

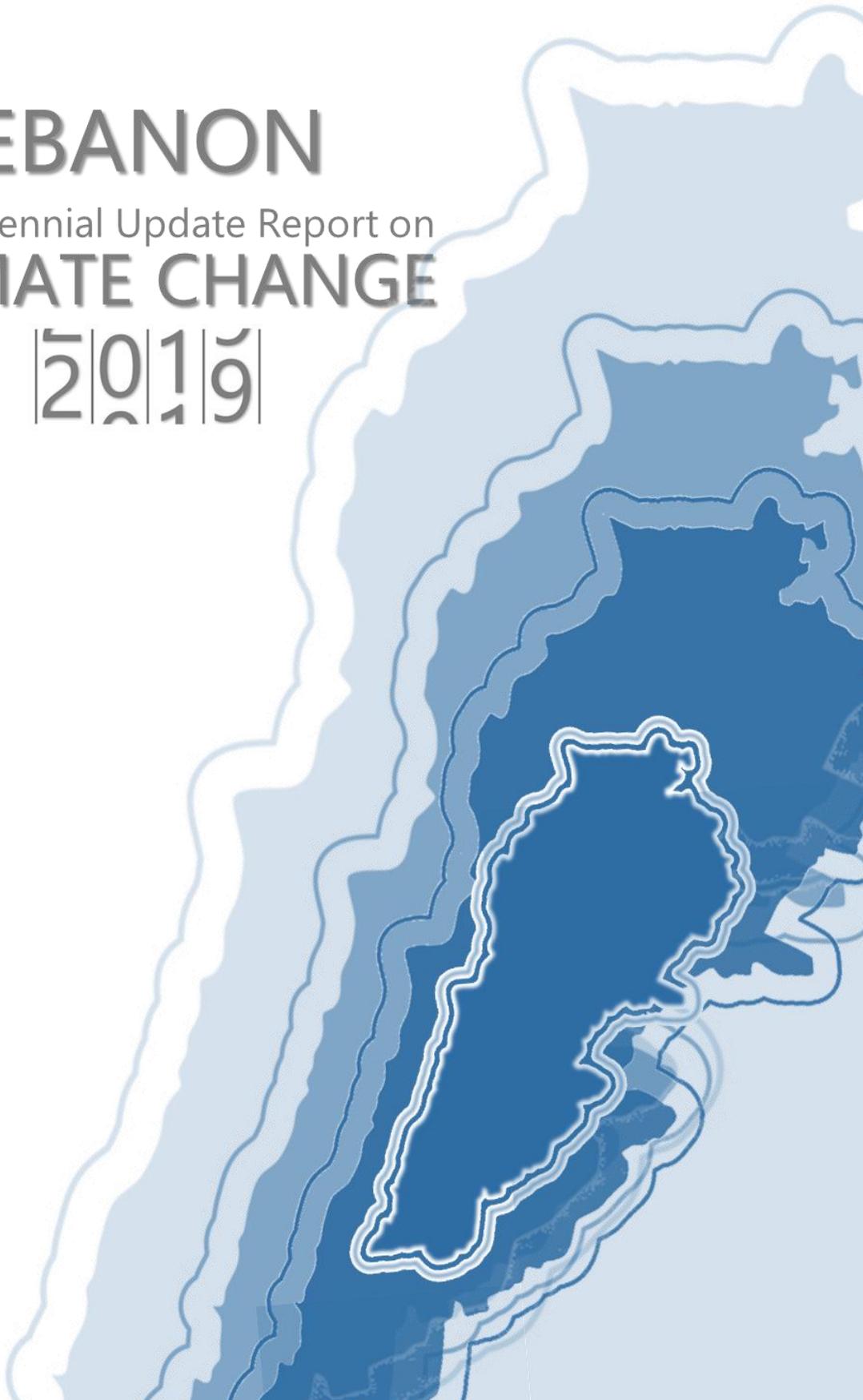


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LEBANON

Third Biennial Update Report on
CLIMATE CHANGE
|2019|

MINISTRY OF
ENVIRONMENT



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Foreword

Since the adoption of the Paris Agreement on climate change in 2015, all nations have been united for the first time to work on ambitious and transparent national climate action plans, that would collectively set the world on the path of low emission development. Leaders of the world, from one UN meeting to another, from one Convention to another, have been drawing linkages between climate change and sustainable development goals on one side, and sustainable social and economic growth on the other.

Lebanon is in a very good position to understand those linkages. Our natural resources are limited, our economy depends on them and our institutions are strained from dealing with crisis response which hindered the continuous focus on sustainable planning. Furthermore, the prevalent regional turmoil since 2011 has been heavily impacting the country's resources, economy and institutions.



During the preparation of the Nationally Determined Contribution (NDC), Lebanon's policymakers had at their disposal unequivocal tools to set national climate change targets: transparent and comprehensive Biennial Update Reports (BUR). Through the Biennial Update Reports, we were able to analyse the mitigation impact of our sectoral policies, to have a multi-stakeholder dialogue on how to measure implementation progress, and to identify our technical, institutional and financial gaps and needs to enhance our coordinated national climate action.

Besides being a national document that tracks linkages between sectoral implementation and climate change mitigation and adaptation and their connection to the Sustainable Development Goals, the BUR is also an international document that informs the global community on our country's take on global climate action. For this, the Ministry of Environment has spent every possible effort to enhance the transparency and comparability of the information contained in its Third Biennial Update Report, guided by the latest work on Modalities, Procedures and Guidelines for the Transparency Framework for Action and Support referred to in Article 13 of the Paris Agreement.

The Ministry of Environment will continue to join efforts with its national and international partners to work towards a low-emission future, bearing in mind that climate change action is an important opportunity to sustain people's livelihoods and well-being. I sincerely hope that Lebanon's Third BUR communicates to international readers how our national climate action is aligned with the commitments we have taken under the Paris Agreement; and supports national policymakers as they plan their next move towards decreasing emissions and increasing resilience.

Fady Jreissati

Minister of Environment

Foreword

Over the last decade, countries have moved towards a new approach to tackle this century's defining challenges, most notably climate change. Global efforts under the Paris Agreement on Climate Change, the Agenda 2030 for sustainable development and the Sendai Framework on Disaster Risk Reduction have been aligned to support an integrated and reinforcing view of sustainable development.

The work of the United Nations Development Programme (UNDP), in partnership with the Government of Lebanon, is aligned with this new vision. In this respect, the preparation of Lebanon's Third Biennial Update Report (BUR) reflects the support of UNDP to the government in mitigating emissions and adapting to the adverse impacts of climate change; while being inclusive, gender-responsive, and focused on the most vulnerable.



Furthermore, the Enhanced Transparency Framework (ETF) under the Paris Agreement has enabled countries to build bridges and launch dialogues between national stakeholders and international partners to better understand the impact of their climate actions. The Ministry of Environment has seized this opportunity to increase its coordination efforts with other relevant ministries and to shed light on the gaps and needs to enhance the country's ambition towards climate action. Lebanon's Third BUR presents the result of this process and outlines Lebanon's planned improvements to comply with the reporting requirements of the Paris Agreement. The BUR has also become an important platform on which reliable national climate data is being gathered and used to drive policy.

We are delighted that the partnership between the UNDP and the Ministry of Environment has helped successfully put Lebanon on the map of climate change transparency. UNDP remains committed to continuing this important work with the Ministry of Environment and other national partners to promote the importance of climate action in meeting Lebanon's Sustainable Development Goals and to support the country in achieving its climate milestones.

Celine Moyroud

UNDP Resident Representative

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Acronyms

AFDC	Association for Forests, Development and Conservation
BRT	Bus Rapid Transit
ACCWAM	Adaptation to Climate Change in the Water Sector in the MENA Region
ACE	Action for Climate Empowerment
AFOLU	Agriculture and Forestry and Other Land Uses
AR	Assessment Report
BDL	Banque Du Liban
BKP	Business Knowledge Platforms
BTR	Biennial Transparency Report
BUR	Biennial Update Report
CA	Conservation Agriculture
CAS	Central Administration of Statistics
CBIT	Capacity Building Initiative on Transparency
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CDR	Council for Development and Reconstruction
CEDAW	Convention on the Elimination of all forms of Discrimination Against Women
CEDRE	Conference Economique pour le Developpement par les Reformes avec les Entreprises
CEDRO	Country Energy Efficiency and Renewable Energy Demonstration Project for the Recovery of Lebanon
CFL	Compact Fluorescent Lamp
CGE	Consultative Group of Experts
CIP	Capital Investment Plan
CMU	Cash Management Unit
CNG	Compressed Natural Gas
CoM	Council of Ministers
CTCN	Climate Technology Center and Network
CVF	Climate Vulnerable Forum
DMFAS	Debt Management and Financial Analysis System
DNA	Designated National Authority
DO	Diesel Oil
DOC	Degradable Organic Carbon
DREG	Decentralized Renewable Energy Power Generation
E/R	Emissions/Removals
ECM	Energy Conservation Measures
EDL	Electricité du Liban
EEWAY	Economic Empowerment of Women And Youth
EF	Emission Factor
EIA	Environmental Impact Assessment
ENS	Energy-Not-Supplied
ETF	Enhanced Transparency Framework
EU	European Union
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
FEV	Fuel-Efficient Vehicles
FOD	First Order Decay
ForFITS	For Future Inland Transport Systems

FSV	Facilitative sharing of views
GAP	Good Agricultural Practices
GBA	Greater Beirut Area
GCF	Green Climate Fund
GDO	Gas Diesel Oil
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIS	Geographic Information System
GIZ	The Deutsche Gesellschaft für Internationale Zusammenarbeit
GL	Guidelines
GoL	Government of Lebanon
GPG	Good Practice Guidance
GSP	Global Support System
GWP	Global Warming Potential
HDV	Heavy-Duty Vehicles
HFO	Heavy Fuel Oil
HPS	High Pressure Sodium
ICA	International Consultation and Analysis
IDAL	Investment Development Authority of Lebanon
IE	Estimated Elsewhere
IFAD	International Fund for Agricultural Development
INC	Initial National Communication
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
IPTEC	IPT Energy Center
KCA	Key Category Analysis
KPI	Key Performance Indicators
LARI	Lebanese Agricultural Research Institute
LCA	Lebanon Climate Act
LCEC	Lebanese Center for Energy Conservation
LDV	Light-Duty Vehicles
LECB	Low Emission Capacity Building Project
LEDS	Low Emission Development Strategy
LEEREFF	Lebanon Energy Efficiency and Renewable Energy Finance Facility
LGIF	Lebanon's Green Investment Facility
LPA	Lebanese Petroleum Administration
LPG	Liquefied Petroleum Gas
LRI	Lebanese Reforestation Initiative
LULUCF	Land Use, Land Use Change and Forestry
MENA	Middle East and North Africa
MEW	Ministry of Energy and Water
MISCA	Management Information System for Climate Action
MMS	Manure Management System
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MoF	Ministry of Finance
MoFA	Ministry of Foreign Affairs

MoI	Ministry of Industry
MoIM	Ministry of Interior and Municipalities
MoPWT	Ministry of Public Works and Transport
MoSA	Ministry of Social Affairs
MoSA	Ministry of Social Affairs
MPG	Modalities, Procedures and Guidelines
MRV	Measuring, Reporting and Verifying
MRVCE	Measuring, Reporting and Verifying Coordinating Entity
MSW	Municipal Solid Waste
N/A	Not Available
NA	Not Applicable
NAMA	Nationally Appropriate Mitigation Action
NAP	National Adaptation Plan
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
NO	Not Occurring
NRP	National Reforestation Plan
ODS	Ozone Depleting Substances
OECD	Organization for Economic Co-operation and development
OMSAR	Office of the Minister of State for administrative Reform
PC	Passenger Cars
PCM	Presidency of the Council of Ministers
PDD	Public Debt Department
POP	Persistent Organic Pollutants
PPP	Public Private Partnership
PRP	Pasture Range and Paddock
PV	Photovoltaics
QA/QC	Quality Assurance/Quality Control
RTPA	Railway and Public Transport Authority
SAVR	Selection of Adaptive Varieties and Rootstocks
SDG	Sustainable Development Goal
SEA	Strategic Environmental Assessment
SECAP	Sustainable Energy and Climate Action Plans
SNC	Second National Communication
SWDS	Solid Waste Disposal sites
SWH	Solar Water Heaters
TACCC	Transparency, Accuracy, Completeness, Comparability and Consistency
TNC	Third National Communication
UN	United Nations
UNCBD	United Nations Convention Biological Diversity

UNCCD	United Nations Convention to Combat Desertification
UNCTAD	United National Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USFS	United States Forest Service
WSA	Whole School Approach
WUI	Wildland-Urban Interface
WWTP	Waste Water Treatment Plan

I. National circumstances

1 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).

In Lebanon, the Ministry of Environment (MoE) is the national focal point for climate change. A climate change team, supported by multilateral funds, works under the Service of Environmental Technology at the Ministry. The mandate of the MoE on climate change includes:

- The preparation of Biennial Update Reports (BURs) and National Communications,
- The preparation, update of Nationally Determined Contributions (NDCs) along with implementation follow up,
- Development and introduction of climate change policy (i.e. Low-Emission Development Strategy (LEDS), financial incentives),
- Follow-up and leading 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.
- Establishing linkages and synergizing work with other international conventions such as the United Nations Convention to Combat Desertification (UNCCD), the UN Convention on Biological Diversity (UNCBD), the Sendai Framework for Disaster Risk Reduction, the Montreal Protocol on Ozone Depleting Substances (ODS) and its Kigali amendments, the Agenda 2030 for Sustainable Development, etc.
- Technical follow up on international climate change negotiations,
- Coordination of regional and international climate change related projects,
- Assuming the role of focal point to the UNFCCC, Green Climate Fund (GCF), Adaptation Fund, Global Environment Facility (GEF), Climate Technology Center & Network (CTCN) and International Panel on Climate Change (IPCC).

No major legislation directly addresses climate change action in Lebanon, nor is mainstreaming of climate change a legislative requirement. However, mainstreaming efforts by the climate change unit at the Ministry of Environment have been successful in several key initiatives (Table 1). In addition, the Environmental Protection Law (no. 444/2002) constitutes an overarching legal instrument for environment protection and management in Lebanon. A number of sectoral regulations (i.e., Air Quality Protection Law 78/2018) address issues that could be linked to climate change. They are mentioned below in relevant sectoral sections.

Table 1: Examples of climate change mainstreaming in sectoral initiatives

Sector/theme	Leading Institutions	Mainstreaming details
The National Strategy for Women in Lebanon 2011-2021	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 behaviours 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 behaviours.
Offshore Petroleum Sector SEA	Lebanese Petroleum Authority	The Government carried out a Strategic Environmental Assessment (SEA) for the Offshore Petroleum Sector in 2012 where it considered different potential development scenarios for the sector. The SEA is currently being updated to take into consideration and abide by Lebanon's NDC targets for 2030.
National Renewable Energy Plan	MoEW	Following the Government's commitments in Copenhagen in 2009 to reach 12% renewable energy by 2020, the National Renewable Energy Plan 2016-2020 sets the individual targets for the different renewable energy technologies needed to reach this target. Its subsequent update(s) will aim and match the Nationally Determined Contribution (NDC) renewable energy target.
Ministry of Agriculture strategy 2015-2019	MoA	Climate change is tackled through Action VIII: Responding to climate change impacts. The proposed measures under this component include: alleviating adverse impacts of climate change on the agriculture sector through introducing adaptation measures; reducing Greenhouse Gas (GHG) emissions from the agriculture sector, conducting studies to estimate greenhouse gas emissions from the agricultural sector, land use changes and forestry.
National cooling plan under Kigali amendments	MoE	The National Cooling Plan for Lebanon is currently being prepared by the National Ozone Unit at the Ministry of Environment. The cooling plan targets the increase in energy demand from cooling services under different climatic scenarios and proposes Minimum Energy Performance measures to reduce demand and consequent GHG emissions. It will also contribute in achieving NDC targets and increasing the mitigation potential of Lebanon.
National Water Sector Strategy (NWSS)	MoEW	Climate change is tackled in the NWSS, which recognizes uncertainties in water availability / supply data due to climate change and emphasizes the need to refine climate change knowledge.
Standard operating procedures to integrate gender into climate change policies, plans and reports	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.

2 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.



Participation of women in decision-making processes is still relatively low, though their representation is increasing. This positive evolution of women's participation in politics has been recently translated into the newly formed government in February 2019 that includes 4 women (ministers of energy and water, interior and municipalities, women's affairs and administrative reforms). At the technical level, ministries and public institutions have nominated gender focal points. Their role is to make sure that gender is taken into consideration in planning processes and policies, identify gaps and obstacles for gender mainstreaming and communicate regularly with other focal points to share experiences and reinforce capacities. A gender focal points unit at the National Commission for Lebanese Women (NCLW), established in 1998 and located under the President of the Republic is responsible for managing and coordinating the network. While the NCLW's main responsibility is to plan women's matters in Lebanon, the Ministry of State for Economic Empowerment of Women and Youth (EEWAY) established in 2016 (formerly Office of the Minister of State for Women's Affairs) has an executive role that includes submitting legislation to parliament. Both institutions may have overlapping mandates and the mandate of EEWAY is being revised to tackle this issue.

A NDC committee was established in 2018 to coordinate the implementation of Lebanon's NDC, including the identification of needs and gaps, reporting, mainstreaming, capacity building and technical support for climate change mitigation. The committee is chaired by the MoE. It currently focuses on the mitigation section of the NDC, since the adaptation sub-committee will be formed as part of the National Adaptation Plan (NAP) consultative process.

A Sustainable Development Goal (SDG) committee was established in June 2017 by the Presidency of the Council of Ministers (PCM) and is chaired by the Prime Minister. It includes 70 members from public institutions (state officials), the civil society and the private sector. Its responsibilities are divided into four main areas (Planet, People, Prosperity and Peace) and a cross-cutting theme for SDG 17 (Partnerships for the Goals). A Task Force for statistics has been established and is in charge for data collection. At the moment, terms of reference are being written for the thematic groups, and a gaps and needs analysis is being conducted. Note that Lebanon submitted its first (VNR, 2018) report in 2018.

With the SDG committee formed, and with the process of updating the country's NDC to be submitted in 2020, a synchronization exercise of both NDC and SDG was conducted with the aim of avoiding duplication of efforts, achieving targeted support requests and enhancing delivery through the identification and formalization of the common entry points for joint NDC and SDG implementation. Under the UNDP Nationally Determined Contribution Support Programme (NDCSP), the linkages between the different mitigation and adaptation policies that make up Lebanon's NDC have been identified, and most of the primary linkages related to non-environment SDGs, further stressing the point that implementing the NDC has economic, social and environmental benefits. Moreover, recommendations for anchoring sustainable development into all NDC sectoral strategies have been identified. In order to act on those recommendations, a technical advisory group is being formed at the institutional level to continue the synchronization work between SDGs and the NDC.

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: 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.
- 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).

Located at the center of one of the most volatile regions of the world, Lebanon has been exposed to numerous security, political and economic shocks since the end of the 1990s. Domestic political tensions and regional geo-political instability have weighed heavily on socio-economic and environmental governance and slowed down institutional efforts and progress (VNR, 2018). Examples include delays in ratifying environmental regulations, lack of synchronisation between institutions for cross cutting policies and plans (different emission factors are used among different institutions), inefficient management of finance (duplication of activities under different donor funded projects) and absence of sound prioritization process.

Finally, eight years into the Syrian crisis, Lebanon remains at the forefront of one of the worst humanitarian crises of our time. The vulnerabilities of the different displaced groups have different root causes, requiring the overall response strategy to include a multifaceted range of interventions, from emergency aid to development assistance. Public services are overstretched with demand exceeding the capacity of institutions and infrastructure to meet needs (LCRP, 2019).

3 Population and social profile

Lebanon's population is estimated to be 5,933,283 in 2015, including foreign workers, Palestinian and Syrian displaced (the latter estimated at 1,069,011) (World Bank, 2019; UNHCR 2015).



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 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 offsprings, unequal rights when it comes to divorce, inheritance or child custody). In addition, the percentage of women in the labor force is very low (26.3%). Also, when working, women earn on average less than men and generally occupy assistant positions. Along with the Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW), the Rio convention, Sendai 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.

4 Geographic and climate profile

Please refer to Lebanon's 2nd BUR.

5 Economic profile

Gross Domestic Product (GDP) has been stalling in the past few years. The real GDP growth dropped from 9.2% for the 2006-2009 period to 1.3% for the 2010-2017 period. The key macroeconomic situation in Lebanon is best described as a "vicious economic cycle" due to pending legislation endorsement, public debt, and reliance on diaspora inflows not channelled into "productive" sectors (McKinsey, 2018).

The Lebanese economy is service oriented with over 78% of GDP generated from services in 2015 (Figure 1). Commerce, tourism and financial services in particular, are the largest contributors- followed by healthcare and higher education. This makes Lebanon dependent on global flows and renders it sensitive to regional and domestic conflicts, which has been evident in the Macro economic trends since the year 2000, with drops in growth rate during years of conflict, followed by high growth in subsequent years, a result of investment in infrastructure (as part of reconstruction efforts) and the return of investor confidence (CIP, 2018) (Figure 2).

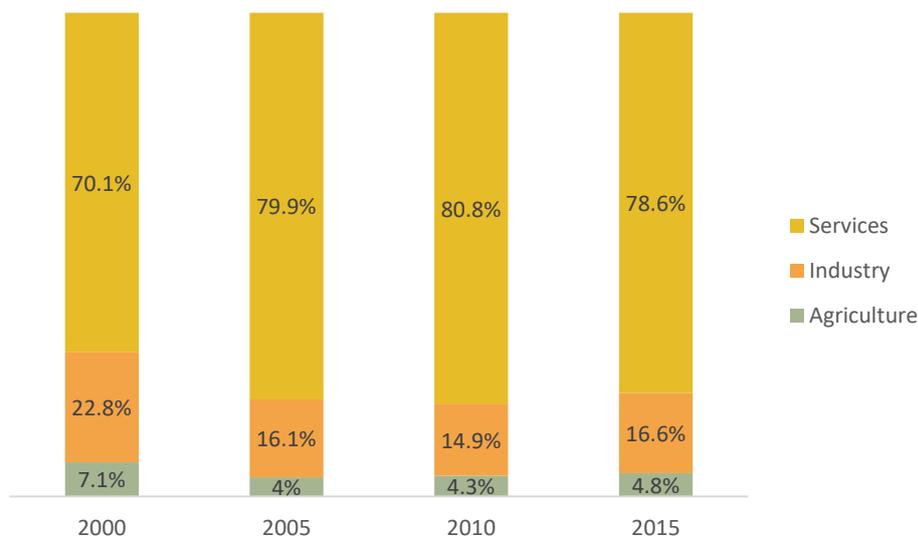


Figure 1: GDP by economic activity, 2000-2015 (CIP, 2018)

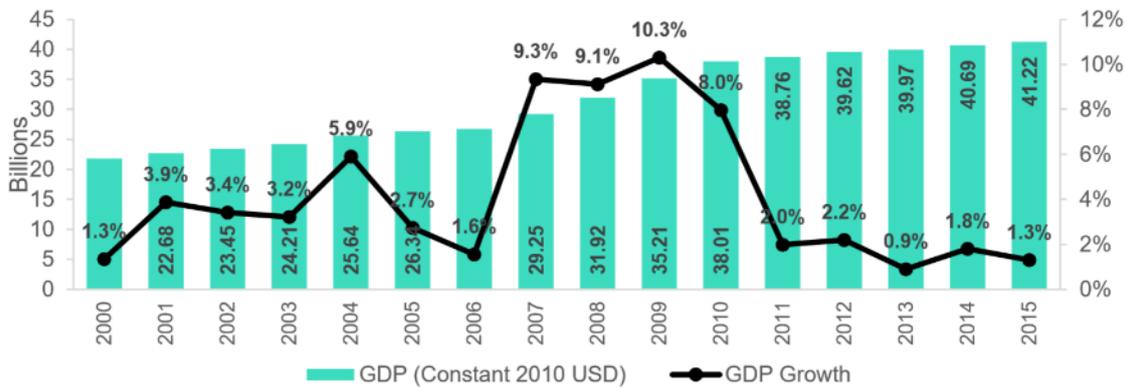


Figure 2: GDP per capita for the period 2000-2015 (CIP, 2018)

The conflict in Syria has significantly impacted Lebanon's social and economic growth, caused deepening poverty and humanitarian needs, and exacerbated pre-existing development constraints in the country. Moreover, at the end of 2015, the crisis had cost the Lebanese economy an estimated USD 18.15 billion due to the economic slowdown, loss in fiscal revenues and additional pressure on public services (LCRP, 2019).

Data on poverty in Lebanon remains limited. The most recent comprehensive study dates back to 2011 (before the full impact of the Syrian Crisis on Lebanon). At the time, poverty in Lebanon was widespread across the country, with overall poverty in Lebanon estimated at 27% (CIP, 2018).

Unemployment and high levels of informal labour were already a serious problem pre-crisis, with the World Bank suggesting that the Lebanese economy would need to create six times as many jobs just to absorb the regular market entrants. Both Lebanese and displaced Syrians perceive that longstanding inequalities are deepening, and competition for jobs and access to resources and services remain drivers of tension at the local level. The economic downturn has had a disproportionate effect on young people entering the workforce: Lebanon's youth unemployment rate is 37 per cent, compared with a 25 per cent national average (LCRP, 2019).

In order to overcome the above economic issues, an "economic vision" (yet to be approved by the Government of Lebanon) has been developed. It entails the following economic targets in 2025: create 370,000 new domestic jobs, reduce unemployment, reduce ratio of public debt to GDP through privatization and deficit reduction, reduce the fiscal deficit via restrained spending and cut subsidies, decrease the time limit for passing legislations (McKinsey, 2018).

6 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. On the other hand, the climate change team is coordinating initiatives on climate change education in the private sector.

Among these initiatives, the implementation of the Whole School Approach (WSA) on SDGs and climate change, led by the Lebanese National Commission for The United Nations Educational, Scientific and Cultural Organization (UNESCO). The WSA to climate change means that an educational institution includes climate change action in every aspect of school life: school governance, teaching content and methodology, campus and facility management as well as cooperation with partners and the broader communities through the active involvement of all internal and external school stakeholders, namely students, teachers, directors, staff and the wider school community such as families and community members. Members of the UNESCO associated schools in Lebanon use The UNESCO's guide for schools on climate action *Getting Climate-Ready* which identifies areas for action to become a climate friendly school to implement the whole school approach.

Furthermore, the Ministry of Environment has issued in 2015 the 'Teacher's Guidebook on Climate Change for Schools in Lebanon'. More details on the teacher's guidebook are available in BUR2. Coordination is underway with the Lebanese National Commission for UNESCO, the Ministry of Education and Higher Education and the Service of Environmental Guidance to update this guidebook and make it available in Arabic, in addition to the already published versions in French and English languages.

Climate change awareness and research in the higher education sector is also expanding. The Notre-Dame University is developing a carbon footprint calculator and related guide applicable to all universities in Lebanon. The American University of Beirut (Beirut POEM project), in collaboration with the Ministry of Environment and UNEP has conducted research on the fuel consumption and related air emissions of the transport sector in Lebanon and private generators (limited to the Beirut area). The University has also initiated a study on the potential of Carbon Capture of Storage in Lebanon through the Baha and Walid Bassatne Department of Chemical Engineering and Advanced Energy. The ESA Business School launched a series of programmes and activities related to climate change awareness and education.

Stakeholders outside the education sphere are also taking private initiatives to educate on climate change, in coordination with the Ministry of Environment. One Bank has developed an online platform called "My Carbon Footprint" where citizens can learn about climate change, how they can help in fighting it, and calculate their carbon footprint from their household and daily activities.

7 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. 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.

