozone. In this way, they contribute to ozone formation and alter the atmospheric lifetimes of other greenhouse gases. These gases are generated through a variety of anthropogenic activities. Emissions trends for indirect greenhouse gases and SO_x (reported as SO_2), presented in Table 17 and

Energy Transport IPPU Agriculture FOLU Waste

Figure 16.

Calculations have identified on-road transport as the main source of carbon monoxide (CO) and non-methane volatile organic compound (NMVOC) and power plants as the main source of SO_2. Emissions of NO_x are generated from both the energy and transport sector at equal rates due to the old age and lack of maintenance of the vehicle fleet as well as power plants, in addition to the increase of the use of private generators to overcome power shortages.

Table 17: Indirect Emissions for Lebanon 1994-2018

(Gg)	1994	2000	2005	2010	2015	2018
CO	117.15	154.65	176.87	212.89	251.16	273.86
NO_x	52.53	62.37	63.70	89.07	130.67	141.66
SO_2	27.09	33.61	32.00	35.92	42.08	50.97
NMVOC	16.93	22.59	26.54	33.19	48.58	48.34

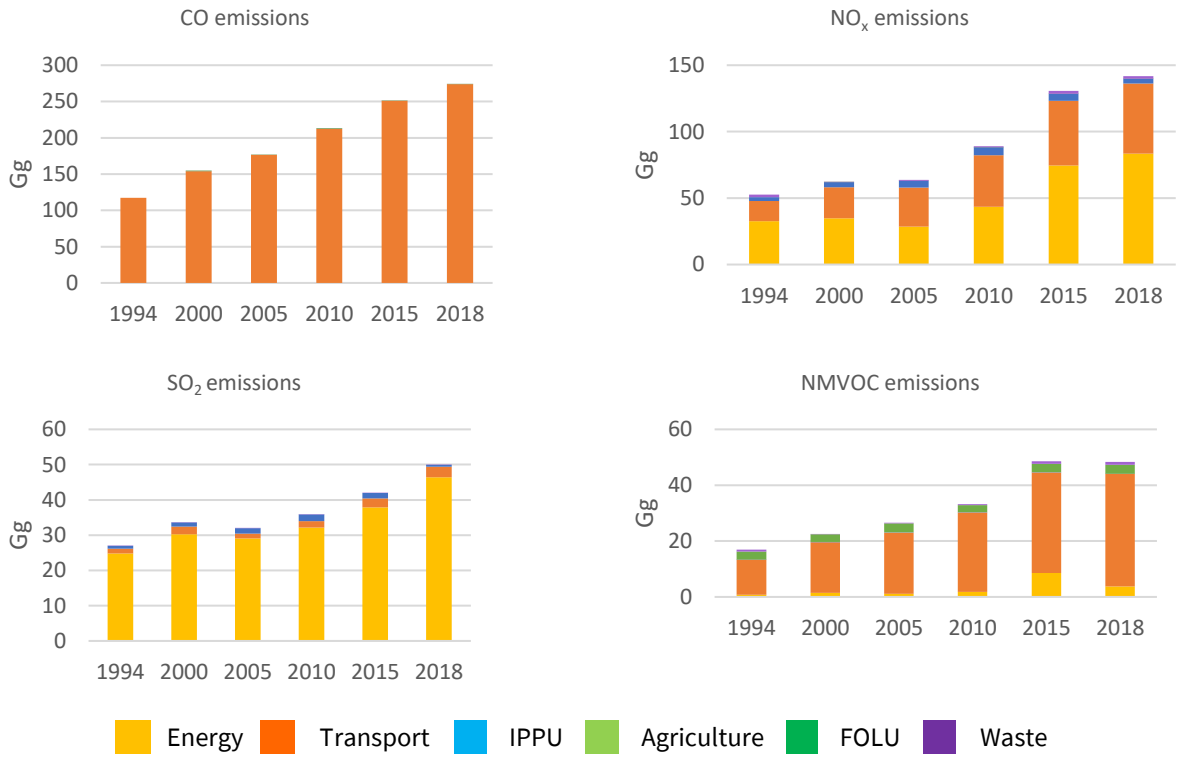


Figure 16: Emissions of indirect GHGs per category

During the period of 1994-2018, NO_x emissions from energy production activities (energy industries, manufacturing industries, commercial/institutional, residential and agriculture/forestry/fishing) increased 2.5 folds mainly from the increase in reliance on private generators, as captured in the Manufacturing industries and Commercial/institutional sectors. Indeed, electricity supply by the public utility Electricité du Liban (EDL) is insufficient to meet the country's growing demand. The energy deficit is driven by inefficiency of thermal power plants, the high technical losses and non-technical losses as well as the additional power demand for the Syrian displaced. The balance of demand is partially satisfied by diesel-fired private generators connected to a have a separate parallel network at the neighborhood level, where it is estimated that 85% of households rely on these private generators (SOER, 2020).
Compared to EDL, studies have shown that private generators emit 6.3 times more CO, 2.2 times more PM2.5, 1.5 times more PM10 and a comparable amount of NO_x (analysis of Waked et al., 2012 results).
Figure 17 and Figure 18 present NOx emissions per sub-category and fuel type, as calculated for this inventory.

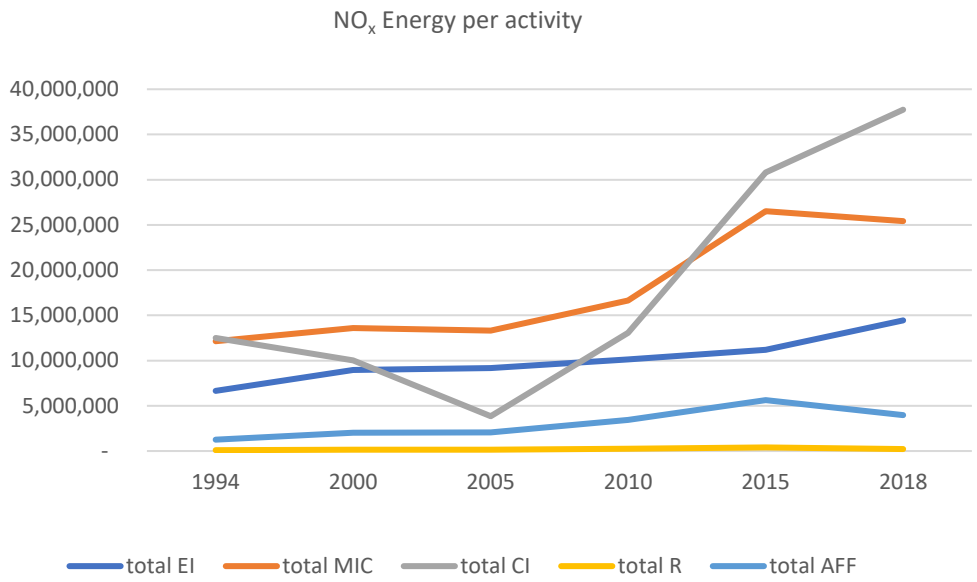


Figure 17: NO_x Emissions per Energy sub-categories

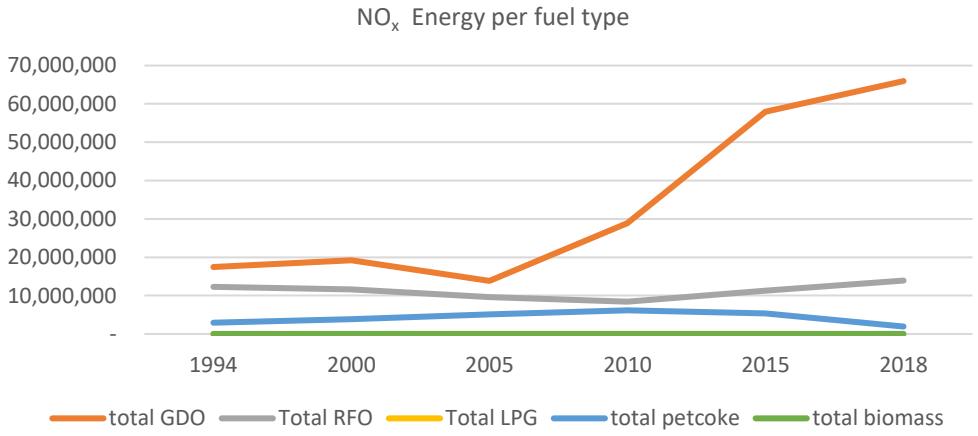


Figure 18: NO_x Emissions per Energy fuel types

Transport is one of the main sources of emissions of Indirect gases, namely CO, NO_x and NMVOCs. As presented in Table 18, passenger cars dominate the exhaust emissions of the different gases, up to a share of almost 75% for CO, followed by LDV for CO, NMVOC, and SO_2, while HDV follow for NO_x with a share of 26.92%. Motorcycles have a considerable share in NMVOC exhaust emissions of 11.15% (Table 18 and Figure 19).

Table 18: Transport sector's indirect GHG emissions for 2018

Category	CO (Gg)	NO_x (Gg)	NMVOC (Gg)	SO_2 (Gg)
1.A.3 - Transport	273.72	51.60	40.52	2.16
1.A.3.a - Civil Aviation	1.13	2.82	0.56	0.25
1.A.3.b - Road Transportation	272.59	48.77	39.95	1.91
1.A.3.b.i - Cars	192.06	27.53	20.16	1.54
1.A.3.b.i.1 - Passenger cars and taxis with 3-way catalysts	14.20	1.33	1.45	0.76
1.A.3.b.i.2 - Passenger cars and taxis without 3-way catalysts	177.86	26.20	18.71	0.78
1.A.3.b.ii - Light-duty trucks and vans	70.34	8.02	8.97	0.35
1.A.3.b.ii.1 - Light-duty trucks and vans with 3-way catalysts	6.58	0.30	0.37	0.11
1.A.3.b.ii.2 - Light-duty trucks and vans without 3-way catalysts	63.76	7.73	8.60	0.24
1.A.3.b.iii - Heavy-duty trucks and buses	3.60	13.13	1.27	0.01
1.A.3.b.iv - Motorcycles	6.60	0.08	3.81	0.02
1.A.3.b.v Evaporative emissions from vehicles	0	0	5.73	0

The annual growth in emissions from road transport fluctuated between 2.0 and 6.9% for CO, -5.9% and 10.5% for NO_x, 2.4% to 8.5% for NMVOC, and -172.6% to 12.9% for SO_2. The growth in emissions did not follow identically the growth in vehicle stock; this is a natural consequence to the advancements in reduction of consumption and emissions of new vehicles with emission control technologies. This was reflected in the decrease of the emission factors over the 1994-2018 period (Figure 20). However, this technology advancement in emission savings did not reduce the fleet average emissions in a way to offset the increase in registered vehicles (Figure 21). The decrease in NO_x emissions in 2018 is due to a lower mileage travelled by the diesel propelled vehicles, i.e. Heavy Trucks and buses. Two sharp decreases in SO_2 emissions in 2002 and 2017 are driven by more stringent regulations of sulfur content in gasoline and diesel in 2002 and only in diesel in 2017.

Over the time series 1994-2018, the transport pollutants emissions increased by 2-3 folds from 117 Gg to 273 Gg for CO, 15 Gg to 49 Gg for NO_x, 13 Gg to 42 Gg for NMVOC, and 1.1 Gg to 1.9 Gg for SO_2. Despite its small share in the vehicle stock, the freight emissions increased on average by a factor of 5 in 2018 compared to 1994 except for SO_2 which decreased to more than two-thirds of the 1994 emissions. On the other hand, SO_2 emissions from private passenger cars and taxis contributed to 62.6% in 1994 and increased to 80.4% in 2018. On the other hand, NMVOC evaporative emissions increased from 1.17 Gg in 1994 to 5.73 Gg in 2018 due to the increase in the number of registered vehicles.

Figure 19: Emissions distribution per type of vehicle for the indirect GHG in 2018

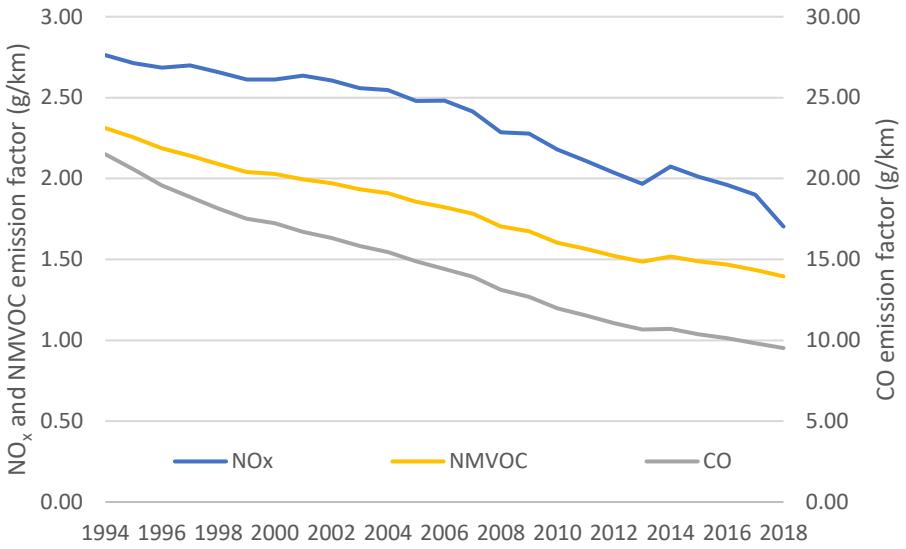


Figure 20: Trend of the indirect GHG emission factors

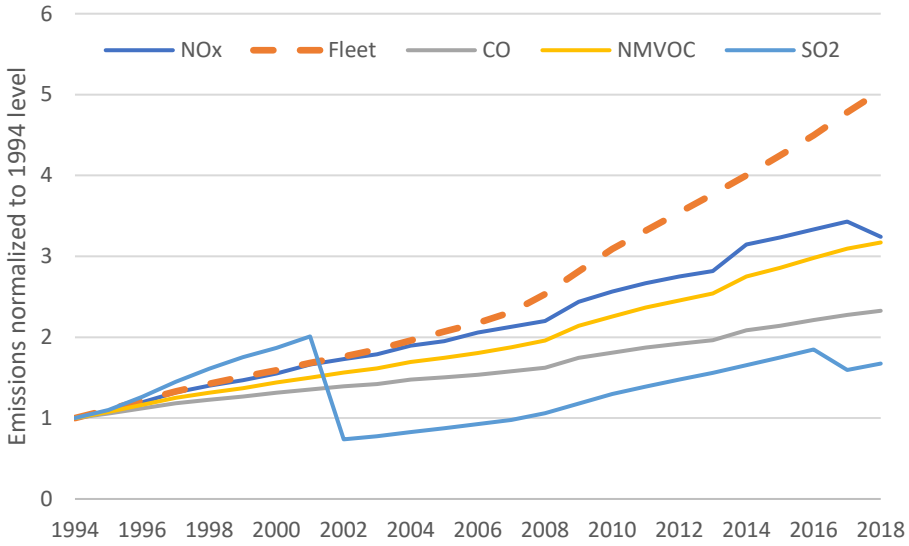


Figure 21. Trend in fleet and emissions growth from 1994 to 2018

3.9 Breakdown of emissions by IPCC sector for 2018

1. Energy

According to the IPCC 2006 guidelines, the source category "Energy" covers all combustion sources of CO_2, CH_4 and N_2O emissions (1.A), fugitive emissions associated with the production, transport and distribution of fossil fuels (1.B) and Carbon Dioxide transport, injection and geological storage (1.C). Since no oil production activities, refineries or gas pipelines exist in the country, and Carbon Capture and Storage activities are undertaken, therefore emissions from (1.B) and (1.C) are reported as Not Occurring (NO) in the inventory reporting tables.

Fuel combustion activities (1.A) are divided in two main categories, on the basis of the characteristics of the methodology applied for the calculation of emissions:

- Stationary combustion, including energy industries, manufacturing industries and construction and other sectors (residential and commercial/institutional sectors and agriculture/forestry/fisheries) (Table 19).
- Transport, including domestic civil aviation, road transport, and domestic navigation (Table 20).

Table 19: Reporting categories under stationary combustion

Reporting categories		Description	Remarks	Methodology
1.A.1 Energy industries		Emissions from combustion of gas/diesel oil, heavy fuel oil and lubricants for electricity generation from thermal power plants. Emissions from the use of landfill gas for energy production.	Since lubricant is mixed with another fuel for co-combustion in the engine, the emissions are estimated and reported as in the Energy Sector.	Emissions are calculated based on the tier 1 methodology and disaggregated by power plant.
1.A.2 Manufacturing industries and construction		Emissions from combustion of gas/diesel oil, heavy fuel oil, petroleum coke and Liquefied Petroleum Gas (LPG) for electricity or heat generation for own use in industries.	Gas/diesel oil is considered to be used in private generators mainly for electricity production within the industrial facilities generators and in residential neighborhoods. Petroleum coke is only used by cement industries.	Emissions are calculated based on the tier 1 methodology.
1.A.3 Transport		Refer to Table 20		
1.A.4 Other sectors	1.A.4.a. Commercial and institutional sector	Emissions from combustion of gas/diesel oil for electricity generation and space heating and LPG for cooking activities in commercial and institutional buildings.	Gas/diesel oil is considered to be used for electricity production from generators. Fuel consumed by neighborhood generators is considered under this category.	Emissions are calculated based on the tier 1 methodology.

	1.A.4.b. Residential sector	Emissions from combustion of gas/diesel oil, LPG, and biomass fuel for space heating and cooking activities.		Emissions are calculated based on the tier 1 methodology.
	1.A.4.c. Agriculture, forestry and fisheries	Emissions from combustion of diesel oil for stationary and mobile activities related to in agriculture, forestry and fishing.	Gas/diesel oil is considered to be used in fishing boats and off-road vehicles.	Emissions are calculated based on the tier 1 methodology.

Table 20: Reporting categories under mobile combustion (1.A.3)

	Reporting categories	Description	Remarks	Methodology
1.A.3.a Aviation	1.A3.aii. International Aviation *International bunkers*	Flights that depart in one country and arrive in a different country.	Emissions are not included in national totals, as they are reported under international bunkers.	Emissions from international aviation are calculated based on the tier 1 methodology.
	1.A.3.aii. Aviation	Military helicopters; civil, commercial aircrafts; and private jet- and propeller-type aircrafts.	Emissions from military aircrafts are not calculated due to the confidentiality of activity data for military case. Jet gasoline used only in Cessna jets is considered.	Civil, aviation emissions are calculated based on the tier 1 methodology.
1.A.3.b. Road transport		On-road vehicle technologies rely on gasoline and gas/diesel internal combustion engines. The fleet encompasses motorcycles, passenger cars, taxis, vans, buses and trucks.	Road transport is the only mobility mean considered under land transport.	Emissions are estimated using the tier 2 methodology based on the number of vehicles per category and their activity in terms of distance driven, fuel consumption and vehicle technology.
1.A.3.c. Railways		Activity reported as Not Occurring in Lebanon		
1.A.3.d Waterborne Navigation	1.A.3.d.i. International waterborne navigation *international bunkers*	Vessels of all flags that are engaged in international water-borne navigation	Emissions are not included in national totals, as they are reported under international bunkers.	Emissions from international navigation are calculated based on the tier 1 methodology.
	1.A.3.dii. Domestic waterborne navigation	Vessels that depart and arrive in the same country.	Emissions from military navigation are not calculated due to the unavailability of activity data for military case.	Emissions from domestic navigation are calculated based on the tier 1 methodology.

		Emissions from fishing are not reported under transport, but rather under the 1A4ciii, agriculture/forestry /fisheries category of the energy sector.

Due to the absence of an energy balance for Lebanon, and the absence of adequate information on specific carbon content of the imported fuel, the tier 1 methodology was used for the calculation of the power-related categories.

In the transport sector, due to the unavailability of default tier 2 values as per the 2006 IPCC guidelines and the absence of country-specific emission factors, the tier 1 methodology was adopted for the calculation of CO_2 emissions from road transport for BUR4. The Tier 2 methodology was however used for the calculation of emissions of CH_4 and N_2O where respective emissions factors are disaggregated by vehicle technology, fuel and operating conditions.

1.A.1 Energy industries

Methodology

The category covered under 1.A.1 energy industries is 1.A.1.a.i electricity generation. The remaining categories such as 1.A.1.B petroleum refining and 1.A.1.c. manufacture of solid fuels are reported as not occurring.

In Lebanon, the category 1.A.1 energy industries considers all heavy fuel oil and gas/diesel oil consumed by public thermal power plants to generate electricity, including the 2 rented power barges located in Zouk and Jiyeh. Emissions from lubricant use for co-combustion and, since 2017, emissions from the use of the Naameh landfill gas for energy production, are included under this category.

Emissions from purchases of electricity from Syria are not accounted in the national totals.

Although this category is a key category under the level and trend assessments, tier 1 methodology is used with annual fuel consumption per power plant as activity data, fuel-specific NCV and default emission factors. The inventory team is making efforts in estimating the carbon content of the imported fuel to be able to use a higher tier. Improvements will be reported in subsequent inventories.

Activity data, emission factors and other parameters

The amounts of fuel consumed in power plants and barges as well as the annual stock has been provided by Electricité du Liban (EDL) for the years 2016-2018, disaggregated per power plant and per fuel type. The amount of electricity being generated by the recovery of the landfill gas of the Naameh landfill has been provided by the Ministry of Energy and Water.

The amount of lubricants is provided by the Lebanese Customs database (HS Code 2170.19.90; by net weight of import). Since insignificant amounts of lubricants are used in industries and other facilities, it is assumed that all imported lubricants are consumed by EDL power plants in co-combustion processes.

Due to the lack of country specific emission factors and emissions measurements, default emission factors for CO_2, CH_4 and N_2O have been used based on the 2006 IPCC Guidelines. Fuel-specific Net Calorific Value

(NCV) have been used, as provided by the Ministry of Energy and Water. The oxidation factor is estimated as 1, since at tier 1, the emission factors assume that 100% of the carbon present in fuel in oxidized during or immediately following the combustion process.

Table 21: Fuel consumed by 1.A.1 Energy Industries

1,000 tonnes	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Gas Diesel oil	49	215	382	548	715	881	533	573	745	826	842	782	1,058
Heavy Fuel oil (Grade A&B)	1,124	1,142	1,161	1,180	1,199	1,217	1,294	1,355	1,238	963	962	1,219	957
Lubricants	0	6	13	19	25	31	38	37	27	28	33	34	30

1,000 tonnes	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Gas Diesel oil	849	1,260	1,133	994	1,306	1,320	1,175	1,245	1,295	1,290	1,177	1,281
Heavy Fuel oil (Grade A&B)	1,071	1,077	1,228	1,283	1,187	988	1,183	1,371	1,328	1,523	1,833	1,975
Landfill Gas	34	34	34	37							7.17	11.27
Lubricants					35	41	41	40	41	47	43	34

Table 22: General parameters by fuel type

Fuel type	Net calorific value (TJ/ktonnes)	Fuel density (kg/TJ)	Fraction of carbon stored**
Gasoline	43.50*	0.74	0
Jet kerosene	42.80*		0
Diesel oil	41.60*	0.83	0
Heavy fuel oil	41.10*		0
Heavy Fuel oil for EDL power plants	40.83**		
LPG	47.31		0
Lubricants	40.19		1
Bitumen	40.19		1
Petroleum coke	35.30*		0
Biomass	15.6		0
Landfill gas	50.4		0

*Country specific values
** Country specific value-weighed average of NCV for Grade A and Grade B fuel oil
** Assumption is made that no carbon is stored, except for bitumen and lubricants, as per the IPCC default values
Source | table 1.2 page 1.18 chapter 1 volume 2 IPCC, 2006 guidelines

Table 23: CO_2, CH_4 and N_2O emission factors for 1.A.1 Energy Industries

	For all categories	Energy Industries	
Fuel type	**CO_2 emission factor (kg/TJ)**	**CH_4 emission factor (kg/TJ)**	**N_2O emission factor (kg/TJ)**
Diesel oil	74,100	3	0.6
Heavy fuel oil	77,400	3	0.6
Lubricants	73,300	3	0.6
Landfill gas	54,600	1	0.1

Source | table 2.2 page 2.16 chapter 2 volume 2, IPCC 2006 guidelines

1.A.2 Manufacturing industries and construction

Methodology

The manufacturing industries and construction category (1.A.2) includes fuel consumption for the following activities:

1- Production of electricity: the industrial sector is one of the major energy consuming sectors in Lebanon. However, due to the intermittent electricity supplied by EDL and the constant power shortages, most industries in Lebanon generate their own energy from in-house generators. Gas/diesel oil is bought either directly from the Ministry of Energy and Water or from private fuel distributors and are used in the premises. It is assumed that 50% of the diesel oil used for private generation is destined for industrial use.

2- Production of steam and process heat by industries: Industries also use heavy fuel oil, LPG and petroleum coke (only cement industries) as feedstock, in the manufacturing process or for the production of steam and heat.

Although this category is a key category under the level and trend assessments, tier 1 methodology is used, and the emissions are reported under 1.A.2.m unspecified industries given the absence of disaggregated data per industry in Lebanon. The inventory team is making efforts in estimating the carbon content of the imported fuel to use a higher tier.

Activity data

The activity data required for the calculation of GHG emissions from this category is the annual consumption (in tonnes) of each type of fuel used in the industrial sector. Values, assumptions, and source of data represented in Table 24.

Table 24: Fuel consumption in 1.A.2 Manufacturing Industries and Construction

Fuel type	Source of data	Assumptions	Activity data 2018 (1000 tonnes)
Heavy fuel Oil (HFO)	Ministry of Energy and Water	$HFO_{MIC} = HFO_{import} - HFO_{EDL} - HFO_{bunkers}$ Where: HFO_{MIC}= HFO consumed by industries HFO_{import} = Total HFO imported in year Y HFO_{EDL}= HFO delivered to EDL in year Y $HFO_{bunkers}$= HFO consumed for international navigation	**140.56**
Gas/Diesel oil (GDO)	Ministry of energy and water Own calculation	$GDO_{MIC} = GDO_{PG}/2$ + stock $GDO_{PG} = GWh_{PG} * CF$ Where: GDO_{MIC}= GDO consumed by industries GDO_{PG} = GDO consumed for private generation Stock = estimated stock of fuel from Y-1 GWh_{PG}= electricity generated by private generators CF = Conversion factor, 0.232 Gg DO/GWh It is assumed that 50% of private generation takes place at the industrial level and 50% at the commercial/institutional level.	**963.05**
Petroleum Coke	Lebanese Customs Database (ISIC code 2713)	It is assumed that the quantity imported in one year is being consumed during the same calendar year.	**438.94**
Liquified Petroleum Gas (LPG)	Ministry of energy and water IPTEC	$LPG_{MIC} = LPG_{import} \times 9\%$ Where: LPG_{MIC}= LPG consumed by industries LPG_{import} = Total LPG imported in year Y In 2018, IPTEC estimated that 9% of imported LPG is consumed by the industrial sector.	**17.98**

Box 5: Estimation of electricity generation by private generation

The electricity sector in Lebanon suffers from a chronic shortage of power supply which has been met by private diesel generators. Although there are no accurate data on the number, distribution, capacity or annual generation, recent studies have estimated that in 2018, around 36 to 45%[1] of electricity demand is being met by private generators (Ali, 2020; World Bank, 2020c).

The "Lebanon Power Sector Emergency Action plan 2020", prepared by the World Bank/ the International Bank for Reconstruction and Development estimated that EDL supplied 55-64% of Lebanon's electricity needs in 2018, and that the balance of electricity needs was supplied by private diesel generators. This can indicate that 36 to 45% of Lebanon's electricity demand is being met by private generators (World Bank, 2020c).

Concurrently, the study on "Distributed Power Generation for Lebanon: Market Assessment and Policy Pathways" prepared in 2020 by the World Bank estimated that the percentage of electricity demand unmet by Électricité du Liban (EDL) has increased from 22% in 2008 to 37% in 2018. This gap between the power supplied

by EDL and demand is covered by private diesel generators that are dispersed almost everywhere in the country. Based on an estimated electricity supply of 13.5 TWh supply, a demand of 22 TWH and a private generation of 8.1 TWh in 2018, it can be concluded from the study that 36.8% of the demand is being met by private generators (Ali, 2020).

To validate this number, a separate analysis was conducted by the climate change team at the Ministry of Environment using MoEW data on electricity generation and demand (MoEW, 2020). Based on an electricity supply of 15,131 GWh (production and purchase), a demand of 23,089 GWh (MoEW, 2020) and technical losses of 17% (4% transmission losses, 13% distribution losses), and assuming that 80% of the Energy-Not-Supplied is being met by generators, calculations reveal that 36.5% of Lebanon's electricity demand has been met by private generators in 2018.

[1] *range depends on which electricity demand assumption is used.*

Box 6: IPT Energy Center (IPTEC) database on distribution of petroleum product per end use

In the absence of accurate data on the distribution of fuel use (mainly gas/diesel oil and LPG) per end consumer (industrial, commercial, residential, agricultural sector), the Ministry of Environment/UNDP climate change team established in 2013 a long-term collaboration with the IPT Energy Center (IPTEC) to acquire data and estimates of these shares. Consequently, every year IPTEC collects and shares data on the petroleum products sales per type and per consumer of all its IPT gas stations in Lebanon.
IPT is one the 13 licensed oil importers in Lebanon and has a network of 180 gas stations, representing around 10% of registered service stations. The Ministry of Environment/UNDP climate change team joined forces with IPT to estimate the distribution of petroleum product per user due to the diversity of the services they provide to their clients (including distribution of LPG, diesel for private generation and diesel for residential and commercial heating), the geographical distribution of their stations (rural and urban, coastal and mountainous areas), their digitized database and most importantly, their willingness to cooperate. In addition, the database is shared with and validated by the Association of Petroleum Importers Companies in Lebanon on an annual basis.

Emission factors and other parameters

Default emission factors from the 2006 IPCC guidelines are used, as presented in Table 25.

Table 25: CO_2, CH_4 and N_2O emission factors for 1.A.2 Manufacturing Industries and Construction

	For all categories	**Manufacturing industries and construction**	
Fuel type	**CO_2 emission factor (kg/TJ)**	**CH_4 emission factor (kg/TJ)**	**N_2O emission factor (kg/TJ)**
Diesel oil	74,100	3	0.6
Heavy fuel oil	77,400	3	0.6
LPG	63,100	1	0.1
Petroleum coke	97,500*	3	0.6

Source | table 2.3 page 2.18- 2.19 chapter 2 volume 2, IPCC 2006 guidelines

1.A.3 Transport

Methodology

The categories included under the transport category are 1.A.3.a civil aviation, 1.A.3.b road transport and 1.A.3.d navigation. The remaining categories such as 1.A.3.c railways and 1.A.3.e other transportation are reported as not occurring.

Road transport (1.A.3.b) covers all internal combustion vehicles used for passengers and goods mobility in Lebanon, except farm tractors and public-work vehicles (considered under the energy sector 1.A.4.c Agriculture/Forestry/Fishing). Types of vehicles investigated in this inventory are motorcycles, passenger cars, taxis, vans, buses and trucks, classified into categories in accordance with the guidelines: motorcycles, Passenger Cars (PC), Light-Duty Vehicles (LDV), and Heavy-Duty Vehicles (HDV) (Table 26). After banning the use of diesel for vehicles with gross weight lower than 3,500 kg in Law 341/2001 and Decree 341/2002, passenger cars, light-duty vehicles and motorcycles run only on gasoline, while heavy-duty vehicles running on diesel. It is worth noting that some vans and taxis still run on diesel illegally, but their number is insignificant.

Table 26: Description of the vehicle categories used in the calculation of road transport emissions

Vehicle category	Description
Passenger Cars (PC)	Private personal gasoline cars and taxis used for mobility including Sport Utility Vehicles (SUV).
Light Duty Vehicles (LDV)	Gasoline Light Commercial Vehicles with rated gross weight less than 3,500 kg including light trucks designed for the transportation of cargo, and gasoline vans for the transportation of passengers.
Heavy Duty Vehicles (HDV)	Diesel Heavy Trucks vehicles with rated gross weight exceeding 3,500 kg designed for transportation of cargo and diesel buses for the transportation of passengers.
Motorcycles	Includes a mixture of 2-stroke and 4-stroke engines as well as mopeds having an engine less than 50cc.

For direct greenhouse gases, CO_2 emissions from road transport have been calculated using IPCC Tier 1 methodology since no information on the specific carbon content of the fuel used in transportation is available. However, Tier 2 technology-specific emissions factors have been used for the calculation of CH_4 and N_2O emissions, which depend largely upon the combustion and emission control technology present in the vehicle.

For indirect greenhouse gases, CO, NO_x, and NMVOC have been calculated for exhaust releases using EMEP/EEA Tier 2 technology specific. In addition to that, NMVOC emissions from diurnal emissions, running losses, and hot-soak emissions have been calculated using EMEP/EEA Tier 1 methodology. SO_2 emissions were calculated based on the regulatory limit of sulfur content in fuels.

Activity data, emission factors and other parameters

The following activity data is considered:

- The number of registered vehicles in Lebanon was provided by the Ministry of Interior and Municipalities/Traffic, Truck and Vehicle Management Authority for the years 2015-2018 (MoIM, 2020). The database includes the number of registered vehicles by category, type of use (private or public), production date, circulation date, horsepower, and type of fuel used (Figure 22). No

category is allocated for fuel-efficient vehicles in the MoIM database; therefore their share cannot be determined over the last few years.

- The vehicle fleet was classified per vehicle type, category and European Union (EU) emission control technology (Figure 23 and Figure 24) taking into consideration the common practice in Lebanon of removing the emission control catalyst without any replacement. The fraction of each vehicle category for which the catalyst was removed was obtained from a survey conducted in Beirut on 3,000 vehicles (Waked, 2012; Waked and Afif, 2012). The results from this survey were extrapolated to the rest of the vehicle fleet.
- Fuel consumed by each type of car by type of fuel is estimated based on:
  - Number of gasoline vehicles (cars, light duty vehicle, vans, motorcycles)
  - Number of diesel vehicles (assuming only heavy-duty vehicles and buses)
  - Average travelled distance
  - Fuel economy
  - Fuel density

Gas/diesel oil is only used by heavy-duty vehicles and buses. The amounts used per year were assumed based on average 29.9 l/100km and an annual mileage of 50,000 km/year. The amounts used by passenger cars (taxis in general), LDV, and vans are considered insignificant.

in 2018, the total number of vehicles was calculated at 2,034,501, categorized as presented in Table 27, Figure 22, Figure 23 and Figure 24.

Table 27: Lebanese fleet categories and numbers from 2016 to 2018

Year	PC	Taxi	LDV	Vans	HDV	Buses	Motorcycles	Total
2016	1,512,167	30,008	106,695	10,782	39,477	4,558	109,438	1,813,125
2017	1,593,355	31,299	116,331	11,457	42,487	4,857	127,643	1,927,429
2018	1,667,641	32,385	126,654	12,105	45,005	5,220	145,491	2,034,501

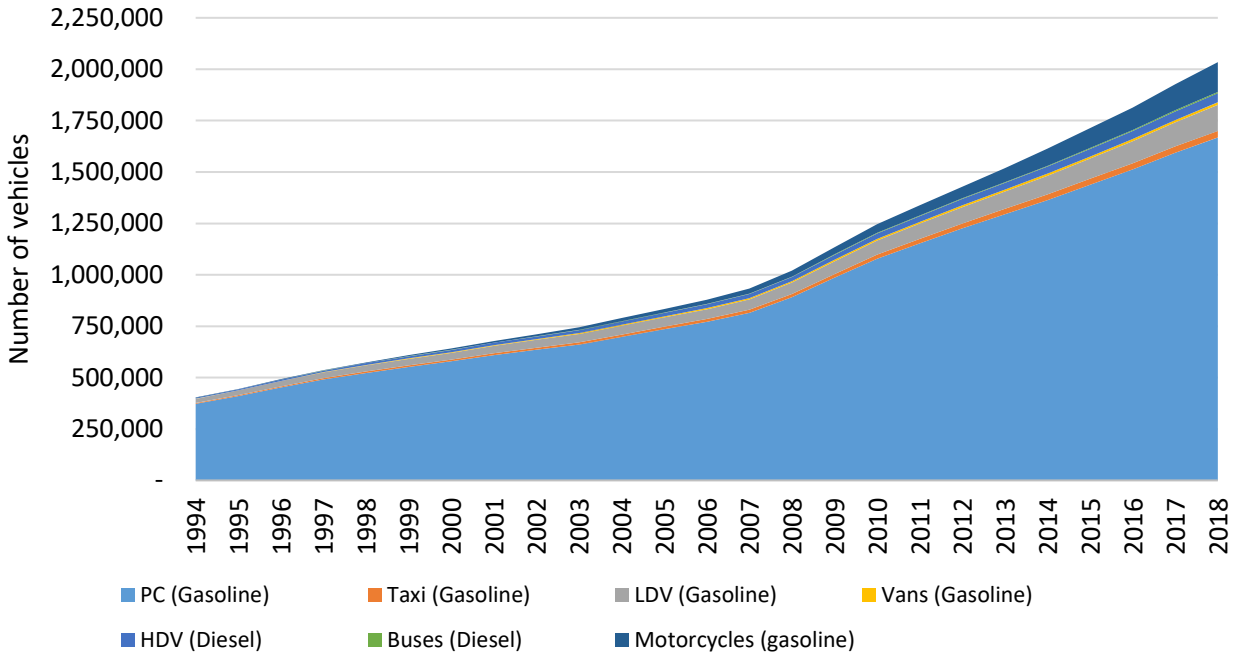


Figure 22: Classification of the Lebanese vehicle fleet per type

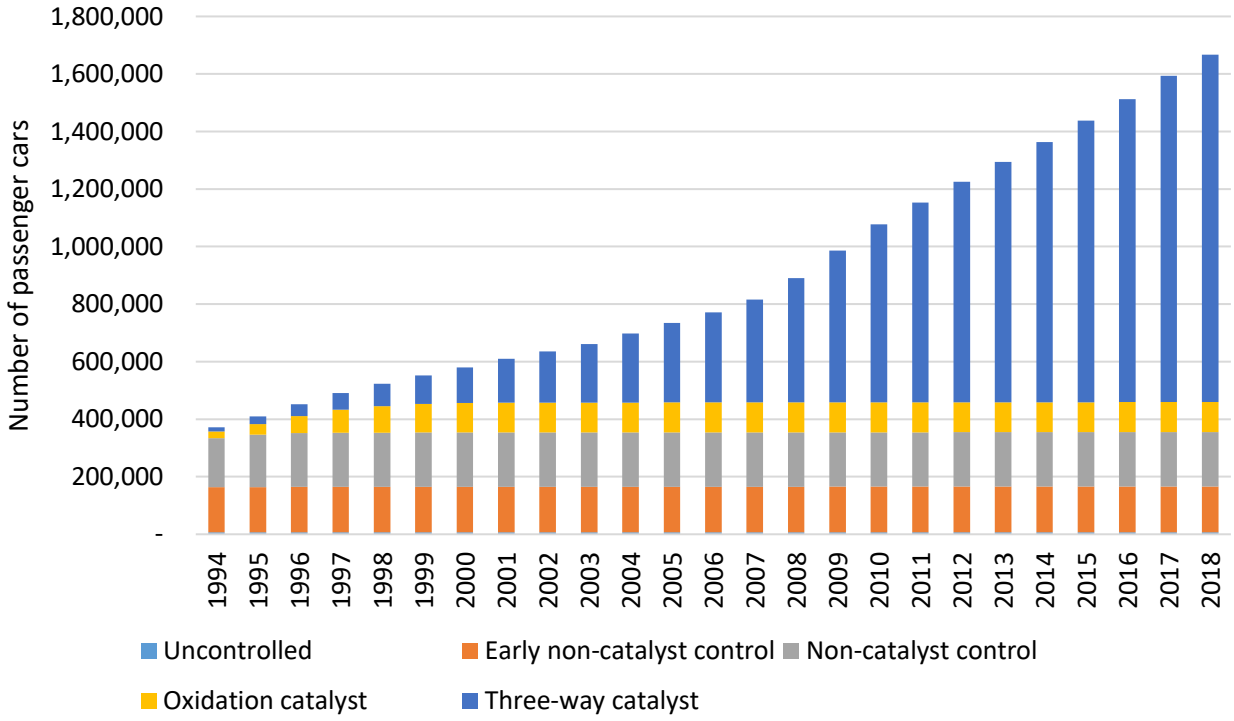


Figure 23: Classification of the passenger cars per emission reduction technology for IPCC

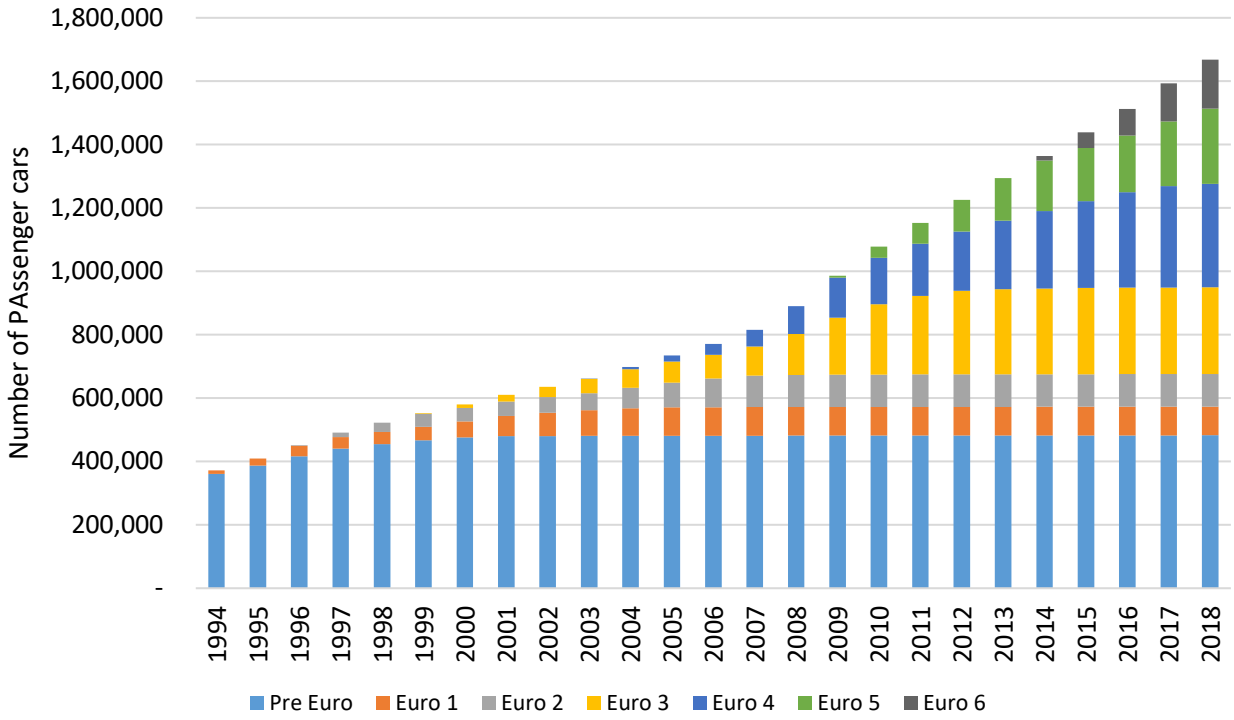


Figure 24: Classification of the passenger cars per emission reduction technology for Euro standards

- In the 2006 revised IPCC guidelines, the tier 1 emission factors are shown as a function of $kg_{emissions}/TJ_{fuelused}$. Therefore, the required activity data is fuel consumption per vehicle type and technology, which is estimated by determining the fuel efficiency, the annual travelled Kms for each vehicle and the NCV for each fuel type.
- In the EMEP/EEA 2019 guidelines, Tier 2 emissions factors are expressed in g of emitted pollutant per km driven for exhaust CO, NO_x, SO_2, and NMVOC. SO_2 emissions require the sulphur content in fuel per fuel type where regulatory limits were used (Decree 3054/2016 for from 2017-2019, Decree 8442/2002 for data from 2002 to 2016, and Second National Communication to UNFCCC sulphur content values for 1994 to 2001). Evaporated NMVOC from gasoline fuelled vehicles including diurnal emissions, running losses, and hot soaking were accounted for following the Tier 1 methodology for annual averaged temperatures of 10°C to 25°C which is expressed by unit of mass emissions per vehicle per day.
- Default CO_2 emission factors are used for each fuel type from the IPCC 2006 guidelines. For N_2O and CH_4 emissions, default EU emission factors per vehicle type and technology are considered since in Lebanon most of the vehicle fleet is constituted of European vehicles (Table 28 and Table 29).
- Default fuel consumption per vehicle type and per technology was used as per the ForFITS model for the direct GHGs (Table 30).
- HDV diesel consumption for the direct and indirect GHG is assumed to be 29.9 liter of diesel/100km, based on the data provided by IPT on their trucks fleet consumption, and double checked against the GREET Model default value (from Argonne National Laboratory) and compared to the results study conducted by VTT Technical Research Centre of Finland. The consumption value is averaged taking into consideration the loaded and unloaded truck trips.

- Due to field data unavailability, the annual travelled distance per vehicle category is considered using the ForFITS database. ForFITS is a modeling tool intended to evaluate the transport activity, energy use and CO_2 emissions, using transport data collected from different national and international transport related agencies (UNECE, 2014). For countries with mobility characteristics similar to Lebanon, a value of 12,000 km/year is estimated for private passenger cars, 50,000 km/year for taxis, 25,000 km/year for light commercial vehicles, 50,000 km/year for vans and heavy-duty vehicles, and 5,000 km/year for motorcycles.

Table 28: Default CO_2 emission factors for 1.A.3 Transport

Fuel type	CO_2 emission factor (kg/TJ)
Gasoline	69,300
Diesel oil	74,100

At tier 1, the emission factors assume that 100% of the carbon present in fuel in oxidized during or immediately following the combustion process.
Source | table 3.6.4 page 3.64 and table 3.5.2 page 3.50 chapter 3, volume 2, IPCC revised 2006 guidelines

Table 29: Default emission factors for CH_4 and N_2O emissions for 1.A.3 Transport

Type of vehicle	**CH_4 emission factor (kg/TJ)**	**N_2O emission factor (kg/TJ)**
Gasoline Private Passenger and Taxis cars		
Uncontrolled	33.00	3.20
Early non-catalyst control	33.00	3.20
Non-catalyst control	33.00	3.20
Oxidation catalyst	25.00	8.00
Three-way catalyst	3.80	5.7
Gasoline LCV and Vans		
Uncontrolled	33.00	3.20
Early non-catalyst control	33.00	3.20
Non-catalyst control	33.00	3.20
Oxidation catalyst	25.00	8.00
Three-way catalyst	3.80	5.70
Diesel Heavy trucks and Buses	3.90	3.90
Gasoline Motorcycles		
<50cc	33.00	3.20
2-strokes	33.00	3.20
4-strockes	33.00	3.20

Source | table 3.2.2 page 3.21 chapter 3 volume 2, IPCC 2006 guidelines

Table 30: Parameters for road transport

	Average Travelled Distance (km)[1]	Fuel Economy (L/100 km)[2]	Fuel Density (kg/L)[3]	Net Calorific Value (TJ/ktonnes)[4]
Gasoline Private Passenger cars				
Uncontrolled	12,000	11.2	0.74	43.5
Early non-catalyst control	12,000	9.4	0.74	43.5
Non-catalyst control	12,000	8.3	0.74	43.5
Oxidation catalyst	12,000	8.1	0.74	43.5
Three-way catalyst	12,000	8.5	0.74	43.5
Gasoline Taxis				
Uncontrolled	50,000	11.2	0.74	43.5
Early non-catalyst control	50,000	9.4	0.74	43.5
Non-catalyst control	50,000	8.3	0.74	43.5
Oxidation catalyst	50,000	8.1	0.74	43.5
Three-way catalyst	50,000	8.5	0.74	43.5
Light commercial vehicles Gasoline cars				
Uncontrolled	25,000	13.6	0.74	43.5
Early non-catalyst control	25,000	13.6	0.74	43.5
Non-catalyst control	25,000	13.6	0.74	43.5
Oxidation catalyst	25,000	13.6	0.74	43.5
Three-way catalyst	25,000	13.6	0.74	43.5
Vans Gasoline cars				
Uncontrolled	50,000	13.6	0.74	43.5
Early non-catalyst control	50,000	13.6	0.74	43.5
Non-catalyst control	50,000	13.6	0.74	43.5
Oxidation catalyst	50,000	13.6	0.74	43.5
Three-way catalyst	50,000	13.6	0.74	43.5
Diesel Heavy trucks and Buses[5]				
Uncontrolled	50,000	29.9	0.83	41.6
Early non-catalyst control	50,000	29.9	0.83	41.6
Non-catalyst control	50,000	29.9	0.83	41.6
Oxidation catalyst	50,000	29.9	0.83	41.6
Three-way catalyst	50,000	29.9	0.83	41.6
Motorcycles Gasoline cars				
<50cc	5,000	2.4	0.74	43.5
2-strokes	5,000	4	0.74	43.5
4-strockes	5,000	5.1	0.74	43.5

1 Default numbers from ForFITS based on similar countries characteristics
2 MoE/UNDP/GEF (2015c).
3 MoE/UNDP/GEF (2011).
4 Country specific Net Calorific Value
5 Average Travelled Distance for HDV and Buses for the year 2018 is 38,000 km

Emissions from other categories under mobile combustion are calculated with default emission factors available in the 2006 IPCC guidelines for GHG emissions.

Table 31: Direct GHG default emission factors for international bunkers and domestic aviation

Fuel type	Net Calorific value (TJ/ktonne)	CO_2 emission factor (kg/TJ)	CH_4 emission factor (kg/TJ)	N_2O emission factor (kg/TJ)
Aviation gasoline	43.5	70,000	0.5	2
Jet kerosene	42.8	71,500	0.5	2
Heavy fuel oil	41.1	77,400	7	2

Source | table 3.6.5 page 3.64 and table 3.5.3 page 3.50 chapter 3 volume 2, IPCC 2006 guidelines

International bunkers

International bunkers include international aviation and international navigation. Emissions from these sources are not accounted in national totals and are reported as memo items in the inventory. The activity data for international civil aviation includes the jet kerosene consumption while that of domestic civil aviation includes gasoline consumption. Fuel consumption for domestic civil aviation are based on personal communication with the Civil Aviation department (El-Hage, 2014) while international bunkers data are collected from the International Energy Agency (IEA, 2020). The activity data for navigation is limited to the heavy fuel oil consumption for international bunkers and it is projected based on the fuel imports data from the International Energy Agency (IEA, 2020).

Table 32: Fuel consumption for aviation and marine international bunkers 2016-2018

Year	**Jet-kerosene (1,000 tonnes)**	**Gasoline (1,000 tonnes)**	**Marine bunkers (1,000 tonnes)**
2016	244	3.65	34
2017	270	3.71	35.3
2018	264	3.76	36.6

1.A.4 Other sectors

Methodology

This category includes the greenhouse gases emitted by fuel combustion in the commercial/ institutional sector (1.A.4.a), residential sector (1.A.4.b) and agriculture/ forestry/ fisheries (1.A.4.c). Different types of fuels are considered under this category and are mainly used for electricity generation, cooking, heating, navigation and use of other off-road mobile equipment.

Emissions from burning of wood are allocated under the residential sectors, where in rural areas logged wood is still being used for cooking and heat generation. Only emissions of non-CO_2 gases derived from biomass fuels are included, and reported, in the emissions of the energy sector and national totals of the inventory. CO_2 emissions from biomass fuels are included only as information item because it is assumed that the consumption of biomass is similar to the volume that is regenerated. Any variation to this hypothesis is reflected and calculated in the AFOLU sector. Therefore, carbon dioxide emissions from

biomass combustion are not included in national totals but are recorded as memo item for cross-checking purposes as well as avoiding double counting.

Tier 1 methodology is used since no country-specific emissions factors are available.

Activity Data

The activity data required for the calculation of GHG emissions from this category is the annual consumption (in tonnes) of each type of fuel used in their respective sectors. Values, assumptions and source of data are presented in Table 33.

Table 33: Fuel consumption in 1.A.4 Other Sectors

Fuel type	Source of data	Assumptions	Activity data 2018 (1,000 tonnes)
Commercial/institutional sector (1.A.4.a)			
Gas/Diesel oil (GDO)	Ministry of energy and water Own calculation	$GDO_{CI} = GDO_{PG}/2$ + stock $GDO_{PG} = GWh_{PG} * CF$ GWh_{PG}= Demand * 36.5% Where: GDO_{CI}= GDO consumed by Commercial/Institutional sector GDO_{PG} = GDO consumed for private generation Stock = estimated stock of fuel from Y-1 GWh_{PG}= electricity generated by private generators CF = Conversion factor, 0.232 Gg DO/GWh It is assumed that 50% of private generation takes place at the industrial level and 50% at the commercial/institutional level.	**963.05**
Liquified Petroleum Gas (LPG)	Ministry of energy and water IPTEC 2018	$LPG_{CI} = LPG_{import}$ x 10% Where: LPG_{CI}= LPG consumed by Commercial/Institutional sector LPG_{import} = Total LPG imported in year Y In 2018, IPTEC estimated that 10% of imported LPG is consumed by the Commercial/institutional sector.	**19.75**
Residential (1.A.4.b)			
Gas/Diesel oil (GDO)	Ministry of energy and water IPTEC	$GDO_{R} = GDO_{import}$ x 3% Where: GDO_{CI}= GDO consumed by Commercial/Institutional sector GDO_{import} = Total GDO imported in year Y In 2018, IPTEC estimated that 3% of imported GDO is consumed by the residential sector.	**102.78**
Liquified Petroleum Gas (LPG)	Ministry of energy and water IPTEC 2018	$LPG_{R} = LPG_{import}$ x 82% Where: LPG_{R}= LPG consumed by the Residential sector LPG_{import} = Total LPG imported in year Y	**166.63**

		In 2018, IPTEC estimated that 82% of imported LPG is consumed by the Residential sector.	
Biomass	FAOSTAT 2020	Data estimated from FAOSTAT database, is based on the volume of fuelwood logged from coniferous and non-coniferous forests (referred to as wood waste). Volume is converted to Mass through using the average of the basic density for P. brutia (519 kg/m^3) and P. pinea (538 +/- 11 kg/m^3)	**9.85**
Agriculture/Forestry/Fishing (1.A.4.c)			
Gas/Diesel oil (GDO)	Ministry of energy and water IPTEC	$GDO_{Fishing}$= GDO_{import} x 1% Where: GDO_{Fish}= GDO consumed by fishing boats GDO_{import} = Total GDO imported in year Y In 2018, IPTEC estimated that 1% of imported GDO is consumed by Fisherman boats	**34.26**
		$GDO_{offroad}$= GDO_{import} x 1% Where: $GDO_{offroad}$= GDO consumed by offroad machineries GDO_{import} = Total GDO imported in year Y In 2018, IPTEC estimated that 1% of imported GDO is consumed by off-road machineries	**34.26**

Emission factors

The same parameters presented in Table 22 under 1.A.1 Energy industries are used for 1.A.4 Other sectors. Default emission factors from the 2006 IPCC guidelines are used.

Table 34: CO_2, CH_4 and N_2O emission factors for stationary sources

	For all categories	Other sectors	
Fuel type	**CO_2 emission factor (kg/TJ)**	**CH_4 emission factor (kg/TJ)**	**N_2O emission factor (kg/TJ)**
Diesel oil	74,100	10	0.6
LPG	63,100	5	0.1
Biomass	112,000	300	4

Source | table 2.4-2.5 page 2.20-2.23 chapter 2 volume 2, IPCC 2006 guidelines

Feedstock and non-energy use of fuels

Some of the imported fuels are used as raw materials for the production of other products in chemical industry and metal production, or the use of fuels for non-energy purposes such as bitumen and lubricants. Since these fuels are not combusted, their carbon content is totally or partially stored in the product and is not oxidized into carbon dioxide for a certain period of time.

The calculation of carbon dioxide emissions from non-energy use of fuels is based on the relevant consumption by fuel type and the fraction of the carbon stored by fuel type.

Results of Energy sector (including transport)

In 2018, the energy sector's GHG emissions were estimated at 26,701 Gg CO_2eq. (26.7 million tonnes CO_2eq.), representing 82% of the total greenhouse gas emissions in Lebanon. Energy is mainly responsible for carbon dioxide emissions (99.63%), while it also contributes to methane and nitrous oxide emissions with 0.17% and 0.20% respectively. Under the Energy sector, Energy industries or the generation of electricity form public thermal power plants contributed to most of the emissions, with 38.3% of CO_2eq., followed by transport (27.7%) and Manufacturing industries and construction (18.7%) as presented in Figure 25.

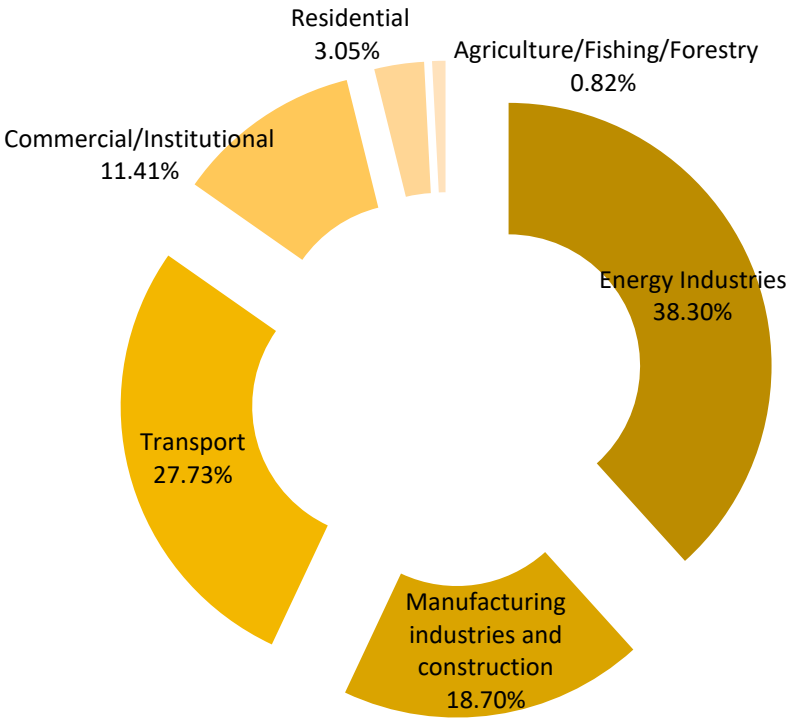


Figure 25: Contribution of energy emission sources to the sector's total for 2018

GHG emissions from the Energy sector grew by 5%/year during the period 1994-2018 due to the increase in consumption of all types of fuel. More specifically, Gas/Diesel oil's imports increased by 4 folds from 1994 to 2018 (Figure 27) mainly due to the increase reliance of private generation during this period (Figure 28).

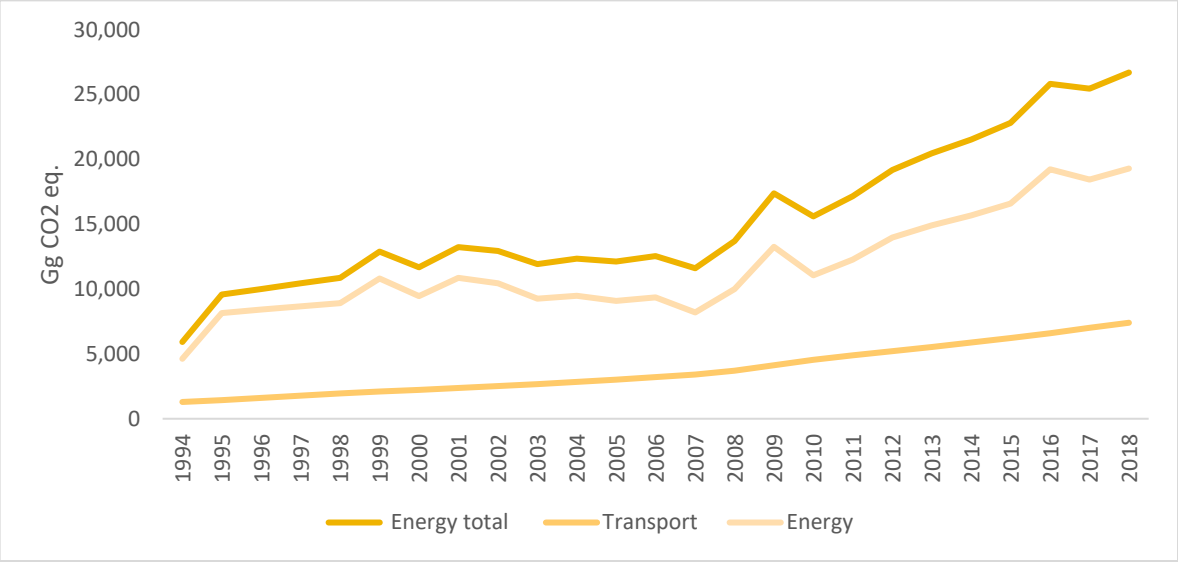


Figure 26: GHG emissions from 1.A Energy for the time series 1994-2018

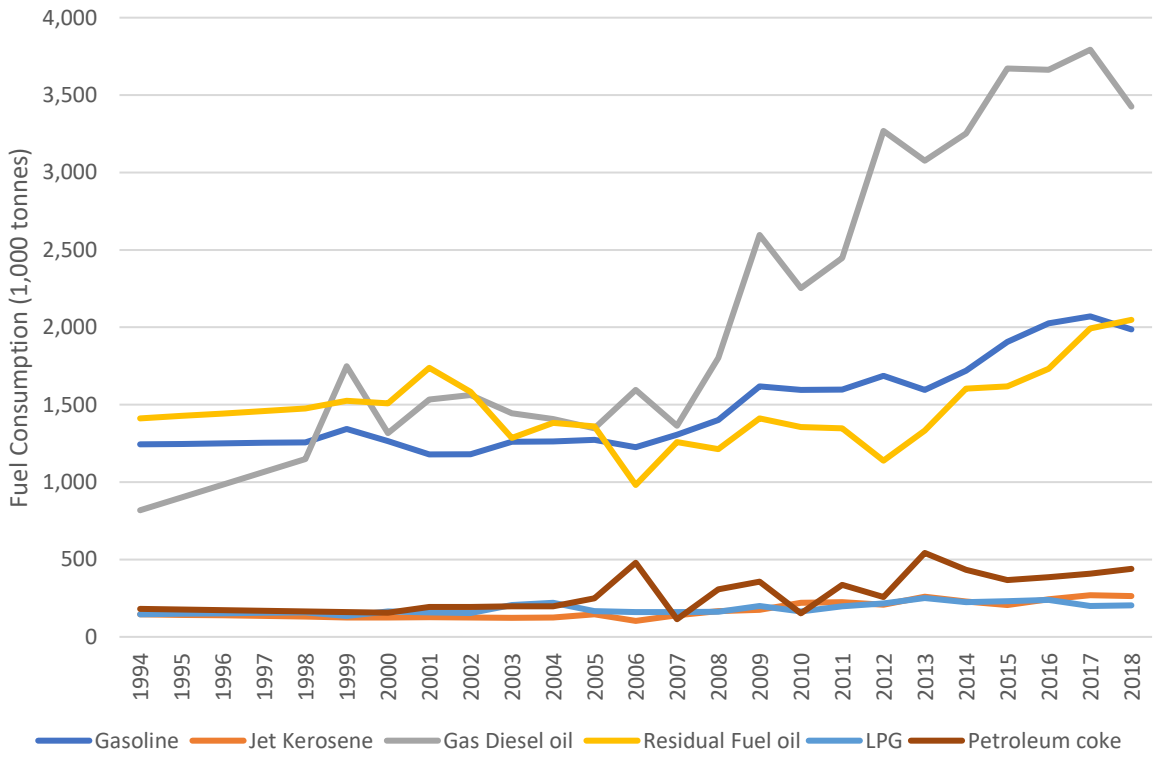


Figure 27: Fuel import per type for 1.A Energy for the time series 1994-2018

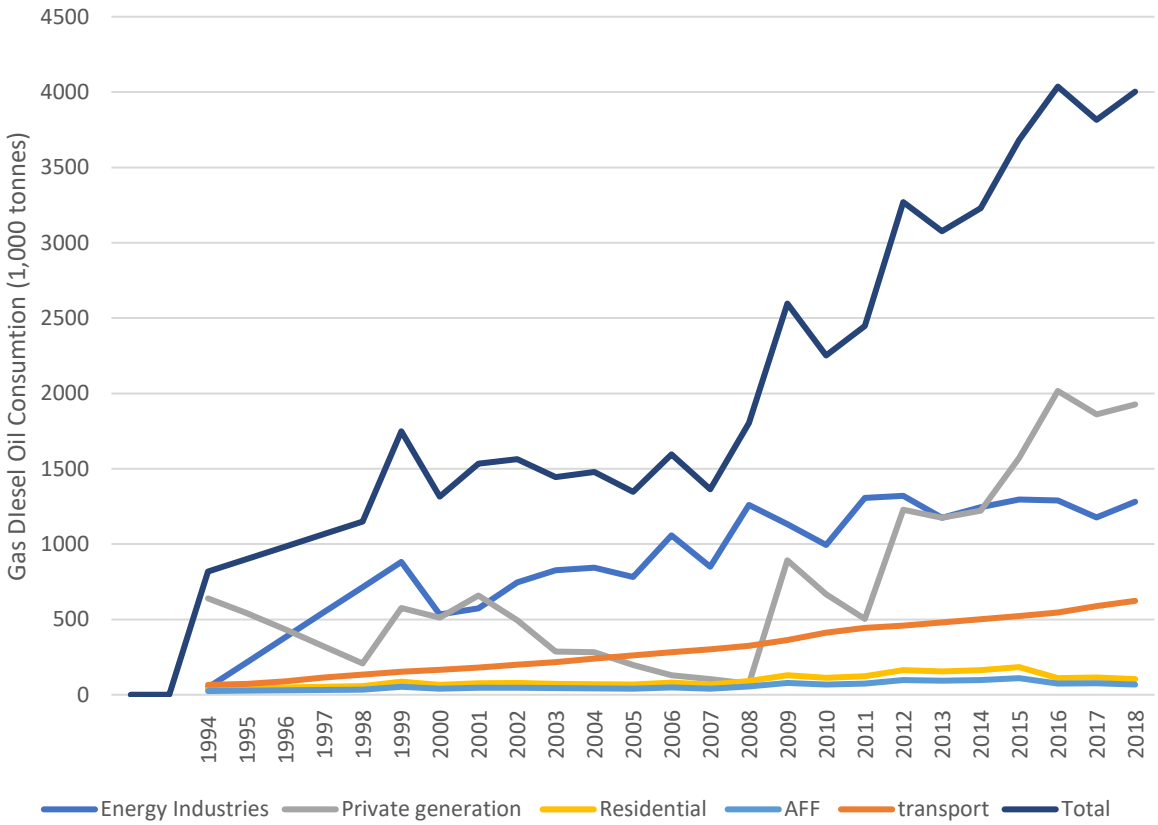


Figure 28: Diesel Oil Consumption per Energy sub-category

Energy industries, or public electricity generation, is the largest contributor to the sector's emissions (37.69% of energy emissions) because more than 92% of imported heavy fuel oil and 37% of imported gas diesel oil are used in thermal power plants for public electricity generation. The main source of GHG emissions is the combustion of fuel oil and gas/diesel oil in the thermal power plants (Table 35). In terms of the share of each plant to the reported emissions, it is estimated that the barges in addition to Zahrani, Deir Aamar and Zouk plants are the highest emitters of greenhouse gases, given that they are the biggest power generators in terms of capacity, electricity generation and fuel consumption (Table 36).