A number of Lebanese municipalities have been engaged in climate action through the formulation and implementation of SECAPs. These documents comprise the city's Sustainable Strategy; the Baseline Emission Inventory of its CO₂ emissions; Calculations of targeted CO₂ reductions; Prescribed actions to reach this target, including well described actions. In an effort to extend climate change support to local authorities, the Ministry of Environment is in the process of exerting efforts to establish a support unit with the aim of providing technical assistance to local authorities in the formulation and implementation of climate mitigation and adaptation plans and actions, through their Sustainable Energy and Climate Action Plans (SECAP).

8 Health

A study on economic costs of climate change in Lebanon revealed that potential impacts on human health pose a great risk. Costs associated with potential increases in the risk of death—from heat stress, malnutrition, diarrhea, malaria, floods, and cardiovascular disease—total USD 54,700 million by 2040. Costs associated with potential increases in illness and disability—from the same climate-related factors—total USD 194,300 million.



Climate change has a direct impact on population's health and that women are more vulnerable because of physiological, behavioural and socially constructed influences. In Lebanon, only formal labour gives access to health coverage. Thus, when women do not work, they do not have health coverage of their own. Instead, they are included under their working husband's social protection scheme (if they have a formal employment) and are dependent on their husband (or parents) to access health services.

9 Water

At a glance	<p>8,600 million m³ of rainfall and snow per year 2,700 million m³ net exploitable water resources 40 major streams and rivers (17 of which are perennial) and more than 2,000 springs with a total yield of 1,200 million m³ in an average year, and less than 200 million m³ available during the dry summer months 43,000 private wells are used for potable water and agriculture 2 dams (Qaraoun and Chabrouh) with a total capacity of 235 million m³ 2,500 km² as average annual snow cover exceeds, equivalent to 25% of the territory 40% to 50% of water for the replenishment of rivers comes from snow melting 839 m³/capita/year water resources available 61% of water consumer for irrigation</p>
Key legislation	<p>National Water sector strategy, 2010 Nationally Determined Contribution, 2015 Water Code, 2018</p>
Gender analysis	<p>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</p>
SDG linkages	<p>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</p>

10 Energy

At a glance	<p>1 Power utility: Electricité du Liban 7 Thermal power plants - 3 operate on Heavy Fuel Oil, 4 on Gas Diesel Oil 96% of electricity generated through thermal power plants in 2015 4% of electricity generated through hydropower in 2015 282 MW of installed capacity hydropower – 480 GWh produced in 2015 12,237 GWh electricity supply in 2015 20,368 GWh electricity demand in 2015 8,131 GWh gap between supply and demand 220 MW capacity from three wind farms, PPA signed in 2018, generation to start by 2021</p> <p>Please refer to Lebanon's 2nd BUR for comprehensive details.</p>
Private generators in Lebanon	<p>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 neighborhoods, 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.</p>
Key legislation	<p>Law 462/2002 - Organization of the Electricity Sector Law 132/2010 - Offshore Petroleum Resources Law Law 288/2014 - License Independent Power Producers Banque Du Liban Circular No. 236 of 2010 to set the conditions of requests for green loans under NEEREA Policy Paper for the electricity sector 2010 Nationally Determined Contribution, 2015 Policy Paper for the Electricity sector 2019 National renewable energy action plan 2016-2020 National Energy efficiency Action Plan 2016-2020</p>
Gender analysis 	<p>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.</p>
SDG linkages	<p>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</p> <p>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</p>

11 Transport

At a glance	<p>1,750,000 vehicles registered in 2015 65% of the cars registered in 2015 are new cars- 35% are used cars % of passenger cars register in 2015 % increase in car fleet for the period 19 years average age vehicle fleet 15% of household income spent on transport 85% of car dependency 50% of trips have a distance lower than 5 km 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 Please refer to Lebanon's 2nd BUR for comprehensive details.</p>
Key legislation	<p>Law 341 (6/08/2001) 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 The master plan land public transport for passengers, 2014 Nationally Determined Contribution, 2015 Article 55 of budget Law 79/2018 and article 25.c of budget law 144/2019 on tax incentives for hybrid and electric cars</p>
SDG linkages	<p>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</p>

12 Industry

At a glance	<p>7.2% of the country's GDP in 2011 No update of industrial census since 2007 50% of industrial activity concentrated at level 3 manufacturing sections (food and beverages, non-metallic mineral products, electrical machinery) Not very diversified: 90% of industries operating in 9 major sectors (food and beverages, non-metallic mineral products, electrical machinery, furniture manufacturing, fabricated metal products, chemicals and chemical products, printing and publishing, paper, rubber and plastic) Highest sectors in terms of export: food and beverages, non-metallic mineral products, electrical machinery, fabricated metal products, chemicals and chemical products, 50% of industries in Mount Lebanon and 18% in Bekaa Between 150 and 163 Mm³ per year of water consumed, around 11% of annual water demand, expected to reach 16% by 2030 Around 20% of wastewater in the country Please refer to Lebanon's 2nd BUR for comprehensive details.</p>
Key legislation	<p>Lebanon Industry 2025: The integrated vision of the Industrial Sector in Lebanon Lebanon SME strategy Environmental Compliance Decree 8471/2012 and its related decisions (202/1, 203/1 and 271/1 - 2013) Policy paper and action plan for industrial waste water management in Lebanon (2013)</p>
SDG linkages	<p>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</p>

13 Waste and wastewater

At a glance	<p>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 60% of wastewater discharged in the sea without treatment 40% of wastewater discharged in septic tanks without treatment 15.7% incremental annual solid waste generated by Syrian displaced 8-14% increase in wastewater generation from Syrian displaced Please refer to Lebanon's 2nd BUR for comprehensive details.</p>
Key legislation	<p>Roadmap of the Integrated Solid Waste Management (CoM decision number 3-27/8/2019) Law 80/2018 for the Integrated Solid Waste Management Decree 5606/2019 Hazardous Waste Management Decree Sorting at Source Decree, approved in CoM decision number 3, 27 Aug 2019 to encourage municipalities to implement sorting at source National Water Sector Strategy (2012) Nationally Determined Contribution, 2015</p>
Waste crisis of 2015	<p>In June 2015, after 17 years of receiving and treating half the country's municipal solid waste, the biggest waste landfill in Lebanon, the Naameh landfill, ceased its operations due to capacity issues and public oppositions. When no contingency plan succeeded, all the waste generated by Mount Lebanon was collected and dumped in valleys, riversides and open dumpsites across the country. Due to the lack of an immediate solution and the severity of the crisis, the landfill was re-opened temporarily in 2016 until it was shut down after 60 days due to heavy complaints from nearby residents. The government then decided to build 2 temporary landfills (4 years of life) in the Southern (Costa Brava) and Northern (Bourj Hammoud) regions of Beirut.</p>
Gender analysis 	<p>The Policy Summary on Integrated Solid Waste Management includes the participation of the EEWAY in the committee chaired by the MoE to oversee the realization of the policy. However, 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.</p>
SDG linkages	<p>SDG 12: Responsible Consumption and Production</p> <p>Contributes to reducing waste generation through prevention, reduction, recycling and reuse</p> <p>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</p>

14 Agriculture

At a glance	<p>4% of Lebanon's GDP in 2011 80% of rural areas' GDP 62% of Lebanon's total surface area 20% of domestic consumption satisfied by local production 70% of available water in Lebanon used for agriculture Please refer to Lebanon's 2nd BUR for comprehensive details.</p>
Key legislation	<p>Ministry of Agriculture Strategy 2015 – 2019 Nationally Determined Contribution, 2015</p>
Gender analysis 	<p>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 analyze what role women can play in adaptation actions to climate change.</p>
SDG linkages	<p>SDG 2: Zero Hunger Ensuring sustainable food production systems improves food security</p>

15 Forestry and other land use

At a glance	<p>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 have 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</p>
Key legislation	<p>National Forest Plan (NFP) to promote the increase in forest cover by 40 million trees by 2020 Lebanon's National strategy for forest fire management.</p>
Gender analysis 	<p>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.</p>
SDG linkages	<p>SDG 15: Life on Land Implementation of sustainable management of forest management to prevent fires and subsequent deforestation</p>

II. The national greenhouse gas inventory of 2015

1 The preparation process of the national Greenhouse Gas inventory

1.1 Introduction

Lebanon has produced three National Communications (NC) (submitted in 1999, 2011 and 2016) and two Biennial Update Reports (BUR), submitted in 2015 and 2017, each containing a national Greenhouse Gas (GHG) inventory. The last GHG inventory, reported as part of Lebanon's 2nd BUR, covers a time series from 1994-2013 and was compiled using the Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories. The inventory in the current BUR extends the time series analysis to 2015 and uses for the first time the 2006 IPCC Guidelines. The inventory was compiled using the IPCC software version 2.54.

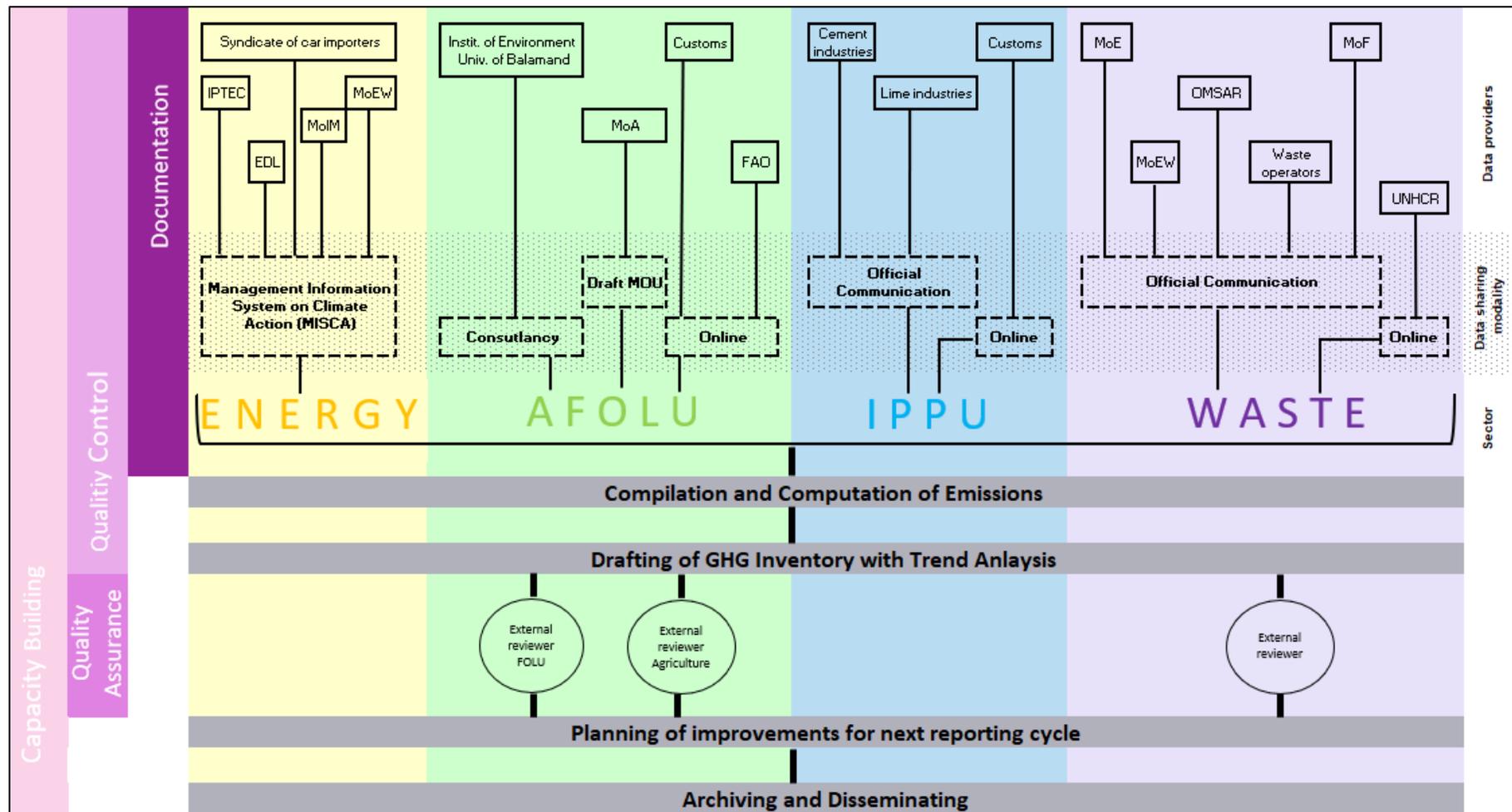
1.2 Cycle and institutional arrangements

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. Although the current BUR is being submitted in October 2019, the completion of administrative procedures to access the GEF fund dedicated to the project was completed in June 2019 due to delays in issuance of grant approval Decree, which has put the team on a very tight deadline.

The BUR and GHG inventory team consists of two members, of which one has been involved in the compilation of the GHG inventories submitted in 2011, 2015, 2016 and 2017 and the other in the 2015, 2016, 2017 inventories. Both staff members are working on other climate-related topics, i.e. are not devoted to GHG inventory compilation full time. Both experts have a good understanding of the IPCC methodologies, and one of the experts has served as a UNFCCC reviewer for National GHG Inventories (Energy Sector) and has participated in a number of reviews, including as lead reviewer.

Previous GHG inventory compilation cycles were supported by consultants, e.g. for data collection, results analysis and drafting of GHG inventory chapters. The present inventory has been completely compiled in-house, using external international and national reviewers for quality assurance only. Despite the extensive involvement of the BUR/NC compilation team, consultants' previous work was not always sufficiently documented to be able to build on the findings in consequent GHG inventory cycles. This situation compromised: 1) the time efficiency of updating GHG inventories for a few years, as a lot of efforts are deployed to find the sources of data and the right contact persons, 2) the accuracy of some figures as the efforts to replicate approaches used by consultants were not always successful, hence the need to use expert judgement or extrapolation methodologies. This situation is gradually improving as GHG inventory compilation activities are being taken up by the Ministry of Environment - Climate Change Office, and as the latter has initiated several data sharing agreements 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 3: GHG Inventory preparation process for the inventory of 2015

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.

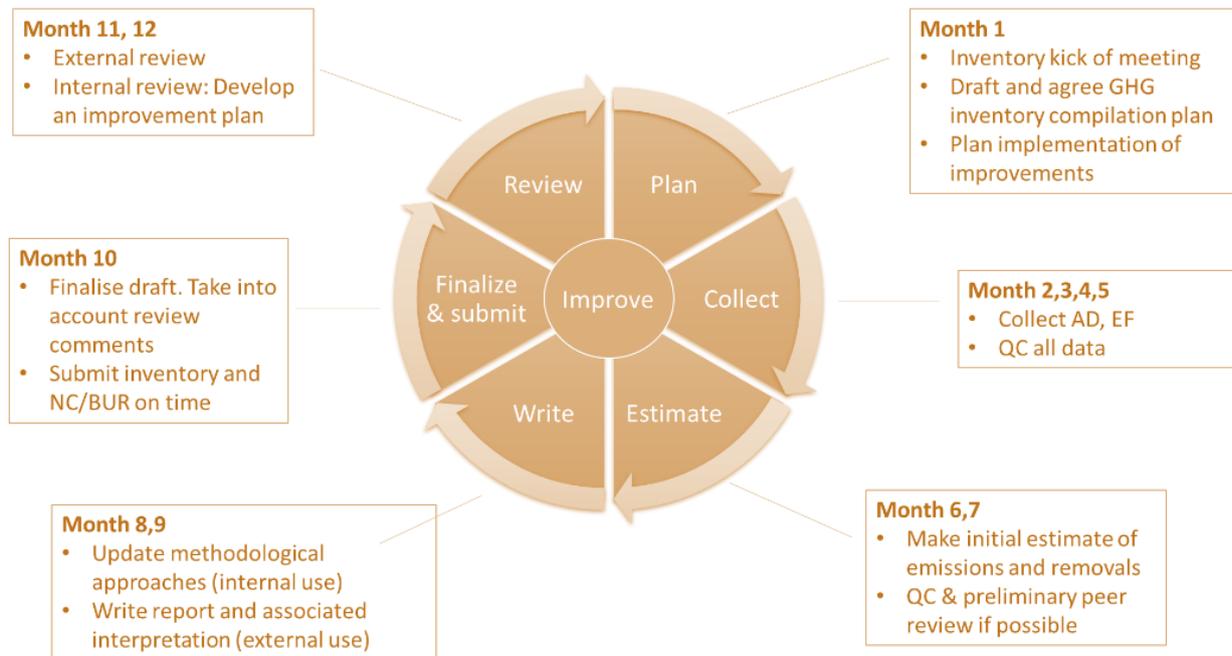


Figure 4: Suggested GHG inventory cycle for Lebanon

Figure 4 summarizes the institutional interactions in place to collect, verify and input data. For the first time during the compilation of a GHG inventory, appropriate and comprehensive data collection templates were established and adopted upstream (more details in section 1.3 below) and data sharing agreements with data providers were initiated.

Data sharing modality for the energy sector: The Management of Information System for Climate Action (MISCA)

A pilot information management system has been established in 2017 to facilitate the sharing of activity data between the inventory compilation team at the Ministry of Environment and different experts at the Ministry of Energy and Water. The Management of Information System for Climate Action (MISCA) has been developed based on the 2006 IPCC guidelines where activity data, emission factors and other energy-related parameters are entered as input and GHG emissions (using both the reference and sectoral approach), indirect emissions and emission trends are computed and published as outputs. All calculations are based on tier 1 methodology, with fuel-specific Net Calorific Values (NCV).

The system includes different level of users, who are the operators within the platform. They are category-related with different rights within each category: the *super administrator* is responsible for entering emission factors and parameters and has the permission to access and edit all worksheets; the *data entry operator* is responsible for entering the activity data; the *data validation operator* is in

charge of QA/QC; and the *data release operator* is a high-level official in charge of releasing the data. The system is composed of "grids", which are the working units within the platform and based on which the calculation is done. Sessions are opened every year (around April) and include a new cycle of data entry, data validation and data calculation for all grids for a specific year.

The system is currently hosted on a cloud but will eventually be transferred to the servers of the Ministry of Environment. MISCA has only been developed for the energy sector so far with the aim to expand it to include other IPCC sectors and national partners relevant to them. In addition, MISCA has a key function related to tracking implementation of mitigation actions and Lebanon's Nationally Determined Contribution (NDC). A memorandum of understanding has been developed to institutionalize the sharing of data, and accordingly, training sessions and one-on-one mentoring sessions have been organized to build the capacity of the different users to use the system.

MISCA has been tested using information of the energy GHG inventory for the year 2015. Concurrently, emission calculation has also been performed using the IPCC software to validate the results and identify bugs and errors in the pilot version of MISCA. A list of improvements to be made to MISCA is being compiled in order to operationalize this platform as soon as possible.

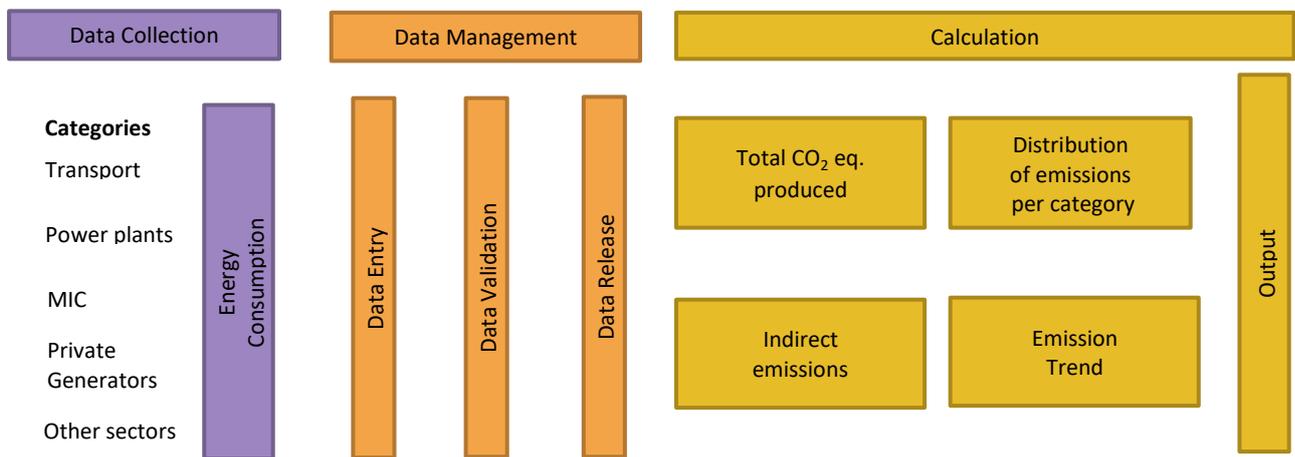


Figure 5: Energy Sector Management Information System

The screenshot displays the 'OUTPUT' section of the GHG Emissions Data Management system. The table lists emissions data for various sources from 2011 to 2012. The columns include Year, Grid, Typology, and emissions for CO₂, CH₄, NO₂, GHG, CO, NO_x, NMVOC, and SO₂, along with an Action column. The data is as follows:

Year	Grid	Typology	CO ₂ (in ton CO ₂)	CH ₄ (in ton CO ₂ eq)	NO ₂ (in ton CO ₂ eq)	GHG (in ton CO ₂ eq)	CO (in Kg)	NO _x (in Kg)	NMVOC (in Kg)	SO ₂ (in Kg)	Action
2012	Private Generators	produced	4,230.177	7,386	10,730	4,248.293	872	8,584	288	26,099	[Grid] [Print] [Delete]
2012	Reference Approach	produced	20,642.261	0	0	20,642.261	0	0	0	0	[Grid] [Print] [Delete]
2012	Transport	produced	6,634.224	33,795	17,732	6,685.751	623,876	61,167	117,225	6,196	[Grid] [Print] [Delete]
2012	Residential, Commercial, Institutional	produced	3,052.023	905	8,018	3,060,946	862	4,311	216	14,982	[Grid] [Print] [Delete]
2012	Agriculture/Forestry/Fisheries	produced	244.201	699	619	245.520	67	333	17	1,505	[Grid] [Print] [Delete]
2012	International Bunkers	produced	737.541	0	0	737.541	0	0	0	0	[Grid] [Print] [Delete]
2012	Power Plants	produced	6,963.240	5,880	17,360	6,986.479	1,400	18,666	467	61,378	[Grid] [Print] [Delete]
2012	Industries	produced	3,391.006	1,856	8,220	3,401.082	442	8,839	221	22,584	[Grid] [Print] [Delete]
2011	Transport	produced	6,001.759	0	0	6,001.759	0	0	0	0	[Grid] [Print] [Delete]
2011	Industries	produced	2,675.098	1,372	6,075	2,682.545	327	6,533	163	18,906	[Grid] [Print] [Delete]

Figure 6: Example of calculation of emissions from the energy sector using MISCA

1.3 Archiving and dissemination

During the preparation of BUR3, a structured documentation and archiving approach in the form of a standardized documentation template and clear responsibilities for archiving of methodologies and data, consultant's reports, expert judgements has been established and adopted for the first time. In previous compilation cycles, data sources and assumptions were documented in Word documents by the team. Team members used different formats and not all information was systematically and comprehensively captured.

The new documentation templates are based on excel workbook, all computed/generated numbers and equations can be traced. For each category workbook, the following information are filled:

- Category information sheet: name and IPCC code of category/subcategory, key category (yes/no, gas), tier level used, category description and definition (what are the processes that cause emissions).
- Methodology sheet: GHG calculated, equations used (for emissions, emission factor calculation, parameter calculations, etc.), reference of methodology used, explanations on choice of methodology and its known limitations.
- Activity data sheet: type of activity data, unit, date of provision, source of provision, contact details, basis for data provision (official correspondence, personal communication, published material, online website, etc.), geographic coverage of activity data, adjustments applied to activity data (examples: adding imported beef to national beef population, conversion in units of lubricants or paraffin wax, etc.), assumptions in activity data (example: it assumed that all imported/produced material is used in the year of import/production), disaggregated activity data time series adopted in previous BUR, disaggregated activity data time series adopted in current BUR.
- Emission factors sheet: gas, type of emission factor, unit, description of appropriateness to national circumstances, time series covered by emission factor, reference, date of provision, contact details, additional comments, emission factor values adopted in previous BUR, emission factor values adopted in current BUR.
- Parameters sheet: same type of information as emission factor sheet, adapted for parameters.
- Recalculations sheet: years that have been recalculated, value that has been recalculated (activity data, emission factor, or parameter), description of changes between previous BUR and current BUR.

Additional steps in subsequent reporting rounds will be undertaken covering: specific QC of activity data, QC of emission factors, general QC measures.

Specific data collection templates for the waste sector were also developed as a result of extensive consultations with the Service of Urban Environment at the MoE. Lebanon has been gradually moving towards the organization of the solid waste sector, with the MoE being the main mandated institution for the management and monitoring of the sector. These templates serve both the Service of Urban Environment to centralize and standardize their national data collection, and the GHG inventory compilation team since data is collected following the IPCC methodology categories.

1.4 Quality Assurance (QA), Quality Control (QC)

The emission estimates are based on the activity data, emission factors and parameters following the recommendations and QA/QC procedures of IPCC 2006 GL.

The adoption of the standardized documentation sheets upstream allowed a significant improvement in the implementation of Quality Assurance (QA) and Quality Control (QC) measures in the present BUR in terms of tracking methodological changes, data sources, assumptions, necessary improvements and recalculations. For the first time, a written plan was developed in advance, QC roles and responsibilities were clearly allocated, both general and category-specific QC measures were defined and applied, sectoral QA was undertaken, outcomes of QA/QC were documented. A timeline was also defined upstream, but it was compromised due to the various delays mentioned in section 1.2 (cycle and institutional arrangements). This is a significant improvement from previous GHG inventory cycles where quality control measures were not undertaken in a systematic way. Quality assurance for all previously published GHG inventories 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. It is the aim of the inventory team of experts to maintain this balance in subsequent inventories and enable continuous improvement of Transparency, Accuracy, Completeness, Comparability and Consistency of inventory estimates.

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 CO₂, CH₄ and N₂O 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 2: List of general QC procedures applied to BUR3

QC Activity	Procedures
Collection, input and computation of data	
Transcription errors between data input and reference	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Reproduce a representative sample of emissions/removals calculations • Record the work done and the findings. Record any improvements identified
Units and conversion factors	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	
	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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 3: List of category specific QC procedures applied to BUR3

QC Activity	Procedures
Emission factors	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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 immediate improvements were applied before submission of the BUR to the UNFCCC. 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 BUR3.

Box 1: Quality Assurance through external reviewers (AFOLU and Waste sectors) undertaken for BUR3

- Performed initial checks to determine the completeness of data.
- Examined procedures and methodologies used from the collection of data to the reported emission estimates (double counting, completeness of years and sources/sinks, key category analysis, QC procedures, assumptions, units, recalculations, etc.).
- Assessed the quality and reliability of the methodology in accordance to established guidelines.
- Detected anomalies/mistakes in activity data.
- Assessed reliability of emission factors used.
- Reviewing documentation sheets and ensure they successfully tackle the 5 principles of GHG inventories: Transparency, Accuracy, Completeness, Comparability and Consistency (TACCC).
- Reviewing the IPCC software (version 2.54) and making sure it is in conformity with the documentation sheets. This includes, but not limited to, double checking the correct use of notation keys.
- Validated time series consistency and compared with data from previous submissions.
- Identified areas for further improvement and noted possible ways for improving the estimation and the reporting of inventory information.
- Reviewing the narrative chapters of Lebanon's 3rd BUR and ensuring that they reflect the extent to which the TACCC principles were considered in the compilation of the GHG inventory.
- Ensuring that changes resulting from recalculations are clear and well documented.

1.5 Uncertainty analysis

As in previous GHG inventories, no uncertainty analysis has been carried out in Lebanon's BUR3 due to the lack of relevant information to facilitate the uncertainty estimation. Lebanon is trying to improve its transparency in reporting and is aiming to collect required information to complete its uncertainty analysis in subsequent reports. The IPCC model used by the team to compile the inventory consists of a simple and accessible methodology to perform the uncertainty analysis. The team was short on time to get fully acquainted with the tool before the submission deadline for BUR3. However, the team is planning to use the tool for the next inventory.

1.6 Capacity building

Since the process of the preparation of the GHG inventory is moving towards an enhanced institutionalization, the GHG inventory team has been focused on building the capacities of all parties involved in data collection, quality control, compilation and computation, documentation and archiving, and dissemination. This line of action also includes participation of Lebanon's GHG inventory in regional and international workshops for experience sharing and exchange of lessons learned.

This section details all capacity building activities undertaken since the submission of Lebanon's second BUR in preparation for the submission of BUR3.

Ministry of Environment

GHG Inventory team

In anticipation to the adoption of the 2006 IPCC GL, the GHG inventory team members and sectoral data providers have undergone general and sector specific trainings on the use of the guidelines.

Table 4: Trainings on GHG inventories and the use of 2006 IPCC guidelines

Training/ workshop	Number of people trained	Date and location	Organizer	Funder
Workshop on the Building of Sustainable National GHG Inventory Management Systems, and the Use of the 2006 IPCC Guidelines for National GHG Inventories for the Asia-Pacific and the Eastern Europe Regions	1	August 2018 – Beijing, China	UNFCCC	UNFCCC
	1	September 2019 – Male, Maldives	UNFCCC	UNFCCC
501 IPCC: Introduction to Cross-Cutting Issues 531 IPCC: Agriculture	1	December 2018 –online	GHGMI	UNDP - GSP
501 IPCC: Introduction to Cross-Cutting Issues 551 IPCC: Waste	1	June 2018 – online	GHGMI	UNDP - GSP
Total number of people trained				4

Air Quality Unit

The Service of Environmental Technology at the Ministry of Environment is looking into linking data collection and reporting processes for air quality, Persistent Organic Pollutants (POPs) and GHG. Therefore, MoE staff from the Air Quality Unit (AQU) were also trained on GHG inventory processes and methodologies. The approach to building the capacities of the AQU was twofold: (1) national and international conventional training workshops (Table 5); (2) mentoring of staff members through involving them in data collection, compilation and documentation (Table 6). Through the second approach, staff members were exposed to activity data requirements, methodologies used, the concept of documentation for GHG inventories, and most importantly, the types of challenges and gaps that need to be tackled to improve national GHG inventories.

Table 5: Trainings on GHG inventories and the use of 2006 IPCC guidelines for MoE staff since the submission of Lebanon's 2nd BUR

Training/ workshop	Number of people trained	Date and location	Organizer	Funder
Air Quality Unit GHG inventory introductory training workshop	5	February 2018 – Beirut, Lebanon	GIZ – MoE/UN DP	GIZ – information matters
2018 UNFCCC-GIR-CASTT Programme on Greenhouse Gases	1	July 2018 – Seoul, Korea	UNFCCC - GIR	UNFCCC GIZ - PATPA
2018 training programme for greenhouse gas inventory review experts – IPPU sector	1	October 2018 – online and Bonn, Germany	UNFCCC	UNFCCC
Total number of people trained		7		

Table 6: Joint working sessions between the GHG inventory team and the AQU team

Topic	Date
Energy - Energy industries	February 5, 2018
Energy - MIC	April 12, 2018
Energy – Other sectors (i.e., residential, commercial, institutional and AFF)	May 2, 2018
Energy – Transport	October 22 2018
Agriculture – Enteric fermentation and manure management	November 6 2018
Agriculture – Agricultural soils	January 14 2019

Service of Urban Environment

The Service of Urban Environment is the main source of data for the solid waste sector in Lebanon. It is therefore crucial for the staff of the Service to be aware of data needed for the GHG inventory, and of the linkages between the preparation of GHG inventories and annual solid waste management reports. Therefore, a training workshop tailored specifically to the staff of the Service was organized at the MoE (Table 7).

Table 7: Training workshop on waste GHG inventory for the Service of Urban Environment at the MoE

Training/ workshop	Number of people trained	Date and location	Organizer	Funder
Workshop on greenhouse gas inventory methodologies and data for the waste sector	9	February 2018 – Beirut, Lebanon	GIZ – MoE/UN DP	GIZ – information matters

Other stakeholders

As reflected previously, several institutions are involved in the different phases of the preparation of the national GHG inventory. Each partner was trained depending on their role in the process. The list of trainings undertaken by the different stakeholders between the submission of Lebanon's 2nd BUR and BUR3 is presented in Table 8.

Table 8: Capacity building activities on GHG inventories for national partners outside the Ministry of Environment since the submission of Lebanon's 2nd BUR

Training/ workshop	Institution	Number of people trained	Date and location	Organizer	Funder
501 IPCC: Introduction to Cross-Cutting Issues 511 IPCC: Energy	Energy expert	1	December 2017 – online	GHGMI	UNDP - GSP
Training on Management and Information System for Climate Action (MISCA)	MoEW EDL LCEC	10	January 2018 – Beirut, Lebanon	EU ClimaSouth – MoE/UNDP	EU ClimaSouth
Workshop on greenhouse gas inventory methodologies and data for the Agriculture sector	MoA LARI	15	February 2018 – Beirut, Lebanon	GIZ – MoE/UNDP	GIZ – information matters
Workshop on greenhouse gas inventory methodologies and data for the Energy sector	MoEW EDL LCEC	11	February 2018 – Beirut, Lebanon	GIZ – MoE/UNDP	GIZ – information matters
Implementation of an Enhanced Transparency Framework in Armenia and Lebanon A South-South exchange platform	MoEW MoA MoE Academic sector	12	September 2018- Beirut Lebanon	UNEP- UNDP GSP	UNEP-UNDP GSP

2 General greenhouse gas inventory overview

2.1 Methodology

The inventory of Greenhouse Gas (GHG) emissions in this report covers the year 2015, with a recalculated time series for 1994-2014. The inventory was prepared based on the 2006 IPCC Guidelines, and using the IPCC software version 2.54, including analysis of key categories 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 (CO₂), Methane (CH₄), Nitrous Oxide (N₂O) were estimated and reported in Gg CO₂ equivalent (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, road transport (for CH₄ and N₂O) and solid waste disposal on land 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.

In order to allow the aggregation and total overview of national emissions, emissions of CH₄ and N₂O were converted to CO₂ 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.

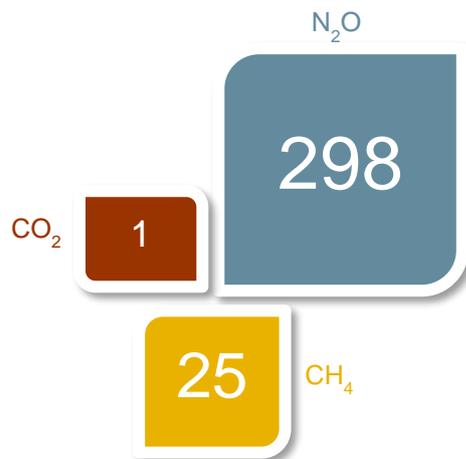


Figure 7: Global Warming Potential (IPCC AR5)

Since 1994, Lebanon has prepared its national GHG inventories using the Revised 1996 IPCC Guidelines on the Preparation of National GHG Inventories. In the Second and Third National Communications and the First and Second Biennial Update Reports, the 2000 Good Practice Guidance and the 2003 Good Practice Guidance for Land Use Land Use Change and Forestry (LULUCF) have been used to improve the preparation of the annual inventories. The adoption of the 2006 IPCC guidelines in BUR3 for the first time carries with it diverse changes in methodologies, assumptions, emission factors and other parameters that influences Lebanon's inventory, thus requiring the recalculation of the whole series for all sectors and sub-sectors. The main changes between the two methodologies and the related impact on Lebanon's inventory are presented in subsequent sections.

2.2 Results

In 2015, Lebanon emitted 27,107 Gg CO₂eq. (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 85% of GHG emissions, followed by industrial processes (8%). CO₂ removals from forestry and land use change amounted to -3,311 Gg CO₂, bringing Lebanon's NET emissions to 23,796 Gg CO₂eq.

Lebanon's GHG Inventory 2015

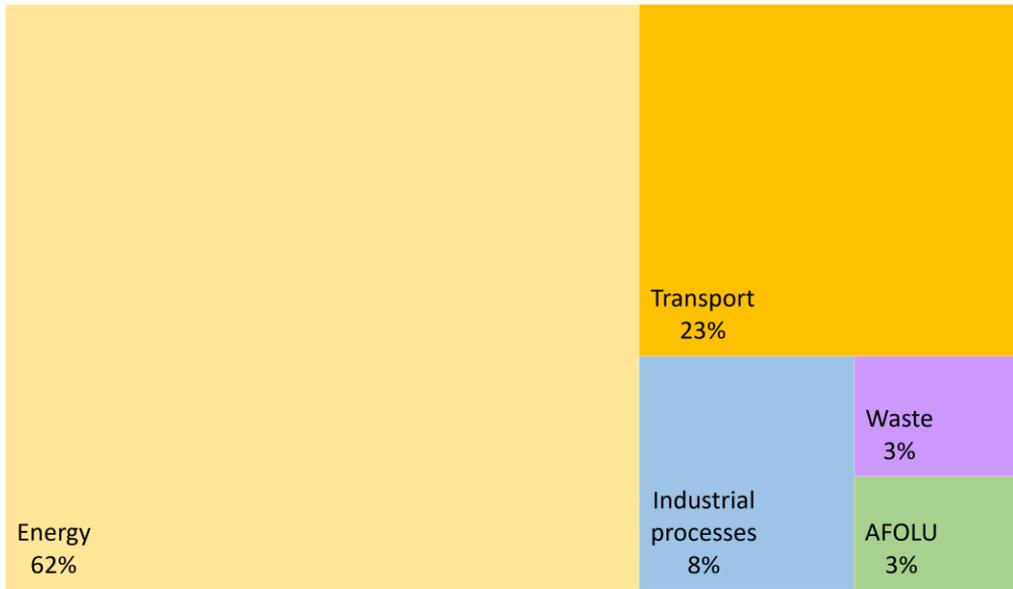


Figure 8: Lebanon's national greenhouse gas inventory by category in 2015

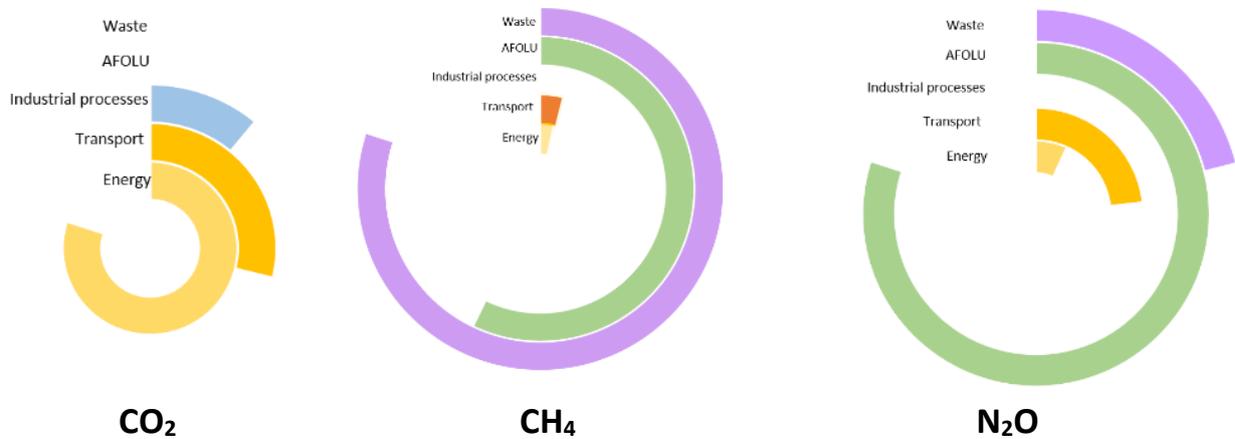


Figure 9: Lebanon's national greenhouse gas inventory by gas in 2015

Table 9: Lebanon's GHG emissions and removals for 2015 per gas and category

Greenhouse gas source and sink categories	CO ₂ emissions/removals Gg	CH ₄	N ₂ O	CH ₄	N ₂ O	Total emissions Gg CO ₂ eq	Net emissions Gg CO ₂ eq
		Gg	Gg	Gg CO ₂ eq.	Gg CO ₂ eq.		
Total National Emissions and Removals	21,805.42	47.35	2.51	1325.87	664.98	27,107.66	23,796.28
1 - Energy	22,803.26	2.22	0.56	62.07	147.38	23,012.71	23,012.71
1.A - Fuel Combustion Activities	22,803.26	2.22	0.56	62.07	147.38	23,012.71	23,012.71
1.A.1 - Energy Industries	8,338.84	0.33	0.07	9.25	17.51	8,365.60	8,365.60
1.A.2 - Manufacturing Industries and Construction	4,549.46	0.17	0.03	4.71	8.88	4,563.05	4,563.05
1.A.3 - Transport	5,999.98	1.18	0.43	32.99	113.65	6,146.61	6,146.61
1.A.4 - Other Sectors	3,914.98	0.54	0.03	15.12	7.34	3,937.44	3,937.44
2 - Industrial Processes and Product Use	2,284.35	0.00	0.00	0.00	0.00	2,284.35	2,284.35
2.A - Mineral Industry	2,283.49	NA	NA	NA	NA	2,283.49	2,283.49
2.A.1 - Cement production	2,276.35	NA	NA	NA	NA	2,276.36	2,276.36
2.A.2 - Lime production	2.11	NA	NA	NA	NA	2.12	2.12
2.A.3 - Glass Production	IE	NA	NA	NA	NA		
2.A.4 - Other Process Uses of Carbonates	5.01	NA	NA	NA	NA	5.01	5.01
2.D - Non-Energy Products from Fuels and Solvent Use	0.87	NA	NA	NA	NA	0.87	0.87
2.D.1 - Lubricant Use	IE	NA	NA	NA	NA		
2.D.2 - Paraffin Wax Use	0.87	NA	NA	NA	NA	0.87	0.87
2.D.3 - Solvent Use	NE	NA	NA	NA	NA		
3 - Agriculture, Forestry, and Other Land Use	-3,311.18	17.44	1.48	488.35	391.39	879.95	-2,431.43
3.A - Livestock	NA	17.43	0.40	487.96	105.85	593.81	593.81
3.A.1 - Enteric Fermentation	NA	14.14	NA	395.95	NA	395.95	395.95
3.A.2 - Manure Management	NA	3.29	0.40	92.01	105.85	197.86	197.86
3.B - Land	-3,311.38	NA	NA	NA	NA	-3,311.38	-3,311.38
3.B.1 - Forest land	-795.12	NA	NA	NA	NA	-795.12	-795.12
3.B.2 - Cropland	-1,165.71	NA	NA	NA	NA	-1,165.71	-1,165.71
3.B.3 - Grassland	NE	NE	NE	NE	NE	NE	NE
3.B.4 - Wetlands	NE	NE	NE	NE	NE	NE	NE
3.B.5 - Settlements	-1,350.54	NA	NA	NA	NA	-1,350.55	-1,350.55
3.B.6 - Other Land	NO	NO	NO	NO	NO	NO	NO
3.C - Aggregate sources and non-CO ₂ emissions sources on land	0.21	0.01	1.08	0.39	285.54	286.14	286.14
3.C.1 - Emissions from biomass burning		0.014	0.00	0.39	0.23	0.62	0.62
3.C.2 - Liming	NO	NA	NA	NA	NA		
3.C.3 - Urea application	0.21	NA	NA	NA	NA	0.21	0.21
3.C.4 - Direct N ₂ O Emissions from managed soils	NA	NA	0.72	NA	191.49	191.49	191.49
3.C.5 - Indirect N ₂ O Emissions from managed soils	NA	NA	0.26	NA	70.23	70.23	70.23
3.C.6 - Indirect N ₂ O Emissions from manure management	NA	NA	0.089	NA	23.60	23.60	23.60
4 - Waste	28.98	27.69	0.48	775.45	126.21	930.64	930.64
4.A - Solid Waste Disposal	0.00	8.02	0.00	224.62	0.00	224.62	224.62
4.B - Biological Treatment of Solid Waste	0.00	1.22	0.07	34.20	19.37	53.57	53.57
4.C - Incineration and Open Burning of Waste	28.98	4.18	0.08	116.90	19.92	165.80	165.80
4.D - Wastewater Treatment and Discharge	0.00	14.28	0.33	399.73	86.92	486.65	486.65

							0.00
Memo Items				0.00	0.00	0.00	0.00
International Bunkers	732.71	0.01	0.02	0.39	5.37	738.47	738.47
1.A.3.a.i - International Aviation	628.69	0.00	0.01	0.12	4.66	633.47	633.47
1.A.3.d.i - International water-borne navigation	104.02	0.01	0.01	0.26	0.71	105.00	105.00

2.3 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.

4 categories have been identified as key in the analysis, with CO₂ being the main gas and the energy sector being the main key category. Analyses of key categories is performed collectively for all sectors and a list of all key categories is presented in Table 10.

Table 10: Key category analysis for 2015

IPCC Category code	IPCC Category	Greenhouse gas	Level Assessment 2015 (with LULUCF)	Level Assessment 2015 (without LULUCF)	Trend assessment (1994-2015)
1.A.1	Energy Industries - Liquid Fuels	CO ₂	X	X	X
1.A.3.b	Road Transportation	CO ₂	X	X	X
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CO ₂	X	X	X
1.A.4	Other Sectors - Liquid Fuels	CO ₂	X	X	X
2.A.1	Cement production	CO ₂		X	X
3.B.5.b	Land Converted to Settlements	CO ₂		X	X
3.B.2.a	Cropland remaining cropland	CO ₂			X
3.B.1.a	Forestland remaining Forestland	CO ₂			X
4.A	Solid Waste Disposal	CH ₄			X
3.A.1	Enteric fermentation	CH ₄			X
4.D	Wastewater treatment and discharge	CH ₄			X
3.A.1	Manure Management	CH ₄			X

2.4 Trend analysis

Lebanon has already prepared national GHG inventories as part of national communication and biennial update report processes and has produced and updated its numbers since 1994. In light of new activity data, improved methodologies and revised emission factors, the inventory has gone through 3 recalculation exercises: one for the Third National Communication (TNC) which resulted in changes in the transport, agriculture, and waste sectors, one for the second BUR which mainly affected the results of the waste sector's emissions and the current recalculation where the IPCC 2006 guidelines are adopted for the first time. The trend of GHG emissions for the period 1994-2013 have therefore changed across time, as presented in Table 11 and Table 12. More details about the impact of recalculations are provided in section 2.5.

Over the period 1994 – 2015, total GHG emissions increased by approximately 3-fold, with the energy sector remaining the largest contributor of GHG emissions in Lebanon. The contribution of the energy

sector to total emissions has remained relatively the same over the time series, with a share ranging between 69% to 85% of total emissions.

Table 11: trend in GHG inventory (in Gg) for the time series 1994-2015 with year-to-year % change

	Total emissions		Net emissions	
	Gg CO ₂ eq.		CO ₂ eq.	
1994	9,233.38		6,196.35	
1995	12,998.57	41%	9,633.53	55%
1996	13,612.10	5%	10,248.01	6%
1997	14,302.67	5%	10,939.45	7%
1998	14,688.49	3%	11,270.47	3%
1999	16,781.82	14%	13,681.92	21%
2000	15,660.21	-7%	12,539.27	-8%
2001	17,383.10	11%	14,040.14	12%
2002	17,106.35	-2%	13,763.49	-2%
2003	16,210.33	-5%	12,967.09	-6%
2004	16,862.88	4%	13,553.02	5%
2005	16,463.46	-2%	13,292.81	-2%
2006	16,694.74	1%	13,593.33	2%
2007	15,970.34	-4%	12,746.23	-6%
2008	18,256.67	14%	15,069.67	18%
2009	22,167.27	21%	19,022.32	26%
2010	20,605.47	-7%	17,461.55	-8%
2011	22,154.60	8%	19,092.59	9%
2012	24,100.43	9%	21,163.83	11%
2013	25,150.24	4%	21,873.30	3%
2014	25,953.74	3%	22,633.83	3%
2015	27,107.65	4%	23,796.27	5%
	Average % change	6%		7%

Table 12: Trend of emissions during the period 1994-2015 (in Gg)

	Total GHG emissions	Energy	Industry	AFOLU (without LULUCF)	AFOLU (with LULUCF)	Waste
1994	9,233	6,335	1,175	744	-2,293	978.42
2015	27,108	23,013	2,284	879.95	(2,431.43)	931
% change 1994-2015	194%	263%	94%	18%	6%	-5%

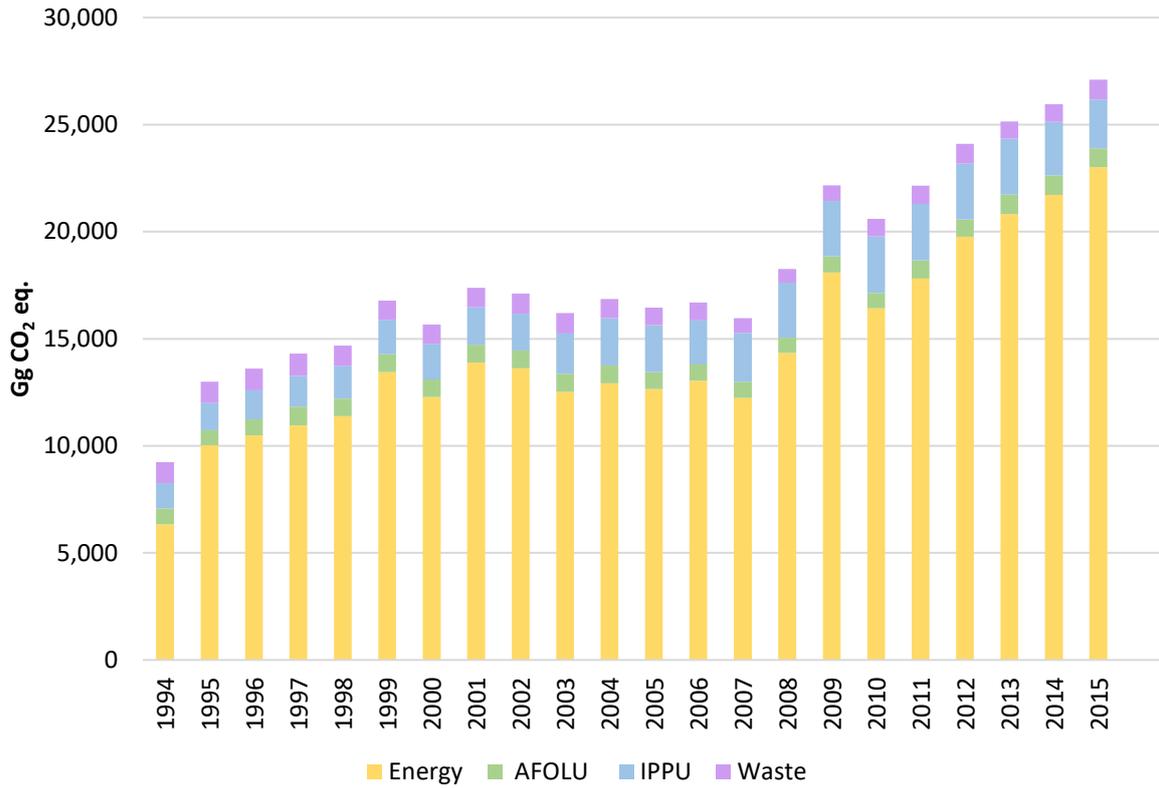


Figure 10: Trend in GHG emissions including share of emissions per sector for the period 1994-2015

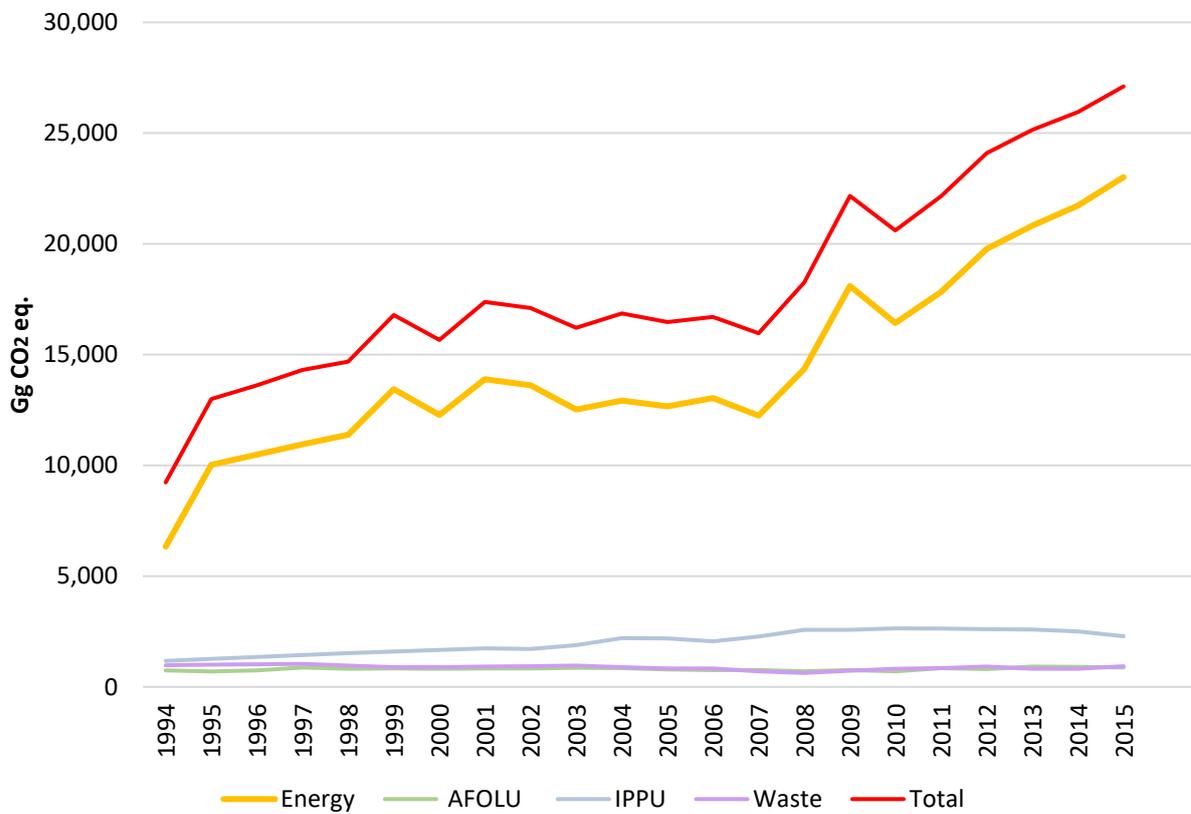


Figure 11: Trend in total and sectoral GHG emissions 1994-2015

Lebanon's GHG emissions are increasing at an average rate of 7% every year, which lead to a significant increase in emissions since 1994. As shown in Figure 11, 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 1994-2015 is also influenced by increase in emissions from the transport sector by a factor of 4.11 reaching 6.1 million tonnes CO₂eq. in 2015, mainly due to the increase in the vehicle fleet by a factor of 3.66 during the same period.

2.5 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 Lebanon, the move between the 1996 Revised IPCC guidelines and Good Practice Guidance to the 2006 IPCC guidelines necessitated the recalculation for all categories for the period 1994-2015.

Table 13 presents the difference between total emissions using both guidelines, without removals from LULUCF.