Table 35: GHG emissions per type of fuel used in power plants

GHG emissions 2018 (Gg CO_2eq)	Gas/Diesel Oil	Residual Fuel oil	Total
	3,949.42	6,243.81	10,193

However, due to the high efficiency of the Zahrani and Deir Aamar installations, both plants are characterized by low emission intensity, generating around respectively 0.54 and 0.63 tonnes CO_2eq. per MWh of electricity produced in 2018. In fact, the Zahrani and Deir Aamar power plants are the most recent installations and make up about half of Lebanon's generation capacity, although not operating under optimal conditions. The two plants are equipped with diesel-fired combined cycle gas turbines, which are designed to best operate using natural gas. Their switch to natural gas is expected to reduce drastically their emissions as well as emission intensity.

As presented in Figure 29 and Table 36, the Hrayche, Zouk and Jiyeh power plants have decreased in carbon intensity due to some rehabilitation work that took place recently. In fact, since 2016, Zouk and Jiyeh have been equipped with new reciprocating engines that work on grade B fuel oil and have higher efficiency: 196 g fuel oil/kWh and 198 g/kWh vs. 285 g/KWh and 356 g/kWh in the Zouk and Jiyeh thermal power plant respectively. In addition, the Hrayche power plant was rehabilitated between 2016 and 2018, which increased significantly its efficiency.

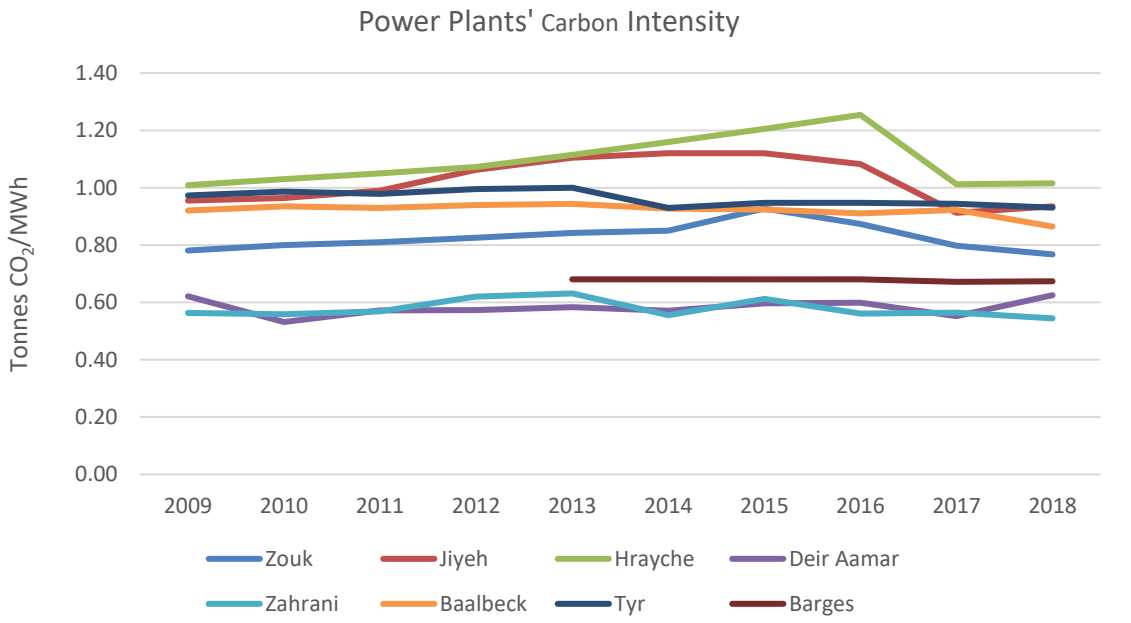


Figure 29: Greenhouse gas emissions per MWh generated

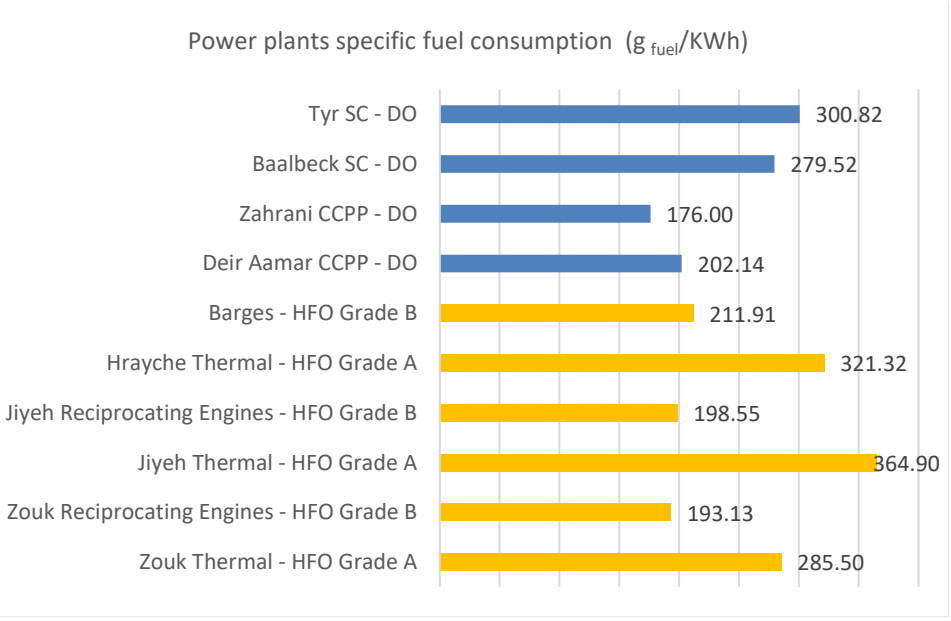


Figure 30: Power plants efficiency

Table 36: Summary of GHG emissions for electricity generation in Lebanon

			2016		2017		2018	
	Installed Capacity (MW)	Actual Capacity (MW)	Energy per Year (MWh)	CO_2 equivalent (tonnes CO_2)	Energy per Year (MWh)	CO_2 equivalent (tonnes CO_2)	Energy per Year (MWh)	CO_2 equivalent (tonnes CO_2)
Zouk Thermal - Grade A	607	350	1,740,320	1,603,237	2,018,973	1,820,418	1,706,656	1,540,526
Zouk Reciprocating Engines - Grade B			322,155	199,415	1,225,319	769,193	1,496,737	919,285
Jiyeh Thermal - Grade A	346	150	754,053	860,682	774,518	838,560	828,320	955,607
Jiyeh Reciprocating Engines - Grade B			94,941	58,927	495,973	321,397	595,728	376,167
Hrayche Thermal - Grade A	75	0	74,267	93,171	221,925	224,665	199,340	202,508
Deir Aamar CCPP - DO	435	300	2,976,223	1,782,565	3,207,727	1,770,745	2,764,644	1,728,304
Zahrani CCPP - DO	435	300	3,144,791	1,764,337	2,618,972	1,476,997	3,409,573	1,855,898
Baalbeck SC - DO	70	30	246,010	224,030	170,708	157,559	190,947	165,068
Tyr SC - DO	70	30	232,382	220,034	250,818	236,660	229,054	213,097
Barges - Grade B	270	0	3,096,901	2,107,741	3,072,525	2,064,566	3,288,314	2,216,121
TOTAL Thermal			**12,682,043**	**8,914,139**	**14,057,458**	**9,680,760**	**14,709,313**	**10,172,582**
Hydro	274	190	385,115	0	421,293	0	345,288	0
RE PV			36,466.00	0	55,591.00	0	83,799.00	0
Naameh LFG			0	0	40,940.00	0	64,350.00	0
Total RE			421,581	0	517,824	0	493,437	0
Total Production GWh	2,237	1,350	13,104	8,914,139	14,575	9,680,760	15,203	10,172,582
Power Purchases GWh	150	150	77.42		542.63		11.63	
Total Production + Purchase GWh	2,387	1,500	13,181	8,914,139	15,118	9,680,760	15,214	10,172,582
Technical Losses %			17.00%		17.00%		17.00%	
Total Electricity reaching consumers GWh			10,940.27		12,547.87		12,627.93	
Demand GWh			21,891		22,416		23,089	
Energy Not Supplied (ENS) GWh			10,951		9,868		10,461	
Private Generation (PG): 80% of (ENS) GWh			8,761	6,235,998	7,895	5,619,378	8,369	5,957,021
Total CO_2 equivalent (tonnes CO_2eq.)				15,150,137		15,300,138		16,129,603
Average CO_2 equivalent / MWh (tonnes CO_2eq/MWh)				0.690		0.665		0.684

Lebanon 's grid emission factor in 2018 is estimated at 0.684 tonnes CO_2 per MWh. This includes the generation from EDL power plants, electricity purchase, generation from renewable energy sources as well as estimated generation from private generation. The emission factor increased during the period 2010-2016 due to the gradual deterioration and decreased efficiency of power plants concurrently with the increase of private generation. Starting 2016, the upgrade of some power plants along with the expansion of renewable energy technologies in the Lebanese market contributed in reducing the grid emission factor. A notable drop can be seen in 2017 due to the increase in electricity purchase from Syria (77.42 GWh in 2016, 542.63 GWh in 2017) which increased electricity supply without inducing any increase greenhouse gas emissions. However in 2018, the decrease in purchase from Syria (11.63 GWh in 2018) has put more pressure on EDL power plants and private generation to produce and supply electricity, thus increasing the Grid Emission Factor back up to 0.684 tonnes CO_2eq./MWh (Figure 31).

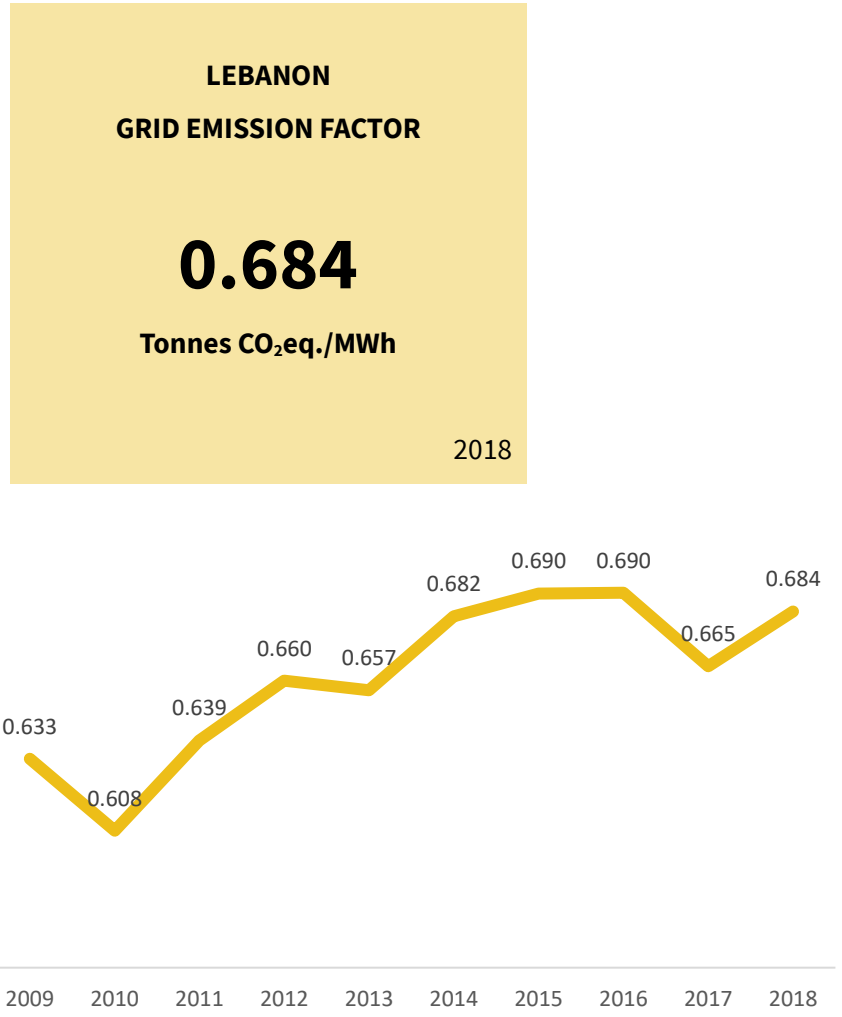


Figure 31: Grid Emission Factor (tonnes CO_2eq./MWh)

Transport (1.A.3)

In 2018, GHG emissions from transport are estimated at 7,404 Gg CO_2eq. carbon dioxide, methane, and nitrous oxide contributing to 97.60%, 0.60%, and 1.80% of total CO_2eq. respectively (Table 37).

Table 37: Transport sector GHG emissions for 2018

Category	CO_2 (Gg)	CH_4 (Gg CO_2eq.)	N_2O (Gg CO_2eq.)	Total (Gg CO_2eq.)
1.A.3 - Transport	7,226.63	44.67	132.54	7,404
1.A.3.a - Civil Aviation	11.45	0.00	0.09	12
1.A.3.b - Road Transportation	7,215.18	44.67	132.46	7,392
1.A.3.b.i - Cars	4,108.69	30.61	87.45	4,227
1.A.3.b.ii - Light-duty trucks and vans	1,144.24	10.68	17.71	1,173
1.A.3.b.iii - Heavy-duty trucks and buses	1,921.10	2.83	26.79	1,951
1.A.3.b.iv - Motorcycles	41.14	0.55	0.50	42

As for the contribution of the different vehicle categories, passenger cars have the highest share of the 2018 emissions with 57.18% of the total transport GHG emissions (in CO_2eq.), while LDV and HDV, account for 16%, 26%. Emissions from motorcycles and domestic aviation are negligible (Figure 32).

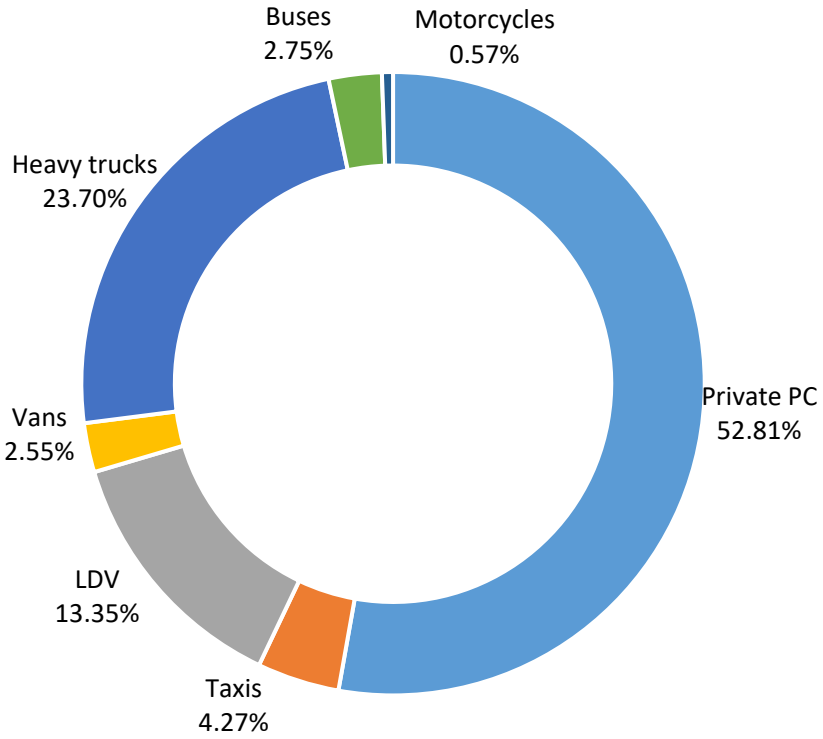


Figure 32: Emissions distribution per type of vehicle in 2018

The annual growth in emissions from transport fluctuated between 6% to 11% during the period 1994-2018, with an average increase of by 7% (Figure 33). The fluctuation between 1994 – 2018 is

the natural consequence of the increase in vehicle numbers mainly; during the 1994-1999 period, an increase of 18.79% in registered Heavy Trucks and Buses numbers while the passenger cars and LDV had an increase of 8.26% and 10.47% respectively. The 2007 – 2011 period was characterized by an increase in the registered vehicles of all categories. The emissions from diesel driven vehicles, i.e. Heavy trucks and Buses, between 1994 and 2018 increased substantially passing from 9% to 26% of the road transport emissions.

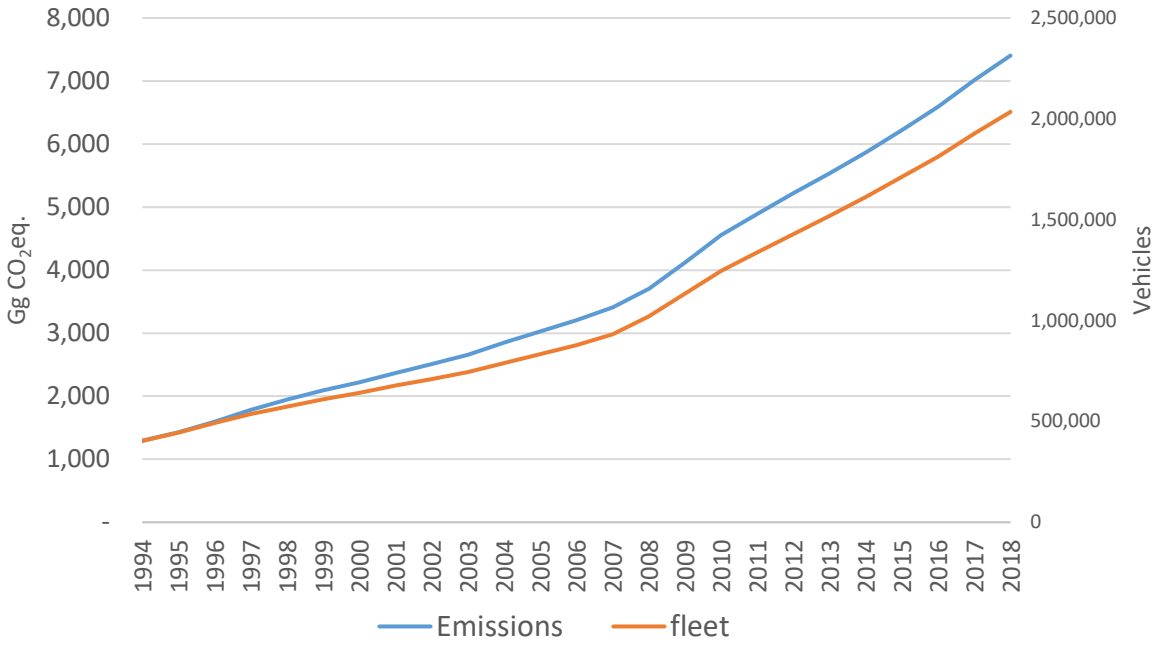


Figure 33: Changes in GHG emissions and fleet size during the period 1994-2018

Over the time-series 1994-2018, almost a 5-fold increase in GHG emissions is observed concurrently with the increase in the number of registered vehicles in Lebanon from 403,201 in 1994 to 2,034,501 in 2018 (Figure 33). Both total emissions and their corresponding growth follow the fleet size. Among the main reasons for this significant increase is the inefficient and unreliable management of the mass transport sector, preventing the modernization and growth of the system and allowing the market to be controlled by private operators with an ad-hoc evolution strategy; consequently, encouraging passengers to rely on their private cars for their daily trips, along with the lack of policy enforcement for encouraging deployment of new fuel-efficient vehicle technologies.

The overall fleet emission factor, in terms of g CO_2eq./km, increased from 1994 to 2018 due to a remarkable growth of the heavy-duty trucks and buses running both on diesel, especially during the period 1996-2000. However, this increase in the overall emission factor has been offset by the decrease of specific emission factors in passenger cars and taxis lowering the average emission factor of the fleet to 258 g CO_2eq./km in 2018.

Indeed, the average CO_2eq. emissions per kilometre driven for passenger cars has decreased as a natural consequence to the advancements in reduction of consumption and emissions of new vehicles with emission control technologies from 202 g CO_2eq./km in 1994 to 194 g CO_2eq./km (Figure 34).

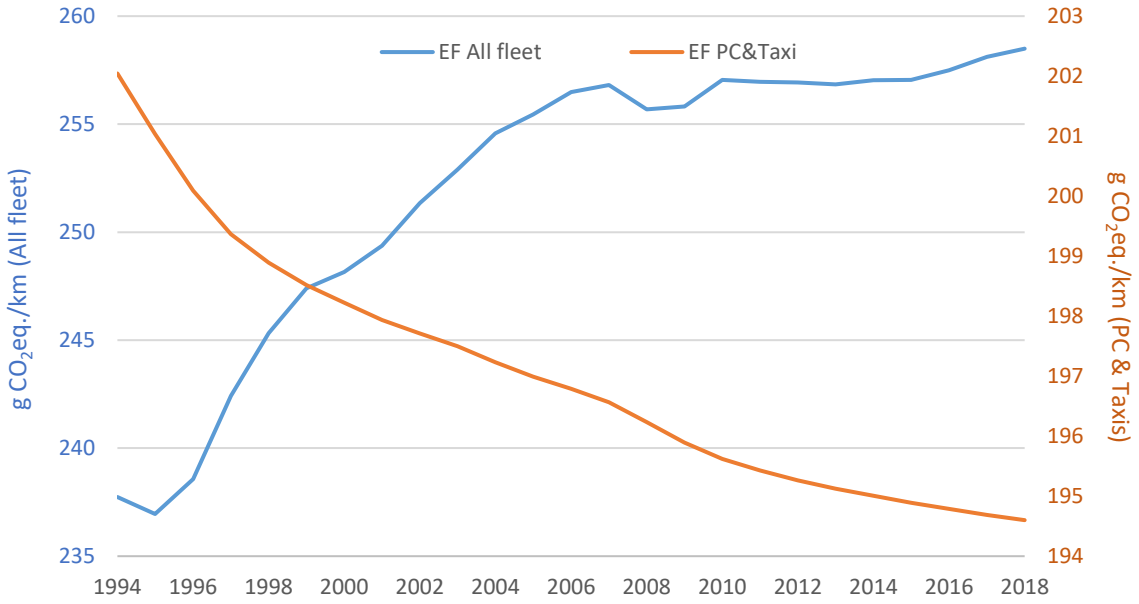


Figure 34: Change in CO_2eq. emission factor over the 1994-2018 period

Domestic aviation

For domestic aviation the total direct GHG emissions from aviation and marine amounted to 11.54 Gg CO_2eq. in 2018.

International bunkers

For international bunkers, the total direct GHG emissions from aviation and marine amounted to 930.73 Gg CO_2eq. in 2018 as per the Table 38.

Table 38: Emissions from international bunkers

	GHG emissions (Gg CO_2eq.)
International aviation	813.21
International water-borne navigation	117.52
Total	930.73

Box 7: Relationship between fuel quality and emissions

Does higher fuel quality decrease CO_2 emissions?

For an internal combustion engine to move a vehicle down the road, it must convert the energy stored in the fuel into mechanical energy to drive the wheels. This process produces carbon dioxide (CO_2).

Fuel contains complex mixture of several types of hydrocarbon molecules mainly formed by carbon and hydrogen atoms. During combustion, the carbon (C) from the fuel combines with oxygen (O_2) from the air to produce carbon dioxide (CO_2). Consequently, the CO_2 emissions are related mainly to fuel consumption. The relationship between fuel standards and fuel consumption is not straightforward, with more stringent fuel standards for some parameters not necessarily leading to lower fuel consumption.

Nevertheless, many of the technologies used to achieve improved fuel efficiency of vehicles rely on high fuel quality. For example, the decision to adopt a 10ppm Sulphur limit in the European petrol standard was made primarily to support carbon dioxide emissions reductions by assisting improvements in fuel efficiency - an important consideration in the context of European fuel efficiency standards for motor vehicles (Hart Energy 2014, European Union 2009).

Therefore, adopting vehicle emissions standards such as Euro 5 or Euro 6 will not directly affect the greenhouse emissions. The emissions standard will require the introduction of higher fuel quality standards which allows for the use of more fuel-efficient vehicle technology, which in turn requires less fuel leading to the reduction of greenhouse emissions.

2. Industrial Processes and Products Use (IPPU)

The IPPU category includes the following 2 sources of the emissions:

- Industrial processes that chemically or physically transform products, thus releasing greenhouse gases.
- Product use that releases gradually greenhouse gases that are contained in the products such as refrigerators, foams and aerosol cans.

Industrial activities are quite limited Lebanon, and the GHG emissions from the sector are mainly generated from mineral production (cement and lime production), HFC uses for refrigeration and air conditioning and some processes that use CO_2 carbonates. Emissions of F-gases from Refrigeration and Air conditioning and N_2O emissions from medical applications have been calculated for the first time in this BUR4 submission. A time-series calculation was also performed for the period 1994-2018 for consistency and completeness of the inventory.

The development of the complete and consistent time series limits reporting of GHG emissions from some categories as data collection remains a challenging task in Lebanon. Extensive efforts have been deployed during previous inventories to collect data to estimate emissions from a number of industries (food and beverages), but the data quality remained highly uncertain. Due to limited capacity, estimation of emissions from NE categories is included into the planned improvements for later submissions.

The present section covers the following IPPU subcategories:

- 2.A.1 Cement production
- 2.A.2 Lime production
- 2.A.4.b Other process Uses of CO_2 carbonates- soda ash use
- 2.D.1 Lubricant use
- 2.D.2 Paraffin wax use
- 2.F.1 Refrigeration and air conditioning
- 2.G.3 N_2O from product uses

Methodology

The GHG inventory of industrial processes in Lebanon is carried out based on calculation methodologies of the 2006 IPCC Guidelines for national greenhouse gas inventories, using tier 1 methodologies with national and default emission factors and adopting the Global Warming Potential of the IPCC Fifth Assessment Report. Only cement production and emissions of f-gases adopted a tier 2 methodology.
Emissions from fuel combustion in the industrial sector for energy purpose is not included under the IPPU sector, but rather in the energy sector (1.A.2).

Table 39: GHG emissions categories the IPPU category

Reporting categories	Methodology, description and remarks
2.A Mineral industries	
2.A.1 Cement production	All 3 cement industries in Lebanon are covered in this calculation. Cement manufacturing is a key category in Lebanon. Tier 2 is adopted to calculate emissions from this category as per equations 2.4 and 2.5 of the IPCC 2006 guidelines.

2.A.2 Lime production	The only lime production plant in Lebanon is covered in this calculation. Lime is also produced in cement manufacturing; however, it is already accounted for in clinker production in cement industries. CO_2 resulting from lime production is not a key category in Lebanon. The tier 1 method, an output-based approach that uses default values for emission estimates was adopted based on equation 2.8 of the IPCC 2006 guidelines.
2.A.3 Glass production	The 2 glass producing factories in Lebanon shut down in the early 2000s. Glass is imported and manufactured into different shapes (containers, windows, etc.) using carbonates. Since there is no survey of the exact amount of carbonates used in glass production, related emissions are not reported under this category, but embedded within the emissions of category 2.A.4 (other carbonates). The notation key Included Elsewhere is therefore used.
2.A.4 Other process Uses of Carbonates	Subcategories from which emissions occur in Lebanon include ceramics (2.A.4.a) and other uses of soda ash (2.A.4.b). Other subcategories do not occur and are reported as such. Data on ceramics is considered incomplete as it only includes the main ceramics production facilities in the country (sanitary and tile) and does not cover the entire time series considered in this inventory. Therefore, the emissions from ceramics is Not Estimated in the current inventory. Note that category 2.A.4.a is not expected to be a key category. There is no soda ash production in Lebanon. Therefore, all soda ash used is imported and it is assumed that all imported soda ash is used during the year of import in the industrial sector. Percentages of soda ash used for each type of industry (glass manufacturing, soap and detergents, water treatment etc.) are not available. CO_2 resulting from soda ash used is not a key category in Lebanon. Thus, the tier 1 methodology was adopted as per equation 2.14 of the IPCC 2006 guidelines.
2.D Non-Energy Products from Fuels and Solvent Use	
2.D.1 Lubricant Use	There is no disaggregated data on the use of lubricants in Lebanon. Therefore, it is assumed that all lubricants are used in the power generation plants. Emissions from this subcategory are therefore reported as Included Elsewhere (reported under 1.A.1 Energy Industries).
2.D.2 Paraffin Wax Use	CO_2 resulting from the use of paraffin wax is not a key category is Lebanon. Therefore, the tier 1 approach was adopted as per equation 5.4. of the IPCC 2006 guidelines.
2.F Product uses as substitutes for ODS	
2.F.1 Refrigeration and A/C	HFC are mainly used in Lebanon under the Refrigeration and Air Conditioning (RAC) sector. The main HFC refrigerants are HFC-134a (48% in 2018) and the mixtures R404A, R407C, R410A resulting in emissions of HFC-125 (38% in 2018), HFC-32 and HFC-143a.
2.F.2 Foam blowing Agents	There is no HFC applications in the foam manufacturing sector. The notation key Not Occurring is therefore used.
2.F.3 Fire protection	There are limited applications of HFCs in fire suppression systems. due to lack of activity data, emissions from this category have not been estimated. The notation key NE is therefore used.
2.G. Other product manufacture and use	
2.G.3 N_2O use for medical purposes	N_2O is used for medical applications in anesthetic use, analgesic use and veterinary use

Activity data and emission factors

2.A.1 Cement production

There are 3 cement plants in Lebanon: Ciment de Sibline SAL, Holcim Liban SAL and Cimenterie Nationale SAL that produce mostly Portland cement. All 3 plants provide their production data on a yearly basis to the Ministry of Environment as part of their reporting. Cement manufacturing is a key category in Lebanon; thus, Tier 2 method was applied to calculate emissions from this category as per equations 2.4 and 2.5 of the IPCC 2006 guidelines.

Clinker production data is only available since 2000, thus the amount of clinker produced for the period of 1994-1999 has been extrapolated based on 2000-2003 information.

Based on the CaO content provided by producers and the default correction factor for cement kiln dust (1.02), the national emission factor of 0.52 tonnes CO_2/t clinker produced was estimated for the category (MoE/UNDP/GEF, 2011).

Box 8: Details on the calculation of the national emission factor for cement production

Data on CaO (quicklime) content of the clincker (CaO_Clincker) and the fraction of this CaO from carbonate (CaO_Carbonate) is needed in order to generate a national emission factor for tier 2 method for the calculation of emissions from cement. The values obtained from cement companies are:

CaO_Clinker = 66%
CaO_Carbonate = 99.8%

The carbonate $CaCO_3$ is 56.03% CaO and 43.97% CO_2 by weight as per table 2.1 of the 2006 IPCC GL. The equation for the clinker emission factor when applying these parameters is:
EF_{cl} = (0.66-(1-0.998))/0.5603*0.4397 = 0.52 tonnes CO_2/tonnes clinker
A correction factor should be applied to this emission factor, the default value of 1.02 was applied.

2.A.2 Lime production

There is only one lime production plant in Lebanon. Due to a shift in management of the plant, a more open approach to the information access is now adopted by the company, which made it possible to collect lime production data directly from the company. CO_2 resulting from lime production is not a key category in Lebanon, so the tier 1 method with default EFs used based on equation 2.8 of the IPCC guidelines. Data prior to 1999 was not available therefore, the values for 1994-1999 have been extrapolated based on 2000-2003 data for completeness.

Table 40: Amount of clinker produced in Lebanon for the years 1994 – 2018

Year	Amount of clinker produced (tonnes)
1994	2,210,505
1995	2,370,276
1996	2,530,048
1997	2,689,819
1998	2,849,591
1999	3,009,362
2000	3,135,084
2001	3,256,096
2002	3,218,768
2003	3,521,511
2004	4,143,809
2005	4,105,625
2006	3,868,051
2007	4,261,477
2008	4,845,337
2009	4,839,191
2010	4,971,936
2011	4,955,079
2012	4,903,268
2013	4,881,844
2014	4,709,453
2015	4,291,773
2016	3,539,385
2017	3,160,432
2018	2,822,053

Table 41: Amount of lime produced in Lebanon for the years 1994-2018

Year	Amount of lime produced (tonnes)
1994	3,978
1995	3,892
1996	3,806
1997	3,720
1998	3,634
1999	3,429
2000	3,776
2001	4,212
2002	2,687
2003	2,903
2004	1,990
2005	3,110
2006	2,503
2007	3,625
2008	2,769
2009	3,466
2010	2,720
2011	2,722
2012	2,070
2013	1,901
2014	1,914
2015	2,825
2016	3,849
2017	1,144
2018	1,004

2.A.4. Other process uses of Carbonates – Other used of Soda Ash

There is no soda ash production in Lebanon, therefore, all soda ash imported and used in the industrial sector during the year of import is considered for the inventory. Percentages of soda ash used for each type of industry (glass manufacturing, ceramics production, soap and detergents, water treatment etc.) are not available, thus all soda ash use emissions are reported aggregated. The two glass producing factories in Lebanon shut down in the early 2000s and starting 2003, soda ash use emissions do not include glass production. The category is not a key one, so the tier 1 methodology was applied using equation 2.14 of the IPCC guidelines.

Data on soda ash use in Lebanon is obtained from the customs online database using the HS code 28.36.20. The consumption is estimated as total import minus total export in a given year. The data prior to the year 2000 is not available, therefore values have been extrapolated for completeness. The default IPCC EF from Table 2.1 page 2.7 of IPCC 2006 volume 3 (part 1) chapter 2 was used for estimates.

Table 42: Quantities of soda ash imported, exported and used in Lebanon from 1994 to 2018

	Soda ash imported (tonnes)	Soda ash exported (tonnes)	Soda ash used (tonnes)
1994			16,727
1995			16,404
1996			16,080
1997			15,756
1998			15,432
1999			15,108
2000	9,555	0	9,555
2001	14,254	1	14,252
2002	14,615	0	14,615
2003	17,400	0	17,400
2004	17,181	1	17,180
2005	18,576	0	18,576
2006	14,602	1	14,601
2007	8,686	0	8,686
2008	10,459	0	10,459
2009	11,646	0	11,646
2010	7,104	1	7,103
2011	9,125	2	9,123
2012	12,587	3	12,584
2013	10,566	2	10,564
2014	13,203	55	13,148
2015	12,108	23	12,085
2016	6,587	25	6,562
2017	2,632	77	2,555
2018	2,850	5	2,845

2.D.2 Paraffin was used

Data on paraffin wax was obtained from the customs online database using the HS code 27.12. Data was obtained in tonnes and converted to terajoules (TJ) using the NCV 40.2 TJ/Gg as per the 2006 IPCC GL (table 1.2 page 1.18 of chapter 1 of volume 2 on Energy). It is assumed that all paraffin imported, minus paraffin wax exported in a given year is used in industrial processes during the same year. Note that data prior to the year 2001 is not available, therefore data has been extrapolated based on an annual average.

Table 43: Paraffin Wax used for 1994-2018

Year	Import (tonnes)	Export (tonnes)	Import - Export (tonnes)	Import - Export (TeraJoules)
1994			2,572	103
1995			2,497	100
1996			2,484	100
1997			2,481	100
1998			2,471	99
1999			2,459	99
2000			2513	101
2001	3,150	25	3,125	126
2002	2,632	89	2,543	102
2003	2,008	106	1,902	76
2004	2,483	108	2,375	95
2005	2,476	94	2,382	96
2006	2,499	71	2,428	98
2007	3,195	36	3,159	127
2008	1,898	98	1,009	41
2009	2,685	62	2,623	105
2010	1,815	33	1,782	72
2011	1,877	29	1,848	74
2012	2,545	55	2,490	100
2013	3,077	2	3,075	124
2014	1,746	65	1,681	68
2015	1,503	35	1,468	59
2016	1,050	13	1,037	41
2017	1,060	50	1,010	40
2018	1,114	11	1,103	44

2.F Product uses as substitutes for Ozone Depleting Substances (ODS)

In 2016, with support from the Multilateral Fund for the Implementation of the Montreal Protocol, the Government of Lebanon through the National Ozone unit has undertaken an Ozone Depleting Substances (ODS) Alternative Survey. The survey was conducted with support from UNDP and in accordance with the ExCom guidelines and was based on the 2012-2015 consumption data (baseline).

The survey indicated a wide range of HFC uses in Lebanon mainly under the Refrigeration and Air Conditioning (RAC) sector. Whereas, there were limited applications of HFCs in fire suppression systems, the survey did not result in any indication of HFC applications in the foam, solvent and aerosol sectors. All ODS alternatives including HFCs are imported primarily from USA, UK, Spain, UAE, Japan and China. Based on the available information, only emissions from refrigeration and air conditioning systems (2.F.1) were estimated and reported in this category. Also, according to the Table 7.3 of the 2006 IPCC Guidelines (Volume 3, chapter 7, p.7.16), Aerosols (2.F.4) and Solvents (2.F.5) contribute a small percentage to the total reported emissions in a number of Annex 1 Parties. Thus, the assumption was made that these categories do not produce HFC emissions in Lebanon.

Methodology for estimating F-gases

In this category, emissions from production, banks (lifetime servicing) and end-of-life emissions (from disposal) were estimated using the Tier 2b approach of the IPCC 2006 Guidelines. A bottom-up approach was applied to gather the necessary data to build the RAC appliances inventory, enable historic inventory estimates and GHG emissions. For production, real consumption of HFC-134a and R404a were obtained from producers for 2014-2018 and extrapolated using domestic sales data for 1999-2013. Emissions from banks and disposal were estimated using equations 7.13 and 7.14 of the 2006 IPCC Guidelines.

Refrigeration and air conditioning systems were divided into the sub-categories of commercial refrigeration, domestic refrigeration, transport refrigeration, mobile air conditioning systems and stationary air conditioning systems (see Table 44). There is only one domestic refrigeration producer in Lebanon, Lematic Industries, that has been using HFCs in their manufacturing processes since 1999. Another company, Leon Industries, S.A.R.L., manufactures refrigerators and condensing units for supermarkets and commercial stores.

Table 44: RAC subsectors and appliance types

Subsector	Appliance types
Air conditioning	
Unitary air conditioning	Window-type air conditioners Split residential air conditioners Split commercial air conditioners Duct split residential air conditioners Commercial ducted splits Rooftop ducted Multi-splits
Chillers	Air conditioning chillers
Mobile air conditioning	Car air conditioning Large vehicle air conditioning
Refrigeration	
Domestic refrigeration	Domestic refrigerators
Commercial refrigeration	Stand-alone equipment Condensing units
Transport refrigeration	Transport refrigeration

The data used in the inventory was collected to develop the National Cooling Plan of Lebanon - (NCP) the Ministry of Environment and funded by the Kigali Cooling Efficiency Program (MoE/UNDP/KCEP, 2020).

Data on appliances sales was gathered through a detailed survey performed at local shops, sales points, and supermarkets. Twelve questionnaires were completed accounting for around 45% of the market share for each of the subsectors. Additionally, data were obtained from statistical outputs of government departments, previous surveys data, custom offices for imported equipment and refrigerants, expert opinions.

For each of the subsectors and their respective appliance types, the methodology estimates an inventory of historic and future unit sales and stocks. From this, refrigerant consumption and emissions were estimated using data on life-time, charge and other parameters, as presented in Table 45. According to the collected information HFC refrigerants used in Lebanon are HFC-134a

and the mixtures of R404A (refrigeration), R407C (AC) and R410A (AC). The shares of the refrigerant mixtures out of total charge were also collected under National Cooling Plan development. Emissions of single refrigerants were estimated using data on blends' composition (table 7.8 2006 IPCC Guideline, V3, Chapter 7, p.44)

Table 45: Parameters for the HFCs emissions estimates

Equipment type	Lifetime (years)	Main refrigerants	Initial charge (IC) (kg)	Life time (years)	Service EF (% of IC)	Disposal EF (% of IC)
Split residential AC	9	R410A	0.9	9	10	95
Split commercial AC	9	R410A	1.8	9	10	80
Rooftop ducted	9	R407C, R410A, R134A	10	9	8	75
Multi-splits	9	R407C, R410A	15	9	10	80
Air conditioning chillers	20	R134A, R410A	35	20	22	95
Car air conditioning	15	R134A	0.6	15	20	100
Large vehicle air conditioning	15	R134A	8	15	30	100
Domestic refrigeration	8	R134A	0.175	10	2	80
Stand-alone equipment	15	R134A, R404A	0.4	15	3	80
Condensing units	20	R134A, R404A	5	9	30	100

Table 46: Consumption of and emissions from substitutes of ODS

	Tonnes				Gg CO_2eq.				
GWP					**1300**	**3170**	**677**	**4800**	
Years	**HFC-134a**	**HFC-125**	**HFC-32**	**HFC-143a**	**HFC-134a**	**HFC-125**	**HFC-32**	**HFC-143a**	**Total**
1994									
1995									
1996									
1997									
1998	7.48	0.52	0.49	0.03	9.73	1.66	0.33	0.14	**11.85**
1999	99.60	3.08	0.98	2.46	129.48	9.76	0.67	11.79	**151.70**
2000	113.74	4.73	2.51	2.56	147.86	15.00	1.70	12.29	**176.85**
2001	167.62	6.28	3.93	2.67	217.91	19.91	2.66	12.81	**253.29**
2002	183.35	7.69	5.09	2.94	238.35	24.38	3.45	14.11	**280.29**
2003	180.62	9.38	6.58	3.13	234.81	29.73	4.46	15.04	**284.04**
2004	203.61	10.75	7.77	3.33	264.70	34.09	5.26	16.00	**320.04**
2005	224.44	24.34	19.78	4.83	291.77	77.17	13.39	23.19	**405.51**
2006	252.03	27.23	22.30	5.19	327.64	86.32	15.10	24.90	**453.95**
2007	310.85	46.58	40.64	5.87	404.10	147.66	27.52	28.18	**607.46**
2008	397.02	50.54	43.70	6.85	516.12	160.21	29.59	32.87	**738.78**
2009	412.37	54.82	45.92	9.22	536.08	173.78	31.09	44.27	**785.21**
2010	452.41	107.38	93.96	13.23	588.13	340.41	63.61	63.51	**1,055.66**
2011	438.60	118.41	100.76	18.17	570.18	375.35	68.21	87.24	**1,100.97**
2012	484.75	127.38	111.92	15.28	630.17	403.79	75.77	73.34	**1,183.07**
2013	492.10	124.34	105.31	19.70	639.72	394.17	71.30	94.55	**1,199.74**
2014	503.91	130.10	107.07	24.37	655.08	412.40	72.49	116.98	**1,256.95**
2015	448.76	165.21	135.46	32.01	583.39	523.72	91.71	153.64	**1,352.45**
2016	470.66	179.93	149.62	32.35	611.85	570.36	101.30	155.28	**1,438.79**
2017	508.27	208.40	178.44	31.26	660.75	660.62	120.80	150.07	**1,592.23**
2018	571.15	249.42	220.33	28.93	742.49	790.68	149.16	138.84	**1,821.17**

2.G.3 N_2O from product use

N_2O Emissions from medical applications were estimated based on the IPCC 2006 Guidelines. Activity data was collected from customs on the amount of import and export of N_2O for medical purposes for 2011-2018 (Table 47). For previous years, data on the N_2O consumption was extrapolated as the average for the available period per capita. It is assumed that none of the administered N_2O is chemically changed by the body, and all is returned to the atmosphere, thus the emission factor of 1.0 was applied.

Table 47: Activity data used for estimation of N_2O emissions from medical use

Years	Import	Export	Consumption (Import-Export)
	Tonnes	Tonnes	Tonnes
1994			79
1995			82
1996			84
1997			85
1998			86
1999			87
2000			90
2001			93
2002			98
2003			102
2004			107
2005			110
2006			111
2007			111
2008			111
2009			112
2010			115
2011	230	110	120
2012	335	118	217
2013	278	141	137
2014	274	143	131
2015	235	35	200
2016	121	10	111
2017	177	26	151
2018	156	4	152

Results of Industrial Processes and Product Use

The Industrial Processes and Product Use (IPPU) category in Lebanon contributed about 10% to the total national emissions in 2018. GHG emissions primary entail the CO_2 gas from the cement production sector being the biggest contributor to the sector until 2016. After 2016, the share of cement production decreased gradually from 62% in 2015 to only 45% in 2018 (Figure 35).

Starting 2010, the share of F-gases from refrigeration and air conditioning increased rapidly due to high bank emissions resulting in almost 54% of the total IPPU emissions in 2018. The use of HFCs as refrigerants grew only gradually starting 1998 summing up to 1,821 Gg CO_2-eq. by 2018. In Lebanon, the leading HFC refrigerants are HFC-134a however it is the mixtures of R404A, R407C, R410A that result in most if the emissions in terms of CO_2eq., due to high Global Warming Potential of HFC HFC-125 (43% in 2018). it is estimated that 83% of emissions of F-gases are generated from stationary sources (residential and commercial refrigerators, air conditioning, condensing units and process

chillers) and 17% from mobile sources (car air conditioning and refrigerated trucks). All other sources have minimal contribution to emissions in the sector (1-2% aggregated throughout the entire timeseries).

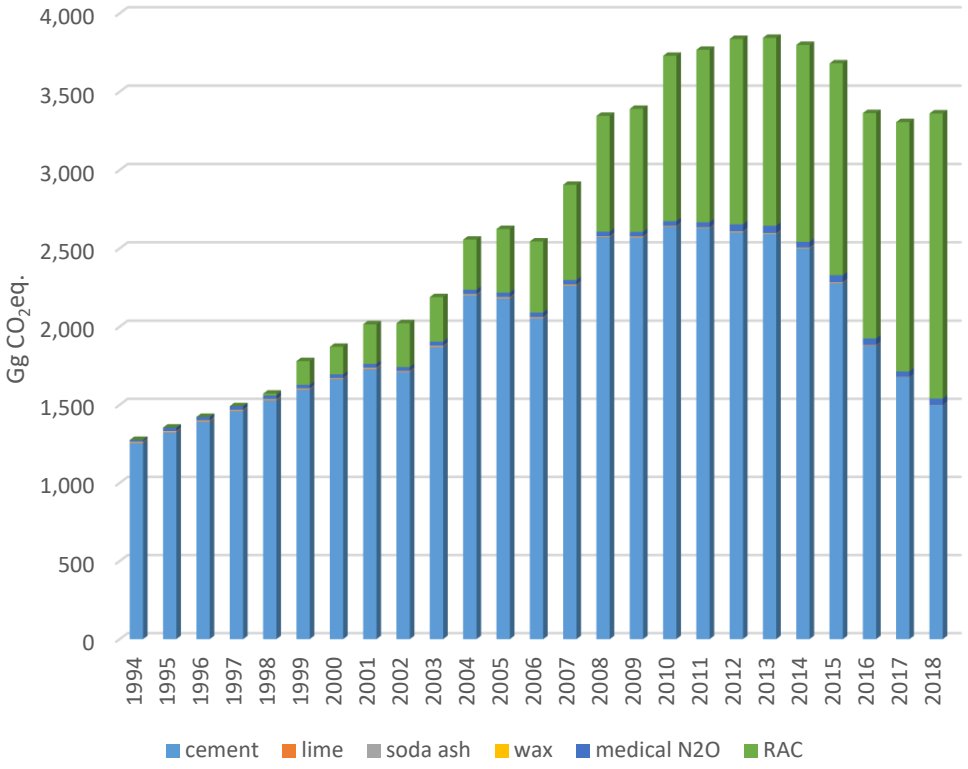


Figure 35: GHG Emissions trend in IPPU sector for 1994-2018

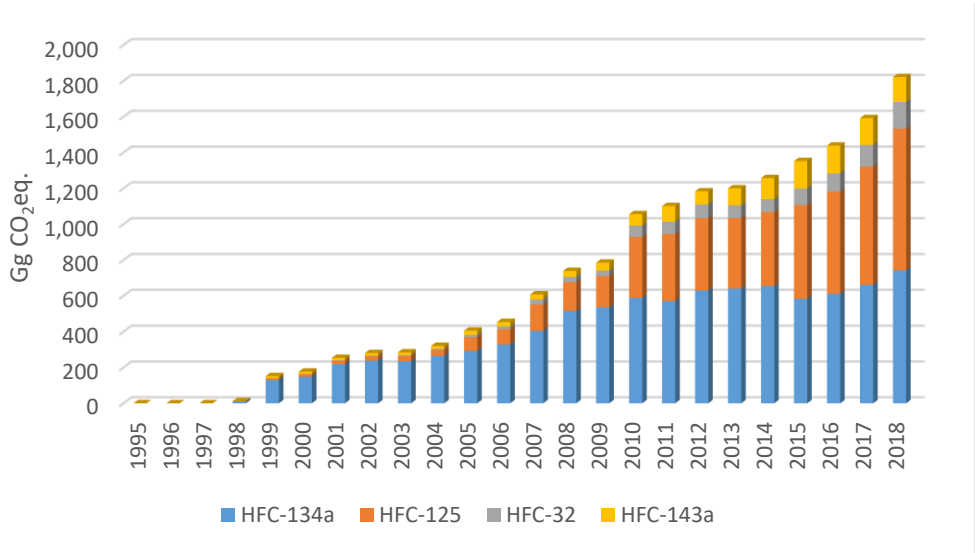


Figure 36: Total HFC emissions

There are few recalculations in emissions in the IPPU sector, due to refinement of the activity data and the inclusion of the sub-category N_2O rom medical applications. However, following the availability of new activity data related to F-gases used in the refrigeration and air conditioning sector, a recalculation for the whole time-series for IPPU was undertaken to ensure consistency in reporting, which increased significantly emissions from IPPU with an average increase +24% Gg CO_2eq. across the 1994-2015 period (Figure 36).

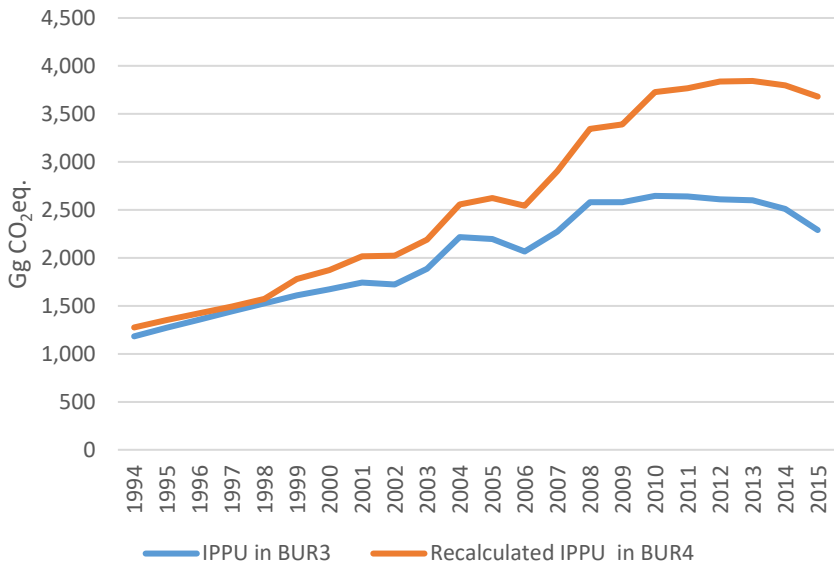


Figure 37: Impact of recalculation on IPPU emissions

3. Agriculture, Forestry and Other Land Use (AFOLU)

Methodology

The present section covers the following AFOLU subcategories:

3.A. Livestock

- 3.A.1 Enteric fermentation
- 3.A.2 Manure management

3.B Land

- 3.B.1 Forest land
- 3.B.2 Cropland
- 3.B.3 Grassland
- 3.B.4 Wetland
- 3.B.5 Settlements

3.C. Aggregate sources and non-CO_2 emission sources on land

- 3.C.1 Emissions from biomass burning
- 3.C.3 Urea application
- 3.C.4 Direct N_2O emissions from managed soils
- 3.C.5 Indirect N_2O emissions from managed soils
- 3.C.6 Indirect N_2O emissions from manure management

3.D. Other

- 3.D.1 Harvested Wood Products

The following subcategories are not occurring in Lebanon and reported as such:

- 3.B.6 Other land
- 3.C.2 Liming
- 3.C.7 Rice cultivation
- 3.C.8 Other

3.A Livestock

This category estimates CH_4 emissions from enteric fermentation in livestock, and CH_4 and N_2O emissions from manure management. As per the guidelines, CO_2 emissions from livestock are not estimated because annual net CO_2 emissions are assumed to be zero (the CO_2 photosynthesized by plants is returned to the atmosphere as respired CO_2). A portion of the C is returned as CH_4 and for this reason, CH_4 requires separate consideration. Cattle are an important source of CH_4 in many countries because of their large population and high CH_4 emissions rate due to their ruminant digestive system. N_2O emissions from manure management vary significantly between the types of management system used and can also result in indirect emissions due to other forms of nitrogen loss from the system.

Methodology

The tier 1 methodology was adopted for the calculation of GHG emissions from enteric fermentation and manure management as information on dietary regimes, rate of pregnancy, rate of lactation and average amount of work done by livestock, manure characteristics and practices required for

tier 2 is not available. Basic characterization was therefore performed to assess the animal population in Lebanon. Population of some species was adjusted to number of days alive as appropriate using equation 10.1. For non-dairy cattle, imported population was added to national population and adjusted to number of days alive.

For enteric fermentation (3.A.1): emission factors for each species were selected from the list of defaults provided in the 2006 IPCC guidelines. Each population subgroup was multiplied by the corresponding emission factor to estimate emissions from each species as per equation 10.19. Finally, total emissions from livestock enteric fermentation were summed up as per equation 10.20. except for poultry since they do not cause enteric fermentation emissions.

For CH_4 emissions from manure management (3.A.2): emission factors for each species were selected from the list of defaults provided in the 2006 IPCC guidelines. The sum of each population subgroup multiplied by its corresponding emission factor was performed to calculate total CH_4 emissions form manure management as per equation 10.22.

For direct N_2O emissions from manure management (3.A.2): definition of manure management systems in Lebanon and attribution of fraction of total nitrogen excretion managed in each manure management system was estimated through stakeholder consultation and expert judgement, as there is no coherent published data on the matter. Emission factors for each species in each manure management system were selected from the list of defaults provided in the 2006 IPCC guidelines. The following parameters were also defined: default nitrogen excretion rate per head per species, typical animal mass per species, fraction of total annual nitrogen excretion that is managed in each manure management system. Annual nitrogen excretion rate per type of livestock was calculated as per equation 10.30 and total direct N_2O emissions from manure management was calculated as per equation 10.25.

Activity data

The livestock categories found in Lebanon are: dairy cattle, non-dairy cattle, sheep, goats, poultry (laying hens, broilers and traditional), swine, horses, mules, asses, and camels. According to experts at the Ministry of Agriculture (MoA), some buffaloes exist in Lebanon in one farm in the country that produces mozzarella *di buffala.* However, statistics on buffaloes are not included in the MoA database nor in the FAOSTAT. While it is estimated that this farm currently has around 80 buffaloes, clear information on historical data is not available nor known. Therefore, emissions from this category are Not Estimated and reported as such.

Activity data was updated for the years 2016-2018 as per new data provided by MoA and available on FAOSTAT. Data on imported beef was estimated by MoA expert judgement for the years 2016-2018 since published information could not be obtained. Populations of imported beef and broilers were adjusted to 60 and 30 days alive respectively.

Table 48: Livestock population in Lebanon (heads) from 1994 to 2018

	Dairy cattle	Non-dairy cattle*	Sheep	Goats	Camels	Horses	Mules	Asses	Pigs (Swine)	Poultry**
1994	51,620	61,577	242,980	418,980	530	6,810	6,500	20,000	52,800	11,790,258
1995	52,000	43,633	250,000	437,630	490	5,280	6,000	20,000	45,000	11,580,417
1996	50,552	54,818	312,550	482,220	470	4,920	5,175	18,000	40,000	11,883,616
1997	34,223	69,439	322,050	496,710	460	5,000	5,500	18,000	35,000	12,965,753
1998	36,324	51,146	350,000	466,340	460	4,000	5,600	17,000	34,000	10,998,630
1999	38,432	55,388	378,050	435,970	450	4,000	5,800	16,000	28,000	11,378,082
2000	38,900	56,399	354,000	417,000	450	3,580	4,780	15,000	26,000	14,491,781
2001	39,577	53,755	328,580	399,180	440	3,580	4,780	15,000	23,000	15,020,548
2002	43,820	63,138	297,830	408,930	440	3,580	4,780	15,000	21,000	15,413,699
2003	47,464	57,014	302,510	428,040	440	3,580	4,780	15,000	14,000	15,542,466
2004	43,856	53,851	305,360	432,160	440	3,580	4,780	15,000	12,500	16,793,151
2005	43,800	48,166	337,300	494,700	440	3,580	4,780	15,000	11,000	16,135,616
2006	43,900	49,216	370,400	484,400	440	3,580	4,780	15,000	10,000	16,972,603
2007	45,300	47,545	324,400	434,700	440	3,580	4,780	15,000	9,000	17,468,493
2008	40,200	45,825	370,000	399,100	450	3,580	5,000	15,000	8,500	16,728,767
2009	40,800	49,551	372,100	430,100	450	3,580	5,000	15,000	8,000	16,235,616
2010	40,161	44,061	265,345	403,861	450	2,634	5,000	15,000	7,735	11,563,554
2011	55,000	31,674	450,000	550,000	200	2,634	5,000	15,000	7,650	13,363,014
2012	55,000	37,903	450,000	550,000	200	3,650	5,000	15,000	7,800	13,849,315
2013	67,118	33,930	450,000	550,000	200	3,800	5,000	15,000	7,900	12,705,479
2014	59,461	43,013	450,000	550,000	200	4,000	5,000	15,000	8,000	13,097,993
2015	51,803	52,096	439,215	526,987	214	3,607	4,868	14,831	7,823	13,490,507
2016	53,249	53,563	428,985	499,176	189	3,281	4,677	14,180	6,559	14,087,301
2017	52,572	53,144	433,018	541,667	164	3,307	4,707	14,259	6,515	14,509,920
2018	51,976	52,775	440,908	541,418	146	3,287	4,684	14,184	6,383	14,945,218

*Including imported beef adjusted to 60 days alive

**Including traditional chicken, hens and broilers adjusted to 30 days alive

Definition of manure management systems in Lebanon and attribution of fraction of total nitrogen excreted by species and managed in each manure management system was done during previous inventory cycles through stakeholder consultation and expert judgement, as there is no published data on the matter. Therefore, the same assumptions used in previous BURs were adopted for this inventory. A detailed list of gaps and constraints encountered during the compilation of data on manure management systems as per categories defined in the 2006 IPCC GL is presented in subsequent sections of the present BUR and will be included in the improvement plan.

Table 49: Fraction of Manure Nitrogen per Manure Management System in Lebanon

	Dairy cattle	Non-dairy cattle	Sheep	Goats	Camels	Horse	Mules asses	Swine	Laying hens	Broiler	Traditional chicken
Anaerobic Lagoons	0.01										
Liquid systems	0.005										
Solid storage and drylot	0.955	1	0.33	0.33				0.9			
Daily spread	0.01							0.1			
Pasture range and paddock	0.02		0.67	0.67	1	1	1		0.04	0.04	1
Poultry manure without bedding									0.19	0.19	
Poultry manure with bedding									0.77	0.77	

Emission factors and other parameters

For enteric fermentation (3.A.1): Emission factors used for calculation of methane emissions from enteric fermentation are default values from 2006 IPCC guidelines and reported in Table 50. For non-cattle species, defaults proposed for developing countries were adopted. For cattle species, defaults proposed for Western Europe were adopted since the majority of cattle in Lebanon are imported from Western European countries, as per expert judgement.

Table 50: Methane emission factors for enteric fermentation

Species	CH_4 Emission factor (kg/head/year)	Source
Sheep	5	Table 10.10 page 10.28 of 2006 IPCC guidelines, volume 4 (part 2) chapter 10. Default for developing countries.
Goats	5	
Camels	46	
Horses	18	
Mules and asses	10	
Swine	1	
Dairy cattle	117	Table 10.10 page 10.28 of 2006 IPCC guidelines, volume 4 (part 2) chapter 10. Default for Western Europe as confirmed by expert consultation.
Non-dairy cattle	57	

For CH_4 emissions from manure management (3.A.2): Table 51 presents the emission factors used for calculating methane emission from manure management. For cattle and swine, emission factors suitable for an average temperature of 24 degrees in Eastern Europe were chosen as they better reflect the conditions for manure management in Lebanon as per expert judgement (i.e., solid based systems are used for the majority of manure). For the other species, emission factors for temperate regions were chosen from the default factors proposed by the 2006 IPCC guidelines.

Table 51: Methane emission factors for manure management

Species	CH_4 Emission factor (kg/head/year)	Source
Sheep	0.15	Table 10.15 page 10.40 of 2006 IPCC guidelines, volume 4 (part 2) chapter 10. Default for developing countries, temperate regions.
Goats	0.17	
Camels	1.92	
Horses	1.64	
Mules and asses	0.9	
Poultry	0.02	
Dairy cattle	35	Table 10.14 page 10.38 of 2006 IPCC guidelines, volume 4 (part 2) chapter 10. Default for Eastern Europe, 24 °C average temperature.
Non-dairy cattle	18	
Swine (breeding)	11	

For direct N_2O emissions from manure management (3.A.2): Two parameters are needed for each livestock species to calculate nitrous oxide emissions from manure management: The Nitrogen excretion rate per head, and the typical animal mass. Default values are provided by region and were adopted as per the recommendation of national experts (Table 52).

In addition, 2 other parameters are needed per animal species and per manure management systems: the fraction of Nitrogen loss in the manure management system, and the amount of N in organic bedding. According to the 2006 IPCC guidelines, the amount of N bedding in manure management systems vary according to bedding materials. The following values are suggested: for dairy cattle, 7 kg N per animal per year, for non-dairy cattle, 4 kg N per animal per year, for breeding swine, 5.5 kg N per animal per year. The IPCC software mentions that N for organic bedding should be considered 0 unless for the following 2 manure management systems: deep bedding and solid storage. For sheep and goat in solid storage, the same value as non-dairy cattle were considered.

Emission factors for direct N_2O emissions from manure management systems are presented in Table 54. As per the 2006 IPCC guidelines, emissions from pasture range and paddock are not reported under manure management, but rather in category 3.C.

Table 52: Nitrogen excretion rate for animal species and typical animal mass for livestock categories

	N excretion rate per head (kg of N per 1,000 kg of animal mass per day)*	Regional characteristics	Typical animal mass (kg/animal) **	Regional characteristics
Dairy cattle	0.48	Western Europe	600	Western Europe
Non-dairy cattle	0.36	Latin America	420	Western Europe
Sheep	1.17	Middle East	28	Developing countries
Goats	1.37	Middle East	30	Developing countries
Camels	0.46	Middle East	217	Developing countries
Horses	0.46	Middle East	238	Developing countries
Mules and asses	0.46	Middle East	130	Developing countries
Swine (breeding)	0.42	Western Europe	28	Western Europe
Laying hens	0.96	Western Europe	1.80	EFDB – IPCC software 2.54
Traditional chicken	0.83	Western Europe	1.80	EFDB – IPCC software 2.54
Broilers	1.10	Western Europe	0.90	EFDB – IPCC software 2.54

*Source: Table 10.19 page 10.59 of 2006 IPCC guidelines, volume 4 (part 2) chapter 10
**Source: Tables 10 A-4 to 10 A-8 page 10.77 of 2006 IPCC guidelines, volume 4 (part 2) chapter 10

Table 53: Fraction of Nitrogen loss in manure management system ($Frac_{LossMS}$)

Animal type	Manure management system	$Frac_{LossMS}$	Source
Swine	Solid storage	0.50	Table 10.23 page 10.67 of IPCC 2006 volume 4 (part 2) chapter 10
Dairy cattle	Anaerobic lagoon	0.77	
	liquid slurry	0.40	
	Solid storage	0.40	
	Daily spread	0.22	
Poultry	Poultry without litter	0.55	
	Poultry with litter	0.50	
Other Cattle	Solid storage	0.50	
Other	Solid storage	0.15	

Table 54: Emission factors for Nitrous Oxide emissions for each utilized manure management system

Manure management system	Emission Factor (kg N_2O-N/kg N excreted)	Source
Anaerobic lagoons	0	Table 10.21 page 10.62 of 2006 IPCC guidelines, volume 4 (part 2) chapter 10
Liquid systems	0	
Solid storage and drylot	0.02	
Poultry with bedding	0.001	
Poultry without bedding	0.001	
Daily spread	0	

3.B Land

There are many factors governing emissions and removals of greenhouse gases that can be both natural and anthropogenic and it can be difficult to clearly distinguish between causal factors. Under the 2006 IPCC guidelines, only anthropogenic GHG emissions and removals are estimated, as all those occur on 'managed land', which is "land where human interventions and practices have been applied to perform production, ecological or social functions" (IPCC, 2006).

Methodology

The representation of most land-use areas and land conversions was done following the Approach 3 of the IPCC guidelines. The nationally adopted land-use classification system of the Land Cover / Land Use map of 1998 was employed for the inventory estimation. Each land category was further subdivided into lands remaining in the same land use (for example, forest lands remaining forest lands) and lands converted into another land-use category (for example, forest lands converted into croplands) during the inventory period. See Annex III for more details.

The tier levels of the activity data acquired by surveys and personal communications depended on the accuracy and completeness of the nationally available estimates. The selection of the appropriate tier level for the land categories and subcategories, non-CO_2 gases and carbon pools, was mostly based on the resources available for the inventory process. The Tier 1 approach, which employs the basic method and the default emission factors provided in the IPCC Guidelines, was typically used in these inventory calculations. The Tier 3 approach, which uses higher order methods including models and inventory measurement systems was used for the representation of most land-use areas and land conversions. This allowed the generation of data about land use changes such as forest, croplands and grasslands conversions to settlements as well as the extent of burned areas in forest, croplands and grasslands. It is the most complex, accurate and spatially explicit method, provided by the IPCC guidelines, which ensured the consistency of the inventory calculations.

Multi-temporal satellite images were employed for mapping changes in land cover and land use changes. These included Landsat TM, ETM+ (1994-2012) and Landsat 8 imagery (2013-2018). The analysis of acquired data comprised mapping and comparing changes in land cover and land use using comparable satellite data of the same spatial resolution and spectral bands.