The recalculation has had a slight impact on the total emissions of Lebanon, with an average change of -5% over the time series. The main changes occurred in the waste sector, with a change of (-34%) due to the shift to the First Order Decay (FOD) method of calculation emissions from solid waste disposal sites. Explanations on the differences for each category are given in Annex V.

Table 13: Impact of recalculation on the Lebanese GHG inventory

	Total GHG emissions (Gg CO ₂ eq.)*			
	2006 IPCC guidelines	1996 revised IPCC guidelines	Difference	% change
1994	9,233.38	13,185.63	-3,952.25	-30%
1995	12,998.57	13,628.88	-630.32	-5%
1996	13,612.10	14,111.12	-499.02	-4%
1997	14,302.67	14,636.61	-333.94	-2%
1998	14,688.49	15,210.14	-521.65	-3%
1999	16,781.82	15,837.13	944.69	6%
2000	15,660.21	16,288.40	-628.20	-4%
2001	17,383.10	16,527.01	856.09	5%
2002	17,106.35	16,902.09	204.26	1%
2003	16,210.33	17,296.35	-1,086.03	-6%
2004	16,862.88	17,710.98	-848.10	-5%
2005	16,463.46	18,045.82	-1,582.36	-9%
2006	16,694.74	17,890.31	-1,195.57	-7%
2007	15,970.34	17,162.36	-1,192.02	-7%
2008	18,256.67	19,415.30	-1,158.63	-6%
2009	22,167.27	23,277.25	-1,109.98	-5%
2010	20,605.47	22,446.50	-1,841.02	-8%
2011	22,154.60	23,743.51	-1,588.91	-7%
2012	24,100.43	25,550.11	-1,449.68	-6%
2013	25,150.24	26,284.69	-1,134.45	-4%
Average change for the time series.				-5%

*Without LULUCF

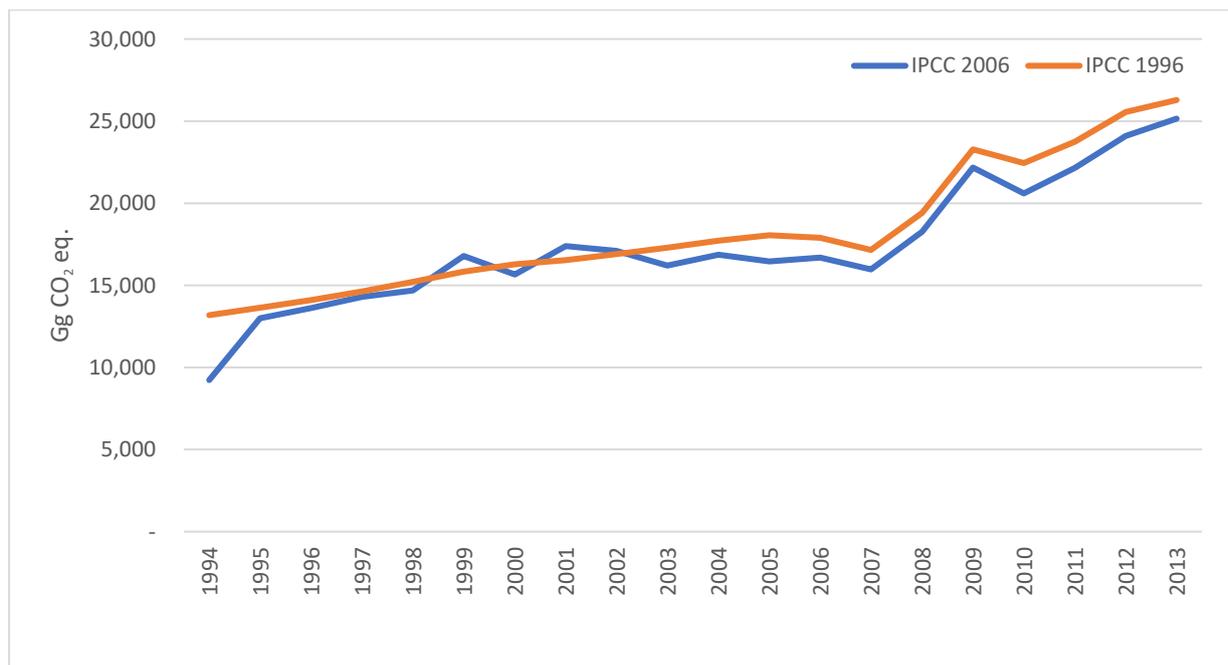


Figure 12: Impact of recalculation on the time series

3 Breakdown of emissions by IPCC sector

3.1 Energy

According to the IPCC 2006 guidelines, the source category "Energy" covers all combustion sources of CO₂, CH₄ and N₂O 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).
- Transport, including domestic civil aviation, road transport, and domestic navigation.

Table 14: 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 the 7 thermal power plants.	Lubricants store 50% of their carbon content and only emit the remaining 50%.	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 mainly for electricity production within the industrial facilities generators and in residential neighborhoods. Fuel consumed by neighborhood generators is considered under this category. Petroleum coke is only used by cement industries.	Emissions are calculated based on the tier 1 methodology.
1.A.3 Transport	Refer to Table 15		
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. 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.	Emissions are calculated based on the tier 1 methodology.

Table 15: Reporting categories under mobile combustion (1.A.3 transport)

Reporting categories	Description	Remarks	Methodology	
1.A.3.a Aviation	1.A3.a.ii. International Aviation <i>International bunkers</i>	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.a.iii. 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.	Civil, private and commercial aircrafts 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, vans, buses and trucks.	Road transport is the only mobility mean considered under land transport as the entire rail network is derelict.	Emissions are estimated using the tier 2 methodology based on the number of vehicles per category and their activity in terms of distance fuel consumption and vehicle technology.	
1.A.3.c. Railways	Activity not occurring in Lebanon			
1.A.3.d Waterborne Navigation	1.A.3.d.i. International waterborne navigation <i>International bunkers</i>	Vessels of all flags that are engaged in international waterborne 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.d.ii. 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 fishing are not reported under transport, but rather under the 1A4ciii, agriculture/forestry /fisheries category of the energy sector.	Emissions from domestic navigation are calculated based on the tier 1 methodology.

Methodology

Due to the absence of an energy balance for Lebanon, and the absence of 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 road transport sector for BUR3.

The Tier 2 methodology was however used for the calculation of emissions of CH₄ and N₂O where respective emissions factors are disaggregated by vehicle technology, fuel and operating conditions. For CH₄ and N₂O emission calculation, few changes have occurred between the 1996 and 2006 IPCC guidelines, with the only changes occurring are related other values of some emission factors.

Difference between 1996 and 2006 IPCC guidelines

The structure of the energy sector is similar between the Revised 1996 IPCC revised guidelines and the 2006 IPCC guidelines. A number of categories have been added, none of which are relevant for Lebanon:

- Treatment of Carbon Capture and Storage (CCS)
- CH₄ from abandoned coal mines
- Catalytic converters using urea
- Uncontrolled combustion and burning of coal deposits.

For the transport sector, some relevant changes have occurred between the 1996 and 2006 IPCC guidelines with regards to the values of the emission factors, notably the CH₄ factors, where significant differences in the factors of three-way catalysts for passenger and light commercial vehicles occurred.

3.1.1 Energy industries (1.A.1)

Methodology

The category covered under 1.A.1 energy industries is 1.A.1.a.i electricity generation (1.A.1). 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.

The country's primary energy imports include jet kerosene, gasoline, gas/diesel oil, heavy fuel oil (also known as residual fuel oil), petroleum coke, Liquefied Petroleum Gas (LPG), petroleum coke, bitumen, and lubricants. Biomass or logged wood is still used in fireplaces or stoves mainly for heating purposes in rural houses.

In Lebanon, the category 1.A.1 energy Industries includes all fuel used in the thermal power plants in addition to the 2 barges located in Zouk and Jiyeh that generate additional electricity, which usually operate either on heavy fuel oil or on gas/diesel oil. Emissions from purchases of electricity from Syria and Egypt 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 use a higher tier. Improvements will be reported in subsequent inventories.

Activity data

The amounts of fuel consumed in the power plants and the annual stock has been provided by Electricité du Liban (EDL) for the years 2014 and 2015. For the period 1999-2013, the fuel delivered by the Directorate General of Oil to EDL power plants is used as activity data, with the assumption that

the fuel delivered is being entirely consumed within one calendar year. The data for the year 1994 is adopted from the Initial National Communication (INC), and the years 1995-1998 have been interpolated accordingly.

Emissions factor and other parameters

Due to the lack of country specific emission factors and emissions measurements, tier 1 methodologies are adopted for the calculation of all greenhouse gases emissions from stationary combustion. CO₂, CH₄ and N₂O emission factors and other parameters used in the calculation are based on default values of the 2006 IPCC Guidelines. CO₂ emission factors are differentiated only by fuel, which depends entirely on the carbon content of the fuel, though a small amount of carbon is unoxidized. CH₄ and N₂O emission factors are differentiated by technology and fuel. Information on the NCV per imported fuel for 2017 is provided by the Ministry of Energy and has been used to calculate the entire time-series.

At tier 1, the emission factors assume that 100 percent of the carbon present in fuel is oxidized during or immediately following the combustion process.

Table 16: Quantities of fuel imported for the period 1994-2015

1,000 tonnes	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Gasoline	1,243.18	1,246.61	1,250.04	1,253.47	1,256.90	1,344.10	1,263.76	1,178.80	1,180.37	1,260.42	1,263.25	1,273.10	1,224.61	1,306.82	1,401.17	1,617.67	1,594.94	1,598.42	1,685.47	1,596.34	1,719.65	1,905.37
Jet Kerosene	145.91	142.34	138.78	135.21	131.64	126.17	124.51	128.20	125.06	124.04	124.52	145.52	103.36	139.73	166.69	174.57	220.95	223.88	207.34	258.89	229.10	205.44
Gas Diesel oil	818.12	901.04	983.96	1,066.88	1,149.80	1,748.09	1,315.65	1,533.28	1,562.97	1,444.32	1,407.61	1,346.72	1,596.27	1,363.19	1,802.75	2,595.35	2,252.02	2,448.07	3,268.81	3,075.58	3,251.76	3,670.82
Heavy Fuel oil	1,411.01	1,427.16	1,443.31	1,459.46	1,475.61	1,525.08	1,507.90	1,738.85	1,583.44	1,284.55	1,382.61	1,360.18	981.33	1,258.70	1,213.52	1,411.69	1,356.08	1,347.37	1,137.89	1,332.03	1,603.39	1,618.61
LPG	146.00	149.19	152.37	155.56	158.75	135.27	165.12	157.73	154.83	205.15	220.23	166.13	161.12	160.67	163.18	199.14	163.57	196.67	215.54	250.98	223.42	230.73
Bitumen	66.00	70.29	74.58	78.86	83.15	87.44	91.73	108.61	112.41	84.05	81.48	59.89	43.86	72.78	73.92	88.30	105.06	59.19	78.56	57.10	54.00	80.39
Lubricants	0.19	6.45	12.71	18.97	25.22	31.48	37.74	37.06	27.39	28.44	32.91	33.81	29.86	34.34	34.34	34.34	36.90	35.24	40.90	40.61	40.35	41.19
Petroleum coke	180.00	176.17	172.34	168.51	164.67	160.84	157.01	193.66	193.66	197.38	197.38	249.47	477.86	114.20	306.70	357.60	151.70	335.60	257.00	542.34	433.22	367.48
Natural gas																35.00	186.00					

Table 17: Fuel consumed by 1.A Energy Industries

1,000 tonnes	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Gas Diesel oil	48.65	215.14	381.64	548.13	714.62	881.12	532.81	573.07	745.41	825.98	842.35	781.74	1,057.70	848.86	1,259.56	1,132.72	994.29	1,305.67	1,320.20	1,174.53	1,245.41	1,295.18
Heavy Fuel oil		1,142.00	1,161.33	1,179.95	1,198.58	1,217.22	1,294.36	1,355.08	1,237.72	963.13	961.51	1,219.07	956.61	1,071.20	1,076.52	1,227.69	1,283.36	1,186.78	988.36	1,183.43	1,370.51	1,328.14
Lubricants	0.19	6.45	12.71	18.97	25.22	31.48	37.74	37.06	27.39	28.44	32.91	33.81	29.86	34.34	34.34	34.34	36.90	35.24	40.90	40.61	40.35	41.19

Table 18: 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
LPG	47.31		0
Lubricants	40.19		0.5
Bitumen	40.19		1
Petroleum coke	35.30*		0
Biomass	15.6		0

*Country specific values

*Assumption is made that no carbon is stored, except for bitumen and 50% of lubricants, as per the IPCC default values

Source | table 1.2 page 1.18 chapter 1 volume 2 IPCC, 2006 guidelines

Table 19: CO₂, CH₄ and N₂O emission factors for stationary sources

Fuel type	For all categories	Energy Industries	
	CO ₂ emission factor (kg/TJ)	CH ₄ emission factor (kg/TJ)	N ₂ O emission factor (kg/TJ)
Diesel oil	74,100	3	0.6
Heavy fuel oil	77,400	3	0.6
LPG	63,100		
Lubricants	73,300	3	0.6
Petroleum coke	97,500*		
Biomass	112,000*		

*Revised emission factor in 2006 IPCC guidelines

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

3.1.2 Manufacturing industries and construction (1.A.2)

Methodology

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

- 1- Production of electricity, steam and process heat by industries: 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 and fuel oil are bought either directly from the Ministry of Energy and Water or from private fuel distributors and are used in the premises. Unfortunately, no

data is recorded on these quantities. Therefore, estimations have been calculated based on data/information sale of fuel per end user for 2016 (IPT, 2017) (Box 2).

- 2- Production of electricity by neighbourhood generators: due to the frequent power shortages, neighbourhood generators have flourished in Lebanon, supplying electricity to households during outages (which range from 3 to 15 hours a day depending on the region). All these generators work on gas/diesel oil, which is bought either directly from private fuel distributors or from gas stations. Unfortunately, no data is available on the number, capacity or quantity of fuel used for private generators in the country. Therefore, based on an intensive consultation process with the main stakeholders (Ministry of Energy, Electricité du Liban, private distributors of fuel, and owners of generators) it was agreed to assume that the gap between public electricity supply and demand (referred as Energy not Supplied ENS) is being met at 80% by private generators.

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. Improvements will be reported in subsequent inventories.

Box 2: Distribution of Gas Diesel oil by end use

The most challenging categorization of fuel used per end-used was for gas diesel oil (GDO), which is consumed in transportation, residential, commercial/institutional and Agriculture, Forestry and Fishing sectors. In the absence of an Energy balance in Lebanon, a study was conducted by the Ministry of Environment and the IPTEC where the share of GDO per sector was estimated. The study was based on the yearly fuel sales per consumer (industries, individuals, commercial institutions, fishing ports, etc.) of all IPT gas stations in Lebanon for the years 2013 and 2016. 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 joined forces with IPT to estimate the distribution of fuel 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 results of the survey were disseminated to the Association of Petroleum Importers Companies in Lebanon, whose members validated the estimated distribution of fuel.

In addition, the estimation of fuel used in the commercial and institutional sector has been validated by a nation-wide survey on the consumption of fuel in 868 facilities distributed across the Lebanese territory taking into account the different regions (with different power cut schedules), climatic zones (coast versus mountains) and settings (rural versus urban). The survey included retail and wholesale shops, commercial malls, restaurants, hotels and resorts, private office buildings, public office buildings, educational institutions, as well as hospitals and healthcare institutions. (MoE/GEF/UNDP, 2015b)

Activity data

The amounts of heavy fuel oil and bitumen consumed by industries are provided by the Ministry of Energy and Water.

Amounts of petroleum coke consumed by manufacturing industries and construction (mainly in cement industries) are provided by the department of chemical safety at the Ministry of Environment.

The amounts of LPG and gas/diesel oil consumed by Manufacturing Industries and Construction (MIC) are calculated based on the fuel imports database of the MoEW and the distribution of fuel per end use provided by IPTEC (see Box 2).

The gas/diesel oil used in MIC, for industrial energy generation and in neighbourhood generators range between 39% and 2% of total GDO import for the period 1994-2015. The values are estimated

based on the following equation, assuming that the GDO used in private generation is divided equally between MIC and CI:

$$GDO_{MIC} = GDO_{import} - \frac{(GDO_{EI} + GDO_T + GDO_{res} + GDO_{AFF})}{2}$$

Emission factors and other parameters

The same parameters presented in Table 18 under 1.A.1 Energy industries are used for 1.A.2 Manufacturing industries and construction. Default emission factors from the 2006 IPCC guidelines are used, as presented in Table 20.

Table 20: CO₂, CH₄ and N₂O emission factors for stationary sources

Fuel type	For all categories	Manufacturing industries and construction	
	CO ₂ emission factor (kg/TJ)	CH ₄ emission factor (kg/TJ)	N ₂ O 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*
Lubricants	73,300		
Petroleum coke	97,500*	3*	0.6
Biomass	112,000*		

*Revised emission factor as in 2006 IPCC guidelines

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

Table 21: Quantities of Gas/Diesel oil consumed in the energy sector for the period 1994-2015

Gas Diesel oil consumption (1,000 tonnes)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total import	818.12	901.04	983.96	1,066.88	1,149.80	1,748.09	1,315.65	1,533.28	1,562.97	1,444.32	1,407.61	1,346.72	1,596.27	1,363.19	1,802.75	2,595.35	2,252.02	2,448.07	3,268.81	3,075.58	3,251.76	3,670.82
1.A. 1 Energy industries	48.65	215.14	381.64	548.13	714.62	881.12	532.81	573.07	745.41	825.98	842.35	781.74	1,057.70	848.86	1,259.56	1,132.72	994.29	1,305.67	1,320.20	1,174.53	1,245.41	1,295.18
1.A. 3 Road transport	65.64	72.63	89.92	113.64	134.60	152.43	165.22	180.10	198.45	216.68	239.86	260.91	282.25	302.10	325.29	363.23	410.87	442.87	458.45	479.50	500.54	521.58
1.A. 2 Manufacturing Industries and Construction	319.19	270.59	216.85	159.88	104.30	287.35	256.18	328.73	247.03	143.06	106.39	98.17	64.31	51.59	36.84	445.89	333.35	251.84	614.32	587.75	622.84	780.20
1.A.4.i a Commercial/institutional	319.19	270.59	216.85	159.88	104.30	287.35	256.18	328.73	247.03	143.06	106.39	98.17	64.31	51.59	36.84	445.89	333.35	251.84	614.32	587.75	622.84	780.20
1.A.4.i.b Residential	40.91	45.05	49.20	53.34	57.49	87.40	65.78	76.66	78.15	72.22	70.38	67.34	79.81	68.16	90.14	129.77	112.60	122.40	163.44	153.78	162.59	183.54
1.A.4.ciii fishing	8.18	9.01	9.84	10.67	11.50	17.48	13.16	15.33	15.63	14.44	14.08	13.47	15.96	13.63	18.03	25.95	22.52	24.48	32.69	30.76	32.52	36.71
1.A.4.cii offroad	16.36	18.02	19.68	21.34	23.00	34.96	26.31	30.67	31.26	28.89	28.15	26.93	31.93	27.26	36.05	51.91	45.04	48.96	65.38	61.51	65.04	73.42

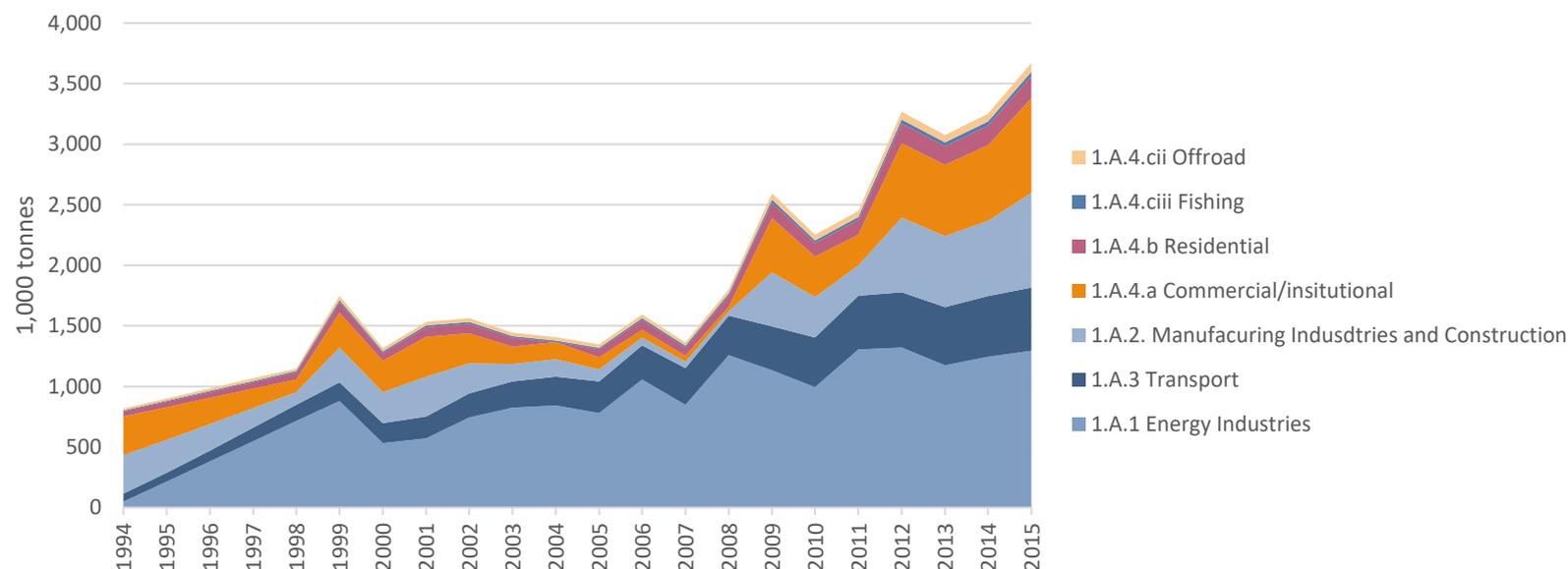


Figure 13: Consumption of gas/diesel oil per end-use

3.1.3 Transport (1.A.3)

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. Types of vehicles investigated in this inventory are motorcycles, passenger cars, vans, buses and trucks, classified into categories in accordance with the guidelines: Passenger Cars (PC), Light-Duty Vehicles (LDV), Heavy-Duty Vehicles (HDV) and motorcycles (Table 22). 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 run on diesel.

Table 22: Description of the vehicles categories used in the calculation of road transport emissions

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

For mobile combustion, CO₂ emissions from road transport have been calculated using 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 CH₄ and N₂O emissions, which depend largely upon the combustion and emission control technology present in the vehicle.

Activity Data

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 2012 and 2015 (MoIM, 2017). 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. Extrapolation and interpolation are used to estimate the vehicle fleet for other years using ForFITS (For Future Inland Transport Systems) (UNECE, 2014).
- The vehicle fleet was classified per vehicle type, category and European Union (EU) emission control technology taking into consideration the common practice in Lebanon of removing the emission control catalyst without any replacement. The fraction of vehicles 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, motorcycles)
 - Number of diesel vehicles (assuming only heavy-duty vehicles)
 - Average travelled distance
 - Fuel economy
 - Fuel density
- Gas/diesel oil is only used by heavy-duty vehicles. 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) and LDV are considered insignificant.
- Domestic flights consist of 5 small propeller-type aircrafts, used only for training. They operate on gasoline (AVGAS LBP 100) with an annual consumption ranging between 2 and 3 ktonnes (El-Hage, 2014).
- Activities related to domestic navigation are limited to fishing boats, which are reported under the category agriculture/forestry/fisheries (1.A.4.c.iii) and consequently, their emissions are not reported under transport. Emissions related to military maritime transport were not considered due to the unavailability of the activity data.

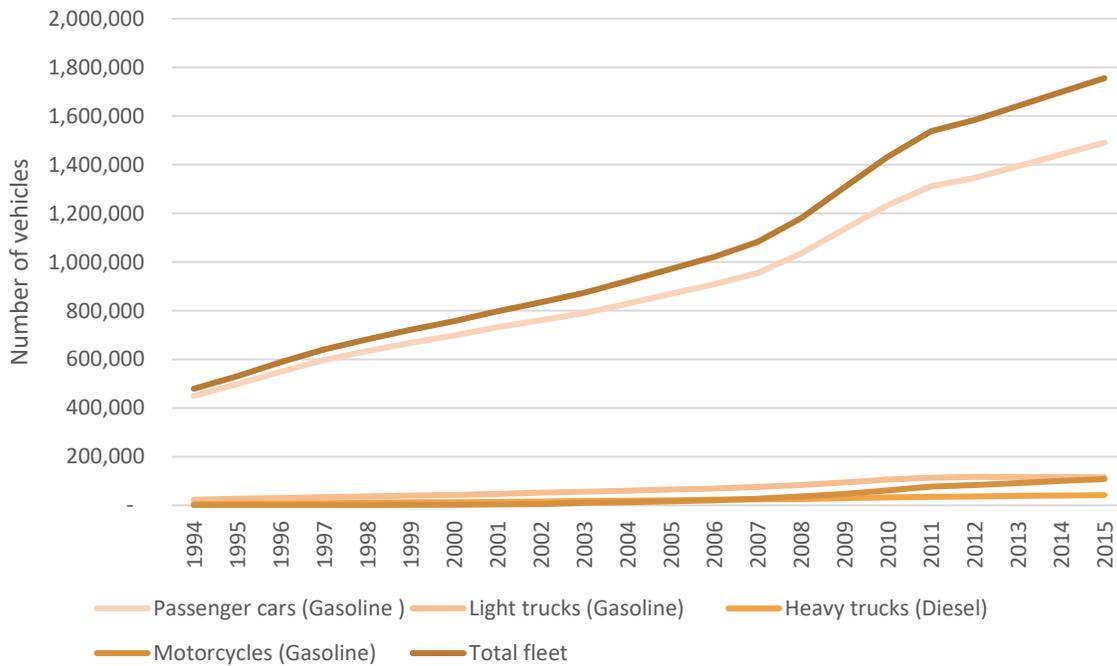


Figure 14: Classification of the Lebanese vehicle fleet per type

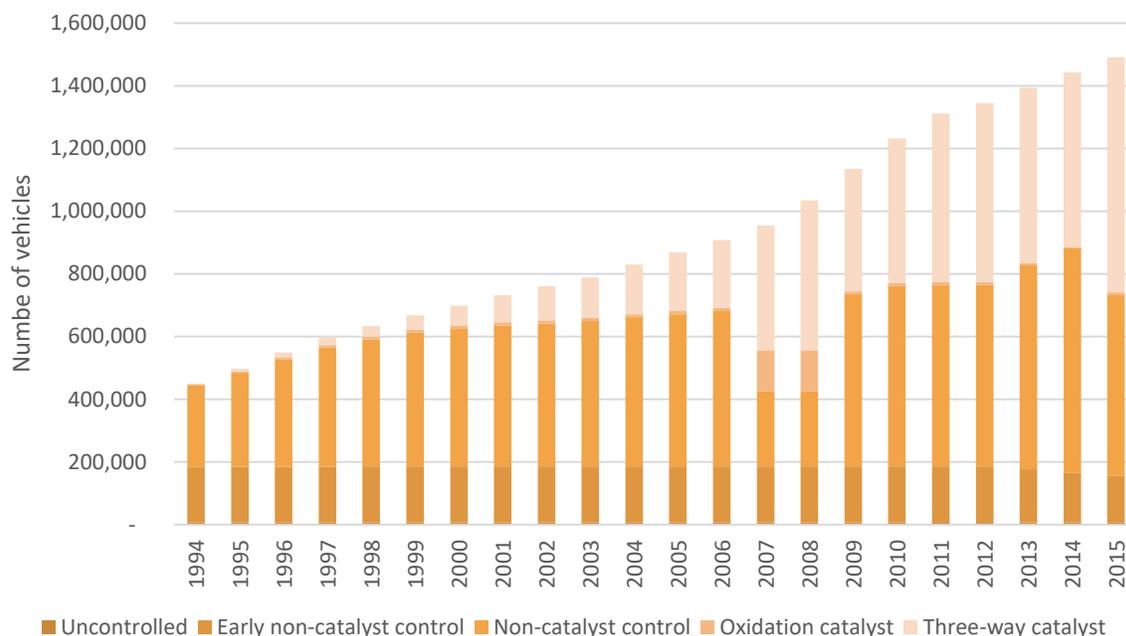


Figure 15: Classification of the passenger cars per emission reduction technology

Emission factors and other parameters

- In the 2006 IPCC guidelines, the tier 1 emission factors are shown as a function of $\text{kg}_{\text{emissions}}/\text{TJ}_{\text{fuelused}}$. 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.
- 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 CO₂ 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 passenger cars, 27,250 km/year for light-duty vehicles, 50,000 km/year for heavy-duty vehicles and 5,000 km/year for motorcycles.
- HDV diesel consumption 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.

Default CO₂ emission factors are used for each fuel type and each category of vehicle from the IPCC 2006 guidelines. For N₂O and CH₄ 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.

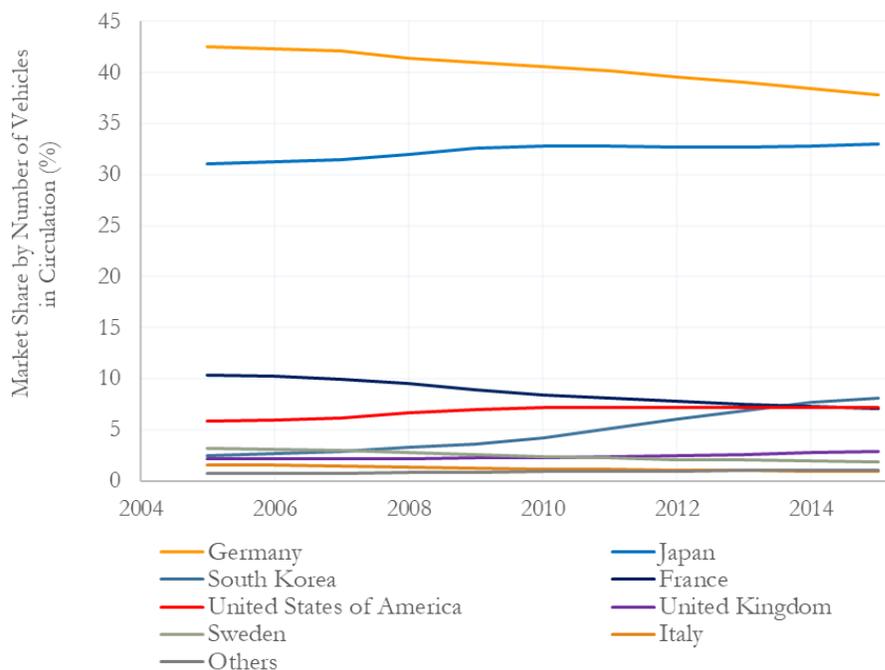


Figure 16: Market share of vehicles in circulation per year (MoE/AUB/UNEP, 2018)

Table 23: Default CO₂ emission factors (kg/TJ) for Transport 1.A.3

Fuel type	CO ₂ emission factor (kg/TJ)
Gasoline	69,300
Aviation gasoline	70,000
Jet kerosene	71,500
Diesel oil	74,100

At tier 1, the emission factors assume that 100 percent of the carbon present in fuel is 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 2006 guidelines

Table 24: Parameters for road transport

	Average Travelled Distance (km)	Fuel Economy (L/100 km)	Fuel Density (kg/L)	Fuel Consumption (k tonnes)	Net Calorific Value (TJ/ktonnes)	Fuel Consumption (TJ)
Gasoline Passenger cars						
Uncontrolled	12,000	11.2	0.74	6.16	43.5	267.76
Early non-catalyst control	12,000	9.4	0.74	125.16	43.5	5,444.33
Non-catalyst control	12,000	8.3	0.74	,424.70	43.5	18,474.44
Oxidation catalyst	12,000	8.1	0.74	6.29	43.5	273.57
Three-way catalyst	12,000	8.5	0.74	565.69	43.5	24,607.62
Light trucks Gasoline cars						
Uncontrolled	27,250	13.6	0.74	1.32	43.5	57.38
Early non-catalyst control	27,250	13.6	0.74	19.37	43.5	842.47
Non-catalyst control	27,250	13.6	0.74	49.42	43.5	2,149.96
Oxidation catalyst	27,250	13.6	0.74	28.84	43.5	1,254.64
Three-way catalyst	27,250	13.6	0.74	216.01	43.5	9,396.48
Heavy trucks Diesel cars						
Uncontrolled	50,000	29.9	0.83	3.15	41.6	130.91
Early non-catalyst control	50,000	29.9	0.83	32.15	41.6	1,337.58
Non-catalyst control	50,000	29.9	0.83	31.99	41.6	1,330.85
Oxidation catalyst	50,000	29.9	0.83	3.45	41.6	143.33
Three-way catalyst	50,000	29.9	0.83	450.84	41.6	18,755.04
Motorcycles Gasoline cars						
<50cc	5,000	2.4	0.74	8.82	43.5	383.72
2-strokes	5,000	4	0.74	0.84	43.5	36.37
4-strockes	5,000	5.1	0.74	0.55	43.5	24.14

Table 25: Default emission factors for CH₄ and N₂O emissions for 1.A.3 transport

Type of vehicle	CH ₄ emission factor (kg/TJ)	N ₂ O emission factor (kg/TJ)
Gasoline Passenger 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	8.00
Light trucks Gasoline 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	5.70
Heavy trucks Diesel cars		
	3.90	3.90
Motorcycles Gasoline cars		
<50cc	33.00	3.20
2-strokes	33.00	3.20
4-strokes	33.00	3.20

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

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

Table 26: International bunkers default CH₄ and N₂O emission factors (kg/TJ)

Fuel type	CO ₂ emission factor (kg/TJ)	CH ₄ emission factor (kg/TJ)	N ₂ O emission factor (kg/TJ)
Aviation gasoline	70,000	0.5	2
Jet kerosene	71,500	0.5	2
Heavy fuel oil	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

3.1.4 Other sectors (1.A.4)

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 fuel are considered under this category and are mainly used for electricity generation, cooking, heating, navigating and use of other mobile equipment.

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

Activity Data

The LPG and gas/diesel oil consumed by 1.A.4 Other sectors are calculated based on the fuel imports database of the MEW and the distribution of fuel per end use provided by IPT (see Box 2).

Accordingly, it is assumed the following:

- 14% of imported LPG is used in commercial and institutional sectors (1.A.4.a) for 2015 and 13% for the period 1994-201
- 75% of imported LPG is used in the residential sector (1.A.4.b) for 2015 and 72% for the period 1994-201
- 5% of imported GDO is used in the residential sector (1.A.4.b) (fixed for the period 1994-2015)
- 1% of imported GDO is used AFF-fishing (1.A.4.ciii) (fixed for the period 1994-2015)
- 2% of imported GDO is used AFF-off-road (1.A.4.ciii) (fixed for the period 1994-2015)
- The remaining GDO (after the amounts used in EI, transport, residential and AFF) are divided equally between MIC and Commercial/institutional to account for private generators

Emissions from burning of wood are allocated under the residential sector's, where in rural areas logged wood is still being used for cooking and heat generation. The biomass activity data is based on the volume of fuelwood logged from coniferous and non-coniferous forests (referred to as wood waste) as reported by FAOSTAT (FAO, 2017). Only emissions of non-CO₂ gases derived from biomass fuels are included, and reported, in the emissions of the energy sector and national totals of the inventory. CO₂ 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 LULUCF 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.

Emission factors

The same parameters presented in Table 18 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 27: CO₂, CH₄ and N₂O emission factors for stationary sources

Fuel type	For all categories		Other sectors
	CO ₂ emission factor (kg/TJ)	CH ₄ emission factor (kg/TJ)	N ₂ O emission factor (kg/TJ)
Diesel oil	74,100	10	0.6
Heavy fuel oil	77,400		
LPG	63,100	5*	0.1*
Lubricants	73,300		
Petroleum coke	97,500*		
Biomass	112,000*	300	4

*Revised emission factors as in 2006 IPCC guidelines

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 (HS code used for Lebanon is HS 27.10.19.90). 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 CO₂ released from the use or decomposition of the product is not reported under the energy sector's inventory but under the industrial sector's inventory (MoE/UNDP/GEF, 2015).

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 (50% for lubricants and 100% for bitumen).

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. Both are collected from the Ministry of Energy and Water. The activity data for navigation is limited to the heavy fuel oil consumption for international bunkers and it is collected from the fuel imports data by the International Energy Agency (IEA, 2017).

Table 28: Fuel consumption for marine bunkers in 2015

Year	1,000 tonnes
Jet-kerosene	243.34
Gasoline	3.60
Marine bunkers	32.70

3.1.5 Results of Energy sector

In 2015, the energy sector's GHG emissions were estimated at 23,012 Gg CO₂eq. (23 million tonnes CO₂eq.), representing 85% of the total greenhouse gas emissions in Lebanon. Energy is mainly responsible for carbon dioxide emissions (99.62%), while it also contributes to methane and nitrous oxide emissions with 0.17% and 0.20% respectively.

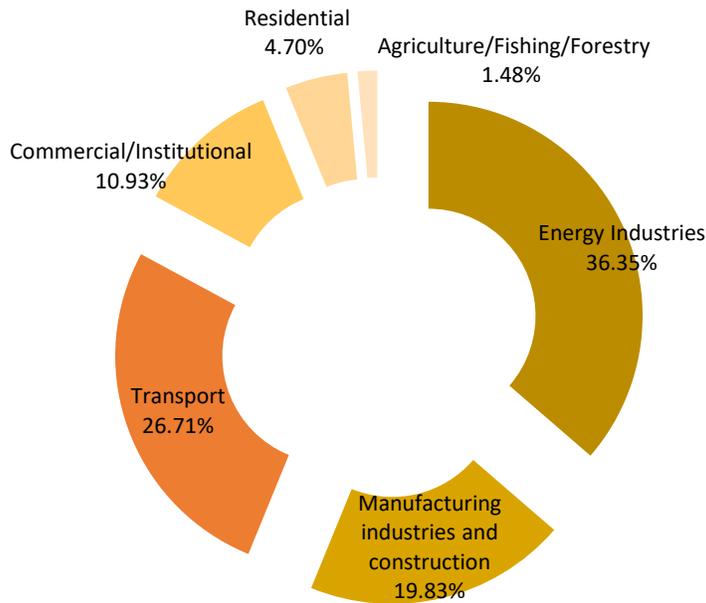
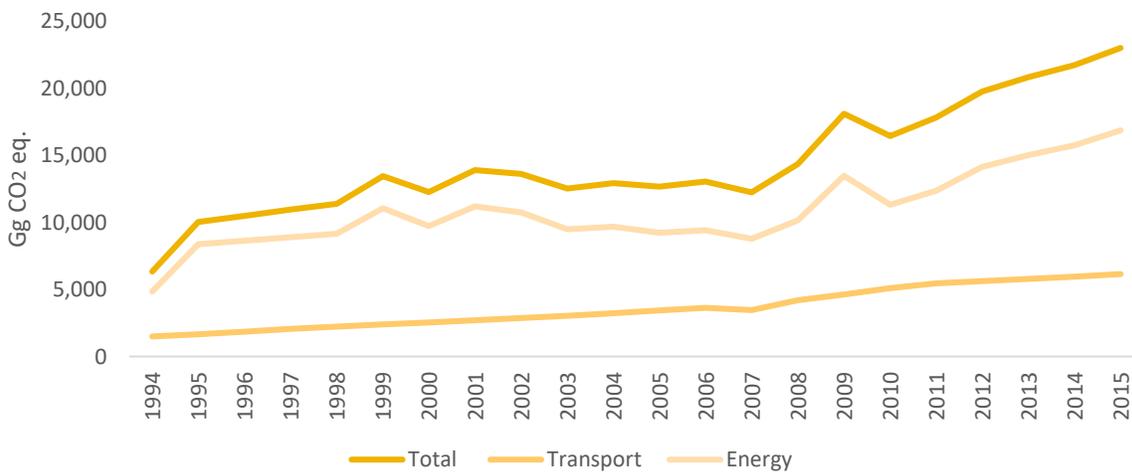


Figure 17: Contribution of energy emission sources to the sector's total for 2015

GHG emissions from the Energy sector grew by 7%/year during the period 1994-2015. The contribution of different subcategories to the total of the energy sector is presented in Figure 17 and Figure 18.

Figure 18: GHG emissions from 1.A energy for the time series 1994-2015



Energy industries (1.A.1)

The energy sector in Lebanon relies on fossil fuel combustion for meeting the bulk of energy requirements in the country. The final energy consumption in 2015 amounted to approximately 109,759 TJ. Since electricity generation from public power plants (energy industries) is the main fuel consumer, it is responsible for 36.35% of the sector's emissions.

Indeed, public electricity generation is the largest contributor to the sector's emissions due to the fact that more than 84% of imported heavy fuel oil and 46% of imported gas diesel oil are used in thermal power plants for public electricity generation (Figure 19).

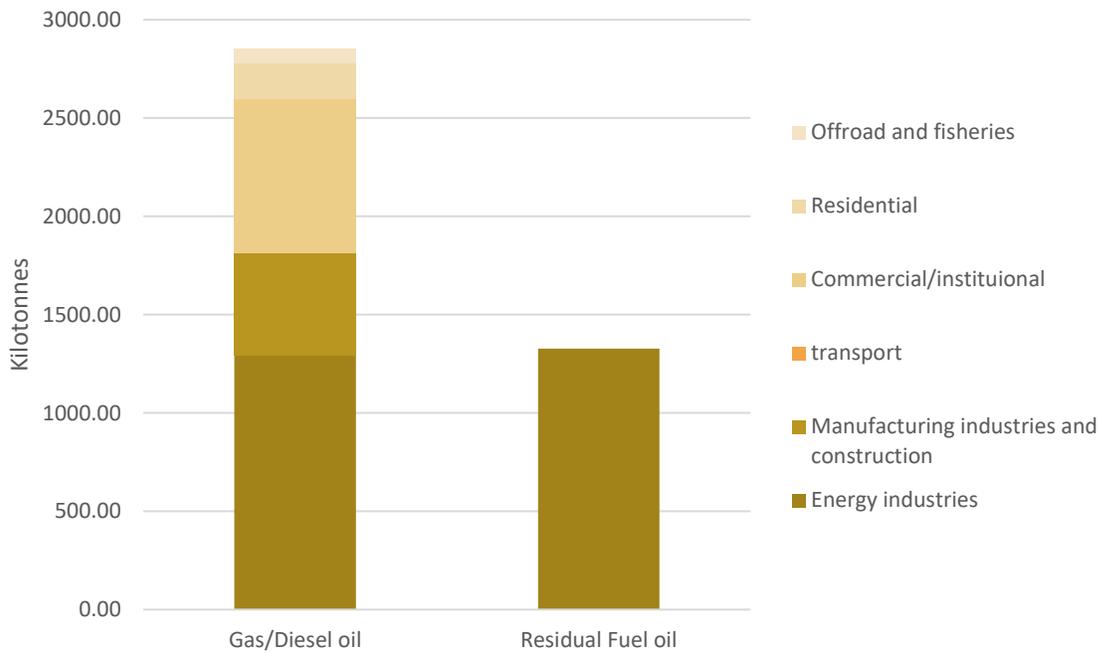
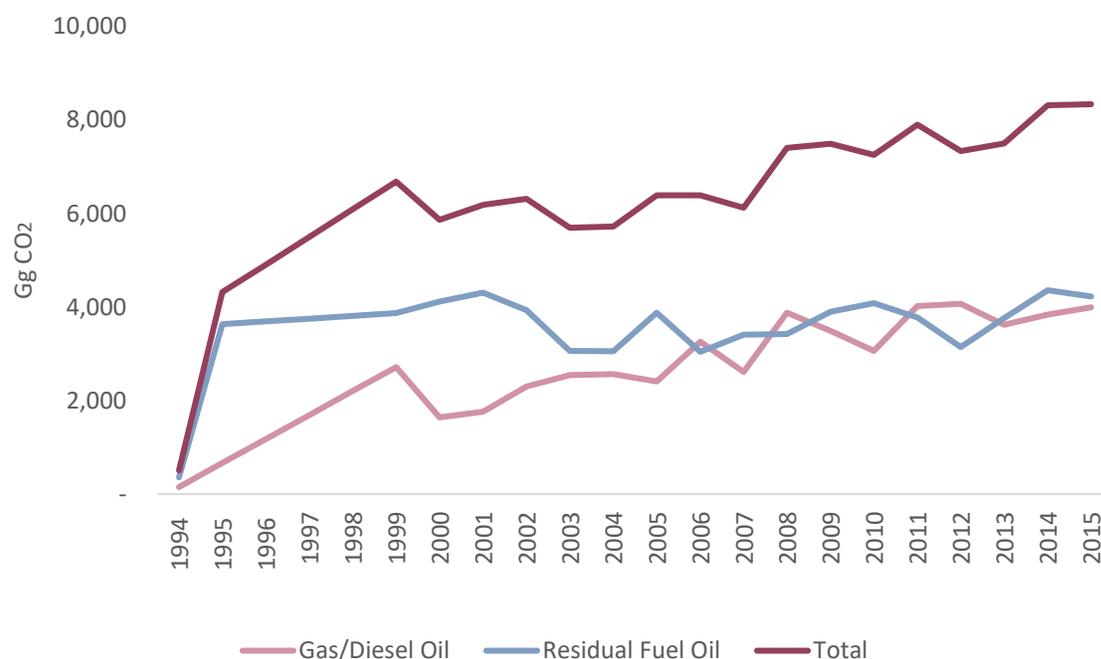


Figure 19: Amount of gas/diesel oil and fuel oil consumed per subcategory

The main gas emitted from energy industries is CO₂, which is the principal chemical by-product of fuel combustion. Gas diesel oil and heavy fuel oil have more or less the same share in CO₂ emissions since 2006, given that around 1,028 MW of installed capacity is generated from fuel oil and 1,280 MW operate on Gas/Diesel oil and the difference between their NCV and CO₂ emission factor justifies the difference in emissions per tonne of fuel consumed.

Figure 20: CO₂ emissions from 1.A.1 Energy Industries per type of fuel

Transport (1.A.3)

In 2015, GHG emissions from transport are estimated at 6,146.76 Gg CO₂eq. Carbon dioxide, methane, and nitrous oxide contributing to 97.65%, 0.62%, and 1.73% of total CO₂eq. respectively.

Table 29: Transport sector GHG emissions for 2015

Category	CO ₂ (Gg)	CH ₄ (Gg CO ₂ eq.)	N ₂ O (Gg CO ₂ eq.)	Total (Gg CO ₂ eq.)
1.A.3 - Transport	5,999.98	33.01	113.77	6,146.76
1.A.3.a - Civil Aviation	10.96	0.00	0.08	11.04
1.A.3.b - Road Transportation	5,989.02	33.01	113.69	6,135.71
1.A.3.b.i - Cars	3,400.39	25.23	72.88	3,498.50
1.A.3.b.i.1 - Passenger cars with 3-way catalysts	1,705.31	2.63	52.21	1,760.15
1.A.3.b.i.2 - Passenger cars without 3-way catalysts	1,695.09	22.60	20.67	1,738.35
1.A.3.b.ii - Light-duty trucks	949.47	4.98	18.02	972.48
1.A.3.b.ii.1 - Light-duty trucks with 3-way catalysts	651.18	1.01	14.31	666.49
1.A.3.b.ii.2 - Light-duty trucks without 3-way catalysts	298.30	3.98	3.71	305.98
1.A.3.b.iii - Heavy-duty trucks and buses	1,607.80	2.38	22.53	1,632.71
1.A.3.b.iv - Motorcycles	31.35	0.42	0.27	32.04

As for the contribution of the different vehicle categories, passenger cars have the highest share of the 2015 emissions with 57% of the total transport GHG emissions (in CO₂eq.), while LDV and HDV, account for 16.5%, 26.3%. Emissions from motorcycles and domestic aviation are negligible.

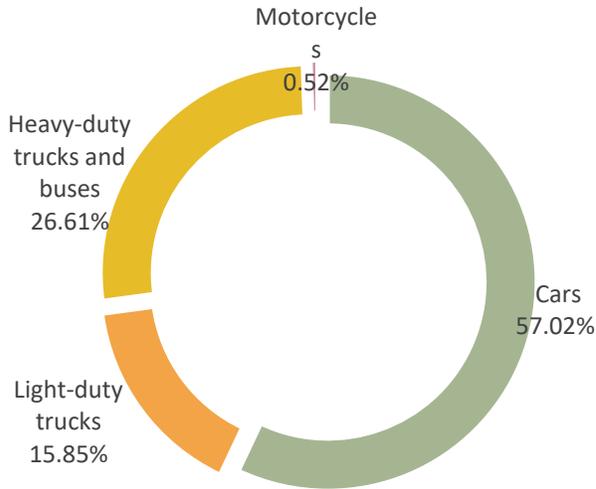


Figure 21: Emissions distribution per type of vehicle in 2015

The annual growth in emissions from transport fluctuated between -5% to +21% during the period 1994-2015, with an average increase of by 7%. The fluctuation (between 1994 – 2000 and 2000 – 2005) is a natural consequence to the advancements in reduction of consumption and emissions of new vehicles with emission control technologies. However, this technology advancement in emission savings did not reduce the fleet average emissions over the period 2005 – 2013 and the upturn that took place is explained by the 8.62% yearly increase in the number of registered vehicles over the same period, and more likely in the increase in the yearly average distance travelled.

Over the time-series 1994-2015, a 4-fold increase in GHG emissions is observed concurrently with the increase of the number of registered vehicles in Lebanon from 479,120 in 1994 to 1,755,264 in 2015. 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.

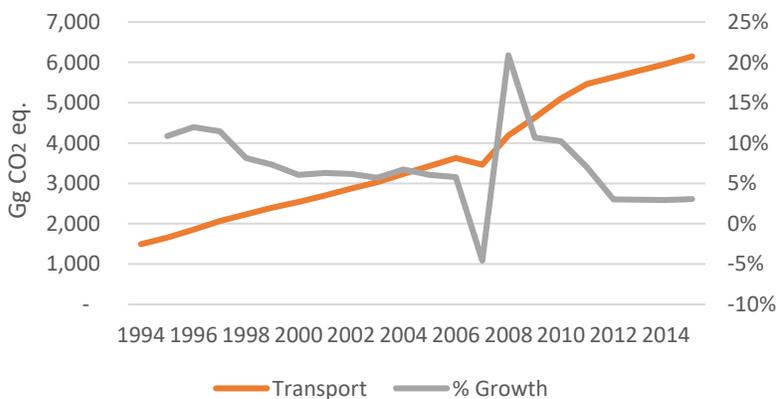


Figure 22: Changes in GHG emissions from transport during the period 1994-2015

Manufacturing industries and construction (1.A.2) and commercial/institutional sectors (1.A.4.a)

Other high-emitting subcategories in the energy sector are manufacturing industries and construction and the commercial/institutional sector since they cover all combustion activities related to the private generation of electricity. Due to the fact that electricity supply do not meet demand, private generation in industries, commercial institutions and at residential neighbourhood levels consume considerable amounts of Gas/Diesel (GDO). In 2015, it is estimated that private generators supplied 6,296 GWh of electricity, calculated as 80% of the Energy-Not-Supplied (ENS), i.e. the difference between supply (12,237 GWh) and demand (20,368 GWh) in 2015. This is estimated to be equivalent to 1,560,000 tonnes of gas diesel have been used for private electricity generation in 2015, exceeding the amount of GDO used in EDL power plants and constituting 42% of total import of gas diesel oil.

Manufacturing industries and construction and commercial/institutional sectors also emit GHG emissions from their consumption of Liquefied Petroleum Gas (LPG) for heating and cooking, heavy fuel oil for heat generation in industries and petroleum coke for cement production (Table 30).

Table 30: CO₂ emissions from manufacturing industries and the commercial/institutional sector in 2015

Fuel Type	Manufacturing industries (including neighbourhood generators)	Commercial/institutional sector
	Emissions in 2015 (Gg CO ₂)	
Gas/Diesel oi for private generation	2,405.00	2,405.00
Heavy fuel oil	543.15	-
LPG use	75.75	96.41
Petroleum coke	1,264.77	-
Total	4,288.67	2,501.41

During the period 1994-2015, emissions from manufacturing industries and construction (1.A.2) increased by 60%, with the lowest value in 2007 (1,382 Gg) and the highest value in 2015. As for emissions from the commercial/institutional sector (1.A.4.a), it has increased by a rate of 1.4 between 1994 and 2015, with the lowest value recorded in 2008 (186 Gg) and the highest in 2015 (2,501 Gg).

Residential sector

In the residential sector, emissions from gas/diesel oil that is used for space and water heating in households are estimated at 566.47 Gg CO₂ eq. and from LPG at 518 Gg CO₂ eq. in 2015. Emissions from the residential sector have increased by a rate of 1.45 since 1994 due to population growth and changes in socio-economic conditions during this period. Emissions from the use of private generators in residential buildings are not allocated in this category to avoid double counting from private generation under the manufacturing industries and construction category.

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 CO₂ 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 31, the difference between the 2 approaches in 2015 is 3.31%. The existing difference results mainly from:

- 1) transport activity data where the amount of gasoline and diesel consumed in 2015 are the main source of the gap between the 2 approached,
- 2) the difference between the emission factors (reference approach uses carbon content of fuel whereas the sectoral approach uses CO₂ emission factor).

Table 31: Energy emissions using the reference approaches for 2015

Fuel (in Gg)	Production	Imports	Exports	International Bunkers	Stock change	Actual CO ₂ Emissions (Gg CO ₂)
Motor Gasoline		1,905.37				5,743.83
Jet Kerosene		205.44		205.44		-
Gas/Diesel Oil		3,670.82			-72.27	11,087.75
Heavy Fuel Oil		1,618.61		32.7	84.82	4,773.12
Liquefied Petroleum Gases		230.73				688.28
Bitumen		80.39				0
Lubricants		41.19				0.20
Petroleum Coke		367.48				1,265.21
TOTAL		8,120.03			76.17	23,884.87

Table 32: difference between reference and sectoral approach

	CO ₂ emissions (Gg)	% difference
Reference approach	23,558	3.31%
Sectoral approach	22,803	

International bunkers

For international bunkers, the total direct GHG emissions from aviation and marine amounted to 738 Gg of CO₂eq. in 2015 as per the below table.

Table 33: Emissions from international bunkers

	GHG emissions (Gg CO ₂ eq.)
International aviation	633.57
International water-borne navigation	105.07
Total	738.69

3.2 Industrial Processes and Products Use

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

1. Industrial processes that chemically or physically transform products, thus releasing greenhouse gases.
2. Product use that release gradually greenhouse gases that are contained in the products such as refrigerators, foams and aerosol cans. Significant time can elapse between the manufacturer of the product and the release of GHG. The delay can vary from a few weeks (aerosol cans) to several decades (rigid foams). In refrigeration, a fraction used in the product can be recovered at the end of the product's life and either recycled or destroyed.