Quality Control (QC) procedures were adopted to ensure data integrity, correctness and completeness, in addition to identifying errors and omissions. GHG emissions and removals were reported using the IPCC 2006 Guidelines and software. This allowed documenting and archiving for all information used to produce the inventory, including all activity data, emission/removal factors and sources of data. In addition, FOLU documentation sheets for Land Use categories and biomass burned were filled in and reviewed. Main activity data and assumptions taken into consideration for the Land Use Categories of the FOLU sector are presented in the tables below, respectively (Table 55 and Table 56).

Table 55: Land use categories and subcategories, carbon pools and non-CO_2 gases accounted for in the inventory estimation of the AFOLU sector in Lebanon

Land use categories	Subcategories	Estimations calculated[1]	Not Estimated (NE)/No activity data available	Assumptions
Forest land	Forest land remaining forest land	Estimated	-	-
	Land converted to Forest land	Other land converted to Forest land through afforestation/ plantations	Grassland and Cropland converted to Forest land	No Settlements converted to Forest land
Cropland	Cropland remaining Cropland	Estimated		
	Land converted to cropland	-	Forest land, Grassland and Other land converted to Cropland	No Settlements converted to Cropland
Grassland	Grassland remaining Grassland	Estimated	-	-
	Land converted to Grassland		Cropland, Forest land and Other land converted to Grassland	No Settlements converted to Grassland
Wetland	Wetland remaining Wetland	-	-	Estimations not required for calculation[2]
	Land converted to Wetland	Grassland converted to Wetland	-	No Cropland, Forest land, Settlements or Other lands that are converted to Wetlands
Settlement	Settlements remaining Settlement			Estimations not required for calculation[2]
	Land converted to Settlements	Forest land, Grassland and Cropland converted to Settlements	Other land converted to Settlements	-
Other land	Other land remaining Other land	-	-	Typically unmanaged
	Land converted to Other land	-	Forest land, Grassland and Cropland converted to Other land	No Settlements converted to Other land

[1] Estimations are calculated for the following carbon pools and non-CO_2 gases depending on data availability: AGB, BGB, DOM, litter and soil carbon; CH_4, N_2O, CO and NO_x

[2] Lebanon is considered as non-Annex I Party in the UNFCCC convention.

Table 56: Main assumptions for FOLU - Land Use Categories for 1994-2018

<table>
<tr><td>Climate region</td><td>Warm temperate dry</td></tr>
<tr><td>Soil type</td><td>High activity clay mineral</td></tr>
<tr><td>Ecosystem type</td><td>Subtropical dry forest</td></tr>
<tr><td>Continent type</td><td>Continental</td></tr>
<tr><td>Species age class</td><td>20 years</td></tr>
<tr><td>Growing stock level</td><td>Unspecified</td></tr>
<tr><td>Area of Forest remaining forest</td><td>The land use classes of 1998 are subdivided here into the three subcategories coniferous, broadleaved, and mixed forests. The class of shrublands is considered to be within the broadleaved forests subcategory since 52% of shrublands are broadleaf, 13% are mixed and only 1% are coniferous (FAO, 2005)</td></tr>
<tr><td>Annually extracted volume of roundwood</td><td>According to experts' surveys (E. Chneis, and J. Stephan, personal communication, May 2013), no roundwood is extracted from Lebanon.
Because of the lack of official data, FAO provides an estimate of commercial roundwood in Lebanon based on the best information available however it was thought more accurate to take into account opinion of national experts.</td></tr>
<tr><td>Biomass density (average weighed)</td><td>The biomass density (tonnes/m^3) are taken as an average of biomass densities of the main tree species occurring in a Forest land subcategory. A weighted average of the biomass densities of all tree species constituting over 3% of the forest land subcategories were calculated to yield the final biomass density of Broadleaved and Coniferous forests, whereas the biomass density of the Mixed forests is the average of the biomass densities of the Broadleaved and Coniferous forests.
The percent of different tree species within the forest land subcategories is based on FAO (2005) and the biomass densities of the different species are taken from the IPCC 2006 GL.
<table>
<tr><th><u>Broadleaved forest</u></th><th>Actual % in forests</th><th>Weighted percentage</th><th>Biomass density of individual species (tonnes d.m.m^{-3} fresh volume)</th><th>Average weighted Biomass Density</th></tr>
<tr><td>Quercus calliprinos</td><td>41.1%</td><td>46.08</td><td>0.58</td><td>0.26</td></tr>
<tr><td>Quercus infectoria</td><td>34.1%</td><td>38.22</td><td>0.58</td><td>0.22</td></tr>
<tr><td>Quercus cerris and var.pseudocerris</td><td>14%</td><td>15.70</td><td>0.58</td><td>0.09</td></tr>
<tr><td>Total</td><td>89.2</td><td>100</td><td></td><td><u>0.58</u></td></tr>
<tr><td><u>Coniferous forest</u></td><td>Actual percentages in forests</td><td>Weighted percentage</td><td>Biomass density of individual species (tonnes d.m.m^{-3} fresh volume)</td><td>Average weighted Biomass Density</td></tr>
<tr><td>Pinus brutia</td><td>43.7</td><td>44.86</td><td>0.53</td><td>0.23</td></tr>
<tr><td>Pinus pinea</td><td>35.8</td><td>36.75</td><td>0.46</td><td>0.18</td></tr>
<tr><td>Juniperus excelsa</td><td>9.7</td><td>9.95</td><td>0.51</td><td>0.05</td></tr>
<tr><td>Cedrus libani</td><td>4.5</td><td>4.62</td><td>0.48</td><td>0.02</td></tr>
<tr><td>Juniperus drupacea</td><td>3.7</td><td>3.79</td><td>0.49</td><td>0.02</td></tr>
<tr><td>Total</td><td>97.4</td><td>100</td><td></td><td><u>0.50</u></td></tr>
<tr><td><u>Mixed</u></td><td></td><td></td><td></td><td><u>0.54</u></td></tr>
</table>
</td></tr>
<tr><td>Mineral soils</td><td>There is no data for the values carbon stocks in mineral soils in Lebanon therefore Tier 1 is used and it assumes that the net change in carbon stocks in mineral soil is zero.</td></tr>
</table>

<table>
<tr><td>Organic soils</td><td>There are no organic forest soils in Lebanon according to experts' surveys (T. Darwish, personal communication, May 2013) therefore the value of area of drained organic forest soils is equals zero.</td></tr>
<tr><td>Disturbances (Forest fire)</td><td>The land use classes in 1998 are subdivided into the Prometheus fuel type classes. The back mapping of the Prometheus fuel type classes is used to the Rothermel fuel models and fuel quantity.
<table>
<tr><th>Prometheus fuel type class</th><th>Rothermel fuel models</th><th>Mass of available fuel (Rothermel averages)</th></tr>
<tr><td>1</td><td>1, 2, 3</td><td>5 tonnes/ha</td></tr>
<tr><td>2</td><td>5</td><td>6.5 tonnes/ha</td></tr>
<tr><td>3</td><td>6</td><td>12.5 tonnes/ha</td></tr>
<tr><td>4</td><td>4</td><td>30 tonnes/ha</td></tr>
<tr><td>5</td><td>8, 9</td><td>9.5 tonnes/ha</td></tr>
<tr><td>6, 7</td><td>7</td><td>12.5 tonnes/ha</td></tr>
</table>
No data exists on the amount of vegetation fires on lands converted to Forestlands, therefore they will not be calculated.</td></tr>
<tr><td>Annual change in carbon stocks in living biomass</td><td>No data exist on losses in forest plantations or afforestation areas, therefore we assume that value is equal to zero.</td></tr>
<tr><td>Other land converted to forest land</td><td>The values for area converted to forest land are taken from publications and personal communications with AFDC, LRI, Jouzour Loubnan, and reforestation project leaders in Lebanon
Afforestation and reforestation are both considered as Afforestation according to FAO (2010) especially that afforestation is happening on lands that haven't been forests in over 50 years.
There is no exact data on the quantity and the type of tree species planted, however through personal communications we assumed that the trees planted are mostly Coniferous. (E. Chneis, personal communication, May 2013).</td></tr>
<tr><td>Annual area of cropland with perennial woody biomass</td><td>The only sub-categories being accounted for here are the perennial woody crops that have and have not been burnt. Both burned and unburned perennial woody crops make up the total of perennial woody crops.</td></tr>
<tr><td>Land converted to cropland</td><td>No data exists on the amount of lands converted to croplands, therefore they will not be calculated.</td></tr>
<tr><td>Area of grassland covered with grasses</td><td>The grasslands category includes only grasses. Grasslands covered with perennial woody biomass are considered shrubland and are included under Forestlands.</td></tr>
<tr><td>Settlements remaining settlements</td><td>No estimates will be made for the subcategory settlements remaining settlements due to lack of data.</td></tr>
<tr><td>Land converted to settlements</td><td>Land converted to Settlements is calculated for Forest lands in addition to Croplands and Grasslands since enough data was available to do the calculation.</td></tr>
</table>

Activity data and emission factors

Data collection was conducted using sources from satellite remote sensing imagery, literature reviews, and surveys. Table 57 represents the type of data sources and databases used in the data collection process. Table 58 represents the Activity Data for the years 2016-2018. Activity data for the 1994-2018 period is presented in Annex III.

Table 57: Type of data sources, databases and references used for data collection

Type of data source	Databases
Online database, Global databases	FAOSTAT, IPCC Emission Factor Database, Google Earth
Scientific articles and papers	As referred to in the National Inventory Report (NIR) of Lebanon's Third National Communication (TNC) (MoE/UNDP/GEF, 2016)
National reports	FAO (2005) FAO (2010) FAO (2015)
Satellite imagery	5 SPOT imagery (2.5 m) Landsat TM, ETM+ images (1998-2012) and Landsat 8 images (2013-2018)
Maps	Land Cover Land Use map of Lebanon of 1998 Annual rainfall map Fertility and pedology maps of Lebanon (scale 1/200 000) Digital Elevation Model (DEM) of Lebanon (25 m)
Surveys and personal communications	Mr. Elie Chneis (AFDC) Mr. Jean Stephan (FAO) Mr. Joseph Bechara (LRI) Mr. Raymond Khoury (Greenplan)

Table 58: Activity Data for selected years

	2013	2015	2018
Forest Land remaining Forest Land	**254,106.19**	**254,009.69**	**253,744.74**
Coniferous	*34,822.44*	*34,818.63*	34,788.47
Broadleaf	*192,925.38*	*192,843.63*	192,663.64
Mixed	*26,358.38*	*26,347.44*	26,292.64
Annual volume of fuelwood gathering (m^3)	**18,769**	**18,706**	**18,641**
Non-Coniferous	*15,000*	*15,000*	*15,000*
Coniferous	*3,769*	*3,706*	*3,641*
Cropland remaining Cropland	**328,364.69**	**327,431.25**	**326,684.30**
Perennial	*158,970.00*	*158,786.44*	*158,516.54*
Annual	*169,394.69*	*168,644.81*	*168,167.77*
Grassland remaining Grassland	**315,180.62**	**315,149.44**	**314,976.94**
Wetland remaining Wetland	**513**	**520.5**	**524.25**
Other Land remaining Other Land	**45,443.45**	**45,094.57**	**44,709.39**
Forest Land disturbances (forest fires) By forest type	**127.56**	**182.56**	**113.13**
Coniferous	*4.75*	*14.87*	*18.63*
Broadleaf	*44.25*	*113.81*	*34.94*
Mixed	*78.56*	*53.87*	*59.56*
Grassland burned	**37.88**	**302.38**	**58.50**
Fuel Type 1	*37.87*	*226.81*	*0.00*
Fuel Type 2	*0*	*75.56*	*58.50*

Cropland Burned		**9.56**	**246.5**	**1.38**
Land converted to Settlements		**1,248.25**	**624.06**	**355.75**
Forest Land to Settlements		356.94	53.31	90.78
	Coniferous	*48.62*	*3.125*	*5.86*
	Broadleaf	*258.75*	*45.12*	*63.99*
	Mixed	*49.56*	*5.06*	*20.93*
Grassland to Settlements		296.68	15.12	66.06
Cropland to Settlements		594.63	555.63	198.91
	Perennial	*265.25*	*98.37*	*87.78*
	Annual	*329.37*	*457.25*	*111.13*
Other land to Forest (cumulative)		3,597.55	3,946.43	4,331.61

GHG emissions and removals reported from the FOLU sector in Lebanon are respectively caused by biomass losses and increments and by variation in soil carbon stocks from the different land use and land use change categories which were taken into consideration in this work (Table 59).

Table 59: Causes of GHG emissions and removals reported for the land categories

Biomass losses	Biomass increments	Increase in soil carbon stocks and litter
Forest converted to settlement	Growth of forest lands	Afforestation
Grassland converted to settlement		
Cropland converted to settlement	Growth of croplands (Perennial crops)	
Burned forest lands		
Burned croplands (perennial crops)		
Burned grasslands	Growth of lands converted to forests or plantations (Afforestation)	
Fuelwood gathering from forests		

Almost all burned areas in Lebanon have resulted from human-caused fires. It is not easily possible to have natural causes of fires such as lightning due to the coincidence of lightning with the start of the wet season.

Emission factors and other parameters

Collection of the Emission/Removal factors was done using Tier 1-IPCC 2006 default data or assumptions and/or Tier 2 - Country-specific data from global databases, literature or surveys, and personal communications depending on the availability and type of data. For CO_2 emissions and removals, a complete list of the emission factors and parameters used and reported is presented in Annex III.

3.C Aggregate sources and non-CO_2 emissions sources on land

Non-CO_2 emissions are derived from a variety of sources, including emissions from soils, livestock and manure, and from combustion of biomass, dead wood and litter. Direct emissions of N_2O from soils are based on the amount of N applied to soils from the following sources:

- Managed soils: Synthetic Fertilizers F_{SN}
  Organic N applied as fertilizer: F_{ON} (animal manure, sewage sludge, composting).
  N in crop residues: F_{CR}
  N mineralization: F_{SOM}

- Drainage/management of organic soils: F_{OS}. According to expert judgement, no organic soils exist in Lebanon as per the IPCC guidelines definition (i.e., 12 to 20% of organic matter content per mass). Soils in Lebanon do not contain more than 5% organic matter. Therefore, this category is reported as Not Occurring.

- Nitrogen contained in urine and manure deposited by grazing animals: F_{PRP}

Indirect nitrous oxide emissions also occur from all the categories above except the F_{OS}. Indirect emissions occur when nitrogen moves away from the site where it was deposited and is converted into N_2O somewhere else. This phenomenon is referred to as nitrogen loss by volatilization and/or leaching and runoff.

Finally, CO_2 emissions occur during application of fertilization of soils with Urea, due to a loss of CO_2 that was fixed in the industrial production process.

Methodology

For emissions from biomass burning (3.C.1): Under the tier 1 approach, the Equation 2.27 was used to estimate CO_2 and non-CO_2 emissions from fire, using the default data. Almost all burned areas in Lebanon have resulted from human-caused fires. It is not easily possible to have natural causes of fires such as lightning due to the coincidence of lightning with the start of the wet season.

For CO_2 emissions from urea applications (3.C.3): Since this is not a key category, tier 1 equation 11.13 was used where the amount of urea applied in tonnes was used with CO_2 default emission factor.

For direct N_2O emissions from managed soils (3.C.4): The tier 1 methodology consists in estimating the amount of nitrogen added to soils from each source. Each group has a unique emission factor that is multiplied by the total amount of N applied. Then the three estimates of the three groups are added for the total direct N_2O emissions from soils as per equation 11.1. The tier 1 methodology assumes that N_2O emissions occur the year the N is added to soils. Tier 2 methodology was not adopted since this is not a key category and information on conditions under which N is applied/deposited is not available.

- To calculate the amount of N in synthetic fertilizers applied to soils (F_{SN}): multiply amount of Nitrogenous fertilizers by the fraction of N content (p.11.12 of IPCC 2006 volume 4 (part 2) chapter 11)

- To calculate the amount of N from organic N additions applied to soils (F_{ON}): equation 11.3 and equation 11.4.
    - The amounts of N in sewage sludge (F_{SEW}) and composting (F_{COMP}) were not considered as there is no information on the Nitrogen content of the sludge and compost. According to expert judgements, the amounts of imported compost decrease over time as more local compost is used. The imported compost is often not fully rotted, so further rotting on the field might take place depending on conditions. Improvement on information related to F_{SEW} and F_{COMP} is needed and is included in the improvement plan in the subsequent section.
    - The IPCC guidelines do not provide a method for estimating other organic amendments which should be included in F_{ON}. the MoA does not have these figures either. Therefore, the emissions from this subcategory are Not Estimated.
    - Other than compost, the amount of N in animal waste that is intentionally applied to soils should also be included here (F_{AM}), and this figure does not include manure that is deposited by grazing animals. This value is calculated using the equation 10.34. In addition to data and parameters already used for calculating emissions from the manure management category (number of livestock, annual average excretion rate per animal, fraction of total annual N excretion for each livestock category that is managed in each manure management system), two additional parameters are needed: Fraction of managed N manure for livestock species that is lost in the manure management system ($Frac_{LOSS}$) and amount of nitrogen from bedding ($N_{beddingMS}$, to be applied only for solid storage and deep bedding systems)

- To calculate the amount of N from crop residues (F_{CR}): equation 11.6. the following parameters are needed for each crop type: dry weight correction of crop yield (equation 11.7), the area of the crop, the above ground residue (R_{AG}) and below ground residue (R_{BG}) (equations page 11.14, the N content of the above ground residue (N_{AG}) and below ground residue (N_{BG}), the fraction of crop area that is renewed ($Frac_{RENEW}$), the fraction of above-ground residue removed from field. No data is available on the practice of removing residues, therefore fractions were adopted by expert judgement.

- To calculate the amount of N in urine and dung deposited by grazing animals (F_{PRP}): equation 11.5. parameters needed for this equation have been determined in the manure management category.

For indirect N_2O emissions from managed soils (3.C.5): the same quantities of N calculated for direct N_2O emissions are used for indirect emissions (F_{SN}, F_{ON}, and F_{PRP} for volatilization, and F_{SN}, F_{ON}, and F_{PRP} F_{SOM} and F_{CR} for leaching and runoff). In addition, default values for the fractions of F_{SN} that volatizes ($Frac_{GASF}$) and of F_{ON} and F_{PRP} that volatizes ($Frac_{GASM}$) are needed to calculate indirect emissions of N volatilized as per equation 11.9. The fraction of N lost through leaching and runoff ($Frac_{LEACH}$) is needed to calculate indirect N_2O emissions from N leaching and runoff as per equation 11.10.

For indirect N_2O emissions from manure management (3.C.6): nitrogen losses due to volatilisation from manure management was calculated as per equation 10.26, using the values for the fraction of managed nitrogen manure that volatizes per species and per manure management species ($Frac_{GasMS}$) from the list of defaults provided in the 2006 IPCC guidelines, in addition to data identified

for direct N_2O emissions. The default emission factor for N volatilisation and redeposition was adopted. Total indirect N_2O emissions from manure management was calculated as per equation 10.27.

Activity data and Emission factors

Biomass burning

In the 2006 IPCC Guidelines, fire is treated as a disturbance that affects not only the biomass (in particular, above-ground), but also the dead organic matter (litter and dead wood). Biomass burning in Lebanon is limited to Forest land, Grassland and Cropland, where data is actually available (Table 60).

Table 60: Area of burned biomass

	2000	2010	2011	2012	2013	2014	2015	2016	2017	2018
Forests-Burned	330	428	161	603	128	121	183	156	102	113
Coniferous	54	60	15	38	5	7	15	44	19	19
Broadleaf	217	312	134	548	44	97	114	94	53	35
Mixed	59	56	13	17	79	17	54	18	31	60
Grassland-Burned	126	271	182	243	38	68	302	70	3	59
Cropland-Burned	502	675	585	1306	10	283	247	50	14	1

For greenhouse, emission factors are reported in Table 61. It is important to note that all emissions factors have changed from the Good Practice Guidance (GPG) 2003. A complete list of other parameter newly investigated and reported is presented in Annex III.

Table 61: Employed Emission Factors from biomass burning for the years 1994-2018

Emission factors (g/kg dm burnt)		**Changes**	**Reference**
CH_4 Emission factor (Forest land)	4.7	Changed from 9 (1994-2013) to 4.7 g/kg dm burnt (1994-2018)	Default value in IPCC 2006 table 2.5 for "extra tropical forest", Considering the note in table 2.5 "the extra tropical forest includes all other forest types"
N_2O Emission factor (Forest land	0.26	Changed from 0.11 (1994-2013) to 0.26 g/kg dm burnt (1994-2018)	
CH_4 Emission factor (Grassland)	2.3	Changed from 3 (1994-2013) to 2.3 g/kg dm burnt (1994-2018)	Default value in IPCC 2006 table 2.5 for "savanna and grassland"
N_2O Emission factor (Grassland)	0.21	Changed from 0.11 (1994-2013) to 0.21 g/kg dm burnt (1994-2018)	
CH_4 Emission factor (Cropland)	4.7	-	Default value in IPCC 2006 table 2.5 for "extra tropical forest"
N_2O Emission factor (Cropland)	0.26		

For CO_2 emissions from urea applications (3.C.3):
The emission factor for carbon emissions from Urea fertilization is 0.2 tonne of C per tonne of Urea (Source: 2006 IPCC guidelines, page 11.34).

Amount of N in synthetic fertilizer applied to soils (F_{SN}):

The types of fertilizers applied to soils in Lebanon are: Urea, Ammonium Sulphate, Ammonium Nitrate, Calcium Nitrate, different combinations of NPK, Di-ammonium Phosphate, Mono-ammonium Phosphate. It is believed that Sodium Nitrate was also used as a fertilizer in the past. However, since the adoption of Ministerial decision on fertilizer (decision number 507/1 of June 2012) which stipulates that any fertilizer that contains more than 3% of Sodium is forbidden of import, import of Sodium Nitrate has completely stopped since 2013, because Sodium Nitrate contains 26% of Sodium. Sodium is deteriorating to organic matter in the soil and destroys the clay-hummus complex in it.

In previous GHG inventories, emissions of Sodium Nitrate were estimated. This inventory reports emissions under Sodium Nitrate as Not Occurring starting the year 2013.

Expert consultation also revealed that 3 types of fertilizers used in Lebanon have not been included in estimations of previous inventories: Urea Phosphate, Potassium Nitrate and Calcium Ammonium Nitrate. However, since historical data could not be obtained nor estimated, these were not estimated in the current inventory. The inventory team plans to work on retrieving data related to these 3 fertilizers in the future.

According to experts, there is no nitrogen fertilizer production in Lebanon. Therefore, all nitrogen fertilizer applied to soil is imported. We assume that the amount imported in a given year is entirely applied to soils in the same year.
Data for synthetic fertilizer was retrieved from the customs online database starting the year 2010. Data series for previous years were retrieved from consultants' work under previous inventories.

For fertilizers composed of several nitrogenous compounds, total imports were divided by 2 as per stakeholder recommendations, in order to apply the N content for each nitrogenous compound as appropriate.

Table 62: Types of fertilizers and Nitrogen content used in Lebanon

Type of fertilizer	HS code	Adjustments applied to data	N content
Urea	3102.10	Total imports	0.46
Ammonium sulphate	3102.21	Total imports	0.21
Ammonium nitrate	3102.60	Total imports divided by 2	0.35
	3102.80	Total imports divided by 2	
	3102.30	Total imports	
Sodium nitrate	3102.50	Total imports	0.16
Calcium nitrate	3102.60	Total imports divided by 2	0.16
NPK	3105.20	Total imports	0.175
di-ammonium phosphate	3105.30	Total imports	0.18
Mono ammonium phosphate	3105.40	Total imports	0.11
Urea phosphate	3105.59	Not estimated	0.18
Calcium ammonium nitrate	3102.90	Not estimated	0.26
Potassium nitrate	3105.90	Not estimated	0.13

Table 63: Breakdown of total amount of nitrogenous synthetic fertilizers used in Lebanon per type of fertilizer for selected years (in tonnes)

Year	Urea	Ammonium Sulphate	Ammonium Nitrate	Sodium Nitrate	Calcium Nitrate	NPK	Di-ammonium	Mono-ammonium	Total
2000	4,962	22,268	31,314	216	0	41,433	3,354	152	103,697
2006	300	17,867	970	273	46	25,553	3,693	1,211	49,911
2012	4,961	34,253	9,556	7	7,634	23,174	5,048	699	85,332
2015	282	34,489	7,548	0	5,231	36,339	4,578	782	89,249
2016	8,813	24,776	7,578	0	2,656	3,0576	4,189	1,309	79,897
2017	8,810	27,422	4,427	0	3,433	3,9084	5,023	2,397	90,596
2018	1,408	23,826	5,946	0	3,486	3,2504	1,928	4,126	73,224

Table 64: Amount of synthetic fertilizer applied to soil in Lebanon and corresponding FSN

Year	Amount of Synthetic Fertilizer applied to soil (tonnes)	F_{SN} (tonnes)
1994-1998		
1998	110,698	27,949
1999	110,767	27,147
2000	103,697	25,824
2001	108,236	29,151
2002	88,538	21,284
2003	102,135	24,754
2004	103,520	25,704
2005	68,479	14,900
2006	49,911	9,550
2007	69,748	13,340
2008	51,571	9,741
2009	71,505	14,912
2010	80,694	17,016
2011	83,833	18,411
2012	85,332	19,083
2013	85,801	17,798
2014	80,766	17,732
2015	89,249	18,120
2016	79,897	18,583
2017	90,596	19,917
2018	73,224	14,779

Amount of N in crop residues:

Production data for the different types of crops in Lebanon was collected on a wet matter basis and converted to dry matter as per the IPCC guidelines. Data on area cultivated per type of crop was also compiled. All data from 1994 to 1996, and from 2010 to 2014 were completed using the FAOSTAT data base (under the domain Production\crops\(name of crop)\production quantity), as data was not available at the MoA. Data series for broad beans, alfalfa, dry peas, oats and sorghum were retrieved from the FAOSTAT data based for the entire time series. Alfalfa production was obtained by multiplying the area harvested by the yield. Area harvested was obtained from FAOSTAT. Yield (40 tonnes Fresh Weight/ha) was obtained from expert judgment. Other data were obtained from MoA.

Table 65: Crop production in tonnes per crop type and total amount of N in crop residues (F_{CR})

	Dry beans	Green beans	Broad, horse beans	Chick peas	Alfalfa	Lentils	Lupins	Dry peas	Green peas	Vetches	Barley
1994	4,726	30,000	1,950	9,700	27,200	13,000	1,170	1,986	12,800	5,000	20,185
1995	5,000	34,000	2,200	11,000	28,000	13,500	1,140	1,990	13,500	4,900	33,410
1996	5,124	36,836	2,409	11,056	28,400	13,810	1,150	2,425	15,437	4,999	28,423
1997	1,400	11,700	2,729	7,789	28,800	3,932	1,180	2,420	8,393	5,000	26,043
1998	400	27,400	1,000	4,100	29,000	1,600	1,147	2,410	8,500	5,100	15,000
1999	500	26,600	300	3,200	29,200	1,400	1,140	2,400	8,700	4,067	13,900
2000	100	45,900	300	2,200	30,000	800	1,150	2,450	4,400	5,250	9,400
2001	100	41,600	300	1,900	30,400	500	1,200	2,500	4,400	5,350	8,100
2002	736	28,829	0	3,189	30,000	1,822	1,150	2,400	4,562	5,250	17,100
2003	300	20,700	800	1,900	30,000	1,500	1,000	2,400	5,400	5,000	25,000
2004	400	18,300	300	1,500	30,000	600	820	2,400	4,600	4,000	23,800
2005	200	12,600	400	1,300	29,200	800	580	2,400	4,600	3,600	29,000
2006	200	12,700	300	1,200	30,000	600	450	2,400	2,900	3,150	31,800
2007	200	14,200	200	1,400	30,000	1,400	300	2,400	5,200	2,800	33,100
2008	100	14,200	300	1,300	30,000	1,100	220	2,400	3,200	2,000	23,600
2009	200	15,900	100	1,200	30,000	1,600	150	2,500	4,900	1,300	29,700
2010	549	27,000	122	2,337	30,000	1,864	100	2,568	5,100	700	21,839
2011	743	25,000	126	3,547	30,000	1,893	132	2,500	4,371	720	30,000
2012	388	25,000	143	2,340	30,000	1,363	110	2,490	4,107	800	35,000
2013	426	24,439	150	2,435	20,000	1,471	115	2,495	4,090	825	35,000
2014	970	23,897	140	3,340	20,000	1,284	134	3,500	4,422	836	33,000
2015	3,206	13,372	125	1,941	20,000	635	151	3,663	11,240	117	29,169
2016	3,726	12,973	126	1,383	20,000	862	142	3,619	12,916	294	48,790
2017	3,235	11,531	126	2,783	20,000	2,151	87	3,766	10,433	286	35,561
2018	3,223	12,773	126	3,550	20,000	2,179	88	3,889	97,64	277	30,000

Table 66: Crop production in tonnes per crop type and total amount of N

	Maize	Oats	Sorghum	Wheat	Carrots	Garlic	Onions	Potatoes	Total (kg N/year)
1994	4,086	510	1,653	52,675	32,620	35,000	70,789	321,767	**2,988,604**
1995	4,670	520	1,780	60,005	33,000	40,000	76,000	340,730	**3,289,958**
1996	4,772	530	1,729	58,342	38,420	46,890	81,097	352,121	**3,454,213**
1997	2,800	700	1,720	58,394	36,941	13,800	75,782	288,948	**2,566,029**
1998	5,000	540	1,703	80,600	15,100	21,400	48,400	302,000	**2,625,609**
1999	4,000	500	1,600	73,000	16,300	19,900	64,100	281,600	**2,528,835**
2000	3,500	400	1,400	108,100	8,200	11,000	157,600	275,000	**2,813,702**
2001	3,800	350	1,200	139,500	10,800	11,000	144,200	257,000	**2,923,087**
2002	2,744	300	1,000	119,000	34,600	9,200	72,623	397,100	**3,101,779**
2003	3,300	312	1,041	116,300	30,100	5,100	62,500	416,400	**3,044,766**
2004	3,300	200	1,180	136,800	9,000	3,800	52,000	499,000	**3,007,279**
2005	3,400	190	950	143,700	10,800	3,300	50,900	511,400	**3,052,168**
2006	3,100	240	860	153,400	5,800	3,100	45,000	398,000	**2,959,583**
2007	3,100	200	770	116,200	7,100	3,300	45,900	514,600	**2,907,485**
2008	3,600	210	690	105,700	5,000	2,200	61,000	385,400	**2,557,248**
2009	4,700	220	580	111,400	5,700	2,800	86,500	425,000	**2,754,669**
2010	6,180	211	440	83,000	5,336	3,571	90,997	264,719	**2,282,184**
2011	3,000	183	450	125,000	5,106	2,837	86,657	275,000	**2,605,003**

2012	3,000	160	460	150,000	4,543	1,901	73,750	280,000	**2,792,927**
2013	3,000	146	500	140,000	3,808	1,911	76,437	412,000	**2,835,626**
2014	3,000	148	480	140,000	2,875	2,232	90,490	451,860	**2,918,810**
2015	1,847	136	430	117,212	13,835	2,244	112,808	607,655	**3,064,781**
2016	2,745	145	455	129,037	9,111	1,086	109,765	631,973	**3,275,315**
2017	4,864	140	480	125,797	11,802	5,000	102,420	651,922	**3,222,002**
2018	3,569	134	429	130,000	10,548	4,304	93,341	645,301	**3,197,890**

For direct N_2O emissions from managed soils (3.C.4):

Parameters per crop type are presented below. In addition, the fraction of crop residue that is renewed annually was assumed to be 1 as recommended by the 2006 IPCC guidelines (page 11.14).

Table 67: Type of crops in Lebanon and related parameters

Crop	Type as listed in Table 11.2 of 2006 IPCC guidelines	Fraction for dry matter	N_{AG}	N_{BG}	*$Frac_{REMOVE}$
Dry beans	individual	0.90	0.01	0.010	0.9
Green beans	beans and pulses	0.91	0.008	0.008	0.2
Broad, horse beans	beans and pulses	0.91	0.008	0.008	0.8
Chick peas	beans and pulses	0.91	0.008	0.008	0.9
Alfalfa	individual	0.90	0.027	0.019	0.7
Lentils	beans and pulses	0.91	0.008	0.008	0.9
Lupins	beans and pulses	0.91	0.008	0.008	0.9
Dry peas	beans and pulses	0.91	0.008	0.008	0.9
Green peas	beans and pulses	0.91	0.008	0.008	0.2
Vetches	beans and pulses	0.91	0.008	0.008	0.8
Barley	individual	0.89	0.007	0.014	0.8
Maize	individual	0.87	0.006	0.007	0.7
Oats	individual	0.89	0.007	0.008	0.7
Sorghum	individual	0.89	0.007	0.006	0.7
Wheat	individual	0.89	0.006	0.009	0.8
Carrots	root crop	0.94	0.016	0.014	0.8
Garlic	root crop	0.94	0.016	0.014	0.7
Onions	tuberous	0.22	0.019	0.014	0.2
Potatoes	individual	0.22	0.019	0.014	0

*Expert judgement as published in BUR1

Parameters related to calculations of direct N emissions from F_{ON} are presented in Table 68. The amount of N bedding in manure management systems vary according to bedding materials. N for organic bedding should be considered 0 unless for the following 2 manure management systems: deep bedding and solid storage.

Table 68: Fraction of managed N manure lost and amount of N bedding per animal and manure management system

Species	Manure management system	Fraction of managed N manure lost ($Frac_{LossMS}$) *	Amount of N bedding (Kg N per animal per year) **
Swine	solid storage	0.5	5.5
Dairy cattle	anaerobic lagoon	0.77	0
	liquid slurry	0.4	0
	solid storage	0.4	7
	daily spread	0.22	0
Poultry	poultry without litter	0.55	0
	poultry with litter	0.5	0
Non-dairy cattle	solid storage	0.5	4
Other	solid storage	0.15	4

*Source: Table 10.23 page 10.65 of IPCC 2006 volume 4 (part 2) chapter 10
**Source: page 10.66 of 2006 IPCC guidelines volume 4 (part 2) chapter 10

Three emission factors are needed to calculate direct N_2O emissions from the different types on Nitrogen input to managed soils as presented in Table 69.

Table 69: Emission factors for direct N_2O emissions from managed soils

	Emission Factor (kg N_2O-N per kg N)	Source
EF1 for N additions from mineral fertilizers. crop residues	0.01	Table 11.1 page 11.11 of IPCC 2006 volume 4 (part 2) chapter 11
$EF3_{PRP, CPP}$ for cattle, poultry and pigs	0.02	
$EF3_{PRP, SO}$ for sheep and "other animals"	0.01	

For indirect N_2O emissions from managed soils (3.C.5):

Table 70: Factors and parameters used for the calculation of indirect N_2O emissions

Fraction of Synthetic Fertilizer Applied Emitted as NO_x and NH_3 ($Frac_{GASF}$)	0.1 kg of N /kg of N applied	**Table 11.3 page 11.24 of IPCC 2006 volume 4 (part 2) chapter 11**
Fraction of F_{ON} and F_{PRP} that volatizes ($Frac_{GASM}$)	0.2 kg of N /kg of N applied	
Fraction of N that is leached or runoff	0.3 kg of N /kg of N applied	
EF4 (N volatilization and redeposition)	0.010 kg of N /kg of N volatilized	
EF5 (leaching and runoff)	0.0075 kg of N /kg of N leached or runoff	

For indirect N_2O emissions from manure management:
In addition to $Frac_{GasMS}$ presented in the below Table 71, EF4 is used to calculate indirect N_2O emissions from manure management.

Table 71: Fraction of managed manure nitrogen for livestock category T that volatizes as NH_3 and NO_x in the manure management system

Species	Manure management system	Fraction of livestock manure nitrogen that volatizes ($Frac_{GasMS}$)	Source
Swine	solid storage	0.45	Table 10.22 page 10.65 of IPCC 2006 volume 4 (part 2) chapter 10
Dairy cattle	anaerobic lagoon	0.35	
	liquid slurry	0.4	
	solid storage	0.3	
	daily spread	0.07	
Poultry	poultry without litter	0.55	
	poultry with litter	0.4	
Non-dairy cattle	solid storage	0.45	
Other	solid storage	0.12	

Results of AFOLU

In 2018, total GHG emissions from the AFOLU category were 907.3 Gg CO_2eq. without the Land category (3.B) and -2,299 Gg CO_2eq. with Land, constituting 3% of total national emissions (Table 72). Net removals were mainly attributed to the decrease/increase in vegetation cover within forest lands, croplands, and grasslands. Indeed, Lebanon's wide forest cover still represents a significant CO_2 sink, deforestation, forest fires and most importantly, urbanization continue to decrease its sink capacities.

CH_4 emissions from AFOLU represented more than half of emissions from AFOLU, with 3.A.1 Enteric fermentation being the main source of emissions (418.99 Gg CO_2eq.). Nitrous oxide (N_2O) emissions from AFOLU were estimated at 387.95 Gg CO_2eq. with 3.C aggregate sources and non-CO_2 emissions sources being the main source of emissions followed by 3.A.2 manure management.

As for CO_2, AFOLU remains a sink category with a net total of -3,205 Gg CO_2eq., and the major sinks being cropland remaining cropland and forest land remaining forestland.

Table 72: Results of the GHG emissions/removals from AFOLU in 2018

	Net CO_2 emissions / removals *Gg CO_2)	GHG Emissions (Gg CO_2eq.)		Net emissions (Gg CO_2eq.)
		CH_4	N_2O	
3 - Agriculture, Forestry, and Other Land Use	-3,205.55	517.97	387.93	-2,299.66
3.A - Livestock	NA	517.80	112.14	629.94
3.A.1 - Enteric Fermentation	NA	418.99	NA	418.99
3.A.1.a - Cattle	NA	274.16	NA	274.16
3.A.1.a.i - Dairy Cows	NA	189.93	NA	189.93
3.A.1.a.ii - Other Cattle	NA	84.23	NA	84.23
3.A.1.b - Buffalo	NA	NE	NA	-
3.A.1.c - Sheep	NA	61.73	NA	61.73
3.A.1.d - Goats	NA	75.80	NA	75.80
3.A.1.e - Camels	NA	0.19	NA	0.19
3.A.1.f - Horses	NA	1.66	NA	1.66
3.A.1.g - Mules and Asses	NA	5.28	NA	5.28
3.A.1.h - Swine	NA	0.18	NA	0.18
3.A.2 - Manure Management	NA	98.81	112.14	210.95

3.A.2.a - Cattle	NA	83.42	72.73	156.15
3.A.2.a.i - Dairy cows	NA	56.82	48.47	105.29
3.A.2.a.ii - Other cattle	NA	26.60	24.26	50.86
3.A.2.b - Buffalo	NA	NE	NE	NE
3.A.2.c - Sheep	NA	1.85	14.49	16.34
3.A.2.d - Goats	NA	2.58	22.32	24.90
3.A.2.e - Camels	NA	0.01	0.00	0.01
3.A.2.f - Horses	NA	0.15	0.00	0.15
3.A.2.g - Mules and Asses	NA	0.48	0.00	0.48
3.A.2.h - Swine	NA	1.97	0.21	2.17
3.A.2.i - Poultry	NA	8.37	2.39	10.76
3.B - Land	-3,194.17	NA	NA	-3194.40
3.B.1 - Forest land	-2026.05	NA	NA	-2026.06
3.B.1.a - Forest land Remaining Forest land	-2025.52	NA	NA	-2025.52
3.B.1.b - Land Converted to Forest land	-0.54	NA	NA	-0.54
3.B.1.b.i - Cropland converted to Forest Land	NE	NA	NA	NE
3.B.1.b.ii - Grassland converted to Forest Land	NE	NA	NA	NE
3.B.1.b.iii - Wetlands converted to Forest Land	NO	NA	NA	NO
3.B.1.b.iv - Settlements converted to Forest Land	NO	NA	NA	NO
3.B.1.b.v - Other Land converted to Forest Land	-0.54	NA	NA	-0.54
3.B.2 - Cropland	-1,220.25	NA	NA	-1220.25
3.B.2.a - Cropland Remaining Cropland	-1,220.25	NA	NA	-1220.25
3.B.2.b - Land Converted to Cropland	NE	NA	NA	NE
3.B.3 - Grassland	NE	NA	NA	NE
3.B.3.a - Grassland Remaining Grassland	0	NA	NA	0
3.B.3.b - Land Converted to Grassland	NE	NA	NA	NE
3.B.4 - Wetlands	NE	NA	NA	NE
3.B.4.a - Wetlands Remaining Wetlands	0	NA	NA	0
3.B.4.b - Land Converted to Wetlands	NE	NA	NA	NE
3.B.5 - Settlements	51.91	NA	NA	51.91
3.B.5.a - Settlements Remaining Settlements	NA	NA	NA	NA
3.B.5.b - Land Converted to Settlements	51.91	NA	NA	51.91
3.B.5.b.i - Forest Land converted to Settlements	29.14	NA	NA	29.14
3.B.5.b.ii - Cropland converted to Settlements	22.08	NA	NA	22.08
3.B.5.b.iii - Grassland converted to Settlements	0.69	NA	NA	0.16
3.B.5.b.iv - Wetlands converted to Settlements	NO	NA	NA	NO
3.B.5.b.v - Other Land converted to Settlements	NO	NA	NA	NO
3.B.6 - Other Land	NO	NA	NA	NO
3.B.6.a - Other land Remaining Other land	NO	NA	NA	NO
3.B.6.b - Land converted to Other land	NE	NA	NA	NE
3.C - Aggregate sources and non-CO_2 emissions sources on land	1.1132	0.17	275.79	277.07
3.C.1 - Emissions from biomass burning	NA	0.17	0.09	0.26
3.C.1.a - Biomass burning in forest lands	NA	0.15	0.08	0.23
3.C.1.b - Biomass burning in croplands	NA	0.00	0.00	0.00
3.C.1.c - Biomass burning in grasslands	NA	0.01	0.01	0.03
3.C.1.d - Biomass burning in all other land	NO	NO	NO	NO
3.C.2 - Liming	NO	NA	NA	NO
3.C.3 - Urea application	1.1132	NA	NA	1.1132
3.C.4 - Direct N_2O Emissions from managed soils (3)	NA	NA	182.59	182.59
3.C.5 - Indirect N_2O Emissions from managed soils	NA	NA	67.61	67.61
3.C.6 - Indirect N_2O Emissions from manure management	NA	NA	25.49	25.49
3.D - Other	-12.27	NA	NA	-12.27
3.D.1 - Harvested Wood Products	-12.27	NA	NA	-12.27

Emissions from the AFOLU category remained more or less stable throughout the 1994-2018 period, with an average yearly increase of 1%, as presented in Figure 38. The most fluctuating category is 3.C aggregate sources, which is mainly vulnerable to changes in the annual amount of biomass burning.

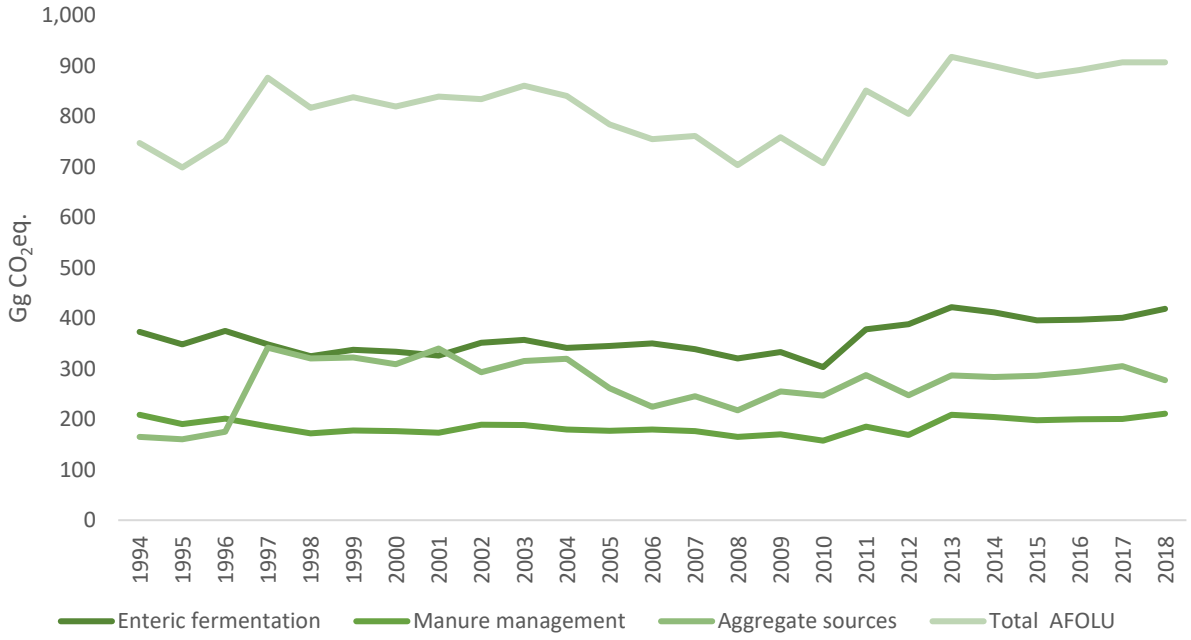


Figure 38: Total emissions from the AFOLU sector excluding the land category for the period 1994-2016

3.A Livestock

Sheep and goats are the main species that drive emissions from the livestock category given that the fluctuations of emissions over the years reflect the fluctuation in the population of these species. For example, in 2010, the drop in GHG emissions from livestock is due to a similar drop in the population of sheep and goats (Figure 39). For enteric fermentation and manure management, dairy cattle are the largest contributor to GHG emissions in 2018, with a share of 47%, followed by non-dairy cattle with a share of 22%.

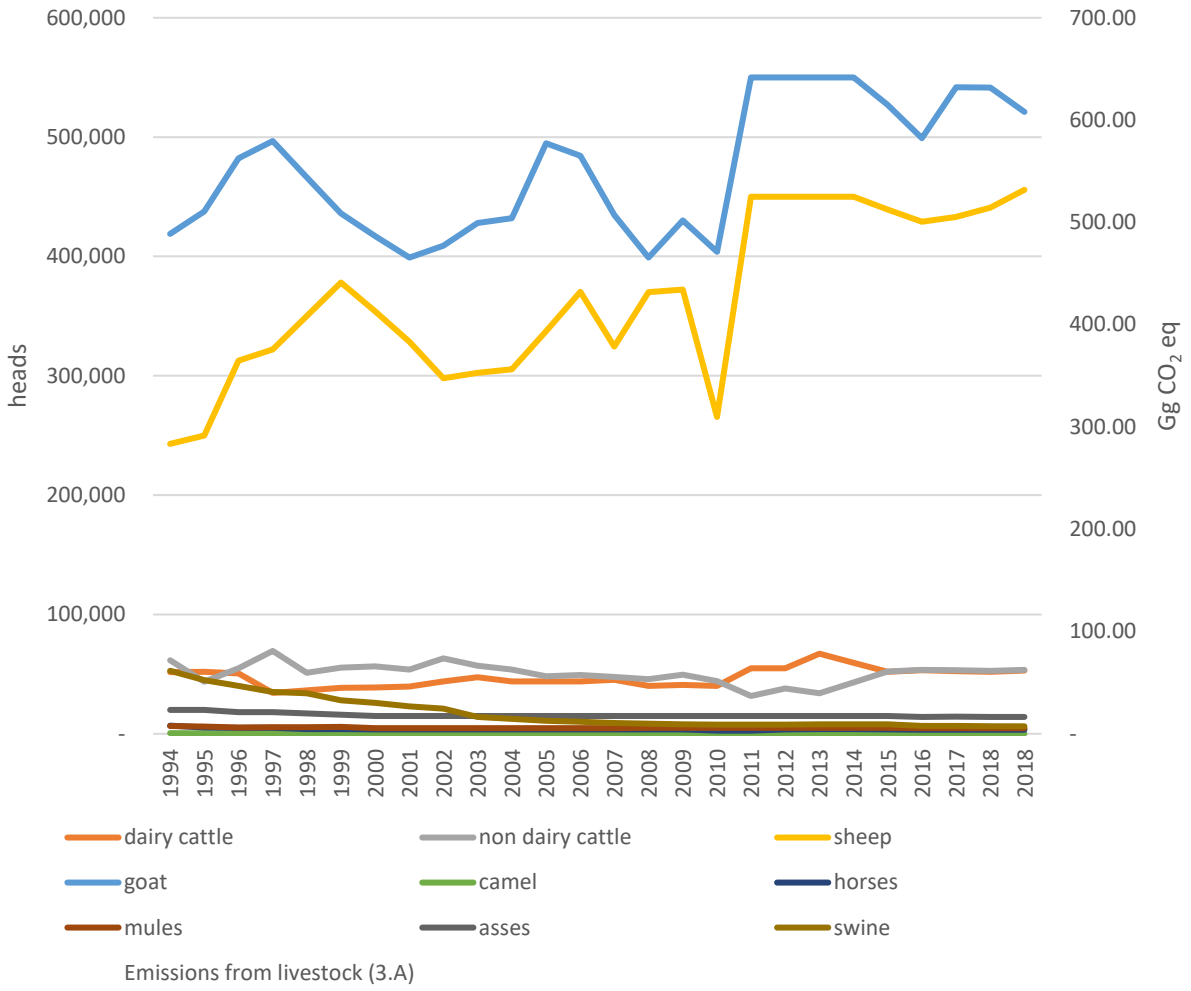


Figure 39: Emissions from the livestock category compared to populations of main livestock species in Lebanon for the period 1994-2018

Table 73: Emissions from livestock category per gas and subcategory from 1994-2018 in Gg CO_2eq.

Year	CH_4 Enteric fermentation (3.A.1)	CH_4 manure management	Direct N_2O manure management	Total manure management (3.A.2)	Total Livestock (3.A)
1994	**373.07**	108.52	100.30	**208.82**	**581.89**
1995	**348.09**	97.35	93.06	**190.41**	**538.50**
1996	**375.06**	100.58	100.78	**201.36**	**576.41**
1997	**348.42**	91.19	94.87	**186.06**	**534.48**
1998	**324.80**	83.93	87.86	**171.79**	**496.59**
1999	**337.75**	86.63	91.17	**177.80**	**515.54**
2000	**334.04**	86.27	90.39	**176.66**	**510.69**
2001	**325.89**	85.34	88.10	**173.44**	**499.32**
2002	**351.77**	93.74	95.43	**189.17**	**540.93**
2003	**357.06**	92.26	96.45	**188.71**	**545.77**
2004	**341.13**	87.36	92.38	**179.74**	**520.87**
2005	**345.06**	84.08	93.21	**177.29**	**522.35**
2006	**350.23**	84.96	94.55	**179.51**	**529.73**
2007	**338.72**	85.02	91.42	**176.44**	**515.16**
2008	**320.73**	78.62	86.27	**164.89**	**485.61**
2009	**333.26**	80.16	89.75	**169.91**	**503.17**
2010	**303.30**	75.68	81.87	**157.55**	**460.85**
2011	**378.13**	84.84	100.31	**185.15**	**563.28**
2012	**388.59**	85.99	82.78	**168.77**	**557.35**
2013	**422.02**	97.62	111.39	**209.01**	**631.03**
2014	**411.54**	94.96	109.28	**204.23**	**615.77**
2015	**395.95**	92.01	105.85	**197.86**	**593.81**
2016	**397.23**	93.82	106.25	**200.07**	**597.30**
2017	**400.87**	93.23	107.42	**200.65**	**601.52**
2018	**418.99**	98.80	112.16	**210.97**	**629.96**

3.B. Land

Inter-annual changes in emissions/removals form 2015 throughout 2018 were presented in Table 74, Table 75, Table 76. The main categories that are contributing significantly to the emissions/removals in FOLU are the conversion from forest land, crop land and grassland to settlements. These are mainly driven by the following factors:

- Unregulated urban sprawl
- Active market of the real estate sector
- Absence of clear zoning
- Expansion and improvement of the road networks in rural areas
- Improvement of public and private services in rural areas
- Lack of interest of owners of cropland, forest land and grassland in keeping such type of lands due to increase in land prices and increase demand for commercial and residential development projects
- High costs of labors to maintain croplands
- Lack of a market for the agricultural products
- Degrading financial situation of citizens (selling agricultural lands and grasslands which are eventually converted to urbanized areas)

Table 74. Changes in emissions/removals between 2015 and 2016

Type of change		Change in area (ha)	Change in volume (m^3)	CO_2 emissions/removals (Gg)
Forest to settlements	Coniferous	+13.56	-	
	Broadleaf	-0.31	-	
	Mixed	+15.5	-	+8.79
Cropland to settlements	Perennial	+18.25	-	
	Annual	-203.13	-	+0.71
Grassland to settlements		+30.12	-	+0.31
Fuelwood gathering (m^3)		-	-33	-0.02
Forest land remaining forest land (difference between 2015 and 2016)		-82.05	-	-5.92
Afforestation (Cumulative)		4,150	-	-32.89

Numbers may reflect rounding

Table 75. Changes in emissions/removals between 2016 and 2017

Type of change		Change in area (ha)	Change in volume (m^3)	CO_2 emissions/removals (Gg)
Forest to settlements	Coniferous	-9.07	-	
	Broadleaf	+26.38	-	
	Mixed	-7.25	-	+3.66
Cropland to settlements	Perennial	-51.12	-	
	Annual	-142.32	-	-14.25
Grassland to settlements		+15.94	-	+0.16
Fuelwood gathering (m^3)		-	-32	-0.02
Forest land remaining forest land (difference between 2016 and 2017)		-92.11	-	-1.76
Afforestation (Cumulative)		4,284	-	-37.19

Numbers may reflect rounding

Table 76. Changes in emissions/removals between 2017 and 2018

Type of change		Change in area (ha)	Change in volume (m^3)	CO_2 emissions/removals (Gg)
Forest to settlements	Coniferous	-1.75	-	
	Broadleaf	-7.19	-	
	Mixed	+7.62	-	-0.49
Cropland to settlements	Perennial	+22.28	-	
	Annual	-0.67	-	+5.12
Grassland to settlements		+4.88	-	+0.05
Fuelwood gathering (m^3)		-	0	0
Forest land remaining forest land (difference between 2017 and 2018)		-90.78	-	+2.96
Afforestation (Cumulative)		4,331	-	-40.61

Numbers may reflect rounding

It was observed that broadleaf forests were the most affected by this type of conversions, which might be influenced by the large extent of broadleaf forests in the country and the fact that urbanization most likely occurs more on shrubland (mostly broadleaf vegetation) than on forested areas.

Conversions to settlements have also affected croplands and grasslands. It is easier, however, to convert annual crops than removing perennial crops (mainly comprising fruit trees and orchards). Conversions of cropland and grassland to settlements might be related to the lack of interest of owners in keeping such type of lands (e.g. increase in land prices related to an increasing number of population, increasing demand for development projects), high costs of labors and lack of a market for the agricultural products, and degrading financial situation of citizens (selling agricultural lands and grasslands which were eventually converted to urbanized areas). This has been at least confirmed for artificialized cropland on the Lebanese coast.

The total estimate for fuelwood gathering in was 18,673 m^3 in 2016 and 18,641 m^3 in each year for 2017 and 2018. The number is almost quite constant over the inventory time period. Decrease in forest land was mainly attributed to urbanization resulting in a decrease in CO_2 removals.

The analysis of the changes in CO_2 emissions/removals of the FOLU sector over the inventory period showed a net decrease in CO_2 removals mainly due to losses in the vegetation cover resulting essentially from land conversions to settlements and wildfires among others The net CO_2 emissions/removals showed that the FOLU sector was an important sink of GHG in Lebanon during the first 5 years of the inventory period. In reference to the decreasing trend line, the changes in net CO_2 emissions/removals for the inventory period (1994-2018) resulted in a decrease of 4.41% (i.e., 130 Gg CO_2eq.) in CO_2 removals from the FOLU sector (Figure 40). A summary of the total CO_2 and non-CO_2 emissions/removals in Gg CO_2eq. from the FOLU sector is presented below (Table 77 and Table 78.

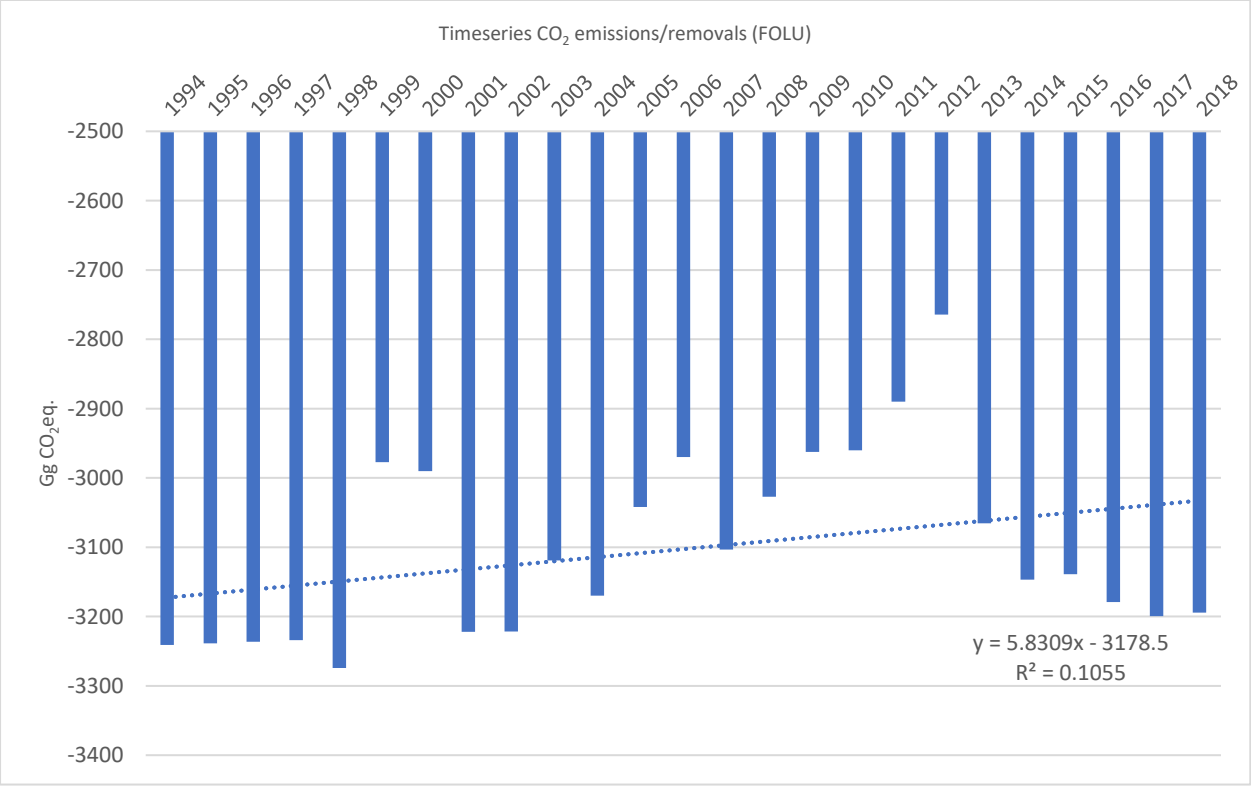


Figure 40: Trend analysis for net CO_2 emissions/removals from the FOLU sector

Table 77: A summary of the total CO_2 and non-CO_2 emissions/removals in Gg CO_2eq. from the FOLU sector for the period 1994-2018 (a)

Gg CO_2eq.	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Forest land	-2075.18	-2073.77	-2072.18	-2070.69	-2070.14	-1961.88	-2034.94	-2059.4	-2059.17	-2034.11	-2058.33	-2016.55	-1933.38
Land converted to forest land	0	0	0	0	0	-3.4434	-3.4434	-3.4434	-3.4434	-3.1386	-3.1386	-3.1386	-3.1386
Land converted to forest land (cumulative)	NE	NE	NE	NE	NE	-3.4434	-6.8868	-10.3302	-13.7736	-16.9122	-20.0508	-23.1894	-26.328
Cropland	-1236.98	-1236.55	-1236.13	-1235.7	-1234.73	-1120.2	-1117.97	-1175.8	-1175.7	-1111.35	-1181.53	-1153.3	-1155.11
Settlements	71.0726	71.4475	71.8723	72.3424	30.7564	104.7619	162.8438	13.0937	13.0937	26.4729	70.2369	127.8861	118.6931
Forest converted to settlements	55.208	55.499	55.8288	56.1943	0	84.6655	146.7162	9.3695	9.3695	17.5367	49.4517	117.6329	99.1712
Cropland converted to settlements	14.7071	14.7847	14.873	14.9697	30.5974	19.0149	13.3944	3.4643	3.4643	8.6241	19.3225	7.4852	17.6125
Grassland converted to settlements	1.1576	1.1637	1.1705	1.1783	0.159	1.0815	2.7332	0.2599	0.2599	0.3121	1.4626	2.768	1.9094
Biomass burning (Non- CO_2 total)	NE	NE	NE	NE	NE	2.2037	1.0212	0.3616	0.3616	1.0923	0.2968	0.9681	2.5893
Emissions from biomass (CH_4) Gg CO_2eq.	NE	NE	NE	NE	NE	1.4354	0.6633	0.2291	0.2291	0.6896	0.1895	0.6301	1.6544
Biomass burning in forest (CH_4) Gg CO_2eq.	NE	NE	NE	NE	NE	1.1652	0.4075	0.0799	0.0799	0.3308	0.0658	0.4522	1.3025
Biomass burning in cropland (CH_4) Gg CO_2eq.	NE	NE	NE	NE	NE	0.2211	0.2248	0.1124	0.1124	0.2368	0.0998	0.1541	0.1498
Biomass burning in grassland (CH_4) Gg CO_2eq.	NE	NE	NE	NE	NE	0.0492	0.0311	0.0368	0.0368	0.122	0.0239	0.0238	0.2021
Emissions from biomass (N_2O) Gg CO_2eq.	NE	NE	NE	NE	NE	0.7683	0.3579	0.1325	0.1325	0.4027	0.1073	0.338	0.9349
Biomass burning in forest (N_2O) Gg CO_2eq.	NE	NE	NE	NE	NE	0.61	0.2133	0.0418	0.0418	0.1732	0.0344	0.2367	0.6819
Biomass burning in cropland (N_2O) Gg CO_2eq.	NE	NE	NE	NE	NE	0.1158	0.1177	0.0589	0.0589	0.124	0.0522	0.0807	0.0784
Biomass burning in grassland (N_2O) Gg CO_2eq.	NE	NE	NE	NE	NE	0.0425	0.0269	0.0318	0.0318	0.1055	0.0207	0.0206	0.1746
Net GHG removals (Gg CO_2eq.) - IPCC2006	-3241.09	-3238.88	-3236.43	-3234.04	-3274.11	-2977.32	-2990.07	-3222.11	-3221.78	-3118.98	-3169.63	-3041.97	-2969.8

*NE: Not Estimated. No activity data about burned areas from 1994-1998 resulting in no data about total emissions during this period

Table 78: A summary of the total CO_2 and non-CO_2 emissions/removals in Gg CO_2 equivalent from the FOLU sector for the period 1994-2018 (b)

Gg CO_2eq.	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Forest land	-1984.83	-2051.21	-2008.44	-2007.93	-2028.11	-1979.96	-2028.41	-2027.3	-2021.33	-2027.26	-2029.02	-2026.06
Land converted to forest land	-3.1386	-0.5871	-0.5871	-1.6678	-0.5871	-4.3038	-3.4165	-1.5777	-2.361	-2.2965	-1.5155	-0.5366
Land converted to forest land (cumulative)	-29.4666	-30.0537	-30.6408	-32.3086	-32.8957	-37.1995	-40.616	-42.1937	-44.5547	-46.8512	-48.3667	-48.9033
Cropland	-1168.83	-1106.32	-1073.9	-1072.22	-1092.02	-924.469	-1221.86	-1158.14	-1165.71	-1209.87	-1218.02	-1220.25
Settlements	50.3792	130.2333	120.0803	120.0803	230.063	140.0752	184.7961	38.8456	48.05	57.8706	47.4422	52.1318
Forest converted to settlements	48.3546	100.9141	64.7808	64.7808	195.3702	100.2475	114.7476	14.04	17.2924	26.085	29.7467	29.251
Cropland converted to settlements	1.8596	26.7588	53.884	53.884	31.0319	37.9453	66.9296	24.7156	30.5985	31.31	17.0524	22.18
Grassland converted to settlements	0.1649	2.5604	1.4156	1.4156	3.6609	1.8823	3.1189	0.09	0.1591	0.4757	0.6431	0.6944
Biomass burning (Non-CO_2 total)	1.4151	0.4301	1.3525	1.3525	0.7461	1.923	0.2408	0.4121	0.617	0.4079	0.2136	0.2575
Emissions from biomass (CH_4) Gg CO_2eq.	0.9264	0.2816	0.8727	0.8727	0.4796	1.2487	0.156	0.2667	0.3882	0.2638	0.14	0.1658
Biomass burning in forest (CH_4) Gg CO_2eq.	0.7927	0.0357	0.5031	0.5031	0.1722	0.6036	0.1423	0.1233	0.2028	0.2242	0.1332	0.1506
Biomass burning in cropland (CH_4) Gg CO_2eq.	0.1231	0.2428	0.3024	0.3024	0.2621	0.585	0.0043	0.1266	0.1104	0.0223	0.0061	0.0006
Biomass burning in grassland (CH_4) Gg CO_2eq.	0.0106	0.0031	0.0672	0.0672	0.0452	0.0602	0.0094	0.0168	0.075	0.0173	0.0008	0.0145
Emissions from biomass (N_2O) Gg CO_2eq.	0.4887	0.1485	0.4798	0.4798	0.2665	0.6743	0.0848	0.1454	0.2288	0.1441	0.0736	0.0917
Biomass burning in forest (N_2O) Gg CO_2eq.	0.415	0.0187	0.2634	0.2634	0.0902	0.316	0.0745	0.0646	0.1062	0.1174	0.0697	0.0789
Biomass burning in cropland (N_2O) Gg CO_2eq.	0.0645	0.1271	0.1583	0.1583	0.1372	0.3063	0.0022	0.0663	0.0578	0.0117	0.0032	0.0003
Biomass burning in grassland (N_2O) Gg CO_2eq.	0.0092	0.0027	0.0581	0.0581	0.0391	0.052	0.0081	0.0145	0.0648	0.015	0.0007	0.0125
Net GHG removals (Gg CO_2eq.) - IPCC2006	-3103.28	-3027.3	-2962.26	-2960.07	-2890.07	-2764.36	-3065.48	-3146.6	-3138.99	-3179.25	-3199.6	-3194.18

The CO_2 emissions/removals resulting from the identified changes in the Land Cover/Land Use areas in the FOLU sector in Lebanon are mainly due to changes in in management activities in Forest lands, which resulted in gains and losses in biomass and carbon stocks in soils and litter (Figure 41).