The present section covers the following IPPU subcategories, all of which emit CO₂:

- 2.A.1 Cement production
- 2.A.2 Lime production
- 2.A.3 Glass production
- 2.A.4 Other process Uses of CO₂ carbonates
- 2.D.1 Lubricant use
- 2.D.2 Paraffin wax use
- 2.H.1 Pulp and paper

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

- 2.B Chemical industry
- 2.C Metal industry
- 2.E Electronics industry
- 2.G Other product manufacture and use

The following categories do occur in Lebanon but are reported as Not Estimated due to lack of activity data:

- 2.F Product uses as substitutes for Ozone Depleting Substances (ODS): The National Ozone Unit has not yet started the process of collection of data on HFCs in Lebanon. It is expected to start after the completion of the ratification process of the Kigali Amendments to the Montreal Protocol. Note that Lebanon is finalizing the deposition of instrument of ratification for the Kigali amendment. Emissions from this category are therefore Not Estimated (NE) and will be noted as improvements to be made in subsequent inventory cycles.
- 2.H Other: Emissions from food and beverages, extensive efforts have been deployed during previous inventories to collect data for this category, and the data quality remained highly uncertain. For the current BUR and with the additional time and resources required to switch to the 2006 IPCC GL, it have been decided not to estimate emissions from this category since it only produces indirect GHGs.

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. Further descriptions of the methodologies used, and gases covered for each source of emissions identified by the guidelines are detailed in Table 34.

Emissions from fuel combustion in the industrial sector for energy purpose is not included under the IPPU sector, but rather in the energy sector.

Table 34: Reporting GHG emissions categories investigated in the inventory of the Lebanese industrial processes sector

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.
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 produced 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.
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 different industrial processes, emissions from glass are not reported under this category, but embedded within the emissions of category 2.A.4 (other carbonates). The notation key Included Elsewhere was therefore used
2.A.4 Other process Uses of Carbonates	<p>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.</p> <p>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. According to the 2006 IPCC Guidelines, data for ceramics production should include production of bricks and roof tiles, vitrified clay pipes, refractory products, expanded clay products, wall and floor tiles, table and ornamental ware, and sanitary ware. Therefore, the emissions from ceramics is Not Estimated in the current inventory, and improvements will be brought to this category in subsequent cycles. Note that category 2.A.4.a is not expected to be a key category.</p> <p>There is no soda ash production in Lebanon. Therefore, all soda ash used is imported. It is also 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. CO₂ resulting from soda ash used is not a key category in Lebanon. Thus, the tier 1 methodology was adopted as per equation 2.14.</p>
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.
2.D.2 Paraffin Wax Use	CO ₂ resulting from the use of paraffin wax is not a key category in Lebanon. Therefore, the tier 1 approach was adopted as per equation 5.4.

Difference between 1996 and 2006 IPCC guidelines

Changes resulting from the change to the 2006 IPCC GL that are relevant for Lebanon are:

- The reorganisation of categories under mineral production
- GHG estimation of non-energy use from fuel and solvent use now require emissions from lubricant, paraffin wax and solvent use.

Activity data

Cement production (2.A.1)

The 3 cement production plants that operate in Lebanon provide the Ministry of Environment with production data on a yearly basis, as part of their reporting mechanism. Since data is only available only since 2000, the amount of clinker for the period 1994-2015 has been extrapolated.

Lime production (2.A.2)

Data adopted for this inventory for lime production is the most accurate to date. It has been obtained from the primary source: i.e. the only lime producing plant in Lebanon. Due to a shift in management of the plant, a more open approach to access to information is now adopted by the company. Note that data prior to 1999 is not available, the values have therefore been extrapolated for completeness.

Table 35: Amount of clinker produced in Lebanon for the years 1994 – 2015

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

Table 36: amount of lime produced in Lebanon for the years 1994-2015

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

2.A.4.b Other uses of soda ash

Data on soda ash use in Lebanon is obtained from the customs online database using the HS code 28.36.20. It is considered that all soda ash imported, minus all soda ash exported in a given year is consumed in the same year. Note that data prior to the year 2000 is not available, therefore values have been extrapolated for completeness.

Table 37: Quantities of soda ash imported, exported and used in Lebanon from 1994 to 2015

	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 was 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.

Table 38: Paraffin Wax used

Year	Import (tonnes)	Export (tonnes)	Import - Export (tonnes)	Import - Export (TeraJoules)
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

Emission factors

Except for the emission factor for cement production which was nationally developed, all other emission factors used in the calculation of emissions from the IPPU category are based on default values provided by the 2006 IPCC GL. Table 39 presents all the emission factors used in the IPPU category. Details on how the national emission factor was calculated are presented in Box 3.

Table 39: Emission factors and other parameters for industrial processes

Reporting category	Emission factor	Source
2.A.1 Cement production	0.52 t CO ₂ /t clinker produced Correction factor for cement kiln dust: 1.02	Nationally developed emission factor (MoE/UNDP/GEF, 2011)
2.A.2 Lime production	0.75 tonnes CO ₂ /tonnes lime produced	
2.A.4.b Other uses of soda ash	0.41492 tonnes CO ₂ /t soda ash	Table 2.1 page 2.7 of IPCC 2006 volume 3 (part 1) chapter 2
2.D.2 Paraffin was use	0.2 (fraction)	Page 5.12 of IPCC 2006 volume 3 (part 1) chapter 5

Box 3: Details on the calculation of the national emission factor for cement production

Data on CaO (quicklime) content of the clinker (CaO_Clinker) 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 cements companies are:

CaO_Clinker = 66%

CaO_Carbonate = 99.8%

The carbonate CaCO₃ is 56.03 percent CaO and 43.97 percent CO₂ by weight as per table 2.1 of the 2006 IPCC GL.

The equation for the clinker emission factor when applying these parameters is:

$$EF_{cl} = (0.66 - (1 - 0.998)) / 0.5603 * 0.4397 = 0.52 \text{ tonnes CO}_2/\text{tonne clinker}$$

A correction factor should be applied to this emission factor, the default value of 1.02 was applied.

Results of IPPU sector

In 2015, total emissions from industrial processes in Lebanon amounted to 2,284 Gg of CO₂. GHG emissions primary entail the CO₂ gas from the cement production sector (2276.36 Gg of CO₂ in 2015). Lime production and soda ash use have a very minimal contribution to CO₂ emissions in the sector (2.12 and 5.01 Gg of CO₂ respectively). This is the case for the entire times series where emissions from the IPPU sector are correlated to clinker production.

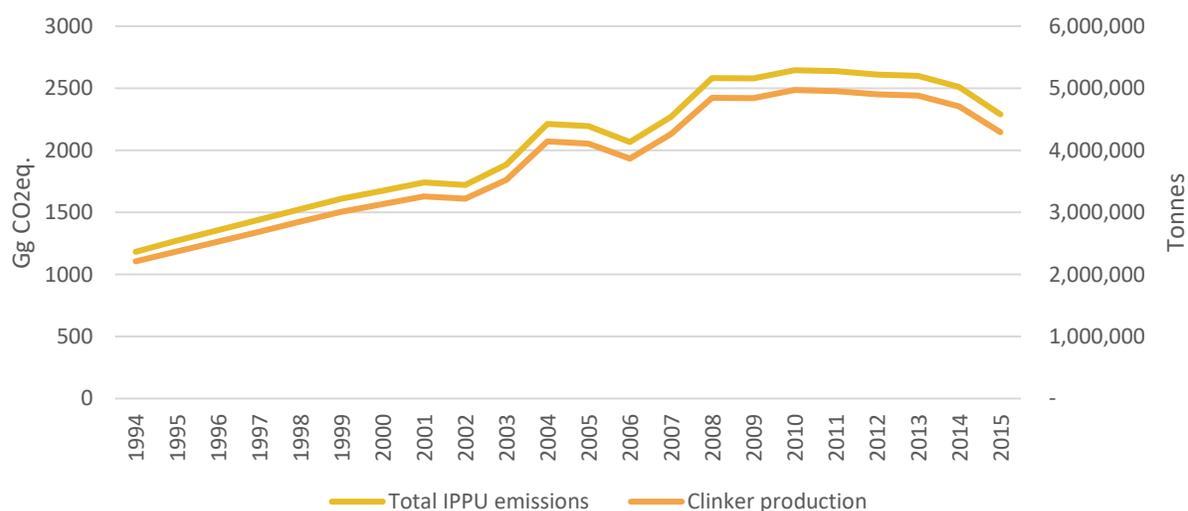


Figure 23: Trend of total emissions from the IPPU sector compared to trend of clinker production for the times series 1994-2015

3.3 Agriculture, Forestry, and Other Land Uses (AFOLU)

Methodology

The present section covers the following AFOLU subcategories:

- 3.A.1 Enteric fermentation
- 3.A.2 Manure management
- 3.B.1 Forest land
- 3.B.2 Cropland
- 3.B.3 Grassland
- 3.B.4 Wetland
- 3.B.5 Settlements
- 3.C.1 Emissions from biomass burning
- 3.C.3 Urea application
- 3.C.4 Direct N₂O emissions from managed soils
- 3.C.5 Indirect N₂O emissions from managed soils
- 3.C.6 Indirect N₂O emissions from manure management

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.D.1 Harvested wood products

Difference between 1996 and 2006 IPCC GL

Under the Revised 1996 IPCC guidelines, Agriculture and Land-Use, Land-Use Change and Forestry (LULUCF) were two separate categories for GHG emission calculations. These have been combined and now known as Agriculture, Forestry and Land-use (AFOLU) category under the IPCC 2006 GL and also led to a reorganisation of categories. Furthermore, a number of previously optional categories were included as requirements (e.g., CO₂ emissions and removals associated with terrestrial carbon stocks in settlements) and a number of methodologies were newly added.

The changes that affected Lebanon's GHG inventory, in terms of reallocation of emissions and changes in totals, are mostly related to agriculture activities:

- Inclusion of indirect NO₂ from manure management
- Inclusion of CO₂ emissions from urea fertilization
- Inclusion of N₂O from nitrogen mineralization associated with loss of soil organic matter resulting from change of land use or management of mineral soils
- Inclusion of harvested wood products

Figure 24 presents the key differences between both sets of guidelines.

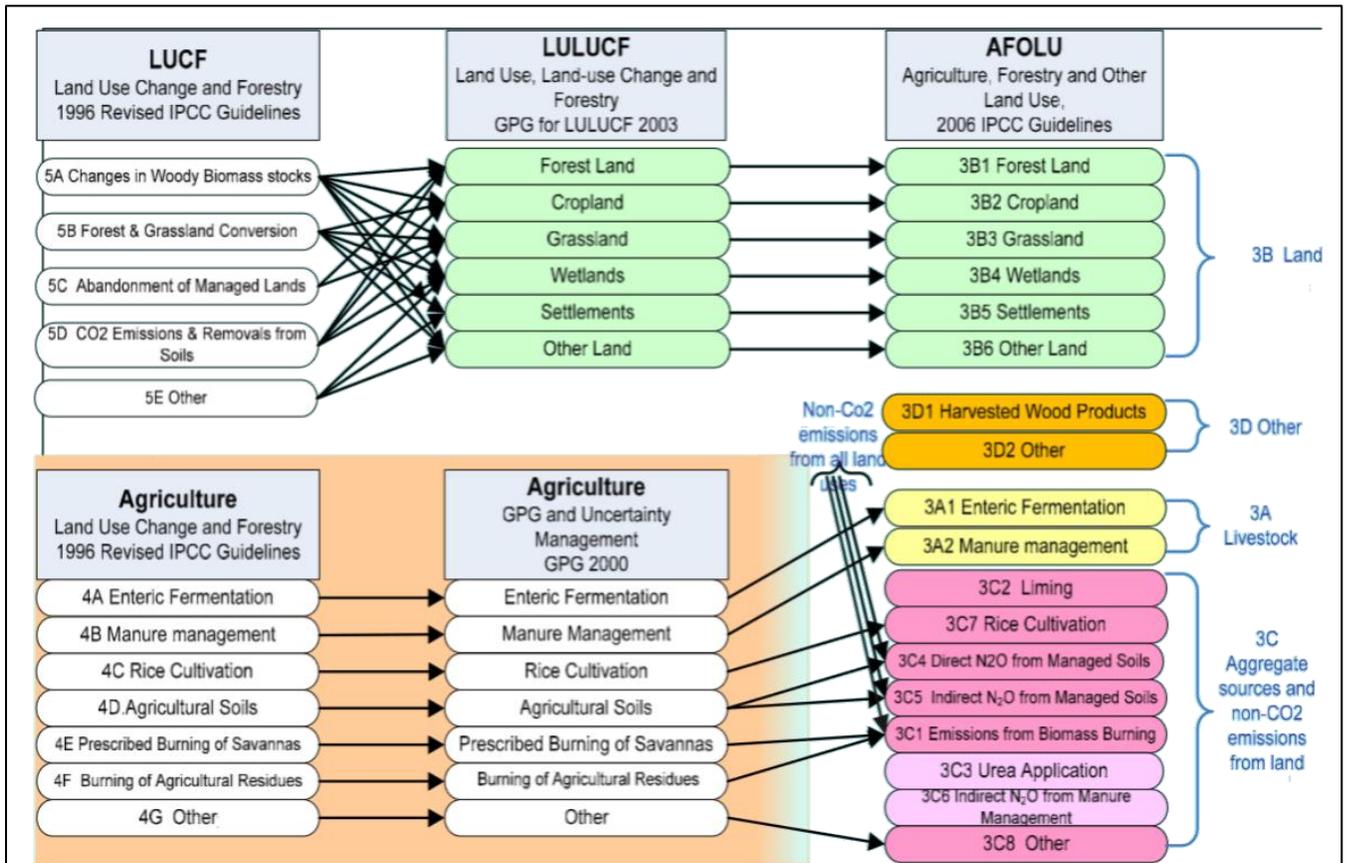


Figure 24: Difference between the IPCC 2006 guidelines and the 1996 IPCC GL for the AFOLU sector

3.3.1 Livestock (3A)

This category estimates CH₄ emissions from Enteric Fermentation in livestock, and CH₄ and N₂O emissions from Manure Management. As per the guidelines, CO₂ emissions from livestock are not estimated because annual net CO₂ emissions are assumed to be zero (the CO₂ photosynthesized by plants is returned to the atmosphere as respired CO₂). A portion of the C is returned as CH₄ and for this reason CH₄ requires separate consideration. Cattle are an important source of CH₄ in many countries because of their large population and high CH₄ emissions rate due to their ruminant digestive system. N₂O 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 was summed up as per equation 10.20. except for poultry since they do not cause enteric fermentation emissions.

For CH₄ 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 CH₄ emissions from manure management as per equation 10.22.

For direct N₂O 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 attempted 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 N₂O 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.

Data for dairy cattle, non-dairy cattle, sheep, goat, traditional poultry, laying hens, and broilers for the years 1997 to 2015 was obtained from the MoA. Data on imported beef was retrieved from previous inventories up until the year 2012 and was estimated by MoA expert judgement for the years 2013-2015 since published information could not be obtained. Data for 2014 was not available from MoA, hence activity data for this year was retrieved from FAOSTAT for goat and sheep and was extrapolated for cattle and poultry due to a different categorization between MoA and Food and Agriculture Organization (FAO). Data for the years 1994-1996 was extrapolated in previous inventories and same numbers were adopted for the current BUR. Quality control measures were applied to data on broilers from the years 1994 to 1999 and on traditional chicken from 1994 to 1997 as the numbers provided by the MoA were deemed outlier numbers. Data from previous inventories was therefore adopted.

Data for swine, camels, horses, mules and asses for the years 1994-2015 was obtained from FAOSTAT as they are not available from national sources (i.e. the MoA).

Populations of imported beef and broilers were adjusted to 60 and 30 days alive respectively.

The size of sheep and goat herds has fluctuated since 1994 mainly due to decrease in number of shepherds and due to competition from imported meat from Australia, Turkey and Syria. In addition, the crisis in Syria has caused the influx of goat and sheep herders to Lebanese rangelands with their flocks but this is hard to quantify. Therefore, there are cross boundary movements of sheep and goats between Lebanon and Syria, partly for grazing purposes. Swine production has decreased steadily since 1994 due to shift in consumer preferences towards poultry, mutton and beef, and due to fear from the swine flu (MoE/UNDP/GEF, 2015).

Table 40: Livestock population in Lebanon (heads) from 1994 to 2015

	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

*Including imported beef adjusted to 60 days alive

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

Table 41: Segregated poultry population in Lebanon (heads) from 1998 to 2015

	Laying Hens (used for meat)	Traditional chicken	Broilers	Broilers adjusted to 60 days alive	Total adjusted to days alive
1994	2,599,000	676,190	51,800,000	8,515,068	11,790,258
1995	2,500,000	779,047	50,500,000	8,301,370	11,580,417
1996	2,725,000	881,904	50,350,000	8,276,712	11,883,616
1997	2,800,000	500,000	58,800,000	9,665,753	12,965,753
1998	3,000,000	900,000	59,000,000	9,698,630	10,998,630
1999	3,200,000	900,000	60,700,000	9,978,082	11,378,082
2000	3,200,000	1,100,000	62,000,000	10,191,781	14,491,781
2001	3,300,000	1,200,000	64,000,000	10,520,548	15,020,548
2002	3,400,000	1,000,000	67,000,000	11,013,699	15,413,699
2003	3,500,000	700,000	69,000,000	11,342,466	15,542,466
2004	3,600,000	700,000	76,000,000	12,493,151	16,793,151
2005	3,600,000	700,000	72,000,000	11,835,616	16,135,616
2006	3,600,000	600,000	77,700,000	12,772,603	16,972,603
2007	3,700,000	700,000	79,500,000	13,068,493	17,468,493
2008	3,700,000	700,000	75,000,000	12,328,767	16,728,767
2009	3,700,000	700,000	72,000,000	11,835,616	16,235,616
2010	3,757,356	411,897	44,982,000	7,394,301	11,563,554
2011	2,500,000	1,000,000	60,000,000	9,863,014	13,363,014
2012	2,000,000	1,000,000	66,000,000	10,849,315	13,849,315
2013	2,500,000	1,000,000	56,000,000	9,205,479	12,705,479
2014	2,648,500	747,000	59,023,500	9,702,493	13,097,993
2015	2,797,000	494,000	62,047,000	10,199,507	13,490,507

Table 42: Segregated imported beef population (heads) from 1998 to 2015

	Imported beef	Imported beef adjusted to 60 days alive	Non-dairy cattle	Total non-dairy cattle including imported beef adjusted to days alive
1994	220,179	18,097	43480	61,577
1995	218,059	17,923	25710	43,633
1996	215,940	17,749	37070	54,818
1997	213,872	17,579	51860	69,439
1998	185,988	15,287	35,859	51,146
1999	218,481	17,957	37,431	55,388
2000	222,634	18,299	38,100	56,399
2001	185,036	15,208	38,547	53,755
2002	227,982	18,738	44,400	63,138
2003	222,382	18,278	38,736	57,014
2004	210,571	17,307	36,544	53,851
2005	183,297	15,066	33,100	48,166
2006	196,074	16,116	33,100	49,216
2007	187,917	15,445	32,100	47,545
2008	149,950	12,325	33,500	45,825
2009	187,992	15,451	34,100	49,551
2010	190,462	15,654	28,407	44,061
2011	202,862	16,674	15,000	31,674
2012	181,314	14,903	23,000	37,903
2013	250,000	20,548	13,382	33,930
2014	250,000	20,548	22,465	43,013
2015	250,000	20,548	31,548	52,096

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 43: Fraction of Manure Nitrogen per Manure Management System in Lebanon based on expert judgement

	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 44. 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 44: 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 CH₄ emissions from manure management (3.A.2): Table 45 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 45: 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 N₂O 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 46).

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 N₂O emissions from manure management systems are presented in Table 48. 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 46: Nitrogen excretion rate for animal species (kg of N per 1,000 kg of animal mass per day) and typical animal mass for livestock categories (kg/animal)

	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 47: 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	0.5	
Other	solid storage	0.15	

Table 48: Emission factors for Nitrous Oxide emissions for each utilized manure management system in Lebanon

Manure management system	Emission Factor (kg N ₂ O-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	

3.3.2 Land (3.B)

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, 2007).

The estimation of GHG emissions and removals in 3.B land is divided into two broad categories:

- 1) methods that can be applied in a similar way for any of the types of land use (i.e., generic methods for Forest Land, Cropland, Grassland, Wetlands, Settlements and Other Land) for estimating ecosystem carbon stock changes as well as for estimating non-CO₂ fluxes from fire,
- 2) methods that only apply to a single land use or that are applied to aggregate data on a national-level, without specifying land use.

Methodology

The representation of most land-use areas and land conversions was done following the Approach 3 of the IPCC, 2006. The nationally adopted land-use classification system of the Land Cover / Land Use map of 1998 was employed for the inventory estimation (Annex III). 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.

Initial collection and calculation of the activity data was conducted following three methodologies depending on the availability and type of country-specific data:

- Tier 3 methodology within 2006 IPCC guidelines
- Surveys and personal communications
- Interpolations and extrapolation

The selection of the appropriate tier level for the land categories and subcategories, non-CO₂ gases and carbon pools, was mostly based on the resources available for the inventory process. Tiers correspond to a progression from the use of simple equations with default data to country-specific data in more complex national systems.

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.

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. The tier levels of the activity data acquired by surveys and personal communications depended on the accuracy and completeness of the nationally available estimates.

Main assumptions and activity data taken into consideration for the Land Use Categories of the AFOLU sector are presented in Table 49.

Table 49: Land use categories and subcategories, carbon pools and non-CO₂ 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	No Settlements converted to Grassland

Land use categories	Subcategories	Estimations calculated ¹	Not Estimated (NE)/No activity data available	Assumptions
			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-CO₂ gases depending on data availability: AGB, BGB, DOM, litter and soil carbon; CH₄, N₂O, CO and NO_x

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

Activity data

Data collection was conducted using satellite remote sensing and Geographic Information System (GIS) techniques, literature reviews, and surveys.

Table 50: Type of data sources and databases used for data collection

Type of data source	Databases
Online database, Global databases	FAOSTAT, EFDB, Google Earth
Scientific articles and papers	Altas et al. (2007); Aksu et al. (2001); Gerard (2009) Mitri et al. (2012); Tragsa (2012); Hreiche (2009) Darwish and Faour (2008); IPCC (2003)
National reports	FAO (2005); FAO (2010)
Satellite imagery	5 SPOT imagery (2.5 m) 30 Landsat TM and ETM+ imagery (25 m)
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 (LU) Dr. Talal Darwish; Mr. Joseph Bechara (LRI) Mr. Raymond Khoury (Greenplan)

Table 51: Land Activity Data for selected years

	1998	2013	2014	2015
Forest Land remaining Forest Land	25,4771.13	254,106.19	254,063.00	254,009.69
<i>Coniferous</i>	34,887.56	34,822.44	34,821.75	34,818.63
<i>Broadleaf</i>	193,467.06	192,925.38	192,888.75	192,843.63
<i>Mixed</i>	26,416.50	26,358.38	26,352.50	26,347.44
Annual volume of fuelwood gathering (m³)	18,833	18,769	18,737	18,706
<i>Non-Coniferous</i>	15,000	15,000	15,000	15,000
<i>Coniferous</i>	3,833	3,769	3,737	3,706
Grassland remaining Grassland	315,697.12	315,180.62	315,168.31	315,149.44
Cropland remaining Cropland	329,415.12	328,364.69	327,986.87	327,431.25
<i>Perennial</i>	159,376.06	158,970.00	158,884.81	158,786.44
<i>Annual</i>	170,039.06	169,394.69	169,102.06	168,644.81
WetLand remaining WetLand	470		516.75	520.5
Other Land remaining Other Land	49,041		45,443	45,303
Forest Land disturbances (forest fires)				
By forest type	161.13	127.56	120.75	182.56
<i>Coniferous</i>	14.63	4.75	6.875	14.87
<i>Broadleaf</i>	133.56	44.25	97	113.81
<i>Mixed</i>	12.94	78.56	16.87	53.87
Grassland burned	182.38	37.88	67.88	302.38
<i>Fuel Type 1</i>	109.06	37.87	47.56	226.81
<i>Fuel Type 2</i>	73.31	0	20.31	75.56
Cropland Burned	585.19	9.56	282.56	246.5
Land converted to Settlements	1,195.06	1,248.25	429.56	624.06
Forest Land to Settlements	603.94	356.94	43.19	53.31
<i>Coniferous</i>	55.88	48.62	0.68	3.125
<i>Broadleaf</i>	495.50	258.75	36.62	45.12
<i>Mixed</i>	52.56	49.56	5.875	5.06
Grassland to Settlements	348.25	296.68	8.56	15.12
Cropland to Settlements	242.88	594.63	377.81	555.63
<i>Perennial</i>	125.63	265.25	85.18	98.37
<i>Annual</i>	117.25	329.37	292.62	457.25
Other land to Forest	2,913	3,530	3,765	4,000
Other land to Wetland	NE	3.75	3.75	3.75

Activity data for the 1994-2015 period is available in Annex IV

Emission factors and other parameters

Collection of the Emission/Removal (E/R) factors was done following two methodologies according to the availability and type of data:

- Tier 1: IPCC 2006 default data or assumptions
- Tier 2: Country-specific data from global databases, literature or surveys, and personal communications

For CO₂ emissions and removals, complete list of the parameters investigated and reported for the period 1994-2015 as well as the assumptions made are presented in the below tables.

Table 52: Main emission factors and parameters for 3.B land

Parameter	Symbol	Value(s) used	Reference	Notes
Carbon fraction of dry matter	CF	0.47 tonnes 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	G _w	1.5 tonnes dm/tonnes shoot	Default IPCC 2006 table 4.9	
Reference carbon stock	SOC _{REF}	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	F _d	0.46	Calculated	Derived from (1-fBI) 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 then finding Fraction of biomass loss in disturbance (fBI) by substitution (1-fBL=0.585 so fBL=0.415)

Parameter	Symbol	Value(s) used	Reference	Notes
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	DCI	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
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 (Darwish and Faour, 2008)
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				

Parameter	Symbol	Value(s) used	Reference	Notes
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 Perennial woody crops 134 tonnes dm/ha Gasslands 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 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 (forestland)		130 tonnes dm/ha	Default IPCC 2006	

Table 53: Main assumptions for AFOLU - Land Use Categories

Climate region	Warm temperate dry																																																																	
Soil type	High activity clay mineral																																																																	
Ecosystem type	Subtropical dry forest																																																																	
Continent type	Continental																																																																	
Species Age class	20 years																																																																	
Growing stock level	Unspecified																																																																	
Area of Forest remaining forest	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 broadleaves, 13% are mixed and only 1% are coniferous (FAO, 2005)																																																																	
Annually extracted volume of roundwood	According to experts' surveys (Chneis, Stephan, 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.																																																																	
Biomass density (average weighed)	<p>The Biomass density (tonnes/m³) 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.</p> <p>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 Table 4.14 and Aksu et al., 2001.</p> <table border="1"> <thead> <tr> <th><u>Broadleaved forest</u></th> <th>Actual percentages 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> </thead> <tbody> <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>0.58</td> </tr> <tr> <th><u>Coniferous forest</u></th> <th>Actual percentages 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>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>0.50</td> </tr> <tr> <td><u>Mixed</u></td> <td></td> <td></td> <td></td> <td>0.54</td> </tr> </tbody> </table>	<u>Broadleaved forest</u>	Actual percentages in forests	Weighted percentage	Biomass density of individual species (tonnes d.m.m ⁻³ fresh volume)	Average weighted Biomass Density	Quercus calliprinos	41.1%	46.08	0.58	0.26	Quercus infectoria	34.1%	38.22	0.58	0.22	Quercus cerris and var.pseudocerris	14%	15.70	0.58	0.09	Total	89.2	100		0.58	<u>Coniferous forest</u>	Actual percentages in forests	Weighted percentage	Biomass density of individual species (tonnes d.m.m ⁻³ fresh volume)	Average weighted Biomass Density	Pinus brutia	43.7	44.86	0.53	0.23	Pinus pinea	35.8	36.75	0.46	0.18	Juniperus excelsa	9.7	9.95	0.51	0.05	Cedrus libani	4.5	4.62	0.48	0.02	Juniperus drupacea	3.7	3.79	0.49	0.02	Total	97.4	100		0.50	<u>Mixed</u>				0.54
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Total	89.2	100		0.58																																																														
<u>Coniferous forest</u>	Actual percentages in forests	Weighted percentage	Biomass density of individual species (tonnes d.m.m ⁻³ fresh volume)	Average weighted Biomass Density																																																														
Pinus brutia	43.7	44.86	0.53	0.23																																																														
Pinus pinea	35.8	36.75	0.46	0.18																																																														
Juniperus excelsa	9.7	9.95	0.51	0.05																																																														
Cedrus libani	4.5	4.62	0.48	0.02																																																														
Juniperus drupacea	3.7	3.79	0.49	0.02																																																														
Total	97.4	100		0.50																																																														
<u>Mixed</u>				0.54																																																														

Mineral soils	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																					
Organic soils	There are no organic forest soils in Lebanon according to experts' surveys (Darwish, May 2013) therefore the value of area of drained organic forest soils is equals zero.																					
Disturbances (Forest fire)	<p>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.</p> <table border="1"> <thead> <tr> <th>Prometheus fuel type class</th> <th>Rothermel fuel models</th> <th>Mass of available fuel (Rothermel averages)</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>No data exists on the amount of vegetation fires on lands converted to Forestlands, therefore they will not be calculated.</p>	Prometheus fuel type class	Rothermel fuel models	Mass of available fuel (Rothermel averages)	1	1, 2, 3	5 tonnes/ha	2	5	6.5 tonnes/ha	3	6	12.5 tonnes/ha	4	4	30 tonnes/ha	5	8, 9	9.5 tonnes/ha	6, 7	7	12.5 tonnes/ha
Prometheus fuel type class	Rothermel fuel models	Mass of available fuel (Rothermel averages)																				
1	1, 2, 3	5 tonnes/ha																				
2	5	6.5 tonnes/ha																				
3	6	12.5 tonnes/ha																				
4	4	30 tonnes/ha																				
5	8, 9	9.5 tonnes/ha																				
6, 7	7	12.5 tonnes/ha																				
Annual change in carbon stocks in living biomass	No data exist on losses in forest plantations or afforestation areas, therefore we assume that value is equal to zero.																					
Other land converted to forest land	<p>The values for area converted to forest land are taken from publications and personal communications with Association for forests, Development and Conservation (AFDC), Lebanese Reforestation Initiative (LRI), Jouzour Loubnan, and reforestation project leaders in Lebanon</p> <p>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.</p> <p>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. (Chneis, May 2013)</p>																					
Annual area of cropland with perennial woody biomass	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.																					
Land converted to cropland	No data exists on the amount of lands converted to Croplands, therefore they will not be calculated.																					
Area of grassland covered with grasses	The grasslands category includes only grasses. Grasslands covered with perennial woody biomass are considered shrublands and are included under Forestlands.																					
Settlements remaining settlements	No estimates will be made for the subcategory settlements remaining settlements due to lack of data.																					
Land converted to settlements	Land converted to Settlements is calculated for Forest lands in addition to Croplands and Grasslands since enough data was available to do the calculation.																					

3.3.3 Aggregate sources and non-CO₂ emissions sources on land (3.C)

There are significant emissions of non-CO₂ from biomass burning, livestock and manure management, or soils.

Biomass burning (3.C.1) 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). Emissions (CO₂ and non-CO₂) need to be reported for all fires (prescribed fires and wildfires) on managed lands, with the exception of CO₂ from grassland.

Emissions of N₂O from managed soils (3.C.4 and 3.C.5) result from anthropogenic N inputs through both a direct and an indirect pathway. Direct pathway occurs via two mechanisms (a) intentional additions of N directly to soils through synthetic fertilizers, nitrogen fixation by N-fixing crops, animal manure, and crop residues and (b) unintentional additions of N through animals grazing on Pasture, Ranges, and Paddocks (PRP). Indirect N₂O emissions occur through two pathways – volatilization from applied fertilizer and manure as NH₃ and NO_x and subsequent deposition, and through leaching and runoff of applied fertilizer and animal manure (Figure 25).

Direct emissions of N₂O 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 N₂O somewhere else. This phenomenon is referred to as nitrogen loss by volatilization and/or leaching and runoff.

Finally, CO₂ emissions occur during application of fertilization of soils with Urea, due to a loss of CO₂ that was fixed in the industrial production process.

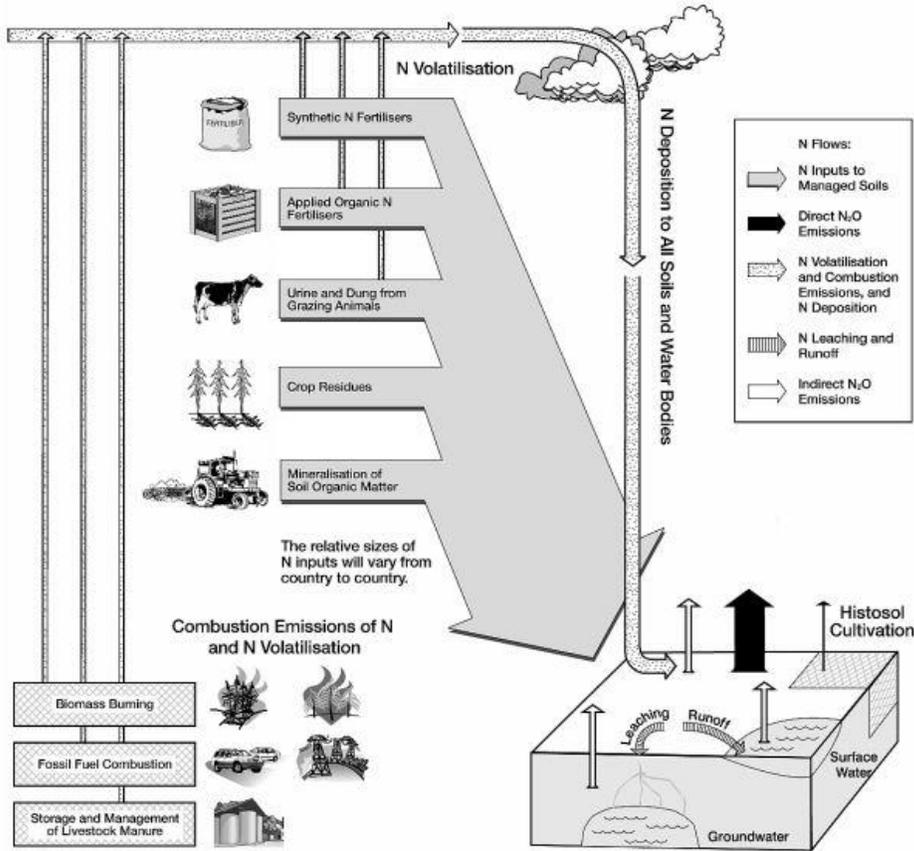


Figure 25: The different pathways of conversion of Nitrogen into Nitrous Oxide (IPCC, 2007)

Methodology

For emissions from biomass burning (3.C.1): Under the tier 1 approach, the Equation 2.27 was used to estimate CO₂ and non-CO₂ 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 CO₂ 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 CO₂ default emission factor.

For direct N₂O 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 N₂O emissions from soils as per equation 11.1. The tier 1 methodology assumes that N₂O 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 volatilizes ($Frac_{GASF}$) and of F_{ON} and F_{PRP} that volatilizes ($Frac_{GASM}$) 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 volatilizes 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

Biomass burning

Biomass burning in Lebanon is limited to Forestland and Grassland, where data is actually available. The biomass density (tonnes/m³) is 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 Table 4.14, and Aksu et al., 2001.

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 54: Area of burned biomass

Year	Area of Forestland burned	Area of Grassland burned	Ares of Cropland burned
1994-1998	-	-	-
1999	1,049	198	494
2000	330	126	502
2001	73	148	251
2002	73	148	251
2003	304	492	529
2004	63	96	223
2005	424	96	344
2006	1,197	815	334
2007	708	43	275
2008	26	13	542
2009	428	271	675
2010	428	271	675
2011	161	182	585
2012	603	243	1,306
2013	128	38	10
2014	119	68	283
2015	183	302	247

Amount of Urea Application:

Table 55: Amount of Urea applied to soils

Year	Amount of Urea applied to soils (tonnes)
1994	
1995	
1996	
1997	4,496
1998	1,445
1999	2,742
2000	4,962
2001	19,294
2002	6,253
2003	8,978
2004	10,330
2005	4,554
2006	300
2007	562
2008	45
2009	3,457
2010	4,090
2011	7,937
2012	4,961
2013	1,087
2014	6,006
2015	282

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 56: Types of fertilizers and their Nitrogen content used in Lebanon and corresponding HS code and adjustments applied to data

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
	3102.60	Total imports divided by 2	
Ammonium nitrate	3102.80	Total imports divided by 2	0.35
	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 57: 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

Table 58: 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

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 59: 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

Table 60: 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

Emission factors and other parameters

For emissions from biomass burning (3.C.1):

Table 61: Emission Factors from biomass burning

Emission factors (g/kg dm burnt)	Reference
CH ₄ Emission factor	4.7
N ₂ O Emission factor	0.26

Table 62: pParameters and assumptions from biomass burning

Parameter	Acronym	Value	reference	note
Mass of fuel available for combustion (Forestland)	MB	Broadleaf 9.5 (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	
		Coniferous 30(tonnes/ha)		
		Mixed 12.5 (tonnes/ha)		
Combustion factor (forest land)	C	0.74	Default IPCC 2006 table 2.6	for Other temperate forests, felled and burned
Mass of fuel available for combustion (Grassland)	MB	5 tonnes/ha		
Combustion factor (Grassland land)	Cf	0.74	Default IPCC 2006 table 2.6	for Shrublands
Mass of fuel available for combustion (cropland)	MB	4.6 tonnes/ha		All savannas woodland (mid/late dry season burn)
Combustion factor (Cropland)	Cf	0.74	Default IPCC 2006 table 2.6	All savannas woodland (mid/late dry season burn)

For CO₂ 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).

For direct N₂O 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 63: 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}	*Fra _{CREMOVE}
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 64. 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 64: 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 N₂O emissions from the different types on Nitrogen input to managed soils as presented in Table 65.

Table 65: Emission factors for direct N₂O emissions from managed soils (kg N₂O-N per kg N)

	Emission Factor	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 N₂O emissions from managed soils (3.C.5):

Table 66: Factors and parameters used for the calculation of indirect N₂O emissions

Fraction of Synthetic Fertilizer Applied Emitted as NO_x and NH₃ (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 volatilizes (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 N₂O emissions from manure management:

In addition to Frac_{GasMS} presented in the below table,, EF4 is used to calculate indirect N₂O emissions from manure management.

Table 67: Fraction of managed manure nitrogen for livestock category T that volatilizes as NH₃ and NO_x in the manure management system

Species	Manure management system	Fraction of livestock manure nitrogen that volatilizes (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	

3.3.4 Results of AFOLU

In 2015, total GHG emissions from the AFOLU category were 879 Gg CO₂eq. without the Land category (3.B) and -2,431.43 Gg CO₂eq. in total, constituting 3% of total national emissions. CH₄ emissions from AFOLU represented more than half of emissions from AFOLU, with 3.A.1 Enteric fermentation being the main source of emissions (395.95 Gg CO₂eq.). Nitrous oxide (N₂O) emissions from AFOLU were estimated at 391.39 Gg CO₂eq. with 3.C aggregate sources and non-CO₂ emissions sources being the main source of emissions followed by 3.A.2 manure management.

As for CO₂, AFOLU remains a sink category with a net total of -3,311.17 Gg CO₂eq., and the major sinks being cropland remaining cropland and forest land remaining forestland.

Table 68: Results of the GHG emissions/removals from AFOLU

	Net CO ₂ emissions / removals *(Gg CO ₂)	GHG Emissions (Gg CO ₂ eq.)		Net emissions (Gg CO ₂ eq.)
		CH ₄	N ₂ O	
3 - Agriculture, Forestry, and Other Land Use	-3,311.17	488.35	391.39	-2,431.43
3.A - Livestock	NA	487.96	105.85	593.81
3.A.1 - Enteric Fermentation	NA	395.95	NA	395.95
3.A.1.a - Cattle	NA	252.85	NA	252.85
3.A.1.a.i - Dairy Cows	NA	169.71	NA	169.71
3.A.1.a.ii - Other Cattle	NA	83.15	NA	83.15
3.A.1.b - Buffalo	NA	NE	NA	NE
3.A.1.c - Sheep	NA	61.49	NA	61.49
3.A.1.d - Goats	NA	73.78	NA	73.78
3.A.1.e - Camels	NA	0.28	NA	0.28
3.A.1.f - Horses	NA	1.82	NA	1.82
3.A.1.g - Mules and Asses	NA	5.52	NA	5.52
3.A.1.h - Swine	NA	0.22	NA	0.22
3.A.2 - Manure Management	NA	92.01	105.85	197.86
3.A.2.a - Cattle	NA	77.02	67.26	144.28
3.A.2.a.i - Dairy cows	NA	50.77	43.31	94.08
3.A.2.a.ii - Other cattle	NA	26.26	23.95	50.20
3.A.2.b - Buffalo	NA	NE	NE	NE
3.A.2.c - Sheep	NA	1.84	14.43	16.28
3.A.2.d - Goats	NA	2.51	21.73	24.24
3.A.2.e - Camels	NA	0.01	0.00	0.01
3.A.2.f - Horses	NA	0.17	0.00	0.17
3.A.2.g - Mules and Asses	NA	0.50	0.00	0.50
3.A.2.h - Swine	NA	2.41	0.25	2.66
3.A.2.i - Poultry	NA	7.55	2.18	9.73
3.B - Land	-3,311.38	NA	NA	-3,311.38
3.B.1 - Forest land	-795.12	NA	NA	-795.12
3.B.1.a - Forest land Remaining Forest land	-793.76	NA	NA	-793.77
3.B.1.b - Land Converted to Forest land	-1.354	NA	NA	-1.3)
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	-1.35	NA	NA	-1.35

3.B.2 - Cropland	-1,165.71	NA	NA	-1,165.71
3.B.2.a - Cropland Remaining Cropland	-1,165.71	NA	NA	-1,165.71
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	-1,350.55	NA	NA	-1,350.55
3.B.5.a - Settlements Remaining Settlements	NA	NA	NA	NA
3.B.5.b - Land Converted to Settlements	-1,350.55	NA	NA	-1,350.55
3.B.5.b.i - Forest Land converted to Settlements	-798.42	NA	NA	-798.42
3.B.5.b.ii - Cropland converted to Settlements	-552.28	NA	NA	-552.28
3.B.5.b.iii - Grassland converted to Settlements	0.16	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 t Other land	NE	NA	NA	NE
3.C - Aggregate sources and non-CO₂ emissions sources on land	0.21	0.39	285.54	286.14
3.C.1 - Emissions from biomass burning	NA	0.39	0.23	0.62
3.C.1.a - Biomass burning in forest lands	NA	0.20	0.11	0.31
3.C.1.b - Biomass burning in croplands	NA	0.11	0.06	0.17
3.C.1.c - Biomass burning in grasslands	NA	0.07	0.06	0.14
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	0.21	NA	NA	0.21
3.C.4 - Direct N ₂ O Emissions from managed soils (3)	NA	NA	191.49	191.49
3.C.5 - Indirect N ₂ O Emissions from managed soils	NA	NA	70.23	70.23
3.C.6 - Indirect N ₂ O Emissions from manure management	NA	NA	23.60	23.60

The trend of total emissions from the AFOLU category follows the trend of emissions from the aggregate sources and non-CO₂ emission sources subcategory (3.C), although emissions from the livestock category (3.A) constitutes the bulk of AFOLU emissions in 2015 (67% in 2015).

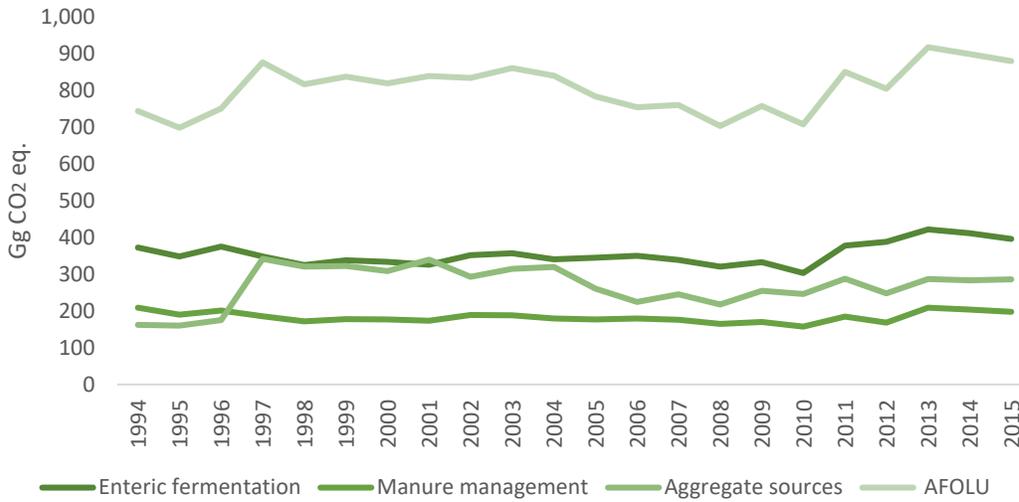


Figure 26: Total emissions from the AFOLU sector excluding the land category for the period 1994-2016 in Gg CO₂eq.

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 therefore 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.

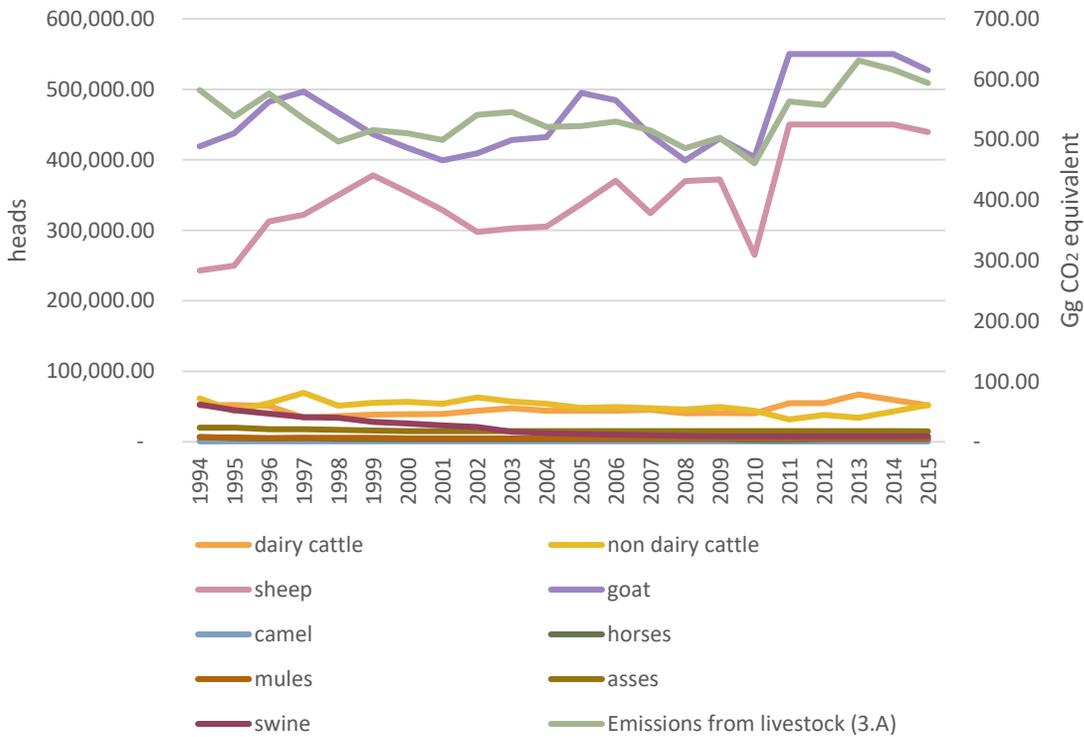
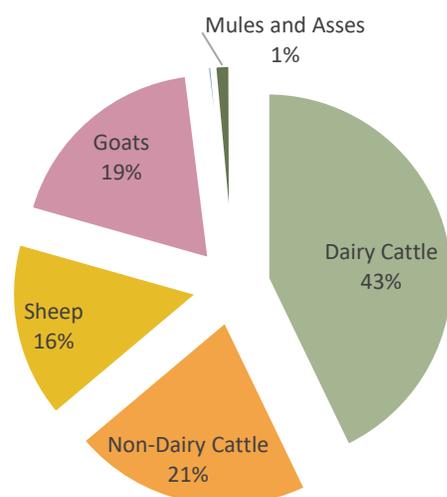


Figure 27: Emissions from the livestock category compared to populations of main livestock species in Lebanon for the period 1994-2015

Table 69: Emissions from livestock category per gas and subcategory from 1994-2015 in Gg CO₂ equivalent

Year	CH ₄ Enteric fermentation (3.A.1)	CH ₄ manure management	Direct N ₂ O 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

For enteric fermentation and manure management, dairy cattle are the largest contributor to GHG emissions in 2015, with a share of 43% and 55% respectively, followed by non-dairy cattle with a share of 21% and 28% respectively. (Figure 28 and Figure 29).

Figure 28: Breakdown of methane emissions from enteric fermentation for 2015 by main species in CO₂eq.

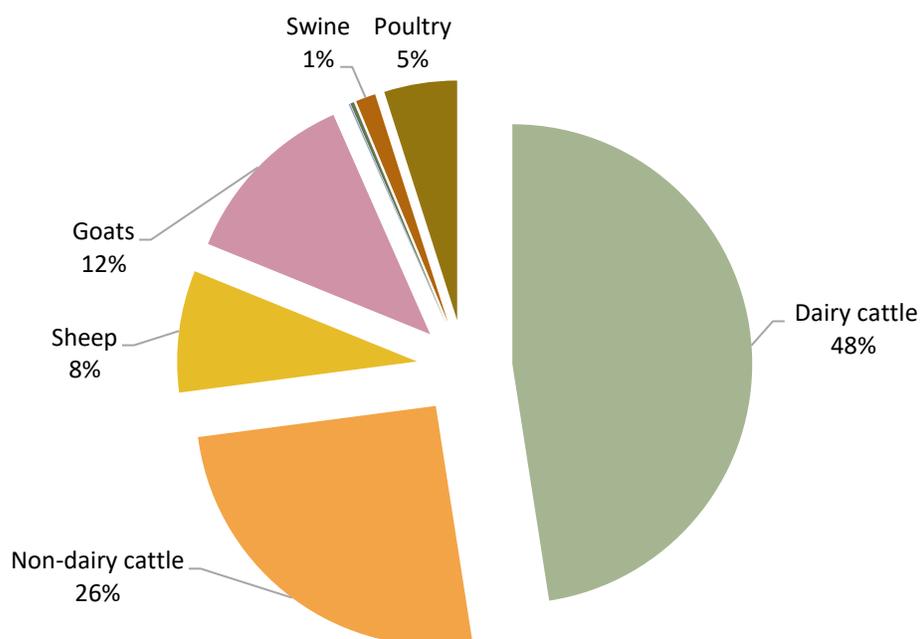


Figure 29: Breakdown of GHG emissions from manure management for 2015 by main species in CO₂eq.

3.B. Land

In 2015, forestry and other land use acted as a greenhouse gas sink in Lebanon, with net removals equal to -3,311 Gg CO₂ mainly attributed to the decrease/increase in vegetation cover within forest lands, croplands, and grasslands. Indeed, Lebanon's forest cover still represents a significant CO₂ sink, although a downward trend in sink capacities have been observed in recent years due to deforestation, forest fires and most importantly, urbanization.

The main categories that are contributing significantly to the emissions/removals in 3.B Land 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 70: Changes in emissions/removals in 2015

Type of change		Change in area (ha)	CO ₂ emissions/removals (Gg)
Forest settlements	to Coniferous	3.125	+0.76771
	Broadleaf	45.125	+10.093
	Mixed	5.0625	+1.188
Cropland settlements	to Perennial	98.375	+22.7246
	Annual	457.25	+8.38292
Grassland to settlements		15.125	+0.04437
Fuelwood gathering (m ³)		18706	+26.7472
Forest land remaining forest land (difference between 2014 and 2015)		-53.31	+0.4833477
Afforestation (Cumulative)		3946.44	-94.5687

In general, it was observed that the changes in CO₂ removals over the inventory period (1994-2015) were mainly attributed to the decrease/increase in vegetation cover within forest lands, croplands, and grasslands. The peak of land converted to settlement recorded in 2013 coincides with a peak in the amount of cement deliveries in the same year, which explains the high rate of urbanization on the expense on forested or planted areas. The lower demand for properties starting 2013 resulted in a drop-in construction during the consecutive years. It is important to note, however, that the reported numbers of annual conversion to settlement accounted only for the annual sum of any conversion that is above 90 to 100 m². This is mainly due to the spatial resolution of the employed satellite imagery. Counting the changes that are below 90 m² can slightly increase the total areas of conversion to settlement.

However, it is to be noted that the relatively small area reported in 2001 might be mainly related to underestimation through interpolation (as previously stated the 2001 satellite imagery was not used due to low quality of data). While the reported small areas of conversion in 2002 and 2007 might be mainly related to the characteristics and inherent conditions (e.g. shades, sun illumination) of the employed satellite imagery that were acquired on those years.

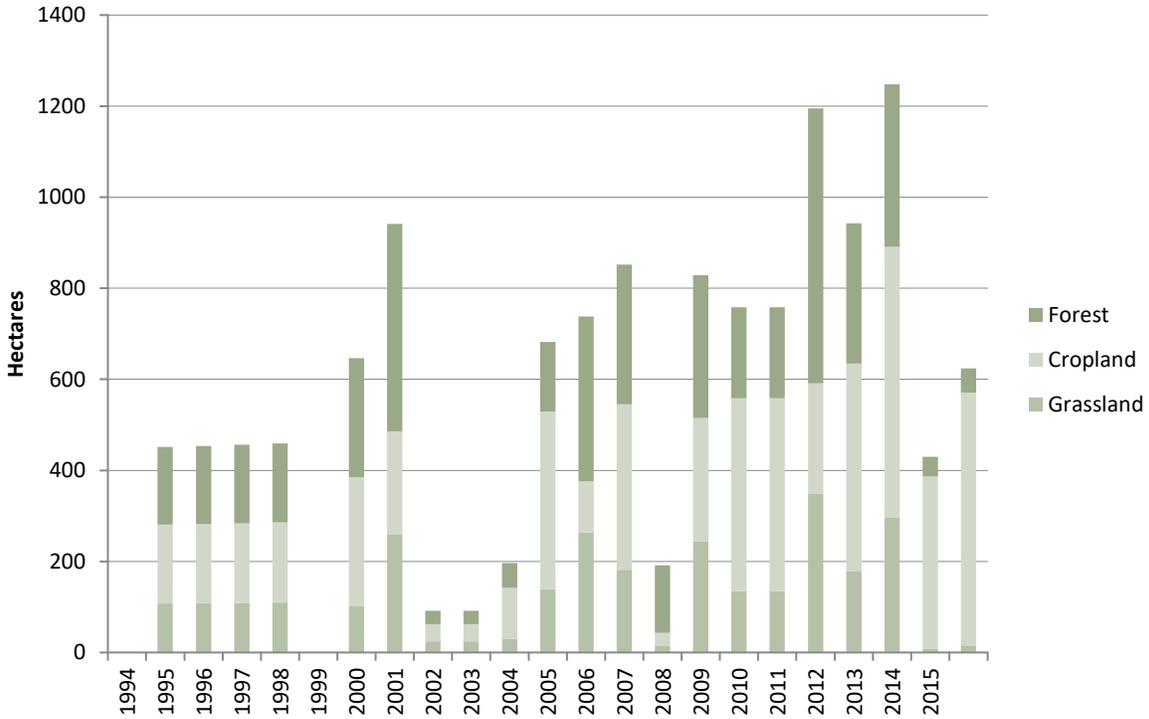


Figure 30: Areas of land categories converted to settlements

Moreover, a decrease of about 1.73% in existing forest lands mainly due to urbanization was shown between 1994 and 2015. These losses in biomass resulted in a decrease in CO₂ removals by an average of 1.82 Gg/yr from the forested areas.