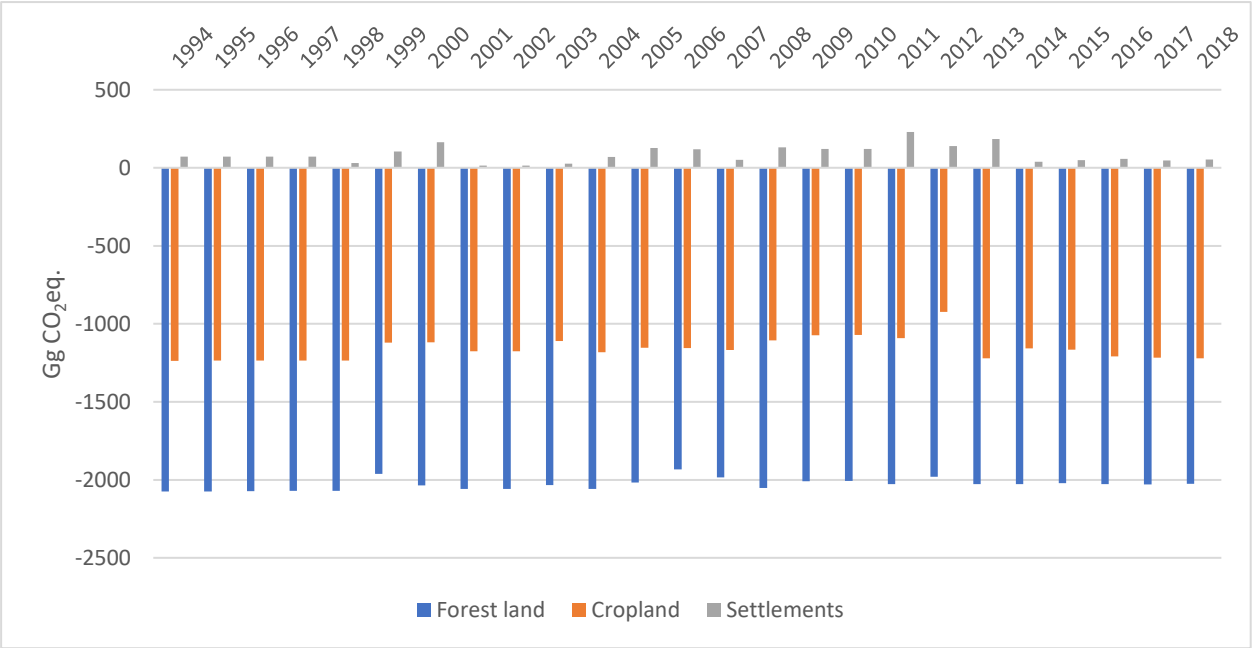


Figure 41: The CO_2 emissions/removals from the changes in the FOLU sector for 1994-2018

Although net emissions/removals proved that the FOLU sector is a major sink, emissions from changes in the FOLU sector were still high and could not be compensated by the afforestation activities. In general, it was observed that the changes in CO_2 removals over the inventory period (1994-2018) were mainly attributed to the decrease/increase in vegetation cover within forest lands, croplands, and grasslands.

In this context, areas of lands converted to settlements was characterized by inter-annual variability including two peaks in 2000 and 2011 (Figure 42). Variations in areas of land converted to settlement might be related to a number of factors including the active market of the real estate sector, the quality of the image classification results, and the general socio-economic situation, among others. In addition, such type of changes might be related to certain policies and public plans contributing to changes in these lands (e.g. expansion and improvement of the road networks, development of areas of public and private services).

Quarries have a compounding effect on natural resources including forests and grassland (Mitri et al., 2019a). Although recent attempts have been made by MoE to stop illegal quarrying activities, many quarries across the country remain active. The causes behind extensive and unsustainable quarrying are the lack of proper law enforcement, urbanization that requires rocks from quarries to build houses, corruption at the political and public levels, and socio-economic factors. A stable rate of land converted to settlement was observed after 2013 with the start of real estate stagnation in the country.

Broadleaf forests were mostly affected by conversions (Figure 43). Broadleaf forests cover larger areas than any other forest type in the country.
Also, conversions to settlements largely affected croplands and grasslands as shown in Figure 44 and Figure 45. The persistent lack of interest of owners in keeping such type of lands (e.g. increase in land prices related to an increasing number of population, increasing demand for development projects),

persistent environmental pressures (Mitri et al., 2019b), high costs of labors and lack of a market for the agricultural products, and degrading financial situation of citizens (selling agricultural lands and grasslands which were eventually converted to urbanized areas) increasingly contributed to degradation and in most of the cases urbanization of agricultural land (especially annual cropland) and low productive land such as grassland.

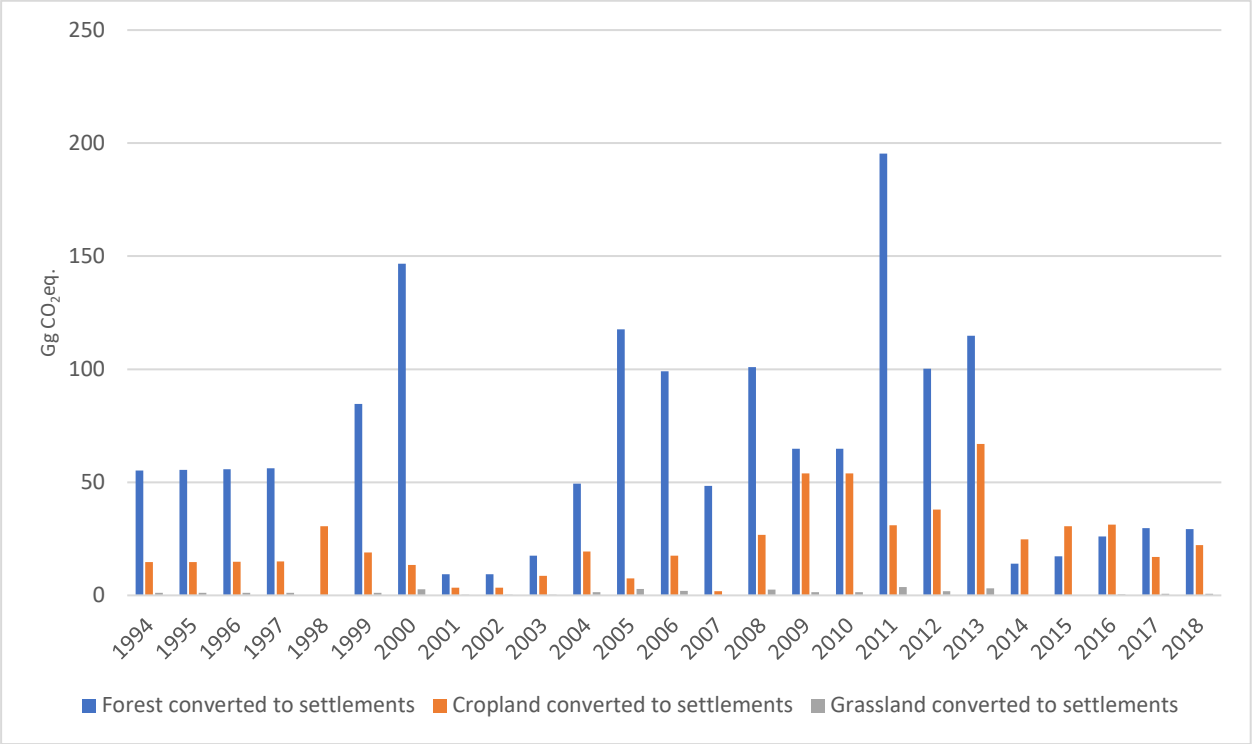


Figure 42: Areas of land categories converted to settlements

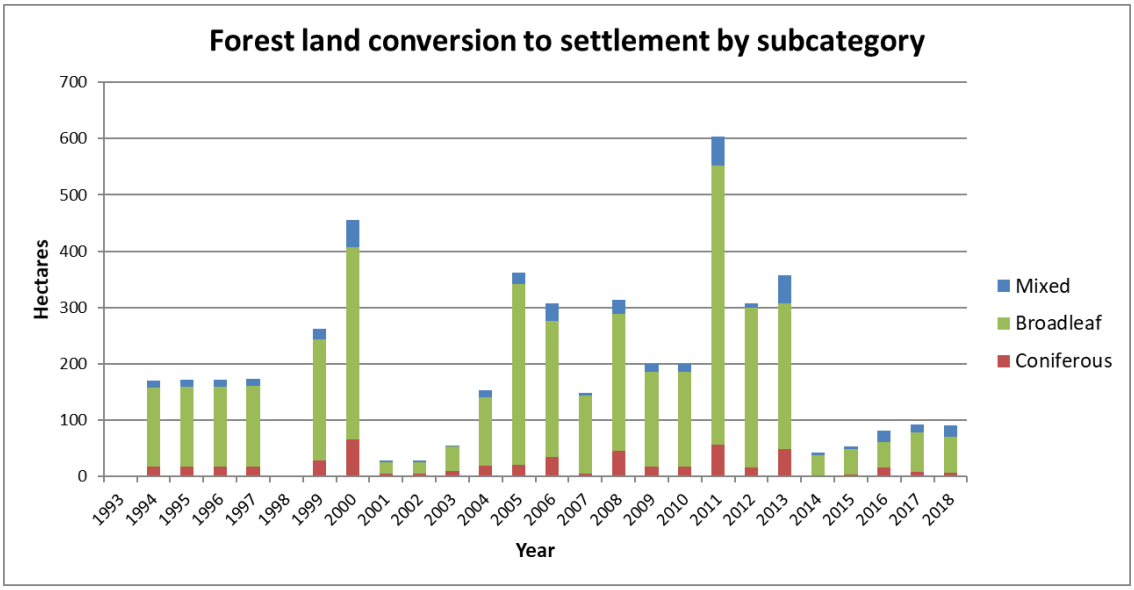


Figure 43: Areas of forest lands converted to settlements by subcategory

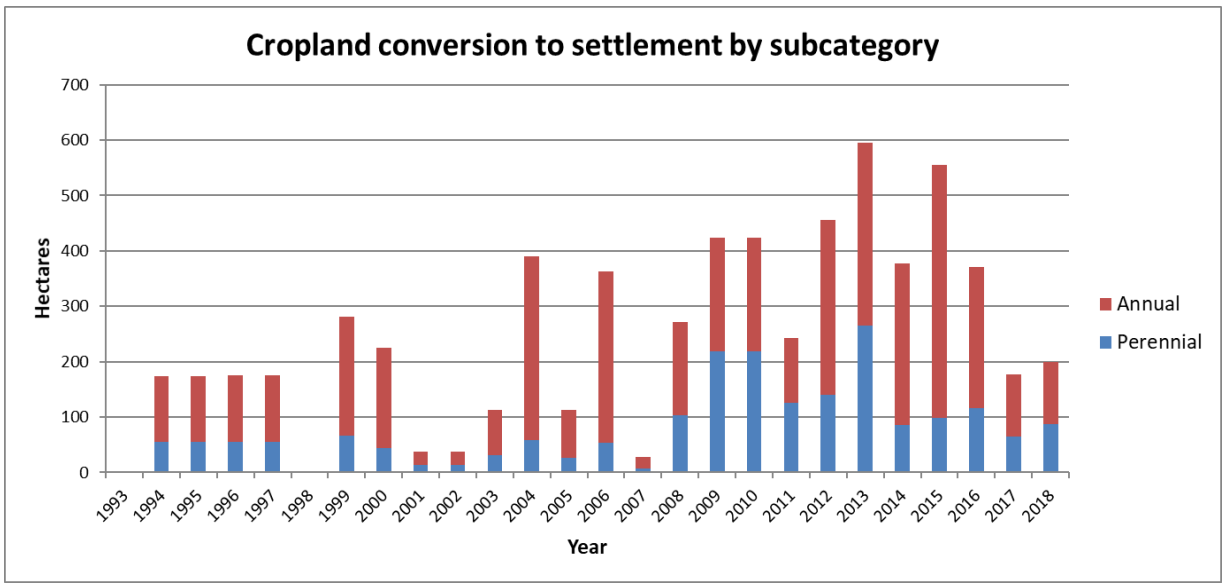


Figure 44: Areas of croplands converted to settlements by subcategory

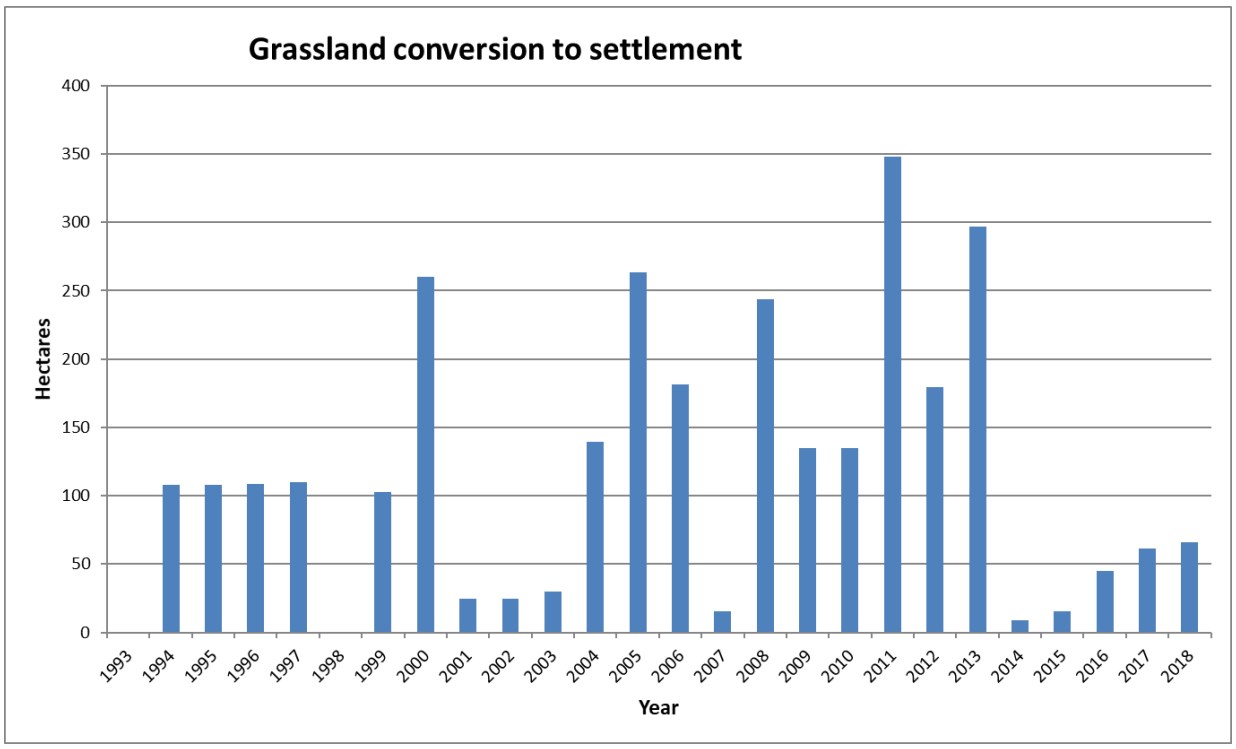


Figure 45: Areas of grassland converted to settlements

Moreover, a constant decrease of about in existing forest lands is always observed due to urbanization outpacing gains in forest cover (Figure 46).

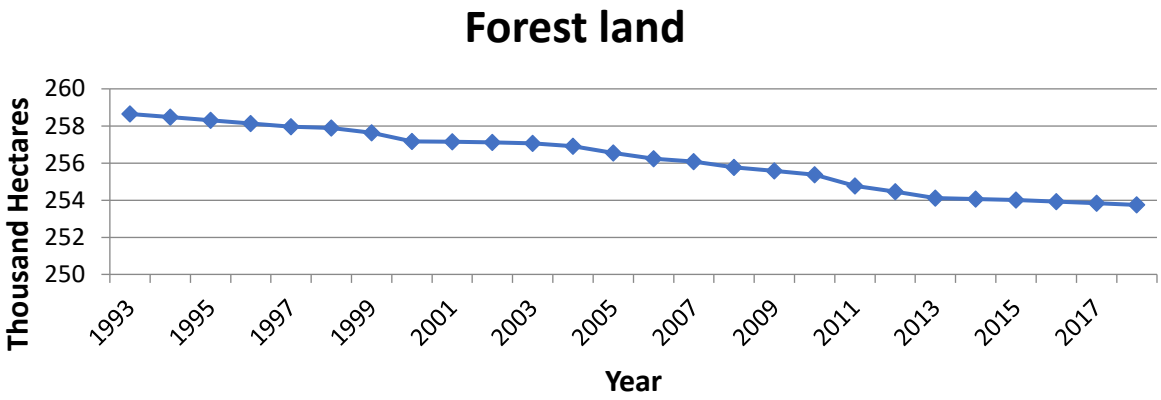


Figure 46: Forest lands remaining forest lands over the inventory period (1994-2018)

Areas of yearly and cumulative afforested areas were presented in Figure 47 and Figure 48, respectively. The decrease in afforested areas after 2007 could be associated to changes in certain reforestation policies especially after the 2007 fires. More efforts have been put to manage wildfire risk (e.g. the development of Lebanon's National Strategy for forest fire management, the launching of the operations room at the Directorate of the Civil Defense). Also, many reforestation activities were interrupted after the July 2006 war and reforestation contracts were subsequently terminated. Subsequent increase and/or decreases in yearly afforested areas could be related to availability of funding for reforestation/afforestation projects. Overall, cumulative afforestation activities resulted in an average increase in CO_2 removal by -2.44 Gg/yr between 1999 and 2018 (Figure 50). A total removal of -48.9 Gg of CO_2eq. has been removed until 2018 by the cumulative afforested area (Figure 50).

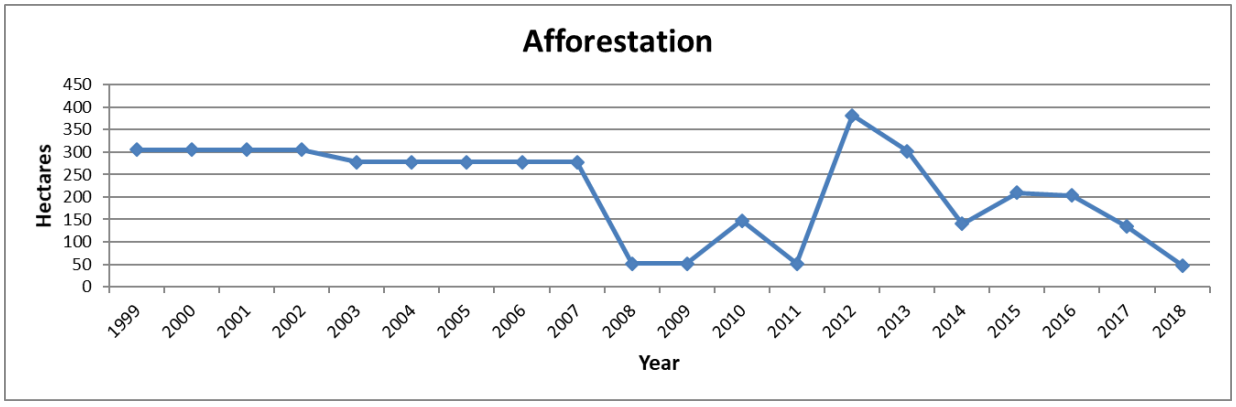


Figure 47: Yearly afforested areas (1999-2018)

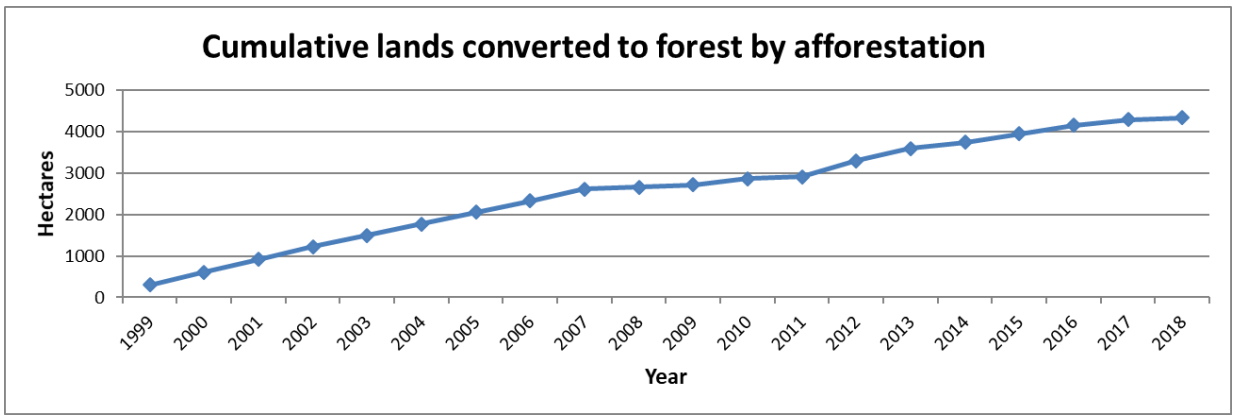


Figure 48: Cumulative lands converted to forests over the inventory period

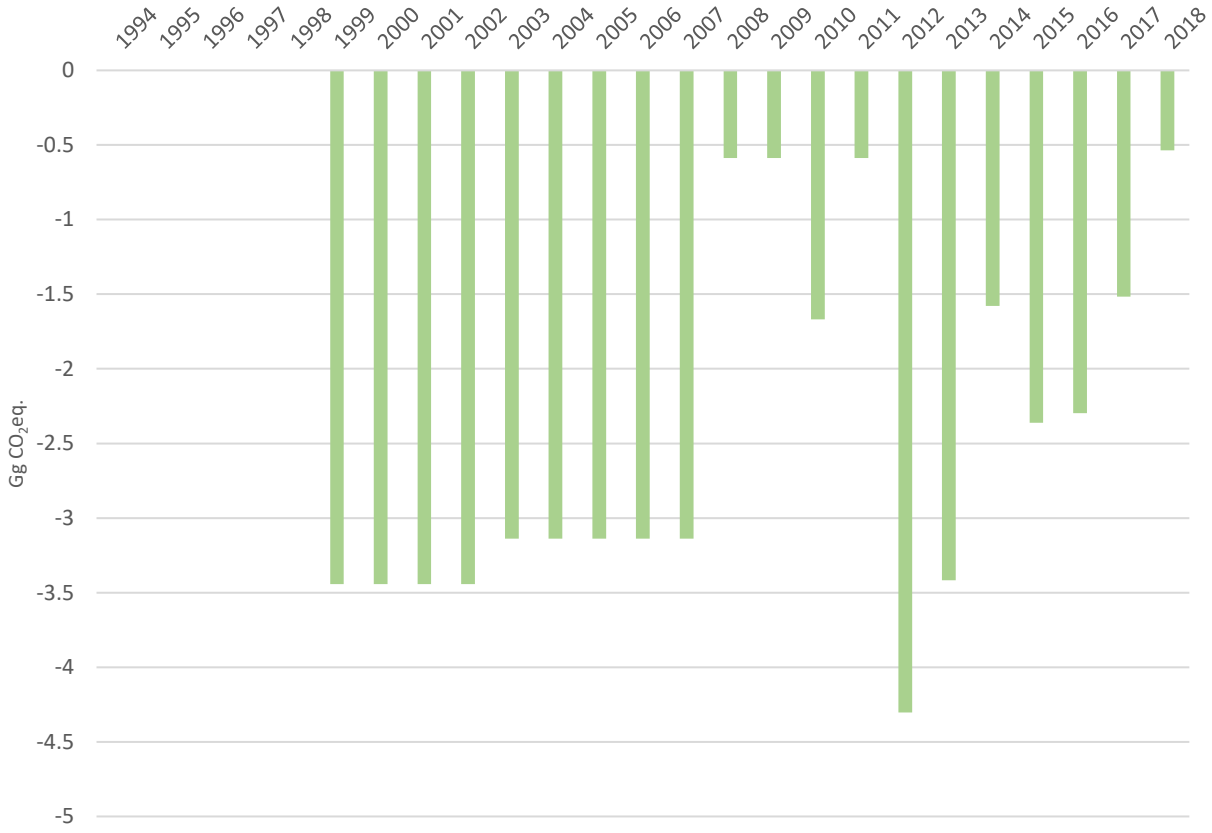


Figure 49: Annual CO_2 removal from land converted to forest between 1999 and 2018

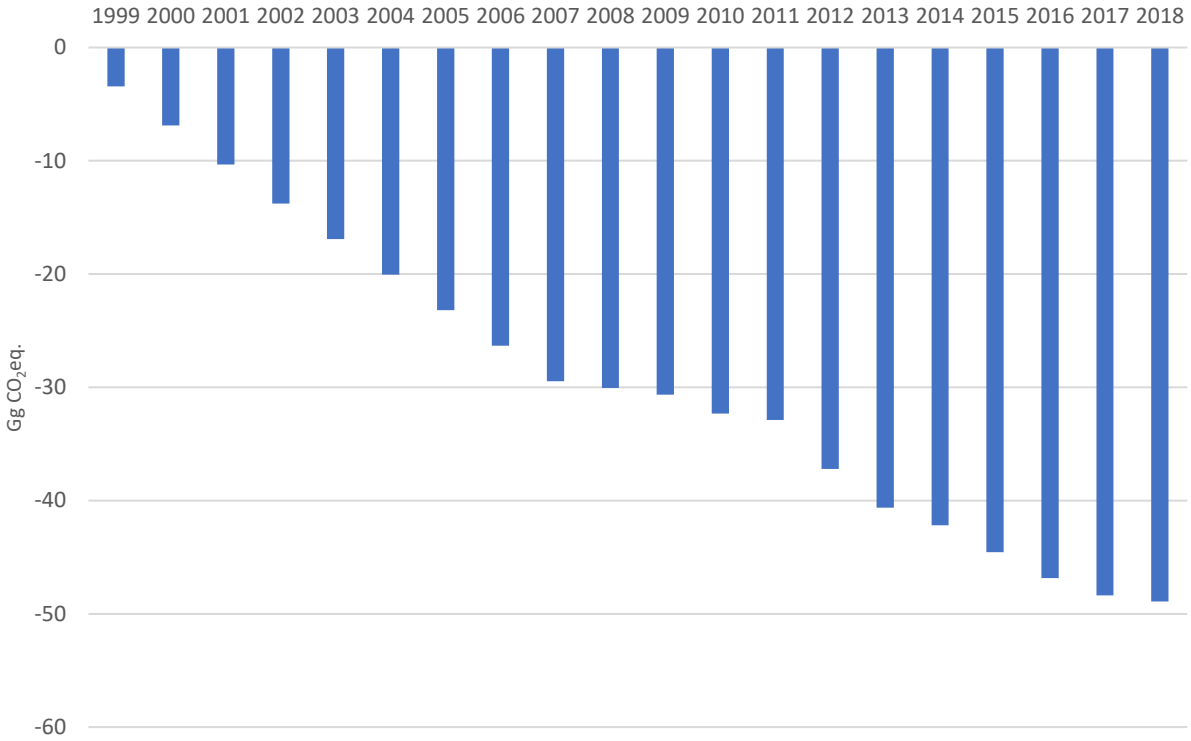


Figure 50: CO_2 removals due to biomass increments and increase in soil carbon stocks from afforestation

A constant decrease in croplands was observed mainly due urbanization and decrease in interest of maintaining agricultural lands (Figure 51).

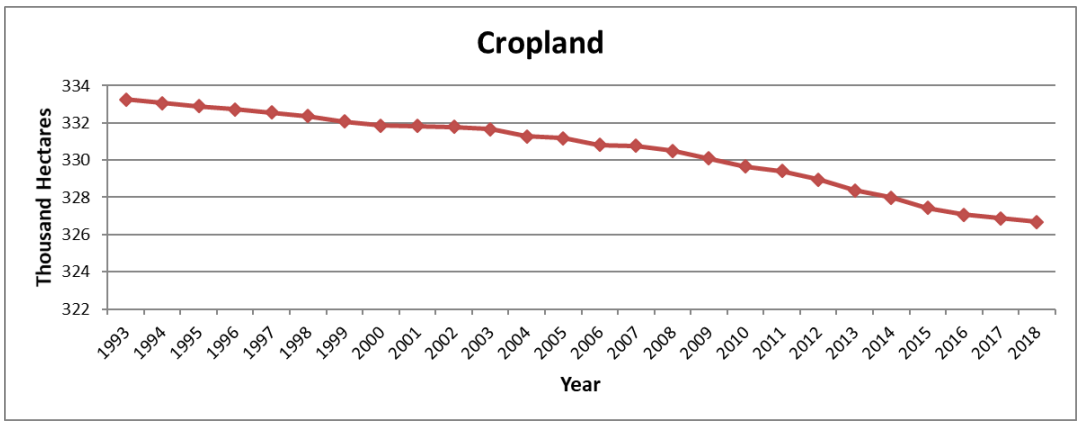


Figure 51: Areas of cropland remaining cropland over the inventory period

3.C Aggregate sources and non-CO_2 emissions sources on land

The bulk of emissions from category 3.C is caused by N_2O emissions, specifically direct n2O emissions from managed soils. These occur in the following subcategories: direct emissions from managed soils (3.C.4) (ei.e. managed manure N available for application to soils) and indirect emissions from managed soils (3.C.5) (i.e application of N synthetic fertilizers) (respectively 182.59 and 67.61 Gg CO_2eq. in 2018) and indirect emissions from manure management (3.C.6) (i.e. amount of Nitrogen that is loss due to the volatilization of NH_3 and NO_x), where emissions amounted to 25.49 Gg CO_2eq. in 2018.

The trend of emissions from category 3.C is highly influenced by direct N_2O emissions from managed soils, and to a lesser extent, indirect N_2O emissions from managed soils (Figure 52).

Table 79: Total emissions from category 3.C and their distribution per gas

Year	Aggregate sources and non-CO_2 emission sources (3.C) (tonnes CO_2eq.)	CO_2	CH_4	N_2O
1994	162.33	0.21		162.12
1995	160.29	0.21		160.08
1996	174.98	0.21		174.77
1997	341.86	3.30		338.56
1998	320.53	1.06		319.47
1999	322.23	2.01	1.43	318.79
2000	309.07	3.64	0.66	304.77
2001	340.10	14.15	0.23	325.72
2002	293.20	4.59	0.23	288.38
2003	315.07	6.58	0.69	307.80
2004	319.68	7.58	0.19	311.91
2005	261.37	3.34	0.63	257.40
2006	224.89	0.22	1.65	223.02
2007	245.79	0.41	0.92	244.46
2008	218.01	0.03	0.28	217.70
2009	255.21	2.54	0.87	251.80
2010	246.72	2.99	0.87	242.86
2011	287.71	5.82	0.48	281.41
2012	247.67	3.64	1.25	242.78
2013	286.83	0.80	0.15	285.88
2014	283.51	4.40	0.26	278.85
2015	286.14	0.21	0.39	285.54
2016	294.60	3.30	0.26	287.74
2017	305.40	6.50	0.14	298.76
2018	277.06	1.11	0.17	275.79

Table 80: Emissions from subcategories of aggregate sources and non-CO_2 emission sources on land in Lebanon for 2015 and their share from the category 3.C (values in Gg CO_2eq.)

Emissions from biomass burning (3.C.1)		CO_2 emissions from Urea application (3.C.3)		Total direct emissions from managed soils (3.C.4)		Total indirect emissions from managed soils (3.C.5)		Indirect emissions from manure management (3.C.6)	
CH_4	**% total**	CO_2	**% total**	N_2O	**% total**	N_2O	**% total**	N_2O	**% total**
0.16	**0.05%**	1.11	**0.4%**	182.5	**65.88%**	67.61	**24.40%**	25.49	**9.20%**

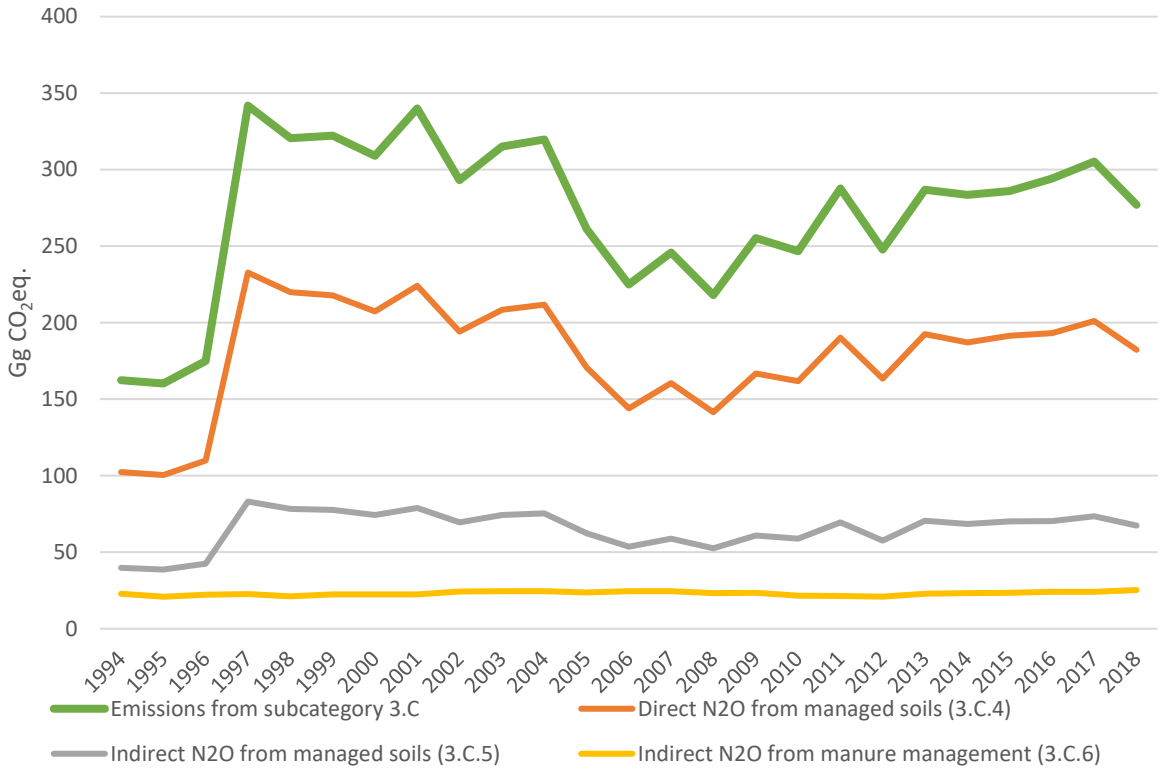


Figure 52: Trend of GHG emissions from Aggregate sources and non-CO_2 emission sources (3.C) and breakdown of N_2O emissions per subcategory for the period 1994-2018

Emissions from biomass burning are caused by wildfires affecting forest land, cropland and grassland, with forest lands being the main target of these fires. GHG emissions are limited to CH_4 emissions, which are insignificant compared to other sources of emissions from this category (Table 81).

Table 81: Emissions from burned areas in 2018

Type		Burned areas (ha)	CH_4 emissions (CO_2eq. Gg)	N_2O emissions (CO_2eq. Gg)
Forest	Coniferous	18.63	+0.1506	+0.0789
	Broadleaf	34.94		
	Mixed	59.56		
Cropland	Annual	NE	NE	NE
	Perennial	1.38	+0.0006	+0.0003
Grassland		58.50	+0.0145	+0.0125

Burned lands are only calculated for perennial crops.

Fires continue to represent a threat to Lebanon's forests (Figure 53 and Figure 54). Although Lebanon's national strategy for forest fire management was endorsed in 2009, very few steps have been implemented since then to reduce the risk of fires. Fire severity and the quick spread of fires are mostly related to limited capabilities in managing fire risk, weak law enforcement and lack of forest management (Mitri et al., 2015; 2017). Although fires have burned relatively smaller areas in 2016-2018 in comparison to previous years, trends linked to climate are making wildfire seasons longer (MoE/UOB, 2018). The increasing frequency of extreme weather events is expected to increase the potential for devastating wildfires across the country.

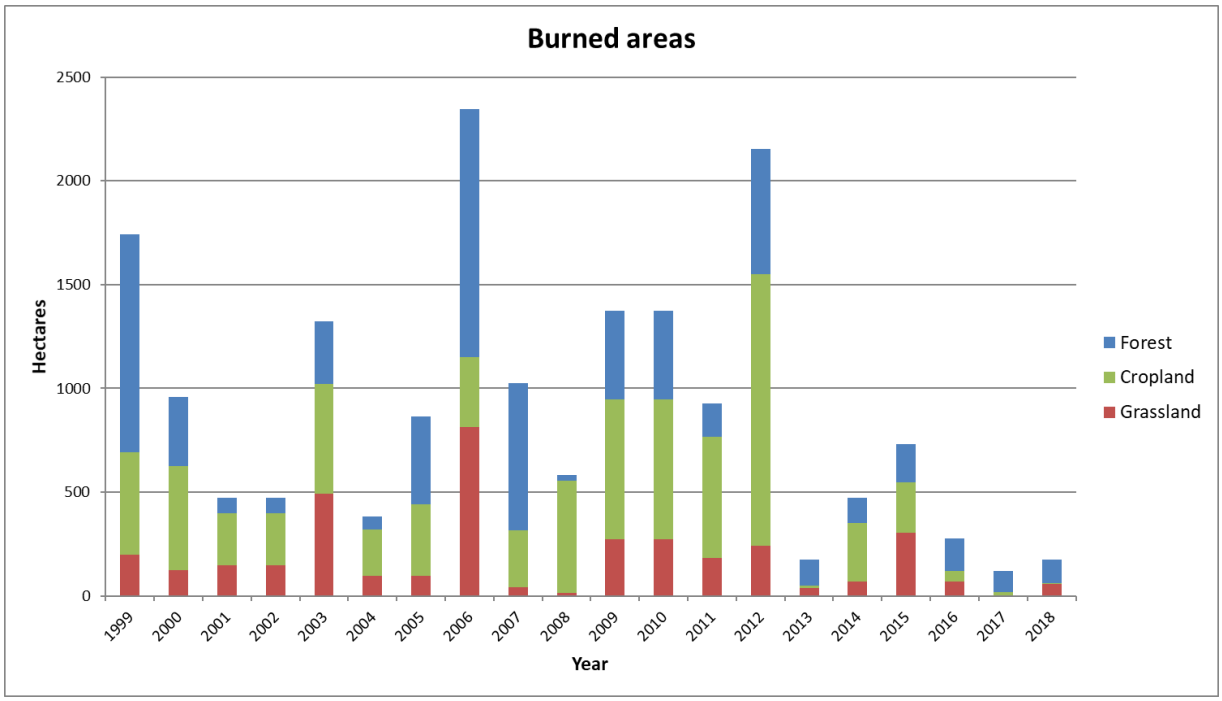


Figure 53: Annual spatial changes in burned areas

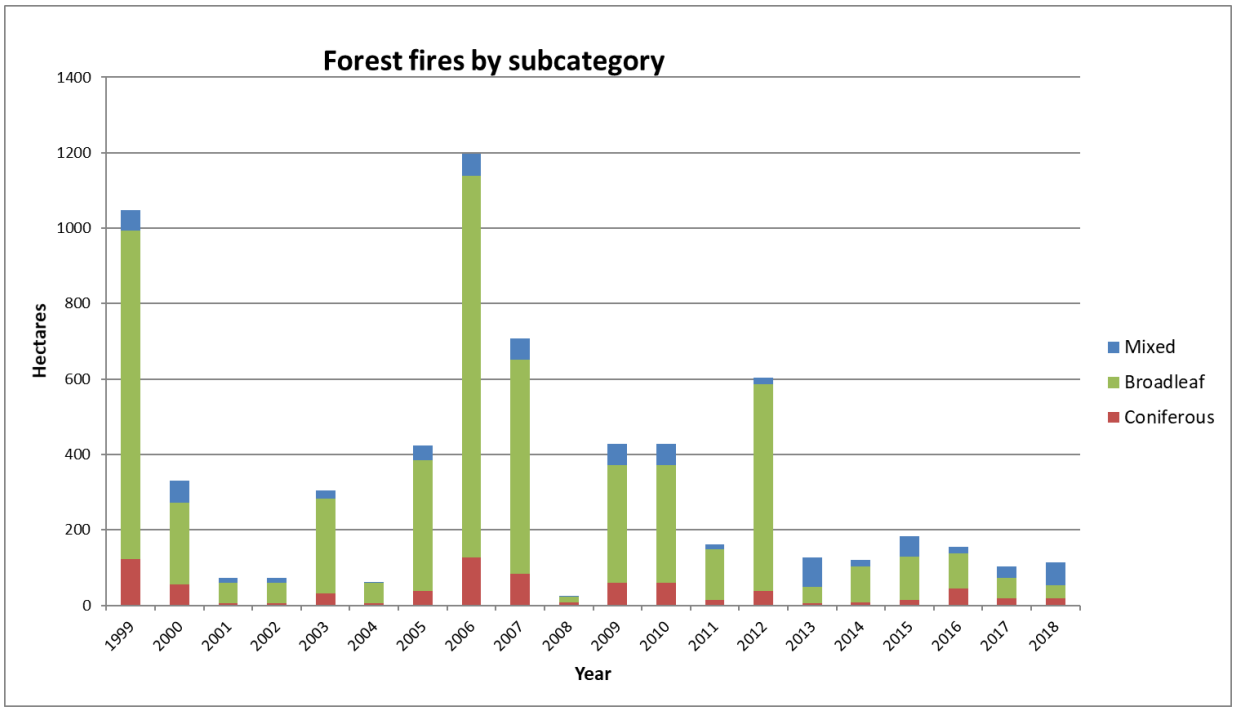


Figure 54: Annual change in areas of forest fires by subcategory

Time series of CO_2 emissions in CH_4 and N_2O in Gg CO_2eq. were produced (Figure 56). In addition, total non-CO_2 emissions in Gg CO_2eq. was produced (Figure 57) indicating peaks of emissions in 1999, 2006 and 2012 varying between 1.92 and 2.58 Gg CO_2eq.

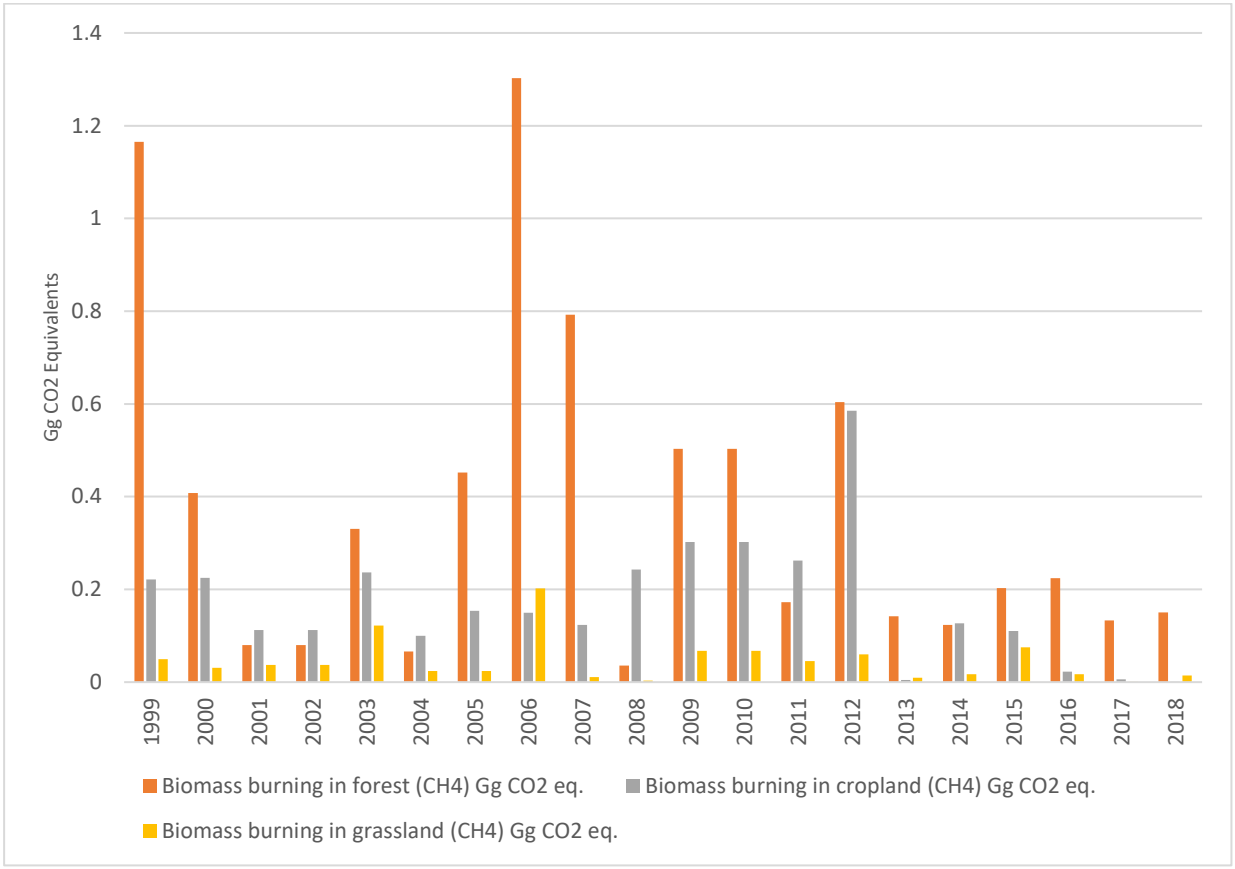


Figure 55: Time series CH_4 emissions from biomass burning

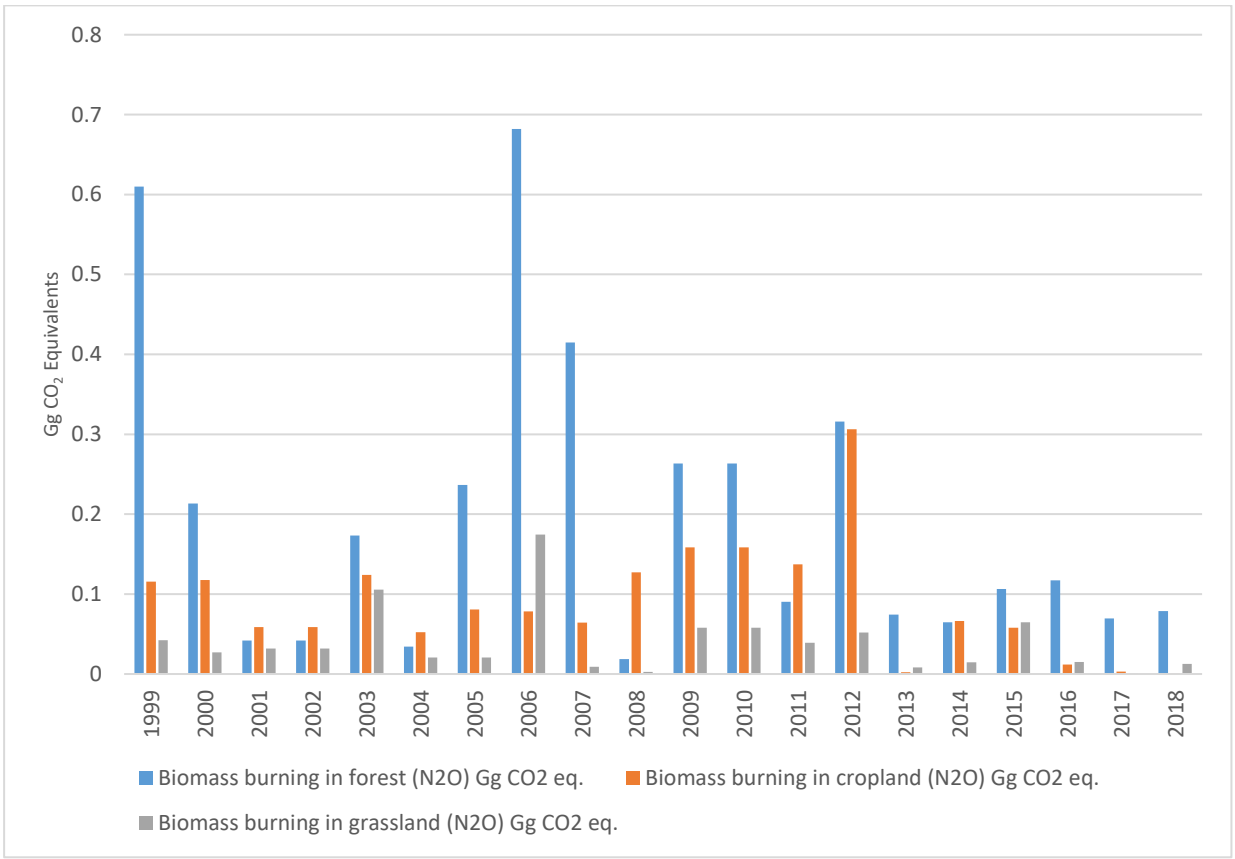


Figure 56: Time series N_2O emissions from biomass burning

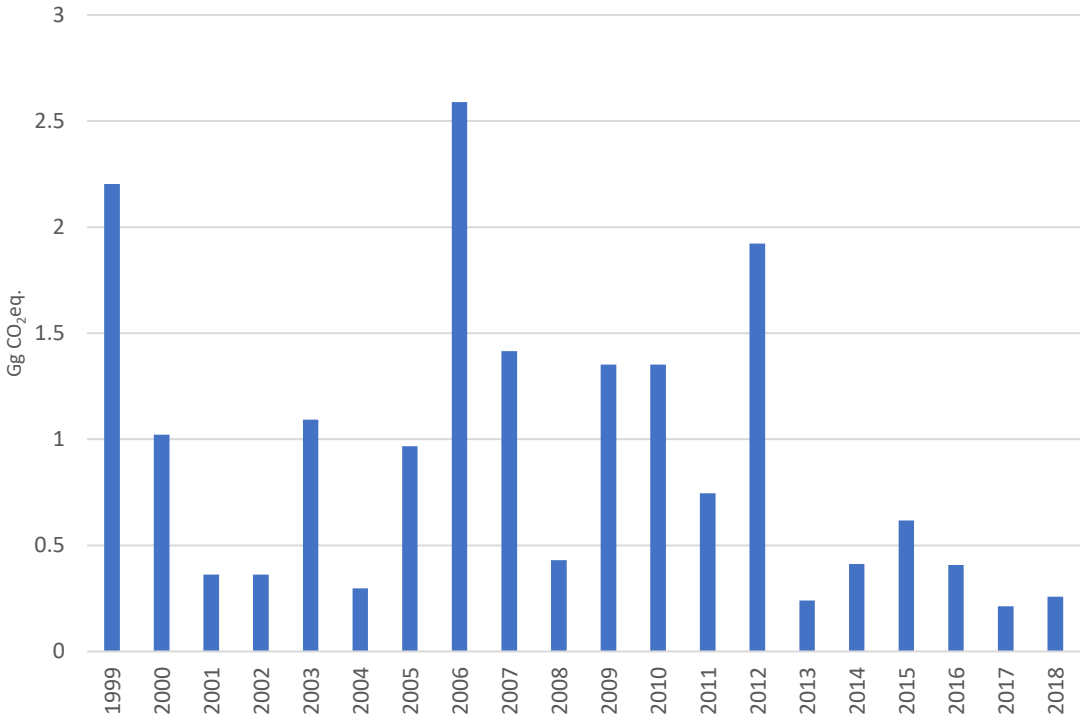


Figure 57: Time series total non-CO_2 emissions from biomass burning

4. Waste and wastewater

According to the IPCC 2006 guidelines, the source category "waste" covers emission from disposal and discharge of both solid waste and wastewater, while differentiating between the various management options.

The present section covers the following waste subcategories:

4.A. Solid waste disposal
4.B Biological treatment of solid waste
4.C Incineration and open burning of waste
4.D. Wastewater treatment and discharge

The major process by which emissions are produced in the waster sector are methanogenesis, nitrification and denitrification, combustion, and aerobic decomposition.

Table 82: Sources of GHG emissions in the waste category

	Solid waste disposal	Biological Treatment of solid waste	Incineration and open burning	Wastewater treatment and discharge
Methanogenesis	CH_4	CH_4		CH_4
Nitrification and denitrification		N_2O		N_2O
Combustion			CH_4, N_2O, CO_2	
Aerobic decomposition	CO_2	CO_2		CO_2

4.A Solid waste disposal

Methodology

Since Solid Waste Disposal Sites (SWDS) on land category has been identified as a key category (CH_4 emissions) in previous inventories, and following the guidance of the IPCC 2006 guidelines, the tier 2 methodology has been used to calculate emissions from this category. Accordingly, the IPCC First Order Decay (FOD) method has been used with defaults parameters and country specific activity data. The FOD method assumes that the transformation of degradable material in the SWDS to CH_4 and CO_2 is by a chain of reactions and parallel reactions, in turn governed by different half-lives for different types of waste.

The CH_4 generation potential of the waste that is disposed in a certain year will decrease gradually throughout the following decades. In this process, the release of CH_4 from this specific amount of waste decreases gradually. Theretofore, the FOD model is built on an exponential factor that describes the fraction of degradable material which each year is degraded into CH_4 and CO_2. Hence, the FOD method requires data to be collected or estimated for historical disposals of waste over a time period of 3 to 5 half-lives (or at least 50 years) in order to achieve an acceptably accurate result. Therefore, Lebanon starts the estimate in year 1965.

Activity data, emission factors and other parameters

Detailed data on solid waste generation is not readily available for all regions in Lebanon and where available, information is disaggregated (by site, operator, local authority, etc.), decentralized and often reported in hard copy reports making any manipulation and analysis time consuming and difficult. Therefore, solid waste amounts are generally estimated based on population and generation

rate per capita estimations. Surveys and assessment conducted across the years are used to estimate waste generation rates, collection rate and disposal pathways. (El Fadel and Sbayti, 2000; CDR, 2006; MoE, 2010; OMSAR, 2018 and MoE, 2019). In addition, expert consultation meetings were held in order to validate assumptions and findings to fill the data gaps. Extrapolations and interpolations were used when data was unavailable.

Table 83: Activity data and main assumptions for solid waste emissions calculations

Population	The population of 2018 was taken from 1) the recent Household Survey prepared by the Central Administration of Statistics (CAS, 2020), 2) UNRWA reports on the Palestinians refugees (UNRWA, 2020) and 3) the UNHCR database on Syrian displaced (UNHCR, 2020). For the time series, the population of Lebanon was adopted from the World Bank database, the 2007 CAS Household survey and the 2018 updated CAS survey (World Bank, 2019, CAS 2007, CAS, 2020). The Syrian displaced population is included in total population starting 2011, and as reported by UNHCR.
Per capita waste generation rate	The generation rate for the Lebanese population, including foreign workers and Palestinian refugees, was extrapolated based on publications issued for the years 1994 (El Fadel and Sbayti, 2000), 2006 (CDR, 2006) and 2010 (MoE, 2010) for the time series 1965-2015. Starting 2016, or other years, the rate used is 1.16 kg/cap/day based on Lebanon's draft solid waste strategy (MoE, 2019). The generation rate used for Syrian displaced was adapted from Lebanon Environmental Assessment of the Syrian Conflict. The rate for Syrian displaced varies between 0.47 for the Bekaa region, 0.5 for the south, 0.51 for the north and 0.53 for Beirut and Mount Lebanon (MoE/EU/UNDP, 2014). An average amount of 0.5 kg/displaced/year has been used (Amounts are based on weight of wet waste).
Municipal solid waste generation	Waste generation for the years 1994 through 2018 was calculated based on the "per capita waste generation rate" (tonnes/capita/year) and the population (capita and displaced) for each year respectively. It includes both urban and rural populations.
Waste composition	The national waste composition is adapted from the Integrated Solid Waste Strategy of the Ministry of Environment, published in 2019 (MoE, 2019), the Office of the Minister of State for Administrative Reform (OMSAR) reports (OMSAR, 2018) and the Assessment of Solid Waste Management Practices in Lebanon (MoE/EU/GFA, 2017).
Industrial waste	No amounts of industrial waste generated in Lebanon is available. Therefore, industrial waste generation is estimated based on the Gross Domestic Product (GDP) and the industrial waste generation per GDP per year, according to the 2006 IPCC guidelines. The GDP for the time-series 1970-2015 was adopted from the IMF and World bank databases (2021). The GDP of 1970 was kept the same for the period 1965-1970. In Lebanon, the rate is estimated at 0.04 Gg of industrial waste/million USD in GDP. The calculation is based on the industrial waste generated of 188,850 tonnes in 2014 (Sweep-net, 2014) and a GDP of 47,833 million USD in 2014 (World Bank, 2019) and extrapolated for the rest of the years. Industrial waste is considered to be disposed with the regular waste stream.
Municipal solid waste disposed in Solid Waste Disposal Sites (SWDS)	Information on the waste quantities landfilled in SWDS was retrieved from the managing entities of these landfills: LACECO reports for the Naameh Landfill, Moores for the Zahleh landfill, BATCO for Tripoli landfill, Sidon Environmental for Saida and OMSAR for Minieh and Baalbeck for the period before 2015. However, due to the waste crisis in 2015 and after the closure of the main landfill in Lebanon, the share of waste disposed in each type pf disposal site changed significantly. It is assumed that in 2016 around 24% of generated waste is disposed in

	landfills and 63% in dumpsites, while in 2018, the percentage increases to 44% in landfills and 36% in open dumpsites (SOER, 2020).
Open dumpsites	It is assumed that prior to 1998, 96% of the waste generated was disposed of in open dumpsites, with the remaining 4% being revered by scavengers and source sorting. After 1998 and with the start of the Naameh landfill operations in Mount Lebanon and the establishment of other waste treatment plants around the country, the amount of waste being disposed in open dumpsites decreased significantly. However, after the 2015 waste crisis, and with the closure of the main landfill, open dumpsites increased from 670 in 2011 to 941 in 2017 (Moe/UNDP/ELARD, 2017), receiving around 30% of Lebanon's waste in 2018.
Percentage of recycle/reuse and composting	For the period 1965-1997, since no national data is available, it is assumed that 4% of the waste generate is being recovered through scavenging and reusing. For the period 1997-2015, and with the gradual establishment of waste treatment plants that undertake sorting and composting before landfilling, the recycling rates varied between 4% and 10% of total MSW generated, with an average of 8%, and the composting rate varied between 5% and 11%, with an average of 9%. Despite the waste crisis in 2015 and the closure of the main landfill and its waste sorting plants, the informal collection of valuable recyclables from waste streams increased, which preserved a recycling rate of 6% throughout the 2016-2018 period. However, the sorting and collection of organic waste as a separate stream decreased in 2016-2017, bringing the composting rate to 6.5% during this period. In 2018, and with more organized collection of domestic waste, the rate of composting increased back to 12.3%.
Quantity of recovered gas	The information of recovered gas in the operational landfills was provided from the supervising consultants' reports for each of the landfills through MoE. After the closure of the Naameh landfill, the amount of the recovered gas decreased significantly due to irregularities of contractual arrangements.
Exported quantities	Quantities of waste exported are minimal and are mainly composed of hazardous material. These amounts have not been taken into account in the calculation of CH_4 emissions from waste disposal mainly due to their composition.
Waste to energy	Since 2013, Saida anaerobic digestion is generating730 MWh/yr of electricity, 839 MWh/yr of heat and 32,000 m^3/day of biogas from CH_4 recovered. In addition, since 2017, the CH_4 received from the Naameh landfill is being used to generate electricity, which is reported to be 64,350 MWh in 2018.
Incineration of waste	Incineration used in Lebanon for small amounts of clinical waste at various medical establishments, although without permits or monitoring. Starting 2003, autoclaving conducted by Arcenciel to treat clinical and medical waste which significantly reduced the amount of waste incinerated. Starting 2012, incineration of plastic waste was initiated at the SICOMO industrial facility, with a rate of 50 tons per day during 2012-2015, which increased to 120 tons during the period 2016-2018.

Table 84: Main activity data collected and computed for solid waste generation and disposal

Year	Population	Total waste generated (Gg/yr)	Industrial waste generated (Gg/yr)	Waste Incinerated (Gg/yr)	Quantity of recovered CH_4 (Gg)	% Deposited in SWDS	% Recycled reused composted
1994	2,974,640	901.17	0.04	2		96%	4%
1995	3,033,394	918.97	0.04	2		96%	4%
1996	3,070,960	930.35	0.05	2		96%	4%
1997	3,092,670	936.92	0.06	2.34		96%	4%
1998	3,113,951	943.37	0.07	1.56	1.10	90%	10%
1999	3,156,646	1,036.96	0.07	1.56	1.50	85%	15%
2000	3,235,366	1,062.82	0.07	1.56	1.90	83%	17%
2001	3,359,859	1,103.71	0.07	1.56	2.30	82%	18%
2002	3,522,837	1,221.54	0.08	1.56	2.70	82%	18%
2003	3,701,464	1,283.48	0.08	1.25	3.13	82%	18%
2004	3,863,267	1,339.59	0.08	0.33	6.70	82%	18%
2005	3,986,852	1,382.44	0.08	0.28	9.91	82%	18%
2006	4,057,350	1,480.93	0.09	0.28	10.98	84%	16%
2007	4,086,466	1,491.56	0.10	0.22	16.94	84%	16%
2008	4,111,047	1,500.53	0.12	0.22	20.08	83%	17%
2009	4,183,156	1,526.85	0.14	0.21	16.87	82%	18%
2010	4,337,141	1,662.21	0.15	0.22	15.12	83%	17%
2011	4,588,368	1,758.49	0.16	0.21	16.16	83%	17%
2012	5,153,782	1,784.34	0.17	16.5	14.39	82%	18%
2013	5,582,899	1,967.56	0.18	16.5	19.90	80%	20%
2014	5,952,699	2,048.86	0.20	16.5	20.41	79%	21%
2015	5,933,283	2,059.45	0.21	16.5	20.77	84%	16%
2016	5,821,219	2,221.20	0.20	39.6	15.00	87%	13%
2017	5,924,324	2,263.25	0.21	39.6	6.82	87%	13%
2018	5,974,396	2,296.37	0.22	40.7	10.72	80%	20%

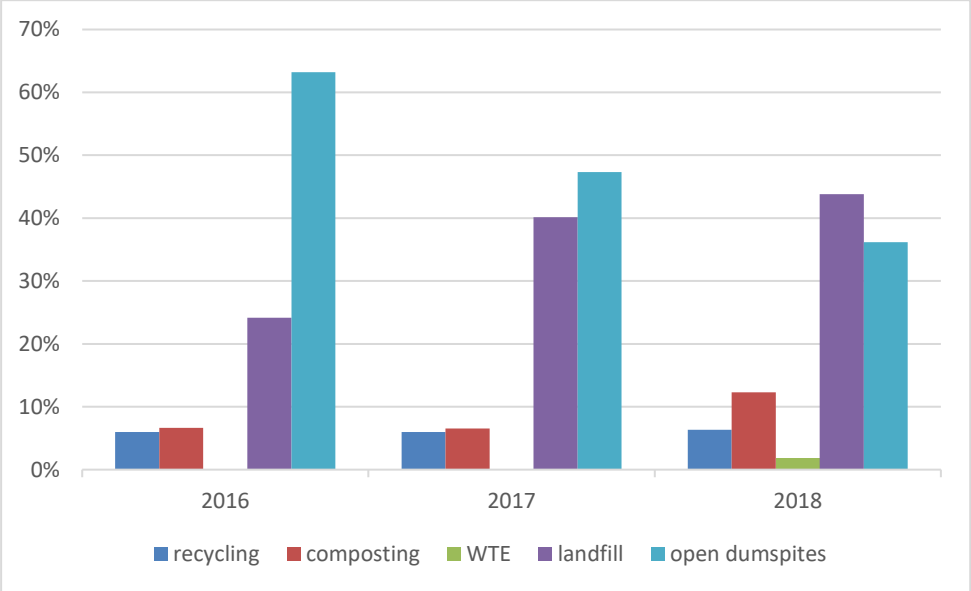


Figure 58: Distribution of waste management systems

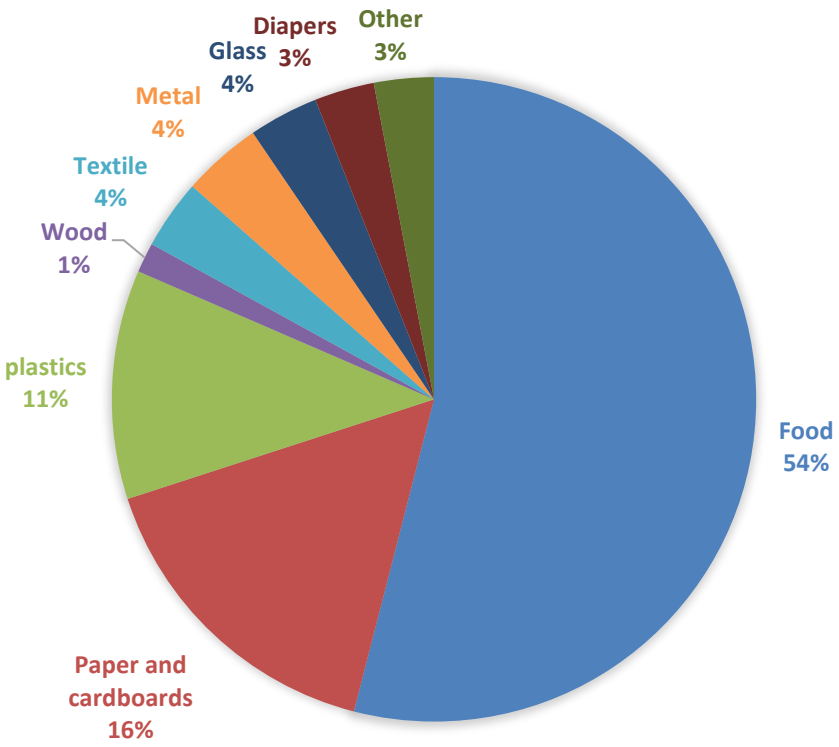


Figure 59: Waste composition in Lebanon

The emissions factors used for the calculation of methane generated from solid waste disposal sites are based on the use of the Methane Correction Factor (MCF) calculated according to the IPCC 2006 GL based on the different SWDS categories. The CH_4 correction factor accounts for the fact that unmanaged SWDS produce less CH_4 from a given amount of waste than anaerobic managed SWDS. In unmanaged SWDS such as open dumpsites, a larger fraction of waste decomposes aerobically in the top layer. In unmanaged SWDS with deep disposal, the fraction of waste that degrades aerobically should be smaller than in shallow SWDS. Semi-aerobic managed SWDS are managed passively to introduce air to the waste layer to create a semi-aerobic environment within the SWDS. The anaerobic SWDS is a closed landfill with no active or passive aeration.

Starting 2016, and after the closure of the Naameh landfill, all disposal sites are considered to be aerobic. Total amounts of waste received by the different managed and unmanaged classes are presented in Table 85.

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Table 85: Description of solid waste disposal sites categories

SWDS Category	MCF	Description	Categorization in Lebanon
Managed anaerobic	1	Anaerobic managed solid waste disposal sites: These must have controlled placement of waste (i.e., waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include **at least one** of the following: (i)cover material; (ii) mechanical compacting; or (iii) levelling of the waste.	Tripoli Jebj ennine Bar elias
Managed – semi-aerobic	0.5	Semi-aerobic managed solid waste disposal sites: These must have controlled placement of waste and will include **all of** the following structures for introducing air to waste layer: (i) permeable cover material; (ii) leachate drainage system; (iii) regulating pondage; and (iv) gas ventilation system.	Naameh (1997-2016) Zahleh Costa brava (2017- current) Bourj Hammoud (2017-current)
Unmanaged – deep (>5 m waste) and /or high-water table	0.8	Unmanaged solid waste disposal sites – deep and/or with high water table: All SWDS not meeting the criteria of managed SWDS and which have depths of greater than or equal to 5 metres and/or high-water table at near ground level. Latter situation corresponds to filling inland water, such as pond, river or wetland, by waste.	The unmanaged dumpsites are classified between deep and shallow. It is estimated that 69% of the open dumpsites are classified as shallow in this study despite having a depth of ≥ 5 m since they were reported to be regularly on fire, thus losing potential methane generation. 31% of open dumpsites are classified as unmanaged-deep (MoE/UNDP/ELARD, 2011). Saida and Baalbeck disposal sites are considered unmanaged sites.
Unmanaged shallow	0.4	Unmanaged shallow solid waste disposal sites; All SWDS not meeting the criteria of managed SWDS and which have depths of less than 5 metres.	
Uncategorised SWDS	0.6	Uncategorised solid waste disposal sites: Only if countries cannot categorise their SWDS into above four categories of managed and unmanaged SWDS, the MCF for this category can be used.	All open dumpsites of the period 1965-1997

Source| IPCC, 2006 and expert judgments.

Table 86: Other parameters considered in GHG emission calculations for solid waste disposal

Approach	Waste by composition
Climate zone	Boreal and temperate dry
Starting year	1965
DOCf (fraction of DOC dissimilated)	0.5
Delay time (months)	6
Fraction of methane (F) in developed gas	0.5
Conversion factor C to CH_4	1.33
Oxidation factor	0
%Paper in industrial waste	NA
% Wood in industrial waste	NA

	Degradable Organic Carbon (DOC) (weight fraction, wet basis)	Methane generation rate constant (k) (1/years)
Food waste	0.15	0.06
Garden	0.20	0.05
Paper	0.40	0.04
Wood and straw	0.43	0.02
Textiles	0.24	0.04
Disposable nappies	0.24	0.05
Sewage sludge	0.05	0.06
Industrial waste		0.05

4.B Biological treatment of solid waste

Composting and anaerobic digestion of organic waste are considered under this category. The CO_2 emissions are of biogenic origin and are not reported here.

Biological treatment of waste is usually linked to N_2O and CH_4 emissions, with a potential for recovery and combustion for energy under anaerobic digestion, where greenhouse gas emissions from the process are to be reported in the energy sector.

Activity data, emission factors and other parameters

Large scale composting activities occurred only in the greater Beirut area at the Coral facility. Although activities were partially suspended in 2015 and 2016, composting continued to take place for the organic portion of the waste collected in 2017 and 2018. Other composting activities also took place in the Zahleh, Saida, Minieh and Baalbeck sorting facilities, however at a smaller scale. All composted amounts have been considered in the calculation of emissions.

In 2013, anaerobic digestion of organic waste started at the Saida-IBC sorting facility, with biogas production of 32,000 m^3/day, 730,000 kWh/year of electricity production and 839,500 kWh/year of heat, both used internally within the facility. It is assumed that 95% of the produced methane is converted into electricity and heat production.

Table 87: Amount of waste biologically treated and methane recovered

	Waste treated through biological treatment (Gg/year)	
Years	***Compost***	***Anaerobic digestion***
1965-1997	0	0
1998	51.45	0
1999	103.37	0
2000	105.22	0
2001	107.77	0
2002	112.63	0
2003	117.29	0
2004	120.22	0
2005	123.30	0
2006	121.91	0
2007	119.79	0
2008	125.88	0
2009	138.59	0
2010	150.05	0
2011	156.78	0
2012	162.25	0
2013	166.05	35.74
2014	189.49	38.79
2015	121.83	30.52
2016	98.245	49.01
2017	80.476	67.51
2018	83.993	86.00

The emissions from composting and anaerobic digestion in biogas facilities depend on factors such as type of waste composted, amount and type of supporting material (such as wood chips and peat) used, temperature, moisture content and aeration during the process. However, since no national data is available to develop country-specific emission factors, default factors for CH_4 and N_2O emissions from biological treatment for tier 1 method are used for this inventory.

It is assumed that that the waste is weighed at dry basis. As per the IPCC 2006 guidelines, it is considered to have 25-50% DOC in dry matter, 2% N in dry matter, and moisture content 60%.

Table 88: Default emission factors for CH_4 and N_2O from biological treatment of waste

Year	**CH_4 Emission Factor (g CH_4 /kg waste treated)**	**N_2O Emission Factor (g N_2O /kg waste treated)**
Composting	10	0.6
Anaerobic digestion	2	0

4.C Incineration and open burning of waste

Incineration and open burning of waste containing fossil carbon, e.g., plastics, are the most important sources of CO_2 emissions in the Waste Sector. Waste incineration is defined as the combustion of solid and liquid waste in controlled incineration facilities, while open burning of waste is defined as the combustion of unwanted combustible materials in nature (open-air) or in open dumps, where smoke and other emissions are released directly into the air without passing through a chimney or stack.

Incineration and open burning of waste are sources of greenhouse gas emissions, like other types of combustion. Relevant gases emitted include CO_2, methane (CH_4) and nitrous oxide (N_2O). Only CO_2 emissions resulting from oxidation, during incineration and open burning of carbon in waste of fossil origin (e.g., plastics, certain textiles, rubber, liquid solvents, and waste oil) are considered net emissions and should be included in the national CO_2 emissions estimate. The CO_2 emissions from combustion of biomass materials (e.g., paper, food, and wood waste) contained in the waste are biogenic emissions and should not be included in national total emission estimates.

Activity data, emission factors and other parameters

Incineration is adopted in Lebanon for small amounts of clinical waste at various medical establishments, although without permits or monitoring. Starting 2003, autoclaving conducted by Arcenciel to treat clinical and medical waste which significantly reduced the amount of waste incinerated. A new sectoral assessment on industrial and unintentionally released Persistent Organic Pollutants (POPs) was prepared by the Ministry of Environment in 2017, which updated the amount of health care waste being incinerated since 2004 based on a field survey in hospitals.

Starting 2012, an incinerator was established at the SICOMO facility to treat plastic waste, starting with a rate of around 50 tonnes/day in 2012 to a rate of 120-150 tonnes/day by 2018.

Open burning of waste is widely adopted in Lebanon throughout the open dumpsites. A study conducted in by the Ministry of Environment in 2017 on the rehabilitation of open dumpsites estimated that 69% of the open dumps were regularly on fire. Therefore, it is assumed that the below amount of waste is open burned every year.

Table 89: Quantities of waste being incinerated

Year	Amount incinerated (Gg)
1994	2.34
1995	2.34
1996	2.34
1997	2.34
1998	1.56
1999	1.56
2000	1.56
2001	1.56
2002	1.56
2003	1.25
2004	0.33
2005	0.28
2006	0.28
2007	0.23
2008	0.23
2009	0.22
2010	0.23
2011	0.22
2012	16.58
2013	16.56
2014	16.56
2015	16.56
2016	49.56
2017	49.56
2018	49.56

Source | MoE/UNEP/GEF, 2017

Table 90: Amount of waste open-burned

Year	Amount deposited in unmanaged dumpsites (tonnes)	Amount burned (tonnes)
1994	865,155.03	596,956.97
1995	882,250.19	608,752.63
1996	893,182.70	616,296.06
1997	899,507.08	620,659.88
1998	515,386.36	355,616.59
1999	142,430.01	98,276.71
2000	168,092.74	115,983.99
2001	181,804.61	125,445.18
2002	245,083.38	169,107.53
2003	256,723.54	177,139.25
2004	285,205.21	196,791.59
2005	298,997.88	206,308.53
2006	380,283.59	262,395.67
2007	420,032.35	289,822.32
2008	401,936.49	277,336.18
2009	306,242.12	211,307.06
2010	338,511.51	233,572.94
2011	369,391.82	254,880.35
2012	340,559.51	234,986.06
2013	423,473.85	292,196.96
2014	391,589.95	270,197.07
2015	973,935.21	672,015.30
2016	1,453,100.29	1,002,639.20
2017	1,169,623.21	807,040.01
2018	903,380.73	623,332.70

The common method for estimating CO_2 emissions from incineration and open burning of waste is based on an estimate of the fossil carbon content in the waste combusted, multiplied by the oxidation factor, and converting the product (amount of fossil carbon oxidised) to CO_2. The emission factors are based on the oxidised carbon content of the waste that is of fossil origin. Relevant data include the amount and composition of the waste, the dry matter content, the total carbon content, the fossil carbon fraction and the oxidation factor.

The Tier 1 methodology is used for calculating CO_2 emissions from incineration/open burning, default data on characteristic parameters (such as dry matter content, carbon content and fossil carbon fraction) for different types of waste are used from the 2006 IPCC guidelines. The calculation of the CO_2 emissions is based on an estimate of the amount of waste (wet weight) incinerated or open-burned taking into account the dry matter content, the total carbon content, the fraction of fossil carbon and the oxidation factor.

Table 91: Parameters for incineration and open burning

	Waste incineration	**Open burning MSW**
Dry matter content in % of wet weight	-	78%
Total carbon content in % of dry weight	60%	34%
Fossil carbon fraction in % of total carbon content	40%	8%
Oxidation factor in % of carbon input	100%	58%

CH_4 emissions from incineration and open burning of waste are a result of incomplete combustion. CH_4 emissions are particularly relevant for open burning, where a large fraction of carbon in the waste is not oxidised. Default emission factors are used for CH_4 emissions from incineration and open burning of waste.

Nitrous oxide emissions from waste incineration are determined by a function of the type of technology and combustion conditions, the technology applied for NO_x reduction as well as the contents of the waste stream. Since this information is not available in Lebanon, a default emission factor is used according the 2006 IPCC guidelines. Since no specific emission factor is available for clinical waste incineration, it is assumed that clinical waste has the same characteristic of industrial waste, accordingly the emission factor for industrial waste incineration is used.

Table 92: Emission factors for incineration and open burning

	Waste incineration	**Open burning MSW**
CH_4 emission factor	0[1]	6,500
N_2O emission factor	100	150

[1] For clinical waste, because of low concentrations and high uncertainties, it is good practice to apply an emission factor of 0

4.D Wastewater treatment and discharge

Wastewater originates from a variety of domestic, commercial and industrial sources and may be treated on site (uncollected), sewered to a centralized plant (collected) or disposed untreated nearby or via an outfall.

Wastewater can be a source of methane (CH_4) and nitrous oxide (N_2O) emissions when treated or disposed anaerobically. The extent of CH_4 production depends primarily on the quantity of degradable organic material in the wastewater, the Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). Usually, BOD is more frequently reported for domestic wastewater, while COD is predominantly used for industrial wastewater. Nitrous oxide (N_2O) is associated with the

degradation of nitrogen components in the wastewater, e.g., urea, nitrate and protein included in human sewage.

Wastewater treatment processes can produce anthropogenic methane (CH_4) and nitrous oxide (N_2O) emissions. Wastewater from domestic and industrial sources is treated to remove soluble organic matter, suspended solids, pathogenic organisms, and chemical contaminants. Treatment may either occur on site, most commonly through septic or latrine systems, or off site at centralized treatment systems.

For this inventory, the IPCC 2006 IPCC guidelines, tier 1 methodology is used since no country specific emission factors and no measurements on wastewater treatment pathways are not available in Lebanon. Data is collected on the share of wastewater treatment in each pathway and emissions are estimated using default emission factors.

Limited information is available in Lebanon with regards to wastewater generation rates, treatment percentages and discharge media. Therefore, all of the activity data relies on estimations that are either made for this inventory or adopted from other publications. Most of population in Lebanon are living in urban and peri-urban areas. In addition, the difference between urban, peri-urban and rural areas in terms of wastewater degradable organic component is minor. Therefore, the population served by the treatment pathway are estimated at the national level.

Activity data, emission factors and other parameters

Domestic Wastewater

Domestic wastewater quantities are calculated based on the estimated resident population (including Palestinian refugee) in Lebanon. Calculations take also into account Syrian displaced located in Lebanon, where it is assumed that the same wastewater discharge practices are adopted. Table 93 presents the estimated population for the years 2016-2018(CAS, 2020; UNRWA, 2020; UNHCR 2019).

Table 93: Population considered in the assessment (2016-2018)

Year	Lebanese (Source: CAS)	Palestinians Refugees (Source: UNRWA)	Syrian displaced (Source: UNHCR)	Total Population
2016	4,624,197	185,657	1,011,366	5,821,219
2017	4,731,845	174,422	1,018,057	5,924,324
2018	4,842,000	163,867	968,529	5,974,396

In Lebanon, domestic wastewater in Lebanon is partly collected and treated in centralized plants or disposed of in waterways, lakes or the sea, via closed sewers. Uncollected wastewater is disposed in septic tanks and/or cesspools that are lined or unlined holes of up to several meters deep. Industrial wastewater is discharged directly into bodies of water, while very limited industrial facilities may have treatment plants. The percentage of the domestic wastewater treatment systems and discharge pathways in Lebanon are shown in Figure 1 and the corresponding percentage of served population.

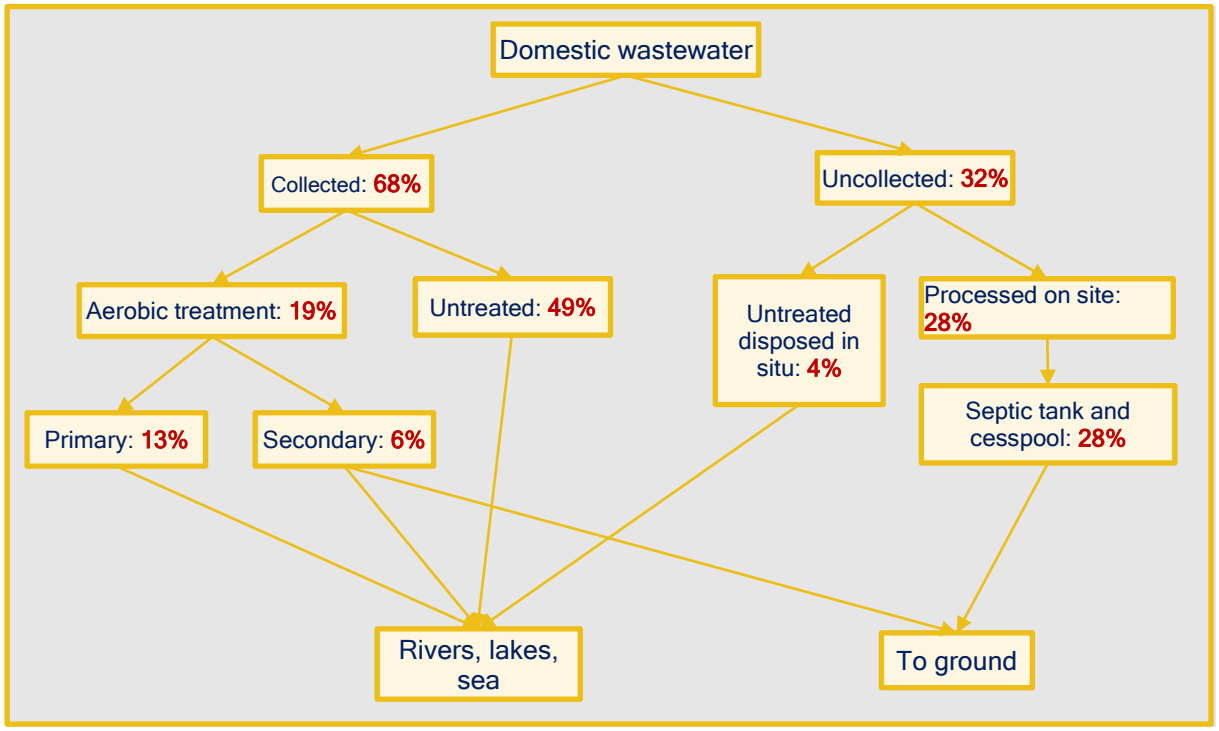

Figure 60: Domestic wastewater treatment systems and discharge pathways in Lebanon for 2018

As shown in Figure 60, 32% of domestic wastewater are processed in on-site systems and 68% are collected, while 19% are treated by centralized aerobic wastewater treatment systems (13% primary and 6% secondary) and 49% are released without treatment to the rivers, lakes, or sea.

Table 94: Types of discharge systems in Lebanon

Collected	**Untreated**	**River/sea discharge**	Stagnant, oxygen-deficient rivers and lakes may allow for anaerobic decomposition to produce CH_4. Rivers, lakes and estuaries are likely sources of N_2O.
	Treated	**Centralized aerobic wastewater treatment plants**	May produce limited CH_4 from anaerobic pockets. Poorly designed or managed aerobic treatment systems produce CH_4. Advanced plants with nutrient removal (nitrification and denitrification) are small but distinct sources of N_2O.
Uncollected	**Untreated**	**Septic tanks**	Frequent solids removal reduces CH_4 production.
		River discharge	Stagnant, oxygen-deficient rivers and lakes may allow for anaerobic decomposition to produce CH_4. Rivers, lakes and estuaries are likely sources of N_2O.

Data on the percentage of population served by the domestic wastewater treatment pathways are not officially available, the percentage of population served by the domestic wastewater treatment pathways are estimated by the author based on several sources.

The percentage of collection of domestic wastewater by sewer systems by 2010 was estimated by the Ministry of Energy and Water at 60% in 2010 (MoEW, 2010). Then the implemented sewer networks projects were estimated between 2010 and 2019 and the additional Lebanese population connected to sewer networks were estimated during this period (Table 97). Therefore, the total population connected to sewer network in 2018 is estimated at 5,354,719.

The centralized wastewater treatment plants (WWTPs) in Lebanon can be classified as primary and/or secondary. Most of the operational centralized WWTPs are primary treatment where physical barriers remove larger solids from the wastewater and remaining particulates are then allowed to settle. The population served by primary and secondary wastewater treatment is estimated in 2018 at around 1,204,415 (24.2% of the Lebanese population) based on data collected from CDR (2020), UNICEF (2016) and USAID (2013).

For on-site processing, it is estimated that 28% of the population is served by septic tank and cesspool systems. A septic tank is an underground chamber made of concrete, fiberglass, or plastic through which domestic wastewater (sewage) flows for basic treatment. Cesspool is an underground reservoir, lined or unlined, where the wastewater flows from the home into it. Organic solids float to the top and inorganic solids sink to the bottom of the tank. The clear liquid flows out the sides of the tank and into the surrounding soil. Settling and anaerobic processes reduce solids and organics, but the treatment efficiency is only moderate.

The percentage of the total uncollected, untreated and disposed in situ domestic wastewater is estimated based on WHO/UNICEF Joint Monitoring Programme (WHO/UNICEF, 2020) at approximately 4%.

Figure 61 presents a summary of the percentages of the wastewater treatment systems and discharge pathways that will be considered for the emissions assessment.

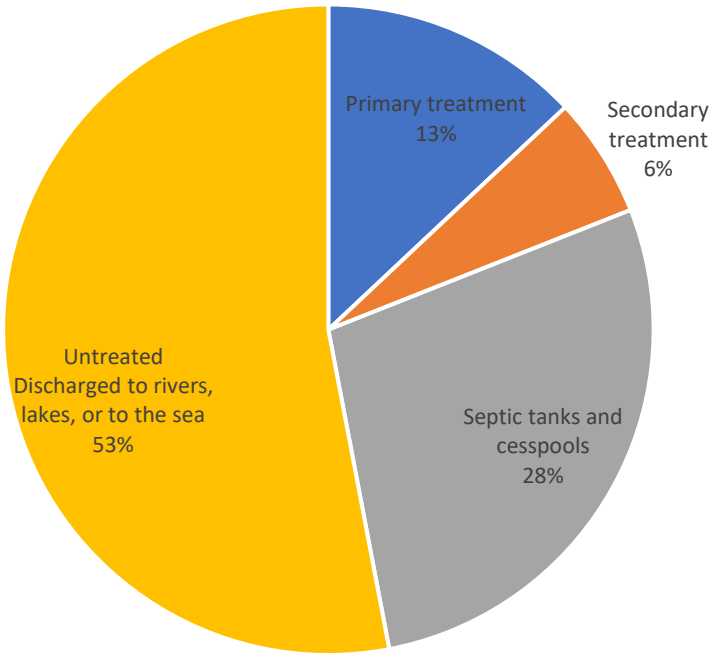

Figure 61: Percentages of the wastewater treatment systems and discharge pathways

Table 95: WWTPs in Lebanon determined by type, status and number of served population

Treatment Plant	Caza	Population that should be Served	Type of treatment	Status	Year of starting operation	Estimation of actual served population	
Ghadir	Baabda-Aley	800,000	Primary	Operational @ 50%	2000	400,000	400,000
Saida	Saida	390,000	Primary	Operational @ 50%	2010	195,000	196,250
Yammouneh	Baalbeck	2,500	Secondary	Operational @ 50%	2010	1,250	
Yahmour	Nabatieh	4,500	Secondary	Operational @ 100%	2011	4,500	12,800
Zawtar	Nabatieh	4,500	Secondary	Operational @ 100%	2011	4,500	
Bakka 2	Rachaya	1,600	Secondary	Operational @ 50%	2011	800	
Rachaya	Rachaya	6,000	Secondary	Operational @ 20%	2011	3,000	
Aitanit	West Bekaa	35,700	Secondary	Operational @ 20%	2012	17,850	103,465
Ablah	Zahleh	14,630	Secondary	Operational @ 20%	2012	7,315	
Forzol	Zahleh	7,400	Secondary	Operational @ 20%	2012	3,700	
El Rihane	Jezzine	4,500	Primary	Operational @ 50%	2012	2,250	
Khiam	Marjayoun	8,000	Primary	Operational @ 50%	2012	4,000	
Baalbeck / Iaat	Baalbeck	100,000	Secondary	Operational @ 50%	2012	50,000	
Ammatour	Chouf	5,000	Secondary	Operational @ 100%	2012	5,000	
Ehden	Zgharta	23,700	Secondary	Operational @50%	2012	11,850	
Wadi Jezzine	Jezzine	1,500	Secondary	Operational @ 100%	2012	1,500	
Ras Nabi Younes	Chouf	88,000	Primary	Operational @ 20%	2014	17,600	391,600
Tripoli	Tripoli	1,000,000	Primary	Operational @ 20%	2014	200,000	
Nabatieh	Nabatieh	100,000	Secondary	Operational @ 100%	2014	100,000	
Joub Jenine	West Beqaa	70,000	Secondary	Operational @ 100%	2014	70,000	
Saghbine	West Beqaa	4,000	Secondary	Operational @ 100%	2014	4,000	
Bcharreh	Bcharreh	300	Secondary	Operational @ 100%	2016	300	300
Zahle	Zahleh	150,000	Secondary	Operational @ 50%	2017	75,000	75,000
Tibnine	Bin Jbeil	25,000	Secondary	Operational @ 100%	2018	25,000	25,000
Total (Primary Treatment)						**818,850**	
Total (Secondary Treatment)						**385,065**	

Industrial Wastewater

No amounts of industrial products generated in Lebanon are available, however, the values of the gross domestic production in USD of industrial products are available in the National Accounts Estimates of relevant categories including: i) manufacturing of food products; ii) beverages and tobacco manufacturing; iii) textile and leather manufacturing; iv) wood and paper manufacturing and printing; and v) chemicals, rubber and plastics manufacturing. The estimation of production quantities of products relevant to these categories will be discussed in sequence:

i) Manufacturing of food products

The average productions by weight are estimated for the manufacturing of food products based on the production value in USD per year (National Accounts Estimates CAS, 2018). The rate used to convert the USD production per year to ton per year is estimated at 1,490 USD/ton of food products (BLOMinvest BANK, 2014). This average rate will be applied to calculate the production quantities for all years.

ii) Beverages manufacturing

The annual production of Arak in Lebanon is estimated to be around 2 billion bottles of 0.70 liters in 2016, equal to 1,372,000 tonnes (unit weight of Arak is 0.98 kg/liter) (BLOMINVEST BANK, 2016). The annual production of beer in Lebanon is estimated to be around 23.3 million liters in 2013, equal to 24,232 tonnes (unit weight of beer is 1.04 kg/liter) (BLOMINVEST BANK, 2013). The quantities for all years are estimated based on the percent of growth of beverages manufacturing in USD per year (National Accounts Estimates CAS, 2018).

iii) Tobacco manufacturing

No significant wastewater produced from the tobacco manufacturing in Lebanon.

iv) Textile and leather manufacturing

The textile and leather manufacturing in Lebanon does not involve the processing and production of textile and leather raw material. Therefore, wastewater of these products is not significant.

v) Wood and paper manufacturing

The wood and paper manufacturing in Lebanon does not involve the processing and production of wood raw material or dried pulp. The wood raw material and pulp are imported. Therefore, wastewater of these products is not significant.

vi) Chemicals, rubber and plastics manufacturing

The chemicals, rubber and plastics manufacturing in Lebanon does not involve the processing and production of raw materials. The raw materials are imported. Therefore, wastewater of these products is not significant.

For completeness of reporting, the data of industrial production of 2016 was interpolated based for the 1994-2018 time series, and the category was recalculated.

Activity data, emission factors and other parameters

The emission factor for a wastewater treatment and discharge pathway is a function of the maximum CH_4 producing potential (Bo) and the MCF for the wastewater treatment and discharge system.

The Bo is the maximum amount of CH_4 that can be produced from a given quantity of organics, based on the BOD of wastewater. The MCF indicates the extent to which the CH_4 producing capacity (Bo) is realised in each type of discharge pathway and system. Expert judgment was used to estimate some of the below parameters.

The average degradable organic component (kg Biological Oxygen Demand (BOD)/cap/yr) for the Lebanese population is estimated at 23.7 kg BOD/cap/yr (MoE/UNDP/GEF, 2019; World Bank, 2011). However, based on the Lebanon Environmental Assessment of the Syrian Conflict and Priority Interventions study (MoE/UNDP/EU, 2014), the incremental pollution load of wastewater generated by displaced is estimated to produce around additional 40,000 tonnes of BOD5 per year (2014), reflecting a significant increase of organic biodegradable load in the environment. Based on the number of Syrian displaced to Lebanon in 2014 of 1,158,995, the degradable organic component is estimated at 34.5 kg Biological Oxygen Demand (BOD) kg/cap/yr.

Therefore, a weighted average degradable organic component that take into consideration Lebanese population and Syria refugees is calculated, to reflect the different weights of population and BOD between both categories.

Table 96: Weighted average of degradable organic component (kg BOD/cap/yr) (2016-2018)

Year	Lebanese and Palestinians	Kg BOD/cap/yr (Leb and Pal)	Syrian Refugees	Kg BOD/cap/yr (Syrian)	Total Population	Total BOD	Weighted Average Kg BOD/cap/yr
2016	4,809,853	113,993,518	1,011,366	34,892,127	5,821,219	148,885,645	25.6
2017	4,906,267	116,278,534	1,018,057	35,122,967	5,924,324	151,401,501	25.6
2018	5,005,867	118,639,055	968,529	33,414,251	5,974,396	152,053,306	25.5

Following wastewater treatment, a fraction of the organic component is removed from wastewater, in the form of sludge. Typical primary and secondary wastewater treatment produces a total of about 0.94 kg of dry solids per 3.78 m^3 of wastewater treated, which is equal to 0.249 kg/m^3 (Metcalf and Eddy, 1991). Based on a rate of 50 m^3 wastewater generated per person per year in Lebanon [=0.8 (coefficient)*0.17(water consumption 170 liter/cap/day) *365), primary and secondary wastewater treatment is estimated to remove 12.43 kg/cap/year of organic sludge.

Table 97: Wastewater parameters and conversion factors for CH_4 emissions for 2018

	Primary treatment	Secondary treatment	Septic tanks	Sea, river and lake discharge	Source
Average BOD (g/cap/year)	25.5	25.5	25.5	25.5	Expert estimation
Bo (kg CH_4/kg BOD)	0.6	0.6	0.6	0.6	Default -Table 6.2 (IPCC 2006)
MCF	0.06[1]	0.03[2]	0.5	0.1	Adapted from Table 6.3 (IPCC 2006) WERF/IWA, 2010 for septic tanks
EF (kg CH_4/kg BOD)	0.036	0.018	0.3	0.06	Calculated using (Equation 6.2)
Sludge removal (kg/cap/year)	12.43	12.43	12.43	12.43	Calculated as above
R (kg CH_4/yr)	0	0	0	0	

1 There is no particular category for the primary treatment plants in IPCC2006. The primary treatment systems are aerobic and they decrease the BOD concentration up to 50%, therefore, we estimated the MCF value as double of the considered value for aerobic secondary treatment plants.

2 The default IPCC 2006 value for well managed aerobic treatment plant is 0, however, we increased the value of this parameter to be 0.03 to account for the risk of mismanagement in some treatment plants

Table 98: Wastewater parameters for CH_4 emissions from industrial wastewater

	W (m^3/tonnes)	COD (kg COD/m^3)	Bo (kg CH_4/kg COD)	MCF	R (kg CH_4/yr)
Manufacturing of food products	13.00[1]	4.10[1]	0.25	0.10	0.00
Beverages (Wine, Arak and Vinegar)	23.00	1.50	0.25	0.10	0.00
Beverages (Beer and Malt)	6.30	2.90	0.25	0.10	0.00
Source	Table 6.9 (IPCC 2006)	Table 6.9 (IPCC 2006)	Table 6.2 (IPCC 2006)	Table 6.8 (IPCC 2006)	No CH_4 recovered

[1] Due to the unavailability of data, the manufacturing of food products is taken in one item and the related parameters are assumed based on the IPCC 2006 default values of Meat and Poultry food item.

Nitrous Oxide (N_2O) emissions can occur as direct emissions from treatment plants or from indirect emissions from wastewater after disposal of effluent into waterways, or the sea.

N_2O emissions from **centralized wastewater treatment plants** may only be of interest for countries that have predominantly advanced centralized wastewater treatment plants with controlled nitrification and denitrification steps. However, since no advanced wastewater treatment plants are operational in Lebanon, only indirect N_2O emissions from wastewater effluent is discharged into aquatic environments is estimated using default emission factors.

Indirect N_2O emissions arising from the discharge of wastewater (treated or untreated) into aquatic receiving environments is also estimated based on the per capita protein consumption in Lebanon and the fraction of nitrogen in the protein.

Table 99: Wastewater parameters and conversion factors for N_2O emissions

	Sea, river and lake discharge	Source
(Protein) (kg protein/per/yr)	30.66	Expert estimation
F_{NPR} (kg N/kg N)	0.16	Default (IPCC, 2006)
$F_{NON-CON}$ (kg N/kg N)	1.1	Default Table 6.10a (IPCC, 2006)
$F_{IND-COM}$ (kg N/kg N)	1.25	Metcalf and Eddy (2003) and expert judgment
N_{SLUDGE} (kg N/yr)	0	Default (IPCC, 2006)
(*EF*) (kg N_2O-N/kg N)	0.005	Expert estimation

Results of Waste and Wastewater category

In 2018, activities related to the generation and treatment of solid waste and wastewater emitted 1,503.6 Gg CO_2eq., thus contributing to 5% of Lebanon's total GHG emissions. As expected, CH_4 emissions are the most common greenhouse gas emitted from waste and wastewater discharge and treatment, constituting 89% of the sector's emissions. As for N_2O emissions, they represents 9% of the waste category's emissions, mainly from wastewater discharge and treatment.

Solid waste disposal (SWDS) on land is also a main source a CH_4 emissions due to the anaerobic and semi-anaerobic decomposition of the organic portion of the waste in landfills or open dumpsites.

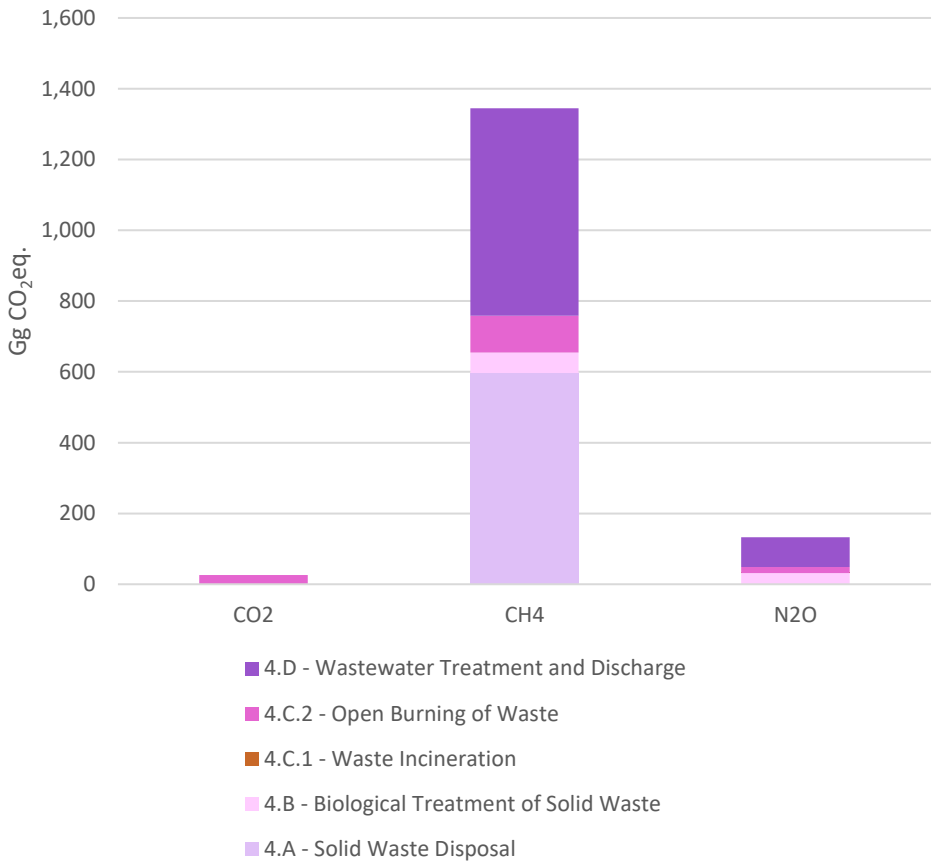

Figure 62: GHG emission from the waste sector in 2018 per subcategory

The trend of GHG emissions from the waste sector is highly fluctuating, as presented in Figure 63. the 2015 waste crisis has a significant impact on GHG emissions, with a 67% increase compared to 2015, mainly due to the increase rate of open dumping and open burning of unsegregated waste, this reducing proper treatment of organic waste. Emission decrease with the start of operation of the Bourj Hammoud and Costa Brava landfill, where sorted waste is disposed in technically managed cells.

With respect to N_2O, the 2018 emissions from domestic wastewater were estimated to be 132.84 Gg CO_2eq. Nitrous oxide emissions from wastewater treatment processes gradually increased across the time series as a result of increasing Lebanon population and protein consumption. Nitrous oxide emissions are not estimated from industrial wastewater treatment because there is no IPCC methodology provided or industrial wastewater emission factors available.

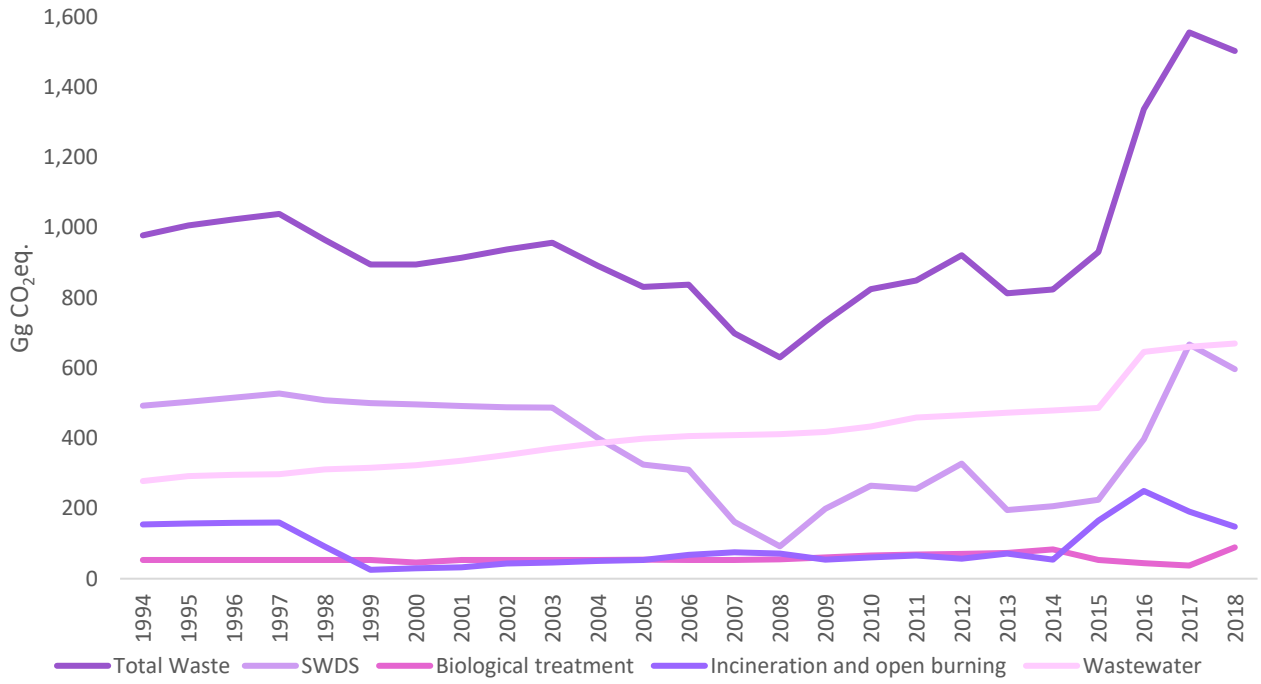

Figure 63: Trend in GHG emissions from the waste category

In 2018, wastewater treatment and discharge and treatment from both domestic and industrial sources amounted to 669.92 Gg CO_2eq. Figure 64 shows CH_4 and N_2O domestic wastewater emissions from three main sources for the year 2018.

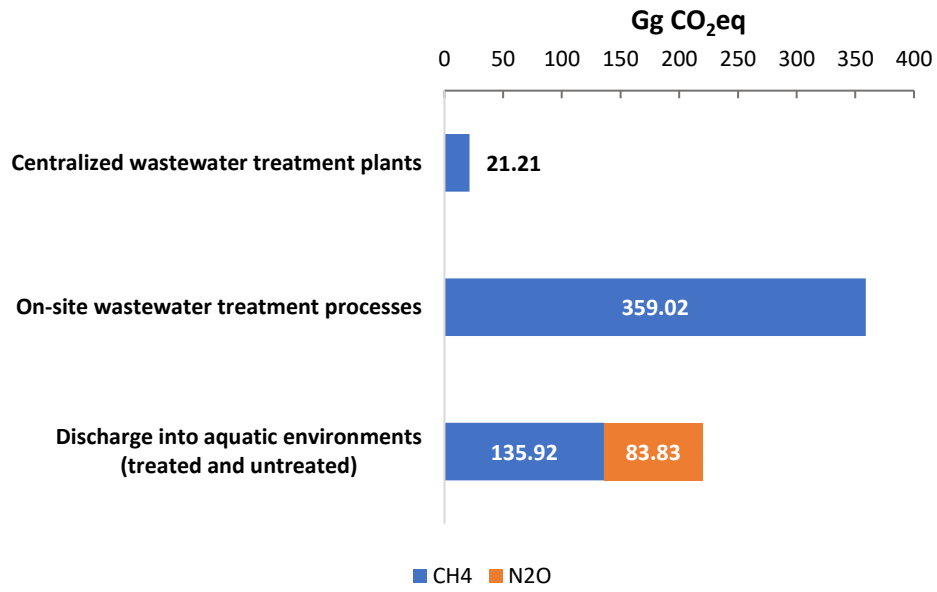

Figure 64: Domestic wastewater GHG emission for 2018

IV. INFORMATION ON MITIGATION POLICIES AND ACTIONS

IV. INFORMATION ON MITIGATION POLICIES AND ACTIONS

As a Party to the UNFCCC, Lebanon has made efforts to implement activities that lead to emission reductions based on its capabilities and taking into account its national circumstances. Information on these mitigation actions and their effects has been documented, to the extent possible, following the guidelines on BUR, including the associated methodologies and assumptions. Emission reductions have been estimated from some of the activities depending on data availability, while other have only been described qualitatively in the below sections. The methodology adopted for the calculation of emission reductions of the identified mitigation actions is based on the 2006 IPCC revised guidelines, as already adopted in the preparation of the inventory. Gases covered include CO_2, CH_4 and N_2O, reported in terms of CO_2 equivalent and using the AR5 GWP.

The main national policy on climate change in Lebanon is the Nationally Determined Contribution (NDC) which was updated in 2020 and which sets clear emission reduction targets. The progress of the implementation of the NDC is not reported in this BUR4, as it will be reported in Lebanon's first BTR according to Decision 18/CMA.1.

Currently, Lebanon has no specific methodology for monitoring the progress of actions described. Consultations with main stakeholders including ministries, research institutions and international organizations helped identify the extent to which each mitigation action was implemented and accordingly, percentages of completion were used to calculate emission reductions achieved. However, due to lack of systematic collection of information, the list of measures reported in this section is not exhaustive, which underestimates the emission reduction that Lebanon is undertaking to combat climate change. The current section captures the mitigation measures that have been implemented in the energy, transport, agriculture, forestry and waste/wastewater sectors.

Sectoral mitigation actions and policies

4.1 Energy

As reported in the national greenhouse gas inventory, the majority of Lebanon's emissions come from the energy sector. Therefore, climate mitigation in this sector plays an important role in reducing national emissions while achieving positive environmental, economic, and social impact through demand side management and cleaner energy production.

Reducing GHG emissions from the energy sector includes planning and implementing activities related to fuel switch, increasing the share of renewable energy, improving energy efficiency at plant and consumer levels, while being supported by proper institutional and legal framework and financing mechanisms.

Emissions reduction from mitigation actions in the energy sector is estimated at 615,663 tonnes CO_2eq. per year for the period 2016-2018 (Table 100). It is important to note that due to the absence of institutional arrangements for reporting mitigation actions in a systematic and sustainable way, the list of actions presented in the following sections is not exhaustive, which underestimates emission reduction efforts undertaken in Lebanon during the period 2016-2018.

Table 100: Summary of emissions reduction from energy related mitigation measures

Measure	Emission reduction per year for 2016-2018 (tonnes CO_2eq./year)
Fuel switch	NA
Increase share of renewable energy	
Decentralized PV	41,853
Landfill Gas	12,085
Grid-connected large-scale solar PV	1,223
Improve energy efficiency at power plant level	332,897
Improve energy efficiency at consumer level	227,605
Energy related financing mechanisms	NA
Institutional and legal framework	NA
Total	**615,663**

1. Fuel switch

Under the Energy Policy Paper 2010 and the Updated Electricity Policy Paper 2019 (MoEW, 2010; MoEW, 2019), the Ministry of Energy and Water planned the conversion of some power plants from gas/diesel oil to natural gas. However, due to the absence of regionally available gas supply options, and due to some technical and financial constraints tied to the import of liquefied natural gas, no gas switch has taken place in Lebanon during the period 2015-2018. In 2021, discussions were initiated at the political level to transport Egyptian gas to Lebanon through the Arab Gas Pipeline which passes through Jordan and Syria. A technical inspection of the pipeline is planned to be conducted by and in the three countries before the start of supply of gas.

2. Renewable energy and energy efficiency

Several action plans have been put forward by the government to increase the share of renewable energy in Lebanon and improve energy efficiency measures, including the National Energy Efficiency Action Plan (NEEAP) and National Renewable Energy Action Plan (NREAP) for 2016–2020 and the most recent IRENA REmap plan (2020). These action plans build on the high availability of renewable energy sources in Lebanon and the potential for the deployment of renewable energy and energy efficiency for both electricity generation and heating purposes (IRENA, 2020).
To date, the total installed renewable energy power capacity amounts to 350 MW, including 286 MW from hydropower sources, 7 MW from landfill and 56.37 MW from solar power. Most of the newly added renewable energy installations are decentralized solar rooftop photovoltaics.

Box 9: Renewable Energy Outlook- IRENA Remap analysis

In 2020, the International Renewable Energy Agency (IRENA) developed a study on the Renewable Energy Outlook for Lebanon in collaboration with the Lebanese Ministry of Energy and Water (MoEW) and the Lebanese Centre for Energy Conservation (LCEC). The report used the REmap analysis, IRENA's global roadmap to scale up renewables, to identify the feasible untapped potential for renewables in Lebanon while quantifying costs and investment needs. The report showed that Lebanon has the potential to supply 30% of its electricity consumed in 2030 from renewables, mainly from solar PV, followed by wind and hydropower, as shown in the below table. The report also suggests an estimated reduction of around 2.85 Mtonnes CO_2 emissions and annual savings of up to USD 249 million (IRENA, 2020).

Potential average savings in the power sector: Comparison between the Remap case 2030 and the Reference case 2030

REF 2030	Capacity (MW)	Average LCOE (USD ¢/KWh)	Generation (GWh)	Cost (USD m)
Natural Gas	4 909	10.76	27 432	2 951
Wind	626	8.27	1 817	150
Hydropower	601	5.33	1 749	93
Solar PV[11]	1 030	4.47	1 789	80
Biogas	8	4.55	59	3
Total energy cost (USD million)				3 277
REmap 2030	**Capacity (MW)**	**Average LCOE (USD ¢/KWh)**	**Generation (GWh)**	**Cost (USD m)**
Natural Gas	4 909	10.76	23 393	2 517
Wind	1 000	8.27	2 655	219
Hydropower	601	5.33	1 749	93
Solar PV[12]	2 500	4.47	4 342	194
Biogas	13	4.55	99	5
Total energy cost (USD million)				3 028

Decentralized solar photovoltaic: By 2018, the decentralized solar photovoltaic market in Lebanon grew from 11.39 MWp in 2015 to 56.37 MWp, generating 83,799 MWh in 2018. It is estimated that such increase in electricity generation from PV has avoided 125,561 tonnes CO_2eq., during the 2016-2018 period, or what is equivalent to **41,853 tonnes CO_2eq. per year**.

The 2016-2018 period witnessed a significant growth of PV installation due to the decrease of cost of the technology and the increase in the cost of oil which created a bigger incentive for industrialists and retailers to reduce their diesel consumption by investing in solar PV systems. The highest solar PV capacity installations were reported in the industrial sector, followed by the commercial sector with respectively 31% and 22% of the total solar PV installed. The most adopted technologies were the on-grid (62%), on-grid with batteries (12%), solar pumping (9%) and hybrid/multi-sources (9%) (MoEW/LCEC, 2019a).

61% of the installed solar PV capacity has been funded through the NEEREA mechanism for a total investment of USD 56.94 Million whereas the remaining was funded by non-NEEREA investments amount to USD 47.86 Million (MoEW/LCEC, 2021b; MoEW/LCEC, 2019a). The National Energy

Efficiency and Renewable Energy Action (NEEREA) is a funding mechanism that provides interest-free long-term loans for green energy projects including solar PV solar PV rooftop installations.

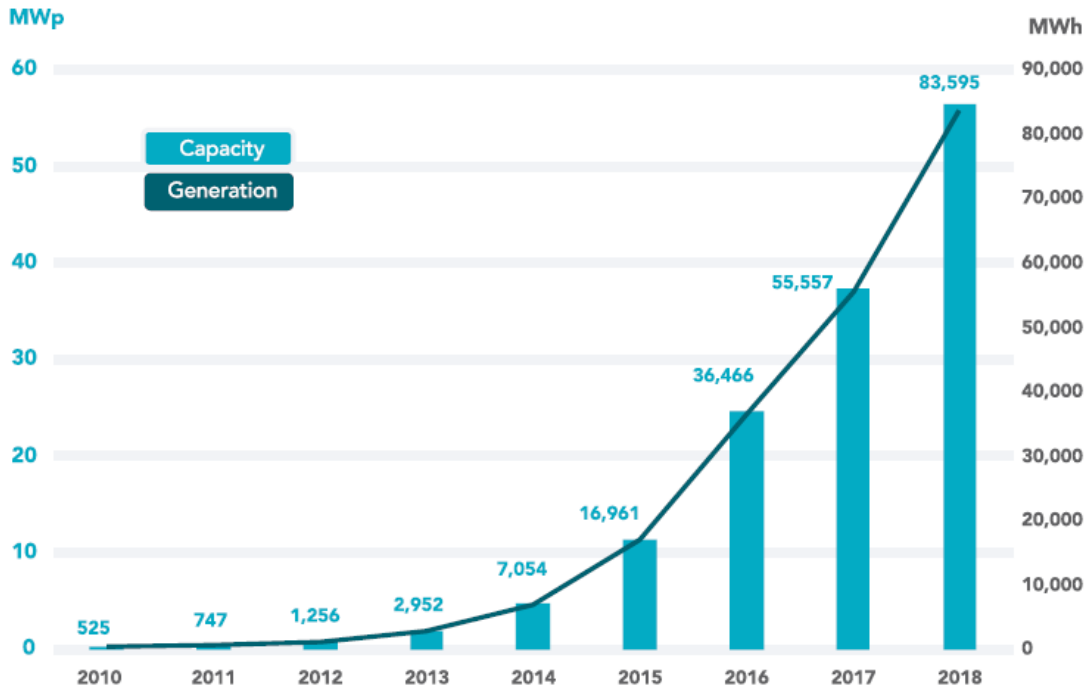

Figure 65: Solar PV Capacity and Annual additions (MoEW/LCEC, 2019).

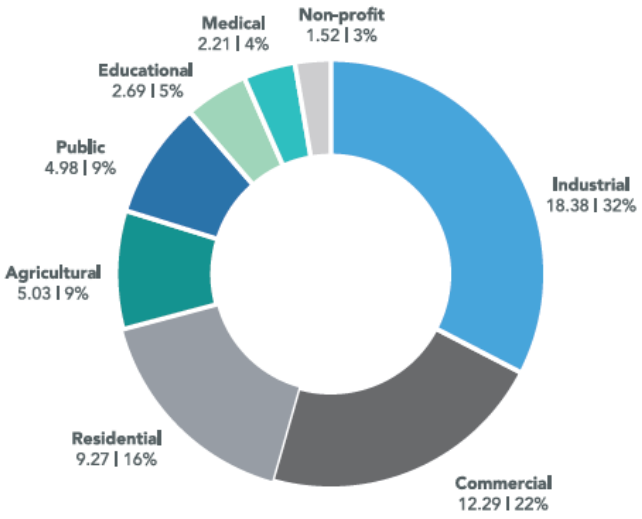

Figure 66: Solar PV capacity per sector (MWp) (MoEW/LCEC, 2019a)

Among these installations, 10 solar PV systems have been installed in public buildings owned by the Minister of Energy and Water initiative that was launched in 2017 to present the public sector as a successful role model and key player in the energy transition. Until date, around 740 kWp have been installed in public buildings with a total cost of USD 717,000 (Table 101).

Table 101: Solar PV installed by the Government of Lebanon in public buildings

Location	Capacity	Years	Budget	Status
Ministry of Energy and Water, Corniche du Fleuve, Beirut	135.3 kWp	2017-2018	USD 220,000	Operational
Lebanese Army Directorate of Engineering, Kfarshima	155.7 kWp	2017-2018	USD 137,500	Operational
LAF and ISF Barracks	141.1 kWp	2017-2018	USD 151,403	Put on hold given economic crisis
Casino du Liban	309.3 kWp	2019-2020	USD 209,397	Commissioned

Grid-connected large-scale solar PV: The deployment of large-scale solar PV projects is driven by competitive procurement either via the Engineering, Procurement and Construction (EPC) model – whereby a private company installs the project and hands it over to EDL for operation – or the Power Purchase Agreement (PPA) model, whereby private developers are invited to bid for a 20-year contract to sell power to EDL. To date, only the Beirut River Solar Snake has been installed following an EPC modality, which has generated 5,427 MWh of electricity from 2015 to mid-2019, based on the installation of 1 MWp as phase 1. It is estimated that 4,070 MWh was produced by the BRSS during the period 2016-2018, thus contributing to a reduction of 2,897 tonnes CO_2eq**.** or **965 tonnes CO_2eq./year** during this period (considering that the same amount of energy would have been produced by private generators with an Emission Factor of 0.7118 tonnes CO_2eq./MWh). The BRSS project was transferred to EDL in 2016.

In addition, the Zahrani Oil Installations has implemented a 1 MWp grid-tied solar PV system in 2016, with the produced energy being consumed by the facility, and the excess being fed to the national grid through net-meters. It is estimated that the PVs generated 361 MWh per year for 2017 and 2018, thus avoiding **257 tonnes CO_2eq./year** (considering that the same amount of energy would have been produced by private generators with an Emission Factor of 0.7118 tonnes CO_2eq./MWh).

In 2017 and 2018, MoEW initiated different Calls for Expression of Interest to install 12 PV farms each with a capacity of 10 to 15 MW, and 3 PV farms of 100 MWp capacity combined with a minimum storage capacity of 70 MWh each. (IRENA, 2020; MoEW/LCEC, 2021b). However, following the civil unrest in 2019, the COVID-19 and economic crisis in 2020, these initiatives have been put on hold.

Onshore and offshore wind: The initial evaluation of wind potential in Lebanon began in 2011 with the publication of the wind atlas (Garrad Hassan, 2011) that estimated a mean wind capacity potential of 6,100 MW. More recently, IRENA's assessed the on-shore wind capacity to 6,233 MW, taking into account resource quality, proximity to transmission lines, topography, population density, protected areas and land cover (IRENA, 2020).

A first contract was awarded in 2018 to Nasseem Akkar to develop 3 wind farms with a total capacity of 226 MW, and a request for proposals was launched in 2018 to procure up to 400 MW of wind farms

to add to the total installed capacity of wind energy and bring the national energy mix a step closer to the renewable energy targets. However, following the civil unrest in 2019, the COVID-19 and economic crisis in 2020, these projects have been put on hold.

Landfill gas: Since 2012, landfill gas is being collected for energy production from the Naameh landfill, which is the biggest sanitary controlled landfill in Lebanon, serving the Greater Beirut and Mount Lebanon area since 1997. After the closure of the landfill in 2015, a gas collection system has been installed to generate energy from methane and other gaseous emission. It is reported that the landfill generated 40,940 MWh and 64,350 MWh in 2017 and 2018 respectively, which has contributed in avoiding the emissions of 24,170 tonnes CO_2eq. during this period (or **12,085 tonnes CO_2eq./year)** (considering that the same amount of energy would have been produced by private generators with an Emission Factor of 0.7118 tonnes CO_2eq. /MWh).

Briquettes: In order to find sustainable solutions to the use of biomass for heating in rural areas, several initiatives were launched in Lebanon to pilot the feasibility of biomass briquetting. The briquettes, which have a relatively high energy content compared to other wood heating fuels, are sold in the local market to substitute the use diesel stoves and electric heating in Lebanon.

A first plant was established in 2012 at the Shouf biosphere reserve that uses woodchips from the forest, from agricultural waste and olive pomace to produce briquettes. The production grew from 1,300 tonnes per year in 2013 to 3,532 tonnes in 2018 and the main market is rural areas around the forest (SBR, 2015).

Through the UNDP-CEDRO project and with EU funding, 2 other briquetting facilities were implemented in two villages, Andaket Akkar and Bkassine. Briquettes are made at the municipal level by using forest's pruning residues as the main source of raw material (85%) and agricultural residues from the surrounding area's vines (10%) and olive (5%) plantations for the remaining share. By 2018, 2.5 tonnes of briquettes were produced at the Bkassine facility and sold in the local market.

No emission reductions have been estimated from the use of briquettes for heating due to the lack of disaggregated data on the quantity that has actually been used by households and the technology that biomass is replacing. efforts will be undertaken to estimate such amounts, and report resulting emission reduction in subsequent reporting.

Energy efficiency

Under the 2016-2020 NREAP and in the Electricity Policy Paper 2010 and its update in 2019 (MoEW, 2010 and MoEW, 2019), several measures aiming at increasing the efficiency of production and distribution of electricity were planned at the plants and consumer levels.

EDL's losses in 2018 exceeded 36% in total (as per electricity billed), with 4% loss of energy in the transmission network and 34% in the distribution system (of which technical losses were estimated at 1% and non-technical at 21%) (World Bank, 2019). Therefore, the updated Policy Paper calls for the reduction of technical and non-technical losses from 34% to 12% at the end of 2021 through the implementation of the transmission and distribution initiatives and the resolution of the non-technical losses. In addition, the Paper calls for the increase in generation capacity through improved efficiency and type of fuel used and the replacement of old plants by new ones.

As a step forward to implement the policy paper, the Council of Ministers endorsed the Transmission Master Plan in 2017, which aims at lowering the technical losses on the transmission grid and subsequently increasing the revenues of EDL. This includes the completion of the 220 KV loop at

Mansourieh, the 66 KV a loop (Bikfaya-Faytroun-Halat) in the region of Jouret Badran and the 66 KV loop between Kobeyate and Hermel and the Tyr Wadi Jilo line, in addition to the protection of the main transmission substations from aggression.

Accordingly, EDL has undertaken a series of rehabilitation and upgrade activities to increase the efficiency of the existing power plants of Jiyeh, Zouk, Deir Aamar, Zahrani, and some hydropower plants. These activities were financed by the government in addition to international donors such as the Danish Export Bank, Agence Francaise de Developement and the Italian Cooperation. It is estimated that these rehabilitation and upgrade activities have contributed in increasing the efficiency of power plants and avoided 998,691 tonnes of GHG emissions during the 2016-2018 period, or **332,897 tonnes CO_2eq./year** (calculation is based on the difference between the emissions of an upgraded specific plant with those that would have been emitted by private generators using an Emission Factor of 0.7118 tonnes CO_2eq. /MWh or by the old power plant for the same production of electricity). Details of activities, methodologies and emission reductions are presented in Annex IV.

Table 102: Summary of Energy Efficiency measures undertaken at power plant level for 2016-2018

Power Plant	Description of activity	Avoided emissions 2016-2018 (tonnes CO_2eq.)
Jiyeh Reciprocating Engines 78.2 MW Power Plant - HFO Grade B	A base load power plant based on 4 units of four-stroke medium speed diesel engines, type 18V48/60B has been commissioned in 2016. Decrease of SFOC from 198 to 186 g/kWh	88,496
Zouk Reciprocating Engines 194 MW Power Plant - HFO Grade B	A base load power plant based on 10 units of four-stroke medium speed diesel engines, type 18V48/60B has been commissioned in 2016. Decrease of SFOC from 194 to 185 g/kWh	279,813
Barges in Zouk and Jiyeh running on Reciprocating Engines - HFO Grade B	Each barge provides a base load power plant from 10 units of four-stroke medium speed diesel engines with SFOC of 213.26 g/kWh	346,416
Deir Ammar Combined Cycle Power Plant - DO	The CMF+ upgrade applies the latest design Controlled Diffusion Airfoil compressor blades to the V94.2 Gas Turbine. This allows a significant increase in compressor mass flow by approximately 3,5%, thus augmenting the power output. The Si3D upgrade superior design, material and coatings leads to a substantial improvement in turbine performance, and increases the overall power output and efficiency of the gas turbine.	No visible emission reduction
Zahrani Combined Cycle Power Plant - DO	The DACCPP SFOC achieved during the period (2016-2019) is SFOC=186.04 g/kWh The ZCCPP SFOC achieved during the period (2016-2019) is SFOC=184.49 g/kWh	283,966
Total avoided emissions		998,691

In terms of energy efficiency at the consumer level, Solar Water Heaters (SWHs) are the most common application in Lebanon that contributes to a reduction of electricity demand. Around 650,000 m^2 of SWH were installed between 2005 and 2018, with a relatively current steady market rate of 50,000 m^2 of installation per year. This is estimated to have reduced electricity demand for

water heating in Lebanon by 1,170,000 MWh for the 2016-2018 period (considering that SWH energy saving in 0.65 MWh/m^2/year), thus avoiding the emissions of 832,816 tonnes CO_2eq. for the same period, or **227,605 tonnes CO_2eq./year.** (considering that the same amount of energy would have been produced by private generators with an Emission Factor of 0.7118 tonnes CO_2eq./MWh). Recent studies showed however that the trend for the SWH market in Lebanon is reaching a plateau, if not a drop. As such, further incentives and introduction of regulatory tools are crucial to regain an upward growth in the market (IRENA, 2020, MoEW/LCEC, 2019b).

Energy related Financing mechanisms

The National Energy Efficiency and Renewable Energy Action (NEEREA) financing mechanism, initiated in 2010 by the Central Bank of Lebanon to provide the private sector with loans at low interest rates for renewable energy or energy efficiency project, has supported 938 projects with a total amount of more than USD 560 Million (as of March 2019), resulting a yearly reduction of 260,163,325 kWh in energy consumption and an annual saving of USD 73,253,210 (MoEW/LCEC, 2021b). The Ministry of Energy and Water reports that 76% of the projects were dedicated for solar photovoltaic installations, that 42% of loans amount were for green buildings and that the top two beneficiaries were the commercial Sector (example: hotels, commercial centers, etc.) with 52% and the residential sector with 31%.

To complement the NEEREA, financing mechanisms such as the Lebanon Energy Efficiency and Renewable Energy Finance Facility (LEEREFF) and the Green Economy Financing Facility (GEFF) were initiated in 2017-2018 through the support of the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD,) but were never implemented due to the financial and economic crisis that Lebanon has been facing since 2019.

Institutional and legal framework

From a legal and institutional perspective, the Ministry of Energy and Water has started developing a Decentralized renewable energy law in 2019 with the support of EBRD. This law sets a basis for stimulating distributed renewable energy production by founding the main principles for the realization of projects using net metering, and peer-to-peer renewable energy trading through direct power purchase agreements and/or renewable energy equipment leasing. A first draft of the law has been prepared, however following the civil unrest in 2019 and the COVID-19 and economic crisis in 2020, it has been put on hold and was not officially endorsed.

In addition to the draft law, a set of policy recommendations were prepared to derisk the renewable energy sector in Lebanon and promote private sector investment in large-scale wind energy and solar PV. These recommendations were presented as part of the UNDP study on Derisking the Renewable Energy Investments (DREI) study to systematically assess investment risks and selecting public instruments to attract renewable energy investment in large-scale projects. Following the political and economic crisis that started in 2019 and that had a detrimental impact on the renewable energy sector, the study has been revised to assess the new emerging risks such as the exchange rate, political risk and instability, investor's risk, uptakers risk, etc. The study found that financing and currency and macroeconomic risk are the priority risk areas that require immediate assistance. Appropriate reforms need to be identified to fast track and scale up technology deployment as per the NDC and sectoral plans. In addition, the technical capacity of the Ministries and the utility need to be improved significantly to ensure the procurement process is transparent and fair (UNDP, 2020). Table 103 presents the proposed key policy and financial derisking instruments to achieve the envisioned investment targets for wind energy and solar PV.

Details of the Energy sector mitigation actions are presented in a tabular form in Annex IV. Information on quantitative goals, progress indicators, estimated emission reductions, including methodologies and assumptions, and progress in implementing the energy mitigation actions are not reported in this BUR due to lack of relevant information that enables Lebanon to do so.

Table 103: Prioritization of actions to be taken to address the Derisking of Renewable Energy Investments

Low	Medium	High		
Risk category	**DREI measures to further minimize risk**	**Immediate (1-year)**	**Short (1-2 years)**	**Medium (3-5 years)**
Currency and macroeconomic risk	• Fiscal and monetary reforms for accessing funds for RE projects			
	• Establish a risk-based financing facility blended with finance from IFIs / donors			
	• Partial indexing of PPA tariffs to hard currencies such as EUR or USD			
Financing risk	• Appoint experts for overseeing PPA process and assessing project bankability			
	• Establish an impact fund / financing facility by blending finance from IFIs and local investors			
	• Explore climate related concessional funding			
Political risk	• Establish a new asset risk product through collaboration with IFIs and National banks			
	• Establish a regulation that licenses private generation of power			
Power markets risk	• Establish a tender regulatory framework			
	• Establish an independent regulatory authority			
	• Conduct a pre-qualification assessment of bidders			
	• Identify few locations (preferably on government land) for large projects >50 MWp			
Grid / Transmission risk	• Undertake grid stability and connectivity assessment			
	• Define a capacity building plan for strengthening EDL's grid management capability			

Developer risk	• Conduct resource mapping study for solar and wind with optimal location for projects			
	• Develop a safeguard strategy to secure land for developer			
Counterparty risk	• Decommission expensive thermal power plants and add solar and wind to recover some deficits			
	• EDL organization restructuring exercise			
	• Government backed 6-month guarantee for PPA payments by EDL must be in USD			
Social Acceptance risk	• Implement a legislation that allows developers to setup mini grids or micro grids			
	• Undertake mini grid / micro grid technical assessment			
Permits risk	• Fast track approval of permits			

4.2 Transport

Since 2015, no major mitigation measure has targeted the transport sector and lead to significant emission reductions from the sector. The majority of the government-lead projects have focused on roadway and parking construction which are not considered sustainable solutions for the state of transportation in Lebanon and are therefore not covered in this section. In addition, the progress toward implementing the National Transport Policy issued in 2014 has been slowed down, especially after the compounded crises that Lebanon has been facing since 2019 that has reshuffled the government's priorities. However, some relevant activities have been put in place to improve the planning and performance of the sector:

From the planning side, 2 major initiatives were implemented during the 2016-2018 period to build institutional capacities and provide strategic support to the sector. The "**Institutional capacity development of the Railways and Public Transportation Authority (RPTA)"** project was launched in 2015 with UNDP to provide the necessary institutional capacity to the RPTA. The project aimed at developing a public transportation master plan and providing technical assistance for the implementation of reforms of the institution and the public transport sector in Lebanon. The project's total budget of USD 1,288,300 was provided by the Lebanese Government through the RPTA to implement the activities. The project, which was closed in 2019, submitted to the RPTA a master plan and a two-year implementation strategy for public transportation, and updated the institutional and technical structural capacities of the RPTA.

In addition, the European Union-funded "**Support Programme for Infrastructure Sector Strategies and Alternative Financing",** prepared and published a baseline study sector and a Strategic Environmental Assessment (SEA) of the Lebanese Land Transport Sector. The project also drafted a National Strategy for the Land Transport sector, but was never endorsed by the Lebanese Government.

The Ministry of Public Works and Transport also initiated contact with EuroMED to regulate public transport and restructure its government authorities, introduce new modes of public transport on the congested main routes, construct transport terminals at entrances of Greater Beirut and main cities and organize on-street and off-street parking. The **"Revitalization of the Public Transport in Greater Beirut"** project, which drafted licensing and enforcement systems for public transport services and launched tenders for the preparation of engineering designs for the railway line along the major corridor was however put on hold following the 2019 economic crisis in Lebanon. This initiative was complemented by the preparation of a Regional Transport Action Plan 2014-2020 as part of the regional **EuroMed Transport Support Project** and the **EuroMed Transport Rail Project.**

From the infrastructure side, 2 initiatives were also been planned during the 2016-2018 period to shift the share of personal transportation from passenger cars to public transport, which is currently dominated by private operators relying on small, low-performance vehicles. Primary among those is the World Bank's "**Greater Beirut Public Transport Project**" which consisted mainly of constructing a Bus Rapid Transport service along the busy northern coastal highway entrance into the Greater Beirut Area as well as further building the capacities of the RPTA for project implementation, supervision and management. The project, signed in 2018 with total cost of USD 345,000,000 (mostly as a loan to the GoL) was put on hold following the economic and financial crises that hit Lebanon in 2019.

In Tripoli, the country's second largest city, another initiative to modernize public transport was launched in 2018 by the EIB and UNDP with a budget of EUR 1 million. The "**Sustainable Urban Public Transport Investment Program"** in Greater Tripoli drafted the EUMEDRAIL Action Plan for Lebanon 2018-2020 to support decision makers in the revitalization of the railway network and revised the organizational structure, functional job descriptions, internal institutional bylaws and working procedures of the RPTA.

To complement these activities and contribute to the deployment of clean technology in the transport sector, a **tax incentive scheme** has been issued by the Government in the budget Law 79/2018 (article 55) and renewed in 2019 (Law 144/2019 – article 25.c) and 2020, providing cuts on customs and registration fees for the purchase of hybrid and electric vehicles in Lebanon. This has created a momentum in the market with the deployment of new lines of fuel-efficient vehicles across car importers as expressed in the first E-Motorshow 2019 in Beirut. It has also increased the interest of the public, academic and private sector to explore research investment opportunities in the infrastructure for electric mobility. Since no disaggregated data is available on the increase penetration rate of hybrid and electric car in the Lebanese market, no emission reduction was estimated from the implementation of this financial measure.

Box 10: National Transport Policy 2014

In 2014, the MoPWT presented to the Council of Ministers the National Transport Policy, with a master plan to revitalize the land public transport for passengers. The objectives of the Policy, as stated in the official document, are the following:

- Ensure an integrated transport system with affordable prices
- Diversify the modes of land transport available for passengers
- Supply the country with an efficient internal transportation system with affordable prices for freight in cities and rural areas
- Remove all barriers that hinder the competitive advantage of Lebanese freight transporters
- Provide Lebanon with a regional competitive role for the supply of logistic services
- Decrease the financial load on the national budgets from transport activities
- Apply specific standards on the infrastructure to conserve natural landscapes
- Ensure public road safety
- Maintain and protect the existing infrastructure

The main actions that are expected to have a direct impact on reducing GHG emissions are:

On the short term:

- Implementation of phase 1 of the rail transportation plan, namely the lane connecting port of Tripoli to the Syrian border.
- Revitalization and restructuring of the operation of public buses inside cities.
- Continuing the development project of traffic management in Great Beirut Area (GBA).
- Improvement of the pedestrian infrastructure.

On the long term:

- Deployment of a Bus Rapid Transit (BRT) on Beirut north and south gates, commuting Jounieh to Jiyeh.
- Development of a mass transit system covering territories all over Lebanon and commuting cities.
- Restructuring the freight transport.

Making up for the slow progress on sustainable transportation projects in the public sector is a host of initiatives by the private sector and NGOs, ranging from proposed plans to awareness building and actual implementations. Notable awareness raising activities included a number of national conferences by international organizations in collaboration with academia and NGOs about sustainable transportation modes and their environmental and cost benefits. Examples include the annual “Automotive Engineering Day” event at the Lebanese American University in collaboration with local car dealers to raise awareness about the transition to electric vehicle technologies through discussion forums and demonstrations, the October 2018 conference by the Agency for Technical Cooperation and Development (ACTED) for promoting environmentally sustainable transportation in Lebanon in collaboration with the Lebanon Hybrid Automotive Club and the first E-Motorshow in Lebanon organized in 2019 by E-ecoslutions to promote hybrid and electric cars.

Beyond awareness building capabilities, the Lebanese private sector and civil society have been dynamic in introducing innovative technological solutions to tackle the main transportation and mobility challenges in the country. Most noteworthy are the mapping initiatives of informal public transport services by the NGO “Bus Map Project” and the startup “Yalla Bus”, both of which evolved from paper maps into mobile applications. In fact, a range of mobile applications have been developed by local entrepreneurs to deliver a variety of functions, from facilitating carpooling (“Carpolo”, “Autopooling” and “Bbeep” apps) to automating parking access and payment (“Soffa” and “Viamobile” apps), to helping drivers navigate congested roadways (“3aj2aaWein?” and “Tari2ak” apps). Only one such application was developed by the public sector, namely the Traffic

Management Organization's (TMO) official app offering live traffic maps, pictures and news reports about traffic and roadway conditions.

Other grassroots initiatives include an annual "Bike to work day" to promote cycling to work and raise awareness about the importance of using environmentally friendly transportation. The event has been held for 3 consecutive years by the "Chain Effect" NGO in collaboration with Beirut municipality and bicycle shops, with increasing participation and endorsement by public figures.

International organizations have also been actively supporting and organizing workshops to raise events, network stakeholders and set an agenda for future actions in the sector. Most notable of these efforts is UNDP's "Sustainable Mobility Conference" in March 2019 held in collaboration with the Ministry of Environment, Ministry of Energy and Water and the Lebanese American University (LAU) to develop a roadmap for the transition to electric mobility. Similarly, the UN ESCWA organized the "Regional Workshop on the Development of Transport Statistics and Transport related Sustainable Development Indicators in the Arab Countries" in September 2019, where recommendations were developed for improving transport data in order to enhance decision-making in transportation and contribute to sustainable transport development.

A series of additional activities and projects are planned for the sector, including:

- **Lebanon Sustainable Low-Emission Transport Systems** to promote innovation and technology transfer for electric drive technologies and electric mobility in greater Beirut and Jbeil – *pending funding*
- **Nationally Appropriate Mitigation Action (NAMA) in Lebanon's Private Road Transport Sector** to create a car scrappage program for replacing old conventional vehicles with newer more efficient and alternative fuel vehicle technologies – *pending funding*
- **Rehabilitation of the northern coastal railway line** to shift to a rail trans-border freight transport system between Tripoli port and Syria – *pending funding from CEDRE*
- **Construction of bike lanes in Beirut** which includes 28 km of dedicated bike lanes inside Beirut in three phases to encourage the use of zero-emission alternative transportation means- *pending tendering for phase I and funding for phase I and II*

Details of the transport sector mitigation actions are presented in a tabular form in Annex V. Information on quantitative goals, progress indicators, estimated emission reductions, including methodologies and assumptions, and progress in implementing the transport mitigation actions are not reported in this BUR due to lack of relevant information that enables Lebanon to do so.

4.3 Agriculture

Limited activities with an emission reduction potential from agricultural activities have been implemented in Lebanon. Pilot projects related to water pumping and irrigation using renewable energy have recently been initiated across the country, but information is not available to estimate the scale of emission reductions from such projects.

Other activities are being explored through research and knowledge generation, capacity building, policy and regulatory framework support. Most climate change related projects and programmes in the agriculture sector are adaptation oriented with the aim to decrease climate change impacts and improve resilience and adaptive capacity of farmers' communities.

An indicative list of climate change projects implemented in Lebanon related to the agriculture sector is presented in Table 110, under the support received section. However due to lack of information, no emission reduction potential has been estimated for such activities. Efforts will be undertaken to report such information in subsequent reporting.

4.4 Forestry and Land Use

The Government of Lebanon launched through Ministry of Agriculture the ambitious "40 Million Trees" national initiative, aiming at planting some 40 million forest trees in public lands by 2030. Accordingly, several, Non-Governmental Organizations, municipalities and governmental institutions have been involved in reforestation projects in the country. Although a National Forest Program (NFP) in Lebanon has been finalized , forest legislations are still being reviewed, while technical and financial resources need to be secured.

Recognizing the need for action against land degradation, the GoL through the Ministries of Agriculture and Environment are also taking measures to reduce and restore degraded ecosystems both at the policy and at the implementation levels.

In this context, the Ministry of Environment with the support of the UNDP and financing from the Global Environment Facility (GEF), has started the implementation (2016 – 2021) of the Sustainable Land Management in the Qaraoun Watershed Project (SLMQ) that aims at embedding sustainability considerations in land use planning and entailing the rehabilitation of degraded natural ecosystems, among which forestlands, through reforestation and afforestation. The project also aimed at preventing further degradation through the promotion of sustainable forest management at the national and local levels. Under this project, many activities of relevance to forest landscape restoration have been undertaken in addition to developing tools to improve the management of forests in Lebanon.

Lebanon's National Biodiversity Strategy and Action Plan (NBSAP) 2016-2030 was issued by MoE in 2016 and endorsed by the Council of Ministers through Decision Number 62/2018, addressing Lebanon's obligations under Article 6a of the Convention on Biological Diversity. More specifically, the new NBSAP was aligned with the new CBD strategic goals and integrated the 2020 Aichi Biodiversity targets while taking into account both global and local needs and aspirations (MoE/UNEP/GEF, 2015; 2016). Forestry was relevant for all 18 National Targets.

Updating Lebanon's National Action Programme (NAP) for the United Nations Convention to Combat Desertification (UNCCD) was completed in 2018 to align national work to the 10-year convention's Strategy (2008-2018). More specifically, this work was coupled with setting the national targets towards Land Degradation Neutrality. This work resulted in the assessment of baseline trends in Land Use and Land Use change, land productivity, and Soil Organic Carbon (SOC) stocks using geo-processing tools, mapping exposure to land degradation, and setting national voluntary targets for LDN. Lebanon has set the following voluntary national LDN targets:

- Improve land productivity and SOC stock, in forests, croplands and grasslands.
- Improve the mosaic of the landscape, including forests, other wooded lands, grasslands and croplands and limit their conversion to other land covers.
- Enhance the role of forests and trees in urban and rural areas in providing sustainable products and services.

LDN, however, would only be achieved through its leveraging into political and development processes, at the national level. The MoA is the lead institution for the implementation and coordination of LDN. It is committed to work with all line ministries, in particular MoE, along with national organizations.

Several other national initiatives have been undertaken at the national level. In this context, the Forest Landscape Restoration Mechanism (FLRM), a 2-year Food and Agriculture Organization (FAO) managed project, aimed at supporting national actions for better forest and natural landscape restoration. Some of the main achieved results implemented during the first phase of the project (2016-2018) included 1) implement model landscape restoration activities, 2) support restoration work in areas vulnerable to climate change, 3) support the development of the methodology for identifying, mapping, assessing and characterizing landscapes across all Lebanese territories and 3) develop a solid foundation for the establishment of a National Forest Fund.

The Smart Adaptation of Forest Landscapes in Mountain Areas (SALMA) is a 5-year project (that effectively started in December 2016) implemented by the FAO in collaboration with the MoA and funded by the GEF. Its activities include the restoration of 1,000 ha of forests and the sustainable management of another 1,000 ha. Other interventions of SALMA focus on the adoption of improved and innovative integrated forest management practices.

In addition, the French Development Agency (AFD) introduced in 2017 the PARSIFAL project, with four main interventions 1) consolidation of infrastructure in rural areas, 2) reforestation, 3) capacity building to allow vulnerable Syrian refugees to acquire skills in agriculture and forestry and 4) institutional capacity building.

At the legislation front, the CoM issued in 2017 Decision #42 (dated 26-10-2017) to form a ministerial committee presided by the Prime Minister to study a request by MoE for developing a master plan for the protection of mountain summits and natural areas. Also, a new Protected Areas law was endorsed by the parliament in 2019, addressing the various categories of protected areas, including objectives, classification, management and financing mechanisms

In order to estimate the amount of carbon that has been sequestered through these activities, and based on the disaggregated information available from implementing entities, the following main categories are considered:

- Protecting existing carbon reservoirs from losses associated with deforestation, forest and land degradation, urbanization, and other land management practices.
- Enhancing carbon sequestration and expanding carbon stores in forests, other biomass, soils, and wood products (including through reforestation, afforestation, and forest management efforts).
- Reducing emissions of other greenhouse gases, primarily CH_4 and N_2O, from land use interventions on from fire management

During the period 2016-2018, afforestation and reforestation activities were sustained and increased by the Ministry of Agriculture and leader organizations in the country such as Lebanon Reforestation Initiative (LRI), Association for Forest Development and Conservation (AFDC) and Jouzour Loubnan, increasing carbon sequestration by 4.33 Gg CO_2eq. during this period.

Other impactful developments include the continuation Lebanon's Reforestation Initiative and Managing Wildfire Risk in the Wildland-Urban Interface, in addition to four new reforestation/afforestation projects across the country.

The results are presented on an annual level basis with cumulative estimations, with the assumption that reforested areas have been successfully planted and maintained and that their removal potential is still happening on a yearly basis even after project completion. As reforestation projects are usually funded though bilateral or multilateral funds with a definite timeline, limited data is available to track the progress of any reforestation activities or mitigation actions beyond the project life. In-depth yearly comparative assessment between the reported mitigation actions and the GHG inventory reported for the same year in addition to field surveys are needed to improve the reporting and validate the sustainability of reforestation and afforestation activities. Details of these mitigations activities are included in a tabular format in Annex VI.

Table 104: Summary of achieved removals in forestry for 2016-2018

Title of mitigation action	Hectares planted 2016-2018	GHG removals 2016-2018
AFDC afforestation / reforestation projects	105.5	-1.18
Jouzour Louban, Shouf Bioshpere reserve, municipalities and other	47	-0.53
Lebanon Reforestation Initiative	232.68	-2.62
Total GHG removals and emissions reductions (Gg CO_2eq.)	**385.18**	**-4.33**

4.5 Solid waste and wastewater

Solid Waste Management

Since the waste crisis of 2015, the Ministry of Environment has been trying to receive the approval of the Council of Minister for a sustainable solid waste management plan. After successive attempts over the years have failed to find a solution to the problem, Law No. 80 for the Integrated Solid Waste Management (ISWM) was ratified by the government in 2018, setting the backbone of future legislative, technical and communication improvements. The law was promulgated following the ISWM policy, adopted by the CoM in 2018 (Decision No. 45 on 11/01/2018), and introduces advanced Solid Waste Management (SWM) principles, of which the polluter pays principle and the decentralization principle.

Even though some of the requirements of Law No. 80 have been achieved (e.g. drafting of the ISWM strategy and establishment of National Solid Waste Coordination Committee), other major components (e.g. local SWM plans and establishment of National Solid Waste Management Authority, among others) remain lacking. For Law No. 80 to be efficiently implemented, required next steps include the (1) adoption of a cost recovery system; (2) filling of infrastructural gaps; (3) enhancement of communication; (4) major upgrades in the regulatory and institutional framework and enforcement capacity of national and local authorities, and (5) completion of planning components and development of implementation instruments. The 2019-2030 roadmap submitted by MoE, and approved by CoM Decision No. 3, on August 2019, addresses major aspects needed for

the implementation of Law No. 80, including financial instruments. The roadmap was revisited in June/July 2020 following new emerging drivers (SOER, 2020).

In parallel to the legislative and institutional work that was undertaken by the Ministry of environment during the 2016-2018 period, various initiatives were launched by the private sector, municipalities and NGOs, with the support of international donors. The Office of the Minister of State for Administrative Reform (OMSAR) with financial support from the EU, launched in 2017 the upgrading Solid Waste Management Capacities in Lebanon (SWAM) project to improve the overall efficiency and effectiveness of solid waste management. With a budget of EUR 14 million as phase I, the project provided for the construction and extension of treatment facilities and sanitary landfills across different regions in Lebanon, as presented in Table 105 (OMSAR, 2021).

Table 105: Overview of OMSAR projects under the SWMP project

Regions	Responsible authorities	Type of Facility	Status	Source of Fund	Capacity per day of MBT (Tonnes/day)
Mount Lebanon					
CHOUF AL SWAIJANI	Federation of CHOUF AL SWAIJANI Municipalities	Treatment facility	Operational	EU, GoL	40
CHOUF AL AALA	Federation of CHOUF AL AALA Municipalities	Treatment facility	Operational	GoL, FeD	35
JBEIL	Federation of JBEIL Municipalities	Sorting Facility	Operational	EU	180
North					
MINIEH	Federation of MINIEH Municipalities	Treatment facility	Operational	EU, GoL	77
TRIPOLI	Federation of AL FAYHAA Municipalities	Treatment facility	Operational	EU, GoL	520
Srar - Akkar					
MICHMICH	Municipality of MICHMICH	Treatment facility	Operational	EU, GoL	10
SRAR	Federations of Municipalities in Akkar	Treatment facility and landfill	Under Execution	EU	300
Bekaa					
ZAHLE	Muncipality of ZAHLE	Treatment facility and landfill	Operational	EU, GoL	250
JOUB JANNINE	Federation of AL BOUHAIRA Municipalities	Treatment facility and landfill	Operational	EU, GoL	100
BAR ELIAS	Municipality of BAR ELIAS	Treatment facility and landfill	Operational	EU, GoL	150
Baalbeck - al Hermel					

Regions	Responsible authorities	Type of Facility	Status	Source of Fund	Capacity per day of MBT (Tonnes/day)
BAALBECK	Municipality of BAALBECK	Treatment facility and landfill	Operational	EU, GoL	250
South					
TYR	Federation of TYR Municipalities	Treatment facility	Operational	EU, GoL	250
Nabatiyeh					
ANSAR	Municipality of ANSAR	Treatment facility	Not Operational	EU	10
KHIAM	Municipality of KHIAM	Treatment facility	Operational	EU, GoL	25
KHIRBIT SALEM	Municipality of KHIRBIT SALEM	Treatment facility	Operational	GoL	25
NABATIYEH	Federation of AL CHQIF - AL NABATIYEH Municipalities	Treatment facility	Operational	EU, GoL	250
QABRIKHA	Municipality of QABRIKHA	Treatment facility	Operational	EU, GoL	15

Source: OMSAR, 2021

Due to the lack of complete information on categorization, waste treatment practice and performance of these waste management facilities in a disaggregated form, related emission reductions were not calculated. In order to quantify and track the evolution of the solid waste sector and its impact on national GHG emissions, key performance indicators (KPIs) should be developed and assessed periodically. Once made available, quantified emission reductions will be presented in subsequent reports.

Wastewater Management

In terms of wastewater collection and treatment, several infrastructure projects were launched between 2016 and 2018, as presented in Table 106 .

The Lebanese Government had invested and mobilized funding of around USD 180 Million in development of wastewater infrastructure projects during the period 2016-2018, as indicated through the signed contracts for the installation of wastewater systems (CDR, 2020b). These projects are expected to be finalized between 2021 and 2023. Once fully implemented, the expected domestic wastewater treatment systems and discharge pathways in Lebanon and the corresponding percentage of served population will change, resulting in an estimated reduction of emissions of 37% compared to a BAU scenario. In fact, it is estimated that the implementation of these project will increase primary treatment from a current 13% to 15% and secondary treatment from a 6% to 21%, while decreasing the use of septic tanks and cesspools from 28% to 13% and the discharge into water bodies from 53% to 51%.

Table 106: Signed contracts of wastewater systems during 2016-2018

Project	Signature Date	Area	Amount USD	Source of Funding	% of GoL Funding (%)	Description	Estimated additional population that will be connected to secondary treatment	Estimated additional population that will be connected to primary treatment	Estimated reduction of population that are served by septic tanks cesspools	Estimated reduction of population with wastewater discharged to water
Construction of Wastewater Networks and Pumping Stations in Jezzine Caza - Phase 1	15-Mar-18	Jezzine	4,487,303	Lebanese Government	100	Construction of 35 km of wastewater networks in jezzine, karkha, kfarfalous, mrah el hbas, sidoun, maknouniye, and hidab, that are converged to the wastewater treatment plant in saida. In addition to 3 pumping stations in hidab, saidoun and maknouniye	30,000		30,000	
Wastewater Collection and Treatment in Akkar Coastal Region	07-Jun-18	Akkar	19,683,719	Arab Fund for Economic and Social Development, Lebanese Government	27	Construction of 190 km of sewers in bebnine, ouadi el jamous - tell el namel, borj arab, aabde, el aamara, qoubbet chamra,bzal, borqayel, sfeinet el kaitaa, zouk el mkacherine, deir dalloum, haddara, majdala, mar touma, hmaira, saissouq, el karkaf, ouyoun el ghezlane, jdaidet el kaitaa. in addition to 2 pumping stations in bebnine and sfainet el qaitaa	100,000		100,000	
Construction of Wastewater Networks for Upper Litani Basin - Northern Bekaa :	18-Jul-17	Baalbeck	11,422,291	Arab Fund for Economic and Social Development,	27	Construction of sewer networks and collectors for five villages draining by gravity towards the WWTP in temnin el tahta - nabi ayla, these villages are nabi chit	90,000		90,000	

Project	Signature Date	Area	Amount USD	Source of Funding	% of GoL Funding (%)	Description	Estimated additional population that will be connected to secondary treatment	Estimated additional population that will be connected to primary treatment	Estimated reduction of population that are served by septic tanks cesspools	Estimated reduction of population with wastewater discharged to water
The Villages of Temnine, Nabi Chit, Seraaine, Chmistar and Bednayel				Lebanese Government		and tobchar, seraaine, chmistar, bednayel and temnine.				
Design and Construction of Wastewater Treatment Plant and Operation and Maintenance and Staff Training in Temnine El Tahta	04-Jul-17	West Bekaa - Baalbeck - Hermel	18,090,810	Arab Fund for Economic and Social Development, Lebanese Government	27	Construction of a wastewater treatment plant (aerobic) in temnin el tahta - nabi ayla with a minimum daily flow of 15,000 m^3/d. serving a population up to 90,000 in year 2025.	Related to the project above			
Wastewater collection and treatment Works in Ablah, Ferzol, Nabi Ayla and Niha	31-Dec-18	Zahle	3,275,633	European Union	0	Wastewater works in Ablah, Ferzol, Nabi Ayla and Niha	10,000		10,000	
Expansion of Sewage Collection to Connect to Zahle Wastewater Treatment Plant Within Lake Qaraoun Pollution Project	13-Oct-17	Zahle	10,539,562	International Bank for Reconstruction and Development (The World Bank), Lebanese Government	0	Construction of 109 km of sewer networks in zahle, saadnyel, quaa el rim, taalabaya, ferzol, and hezzerta to connect these villages to zahle's WWTP. The rehabilitation of part of the old network, and the establishment of 6,000 house connections. Construction of the main	25,000		10,000	15000

Project	Signature Date	Area	Amount USD	Source of Funding	% of GoL Funding (%)	Description	Estimated additional population that will be connected to secondary treatment	Estimated additional population that will be connected to primary treatment	Estimated reduction of population that are served by septic tanks cesspools	Estimated reduction of population with wastewater discharged to water
						collector that connects the village of qabb elias to WWTP in el marej.				
Complementary Works to Hermel Wastewater Project	09-Jul-18	Hermel	1,389,130	Arab Fund for Economic and Social Development, Lebanese Government	100	Complementary Works to Hermel Wastewater Project				
Construction of Sewerage Networks and Design and Construction of Wastewater Treatment Plant in Marjayoun - El Khiyam Region - Part 1 & Part 2	01-Mar-17	Marjeoun	48,513,660	Kuwait Fund for Arab Economic Development, Lebanese Government	22	Construction of wastewater collection and conveyance systems, the construction of wastewater treatment plant in Marjayoun-el Khiyam plain including operation, maintenance and staff training.	200,000		200,000	
Wastewater Works in Koura Caza	29-Jun-18	Koura	6,899,021	European Union	0	Construction of wastewater gravity conveyors in the koura and qalamoun regions and their connection to the existing wastewater treatment plant of tripoli. The new collectors will provide wastewater treatment services to approximately 300,000 people. An additional 39,000m^3 of wastewater will reach daily the	300,000		300,000	

Project	Signature Date	Area	Amount USD	Source of Funding	% of GoL Funding (%)	Description	Estimated additional population that will be connected to secondary treatment	Estimated additional population that will be connected to primary treatment	Estimated reduction of population that are served by septic tanks cesspools	Estimated reduction of population with wastewater discharged to water
						tripoli plant that has a capacity of 135,000 m^3/day.				
Construction of Main Sewer Collectors and Networks Within Sarafand Wastewater Project	02-Jul-18	Saida	30,734,229	Kuwait Fund for Arab Economic Development, Lebanese Government	14	Construction of sewer main lines and networks for sarafund area, which includes the following towns and villages: adloun, irzay, bissarieh, deir el zahrani, sharqieh, adousieh, bablieh, hajje, khrayeb, loubieh, marwanieh, nmeirieh, saksakieh, zrerieh, ghassanieh, ansar, ansarieh, kawtharyet el rizz, kawthariyet el siyyad, kfarwa, khartoum, kherbet dweir, maameriet el khrab, mazraat el osta, with a total length of 379 km, and the construction of sewer pumping stations in sarafund.				100,000
Remaining Wastewater Networks in the Coastal Chouf Area	21-Jun-17	Chouf	13,928,566	Arab Fund for Economic and Social Development, Lebanese Government	32	Constructionsof main and secondary sewer lines with its house conections of about 1,748 km, in addition to a sewer pumping station for jiye WWTP. Beneficiary villages are jiye , haret baasir , daher elmagarah , barja , el borjain , shihim , jadra , alrimaleh , alwardaniye , daoood	75,000		75,000	

Project	Signature Date	Area	Amount USD	Source of Funding	% of GoL Funding (%)	Description	Estimated additional population that will be connected to secondary treatment	Estimated additional population that will be connected to primary treatment	Estimated reduction of population that are served by septic tanks cesspools	Estimated reduction of population with wastewater discharged to water
						el ali , mazboud , almigayrieh , kitirmaya.				
Construction of Remaining Wastewater Works in Chahhar Area - Part 1	11-Oct-17	Aley	4,644,671	Lebanese Government	100	Construction of sewer networks in the towns of chahhar area (aley caza) – package one, which consist of the construction of sewer networks in the towns of baawerta and abey - ain drafil, which flow through the coastal sewage line in the town of naameh.				30,000
Complementary Works for Wastewater Collection Sewer Lines for Greater Beirut Northern Scheme - Phase 1	19-Nov-18	Maten	5,358,272	Lebanese Government	100	Construction of sewer networks for zkrit, mtayleb, kornit al hamra, mazraait yachouh, kornit chehwan, dbayeh, and beit el chaar , jdeideh, fanar, dekwaneh, beit mery and mar chaaya.		150,000	150,000	
Construction of El Mina Coastal Sewer Collectors Within Rehabilitation of El Mina Sewer System in Tripoli Caza Project	16-Nov-17	Tripoli	1,995,460	Kuwait Fund for Arab Economic Development	30	Construction of el mina coastal sewer collectors line a and b. Supply and laying of about 4.3 km of gravity wastewater lines diameter going from 300 mm up to 1000 mm, with the related manholes and sewer connections.	100,000			100,000
			180,962,327				**930,000**	**150,000**	**965,000**	**245,000**

As for industrial wastewater collection and treatment, the Ministry of Environment in collaboration with Banque du Liban, the World Bank, the UNDP and the Italian Agency for Development Cooperation supported Lebanese industries to improve their environmental performance, including wastewater management, through the Environmental Pollution Abatement Project (LEPAP). In additional to providing technical assistance, a financial mechanism was developed to support the industries accessing concessional loans supported by BDL through commercial banks. Several industries benefited from the project to install on-site secondary aerobic wastewater treatment plants (Table 107) (LEPAP, 2020). Through these activities, a proportion of the industrial wastewater was re-directed from being discharged in water bodies, to being treated inside industrial facilities, consequently reducing related GHG emissions by 12% compared to a BAU scenario.

Table 107: Changes in discharge/treatment system for industrial wastewater

	Food products (tonnes)		Wine and Arak (tonnes)		Beer and Malt (tonnes)	
	WW Treated	WW Discharged	WW Treated	WW Discharged	WW Treated	WW Discharged
BAU scenario	0	776,462	0	1,372,000	0	29,297
Mitigation measures	38,177	738,285	15,487	1,356,513	4,000	25,297

Information on quantitative goals, progress indicators, estimated emission reductions, including methodologies and assumptions, and progress in implementing the waste and wastewater mitigation actions are not reported in this BUR due to lack of relevant information that enables Lebanon to do so.

4.6 Information on international market mechanisms

The Ministry of Environment has been appointed Designated National Authority (DNA) for Clean Development Mechanism (CDM) projects in 2006 and 7 projects have been submitted to the CDM Executive Board with only 6 being registered. No Certified Emission Reductions have been issued to date.

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
05 Dec 12	The Lebanese CFL Replacement CDM Project – in and around Beirut Central, Northern and Eastern Suburbs	Lebanon	France	AMS-II.J. ver. 4	20091	7358
05 Dec 12	The Lebanese CFL Replacement CDM Project – in and around Beirut Southern Suburbs	Lebanon	France	AMS-II.J. ver. 4	14138	7367
05 Dec 12	The Lebanese CFL Replacement CDM Project – Mount Lebanon	Lebanon	France	AMS-II.J. ver. 4	20091	7386
06 Dec 12	The Lebanese CFL Replacement CDM Project - North and Bekaa	Lebanon	France	AMS-II.J. ver. 4	21281	7392
06 Dec 12	The Lebanese CFL Replacement CDM Project – South Lebanon	Lebanon	France	AMS-II.J. ver. 4	14435	7214
18 Dec 12	Thermal Solar Plant Project at Zeenni Trading Agency; Bsarma El Koura, Lebanon	Lebanon		AMS-I.C. ver. 19	1685	8841

* AM - Large scale, ACM - Consolidated Methodologies, AMS - Small scale

** Estimated emission reductions in metric tonnes of CO_2eq. per annum (as stated by the project participants)

V. Finance, Technology and Capacity Building Needs and Support Received

V. FINANCIAL, TECHNICAL AND CAPACITY NEEDS, INCLUDING A DESCRIPTION OF SUPPORT RECEIVED

Climate finance from multilateral and bilateral sources plays an important role in advancing climate action in Lebanon. It has contributed to the implementation of sectoral policies and programs and supported initiatives from governmental and non-governmental institutions. Therefore, having a clear understanding of these finance flows is crucial to assess outcomes of support received and optimize available and future climate resources.

Building on the progress of UNFCCC negotiations related to transparency of reporting on climate finance, and based on recommendations of the ICA process, Lebanon has attempted in every BUR to improve the collection of information on support received. Currently, no single entity is officially responsible for tracking and reporting on climate change projects and related expenditures. The MoE has attempted to identify and track climate change related activities in Lebanon and their related financing, however limited information was available to estimate the overall support that Lebanon is receiving for climate action. Therefore, the tables below do not provide a comprehensive overview of the financial, technical and capacity building support received in relation to climate change in the country. It is important to note that the identified funds do not present a complete overview of domestic support from the government, including loans, for the implementation of mitigation measures due to unavailability of complete data.

Financial, technical and capacity building support received to Lebanon since 2016 is reported under this section and in Table 108, Table 109, Table 110, Table 111 and Table 112.

Table 108: Financial and technical support for general climate change related projects

Donor/executing entity	Project/initiative	Expected outputs	Budget *	Timeframe
Global Environment Facility/UNDP	Enabling activities for the preparation of Lebanon's Fourth National Communication and Third Biennial Update Report under the UNFCCC	Prepare and submit Lebanon's third biennial update report and fourth national communication	USD 852,000	2019 – 2023
The European Union, Spain Germany /UNDP	Nationally Determined Contribution Support Programme (NDCSP)	- Enhance NDC implementation and synchronization with SDGs - Increase mitigation investment by the public and private sectors - Mainstream gender in NDC	USD 802,500	2018 – 2021
UNDP climate promise	Climate proofing of Lebanon's development plans	Technical assistance to develop guidelines and model on how to integrate carbon reduction estimations to any development project in Lebanon	USD 120,000	2020

Donor/executing entity	Project/initiative	Expected outputs	Budget *	Timeframe
Green Climate Fund / South Centre	Strengthening and enhancing Lebanon's institutional arrangements and capacity to enable and optimize access to the GCF	- Building the capacities of the Nationally Designated Authority to engage with the Fund - Develop a Country Programme -Design and adopt a No Objection Procedure (NOP)	USD 828, 159	2020-2022
Green Climate Fund	Technical Advisory Services for the Preparation of GCF country Programmes	Technical assistance to - Study the macro-economic risk profile from climate change - Study greenhouse gas emissions' scenarios up to 2050 - Develop a climate risk profile for Lebanon	USD 50,000	2020-2021
NDC partnership	NDC Partnership support	Technical assistance to support in the development of sectoral of Partnership Plans to accelerate the implementation of the NDC	USD 320,000	2019-ongoing
Islamic Development Band and World Bank	Lebanon Green Investment Facility	Technical assistance to prepare for the establishment of Lebanon Green Investment Facility to provide climate and green finance through accessible and affordable finance instruments for both the public and private sectors.	USD 360,000	2020-2021
The European Union – ClimaMED project		Technical assistance to: - Support sustainable energy policies and strategies both at national and local levels - Provide technical assistance to support the formulation and implementation of local Sustainable Energy Access and Climate Action Plan (SEACAPs), - Facilitate access to climate finance	Total for the region EUR 6.9 Million (Lebanon's share EUR 1 Million)	2018 - ongoing
UNDP/UNEP Global Support Program for National Communications and Biennial Update Reports	Implementation of an Enhanced Transparency Framework in Armenia and Lebanon A South-South exchange platform	Exchange experiences with the Armenia BUR/NC team on lessons learned and good practices	NA	2018

*Budget includes the allocated amounts from the donors and not disbursed amount

Table 109: Funding received for mitigation measures in the energy sector since 2016

Donor/ executing Entity	Project/initiative	Expected outputs	Budget *	Timeframe
Global Environment Facility/UNDP	Small Decentralized Renewable Energy Power Generation (DREG)	- Install 2.6 MWp in 9 facilities - Prepare grid code data assessment and guidelines to MoEW - Prepare Lebanon's first PV status report - Build capacity for adoption of earthing and lightning protection for PV Systems - Provide technical assistance for additional PV quality standards - Develop PV courses and multi-day training workshop for the Lebanese Army's Directorate of Engineering staff.	USD 1.575 Million (GEF - USD 1.45 Million UNDP - USD 125,000)	2014-2019
The European Union /UNDP	CEDRO-4 Country Energy Efficiency and Renewable Energy Demonstration Project for the Recovery of Lebanon	Promote the use of EE/RE through the application of renewable energy and energy efficiency systems and measures across Lebanon's several economic sectors (commercial, industrial, and utility-scale), and a demonstration project on a village scale and bioenergy sourced heating.	USD 4.86 Million	2013-2017
The European Union /UNDP	CEDRO-5 Country Energy Efficiency and Renewable Energy Demonstration Project for the Recovery of Lebanon	- Create and Energy Hub with a local incubator to support green start-ups and entrepreneurs for clean energy transitions - Advance commercial-scale solar PV with storage - Advance the local 'ARZ' green building certification through a free and new online portal - Assess and establish value chain for solar thermal biogas applications - Advance SEACAP / SEEAP applications through direct interventions (with Clima-MED) - Provide assistance to national utility to advance net metering and virtual community net metering, - Build capacity and train vocational schools	USD 6.66 Million	2013-2019

Donor/executing entity	Project/initiative	Expected outputs	Budget *	Timeframe
The European Union /UNDP	Sustainable Energy for Security (SE4S)	- Support the Lebanese Army Forces (LAF) in implementing their Sustainable Energy Strategy - Install solar PV and/or microwind integration systems - Install solar hot water systems in border communities - Promote the use of biomass for heating in LAF facilities - Expand the use of energy efficient and renewable energy lighting systems - Build the technical capacity of the LAF and relevant municipalities on the design, maintenance and operation of renewable energy applications	USD 4.6 million (EU - USD 4.5 Million UNDP - USD 125,000)	2019-2021
Kigali Cooling Efficiency Programme (KCEP)/UNDP	National Cooling Plan for Lebanon	Technical assistance to prepare a national cooling plan to improve energy efficiency and avoiding HFCs, and develop a roadmap for accelerating market transformation in domestic refrigeration and air conditioning sector	USD 407,000	2019-ongoing
The European Union /Fondation Diane	REFIT	Support the application and promotion of renewable energy and energy efficient technologies	EUR 1.87 million (80% financed by EU)	2019-2022
The European Union / Lebanese Solar Energy Society	REESTART	Promote entrepreneurship, innovation and job creation in support of Lebanon's clean energy transition	EUR 2.5 million (80% financed by EU)	2019-2022
The European Union/RECREE /ALMEE	meetMED I Mitigation Enabling Energy Transition in the Mediterranean Region	Advance regional cooperation with regards to renewable energy and energy efficiency	EUR 1.5 million (regional)	2018-2020
ENI CBC Med Programme	Energy Smart Mediterranean Schools Network project (ESMES)	- Set-up strategies to support efficient and cost-effective energy mix in public schools - Set-up national energy efficiency hubs - Prepare and pilot REEE rehabilitation plans for public schools based on monitoring data and energy audits	EUR 29 million (regional)	2019-2020

Donor/executing entity	Project/initiative	Expected outputs	Budget *	Timeframe
ENI CBC Med Programme	BIM for Energy Efficiency in the Public sector (BEEP)	Technical assistance to -develop Energy Efficiency Heritage Building Information Model for the Municipality of Tripoli and the Rashid Karami Municipal Cultural Center - develop training guides for architecture, energy and construction professionals involved in the refurbishment of building - conduct pilot projects for the implementation of Energy Performance Contracting - prepare case studies on innovative energy rehabilitation interventions of historical building	EUR 1.7 million (regional)	2019-2022
European Bank for Reconstruction and Development	BUS Distribution	Corporate loan for BUTEC Utility Services to install smart meters to all of the company's consumers (520,000) and upgrade of the distribution network to reduce technical and commercial losses from their current level of 25% to 10-13%.	USD 20 million (loan)	2018-2021
European Bank for Reconstruction and Development/ LCEC	Decentralized Renewable Energy Generation	Technical and legal support for drafting of the “Decentralized Renewable Energy Law” and RFP package for solar PV and storage tender	NA	2018
The Netherlands RVO-ETF Dutch Embassy in Lebanon/LCEC	Developing and finalizing Energy Conservation Law	Technical assistance to develop a draft version of Lebanon’s “Energy Conservation Law”.	NA	2020
Netherlands enterprise agency/LCEC	Feasibility study for CSP in Lebanon	Technical assistance to study the feasibility of developing a Concentrated Solar Power (CSP) Plant in northern Lebanon.	NA	2019

Donor/executing entity	Project/initiative	Expected outputs	Budget *	Timeframe
Sweden/ Swedish International Development Cooperation Agency	The MENA Region Initiative as a Model of NEXUS Approach and Renewable Energy Technologies (MINARET)	Technical assistance to: - Build municipality's resilience to climate change through adopting renewable energy resources and energy efficiency, water management techniques and food security - Strengthen institutional capacities through promoting policy dialogue and implementing capacity building programmes - Develop a MENA dialogue online platform and website focusing on knowledge sharing, education, and lesson learned.	NA	2017-ongoing
Italian Ministry for the Environment, Land and Sea (IMELS)/LCEC	National Heat Pump Project	- Install 30 heat pumps in residential and commercial buildings - Establish a national test laboratory for quality insurance and certification of domestic hot water production, air conditioners and heat pump products. - Establish of a financial mechanism and a monitoring scheme for highly efficient domestic hot water, air conditioners and space heating appliances based on vapor compression technology.	EUR 500,000	2016
Italian Ministry for the Environment, Land and Sea (IMELS)/LCEC	Energy Efficient Home Appliances	- Distribute rebates to end-users directly or through local retailer shops to incentivize the purchase of highly energy-efficient equipment. - Promote energy-efficient and environmentally-friendly Italian home appliance	NA	2016-current
Italian Agency for Development Cooperation /LCEC	Solar for Centralized Grid	Provision of solar lamps in village for the enhancement of the security of locals.	USD 136,000	2016

Donor/executing entity	Project/initiative	Expected outputs	Budget *	Timeframe
Italian Agency for Development Cooperation /Banque du Liban	Contribution to the Lebanese National Energy Program (NEEREA)	Subsidized credit line for projects presented by Lebanese companies in the field of renewable energy and energy saving.	USD 5.9 Million	2017
Italian Agency for Development Cooperation	Clean Energy and Sustainable development in the Municipality of Kahale	Installation of PV street Lights in Kahale, to contribute to the development of alternative energy	EUR 799,389	2018-2021
International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)/LCEC	Build ME - Accelerating 0-emission building sector ambitions in the MENA region	- Conduct analysis and research on the building sector in Lebanon - Identify barriers toward a low-carbon building sector - Publish and test building energy performance tool - Pilot energy efficiency and renewable energy measures in ongoing building projects	EUR 3.7 Million (Regional)	2016-2022
Multi-Donor (UNHCR, NET, DFID, JPN)	Energy and Waste Solutions	- Install renewable energy systems in schools, hospitals and wastewater treatment plants; - Install 400 solar home systems in households in Dinniyeh and Bekaa - Rehabilitate 19 storage systems in public school - Upgrade of briquetting plants in Bkassine and Andqe - Upgrade of distribution network in Bekaa and South	USD 15.6 Million	2014-2020

Table 110: Funding received for adaptation and mitigation measures in the agriculture sector in since 2016

Donor	Project/initiative	Expected outputs	Budget *	Timeframe
FAO Technical Cooperation Programme	Update of the National Agriculture Strategy	- Update National Agriculture Strategy and Action Plan 2019-2023 - Assess the agricultural sector's support programmes - Assist in developing and efficient subsidies system - Develop a Monitoring plan for the SDGs and their integration in MoA planning.	USD 217,000	2019-2020
FAO	Support to the Regional Collaboration Platform of Water Scarcity Initiative to increase water productivity	- Establish operational framework on water productivity determinations (bio-physical and economical), through field and satellite Remote Sensing - Assess good agricultural practices and technologies to increase water productivity and to be adopted by each country	USD 400,000 (Regional)	2017-2019
Swiss Agency for Development and Cooperation (SDC) / FAO	Improved Water Resources Monitoring System/Integrated Water Resources Management at regional level in Lebanon	- Provide water monitoring systems and accounting tools to monitor water resources in the North Lebanon Water Establishment - Support institutional decision-making and resources planning for IWRM and enhanced crop water productivity	USD 2.43 Million	2019- current
World Bank/FAO	Promotion of Good Agricultural Practices, Including Integrated Pest Management, to reduce agrochemical pollution in upper Litani basin	- Promote, test and implement good agricultural practices including IPM programs	USD 1.5 Million (Loan)	2017-2021
The Kingdom of the Netherlands /FAO	Promotion of Agricultural Livelihoods and Employment through Investment in Land Reclamation and Water Reservoirs	- Construct and rehabilitate Land reclamation and water infrastructure construction sites - Promote Sustainable agriculture production for individual small and medium male and female farmers	USD 8.25 Million	2016-2020

Donor	Project/initiative	Expected outputs	Budget *	Timeframe
Global Environment Facility- Small Grant Program (SGP)	Adaptation measures to counterpart climate change effects on Biodiversity in Horsh Ehden Nature Reserve	Prepare an action plan adapted to insect pests that are increasing in Horsh Ehden Nature Reserve	USD 50,000	2018-2021
Global Environment Facility- Small Grant Program (SGP)	Blawza Solar Pumping Project	Install solar (PV) system for two water pumps and organize training and workshops for the residents of Blawza	USD 50,000	2015-2016
The European Union	Agriculture and Rural Development Project (ARDP)	- Execute irrigation infrastructures - Promote sustainable water management - Improve the livelihoods and income of quality of their agricultural production	USD 1.9 Million	2015-2018
Adaptation Fund and Italian Agency for Development Cooperation / IFAD	Climate Smart Agriculture: Enhancing Adaptive Capacity of the Rural Communities in Lebanon (AgriCAL)	Enhance the agricultural sector's adaptation capacity to climate change	USD 9.2 Million	2018-2020
The Netherlands/ FAO	Promotion of Agricultural Livelihoods and Employment through Investment in Land Reclamation and Water Reservoirs	Sustain the agriculture and rural livelihoods of small and medium men and women farmers in Lebanon, while adapting climate change sustainable natural resources management and conservation approaches	USD 8.25 Milion	2016- 2019
Multi-Donor (SDC, GoG, BPRM, JPN)/ UNDP	Support to Host Communities in the WASH Sector	- Construct concrete irrigation canals and networks in Anjar, Khirbet Qanafar, Chaat Younine, Ainata Hissa Samounié, Dahr Qonbar, Nahr Ibrahim, Khreybet Al Jundi, Khyem, and Hasbaya - Rehabilitate irrigation canal and capacity building for on-farm irrigation and agricultural practices in Qab Elias - Design an irrigation pond in Jezzine, Sir Al Denniyyeh/ Beqaa Sifirine	USD 21.2 Million	2014-2023

*Budget is reflecting the total budget of the referenced project and not the budget related to identified activities – budget is estimated based on the endorsed amount and not the spent amounts.

Table 111: Funding received for adaptation and mitigation measures in the forestry and land use sector in since 2016

Donor/ Executing Entity	Project/initiative	Expected outputs	Budget *	Timeframe
Global Environment Facility- Small Grant Program (SGP)	Forest protection in Qobeiyat, Zgharta	- Establish tree trimming technique for forests and produce biomass fuel in Qobeiyat -Facilitate access to the burned areas and organize and develop process of forest fire fighting and prevention in Zgharta.	USD 82,500	2015-2020
Global Environment Facility- Small Grant Program (SGP)	Emergency reforestation plan for burnt forests in Lebanon	Maintain green cover by increasing the size of forests raising awareness on fire detection and prevention	USD 24,000	2015-2017
The European Union	Agriculture and Rural Development Project (ARDP)	Restore degraded high mountain systems in Jezzine by planting 32,000 trees and 4,000 seeds over 40 hectares.	USD 1.9 Million	2015-2018
The European Union	Assisting reforestation and forest development activities in partnership with local communities (ARDAC)	Implement reforestation and sustainable forest management activities in Menjez, Akkar	USD 333,427	2014-2018
The European Union	Deir el Ahmar, Ainata and al-Barqua reforestation/afforestation activities	Implement reforestation and sustainable forest management activities Deir el Ahmar and Ainata	NA	2014-2018
The European Union	Hasbaya,Kawkaba, Baalbeck and Aramoun reforestation/afforestation activities	Implement reforestation and sustainable forest management activities	NA	2014-2018
USAID and USFS	Lebanon Reforestation Initiative (LRI)	- Promote sustainable management of natural resources in Lebanon - Build social stability and promote sectarian harmony in host communities, through sustainable participatory reforestation capacity building, and protection from environmental threats	USD 19.5 Million	2011-2018

Donor/ Executing Entity	Project/initiative	Expected outputs	Budget *	Timeframe
German Development Cooperation (BMZ)/WFP/LRI	Implementation of forest management related livelihoods activities in the North and Beqaa	Implement reforestation, forest management and trail management activities while providing seasonal job opportunities for vulnerable Lebanese rural citizens and Syrian refugees	USD 638,000	2018-2019
German Development Cooperation (BMZ)	Adapting forest policies to climate change in the Near East and North	- Reinforce capacities for forest administrations regarding climate change - Support inter-institutional relations - Strengthen mobilization of support	USD 4 Million (regional)	2010-2017
German Development Cooperation (BMZ)/WFP/LRI	Forest Management and Reforestation Activity	Implement reforestation activities to contribute to the rural development of the North Akkar region	USD 272,200	2018-2019
Japan	Improving forest fire management operations in Dmit and Moukhtara villages	Conserve and protect the natural heritage of two communities and reduce their fire risk through capacity building and provision of key equipment	USD 88,000	2016-2017
Global Environment Facility-Special Climate Change Fund (GEF-SCCF)/FAO	Smart Adaptation of Forest Landscapes in Mountain Areas (SALMA)	- Reduce soil erosion, fragmentation of forest resources and biodiversity losses for more resilient forest and rural mountain forest communities - Increase technical and institutional capacity at national level to replicate participatory climate proof forest management	USD 7.4 million	2016-2021
Global Environment Facility / UNDP	Land Degradation Neutrality of Mountain Landscapes in Lebanon	- Conduct Landscape-scale survey of mountain lands and high country areas in Akkar and Jbeil Districts - Restore degraded forests, high country grasslands, quarries and farmland in 2-3 pilot projects sites each - Improve Land Use Planning process	USD 641,660	2019-2024

Donor/ Executing Entity	Project/initiative	Expected outputs	Budget *	Timeframe
Global Environment Facility/ UNDP	Sustainable Land Management in the Qaraoun Catchment	- Undertake reforestation activities - Draft Strategic Masterplan, Strategic Environmental Assessment and Local Development Action Plans for Bekaa Governorate -Prepare guidelines for rangelands management and forest management - Initiation of Management plans for rangelands outside forests	USD 3.5 Million	2016-2021
Norway/FAO	National Center for Forestry Seeds of Lebanon	- Establish a functional seed centre - Start a seed provenance protocol system - Select better plant material with higher adaptive capacity to climate extremes	USD 373,032	2016 – 2018
International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)/ Korea Sweden/FAO	The Paris Agreement in action: upscaling forest and landscape restoration to achieve nationally determined contributions	- Enhance national and regional capacities to successfully plan, implement and monitor large-scale programmes mainstreaming Forest and Land Restoration (FLR) activities to achieve Lebanon's NDCs - Restore 5,000 ha of degraded forests and landscapes	USD 900,000	2018-current
International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)	Technical assistance facility for Forest and Land Restoration and Management (FLRM) projects	- Estimate emission reductions from Forest and Land Restoration (FLR) activities - Project emission reductions by 2030 from FLR activities - Integrate FLR activities in the update of the NDC (both under mitigation and adaptation sections)	Euros 35,000	2019- 2020

Table 112: Funding received for mitigation and adaptation measures in waste and wastewater since 2016

Donor/Executing Entity	Project/initiative	Expected outputs	Budget *	Timeframe
Global Environment Facility- Small Grant Program (SGP)	Integrated Solid Waste Management (ISWM) in a Rural Community in Mount Lebanon: Berbara Municipality – Jbeil	- Develop an ISWM program based on data gathered - Purchase and distribute waste collection bins -Develop training Programme for waste collection and disposal - Organize awareness activities	USD 49,800	2017-2019
Global Environment Facility- Small Grant Program (SGP)	Center for segregated waste collection in Tannourine	Construct and equip a center for collecting and separating waste from the Tannourine area.	USD 50,000	2015-2017
Multi-Donor (UNHCR, NET, DFID, JPN)/UNDP	Energy and Waste Solutions	- Construct a sanitary landfill to serve the union of municipalities of Deir Al Ahmar and Bar Elias - Provide collection trucks for the Municipality of Hezzerta the collection and transport of waste to Zahle Facility. - Prepare study on for the closure/rehabilitation of existing dumpsite - Draft ISWM Lebanon National Strategy for the MoE	USD 15.6 Million	2014-2020
Italian Agency for Development Cooperation /UNDP	Integrated Solid Waste Management of Baalbek Caza	- Install biogas co-generators at Baalbek site. - Finalize rehabilitation/closure activities of Kayal dumpsite	USD 2.476 Million	2011-2020
The European Union	Protection and sustainable development of maritime resources in Lebanon – PRO MARE	- Develop comprehensive waste management schemes at municipalities	USD 13 Million	2017-current
The European Union	Upgrading the Solid Waste Management capacities in Lebanon (SWAM 1 & 2)	- Construct or extend 8 sanitary landfills and 8 solid-waste treatment plants - Provide disposal and collection equipment (bins, trucks and compactors)	USD 35 Million	2014-current
The European Union	Support to Reform – Environmental Governance (StREG)	- Prepare studies on the Impacts of the Naameh sanitary landfill and Tripoli controlled dump	USD 8 Million	2011-2017

		- Establish an environmental monitoring plan for their post-closure - Draft/revise legal frameworks in fields that are related to SWM (e.g. waste-to-energy laws, responsibilities and mandates of SWM)		
Finland	Btihroz Tefroz	Promote waste sorting at the source in the village of Chhim in Chouf Casa through awareness raising and capacity building of the local community in waste reduction sorting and recycling	USD 56,000	2017

VI. GAPS, CONSTRAINTS AND NEEDS

VI. GAPS, CONSTRAINTS AND NEEDS

Throughout the chapters on the greenhouse gas inventory, mitigation actions, and support received of Lebanon's 4th Biennial Update Report, progress and improvement made thus far were presented, reflecting the several challenges that Lebanon still faces to increase its ambition in climate action and transparency in reporting.

A well-defined and institutionalized methodology to systematically identify and quantify the technical, financial, technological and capacity building and other needs is yet to be developed and implemented. This section presents an overview on Lebanon's needs to improve 1) climate change reporting, 2) climate action implementation, 3) non-state actors engagement, and 4) gender mainstreaming. Work to label these needs as capacity building needs or financial needs and categorize and prioritize those needs in a nationally endorsed and standardized system is yet to be deployed.

6.1 Climate Change Reporting

Through the progressive preparation of the 4 BURs, Lebanon is preparing itself to transition to Biennial Transparency Reports (BTR), as per the Modalities, Procedures and Guidelines (MPG) for the transparency framework referred to in Article 13 of the Paris Agreement.

Many provisions in the MPGs are already being applied by Lebanon and are reflected in the present BUR. Some other provisions include flexibility which Lebanon is using and will continue to use while clearly improving the documentation of rationales for the needed flexibility and planning for their achievement in the areas of improvement. Table 114 provides a summary of the status of Lebanon in implementing MPGs related to the NIR as per the current BUR. The provisions that could not be tackled in this BUR are considered as the gaps that need to be tackled in order to further comply with the MPGs.

In addition, gaps and needs have been identified and compiled through the International Consultation and Analysis (ICA) process in order to improve Lebanon's reporting (Table 113). Most of these listed needs are still valid, even though many of them have been tackled in at least one of Lebanon's 4 submitted BURs. However, given the iterative nature of submissions under the UNFCCC, improvements are always possible, especially in light of the newly adopted MPGs, with which Lebanon is planning to comply.

Box 11: Main results of the UNFCCC ICA 2020 for Lebanon's BUR3

> "The TTE noted improvements in the reporting in the Party's current BUR compared with that in the previous BUR analysed. Information on the GHG inventory, mitigation actions and their effects, and needs and support reported in the Party's third BUR demonstrates that it has taken into consideration the areas for enhancing transparency noted by the previous TTEs in the summary reports on the technical analysis of the Party's previous BURs. Specifically, the Party improved documentation of AD and EFs for the various sectors, upgraded to using the 2006 IPCC Guidelines and GWP values from the AR5, provided recalculated emissions for the time series and documented the effects of the recalculations on emissions for each year, and enhanced the capacity of its local inventory team to support the sustainability of reporting on a continuous basis."
>
> "Regarding the areas for enhancing understanding of the extent of the information reported in the BUR noted by the previous TTE in the summary report on the technical analysis of the Party's previous BUR, Lebanon identified the areas that were not addressed in its current BUR. They include the lack of an institutionalized GHG inventory team with capacity to track emissions from all sources and sinks, and the lack of a data repository provided for under law that facilitates data acquisition from all data providers, which are potential areas for enhancing national capacity."

Table 113: Gaps and needs identified by the UNFCCC Technical Team of Experts during the ICA 2020 of BUR3

	Gaps and needs	Tackled in BUR4
Institutional arrangements	Transparency of the information reported on institutional arrangements could be further enhanced	Partially - please refer to section 2
GHG emissions and removals	Information on nitrogen oxides, carbon monoxide and non-methane volatile organic compounds was not reported in Lebanon's BUR.	Yes – please refer to section (III) 3.8
	Information on product uses as substitutes for ozone-depleting substances (HFCs), PFCs, SF6 and emissions from food and beverage was reported as "NE" in Lebanon's BUR.	Yes – please refer to section (III) 3.9-2.F
	Information on solvent use was not reported	No – efforts were prioritized on Key Categories
	Review of AD and Parameters for waste sector	Partially – please refer to section (III) 3.9-4.D
	Information on the uncertainty assessment (level) of its national GHG inventory was not reported	Yes – please refer to section (III) 3.5
Mitigation Actions	The list of mitigation actions reported in tabular format was not exhaustive	Partially - please refer to section (IV)
	Coverage (gases) and progress indicators were not reported for the Greater Beirut Public Transport Project or the NAMA for the transport sector.	Partially - please refer to section (IV) 4.2
	Coverage (gases) was not reported for the NAMA for the waste sector.	No – no new data is available
	Information on progress of implementation, methodologies and assumptions, steps taken and estimated outcomes was not reported in relation to the LEDS.	No – no new data is available
	Information on the estimated outcomes of certain individual projects as well as methodologies and assumptions used were not reported for the National Energy Efficiency and Renewable Energy Action or the Lebanon Energy Efficiency and Renewable Energy Finance Facility	Partially - please refer to section (IV) 4.1 and Annex IV
	The methodologies and assumptions used for estimating the impact of the energy efficiency measures in public power production were not clearly stated	Yes - please refer to section(IV) 4.1 and Annex IV
	The steps envisaged or the progress of implementation was not clearly stated for the Lebanon Energy Efficiency and Renewable Energy Finance Facility or for the de-risking instruments	No – no new data is available
	For some of the individual projects promoting renewable energy and energy efficiency, information on the steps envisaged or the results achieved was lacking.	No – no new data is available

	Information on quantitative goals, progress indicators, estimated emission reductions, including methodologies and assumptions, and progress in implementing the National Transport Policy 2014, Greater Beirut Public Transport Project and NAMA for transport was not reported	No – no new data is available
	Information on the progress of implementation of these mitigation projects and results achieved in the agriculture sector was not reported	No – no new data is available
	Information on the envisaged steps of ongoing projects in forestry and land-use and on activities to assist reforestation and forest development activities conducted in partnership with local communities and others was not reported.	Partially – please refer to section (IV) 4.4 and Annex VI
	Information on the assumptions and methodologies used for estimating the reported emission reduction, implementation progress, and the expected results of the solid waste and wastewater mitigation action was not reported	Partially – please refer to section (IV) 4.5
Support needed	Lebanon did not report information on nationally determined technology needs with regard to the development and transfer of technology	No – no new data is available

Table 114: Status of Lebanon in implementing MPGs on National Inventory Report as reflected in the GHG inventory submitted within BUR4

Topic	Provision in Annex	Currently applied
Flexibility	The application of flexibility provided for in these MPGs is self-determined. The developing country Party shall clearly indicate the provision to which flexibility is applied, concisely clarify capacity constraints, and provide self-determined estimated time frames for improvements.	Yes
Improved reporting and transparency	Identify, update and include as part BTR information on areas of improvement in relation to reporting pursuant to NIR, tracking NDC progress, support provided, needed and received, including: (a) Areas of improvement identified by the Party and the technical expert review team; (b) How the Party is addressing or intends to address areas of improvement; (c) highlight the areas of improvement that are related to the flexibility provisions used; (d) Identification of reporting-related capacity-building support needs, and any progress made, including those previously identified as part of the technical expert review.	Yes
Reporting format	In the BTR: (a) Each Party shall provide a national inventory report of anthropogenic emissions by sources and removals by sinks of GHGs; (b) Each Party shall provide the information necessary to track progress in implementing and achieving its NDC; (e) Developing country Parties should provide information on financial, technology transfer and capacity-building support needed and received.	Partially
Definitions	The definitions of the GHG inventory principles used shall be as provided in the Intergovernmental Panel on Climate Change (IPCC) 2006 Guidelines	Yes
National circumstances and institutional arrangements	Implement and maintain national inventory arrangements, for the continued estimation, compilation and timely reporting of national inventory reports in accordance with these MPGs. National inventory arrangements can vary depending on national circumstances and preferences and change over time.	Yes
	Each Party shall report on the following functions: (a) national entity or national focal point with overall responsibility for the national inventory; (b) inventory preparation process, including division of specific responsibilities of institutions participating in the inventory preparation to ensure that sufficient activity data collection, choice and development of methods, emission factors and other parameters are in accordance with the IPCC guidelines (c) archiving of all information for the reported time series, including all disaggregated emission factors and activity data, all documentation about generating and aggregating data, including quality assurance/quality control (QA/QC), review results and planned inventory improvements; (d) processes for the official consideration and approval of the inventory.	Yes

Methods	Use the 2006 IPCC Guidelines, and any subsequent version or refinement of the IPCC guidelines agreed upon by the Conference of the Parties	Yes
	Make every effort to use a recommended tier level for key categories in accordance with those IPCC guidelines.	Yes
	A Party may be unable to adopt a higher tier method for a particular key category owing to lack of resources. In such cases, the Party may use a tier 1 approach, and shall clearly document why the methodological choice was not in line with the corresponding decision tree of the IPCC guidelines. The Party should prioritize for future improvement any key categories.	Yes
	Use country-specific and regional emission factors and activity data, where available, or propose plans to develop them.	Partially
	Identify key categories for the starting year and the latest reporting year, including and excluding land use, land-use change and forestry (LULUCF) categories, using approach 1, for both level and trend assessment; those developing country Parties that need flexibility have the flexibility to instead identify key categories using a threshold no lower than 85 per cent, in place of the 95 per cent threshold.	Yes
	Time series consistency and recalculations: use the same methods and a consistent approach to underlying activity data and emission factors for each reported year.	Yes
	Use surrogate data, extrapolation, interpolation and other methods consistent with splicing techniques contained in the IPCC guidelines to estimate missing emission values.	Yes
	Perform recalculations in accordance with the IPCC guidelines, ensuring that changes in emission trends are not introduced as a result of changes in methods or assumptions across the time series.	Yes
	Quantitatively estimate and qualitatively discuss the uncertainty of the emission and removal estimates for all source and sink categories, including inventory totals, for at least the starting year and the latest reporting year of the inventory time series. Also estimate the trend uncertainty of emission and removal estimates for all source and sink categories, including totals, between the starting year and the latest reporting year of the inventory time series, using at least approach 1;	Yes No
	Indicate the sources and sinks (categories, pools and gases) that are not considered and explain the reasons for such exclusion.	Yes
	Use notation keys where numerical data are not available, indicating the reasons why emissions from sources and removals by sinks and associated data for specific sectors, categories and subcategories or gases are not reported.	Yes
	Use the notation key “NE” (not estimated) when the estimates would be insignificant in terms of level (if the likely level of emissions is below 0.05 per cent of the national total GHG emissions, excluding LULUCF and 500 kilotonnes of carbon dioxide equivalent (kt CO_2eq.), whichever is lower). The total national aggregate of estimated emissions for all gases from categories considered insignificant shall remain below 0.1 per cent of the national total GHG emissions, excluding LULUCF.	Yes

	Elaborate an inventory quality assurance/quality control (QA/QC) plan in accordance with the IPCC guidelines, including information on the responsible agency; those developing country Parties that need flexibility are instead encouraged to elaborate a QA/QC plan in accordance with the IPCC guidelines, including information on the inventory agency responsible for implementing QA/QC.	Partially
	Implement and provide information on general inventory QC procedures in accordance with QA/QC plan; those developing country Parties that need flexibility are instead encouraged to implement and provide information on general inventory QC procedures. In addition, Parties should apply category-specific QC procedures in accordance with the IPCC guidelines for key categories and for those individual categories in which significant methodological changes and/or data revisions have occurred. In addition, Parties should implement QA procedures by conducting a basic expert peer review of their inventories, in accordance with the IPCC guidelines.	Partially
	Compare the national estimates of CO_2 emissions from fuel combustion with those obtained using the reference approach, as contained in the IPCC guidelines.	Yes
Metrics	Use the 100-year time-horizon global warming potential (GWP) values from the IPCC Fifth Assessment Report, or 100-year time-horizon GWP values from a subsequent IPCC assessment report as agreed upon by the CMA.	Yes
Reporting guidance	Report methods used, including the rationale for the choice of methods, and the descriptions, assumptions, references and sources of information used for the emission factors and activity data used.	Yes
	Provide information on the category and gas, and the methodologies, emission factors and activity data used at the most disaggregated level, to the extent possible.	Yes
	Describe the key categories, including information on the approach used for their identification, and information on the level of disaggregation used.	Yes
	Report the individual and cumulative percentage contributions from key categories, for both level and trend.	Yes
	Report recalculations for the starting and all subsequent years of the inventory time series, together with explanatory information and justifications for recalculations with an indication of relevant changes and their impact on the emission trends.	Yes
	Report the results of the uncertainty analysis as well as methods used, underlying assumptions, as applicable, and trends, at least for the starting year and the latest reporting year of the inventory time series	Yes
	Report information on the reasons for lack of completeness, including information on any methodological or data gaps.	Yes
	Report the QA/QC plan and information on QA/QC procedures already implemented or to be implemented in the future.	Yes
	Report estimates of emissions and removals for all categories, gases and carbon pools considered in the GHG inventory throughout the reported period on a gas-by-gas basis in units of mass at the most disaggregated level, in accordance with the IPCC guidelines , using the common reporting tables, including a descriptive summary and figures underlying emission trends, with emissions by sources listed separately from removals by sinks.	Yes

Report seven gases (CO_2, CH_4, N_2O, HFCs, PFCs, SF6 and NF3); those developing country Parties that need flexibility have the flexibility to instead report at least three gases (CO_2, CH_4 and N_2O) as well as any of the additional four gases (HFCs, PFCs, SF6 and NF3) that are included in the Party's NDC.	Yes
Sectors and gases: Each Party reporting HFCs, PFCs, SF6 and NF3 shall report actual emissions of the gases, providing disaggregated data by chemical (e.g., HFC-134a) and category in units of mass and in CO_2eq.	yes
Report the following sectors: energy, industrial processes and product use, agriculture, LULUCF and waste, according to the IPCC guidelines.	Yes
Provide information on the following precursor gases: carbon monoxide (CO), nitrogen oxides and non-methane volatile organic compounds (NMVOCs), as well as Sulphur oxides.	Yes
Report indirect CO_2 from the atmospheric oxidation of CH_4, CO and NMVOCs. For Parties that decide to report indirect CO_2, the national totals shall be presented with and without indirect CO_2. Each Party should report indirect N_2O emissions from sources other than those in the agriculture and LULUCF sectors as a memo item. Those estimates of indirect N_2O shall not be included in national totals.	Yes
Report international aviation and marine bunker fuel emissions as two separate entries and should not include such emissions in national totals, if, making every effort to both apply and report according to the method contained in the IPCC guidelines for separating domestic and international emissions.	Yes
Clearly indicate how feedstocks and non-energy use of fuels have been accounted for in the inventory.	Yes
When addressing the emissions and subsequent removals from natural disturbance on managed lands in its national GHG inventory, that Party shall report information on the approach taken, and how it is consistent with IPCC guidance, as appropriate, and shall indicate if the estimates are indicated in national totals.	Yes
Sectors and gases: In the case of a Party using an approach to reporting emissions and removals from harvested wood products in accordance with IPCC guidance other than the production approach that Party shall also provide supplementary information on emissions and removals from harvested wood products estimated using the production approach.	No
Report a consistent annual time series starting from 1990; those developing country Parties that need flexibility have the flexibility to instead report data covering, at a minimum, the reference year/period for its NDC in addition, a consistent annual time series from at least 2020 onwards.	Partially
The latest reporting year shall be no more than two years prior to the submission of its national inventory report; those developing country Parties that need flexibility have the flexibility to instead have their latest reporting year as three years prior to the submission.	No

6.2 Implementation of climate action

Achieving the mitigation targets of Lebanon's NDC and increasing Lebanon's resilience to the negative impacts of climate change require significant coordinated work by line government and non-governmental institutions in the main mitigation and adaptation related sectors. Many gaps still need to be bridged to optimize synchronized implementation of sectoral strategies.

With the support from the NDC partnership, a detailed list of gaps and needs to accelerate the implementation has been prepared in consultation with stakeholders and based on national strategies from the following sectors: energy, transport, waste, forestry, agriculture and water. The needs have also been update based on new published reports such as the NDC update 2020, IRENA outlook 2020, Electricity policy paper 2019, Agriculture strategy 2020, the Water sector policy 2019, and the SOER 2020.

The outcomes of this analysis are presented in this section and in the following tables. At this stage, the information is presented with 3 levels of detail: the type of gap, the gap itself and it corresponding need and request.

Table 115: Implementation gaps and needs for the energy sector

	Gap/challenge	Corresponding need and request
Technical	Energy insecurity: Lebanon heavily depends on imported petroleum products to meet its energy demand	- Facilitate the import and use of natural gas in power plants - Import electricity from neighboring countries - Increase energy production from public utilities and increase clean energy production - Need for a modality to connect renewable energy to the grid - Need for a mechanism for renewable energy IPP licensing
	Low renewable energy integration: high-risk investments, lack of needed infrastructure	
	Limited access to risk coverage instruments	Consider derisking measures to facilitate development and access to financing and risk mitigation schemes
	Limited interest from local banks to fund small-scale distributed RE projects	Bundle smaller-size renewable energy projects to achieve the required scale
	Land acquisition limitations and complex administrative processes for RE expansion	- Consider conducting land-specific auctions taking into account the inherent trade-offs between potentially the most cost-effective outcomes - Standardize requirements in the bidding process
	Inadequate governing framework for hydropower concessions	- Develop new administrative framework and a re-evaluation of the agreements of existing hydropower concessions to include higher tariffs - Consider the broader benefits of sustainable hydro development as contributions to irrigation as well as flood and drought control
	High technical losses and non-technical losses	- Improve transmission through completing the installation of several transmission lines - Improve distribution through removing infrigements and imposing fines - Complete the electric distribution projects and the smart grid to limit losses and control billing and collection

	High energy demand: lack of standards, high-consumption lifestyle	Decrease energy demand through: -finalizing and adopting the energy conservation Law, standards for green buildings, green public procurement, standards for retrofitting - Launching the national plan for energy conservation -Disseminating the use of energy efficient technology through proper incentives - Establishing a reporting mechanism for energy conservation and renewable energy and developing ESCO operations - Respecting and complying with international standards in the areas of consumption guidance, environment and public safety
	Grid instability and capacity constraints	- Conduct a complete grid impact assessment - Reinforce the transmission grid through the implementation of the existing transmission master plan - Deploy smart meters at the distribution level to ease the connections of distributed RE projects
	Lack of certification and standardization of distributed and off-grid solar systems in the local Lebanese market	Complete the set of standards and adopt a national certification scheme for the design and installation of renewable energies
Policy, legal, regulatory and Institutional	Lack of a stable regulatory framework, including for renewable energy deployment, and incomplete implementation of Law 462	- Consider a new electricity law clarifying the role of renewable energy - Concluding a legal study to transform EDL into a company and preparing the necessary legal steps - Implement Law 462/2002 - Implement Law 288/2012 - Establish an independent electricity regulatory authority
	High subsidies and low tariffs	Reform subsides and tariffs to increase penetration of renewable energy and to decrease demand
	Limited small-scale RE applications	Adopt legislation to promote distributed renewable electricity
	Coupling heating and cooling technologies in a national scheme	Reinstate incentives for the installation of small-scale heating and cooling applications

Table 116: Implementation gaps and needs for the transport sector

	Gap/challenge	Corresponding need and request
Policy, legal and regulatory	Insufficient regulations to specify the operations maneuvers of private bus operators and taxi owners	Set clear regulations for operation maneuvers, preceded by setting up a national policy for public transport
	Lack of implementation of legislation governing buses emissions	Update and implement Decree 6603/1995 related to standards for operating diesel trucks and buses, monitoring and permissible levels of exhaust fumes and quality
	Possible decrease in some government revenues due to deployment of transit bus systems	-Enforce legislative reforms in urban planning Laws, expropriation Laws and traffic Laws - Restructure, empower and enhance the role of the traffic management organization
	Missing/insufficient executive and regulatory bodies relevant to mass transit systems	Create/enhance executive and regulatory bodies in charge of ensuring the design, deployment and follow-up of the regulatory framework.
	Lack of regulation or legislation on fuel efficiency and emission standards of imported pre-owned cars	-Update and implement Decree 6603/1995 related to standards on permissible levels of exhaust fumes and quality. -Enforce/update the vehicle inspection program requirements, taking into account the requirements for hybrid cars inspection, and mandate the presence of catalytic converts on conventional gasoline cars.
Institutional	Fragmentation and/or overlapping of responsibility among government agencies	Clarify and centralize responsibility among concerned government agencies to tackle the gap in the transport system management function
	Insufficient coordination between relevant ministries and HEV suppliers. No cooperation between relevant ministries and R&D institutions	Enforce cooperation and communication on transport studies between relevant authorities.
	Lack of/inefficient regulatory body in the transport sector, and lack of institutions to support technical standards for transportation	Set up a mechanical inspection unit in charge of checking the emissions and safety standards of imported pre-owned cars before entering the country.

	Lack of R&D in transportation	Promote R&D in transportation to adopt knowledge-intensive, high-tech management approaches: -Encourage local industry to develop and manufacture spare parts - Provide incentives to R&D institutions playing a key role in mitigating transport technologies - Encourage universities to create engineering mobility programmes - Create Mobility Monitoring Indicators to support transport studies aiming at the development of sustainable transportation strategies.
Market failures	Poor market infrastructure for transit bus systems: - Poor passenger demand - Under-developed supply channels of transit bus system - Mismanaged public sector with irregularities in bus operation and poor information on bus tracking	-Stimulate passenger demand through the design of a complete bus network covering all boroughs within the high density areas - Deploy effective infrastructure measures such as an optimized land use planning. - Deploy effective operation measures such as optimizing the operation management of the system through real-time information and tracking, intelligent transport technologies, cleanliness programs, etc. - Develop the supply channels of the transit system (purchase enough buses, construct bus stations)
	Lack of Hybrid and Electric Vehicles reference projects in Lebanon	Require all government vehicles to switch to HEV when buying new cars to take the lead as a reference project.
	Well-established alternatives to public transit systems	Manage the transport demand by deploying a combination of access, personal travel planning, and parking spots to lock the benefits from the operational and infrastructural measures
Financial	High purchase cost of clean bus technologies; High implementation cost of mass transit bus system, and lanes reservation	-Exempt mass transit buses from custom and excise fees, registration fees, and other fees. -Plan for BRT/Feeder Buses in high traffic areas
	Favorable treatment for conventional pre-owned gasoline vehicles rather than the mass transit bus system, including the lack of consideration of negative externalities in pricing transportation	-Provide incentives to taxi drivers to get involved in the bus system -Allocate concessionary fares to the elderly, students and disabled. - Use smart card ticketing schemes with subscription choices
	Favorable treatment for conventional pre-owned gasoline vehicles rather than hybrid vehicles, including the lack of consideration of negative externalities in pricing transportation	- Enforce tax policies that disadvantage the demand for high fuel consuming pre-owned vehicles - Set up stringent fuel-efficiency and emission standards on pre-owned imported vehicles to help set adequate tax policies.

	High tax on maintenance and repair of imported spare parts in mass transit bus systems	Exempt spare parts from custom and excise fees
Awareness	Consumer preference: using their own private passenger cars rather than public transportation	Incentivize the use of mass transit buses: use smart card ticketing schemes with appropriate reduced tariffs and possibilities for long term subscriptions that reduce cost.
	No dissemination of information on ecological and economic benefits of transit bus systems	Provide information on CO_2 and fuel savings comparing to passenger cars, through the proper info display tools: mobile applications, dedicated website, media campaigns, etc.

Table 117: Implementation gaps and needs for the waste sector

	Gap/challenge	Corresponding need and request
Policy, legal regulatory	Lack of a single and empowered regulatory body responsible for the solid waste sector	Establish the National Solid Waste Management Authority
	Absence of legislation specifying the procedures, conditions, standards and specifications regarding waste management	Adopt provisions for the development of a national waste management and prevention plan, and regional waste management. These provisions will define responsibilities, timeframe, content and specifications for the plans
	Weak environmental monitoring of waste management activities	Establish recycling, treatment and disposal monitoring and reporting system (self-monitoring, compliance control and field inspections). On the medium term, establish permits for waste collectors
	Frequent political interference not in line with the view, priorities and arrangements of integrated waste management	Adopt the National Action Plan detailing the government's short to medium term waste treatment and recycling actions and priorities
	No decentralized / regional planning	Establish conditions, regulations, specifications and requirements for the regionalization of waste management
	Secondary products (compost, Compost Like Output, Refuse Derived Fuel, etc.) lack standardization and qualities applicable to end users	Set standards and specifications for reusable, recycled and secondary products, and run a study for the marketing of secondary products
	Absence of a grid feed-in-tariff and proper regulatory text related to the operation of waste-to-energy applications	Issue proper regulation to allow selling electricity to the grid from waste-to-energy facilities
Institutional	Vague and chaotic roles and responsibilities	Redefine roles and responsibilities by strengthening administrative capacities
	Weak capacities of authorities in relation to the complexity and demands of integrated waste management	Strengthen administrative capacities in relation to waste planning
	Lack of financial and human resources of waste management operators for proper design, construction and operation of facilities	Strengthen capacities of all institutions involved in waste management by additional re-organization and financial resources, additional employment and adequate training of staff at national, regional and local levels
	Lack of organized effort for implementation of source-specific separation systems that will facilitate materials utilization from waste	Enforce cooperation between industrial sectors so as industrial side streams and waste of one sector to be channeled as raw materials or to be exploited by other industrial sectors

Financial	Absence of economic instruments (taxes, pay as you throw, etc.) and other incentives	-Introduce a landfill tax on the medium run. -Promote the polluter pays principle and develop a methodology for the development of waste tariffs connected to the real cost of waste management.
	High cost of collection due to lack of economies of scale since each municipality organizes its own collection system	Connect inhabitants to organized waste collection services
	Inability to finance in a sustainable manner and to cover the current waste management cost.	-Develop a financing plan for recycling activities (including a cost recovery system and the introduction of economic instruments for waste reduction) - Ensure full cost recovery and self-sustainability of the waste management system while minimizing the need for governmental subsidies
	Lack of provisions and methodology for full cost accounting and cost recovery of waste management services	Establish Extended Producer Responsibility on the medium term, and design a cost recovery system
Technical	Most infrastructure is developed as a response to waste crisis and not on adequate planning.	Improve waste management infrastructure and support sustainable operation and maintenance
	Local technologies are deficient. Specifically, waste collection equipment is inappropriate, insufficient and not properly maintained	Set standards and specifications for waste collection equipment
Environmental	Non-existent initiatives for waste prevention and reduction	Acquire equipment for home-composting, promote reuse and repair centers, set training programs for waste prevention
	High risk of pollution for ground and underground water and atmosphere from dumpsites	-Rehabilitate priority dumpsites and develop technical specifications for that purpose - Develop guidelines for the improvement of the operation of existing and new sanitary landfills -Ensure adequate leachate management - Introduce a penalty system for uncontrolled disposal
Awareness	Poor public awareness around waste prevention and segregation	Improve public awareness on waste segregation at the source, and organize awareness campaigns for waste prevention
	Insufficient promotion of the concept of integrated solid waste management and waste management principles (e.g. circular economy, resource efficiency, waste hierarchy)	Organize education and public awareness sessions around uncontrolled disposal, special waste streams management, and training programmes for waste prevention
	Inadequacy of some locations for new landfills especially in the coastal areas	Follow the set of criteria (including social) introduced in the National Solid Waste Strategy when selecting a location for waste management facilities

Table 118: Implementation gaps and needs for the forestry sector

	Gap/challenge	Corresponding need and request
Technical and financial	Absence of a monetary valuation of forestry services.	Perform valuation of forest goods and services and develop studies on economics of land degradation
	Absence of promotion for sustainable use of natural resources	- Promote sustainable forest management allowing timber and wood production, valorisation of non-timber forest products such as aromatic and medicinal plants - Develop sustainable rangeland management - Encourage related opportunities for agro- and eco-tourism
	Limited financial resources for reforestation activities to restore forest cover	Mobilize funding for reforestation on public lands and increase urban forests
Legal and Institutional	Outdated Forest Law and lack of its enforcement	- Update Forest Law - Strengthen the role of the judiciary system in the follow-up on illegal activities impacting forest areas (including fires and wood cutting) and impose sanctions on perpetrators - Activate the role of environmental policing with MoE to protect terrestrial natural resources
	Lack of adequate forest management causing intense and large forest fires	- Adopt and ensure the implementation of the national guidelines for forest management, developed under the SLMQ project -Update and implement the national fire strategy -Provide infrastructure and equipment for forest fire fighting
	Poor land management due to the lack of enforcement of zoning Decrees.	Update zoning Decrees, complete zoning, and complete land cadastral survey map
	Inconsistencies in land classification	Develop guidelines for restoration of landscapes and promote agro-sylvo-pastoral practices in legal documents
	Lack of enforcement on privately owned buffer zones around reserves	Allocate fund for expropriation in buffer zones around reserves
	Lack of implementation of the National Land Use Master Plan: “Schéma d’Aménagement du Territoire Libanais” (SDATL)	Develop regional master plans and allocate fund for endorsement and implementation of national and regional parks and undertake capacity building and update the master plan
	Absence of a monitoring system for forests and other wooded lands	Ensure adequate, more comprehensive and thorough monitoring and control system of Lebanon’s Forests , other wooded lands, trees and rangelands
	Overlapping responsibilities and mandates in forest management and conservation	Revise and streamline conflicting responsibilities to overcome current overlaps
Research	Lack of linkages between research and informed decision making	Promote fundamental and strategic research in national universities towards improved socio-economic and environmental management practices

Table 119: Implementation gaps and needs for the agriculture sector

	Gap/challenge	Corresponding need and request
Institutional and Policy	Deficiency in institutional arrangements for crediting system, subsidies and Intellectual Property Right in Lebanon for appropriate technologies	-Undertake the necessary decisions and Laws allowing subsidies for Selected Adapted Varieties - Conduct a participatory process to reach the respect of Intellectual Property Right - Ratify international agreements to resolve import restrictions on patented plant material - Create a seed Law and national registrar for traceability of produced or imported plant material
	Inappropriate land tenure system and deficiency in institutional arrangements for subsidies	Guide decision makers to shift from crop-oriented to practice-oriented subsidies
	Absence of quality control and institutional and financial arrangements to guarantee the quality of products	- Provide incentives for the import of equipment and material; - Elaborate norms of production -Provide legislative arrangements for the recruitment of skilled technicians; - Establish quality control system and facilitating the agriculture crediting system
	Poor quality control and traceability due to the lack of staff in the Ministry of Agriculture and private enterprises	Increase Ministry's budget for recruitments of staff
Technical	Absence of technologies related to animal husbandry, biological pesticides and others, and of machineries required for no-till agriculture	- Explore market opportunities
	Limited qualified nurseries, limited availability of healthy/certified plant material, deficit in necessary infrastructure for plant conservation, sanitization and demonstration plots for adapted varieties	-Enable research institutes to implement conservation, sanitization and multiplication of certified plant material, seed banks, germplasms, plant breeding and mother plot trees. - Create demonstration plots for extension purpose
	Mismanagement of agriculture wastes and residues from both animal production and plant production	Enhance R&D for the manure valorization as bioenergy source for poultry and dairy farms, and composting of agriculture residues from both plant and animal origin
	Inefficient use of water resources for irrigation	- Expand the supply of water resources for irrigation, including management of water harvesting and storage and construction of hill lakes and water tanks - Enhance efficiency of distribution and governance - Promote the adoption of modern irrigation techniques - Encourage and support the use of renewable energy in the agricultural sector
Financial	Budget restrictions for R&D, absence of appropriate subsidies, cereal growers' low income and export of agricultural residues	Allocate the necessary budget for R&D and for subsidies
	High cost of imported patented plant material Absence of crediting system, subsidies for farmers and funds for R&D	- Allocate the necessary budget for R&D as well as for the necessary funds for demonstration plots and extension and infrastructure for plant material multiplication and certification. - Enhance agriculture crediting system for small farmers

	Low private investment in climate change adaptation and along the agrifood value chains	- Adopt innovative technical solutions - Improve access to climate finance and insurance - Promote climate smart agriculture techniques such as conservation agriculture, and smart planting,
Information and awareness	Lack of human skills in the following: - skilled extension service in Good Agriculture Practices - research and academic institutes - extension and research	- Train trainers for extension service, technicians, private sector, government staff and other relevant stakeholder on sustainable practices through seminars, workshops and field visits
	Lack of vocational training, weakness of training programs, scarcity of applied research and lack of information on ecosystem services and forest values	- Organizing relevant training programmes
	Limited information and know-how, and inefficient dissemination, at farmers and decision-maker's level about adaptation in agriculture and limited number of demonstration plots	-Plan and implement an information dissemination strategy to farmers and relevant stakeholders; -Organize awareness campaign and field visits to demonstration plots, seminars, trainings. -Capacity building of extension service through training and demonstration plots at farmers, nurserymen and seed importers level, and awareness campaign
	Inherited behavior affecting farmer's perception of no-till and the export of agriculture residues Difficulties in changing food and agriculture habits.	-Arrange field visits to demonstrating plots and conduct seminars and TV programme for farmers to show the comparative advantage of good agricultural practices -Launch marketing campaigns, tasting, and awareness sessions of adapted crops varieties

Table 120: Implementation gaps and needs for the water sector

	Gap/challenge	Corresponding need and request
Institutional and policy	Lack of coordination between different ministries on key water issues and common priorities	- Establish inter-ministerial committees, to enhance the level of operations at all administrative levels and identify sources of financing - Enhance and streamline protocols for coordination and cooperation between public sector agencies.
	Lack of enforcement in permitting and control of groundwater abstraction, making it an illegal activity	- Enforce stricter control of wells - Increase staffing within water establishments and build the capacity of staff on monitoring of unlicensed wells - Enhance cooperation mechanisms established with the Internal security forces to speed up closure of illegal wells
	Lack of standards on wastewater, greywater and stormwater reuse, as well as aquifer recharge	- Establish standards for wastewater reuse using regional standards as a baseline - Develop and maintain a focused program for technical and scientific improvement in the water sector
	Lack of localized management of water resources leading to wasteful behaviors and disregard to neighbors' interest	Establish water users association and determine mandate
	Lack of attention to water harvesting, recycling and reuse in policies	- Develop and implement programs and incentives for climate proofing and retrofitting water infrastructure at household and community level. - Develop policies promoting eco-efficient water infrastructures and conservation for industries
	Weak climate change mainstreaming in management processes of water supply systems	- Develop policies for water conservation, allocation, recycling and reuse. - Adopt centralized wastewater treatment systems in highly urbanized and densely populated areas. - Rehabilitate existing infrastructure - Identify alternative waste sources and demand management - Develop monitoring networks for hydrologic trend analysis and forecasting of precipitation shifts
	Lack of centralized data systems and poor maintenance of water monitoring systems	- Establish the water center as a central entity for water data collection, management and analysis. The entity will be also responsible for long term monitoring of water systems - Secure international accreditation for all public sector laboratory resources.
	Understaffing of MoEW leading to poor implementation and follow up	Conduct a detailed assessment of the resources needs of key agencies and fill vacant positions

Legal and regulatory	Absence of / gaps in Laws in the water sector (National Sewerage Program and Clean Water Act)	- Assess gaps in the implementation of these Laws and identify needs for full implementation - Develop and implement a groundwater management program including a vulnerability assessment, database management, monitoring, quality management, and licensing
	Lack of integrated watershed management plans due to the poor enforcement of legal requirements	Profile priority watersheds and river basins, identify sources of vulnerability and customize a management plan
Financial and Technical	Scarcity of funds to cover the high cost for infrastructure for water storage and high cost of land acquisition (private land)	Conduct arrangements for budget allocation and creation of a financial mechanism
	Lack of budget for capital investments	Explore public-private financing mechanisms
	Inadequacy of the tariff system hindering water conservation	Review current approaches to institutionalize the polluter's pay principle
	Absence of supply and demand analysis under different climatic and hydrologic conditions	- Map water users in Lebanon and conduct a water availability assessment - Study low cost adaptation measures and technologies under various hydrologic conditions. - Identify policy scenarios for surface and groundwater systems
	Absence of water users associations to manage share water bodies	Preparation of feasibility study and financial mechanism for water users associations
	Sanitation infrastructure in need of improvement to enhance access to safe and sustainable water	- Implement monitoring of water-borne disease incidences due to climate change - Establish micro-water purification systems in areas that are not reached by safe water supply - Conduct water quality survey for drinking water
Research	Limited Research and development on new innovative technologies for increasing water storage	Conduct research and development programmes on new technologies, on different storage variances for: i) cost effectiveness, ii) optimizing stored water use according to climate demand and iii) selecting crops according to storage capacity
Awareness	Limited awareness on water conservation - Absence of dissemination of good practices	- Promote public disclosure and sharing of data and key research findings with the public as well as national and regional organizations - Organize targeted awareness campaign, through seminars, field visits and TV programmes

6.3 Engagement of Non-State Actors

Following the Paris Agreement and the momentum that it has created in the business community, the Lebanese private sector joined the call for action and mobilized resources to plan and implement climate-related activities. The Lebanon Climate Act was established in 2016 to coordinate and organize these privately-led initiatives and as of 2018, more than a 100 companies and NGOs have joined the Act. Many opportunities through funded projects and technical support have allowed to lock the engagement of non-state actors through a multitude of ad-hoc self-initiated activities. Unfortunately, the 2019 economic and monetary crisis that had mainly hit the private sector reshuffled national and business priorities and slowed significantly the engagement of non-state actors in climate action. However, with the exacerbation of the energy crisis in 2021 and the removal of fuel subsidies, investments in decentralized renewable energy by the commercial and residential sector have witnessed a sharp growth and it is expected that this growth remains in the upcoming years to mitigate electricity shortages and increased prices.

Therefore, there is a need to coordinate the efforts of non-state actors to better capture and guide such investments and ensure a targeted implementation that would simultaneously serve national climate targets including the NDC and international reporting requirements. Table 121 summarizes the gaps and the needs related to enhancing and targeting climate action by non-state actors.

Table 121: Support needed to coordinate climate action by non-state actors and align it with the NDC

Gap	Needed support	**Description**
Lack of strategy, vision and direction	Establish a strategy with objectives, targets and indicators that would form the framework of non-state actors initiatives.	Set a GHG reduction target and evaluate action of non-state actors against these targets. Include lines of work dedicated to sectoral action like academia, banks, syndicates, retails, etc.
Lack of awareness and common understanding of what qualifies as climate action	Communication and awareness campaign on how non-state actors can design and implement climate change projects.	Use existing platforms like the LCA to communicate how climate action can bring transformational change. Develop further training material based on recent national developments and lessons learned from previous initiatives.
Lack of financing mechanisms to support private investments	Revise feasibility of existing funding mechanisms and establish new procedures to mobilize funds to non-state actors	Assess the feasibility nationally or regionally available financial mechanisms, in view of the current circumstances Accelerate the establishment of Lebanon's Green Investment Facility (LGIF)
Lack of technical information on available technologies	Improve communication on the availability and technical feasibility of RE and other technologies	Establish an interactive platform to guide business in making climate-friendly choices Connect non-state actors with the appropriate service and products providers
Scattered non-state actors initiatives	Define links among non-state actors related initiatives and platforms in Lebanon, with a focus on the Paris Agreement and the NDC.	Establish a platform to build a non-state actors network and facilitate connection and communication

Achievements not captured, information scattered, progress against targets of action plans unclear	Set institutional arrangements that anchor the linkages among the various non-state actors and systematically capture their achievements.

6.4 Gender mainstreaming

Gender and its relationship to climate change is a relatively new aspect in Lebanon and the concept remains unclear for a majority of stakeholders. To understand men and women's different situations and needs with regards to climate change, sex disaggregated data is essential. It informs on development gaps and allows the identification of adequate actions towards sustainable development and mainstreaming gender into climate related policies.

Unfortunately, disaggregation of data by sex is not automatic in Lebanon. For example, women represent 7.1% of the agriculture enterprise holders and 40% of the agriculture labor force, but no data is available on the share of women in informal and unpaid agriculture work. Because of the gender roles culturally attributed to women, they are likely to undertake unpaid work – and therefore not registered – in food production, informally supporting spouses and families.

The latest The Labour Force and Household Living Conditions Survey 2018-2019 organized by the Central Administration of Statistics and supported by the ILO and the EU, provided disaggregated gender data related to the share of women and men in the total residential population, martial status, head of households, educational attainment, participation in labour market including the informal sector, unemployment rates and health and disability (CAS, 2020). Although this is considered as a significant improvement towards gender mainstreaming, there still is a need to expand such studies to understand how gender roles are distributed and inform climate change policies in this regard. Additional information to be collected can include:

- Share of women and men in rural/urban population
- Share of men and women working in each sector (agriculture, industry, energy, forestry, transport, public institutions)
- Type of unpaid activities and time spent for each activity by sex
- Number and percentage of land-owners by sex
- Behavioral studies on water use, transportation pattern, food consumption, etc. by sex
- Access to loans and financial possibilities for renewable energy by sex.

Besides the need to make sex disaggregated data available, the following capacity building needs have been identified:

- Strengthen the capacities of public institutions in general and gender focal points in particular to mainstream gender in climate change mitigation/adaptation,
- Increase awareness on the linkages between climate change and gender,
- Review climate related policies, especially the NDC, and mainstream gender in them to the extent possible,
- Allocate specific budget lines in ministries and project to work on linkages between climate change and gender,
- Involve women as a vulnerable group in climate change mitigation and adaptation planning.

REFERENCES

Al-Hassan (2011). A National Consultancy on the Fertilizer Supply Chain in Lebanon. Survey Report submitted to Food and Agriculture Organization (FAO).

Ali, A. (2020). Distributed Power Generation for Lebanon- Market Assessment and Policy Pathways. World Bank, Washington, DC. https://openknowledge.worldbank.org/handle/10986/33788 License: CC BY 3.0 IGO.

Asmar, F. (2011). FAO Country Pasture/Forage Resource Profiles: Lebanon. Available: http://www.fao.org/ag/AGP/AGPC/doc/counprof/lebanon/lebanon.html. Accessed November 2014.

BLOMINVEST BANK, (2014). Agro-Industry in Lebanon: Looming Potential Restrained by Numerous Deficiencies. Available: https://blog.blominvestbank.com/wp-content/uploads/2014/09/2014-06-Agro-industry-in-Lebanon-Looming-Potential-Restrained-by-Numerous-Deficiencies.pdf. Accessed September 2020.

BLOMINVEST BANK (2016). Arak: Lebanon's Noble Drink. https://blog.blominvestbank.com/wp-content/uploads/2016/08/Arak-Lebanons-Noble-Drink.pdf. Accessed September 2020.

CAS (2007). Households Living Conditions Survey 2007 Lebanon. Available: http://www.cas.gov.lb/images/PDFs/Living%20conditions%20survey%202007.zip. Accessed September 2019.

CAS (2018). National Accounts Estimates for 2018. Available: http://www.cas.gov.lb/index.php/national-accounts-en. Accessed August 2020.

CAS (2020). Labor Force and Household Living Conditions Survey 2018-2019 Lebanon. Available: http://www.cas.gov.lb/index.php/demographic-and-social-en/population-en. Accessed September 2020.

CCAC (2020). Estimation of waste sector greenhouse gas emissions in Tyre caza, Lebanon using the Solid Waste Emissions Estimation Tool (SWEET). Climate and Clean Air Coalition, International Solid Waste Association, SCS engineers.

CDR (2006). Municipal Solid Waste Management in Lebanon. Council for Development and Reconstruction. Beirut, Lebanon.

CDR (2014). Personal communication. Council for Development and Reconstruction. October 2014, Beirut, Lebanon.

CDR (2016). Supervision of Greater Beirut solid waste treatment plants. 18th annual report. Council for Development and Reconstruction. Beirut, Lebanon.

CDR (2020a). CDR website. Available: https://cdr.gov.lb/en-US/Projects.aspx. Accessed September 2020. Council for Development and Reconstruction. Beirut, Lebanon.

CDR (2020b). Personal Communication with Mr. Talal Farhat, Head of the wastewater department. Council for Development and Reconstruction. Beirut, Lebanon.

CEDRO (2020). CEDRO website. Available: https://www.cedro-undp.org/ accessed August 2020. Country Energy Efficiency and Renewable Energy Demonstration Project for the Recovery of Lebanon. Beirut, Lebanon.

Chneis and Stephan (2013). Personal Communication. Beirut, Lebanon.

Darwish, T., and Faour, G., (2008). Rangeland Degradation in Two Watersheds of Lebanon. Lebanese Science Journal, 9, 71-80.

EastMED (2012). Report of the FAO EastMED Support to the Fishing Trials Carried Out of the South Lebanese Coasts. Retrieved from www.faoeastmed.org.

EBRD (2021). Green Economy Financing Facility, European Bank for Reconstruction and Development. Available: https://ebrdgeff.com/

El Fadel and Sbayti (2000). Economics of mitigation greenhouse gas emissions from solid waste in Lebanon. Waste Management and Research (18), 329-340.

El-Hage (2014). Personal communication with captain Said El-Hage. Environment Affairs Manager, Middle East Airlines. Beirut, Lebanon.

FAO (2000). Global ecological zoning for the global forest resources assessment 2000. Final report. Available: http://www.fao.org/3/ad652e/ad652e00.htm#TopOfPage. Food and Agriculture Organization, Rome.

FAO (2005). Global Forest Resources Assessment 2005. Country Report: Lebanon, Forestry Department, Rome.

FAO (2005). National Forest and Tree Resources Assessment 2003-05 (TCP/LEB/2903). Working paper 95, Forest Resources Assessment, Forestry, Beirut.

FAO (2010). Global Forest Resources Assessment 2010. Country Report: Lebanon, Forestry Department, Rome.

FAO (2011). FAOSTAT- Lebanon- Land Use. Food and Agriculture Organization Statistics, Rome.

FAO (2015). Global Forest Resources Assessment 2015. Country Report: Lebanon, Forestry Department, Rome.

FAO (2017). FAOSTAT- Food and Agriculture Organization of the United Nations Statistical Database. Accessed on September 2017.

FAOstat (2020). Food and Agriculture Organization of the United Nations Statistical Database. Accessed on September 2021.

Garrad Hassan (2011). The national wind atlas for Lebanon, UNDP-CEDRO, Beirut.

GoL (2018). Capital Investment Plan. Conference Economique pour le Developpement par les Reformes avec les Entreprises (CEDRE). Government of Lebanon, Beirut.

Hreiche, A. (2009). Integrated Water Resources Management Planning in the Republic of Lebanon- Irrigation Needs and Management, EUWI MED.

IEA (2020). Fuel imports from 2005 to 2020: International Energy Agency.

IKI (2021). BUILD ME – Boosting ambitions to achieve a climate-neutral building standard in the MENA region- International Climate Initiative, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. accessed in August 2021 - Available: https://www.international-climate-initiative.com/en/details/project/build-me-boosting-ambitions-to-achieve-a-climateneutral-building-standard-in-the-mena-region-16_I_276-502.

IPCC (1997). Revised 1996 IPCC guidelines for national greenhouse inventories. Houghton J.T., Meira Filho L.G., Lim B., Tréanton K., Mamaty I., Bonduki Y. et al. (Eds). London: Intergovernmental Panel on Climate Change WGI technical support unit.

IPCC (2000). Good practice guidance and uncertainty management in national greenhouse gas inventories. Pennman J., Kruger D., Galbally I., Hiraishi T., buruhani N., Emmanuel S. et al. (Eds). Japan: Institute for Global Environmental Strategies.

IPCC (2003). Good Practice Guidance for Land Use, Land-Use Change and Forestry. Hayama, Kanagawa, Japan: Institute for Global Environmental Strategies (IGES).

IPCC (2006). 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.

IPCC (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

IPT (2019). Survey on fuel consumption by end user. IPT Energy Center: Beirut, Lebanon.

IRENA (2020). Renewable Energy Outlook: Lebanon. International Renewable Energy Agency, Abu Dhabi.

Jordan and Kurtz (2012). Photovoltaic Degradation Rates - An Analytical Review (NREL/JA-5200-51664, Publication). Available: http://www.nrel.gov/docs/fy12osti/51664.pdf

LACECO (2020). Annual reports of solid waste management. Ministry of Environment, Beirut, Lebanon.

LCA (2017). How to create value from climate change. Lebanon Climate Act, Greenmind, UNDP. Available: https://www.lebanonclimateact.com/files/guidebook.pdf

LCA (2021). Lebanon Climate Act Website. Available: https://www.lebanonclimateact.com/

LCRP (2019). Lebanon Crisis Response Plan- Energy projects database. Beirut, Lebanon.

Lebanese Customs (2020). Annual trade statistic Data- www.customs.gov.lb- accessed on May 2020. Beirut, Lebanon.

LEPAP (2020). Lebanon Environmental Pollution Abatement Project. UNDP, Ministry of Environment. Beirut, Lebanon. https://lepap.moe.gov.lb/

Mansour, C. (2011). Evaluating impact of electrified vehicles on fuel consumption and CO_2 emissions reduction in Lebanese driving conditions using onboard GPS survey. Mansour C., Zgheib E., Saba S., Journal of Energy Procedia, Elsevier, 2011, vol. 6, pp. 261-276.

McKinsey (2018). Lebanon's Economic Vision. Ministry of Economy and Trade, Beirut, Lebanon.

Mitri et al., (2019). State of Lebanon's forests 2018. Beirut, Lebanon.

Mitri, G., Boufakhreddine, S., Amidi, J., Azzam, C., Chnais, E., Bouazza, K., Mansour, S., and Asmar, F. (2019a). State of Lebanon’s Forests 2018 (Mitri, G., Ed). Association for Forests, Development and Conservation/Ministry of Agriculture/Ministry of Environment/Lebanon Reforestation Initiative/United Nations Development Programmed/Global Environment Facility, Beirut. Pp.166.

Mitri, G., Nasrallah, G., Gebrael, K., Bou Nassar, M., Abou Dagher, M., Nader, M., Masri, N., and Choueiter, D. (2019b). Assessing land degradation and identifying potential sustainable land management practices at the subnational level in Lebanon. Environmental Monitoring and Assessment 191: 567. https://doi.org/10.1007/s10661-019-7739-y.

Mitri, G., Jazi, M., and McWethy, D. (2015). Assessment of wildfire risk in Lebanon using Geographic Object-based image analysis. Photogrammetric Engineering & Remote Sensing 81, 499–506.

Mitri, G., Saba, S., Nader, M., and McWethy, D. (2017). Developing Lebanon’s fire danger forecast. International Journal of Disaster Risk Reduction 24, 332-339.

Mitri, G., Salloum, L., and Nader, M. (2012). Forest fuel type mapping in Lebanon. 18th International science meeting. 22-24 March 2013. Lebanon.

MoA (2010a). Ministry of Agriculture. Lebanon, Strategy 2010-2014. Retrieved from http://www.agriculture.gov.lb/Arabic/AboutUs/Strategy_2010_2014/Pages/default.aspx

MoA (2010b). Ministry of Agriculture, Lebanon. Agriculture Census 2010. Retrieved from http://www.agriculture.gov.lb/Arabic/DataAndAgriStatistics/OverallAgriStatistics/Pages/defaul.aspx

MoA (2015). Lebanon National Forest Program 2015 - 2025. Rural Development and Natural Resources Directorate, Ministry of Agriculture, Beirut, Lebanon.

MoA, (2018). Integration of Lebanon's Land Degradation Neutrality (LDN) Targets within the National Action Program (NAP) to Combat Desertification. Ministry of Agriculture, Beirut, Lebanon.

MoA/FAO (2005). National Forest and Tree Resources Assessment 2003-05 (TCP/LEB/2903). Ministry of Agriculture, Food and Agriculture Organization. Working Paper 95, Forest Resources Assessment, Forestry.

MoA/FAO (2015). Global Forest Resources Assessment 2015. Country Report: Lebanon, Forestry Department, Rome. Ministry of Agriculture, Food and Agriculture Organization. Beirut, Lebanon.

MoE (2010). Country Report on the Solid Waste Management in Lebanon. Ministry of Environment, Beirut, Lebanon.

MoE (2012). Lebanon's National Report to the United Nations Conference on Sustainable Development - RIO+20. Lebanon: Wide Expertise Group. Ministry of Environment, Beirut, Lebanon.

MoE (2019). Integrated Solid Waste Management Strategy - Roadmap. Ministry of Environment, Beirut, Lebanon.

MoE (2020). Lebanon Recycling rates. Personal Communication Mr. Bassam Sabbagh, April 2020. Ministry of Environment, Beirut, Lebanon.

MoE/EU/GFA (2017). Support to Reforms – Environmental Governance (STREG): Assessment of Solid Waste Management Practices in Lebanon in 2015. Ministry of Environment (MoE), European Union (EU), GFA Consulting Group (2017).

MoE/UNDP/ELARD (2011). Provision of consultancy services for the Preparation of a Master Plan for the Closure and Rehabilitation of Uncontrolled Dumps throughout the country of Lebanon.

MoE/UNDP/ELARD (2017). Updated Masterplan for the Closure and Rehabilitation of Uncontrolled Dumpsites. Lebanon.

MoE/UNDP/EU (2014) Lebanon Environmental Assessment of the Syrian Conflict & Priority Interventions. Beirut, Lebanon.

MoE/UNDP/GEF (2011). Lebanon's Second National Communication (SNC) to the United Nations Framework Convention on Climate Change (UNFCCC).

MoE/UNDP/GEF (2015a). National Greenhouse Gas Inventory Report and Mitigation Analysis for the Agriculture Sector in Lebanon. Beirut, Lebanon.

MoE/UNDP/GEF (2015b). Energy consumption in the commercial and institutional sector. Beirut, Lebanon.

MoE/UNDP/GEF (2015c). National Greenhouse Gas Inventory Report and Mitigation Analysis for the Energy Sector in Lebanon. Beirut, Lebanon.

MoE/UNDP/GEF (2016). Lebanon's Third National Communication report to the UNFCCC. Beirut Lebanon.

MoE/UNDP/GEF (2019) Lebanon's Third Biennial Update Report (BUR) to the UNFCCC. Beirut, Lebanon.

MoE/UNDP/KCEP (2020). National Cooling Plan for Lebanon. Beirut, Lebanon.

MoE/UNEP (2013). Environmental Resources Monitoring in Lebanon Project, Analysis of the Current Land Use and Socio-Economic Activities in the Coastal Zone (to be published). Ministry of Environment.

MoE/UNEP/GEF (2015). Fifth National Report of Lebanon to the Convention on Biological Diversity, Beirut.

MoE/UNEP/GEF (2017). National Assessment of POPs Impacts and Management - Pesticides, Industrial and Unintentionally Released. Beirut, Lebanon.

MoE/UNEP/GEF, (2016). Lebanon's National Biodiversity Strategy and Action Plan. Ministry of Environment, Beirut, Lebanon.

MoE/UOB (2018). State of Lebanon's wildfires reports (2008-2017). Ministry of Environment and the University of Balamand, Beirut, Lebanon.

MoE/URC/GEF (2012). Lebanon Technology Needs Assessment Report for Climate Change. Ministry of Environment, Beirut, Lebanon.

MoEW (2010). National Water Sector Strategy. Ministry of Energy and Water. Beirut, Lebanon.

MoEW (2010a). National Water Sector Strategy. Ministry of Energy and Water, Beirut, Lebanon.

MoEW (2010b). Policy Paper for the Electricity Sector. Ministry of Energy and Water, Beirut, Lebanon.

MoEW (2018). Fuel import data sheet 2015-2018. Ministry of Energy and Water, Directorate General of Petroleum, Beirut, Lebanon.

MoEW (2019). Updated Electricity Policy Paper. Ministry of Energy and Water, Beirut, Lebanon.

MoEW (2020). Data on EDL power generation, fuel oil and Gas/diesel oil consumption, power plants stock and estimated demand for 2018-2019. Official communication, 19/2/2020, Ministry of Energy and Water, Beirut, Lebanon.

MoEW/LCEC (2019a). The 2018 Solar PV status report. Ministry of Energy and Water, Lebanese Center for Energy Conservation, Beirut, Lebanon.

MoEW/LCEC (2019b). The evolution of the solar water heaters market in Lebanon, 2012-2017 and beyond. Ministry of Energy and Water, Lebanese Center for Energy Conservation, Beirut.

MoEW/LCEC (2011). The National Energy Efficiency Action Plan for Lebanon NEEAP 2011-2015. Ministry of Energy and Water, Lebanese Center for Energy Conservation, Beirut, Lebanon.

MoEW/LCEC (2012a). Net Metering in Lebanon. Lebanese Center for Energy Conservation. UNDP, September 2012.

MoEW/LCEC (2012b). The Residential Solar Heaters Market in Lebanon. Ministry of Energy and Water, Lebanese Center for Energy Conservation, Beirut, Lebanon.

MoEW/LCEC (2013). National Milestones for Energy Efficient Lighting and Solar Water Heaters. Ministry of Energy and Water, Lebanese Center for Energy Conservation, Beirut, Lebanon.

MoEW/LCEC (2016a). National Energy Efficiency Action Plan 2016-2020. Ministry of Energy and Water, Lebanese Center for Energy Conservation, Beirut.

MoEW/LCEC (2016b). National Renewable Energy Action Plan 2016-2010. Ministry of Energy and Water, Lebanese Center for Energy Conservation, Beirut, Lebanon.

MoEW/LCEC (2020). The Beirut River Solar Snake, the dawn of the solar market in Lebanon. Ministry of Energy and Water, Lebanese Center for Energy Conservation, Beirut, Lebanon.

MoEW/LCEC, (2021a). LCEC website. Ministry of Energy and Water, Lebanese Center for Energy Conservation, Beirut. Available: https://lcec.org.lb/our-work

MoEW/LCEC, (2021b). The 2019 Solar PV status report. Ministry of Energy and Water, Lebanese Center for Energy Conservation, Beirut, Lebanon.

MoEW/UNDP/GEF (2016). The 2016 Solar PV Status Report for Lebanon. Small Decentralized Renewable Energy Power Generation (DREG) Project, Ministry of Energy and Water, Beirut, Lebanon.

MoEW/UNDP/GEF (2017). The 2017 Solar PV Status Report for Lebanon. Small Decentralized Renewable Energy Power Generation (DREG) Project, Ministry of Energy and Water, Beirut, Lebanon.

MoIM (2017). Database of vehicle fleet characteristics 2015. Ministry of Interior and Municipalities, Traffic, Trucks and Vehicles Management Authority, Beirut, Lebanon.

MoInd (2015). Industrial sector database. Ministry of Industry, Beirut, Lebanon.

MoInd/ALI/UNIDO (2010). The Lebanese Industrial Sector: Facts and Findings – 2007. Ministry of Industry, Beirut, Lebanon.

Nakat, Z. (2018). The Greater Beirut Public Transport Project. Presentation at International Beirut Energy Forum on 27-09-2018.

OECD (2021). OECD DAC External Development Finance Statistics. Available: https://www.oecd.org/dac/financing-sustainable-development/development-finance-topics/climate-change.htm

OMSAR (2018). Technical support to upgrading the solid waste management capacities in Lebanon - ENPI/2017/389-095.

OMSAR (2021). Status of SWAM project. Office of the Minister of State for Administrative Reforms- Available: http://swmp.omsar.gov.lb/en/our-projects. Beirut, Lebanon.

SBR (2015). Thermal Biomass for Lebanon: Meditterarean Mosaic Project for the Shouf Biosphere Reserve. Mediterranean Mosaics: strengthening the resilience of Mediterranean landscape to socio-economic and climate change. Shouf Biosphere Reserve, Lebanon.

SOER (2011). State and trends of the Lebanese Environment 2010. Beirut: Ministry of Environment. Beirut, Lebanon.

SOER (2020). Lebanon State of the Environment and future outlook: turning the crises into opportunities. UNDP, UNICEF, UNHCR, Ministry of Environment, Beirut, Lebanon.

SWEEP-Net (2010). Country Report on the Solid Waste Management in Lebanon. Beirut, Lebanon.

SWEEP-Net (2014). Cost Assessment of Solid Waste Degradation due to waste Management Practices in Beirut and Mount Lebanon. Beirut, Lebanon.

TRAGSA (2012). General Protection Plan Against Forest Fires in Lebanon. Beirut, Lebanon.

Tripoli port statistics (2014). Annual number of incoming ships from 2005 to 2009. Available: www.portdetripoli.com.

UNDP (2015). Solar-Powered Pumping in Lebanon: A Comprehensive Guide on Solar Water Pumping Solutions. UNDP, Beirut, Lebanon.

UNDP (2017). Lebanon: Derisking Renewable Energy Investment. New York, NY: United Nations Development Programme. UNDP, Beirut, Lebanon.

UNDP (2020). Analysis of Lebanon's Nationally Determined Contributions (NDC)-Current State Assessment of Derisking Renewable Energy Instruments. UNDP, Beirut, Lebanon.

UNDP (2021). Climate-Proofing Lebanon's Development Plans. Beirut, Lebanon.

UNEP (2016). Solar Water Heaters' Market Evaluation: Case Study of Lebanon 2015.

UNHCR (2015). Syrian Refugees in Lebanon. Daily Statistics. UNHCR registration Unit, December 31, 2015

UNHCR (2019) 2019 Year-End report. Available: https://reporting.unhcr.org/node/2520. Accessed August 2020.

UNRWA (2020). United Nations Relief and Works Agency for Palestine refugees in the near east -Lebanon Profile. Available: https://www.unrwa.org/where-we-work/lebanon. Accessed September 2020.

USAID (2013). Small villages wastewater treatment systems program (SVWTS): Final External Evaluation. Available: https://files.globalwaters.org/water-links-files/svts-program-lebanon-final-evaluation-2013.pdf. Accessed August 2020.

VNR (2018). Voluntary National review report on sustainable development goals. Government of Lebanon, Beirut.

Waked (2012). Caractérisation des aerosols organiques à Beyrouth, Liban: Unpublished data.

Waked and Afif (2012). Emissions of air pollutants from road transport in 987 Lebanon and other countries in the Middle East region. Atmos. Environ. 988 61, 446–452.

WERF/IWA (2010). Evaluation of Greenhouse Gas Emissions from Septic Systems. Water Environment Research Foundation (WERF)/International Water Association (IWA) London, UK. Available: http://geoflow.com/wp-content/uploads/2017/pdfs/WERF%20Report.pdf. Accessed August 2020.

WHO/UNICEF (2020). Joint Monitoring Programme Database. Available: https://washdata.org. Accessed August 2020.

World Bank (2011). Republic of Lebanon: Country Environmental Analysis. The World Bank Group, Washington DC.

World Bank (2019). Lebanon Electricity Transmission Project (P170769), project information document. The World Bank Group, Washington DC.

World Bank (2020a). Lebanon Economic Monitor The Deliberate Depression- The World Bank Group, Washington DC.

World Bank (2020b). Beirut Rapid Damage and Needs Assessment (RDNA), The World Bank Group, Washington DC.

World Bank (2020c). Lebanon Power Sector Emergency Action Plan, 2020. International Bank for Reconstruction and Development/The World Bank Group, Washington DC.

ANNEXES

Annex I. QA/QC procedures and Uncertainty assessment

Quality control

The team uses standardized notations in the documentation sheets to document changes, data sources and necessary improvements.

Recalculation of the time series for the gases CO_2, CH_4 and N_2O for all sectors caused changes to the greenhouse gas calculations which were verified by sum checks and by using the previous data sets to compare the results. The sum checks were performed for the totals and for the sectors to ensure no data was lost. Also, the transfer of activity data from the documentation sheets to IPCC model was made more automatic decreasing a chance for inserting errors. Recalculations files, comparing the current and the previous submission, allow to check that no changes were made unless necessary and documented. General and sectoral QC activities include cross-checking of outputs, tables and calculation files at various stages of the inventory compilation process.

Table A.1.1: List of general QC procedures applied to BUR4

QC Activity	Procedures
Collection, input and computation of data	
Transcription errors between data input and reference	Cross-check descriptions of activity data and emission factors with information on categories and ensure that these are properly recorded and archived Confirm that bibliographical data references are properly cited in the internal documentation Cross-check a sample of input data from each category for transcription errors. Utilize electronic data where possible to minimize transcription errors Use automatization (e.g. calculation formulae and Lookup functions in Excel) to minimize user/entry error Do not include values like emission factors, net calorific values, assumptions into formulae, rather link them to documented cells Ensure spreadsheets contain clear instructions for updating and a description of how the spreadsheet works Ensure a record is kept in the spreadsheets of developments, how these have been implemented and checked
Calculations	Reproduce a representative sample of emissions/removals calculations Record the work done and the findings. Record any improvements identified
Units and conversion factors	Check that units are properly labelled in calculation sheets and the data and methodology documentation sheet Check that units are correctly carried through from beginning to end of calculations Check that conversion factors are correct Check that temporal and spatial adjustment factors are used correctly
Consistency	Identify parameters (e.g., activity data, constants) that are common to multiple categories and confirm that there is consistency in the values used for these parameters in the emissions/removals calculations
Documentation	
Check that there is detailed internal documentation to support the estimates and enable duplication of calculations Check that every primary data element has a reference for the source of the data Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review Check that the archive is closed and retained in secure place following completion of the inventory	
Calculation	

Completeness	Confirm that estimates are reported for all categories and for all years from the appropriate base year over the period of the current inventory For subcategories, confirm that the entire category is being covered Check that known data gaps that result in incomplete category emissions/removals estimates are documented, including qualitative evaluation of the importance of the estimate in relation to total net emissions (e.g. subcategories classified as 'not estimated')
Recalculations	Check for consistency in time series input data for each category Check for consistency in the method used for calculations throughout the time series Reproduce a representative sample of emission calculations to ensure mathematical correctness
Time series consistency	Check for consistency in time series input data for each category Check for consistency in the method used for calculations throughout the time series Check methodological and data changes resulting in recalculations
Trend	For each category, compare current inventory estimates to previous estimates, if available. Check if there any unusual or unexplained trends noticed for activity data or other parameters across the time series

Table A.1.2: List of specific QC procedures applied to BUR4

QC Activity	Procedures
Emission factors	
Evaluate whether national conditions are similar to those used to develop the IPCC default factors Compare country-specific factors to IPCC defaults; document any significant discrepancies Consider options for obtaining country-specific factors Document results of this assessment	
Time series consistency	
Review changes in year-on-year estimates for categories and sub-categories Where possible, use alternative methodologies to cross check results (i.e., reference and sectoral approach for energy sector)	
Activity data	
Determine the level of QC performed by the data collection agency and document it. Ensure that qualifications of individuals providing expert judgement for estimates are appropriate and properly recorded	

Quality assurance

Lebanon's GHG inventory reported under BUR3 has been subject to review by international sectoral experts for the Waste, Agriculture and Forestry and Other Land Uses (AFOLU) categories. Some of the recommended improvements were applied in the preparation this BUR4. Other improvements - requiring time and resources- will be applied in subsequent GHG inventories. The results of the reviews are prioritized in terms of their contribution to total GHG emissions and the magnitude of the flagged issue.

Results and recommendations from the reviews of previous BURs through the International Consultation and Analysis (ICA) were considered also in the BUR4.

Uncertainty Assessment

IPCC Category	Base year emissions (Gg CO_2 eq)	Current year emissions (Gg CO_2 eq)	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Contribution to Variance in current year	Type A sensitivity	Type B sensitivity	Uncertainty in the trend in national emissions introduced by EF	Uncertainty in the trend in national emissions introduced by AD	Uncertainty introduced into the trend in total national emissions
1A1 - Fuel Combustion Activities - Energy Industries (Liquid Fuel) - CO2	508.00	10,193.00	1%	5%	0.051	0.000	1.408	1.882	0.070	0.027	0.006
1A1 - Fuel Combustion Activities - Energy Industries (Liquid Fuel) - N2O	1.06	21.32	1%	60%	0.600	0.000	0.003	0.004	0.002	0.000	0.000
1A1 - Fuel Combustion Activities - Energy Industries (Liquid Fuel) - CH4	0.56	11.27	1%	30%	0.300	0.000	0.002	0.002	0.000	0.000	0.000
1A2 - Fuel Combustion Activities - Manufacturing Industries and Construction - CO2	2,534.00	4,977.00	5%	5%	0.071	0.000	1.433	0.919	0.072	0.065	0.009
1A2 - Fuel Combustion Activities - Manufacturing Industries and Construction - N2O	4.90	9.77	5%	60%	0.602	0.000	0.003	0.002	0.002	0.000	0.000
1A2 - Fuel Combustion Activities - Manufacturing Industries and Construction - CH4	2.60	5.17	5%	30%	0.304	0.000	0.001	0.001	0.000	0.000	0.000
1A3b - Fuel Combustion Activities - Transport - Road transportation - CO2	1,265.00	7,226.00	30%	5%	0.304	0.006	0.156	1.334	0.008	0.566	0.320
1A3b - Fuel Combustion Activities - Transport - Road transportation - N2O	16.24	132.90	30%	60%	0.671	0.000	0.009	0.025	0.006	0.010	0.000
1A3b - Fuel Combustion Activities - Transport - Road transportation - CH4	14.39	44.72	30%	50%	0.583	0.000	0.005	0.008	0.003	0.004	0.000
1A4a b - Fuel Combustion Activities - Other Sectors - CO2	1,562.00	4,055.00	15%	5%	0.158	0.001	0.703	0.749	0.035	0.159	0.026
1A4a b - Fuel Combustion Activities - Other Sectors - N2O	2.86	7.90	15%	60%	0.618	0.000	0.001	0.001	0.001	0.000	0.000
1A4a b - Fuel Combustion Activities - Other Sectors - CH4	6.50	15.75	15%	50%	0.522	0.000	0.003	0.003	0.002	0.001	0.000
2A1 - Mineral industry - Cement Production - CO2	1,172.45	1,496.82	1%	2%	0.022	0.000	0.813	0.276	0.016	0.004	0.000

2A2 - Mineral Industry - Lime Production - CO2	2.90	0.75	1%	2%	0.022	0.000	0.003	0.000	0.000	0.000	0.000
2A4 - Mineral Industry - Soda Ash Use - CO2	6.90	1.18	5%	1%	0.051	0.000	0.006	0.000	0.000	0.000	0.000
4A - Enteric Fermentation - CH4	373.00	418.99	20%	20%	0.283	0.000	0.270	0.077	0.054	0.022	0.003
4B - Manure Management - CH4	108.00	98.81	20%	20%	0.283	0.000	0.082	0.018	0.016	0.005	0.000
4B - Manure Management - N2O	100.30	112.16	62%	50%	0.796	0.000	0.073	0.021	0.036	0.018	0.002
5A1 - Forest Land Remaining Forest Land (Removals) - CO2	-2,075.00	-2,026.00	10%	92%	0.925	0.005	1.563	0.374	1.438	0.053	2.071
5B1 - Cropland Remaining Cropland (Removals) - CO2	-1,236.00	-1,120.00	10%	70%	0.707	0.001	0.946	0.207	0.662	0.029	0.439
5D2 - Land Converted to Settlements (Emissions) - CO2	71.00	51.91	10%	60%	0.608	0.000	0.056	0.010	0.034	0.001	0.001
5A1 - Forest Land Remaining Forest Land - Biomass Burning - CH4	0.00	0.17	14%	70%	0.714	0.000	0.000	0.000	0.000	0.000	0.000
5A1 - Forest Land Remaining Forest Land - Biomass Burning - N2O	0.00	0.09	14%	70%	0.714	0.000	0.000	0.000	0.000	0.000	0.000
4D1 - Direct N2O Emissions from Managed Soils - N2O	102.30	182.59	20%	60%	0.632	0.000	0.061	0.034	0.037	0.010	0.001
4D3 - Indirect N2O Emissions from Managed Soils - indirect N2O	39.83	67.60	20%	80%	0.825	0.000	0.025	0.012	0.020	0.004	0.000
4D2 - N2O Emissions from Grazing Animals - N2O	22.97	25.49	20%	70%	0.728	0.000	0.017	0.005	0.012	0.001	0.000
6A - Solid Waste Disposal - CH4	492.60	596.52	43%	30%	0.524	0.000	0.348	0.110	0.104	0.067	0.015
6C - Incineration of Waste - CO2	26.90	25.87	10%	40%	0.412	0.000	0.020	0.005	0.008	0.001	0.000
6B2 - Wastewater Treatment and Discharge: Domestic - N2O	33.70	83.91	13%	90%	0.909	0.000	0.016	0.015	0.014	0.003	0.000
6B2 - Wastewater Treatment and Discharge: Domestic - CH4	256.30	586.02	59%	70%	0.915	0.000	0.130	0.108	0.091	0.090	0.016
	5,416.26	**27,302.68**				**0.014**					**2.913**
					Percentage uncertainty in total inventory	**12%**				**Trend uncertainty**	**171%**

Annex II. Indirect GHG emissions

Road transport for EMEP/EEA methodology

Table A.2.1: Parameters for road transport for EMEP/EEA methodology

	Average Travelled Distance (km)	Fuel Economy (L/100 km)	Fuel Density (kg/L)
Private Passenger cars – Gasoline fueled			
Pre ECE	12,000	10.41	0.74
ECE 15.00-01	12,000	10.41	0.74
ECE 15.02	12,000	10.41	0.74
ECE 15.03	12,000	10.41	0.74
ECE 15.04	12,000	10.41	0.74
Euro 1	12,000	8.91	0.74
Euro 2	12,000	8.91	0.74
Euro 3	12,000	8.91	0.74
Euro 4	12,000	8.91	0.74
Euro 5	12,000	8.91	0.74
Euro 6	12,000	8.91	0.74
Taxis – Gasoline fueled			
Pre ECE	50,000	10.41	0.74
ECE 15.00-01	50,000	10.41	0.74
ECE 15.02	50,000	10.41	0.74
ECE 15.03	50,000	10.41	0.74
ECE 15.04	50,000	10.41	0.74
Euro 1	50,000	8.91	0.74
Euro 2	50,000	8.91	0.74
Euro 3	50,000	8.91	0.74
Euro 4	50,000	8.91	0.74
Euro 5	50,000	8.91	0.74
Euro 6	50,000	8.91	0.74
Light Commercial vehicles - Gasoline fueled			
Conventional	25,000	11.49	0.74
Euro 1	25,000	9.46	0.74
Euro 2	25,000	9.46	0.74
Euro 3	25,000	9.46	0.74
Euro 4	25,000	9.46	0.74
Euro 5	25,000	9.46	0.74
Euro 6	25,000	9.46	0.74
Vans - Gasoline fueled			
Conventional	50,000	11.49	0.74

Euro 1	50,000	9.46	0.74
Euro 2	50,000	9.46	0.74
Euro 3	50,000	9.46	0.74
Euro 4	50,000	9.46	0.74
Euro 5	50,000	9.46	0.74
Euro 6	50,000	9.46	0.74
Heavy Trucks – Diesel fueled[1]			
Conventional	50,000	29.9	0.83
Euro I	50,000	29.9	0.83
Euro II	50,000	29.9	0.83
Euro III	50,000	29.9	0.83
Euro IV	50,000	29.9	0.83
Euro V	50,000	29.9	0.83
Euro VI	50,000	29.9	0.83
Buses – Diesel fueled			
Conventional	50,000	29.9	0.83
Euro I	50,000	29.9	0.83
Euro II	50,000	29.9	0.83
Euro III	50,000	29.9	0.83
Euro IV	50,000	29.9	0.83
Euro V	50,000	29.9	0.83
Euro VI	50,000	29.9	0.83
2- wheelers - Gasoline fueled			
2-strokes <50cc			
Conventional	5,000	3.38	0.74
Euro 1 and above	5,000	2.7	0.74
2-strokes >50cc			
Conventional	5,000	4.46	0.74
Euro 1	5,000	3.38	0.74
Euro 2	5,000	3.11	0.74
Euro 3 and above	5,000	2.30	0.74
4-strockes 250-750 cc			
Conventional	5,000	5.0	0.74
Euro 1 and above	5,000	4.86	0.74

1 Average Travelled Distance for HDV and Buses for the year 2018 is 38,000 km
Source of fuel economy (except HDV diesel consumption): EMEP/EEA 2019 guidebook, chapter 1.A.3.b.i. ii.iii.iv, Table 3-27

Table A.2.2: Emission factors for CO, NO_x, and NMVOC for the EMEP road transport

	CO emission factor (g/km)	NO_x emission factor (g/km)	NMVOC exhaust emission factor (g/km)	NMVOC evaporation emission factor (g/day/veh)
Passenger cars – Gasoline fueled				
Pre ECE	37.3	2.53	2.8	7.8
ECE 15.00-01	29.6	2.53	2.19	7.8
ECE 15.02	21.7	2.4	2.06	7.8
ECE 15.03	21.1	2.51	2.06	7.8
ECE 15.04	13.4	2.66	1.68	7.8
Euro 1	3.92	0.485	0.53	7.8
Euro 2	2.04	0.255	0.251	7.8
Euro 3	1.82	0.097	0.119	7.8
Euro 4	0.62	0.061	0.065	7.8
Euro 5	0.62	0.061	0.065	7.8
Euro 6	0.62	0.061	0.065	7.8
Light Duty vehicles - Gasoline fueled				
Conventional	25.5	3.09	3.44	12.7
Euro 1	8.82	0.563	0.614	12.7
Euro 2	5.89	0.23	0.304	12.7
Euro 3	5.05	0.129	0.189	12.7
Euro 4	2.01	0.064	0.128	12.7
Euro 5	1.3	0.064	0.096	12.7
Euro 6	1.3	0.064	0.096	12.7
Heavy Duty Vehicles– Diesel fueled				
Conventional	2.13	8.92	0.776	-
Euro I	1.02	5.31	0.326	-
Euro II	0.902	5.5	0.207	-
Euro III	0.972	4.3	0.189	-
Euro IV	0.071	2.65	0.008	-
Euro V	0.071	1.51	0.008	-
Euro VI	0.071	0.291	0.008	-
Motorcycles - Gasoline fueled				
2-strokes <50cc				
Conventional	14.7	0.056	8.38	4.6
Euro 1	4.6	0.18	3.18	4.6
Euro 2	2.8	0.17	2.56	4.6
Euro 3	1.8	0.17	1.78	4.6
Euro 4	1.8	0.17	1.78	4.6

2-strokes >50cc				
Conventional	24.3	0.067	9.97	4.6
Euro 1	16.3	0.028	5.82	4.6
Euro 2	11.2	0.104	1.84	4.6
Euro 3	2.73	0.28	0.806	4.6
Euro 4	2.73	0.28	0.806	4.6
4-strockes 250-750 cc				
Conventional	25.7	13.8	7.17	3.03
Euro 1	0.233	0.477	0.317	0.194
Euro 2	1.68	1.19	0.918	0.541
Euro 3	4.6	4.6	4.6	4.6
Euro 4	25.7	13.8	7.17	3.03

Source:
Exhaust emissions EMEP/EEA 2019 guidebook, chapter 1.A.3.b.i. ii.iii.iv, Table 3-17/21/23/25
Evaporative emissions EMEP/EEA 2019 guidebook, chapter 1.A.3.b.v Table 3-2

Table A.2.3: International bunkers default direct GHG CH_4 and N_2O emission factors (kg/TJ)

Fuel type	CO emission factor	NO_x emission factor	SO_2 emission factor	NMVOC emission factor
Aviation gasoline (kg/TJ)	100	250	43.75	50
Jet kerosene (kg/TJ)	100	250	21.98	50
Heavy fuel oil (kg/tonne)	7.4	79.3	20	2.7

Source | table 3.6.5 page 3.64 chapter 3 volume 2, IPCC 2006 guidelines, EMEP/EEA 2019, table 3-1 Navigation chapter.

Table A.2.4: Sulfur content of automotive fuels

Period (years)	Gasoline Sulfur content (ppm)	Diesel Sulfur content (ppm)
1994-2001	1,000	3,000
2002-2016	500	350
2017-2019	500	10

Source:
Lebanon SNC to UNFCCC
Lebanese decree 3054/2016
Lebanese decree 8442/2002

Table A.2.5: SO_2 emission factors for the EMEP road transport

	SO_2 emission factor (g/km) 1994-2001	SO_2 emission factor (g/km) 2002-2016	SO_2 emission factor (g/km) 2017-2019
Passenger cars – Gasoline fueled			
Pre ECE	0.154	0.077	0.077
ECE 15.00-01	0.154	0.077	0.077
ECE 15.02	0.154	0.077	0.077
ECE 15.03	0.154	0.077	0.077
ECE 15.04	0.154	0.077	0.077
Euro 1	0.132	0.066	0.066
Euro 2	0.132	0.066	0.066
Euro 3	0.132	0.066	0.066
Euro 4	0.132	0.066	0.066
Euro 5	0.132	0.066	0.066
Euro 6	0.132	0.066	0.066
Light Duty vehicles - Gasoline fueled			
Conventional	0.17	0.085	0.085
Euro 1	0.14	0.07	0.07
Euro 2	0.14	0.07	0.07
Euro 3	0.14	0.07	0.07
Euro 4	0.14	0.07	0.07
Euro 5	0.14	0.07	0.07
Euro 6 up to 2016	0.14	0.07	0.07
Euro 6 2017-2019	0.14	0.07	0.07
Heavy Duty Vehicles – Diesel fueled			
Conventional	1.488	0.1736	0.00496
Euro I	1.488	0.1736	0.00496
Euro II	1.488	0.1736	0.00496
Euro III	1.488	0.1736	0.00496
Euro IV	1.488	0.1736	0.00496
Euro V	1.488	0.1736	0.00496
Euro VI	1.488	0.1736	0.00496
Motorcycles - Gasoline fueled			
2-strokes <50cc			
Conventional	0.05	0.025	0.025
Euro 1	0.04	0.02	0.02
Euro 2	0.04	0.02	0.02
Euro 3	0.04	0.02	0.02
Euro 4	0.04	0.02	0.02

2-strokes >50cc			
Conventional	0.066	0.033	0.033
Euro 1	0.05	0.025	0.025
Euro 2	0.046	0.023	0.023
Euro 3	0.034	0.017	0.017
Euro 4	0.034	0.017	0.017
4-strockes 250-750 cc			
Conventional	0.074	0.037	0.037
Euro 1	0.072	0.036	0.036
Euro 2	0.072	0.036	0.036
Euro 3	0.072	0.036	0.036
Euro 4	0.072	0.036	0.036

Source: SO_2 emission factor calculated based sulfur content values

Annex III. Additional Information for forestry and Other Land Use

Table A.3.1: Land-use classification, definitions and disaggregation, activity data and parameters

	Definition according to IPCC GPG for LULUCF	**Definition according to the national classification system**	**Disaggregation adopted according to the national classification system (land use map of 1998)**	**Disaggregation as per the IPCC GPG for LULUCF recommendations**
Settlements	This category includes all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories. This should be consistent with the selection of national definitions.	This category includes all developed land, including transportation infrastructure and human settlements	Dense urban area Unorganized dense urban area Moderately dense urban area Moderately dense unorganized urban area Low density urban area Low density unorganized urban area Tourist resort Archeological site Large equipment Industrial or commercial zone Harbor zone Airport Train station Highway Other type of road Farm building Farm building with field crops Farm building with deciduous fruit trees Quarry Dump Sea filling Urban sprawl and /or construction site Vacant urban land Green urban space Large sport or leisure equipment	No disaggregation needed

	Definition according to IPCC GPG for LULUCF	Definition according to the national classification system	Disaggregation adopted according to the national classification system (land use map of 1998)	Disaggregation as per the IPCC GPG for LULUCF recommendations
Cropland	This category includes arable and tillage land, and agro-forestry systems where vegetation falls below the threshold used for the forest land category, consistent with the selection of national definitions.	This category includes arable and tillage land. More specifically, the following classes were considered under this category: crops, olive groves, vineyards, deciduous fruit trees, bananas, citrus trees, and greenhouse cultivations.	Field crops in large area	Annual
			Field crops combined with olive	Annual
			Field crops combined with vines	Annual
			Field crops combined with deciduous fruit trees	Annual
			Field crops combined with citrus trees	Annual
			Field crops combined with greenhouses	Annual
			Field crops in small plots or terraces	Annual
			Urban sprawl on field crops	Annual
			Olives	Perennial
			Olives combined with field crops	Perennial
			Olives combined with vines	Perennial
			Olives combined with deciduous fruit trees	Perennial
			Olives combined with citrus trees	Perennial
			Olives combined with intensive field crops	Perennial
			Olives combined with greenhouses	Perennial
			Vineyards	Perennial
			Vineyards combined with field crops	Perennial
			Vineyards combined with olives	Perennial
			Vineyards combined with deciduous fruit trees	Perennial
			Vineyards combined with intensive field crops	Perennial
			Vineyards combined with greenhouses	Perennial
			Deciduous fruit trees	Perennial
			Deciduous fruit trees combined with field crops	Perennial

	Definition according to IPCC GPG for LULUCF	Definition according to the national classification system	Disaggregation adopted according to the national classification system (land use map of 1998)	Disaggregation as per the IPCC GPG for LULUCF recommendations
			Deciduous fruit trees combined with olives	Perennial
			Deciduous fruit trees combined with vines	Perennial
			Deciduous fruit trees combined with citrus trees	Perennial
			Deciduous fruit trees combined with banana trees	Perennial
			Deciduous fruit trees combined with intensive field crops	Perennial
			Deciduous fruit trees combined with greenhouses	Perennial
			Citrus trees	Perennial
			Citrus trees combined with field crops	Perennial
			Citrus trees combined with olives	Perennial
			Citrus trees combined with deciduous fruit trees	Perennial
			Citrus trees combined with banana trees	Perennial
			Citrus trees combined with intensive field crops	Perennial
			Citrus trees combined with greenhouses	Perennial
			Banana trees	Perennial
			Banana trees combined with deciduous fruit trees	Perennial
			Banana trees combined with citrus trees	Perennial
			Banana trees combined with intensive field crops	Perennial
			Banana trees combined with greenhouses	Perennial
			Urban sprawl on orchard	Perennial
			Intensive filed crops	Annual

	Definition according to IPCC GPG for LULUCF	Definition according to the national classification system	Disaggregation adopted according to the national classification system (land use map of 1998)	Disaggregation as per the IPCC GPG for LULUCF recommendations
			Intensive filed crops combined with olives	Annual
			Intensive filed crops combined with deciduous fruit trees	Annual
			Intensive filed crops combined with citrus trees	Annual
			Intensive filed crops combined with greenhouses	Annual
			Greenhouses	Annual
			Greenhouses combined with field crops	Annual
			Greenhouses combined with vines	Annual
			Greenhouses combined with deciduous fruit trees	Annual
			Greenhouses combined with citrus trees	Annual
			Greenhouses combined with banana trees	Annual
			Greenhouses combined with intensive field crops	Annual
			Urban sprawl on greenhouses	Annual
Forest land	Forest: This category includes all land with woody vegetation consistent with thresholds used to define forest land in the national GHG inventory, sub-divided at the national level into managed and unmanaged and also by ecosystem type as specified in the IPCC Guidelines.6 It also includes systems with vegetation that currently falls below, but is expected to exceed, the threshold of the forest land category. Managed forest: All forests subject to some kind of human	This category included the following:	Dense pine forests (mainly Pinus brutia and Pinus pinea)	Coniferous
			Dense cedar forests (Cedrus libani)	Coniferous
			Dense fir forests (Abies Cilicia)	Coniferous
			Dense cypress forests (Cupressus ssp.)	Coniferous
			Dense oak forests (Quercus ssp.)	Broadleaf
			Dense broadleaves forests (Platanus, Populus, Salix)	Broadleaf
			Mixed dense forests	Mixed
			Urban sprawl on dense forest	Mixed

	Definition according to IPCC GPG for LULUCF	Definition according to the national classification system	Disaggregation adopted according to the national classification system (land use map of 1998)	Disaggregation as per the IPCC GPG for LULUCF recommendations
	interactions (notably commercial management, harvest of industrial round-wood (logs) and fuelwood, production and use of wood commodities, and forest managed for amenity value or environmental protection if specified by the country), with defined geographical boundaries.		Low density pine forests (Pinus brutia and Pinus pinea)	Coniferous
			Low density cedars forests (Cedrus libani)	Coniferous
			Low density Juniper forests (Juniperus ssp.)	Coniferous
			Low density fir forests (Abies, Cilicia)	Coniferous
			Low density cypress forests (Cupressus ssp.)	Coniferous
			Low density oak forests (Quercus ssp.)	Broadleaf
			Low density broadleaves forests (Platanus, Populus, Salix)	Broadleaf
			Low density mixed forests	Mixed
			Urban sprawl on low density forest	Mixed
			Shrubland	Broadleaf
			Shrubland with dispersed trees	Broadleaf
			Urban sprawl on shrubland	Broadleaf
Grassland	This category includes rangelands and pasture land that is not considered as cropland. It also includes systems with vegetation that fall below the threshold used in the forest land category and is not expected to exceed, without human intervention, the thresholds used in the forest land category. This category also includes all grassland from wild lands to recreational areas as well as agricultural and silvo-pastural systems, subdivided into managed and unmanaged, consistent with national definitions.	This category includes rangelands and pasture land that is not considered as cropland. More specifically, it included moderately dense herbaceous vegetation, and highly dense herbaceous vegetation.	Moderately dense herbaceous vegetation	Annual grasses
			Low density herbaceous vegetation	Annual grasses

	Definition according to IPCC GPG for LULUCF	Definition according to the national classification system	Disaggregation adopted according to the national classification system (land use map of 1998)	Disaggregation as per the IPCC GPG for LULUCF recommendations
Wetland	This category includes land that is covered or saturated by water for all or part of the year (e.g., peatland) and that does not fall into the forest land, cropland, grassland or settlements categories. This category can be subdivided into managed and unmanaged according to national definitions. It includes reservoirs as a managed sub-division and natural rivers and lakes as unmanaged sub-divisions.	This category includes land that is covered or saturated by water for all or part of the year. More specifically, it included the following classes: surface water bodies, lakes, rivers, and reservoirs.	Continental humid zone Marine humid zone Water plane (reservoir) Hill lake Stream or river Harbor basin	Flooded areas (Artificial reservoirs and hill lakes)
Other land	This category includes bare soil, rock, ice, and all unmanaged land areas that do not fall into any of the other five categories. It allows the total of identified land areas to match the national area, where data are available.	This category included bare soil, rock, ice, and recently burned forested lands	Bare rock Urban sprawl on bare rock Bare soil Beach Sand dune Burned area	No need for disaggregation

Table A.3.2: Land-use activity data and parameters

In hectares (ha)	1994	1998	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018
FF-Total	258475.95	257890.00	257172.00	256543.94	255375.06	254771.13	254463.13	254106.19	254063.00	254009.69	253927.64	253835.53	253744.74
Coniferous	35257.05	35216.00	35121.00	35063.13	34943.44	34887.56	34871.06	34822.44	34821.75	34818.63	34801.95	34794.33	34788.47
Broadleaf	196517.58	196008.00	195451.75	194924.19	193962.56	193467.06	193184.13	192925.38	192888.75	192843.63	192798.82	192727.63	192663.64
Mixed	26701.32	26666.00	26599.25	26556.63	26469.06	26416.50	26407.94	26358.38	26352.50	26347.44	26326.88	26313.57	26292.64
GG-Total	318023.29	317600.00	317237.13	316755.56	316008.37	315660.12	315481.06	315180.62	315168.31	315149.44	315104.19	315043.01	314976.94
CC-Total	333069.80	332364.00	331856.69	331167.25	329658.00	329415.12	328959.31	328364.69	327986.87	327431.25	327060.51	326883.21	326684.30
Perennial	160646.49	160354.00	160243.25	160100.63	159501.69	159376.06	159235.25	158970.00	158884.81	158786.44	158669.82	158604.32	158516.54
Annual	172423.32	172010.00	171613.44	171066.63	170156.31	170039.06	169724.06	169394.69	169102.06	168644.81	168390.69	168278.89	168167.77
FF-Burned	NE	0.00	330.00	423.69	427.72	161.13	603.00	127.56	120.75	182.56	155.56	102.49	113.13
Coniferous	NE	0.00	54.25	37.44	59.97	14.63	37.69	4.75	6.88	14.88	44.00	18.55	18.63
Broadleaf	NE	0.00	217.06	347.56	311.59	133.56	548.31	44.25	97.00	113.81	93.50	53.38	34.94
Mixed	NE	0.00	58.69	38.69	56.16	12.94	17.00	78.56	16.88	53.88	18.06	30.56	59.56
FF-Burned	NE	0.00	330.00	423.69	427.72	161.13	603.00	127.56	118.75	182.56	155.56	102.49	113.13
Fuel Type 3	NE	0.00	98.63	163.69	184.59	58.06	262.31	78.56	34.19	65.38	25.13	5.88	4.94
Fuel Type 4	NE	0.00	97.63	134.56	155.59	53.06	185.13	44.25	45.25	83.31	6.75	22.38	20.06
Fuel Type 5	NE	0.00	14.75	1.81	7.00	2.88	10.25	0.00	1.19	12.81	87.81	26.24	11.06
Fuel Types 6&7	NE	0.00	119.00	123.63	80.53	47.13	145.31	4.75	38.13	21.06	35.88	48.00	77.06
GG-Burned	NE	0.00	125.50	95.94	271.00	182.38	242.75	37.88	67.88	302.38	69.81	3.13	58.50
Fuel Type 1	NE	0.00	78.50	74.69	206.72	109.06	184.88	37.88	47.56	226.81	54.50	1.00	0.00
Fuel Type 2	NE	0.00	47.00	21.25	64.28	73.31	57.88	0.00	20.31	75.56	15.31	2.13	58.50
CC-Burned	NE	0.00	501.75	344.06	675.09	585.19	1305.81	9.56	282.56	246.50	49.81	13.55	1.38
Total burned			957.25	863.69	1373.81	928.69	2151.56	175.00	469.19	731.44	275.19	119.16	173.00
LS-Total	451.34	0.00	941.56	738.00	758.16	1195.06	942.88	1248.25	429.56	624.06	498.04	330.60	355.75
FS	170.70		456.13	362.00	199.97	603.94	308.00	356.94	43.19	53.31	82.05	92.11	90.78
Coniferous	17.19	0.00	66.56	20.56	17.00	55.88	16.50	48.63	0.69	3.13	16.68	7.61	5.86
Broadleaf	140.60	0.00	340.69	320.56	168.91	495.50	282.94	258.75	36.63	45.13	44.81	71.19	63.99

Mixed	12.91	0.00	48.88	20.88	14.06	52.56	8.56	49.56	5.88	5.06	20.56	13.31	20.93
GS	107.61	0.00	260.00	263.31	134.66	348.25	179.06	296.69	8.56	15.13	45.25	61.18	66.06
CS	173.02	0.00	225.44	112.69	423.53	242.88	455.81	594.63	377.81	555.63	370.74	177.30	198.91
Perennial	54.87	0.00	44.50	25.94	218.00	125.63	140.81	265.25	85.19	98.38	116.62	65.50	87.78
Annual	118.15	0.00	180.94	86.75	205.53	117.25	315.00	329.38	292.63	457.25	254.12	111.80	111.13
OF-Total (Aff)	NE	0.00	305.00	278.00	147.73	52.00	381.21	302.62	139.75	209.13	203.41	134.24	47.53
LF-Cumul	NE	0.00	610.00	2054.00	2861.73	2913.73	3294.93	3597.55	3737.30	3946.43	4149.84	4284.08	4331.61
LW-Total	NE	0.00	0.00	0.00	0.00	0.00	0.00	3.75	3.75	3.75	0.00	0.00	0.00
GW	NE	0.00	0.00	0.00	0.00	0.00	0.00	3.75	3.75	3.75	0.00	0.00	0.00
LW-Cumul	NE	476.00	476.00	476.00	513.00	513.00	513.00	516.75	520.50	524.25	524.25	524.25	524.25
OO	NE	49041.00	48431.00	46987.00	46179.28	46127.28	45746.07	45443.45	45303.70	45094.57	44891.16	44756.92	44709.39

NE: Not Estimated (No activity data available) - NO: Not Occurring
FF = Forest Land remaining Forest Land
GG = Grassland remaining Grassland
CC = Cropland remaining Cropland
LS = Land converted to Settlement
FS = Forest Land converted to Settlement
GS = Grassland converted to Settlement
CS = Cropland converted to Settlement
LF = Land converted to Forest Land
OF = Other land converted to Forest Land
LW = Land converted to Wetland
GW = Grassland converted to Wetland
OO = Other land remaining Other land

Table A.3.3: Land-use parameters

Parameter	Symbol	Value(s) used	Reference	Notes
Carbon fraction of dry matter	CF	0.47 tonne C/tonne dm	Default IPCC 2006 table 4.3	-
Forestland-				
Ratio of below-ground biomass to above-ground biomass	R	0.27 tonnes root/tonne shoot	FAO 2005	-
Biomass conversion and expansion factor for conversion of removals in merchantable volume to biomass removals	BCEfr	1.33 coniferous 2.11 broadleaved 1.72 mixed	Table 4.5 IPCC 2006	
Average biomass in forest	Bw	130 tonnes dm/ha	Default IPCC 2006 table 4.7	--
Aboveground biomass growth in forest	GW	3.7 tonnes d.m. ha-1 yr-1 as average of subtropical humid and subtropical dry forests (FAO, 2000)	Default IPCC 2006 table 4.12	-
Reference carbon stock	SOCREF	38	Default IPCC 2006	-
Litter carbon stocks of mature forests	-	20.30 coniferous	Default IPCC 2006 table 2.2	-
Relative Stock change factor for land	FLU	0.82	Default IPCC 2006 table 5.5	Experts' surveys J. Stephan
Relative Stock change factor for management	FMG	1	Default IPCC 2006 table 5.5	Experts' surveys J. Stephan
Relative Stock change factor for input	FI	1	Default IPCC 2006 table 5.5	Experts' surveys J. Stephan
Biomass density	D	0.500 coniferous 0.58 broadleaved 0.54 mixed	FAO 2005 table 4.13 and 4.14	-
Fraction of Biomass loss due to disturbance	Fd	0.415	Calculated	Derived from (1-Fbl) from the IPCC GPG Table 3A.1.12 by first finding the average of 'All "other" temperate forests' and 'All shrublands' which is 0.585 ((0.45+0.72)/2=0.585); and

Parameter	Symbol	Value(s) used	Reference	Notes
				then finding Fraction of biomass loss in disturbance (Fbl) by substitution (1-fBL=0.585 so Fd=0.415)
Cropland				
Above ground biomass (perennial)	B	134 tonnes dm/ha	IPCC 2006 default Model	-
Above ground biomass (annual)	B	10 tonnes dm/ha	IPCC 2006 default Model	-
Reference soil organic carbon stock	SOC	38 tonnes C/ha	IPCC 2006 default Model	For high activity clay mineral soil type
Harvest Maturity Cycle	-	30 years	IPCC 2006 default Model	-
Biomass carbon loss	DCl	63 tonnes C/ha/yr	IPCC 2006 default table 5.1	Assuming climate region "temperate (all moisture regimes)"
Biomass accumulation rate	DCG	2.1 tonnes C/ha/yr		
Inventory time period	T	20	IPCC 2006 Default	
Stock change factor for land-use in the last year of inventory time	FLU	0.82	Default IPCC 2006 table 5.5	Lebanon's croplands are long-term cultivated according to Experts' surveys J. Stephan
Stock change factor for management regime in the last year of inventory time period	Fmg	1	Default IPCC 2006 table 5.5	Lebanon's level of tillage in its croplands is full according to Experts' surveys J. Stephan
Stock change factor for input of organic matter in the last year of inventory	FI	1	Default IPCC 2006 table 5.5	Lebanon's level of input of organic matter in its croplands is medium according to Experts' surveys J. Stephan
Emission factor for climate type c	EF	0	IR	No organic soils (Expert's surveys, T. Darwish)
Grassland				
Stock change factor for land-use in the last year of inventory time period	FLU	1	Default IPCC 2006 table 5.5	All levels, All climatic regimes

Parameter	Symbol	Value(s) used	Reference	Notes
Stock change factor for management regime in the last year of inventory time period	FMG	0.95	Default IPCC 2006 table 5.5	Lebanon's grasslands are moderately degraded grasslands according to (MoE/UNDP/GEF, 2016)
Stock change factor for input of organic matter in the last year of inventory time period	FI	1	Default IPCC 2006 table 5.5	Lebanon's level of management inputs in its grasslands is nominal according to Experts' surveys J. Stephan
Settlements				
Carbon stock in living biomass immediately following conversion to settlements	-	0	Default values IPCC 2006	Tier 1 assumes that carbon stocks in living biomass following conversion are equal to zero.
Biomass stocks before conversion	-	Annual crops 10 tonnes dm/ha Perrenial woody crops 134 tonnes dm/ha Grasslands 0 tonnes dm/ha forests 130 tonnes dm/ha	Default values IPCC 2006 Model	-
Stock change factor for land-use in the last year of inventory time period	FLU	1	Default IPCC 2006 table 5.5	-
Stock change factor for management regime in the last year of inventory time period	FMG	1	Default IPCC 2006 table 5.5,	-
Stock change factor for input of organic matter in the last year of inventory time period	FI	1	Default IPCC 2006 table 5.5	
Dead wood/litter stock under the old category (Cropland)	-	0	Default IPCC 2006	The Tier 1 method assumes that the dead wood and litter stocks are not present in Cropland or are at equilibrium as in agroforestry systems and orchards. Thus, there is no need to estimate the

Parameter	Symbol	Value(s) used	Reference	Notes
				carbon stock changes for these pools.
Dead wood/litter stock under the new category	-	0	Default IPCC 2006	The value is taken as a default from the IPCC 2006 as 0 tonnes C ha-1 according to Tier 1 which assumes that carbon stocks in living biomass following conversion are equal to zero.
Dead wood/litter stock under the old category (Forest land)	-	130 tonnes dm/ha	Default IPCC 2006	-
Biomass burning				
Emission factor (Forestland)	Gef	4.7 (CH_4) 107 (CO) 0.26 (N_2O) 3 (NO_x)	Default value in IPCC 2006 table 2.5	for “extra tropical forest”, Considering the note in table 2.5 “the extra tropical forest includes all other forest types
Emission factor (Grassland)	Gef	2.3 (CH_4) 65 (CO) 0.21 (N_2O) 3.9 (NO_x)	Default value in IPCC 2006 table 2.5	for “extra tropical forest”, Considering the note in table 2.5 “the extra tropical forest includes all other forest types
Emission factor (Cropland)	Gef	4.7 (CH_4) 107 (CO) 0.26 (N_2O)	Default value in IPCC 2006 table 2.5	for “extra tropical forest”
Mass of fuel available for combustion (Forestland)	MB	Broadleaf 9.5 (tonnes/ha) Coniferous 30 (tonnes/ha) Mixed 12.5 (tonnes/ha)	The values for MB are derived from the back mapping of the Prometheus fuel type classes to the Rothermel fuel models and fuel quantity	-
Mass of fuel available for combustion (Grassland)	MB	5 tonnes/ha		-
Mass of fuel available for combustion (Cropland)	MB	4.6	Default values IPCC 2006	Perennial woody crops burned For All savannas woodland (mid/late dry season burn)
Combustion factor (Forest land)	Cf	0.51	Default IPCC 2006 table 2.6	for Other temperate forests, felled and burned
Combustion factor (Grassland)	Cf	0.77	Default IPCC 2006 table 2.6	For All savanna grasslands (mid/late dry season burns)

Parameter	Symbol	Value(s) used	Reference	Notes
Combustion factor (Cropland)	Cf	0.74	Default IPCC 200 table 2.6	Perennial woody crops burned For All savannas woodland (mid/late dry season burn)

Annex IV. Mitigation action tables for the Energy sector

Jiyeh Reciprocating Engines 78.2 MW Power Plant - HFO Grade B	
General description and overall objective: A base load power plant based on four (4) units of four-stroke medium speed diesel engines, type 18V48/60B has been commissioned in 2016. The Jiyeh performances achieved during the performance tests are the following: With STG: NHR = 7,546 kJ/kWh, SFOC=186 g/kWh, NPO=78.8 MW Without STG: NHR = 8,048 kJ/kWh, SFOC=198 g/kWh, NPO=73.2 MW	
Type of support	Financial support from Danish Export Bank - EKF, Via HSBC
Source of support	Government
Budget allocated	83,978,000 €
Implementing agency	Ministry of Energy and Water
Geographic Coverage	Jiyeh Area
Timeframe	2013-2016
Goals of the mitigation action	Replacement of DO Private Generation by generation technologies with a lower emission factor in $tCO_2eq./MWh$ (DO PG EF is 0.7118 $tCO_2eq./MWh$).
Progress indicators	MWh generation from upgraded plant
Main achievements and results	Avoided Emission from 2016 till 2018 are 88.496 Gg $CO_2eq.$
GHG emissions avoided (Gg $CO_2eq.$ per year)	29.5 Gg $CO_2eq.$
Cumulative GHG emissions avoided for the project (Gg $CO_2eq.$)	Avoided Emission from 2016 till 2018 are 88.496 Gg $CO_2eq.$
Potential GHG emissions avoided for the whole period of project (Gg $CO_2eq.$)	For a period of 25 years the avoided emissions will be 737 Gg $CO_2eq.$
Progress of implementation	Project Completed in December 2016. Power Plant in service.
Steps envisaged to be taken to achieve that action	Done
Methodology and assumptions for emission reduction calculation	For the generated amount of MWh, the avoided emissions have been calculated as the difference between the emissions of the ICE plant and those of the PG for the same amount of energy.

Zouk Reciprocating Engines 194 MW Power Plant - HFO Grade B	
General description and overall objective: A base load power plant based on ten (10) units of four-stroke medium speed diesel engines, type 18V48/60B has been commissioned in 2016. The Zouk performances achieved during the performance tests are the following: With STG: NHR = 7,550 kJ/kWh, SFOC=185 g/kWh, NPO=197.8 MW Without STG: NHR = 7,900 kJ/kWh, SFOC=194 g/kWh, NPO=183.9 MW	
Type of support	Financial support from Danish Export Bank - EKF, Via HSBC
Source of support	Government
Budget allocated	185,247,000 €
Implementing agency	Ministry of Energy and Water
Geographic Coverage	Zouk Area
Timeframe	2013-2016
Goals of the mitigation action	Replacement of DO Private Generation by generation technologies with a lower emission factor in $tCO_2eq./MWh$ (DO PG EF is 0.7118 $tCO_2eq./MWh$).
Progress indicators	MWh generation from upgraded plant
Main achievements and results	Avoided Emission from 2016 till 2018 are 279.813 Gg $CO_2eq.$
GHG emissions avoided (Gg $CO_2eq.$ per year)	93.27 Gg $CO_2eq.$
Cumulative GHG emissions avoided for the project (Gg $CO_2eq.$)	Avoided Emission from 2016 till 2019 are 279.813 Gg $CO_2eq.$
Potential GHG emissions avoided for the whole period of project (Gg $CO_2eq.$)	For a period of 25 years the avoided emissions will be 2,331.7 Gg $CO_2eq.$
Progress of implementation	Project Completed in December 2016. Power Plant in service.
Steps envisaged to be taken to achieve that action	Done
Methodology and assumptions for emission reduction calculation	For the generated amount of MWh, the avoided emissions have been calculated as the difference between the emissions of the ICE plant and those of the PG for the same amount of energy.

Zouk and Jiyeh Sites have been equipped with Barges running on Reciprocating Engines - HFO Grade B	
General description and overall objective: Each barge provides a base load power plant from ten (10) units of four-stroke medium speed diesel engines. The Barges SFOC achieved during the period (2016-2018) is SFOC=212.4 g/kWh	
Type of support	None
Source of support	Government
Budget allocated	185,247,000 €
Implementing agency	Electrecite Du Liban
Geographic Coverage	Zouk and Jiyeh Areas
Timeframe	2016-2021
Goals of the mitigation action	Replacement of DO Private Generation by generation technologies with a lower emission factor in $tCO_2eq./MWh$ (DO PG EF is 0.7118 $tCO_2eq./MWh$).
Progress indicators	MWh generation from barges
Main achievements and results	Avoided Emission from 2016 till 2018 are 346.41 Gg $CO_2eq.$
GHG emissions avoided (Gg $CO_2eq.$ per year)	115.4 Gg $CO_2eq.$
Cumulative GHG emissions avoided for the project (Gg $CO_2eq.$)	Avoided Emission from 2016 till 2018 are 346.41 Gg $CO_2eq.$
Potential GHG emissions avoided for the whole period of project (Gg $CO_2eq.$)	For a period of 7 years the avoided emissions will be 807.8 Gg $CO_2eq.$
Progress of implementation	Project Completed
Steps envisaged to be taken to achieve that action	Done
Methodology and assumptions for emission reduction calculation	For the generated amount of MWh, the avoided emissions have been calculated as the difference between the emissions of the Barges plant and those of the PG for the same amount of energy.

Zahrani Combined Cycle Power Plant - DO	
General description and overall objective: The ZCCPP has been upgraded to increase efficiency. The CMF+ upgrade applies the latest design Controlled Diffusion Airfoil (CDA) compressor blades to the V94.2 Gas Turbine. This allows a significant increase in compressor mass flow by approximately 3,5%, augmenting the power output of the GT and the subsequent Steam Turbine (ST) in combined cycle operation. The Si3D upgrade superior design, material and coatings leads to a substantial improvement in turbine performance, and increases the overall power output and efficiency of the gas turbine. The ZCCPP SFOC achieved during the period (2016-2018) is SFOC=179.67 g/kWh	
Type of support	None
Source of support	Government
Budget allocated	25,000,000 $
Implementing agency	Electrecite Du Liban
Geographic Coverage	Deir Ammar Area
Timeframe	2016-2019
Goals of the mitigation action	improved efficiency of power plant through decreasing the SFOC from 190 g DO/KWh (average 2009-2015) to 179.92 gDO/KWh (2016-2018), hence decreasing the EF from 0.587 tonnes CO_2eq./MWh to 0.556 tonnes CO_2eq./MWh
Progress indicators	MWh generation from upgraded plant
Main achievements and results	Avoided Emission from 2016 till 2018 are 283.966 Gg CO_2eq.
GHG emissions avoided (Gg CO_2eq. per year)	94.65 Gg CO_2eq.
Cumulative GHG emissions avoided for the project (Gg CO_2eq.)	Avoided Emission from 2016 till 2019 are 283.966 Gg CO_2eq.
Potential GHG emissions avoided for the whole period of project (Gg CO_2eq.)	For a period of 25 years the avoided emissions will be 2,366 Gg CO_2eq.
Progress of implementation	Project Completed
Steps envisaged to be taken to achieve that action	Done
Methodology and assumptions for emission reduction calculation	For the generated amount of MWh, the avoided emissions have been calculated as the difference between the emissions of the ZCCPP plant and those of the PG for the same amount of energy.

Solar PV Distributed Generation				
General description and overall objective: Solar PV distributed generation relates to rooftop solar PV systems or solar PV systems at existing facilities with consumption at source that may be connected to the grid through a Net Metering scheme.				
Type of support	Financial			
Source of support	Government	Private Sector	Donor (Specify)	NGO (specify)
	NEEREA	X		
Budget allocated				
Implementing agency	MoEW, LCEC	Various		
Geographic Coverage	All regions of Lebanon			
Timeframe	2016-2018			
Goals of the mitigation action	to replace private generation by renewable energy			
Progress indicators	MW installed per year, MWh generated per year			
Main achievements and results	Solar PV Installed Capacity increased from 11.39 MW in 2015 to 56.55 MW in 2018 and related MWh generation increased from 16,961 MWh to 83,799 MWh.			
GHG emissions avoided (Gg CO_2eq. per year)	41.725 Gg CO_2eq.			
Cumulative GHG emissions avoided for the project (Gg CO_2eq.)	125.176 Gg CO_2eq. For the 2016-2018 period			
Potential GHG emissions avoided for the whole period of project (Gg CO_2eq.)	834.5 Gg CO_2eq. of avoided GHG emissions for a 20 years lifetime			
Progress of implementation				
Steps envisaged to be taken to achieve that action	Further awareness raising campaigns on the Solar PV subject			
Methodology and assumptions for emission reduction calculation	For the generated amount of MWh, the avoided emissions have been calculated as the emissions of the PG for the same amount of energy (using the PG emission factor of 0.7118 Tonnes CO2eq./MWh)			

Solar Water Heaters				
General description and overall objective: Solar Water Heaters deployment have a significant effect on Electrical energy consumption generating energy savings of 0.65 MWh/m2/year.				
Type of support	Financial			
Source of support	Government	Private Sector	Donor (Specify)	NGO (specify)
	NEEREA	X		
Budget allocated				
Implementing agency	MoEW, LCEC	Various		
Geographic Coverage	All regions of Lebanon			
Timeframe	2016-2018			
Goals of the mitigation action	to replace electric water heating using boilers and/or DO by SWH rhus reducing 0.65 MWh per m^2 installed per year			
Progress indicators	m^2 installed per year, MWh savings per year			
Main achievements and results	installations grew from 550,000 m^2 to 650,000m^2 during the period 2016-2016, avoiding 832.816 Gg CO_2eq.			
GHG emissions avoided (Gg CO_2eq. per year)	277.6 Gg CO_2eq.			
Cumulative GHG emissions avoided for the project (Gg CO_2eq.)	N.A.			
Potential GHG emissions avoided for the whole period of project (Gg CO_2eq.)	N.A.			
Progress of implementation	Target of 1,053,988 m^2 by 2020 has been partially achieved. The actual progress of 750,000 m^2 is between the pessimistic scenario and the realistic scenario of NREAP 2016-2019.			
Steps envisaged to be taken to achieve that action	More efforts are needed to develop local SWH production and laws to improve the SWH installation performance.			
Methodology and assumptions for emission reduction calculation	For the generated amount of MWh, the avoided emissions have been calculated as the emissions of the PG for the same amount of energy (using the PG emission factor of 0.7118 Tonnes CO2eq./MWh).			

Naame LFG Power Plant	
General description and overall objective: The power generation plant consists of 7 containerized Gen-sets powered by GE Jenbacher gas engines. The capacity of each gen-set is 1,067 kWe. The plant works at N+1 configuration (6 gensets running and one gen-set as standby), plant total capacity is 6.4 MWe (6 gensets running) with and installed capacity of 7.469MWe. The produced electricity exported to the national grid will last for an estimated period of 10 years depending on the estimated gas quantities and composition. The Naameh LFG consumption achieved during the period (2016-2019) is 0.4305 Nm^3/kWh	
Type of support	None
Source of support	Government
Budget allocated	
Implementing agency	Electrecite Du Liban
Geographic Coverage	Naameh Area
Timeframe	2017-2018
Goals of the mitigation action	Replacement of DO Private Generation by generation technologies with a lower emission factor in $tCO_2eq./MWh$ (DO PG EF is 0.7118 $tCO_2eq./MWh$).
Progress indicators	Average EF for the Naameh LFG Plants from 2017-2019 is 0.482 $tCO_2eq./MWh$.
Main achievements and results	Avoided Emission from 2017 till 2018 are 24.170 Gg CO_2eq.
GHG emissions avoided (Gg CO_2eq. per year)	12.085 Gg CO_2eq.
Cumulative GHG emissions avoided for the project (Gg CO_2eq.)	Avoided Emission from 2017 till 2018 are 24.170 Gg CO_2eq.
Potential GHG emissions avoided for the whole period of project (Gg CO_2eq.)	For a period of 10 years the avoided emissions will be 120.851 Gg CO_2eq.
Progress of implementation	Project Completed
Steps envisaged to be taken to achieve that action	Done
Methodology and assumptions for emission reduction calculation	For the generated amount of MWh, the avoided emissions have been calculated as the difference between the emissions of the Naameh LFG plant and those of the PG for the same amount of energy.

Annex V. Mitigation action tables for the Transport sector

<table>
<tr><th colspan="5">The Greater Beirut Public Transport Project</th></tr>
<tr><td colspan="5">Implement a Bus Rapid Transit (BRT) system for the Greater Beirut Area to improve the speed, quality and accessibility of public transport for commuters in Beirut and along the northern coastal highway.</td></tr>
<tr><td>Type of support</td><td colspan="4">Financial, technical assistance and capacity building.</td></tr>
<tr><td rowspan="2">Source of support</td><td>Government</td><td>Private sector</td><td>Donor</td><td>NGO</td></tr>
<tr><td></td><td></td><td>World Bank (concessional and non-concessional loan)</td><td></td></tr>
<tr><td>Budget allocated</td><td></td><td>USD 50 million</td><td>USD 345,000,000 (295,000,000 in loans)</td><td></td></tr>
<tr><td>Status</td><td colspan="4">On hold</td></tr>
<tr><td>Implementing agency</td><td colspan="4">World Bank</td></tr>
<tr><td>Geographic coverage</td><td colspan="4">Greater Beirut and Beirut Northern entrance at Tabarja.</td></tr>
<tr><td>Timeframe</td><td colspan="4">2018 – 2024</td></tr>
<tr><td>Goals of the mitigation action</td><td colspan="4">Reduce reliance on passenger cars by creating an accessible mass-transit system that can deliver reliable and affordable public transport services.</td></tr>
<tr><td>Progress indicators</td><td colspan="4">a. Intermediate Results Indicators:
- Number of labor days of short-term jobs created for Lebanese and Syrians
- At least one contract signed with a private BRT operator
- Number of km of the BRT infrastructure constructed
- Number of operating BRT and regular bus lines, BRT and regular buses
- Annual net savings of GHG emission (tonnes CO_2)
- Monitoring of fare collection system installed at the RPTA
b. Project Development Objective Indicators
- Percent of female ridership in BRT and regular buses per weekday
- Percent of population within 60 mins of GBA centre using public transport
- Average morning peak travel time from Tabarja to Charles Helou stations
- Share of passengers and female riders satisfied with quality of bus system</td></tr>
<tr><td>Main achievements and results</td><td colspan="4">Signature of contract.
ESIA preparation.
Two roads and maintenance sub-projects out of 10 under implementation.</td></tr>
<tr><td>GHG emissions avoided (tonnes CO_2 eq. per year)</td><td colspan="4"><table><tr><th>Type of Bus</th><th>Average per Year ($tCO_2eq.$)</th></tr><tr><td>Diesel articulated bus</td><td>60,590</td></tr><tr><td>Hybrid articulated bus</td><td>71,902</td></tr><tr><td>CNG articulated bus</td><td>71,902</td></tr></table></td></tr>
<tr><td>Cumulative GHG emissions avoided for the project (tonnes CO_2 eq.)</td><td colspan="4"><table><tr><th>Type of Bus</th><th>Total Savings ($tCO_2eq.$)</th></tr><tr><td>Diesel articulated bus</td><td>1,211,808</td></tr><tr><td>Hybrid articulated bus</td><td>1,438,045</td></tr><tr><td>CNG articulated bus</td><td>1,438,045</td></tr></table>* Total savings are over the 20 years of the project lifetime</td></tr>
<tr><td>Progress of implementation</td><td colspan="4">The project has been put on hold</td></tr>
</table>

Steps envisaged to be taken to achieve that action	- Construct stations, acquire bus fleet and install systems. - Capacity building and project management. - Operate feeder and regular bus services.
Methodology and assumptions for emission reduction calculation	Calculation does not account for the GHG savings related to improved congestion on general traffic lanes (improved speed).

Sustainable Urban Public Transport Investment Program (SUPTIP) in Greater Tripoli				
the modernization of the Railway and Public Transportation Authority (RPTA) by building its institutional capacity to define, develop and implement strategic public transport projects, and by providing the needed technical assistance to the RPTA and the public transport sector to implement reforms				
Type of support	Financial, technical assistance and capacity building			
Source of support	Government	Private sector	Donor	NGO
			European Investment Bank (EIB)	
Budget allocated			Euro 1,000,000 to date	
Status	Planned			
Implementing agency	Railway and Public Transportation Authority (RPTA); UNDP			
Geographic coverage	Greater Tripoli			
Timeframe	10-2018 – 10-2019			
Goals of the mitigation action	Revitalize public transportation by updating institutional and technical structural capacities of the RPTA, developing public transportation strategies and linkages with resource organizations, and creating a public bus network in Tripoli as a quick win project.			
Progress indicators	- Technical Assistance for the program (SUPTIP) in Greater Tripoli is developed. - Tender documents for the bus network system of Tripoli are prepared.			
Main achievements and results	- Terms of Reference (TOR) prepared and budget allocated for the formulation of railway master plan and related expropriation decrees. - Current regulations and frameworks of the RPTA assessed to strengthen its institutional capacity and revise current organizational structure, functional job descriptions, internal institutional bylaws and working procedures. - Protocol signed for the restoration and adaptive reuse of the Mina Railway Station in Tripoli. - EUMEDRAIL Action Plan for Lebanon 2018-2020 launched to support decision makers in the revitalization of the railway network.			
GHG emissions avoided (tonnes CO_2 eq. per year)	Not available			
Cumulative GHG emissions avoided for the project (tonnes CO_2 eq. per year)	Not available			
Progress of implementation	- Impeded by the termination of the project team in 2019			
Steps envisaged to be taken to achieve that action	- Finalizing loan estimation (currently at Euro 100 Million). - Assisting the RPTA on the technical and administrative levels - Updating transport strategy and implementation plan - Creating the Tripoli Transport Authority (TTA) - Elaborating a New Bus Network - Integrating tariff and ticketing systems, reforming concession fares/subsidies - Supporting the donor (EIB) in identifying needed loans for (a) construction of new bus terminal at Bahsas; (b) acquisition of new buses; (c)			
Methodology and assumptions for emission reduction calculation	Not available			

Revitalization of Public Transport in Greater Beirut				
Upgrading public transport as a means to economic growth and economic integration				
Type of support	Financial, technical assistance, technology transfer, capacity building			
Source of support	Government	Private sector	Donor	NGO
	Ministry of Public Works and Transport (MOPWT)		EuroMed	
Budget allocated	Unknown		Unknown	
Status	Not started			
Implementing agency	Unknown			
Geographic coverage	National			
Timeframe	Unknown			
Goals of the mitigation action	- Regulate public transport and restructure its government authorities - Introduce new modes of public transport on the congested main routes and enhance current coverage and level of service - Construct transport terminals at entrances of Greater Beirut and main cities - Organize on-street and off-street parking facilities			
Progress indicators	- Adoption of a joint ministerial decision between MOPWT and the Ministry of Interior and Municipalities (MOIM) to regulate public transport services - Cabinet approval of the MOPWT land transport policy - Cabinet approval of the reorganization of the Higher Council of Transport (HCT) and the Railway and Public Transport Authority (RPTA) - Cabinet approval and parliament endorsement of the law for establishing the Land Transport Authority (LTA) - Cabinet approval and parliament endorsement of incentives to public transport operators			
Main achievements and results	- Introduction of improved licensing and enforcement system for public transport services (pending joint MOPWT and MOIM approval) - Comprehensive study for the revitalization of public transport industry (initial national transport model and preliminary route/terminal design completed) - Tenders launched for the preparation of the conceptual and detailed engineering designs and tender documents for the railway line along the major corridor in Greater Beirut and the northern coastal corridor			
GHG emissions avoided ((tonnes CO_2 eq. per year)	Unknown			
Cumulative GHG emissions avoided for the project (tonnes CO_2 eq. per year)	Unknown			
Progress of implementation	- Project not active, a major part of it (implementation of a modern public bus system in Greater Beirut) now overlaps with the World Bank's "The Greater Beirut Public Transport Project" and EIB's "Sustainable Urban Public Transport Investment Program" in Greater Tripoli Financial needs: secure funding for the entire project or parts of the project			
Steps envisaged to be taken to achieve that action	- Pilot project on implementing revitalization plans for public transport in Greater Beirut - Initiation of the construction of the northern coastal railway line			
Methodology and assumptions for emission reduction calculation	Not available			

EuroMed Transport Support Project (EuroMed TSP)				
Support South Mediterranean partner countries in the implementation of the Regional Transport Action Plan				
Type of support	Technical assistance, capacity building			
Source of support	Government	Private sector	Donor	NGO
			European Union (EU)	
Budget allocated			EUR 2,899,500 (for nine countries) EUR 323,000 estimated for Lebanon	
Status	Ongoing			
Implementing agency	Ministry of Public Works and Transport (MoPWT)			
Geographic coverage	National (Lebanon) and regional (South Mediterranean)			
Timeframe	2016 – 2020			
Goals of the mitigation action	- Contribute to creating an integrated transport system in the Mediterranean to achieve regional economic integration and economic well-being - Improve efficiency, safety and sustainability of all transport modes, with a focus on multimodal and land transport. - Lower the environmental impact and financial costs of transport.			
Progress indicators	Regional Transport Action Plan 2014-2020			
Main achievements and results	- Training professional drivers on safe transport of goods and passengers - Awareness raising workshops			
GHG emissions avoided (tonnes CO_2 eq. per year)	Unknown			
Cumulative GHG emissions avoided for the project (tonnes CO_2 eq. per year)	Unknown			
Progress of implementation	Ongoing			
Steps envisaged to be taken to achieve that action	- Harmonize transport regulations in the region and undertake regulatory reform actions - Establish urban transport authorities and efficient and innovative fleet management solutions. - Identify priorities and objectives for each country and raise awareness among stakeholders about project actions.			
Methodology and assumptions for emission reduction calculation	Not available			

EuroMed Transport Rail Project (EUMedRail)				
Support South Mediterranean partner countries in the implementation of the Regional Transport Action Plan				
Type of support	Technical assistance, capacity building			
Source of support	Government	Private sector	Donor	NGO
			European Union (EU)	
Budget allocated			EUR 2,000,000 (for nine countries)	
Status	Ongoing			
Implementing agency	Ministry of Public Works and Transport (MoPWT)			
Geographic coverage	National (Lebanon) and regional (South Mediterranean)			
Timeframe	2016 – 2020			
Goals of the mitigation action	- Promote best practices in rail regulation and standards and convergence with EU and international standards. - Offer technical support through a network of international specialists. - Facilitate interoperability - Increase participation of beneficiaries in the activities of the European			
Progress indicators	Regional Transport Action Plan 2014-2020			
Main achievements and results	- Workshop covering international railway legislation, cross-border traffic and safety held in 2017 - Meeting held to discuss action plan supporting revitalisation of the Tripoli-Beirut railway and reform of the Railway and Public Transport Authority			
GHG emissions avoided (tonnes CO_2 eq. per year)	Unknown			
Cumulative GHG emissions avoided for the project (tonnes CO_2 eq. per year)	Unknown			
Progress of implementation	Ongoing by European Rail Agency			
Steps envisaged to be taken to achieve that action	- Create of a network of railway experts. - Enhance knowledge about EU and international railway legislation and standards by such as by capacity building and training of trainers. - Adopt and implement safety management systems (SMS), technical specifications for interoperability (TSI), registers, European railways traffic management system (ERTMS)			
Methodology and assumptions for emission reduction calculation	Not available			

<table>
<tr><th colspan="5">Law #79 (Budget 2018)</th></tr>
<tr><td colspan="5">Tax exemptions and reductions under Article 55 on new purchase of hybrid and electric cars.</td></tr>
<tr><td>Type of support</td><td colspan="4">Capacity building</td></tr>
<tr><td rowspan="2">Source of support</td><td>Government</td><td>Private sector</td><td>Donor</td><td>NGO</td></tr>
<tr><td>Ministry of Finance</td><td></td><td></td><td></td></tr>
<tr><td>Budget allocated</td><td>Unknown</td><td></td><td></td><td></td></tr>
<tr><td>Status</td><td colspan="4">Completed</td></tr>
<tr><td>Implementing agency</td><td colspan="4">Ministry of Finance</td></tr>
<tr><td>Geographic coverage</td><td colspan="4">National</td></tr>
<tr><td>Timeframe</td><td colspan="4">Unknown</td></tr>
<tr><td>Goals of the mitigation action</td><td colspan="4">Incentivize the adoption of new battery electric vehicles (BEV) and hybrid electric vehicles (HEV) by exempting BEV from customs and registration fees and reducing taxes on HEV to 20% of purchase price.</td></tr>
<tr><td>Progress indicators</td><td colspan="4">New car sales of HEVs and BEVs since 2015</td></tr>
<tr><td>Main achievements and results</td><td colspan="4">None</td></tr>
<tr><td>GHG emissions avoided (tonnes CO_2 eq. per year)</td><td colspan="4">Same as assessed under the SODEL project:<table><tr><th>Type of Passenger car</th><th>Average per Year per Passenger Car (tonnes CO_2eq.)</th></tr><tr><td>CNG</td><td>0.85</td></tr><tr><td>Hybrid</td><td>1.21</td></tr><tr><td>Electric</td><td>2.92</td></tr></table>* Compared to Gasoline passenger car</td></tr>
<tr><td>Cumulative GHG emissions avoided for the project (tonnes CO_2 eq. per year)</td><td colspan="4">Unknown</td></tr>
<tr><td>Progress of implementation</td><td colspan="4">Not applicable</td></tr>
<tr><td>Steps envisaged to be taken to achieve that action</td><td colspan="4">Not applicable</td></tr>
<tr><td>Methodology and assumptions for emission reduction calculation</td><td colspan="4">Not applicable</td></tr>
</table>

Nationally Appropriate Mitigation Action (NAMA) in Lebanon's Private Road Transport Sector				
Creation of a car scrappage program for replacing old conventional vehicles with newer more efficient and alternative fuel vehicle technologies				
Type of support	Financial, technical assistance, capacity building			
Source of support	Government	Private sector	Donor	NGO
	Ministry of Finance Banque du Liban	Banks, microfinance, insurance companies, car dealers and importers, car scrappage facilities	TBD	
Budget allocated			USD 15,164,000	
Status	Planned			
Implementing agency	Ministry of Interior and Municipalities Traffic Trucks and Vehicles Management Authority (TTVMA)			
Geographic coverage	National			
Timeframe	Phase 1 (y1-y2) Phase 2 y3-y10			
Goals of the mitigation action	Incentivize the removal of old polluting cars and their replacement with new fuel-efficient vehicles (FEVs) through a car scrappage program in order to reduce GHG emissions Phase 1 includes a pilot project on car scrappage for taxi cars Phase 2 includes a scaling up programme for taxis and passenger cars			
Progress indicators	- Coordinating and Implementing entities are established and financed - NAMA Finance Facility is established and its operation is financed - Monetary values of financial incentives disbursed on a national level - Emissions limit for newly imported cars is legally enacted - Amount of replacement fees disbursed as part of the scrappage program - Value of soft loans issued for purchase of FEVs under scrappage program - Value of tax exemptions for newly imported FEVs under scrappage program - Number of taxi drivers placing ads on their vehicles - List of scrappage sites complying with environmental standards is compiled - Money spent on training on and marketing of the scrappage program - Environmental standards for all newly imported cars are legally			
Main achievements and results	Not started			
GHG emissions avoided (tonnes CO_2 eq. per year)	Between a minimum of 230,818 (for 50% replacement scenario) and a maximum of 848,604 (for 100% replacement scenario) of the entire passenger car fleet			
Cumulative GHG emissions avoided for the project (tonnes CO_2 eq. per year)	Between a minimum of 3,000,635 (for 50% replacement scenario) and a maximum of 11,031,852 (for 100% replacement scenario)			
Progress of implementation	Not started			

Steps envisaged to be taken to achieve that action	- Establish a NAMA coordinating entity (CE), an implementing entity (IE) and a Finance Facility (NFF) - Define eligibility criteria for old cars, emission standards for new cars, and incentive scheme for car replacement, and provide legal basis/force - Ensure upgrade of participating scrappage sites - Build awareness about the car scrappage program among car dealers and promote the program with the general public - Implement a pilot scrappage program to scrap old red plate cars and replace with FEVs, and extend implementation to old white plate cars Financial needs: secure funding for the entire project or parts of the project Technical needs: complete assessment of all existing vehicle inspection facilities, equipment, and staff and provide recommendations for upgrading current capabilities to inspect electrified and natural gas vehicles
Methodology and assumptions for emission reduction calculation	As documented in section 4.2.2 of "Nationally Appropriate Mitigation Action in Lebanon's Private Road Transport Sector (FEVs) - NAMA Proposal and Design Document" by UNDP and Ministry of Environment (2017)

Rehabilitating of the northern coastal railway line				
Re-establishing the railway line between Tripoli and the Syrian border for freight				
Type of support	Financial, technical assistance			
Source of support	Government	Private sector	Donor	NGO
			CEDRE	
Budget allocated			USD 90,000,000	
Status	Planned			
Implementing agency	2026-2030			
Geographic coverage	North region			
Timeframe	4 years from the time funds are secured			
Goals of the mitigation action	Shift to rail trans-border freight transport between Tripoli port and Syria			
Progress indicators	railway is operational for freight			
Main achievements and results	Design partially completed			
GHG emissions avoided (tonnes CO_2 eq. per year)	Unknown			
Cumulative GHG emissions avoided for the project (tonnes CO_2 eq. per year)	Unknown			
Progress of implementation	Not started			
Steps envisaged to be taken to achieve that action	- operationalization of the CEDRE plan following the approval of the reform package - CAPEX/OPEX validation - Design finalization and start of construction works			
Methodology and assumptions for emission reduction calculation	Unknown			

Construction of bike lanes in Beirut				
Construction of 28 km of dedicated bike lanes inside Beirut in three phases to encourage the use of zero-emission alternative transportation means				
Type of support	Financial, technical assistance			
Source of support	Government	Private sector	Donor	NGO
	Beirut Municipality	Beirut by Bike		
Budget allocated	USD 640,000 (phase 1 only)	USD 50,000 (design)		
Status	Planned			
Implementing agency	Beirut Municipality			
Geographic coverage	Greater Beirut Area			
Timeframe	unknown			
Goals of the mitigation action	- Encourage bicycle use to reduce mobility emissions - Improve cycling safety, reduce traffic congestion in busy city districts and promote healthy exercise/practice of sports and social distancing			
Progress indicators	- Completion of tender process for construction of phase 1 (8km of 28 km)			
Main achievements and results	Tender documents prepared and tender was initiated under Beirut Municipality decision No. 841 dated 16/11/2018, but initial tender has been cancelled and is now pending retender			
GHG emissions avoided (tonnes CO_2 eq. per year)	Unknown			
Cumulative GHG emissions avoided for the project (tonnes CO_2 eq. per year)	Unknown			
Progress of implementation	On hold pending retender			
Steps envisaged to be taken to achieve that action	- Re-initiate tender for phase 1 - Secure funding for phase 2 (USD 720,000) and phase 3 (USD 880,000)			
Methodology and assumptions for emission reduction calculation	Not available			

Loop Beirut				
Electric scooter sharing in Beirut				
Type of support	technology transfer			
Source of support	Government	Private sector	Donor	NGO
		Loop SAL		
Budget allocated		Unknown		
Status	Ongoing			
Implementing agency	Loop SAL, a zone operator of the international company LOOPShare Ltd.			
Geographic coverage	Beirut			
Timeframe	Ongoing			
Goals of the mitigation action	avoid traffic congestion and reduce carbon footprint by using an ecofriendly scooter under a flexible and affordable on-demand rental service			
Progress indicators	Number of scooter sharing stations Number of operational scooters Number of subscribed users			
Main achievements and results	Developed the first commercial scooter sharing service in Lebanon			
GHG emissions avoided (tonnes CO_2 eq. per year)	Unknown			
Cumulative GHG emissions avoided for the project (tonnes CO_2 eq. per year)	Unknown			
Progress of implementation	Grew from a fleet of 15 scooters and 1 scooter sharing station in mid-2017 to 110 electric scooters and 13 scooter sharing stations by end of 2019			
Steps envisaged to be taken to achieve that action	Financial needs: access to funding has been the biggest obstacle to scaling up the business Financial needs: access to funding has been the biggest obstacle to scaling up the business Enhance software application with new features and functionalities for the operator and the users to increase subscribers and scale up the system			
Methodology and assumptions for emission reduction calculation	Unknown			

Annex VI. Mitigation action tables for the Forest and Other Land Use

LRI reforestation/afforestation projects in 2016				
General information: A total of 17 reforestation/afforestation projects were executed in different areas across Lebanon in partnership with municipalities, Non-Governmental Organizations (NGOs) (e.g., Shouf Biosphere Reserve) and others. Planted lands were mostly public-municipal lands including one religious endowment land. Projects were mostly funded by international organizations and private sector including banks.				
Implementing agency		Lebanon Reforestation Initiative		
Geographical coverage	Planted area (ha)	Source of funding		
Aaqoura	41.38	United States Agency for International Development (USAID)		
Bcharre	11.75	United Nations Development Programme (UNDP) and USAID		
Bire Rachaya	15.18	UNDP/USAID		
Ehmej	1.9	Mobile Interim Company 2 (MIC2)		
Hasroun	5.58	USAID		
Hasroun	3.41	USAID		
Jaj	6.9	LRI		
Jbaa	5.66	Advance Car Rental		
Khirbet Rouha	5.6	USAID		
Khirbet Rouha	6.94	UNDP/USAID		
Maasser el Chouf	3	USAID/Byblos Bank		
Mdoukha	17.46	USAID		
Mhaidse	0.7	USAID		
Niha	11.54	USAID		
Rafid	8.52	UNDP/USAID		
Tannourine	0.89	MIC2		
Yammoune	0 (only replacement of seedlings)	USAID		
Budget		N.A.		
Timeframe		April 2016 - December 2016		
Goals: Within the scope of these projects, LRI plans to increase the woodland area in Lebanon and participate in the restoration of its degraded high mountain ecosystem in close partnership local authorities and community groups.				
Achievements or progress		Year	Area (ha)	Yearly CO_2 removal (Gg CO_2eq.)
		2016	146.41 (i.e., estimated 102,478 seedlings)	1.65 Gg CO_2eq.
Methodology		Intergovernmental Panel on Climate Change (IPCC) 2006 Guidelines, IPCC software		
Assumptions		Assuming that each ha of planted land comprised 700 seedlings. Also, assuming the total area of land was successfully planted and maintained.		

AFDC reforestation/afforestation projects in 2016				
General information: A total of 9 reforestation/afforestation projects were executed in different areas across Lebanon in partnership with municipalities and union of municipalities. Planted lands were mostly public-municipal and Lebanese Republic lands. Projects were mostly funded by international organizations and private sector.				
Implementing agency		Association for Forests, Development and Conservation		
Geographical coverage	Planted area (ha)	Source of funding		
Rachaya	3	Tom Jopson		
Anjar	2	Tom Jopson		
Bqerzala	10	UNDP		
Bqarsouna	5	UNDP		
Deir Aamar	5	UNDP		
Ehden	10	UNDP		
Kfarqouk	15	UNDP		
Aayoun El Siman	1	Corporate Social Responsibility fund		
Mazrat El Shouf	6	Ananda Marga Universal Relief Team (AMURT)		
Budget		N.A.		
Timeframe		February 2016 - November 2016		
Goals: AFDC contributes to increasing the woodland area in Lebanon and participates in the restoration of its degraded lands in close partnership local authorities and community groups.				
Achievements or progress		Year	Area (ha)	Yearly CO_2 removal (Gg CO_2eq.)
		2016	57 (i.e., estimated 39,900 seedlings)	0.64 Gg CO_2eq.
Methodology		IPCC 2006 Guidelines, IPCC software		
Assumptions		Assuming that each ha of planted land comprised 700 seedlings. Also, assuming the total area of land was successfully planted and maintained.		

LRI reforestation/afforestation projects in 2017		
General information: A total of 36 reforestation/afforestation and restoration projects were executed in different areas across Lebanon in partnership with municipalities, NGOs and others. Planted lands were mostly public-municipal lands. Projects were mostly funded by international organizations and private sector.		
Implementing agency		Lebanon Reforestation Initiative
Geographical coverage	Planted area (ha)	Source of funding
Aaqoura	1.21	USAID
Ain Aarab	0 (replacement of seedlings)	USAID
Ainata	1.11	USAID
Aitanit	0.63	MIC2
Anjar	6.35	Advance Car Rental
Bakka	13.92	USAID
Bcharre	15.07	USAID
Chatine	0.41	USAID
Chatine	0 (replacement of seedlings)	USAID
Dahr el Ahmar	0 (replacement of seedlings)	USAID
Dahr el Ahmar	4.27	USAID
Deir El Ahmar	0.46	Hilton
Ehmej	0 (replacement of seedlings)	MIC2
Hasroun	0 (replacement of seedlings)	USAID
Jaj	0 (replacement of seedlings)	N.A.
Jebrayel	2.94	USAID
Kaoukaba	2.07	USAID
Kaoukaba	0 (replacement of seedlings)	USAID
Kfar Danis	1.8	USAID
Kfar Mechki	3.69	USAID
Majdal Balhis	1.43	USAID
Mazraat Sarada	0 (replacement of seedlings)	USAID
Mounjez	5	USAID
Qaraoun	1.57	MIC2
Rachaiya	0 (replacement of seedlings)	DHL
Tannourine	2.39	USAID
Ain Aarab	0 (replacement of seedlings)	USAID/Municipality
Dahr el Ahmar	0 (replacement of seedlings)	LLWB
Ehden	0.88	USAID
Ehmej	0.26	Holy Spirit University of Kaslik (USEK)/USAID
Ehmej	0 (replacement of seedlings)	USAID
Jbaa	0 (replacement of seedlings)	Advance Car Rental
Kfar Mechki	6.18	USAID
Maasser el Chouf	0 (replacement of seedlings)	USAID
Mhaidse	5.6	USAID
Niha	0 (replacement of seedlings)	USAID
Budget		N.A.
Timeframe		January 2017 - December 2017
Goals: Within the scope of these projects, LRI plans to increase the woodland area in Lebanon and participate in the restoration of its degraded high mountain ecosystem in close partnership local authorities and community groups.		

Achievements or progress	Year	Area (ha)	Yearly CO_2 removal (Gg CO_2eq.)
	2017	77.24 (i.e., estimated 54,068 seedlings)	0.87 Gg CO_2eq.
Methodology	IPCC 2006 Guidelines, IPCC software		
Assumptions	Assuming that each ha of planted land comprised 700 seedlings. Also, assuming the total area of land was successfully planted and maintained.		

AFDC reforestation/afforestation projects in 2017				
General information: One main reforestation/afforestation project was executed by AFDC in 2017 in partnership with the municipality of Anjar by expanding an old reforested site on Lebanese Republic land.				
Implementing agency		Association for Forests, Development and Conservation		
Geographical coverage	Planted area (ha)	Source of funding		
Anjar	10	UNDP		
Budget		N.A.		
Timeframe		March 2017		
Goals: AFDC contributes to increasing the woodland area in Lebanon and participates in the restoration of its degraded lands in close partnership local authorities and community groups.				
Achievements or progress		Year	Area (ha)	Yearly CO_2 removal (Gg CO_2eq.)
		2017	10 (i.e., estimated 7,000 seedlings)	0.11 Gg CO_2eq.
Methodology		IPCC 2006 Guidelines, IPCC software		
Assumptions		Assuming that each ha of planted land comprised 700 seedlings. Also, assuming the total area of land was successfully planted and maintained.		

Other reforestation/afforestation projects in 2017				
General information: Different reforestation/afforestation projects were executed in different areas across Lebanon with the participation of different NGOS (such as Jouzour Loubnan, Shouf Biosphere Reserve and the Lebanese Organization for Studies and Training-LOST) and municipalities (such as Ehden and Tannourine).				
Implementing agency		NGOs (Jouzour Loubnan, Shouf Biosphere Reserve and LOST) and municipalities (Ehden and Tannourine)		
Geographical coverage	Planted area (ha)	Source of funding		
Tannourine	Un-confirmed	N.A.		
Ehden	Un-confirmed	N.A.		
Baalbak district (Baalbak, Douris, Iaat, Ansar, Majdaloun, Harbata, Kfarden, Makne) and Zahleh district (Ksarnaba), Sarada, Jaj, and Bsharreh	37 (as a minimum confirmed area)	Different funding sources including the UN World Food Programme (WFP) and the Food and Agriculture Organization (FAO) Smart Adaptation of Forest Landscapes in Mountain Areas (SALMA) project SALMA project		
Niha	10	FAO		
Budget		N.A.		
Timeframe		April 2017 - November 2017		
Goals: The different projects contribute to the 40 million trees programme of the Ministry of Agriculture.				
Achievements or progress		Year	Area (ha)	Yearly CO_2 removal (Gg CO_2eq.)
		2017	A minimum of 47 ha (i.e., estimated 32,900 seedlings)	0.53 Gg CO_2eq.
Methodology		IPCC 2006 Guidelines, IPCC software		
Assumptions		Assuming that each ha of planted land comprised 700 seedlings. Also, assuming the total area of land was successfully planted and maintained.		

<table>
<tr><th colspan="5">LRI reforestation/afforestation projects in 2018</th></tr>
<tr><td colspan="5">General information: A minimum of 5 reforestation/afforestation projects were executed in different areas across Lebanon in partnership with municipalities and the Lebanese Army Forces (LAF). Planted lands were mostly public-municipal and Lebanese Republic lands. Projects were mostly funded by USAID.</td></tr>
<tr><td colspan="2">Implementing agency</td><td colspan="3">Lebanon Reforestation Initiative</td></tr>
<tr><td>Geographical coverage</td><td>Planted area (ha)</td><td colspan="3">Source of funding</td></tr>
<tr><td>Ainata</td><td>0.27</td><td colspan="3">USAID</td></tr>
<tr><td>Ehmej</td><td>0.38</td><td colspan="3">USAID</td></tr>
<tr><td>Majdal Balhis</td><td>3.72</td><td colspan="3">USAID</td></tr>
<tr><td>Mdoukha</td><td>4.66</td><td colspan="3">USAID</td></tr>
<tr><td>Yammoune</td><td>0 (replacement of seedlings)</td><td colspan="3">USAID</td></tr>
<tr><td colspan="2">Budget</td><td colspan="3">N.A.</td></tr>
<tr><td colspan="2">Timeframe</td><td colspan="3">February 2018-March 2018</td></tr>
<tr><td colspan="5">Goals: Within the scope of these projects, LRI plans to increase the woodland area in Lebanon and participate in the restoration of its degraded high mountain ecosystem in close partnership local authorities and community groups.</td></tr>
<tr><td colspan="2" rowspan="2">Achievements or progress</td><td>Year</td><td>Area (ha)</td><td>Yearly CO_2 removal (Gg CO_2eq.)</td></tr>
<tr><td>2018</td><td>A minimum of 9.03 (i.e., estimated 6,321 seedlings)</td><td>0.1 Gg CO_2eq.</td></tr>
<tr><td colspan="2">Methodology</td><td colspan="3">IPCC 2006 Guidelines, IPCC software</td></tr>
<tr><td colspan="2">Assumptions</td><td colspan="3">Assuming that each ha of planted land comprised 700 seedlings. Also, assuming the total area of land was successfully planted and maintained.</td></tr>
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<table>
<tr><th colspan="5">AFDC reforestation/afforestation projects in 2018</th></tr>
<tr><td colspan="5">General information: A minimum of 4 reforestation/afforestation projects were executed in different areas across Lebanon in partnership with municipalities. Planted lands were mostly public-municipal and Lebanese Republic lands. Projects were mostly funded by FAO SALMA project.</td></tr>
<tr><td colspan="2">Implementing agency</td><td colspan="3">Association for Forests, Development and Conservation</td></tr>
<tr><td>Geographical coverage</td><td>Planted area (ha)</td><td colspan="3">Source of funding</td></tr>
<tr><td>Chmistar</td><td>15</td><td colspan="3">FAO-SALMA</td></tr>
<tr><td>Anjar</td><td>10</td><td colspan="3">FAO-SALMA</td></tr>
<tr><td>Bqarsouna</td><td>10</td><td colspan="3">FAO-SALMA</td></tr>
<tr><td>Rmaich</td><td>3.5</td><td colspan="3">N.A.</td></tr>
<tr><td colspan="2">Budget</td><td colspan="3">N.A.</td></tr>
<tr><td colspan="2">Timeframe</td><td colspan="3">February 2018 – April 2018</td></tr>
<tr><td colspan="5">Goals: AFDC contributes to increasing the woodland area in Lebanon and participates in the restoration of its degraded lands in close partnership local authorities and community groups.</td></tr>
<tr><td colspan="2" rowspan="2">Achievements or progress</td><td>Year</td><td>Area (ha)</td><td>Yearly CO_2 removal (Gg CO_2eq.)</td></tr>
<tr><td>2018</td><td>A minimum of 38.5 (i.e., estimated 26,950 seedlings)</td><td>0.43 Gg CO_2eq.</td></tr>
<tr><td colspan="2">Methodology</td><td colspan="3">IPCC 2006 Guidelines, IPCC software</td></tr>
<tr><td colspan="2">Assumptions</td><td colspan="3">Assuming that each ha of planted land comprised 700 seedlings. Also, assuming the total area of land was successfully planted and maintained.</td></tr>
</table>

UNDP is the leading United Nations organization fighting to end the injustice of poverty, inequality, and climate change. Working with our broad network of experts and partners in 170 countries, we help nations to build integrated, lasting solutions for people and planet.