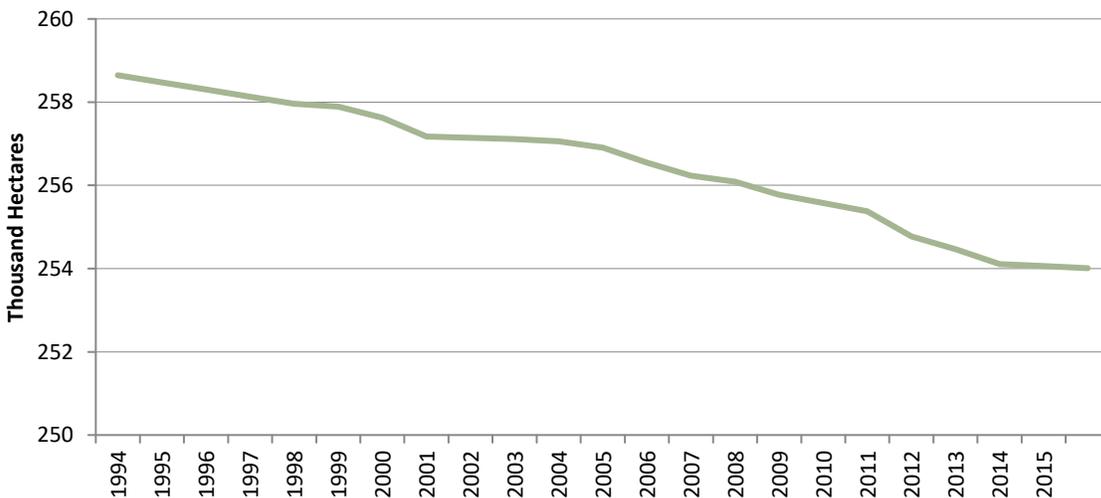


Figure 31: Forest lands remaining forest lands over the inventory period (1994-2015)

It was observed that broadleaf forests were the most affected by this type of conversions (Figure 32). This 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.

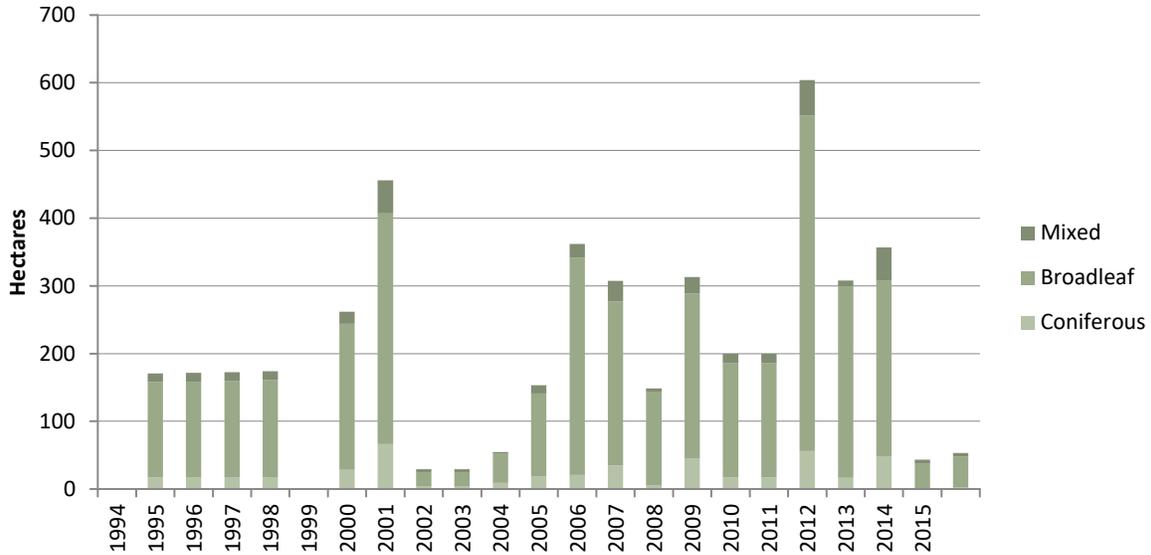


Figure 32: Areas of forest lands converted to settlements by subcategory

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 labour 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.

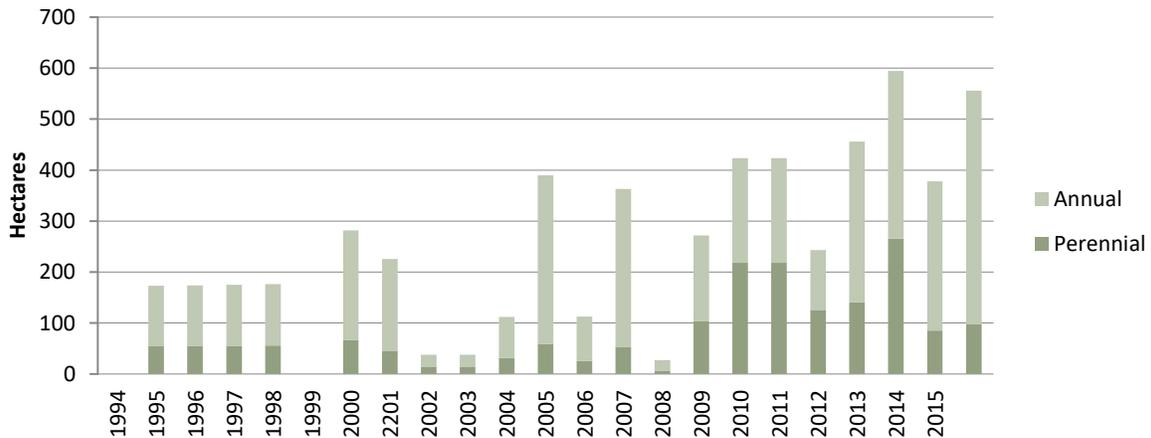


Figure 33: Areas of croplands converted to settlements by subcategory

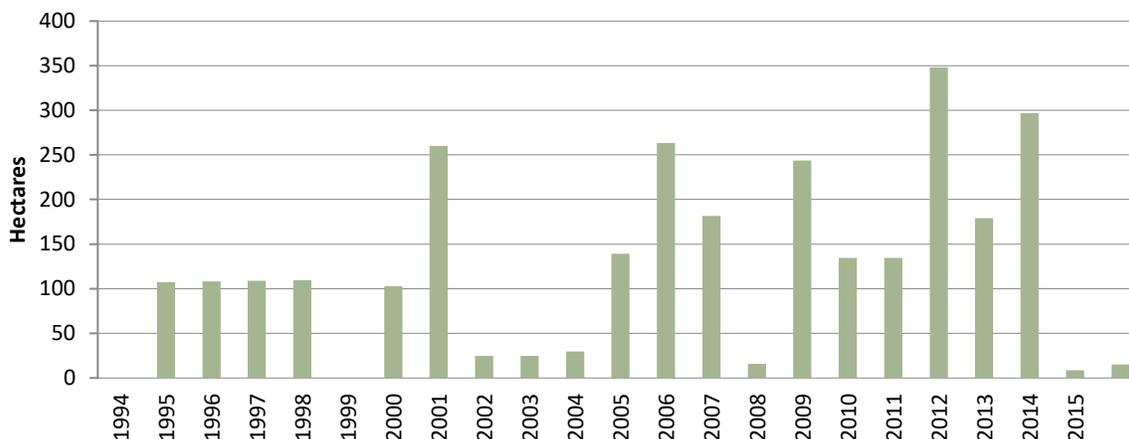


Figure 34: Areas of grasslands converted to settlements

The total estimate for fuelwood gathering in 2015 was 18,706 m³, a quite constant number over the inventory time period resulting in an average CO₂ emission of about 27 Gg/yr. Moreover, a decrease of 1.73% in existing forest lands from 1994 was shown in 2015, which is mainly attributed to urbanization resulting in a decrease in CO₂ removals from forest areas by an average of 1.82 Gg/yr.

Also, afforestation activities (Figure 35 and Figure 36) resulted in an average increase in CO₂ removal by 5.13 Gg/yr between 1999 and 2015. The decrease in afforested areas after 2007 might be related 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. In parallel to a gap of sustained reforestation activities which were observed between 2008 and 2011, the MoE resumed work on the National reforestation Plan (NRP) in 2009 through the project "Safeguarding and Restoring Lebanon's Woodland Resources" and signed in 2010 around 41 reforestation agreements worth USD 1.3 Million and covering 185 ha. Also, USFS launched in 2010 a five-year and USD 12 Million LRI. This has possibly contributed to an increase in afforested areas starting 2012. Subsequent decreases in yearly afforested areas could be related to limited availability of funding for reforestation/afforestation projects knowing that funding priorities were more oriented towards providing support to solve problems associated with the Syrian refugees' crisis.

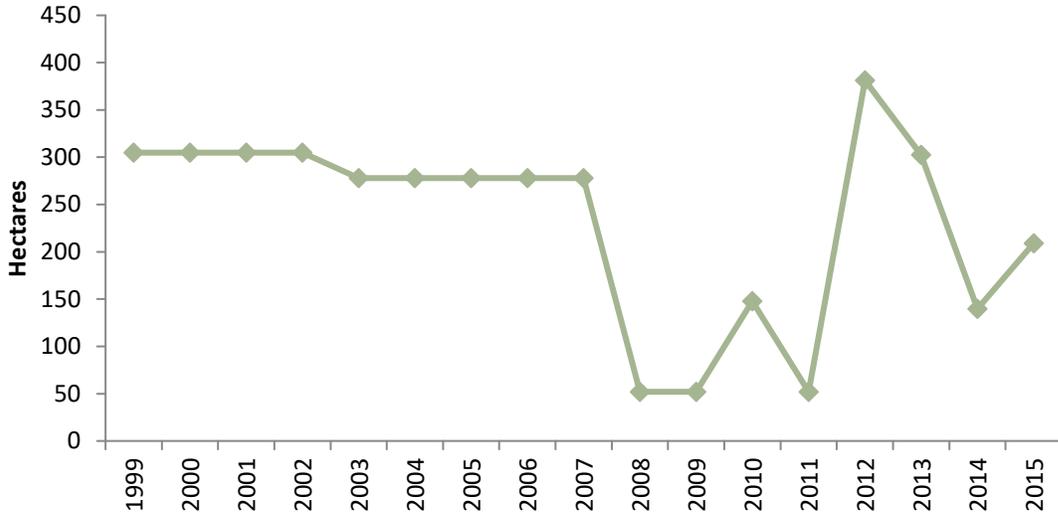


Figure 35: Yearly afforested areas

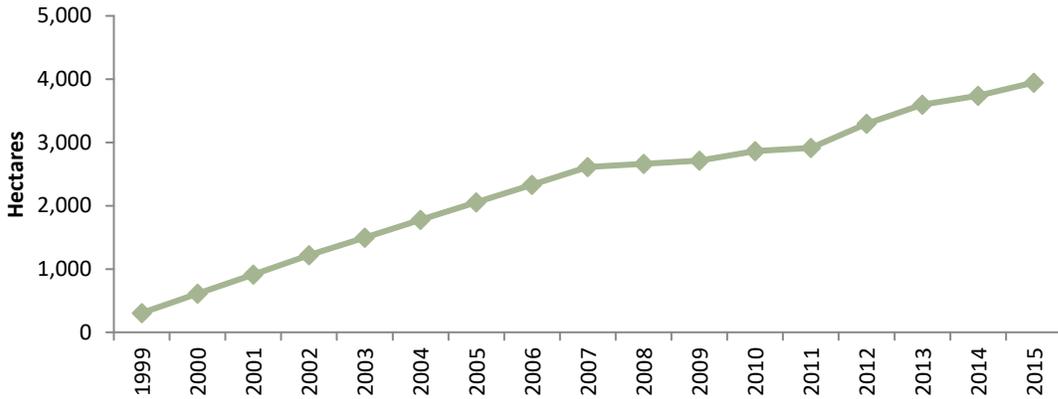


Figure 36: Cumulative lands converted to forests over the inventory period

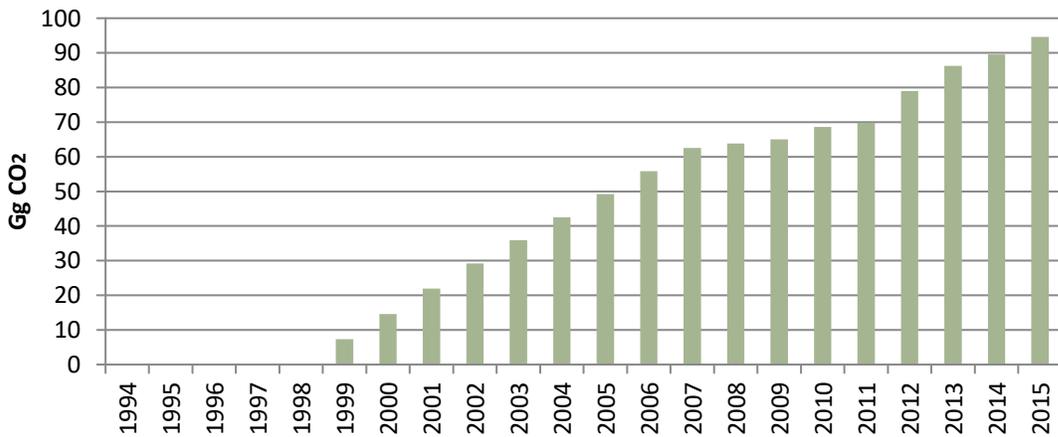


Figure 37: CO₂ removals due to biomass increments and increase in soil carbon stocks from afforestation

The decline in cropland areas covered with perennial woody crops resulted in the decrease of CO₂ removals by 1.15% from 1994 to 2015 with an average decrease rate of CO₂ removal of 0.65 Gg/yr (Figure 38).

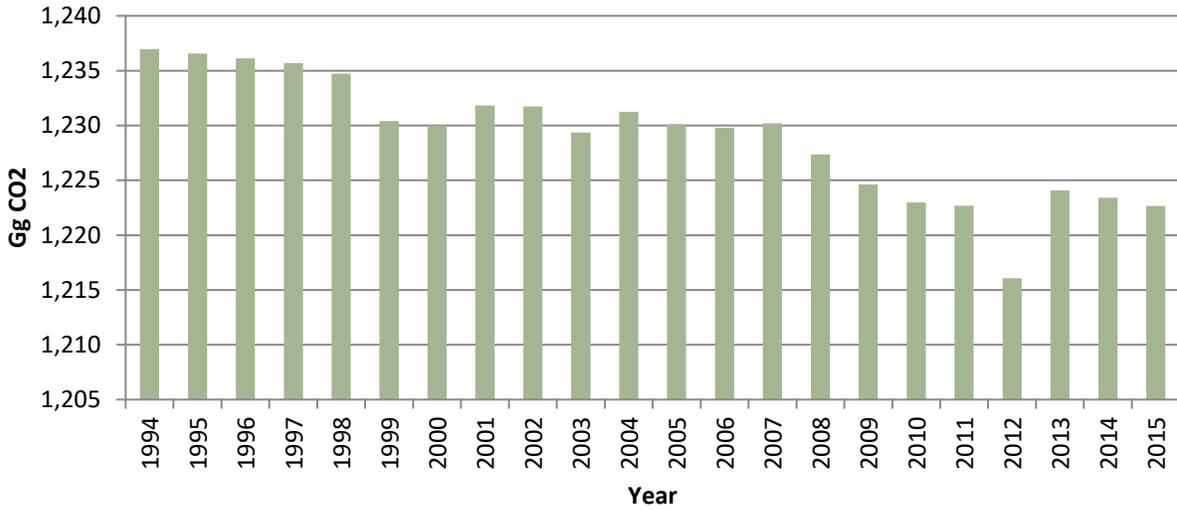


Figure 38: CO₂ removals due to biomass increments from cropland

Forests followed by croplands have the largest contribution to CO₂ emissions/removals in the LULUCF sector in Lebanon (Figure 39). However, further data (when available) on areas of wetlands (namely hill lakes) and grasslands along with their management systems (e.g. status of grazing,) can help in providing new insights on their level of contribution in GHG emissions or removals in the future.

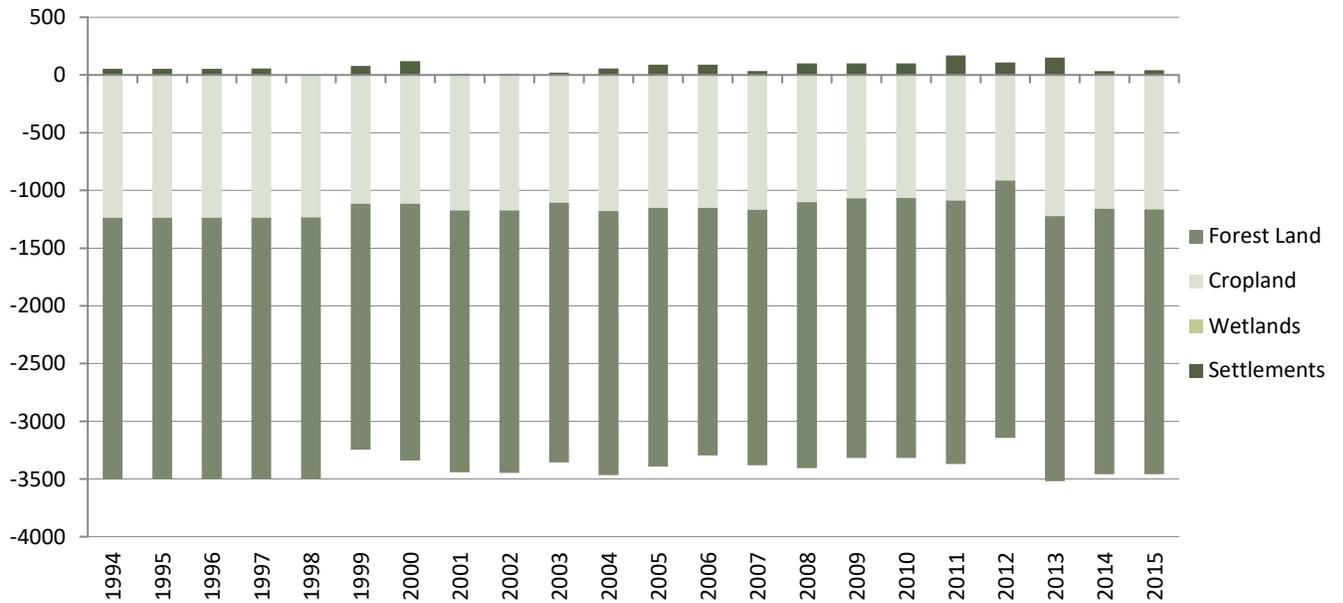


Figure 39: CO₂ emissions/removals for forest, cropland, wetlands and settlements (Gg CO₂eq.)

Overall, the comparison of emissions and removals shows that emissions from land conversions, burning of biomass and fuelwood gathering are higher than the removals caused by the growth of new plantations (afforestation). Although net emissions/removals proved that LULUCF is a major sink, emissions from changes in land use and land cover were still high and are not compensated by the afforestation activities.

Reforestation activities have played an important role in increasing removals during the last decade, especially after the Ministry of Environment signed in 2010 around 41 reforestation agreements covering 185 ha. and the five-year LRI was launched by the United States Forest Service in 2010.

3.C Aggregate sources and non-CO₂ emissions sources on land

The bulk of emissions from category 3.C is caused by N₂O emissions. These occur in the following subcategories: direct emissions from managed soils (3.C.4) and indirect emissions from managed soils (3.C.5) (respectively 191.488 and 70.229 Gg CO₂eq. in 2015) and indirect emissions from manure management (3.C.6), where emissions amounted to 23.597 Gg CO₂eq. in 2015. The trend of emissions from category 3.C is highly influenced by direct N₂O emissions from managed soils, and to a lesser extent, indirect N₂O emissions from managed soils (Figure 40).

Table 71: Total emissions from category 3.C and their distribution per gas (values in Gg CO₂eq.)

Year	Aggregate sources and non-CO ₂ emission sources (3.C)	CO ₂	CH ₄	N ₂ O
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

Table 72: Emissions from subcategories of aggregate sources and non-CO₂ emission sources on land in Lebanon for 2015 and their share from the category 3.C (values in Gg CO₂eq.)

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 ₂ O	% total	N ₂ O	% total	N ₂ O	% total
0.39	0.14%	0.21	0.07%	191.48	66.75%	70.23	24.54%	23.59	8.24%

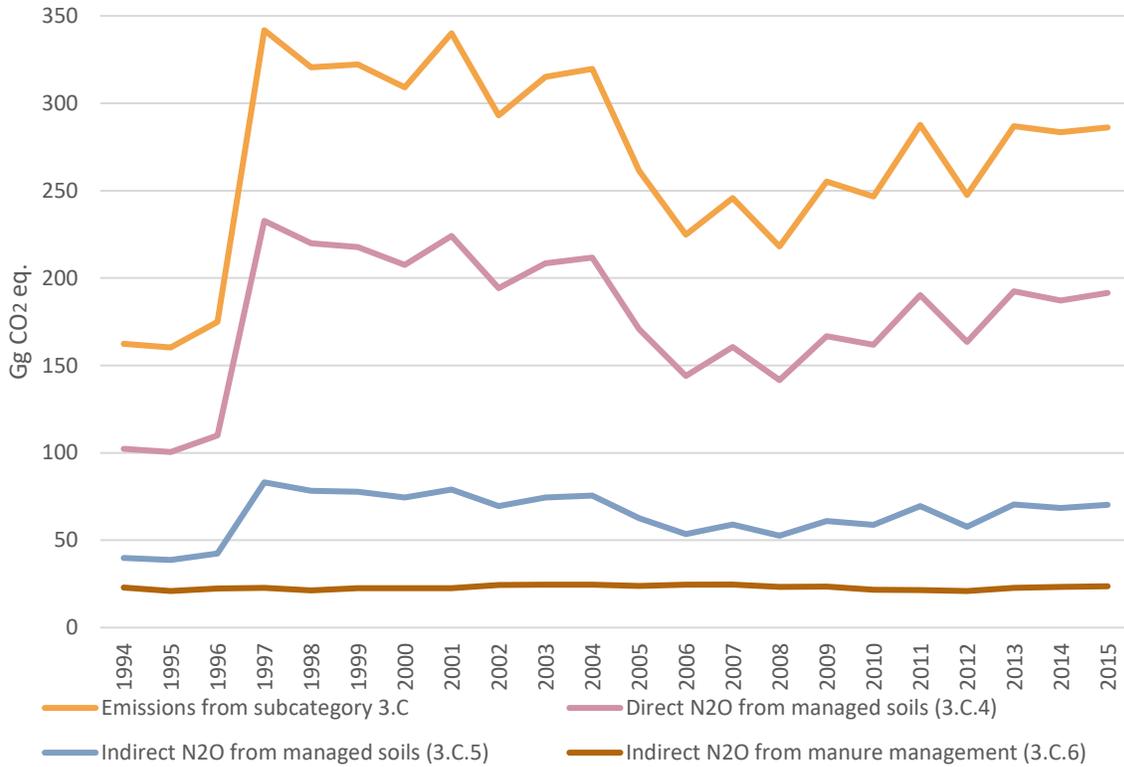


Figure 40: Trend of GHG emissions from Aggregate sources and non-CO₂ emission sources (3.C) and breakdown of N₂O emissions per subcategory for the period 1994-2015

The downwards trend of N₂O emissions reflects the continuous decrease in fertilizer applications, which means that nitrogen input from synthetic fertilizer (F_{SN}) is also decreasing. According to experts from the MoA and Lebanese Agriculture Research Institute (LARI), farmers are becoming increasingly aware of the necessity to control quantities and types of fertilizers applied to soils depending on soil composition and crop needs.

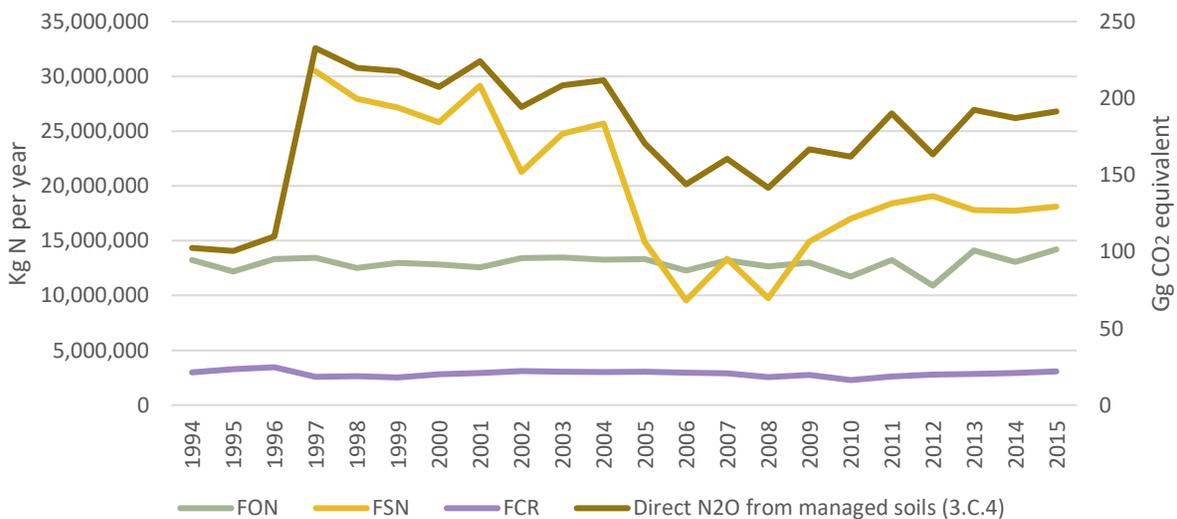


Figure 41: Quantity of N applied to soil from animal manure (F_{ON}), synthetic fertilizer (F_{SN}) and crops residues (F_{CR}) and N₂O emissions from managed soils

For 3.C.1 biomass burning, the main source of GHG emissions are wildfires affecting forest land, cropland and grassland. It can be observed that the fire affected area was highly variable for the last decade. A large trend of inter-annual variability of fire extent was recorded between 1999 and 2015, with three clear peaks in 1999, 2006 and 2012 (Figure 42). More specifically, the largest forest fire affected areas were recorded in 2006 (~1,197 ha), while the largest cropland fire affected areas were recorded in 2012 (~ 1,305 ha).

The peaks in the extent of fire affected areas might be related to the remarkable extended drought conditions during those years, which significantly contribute to water stress in the vegetation cover. This allows larger fire to spread across the vegetated landscape.

The 2006 July war might have contributed to increasing the extent of burned areas, especially in South Lebanon. Given that most of the conflict took place before the start of the normal fire season, it is likely that most of the outbreaks were caused by bombing incineration. A review of archive satellite data from NASA's MODIS Rapid Response System detected only two fire events in southern Lebanon between 12 July and 13 August in 2004 and 2005 respectively but registered 48 fire events during the same period in 2006. Damages from fires affected olive trees, broadleaf species and maquis scrub vegetation. It is to be noted that broadleaf was found to be more affected by fires mainly due to the large extent of broadleaf vegetation cover.

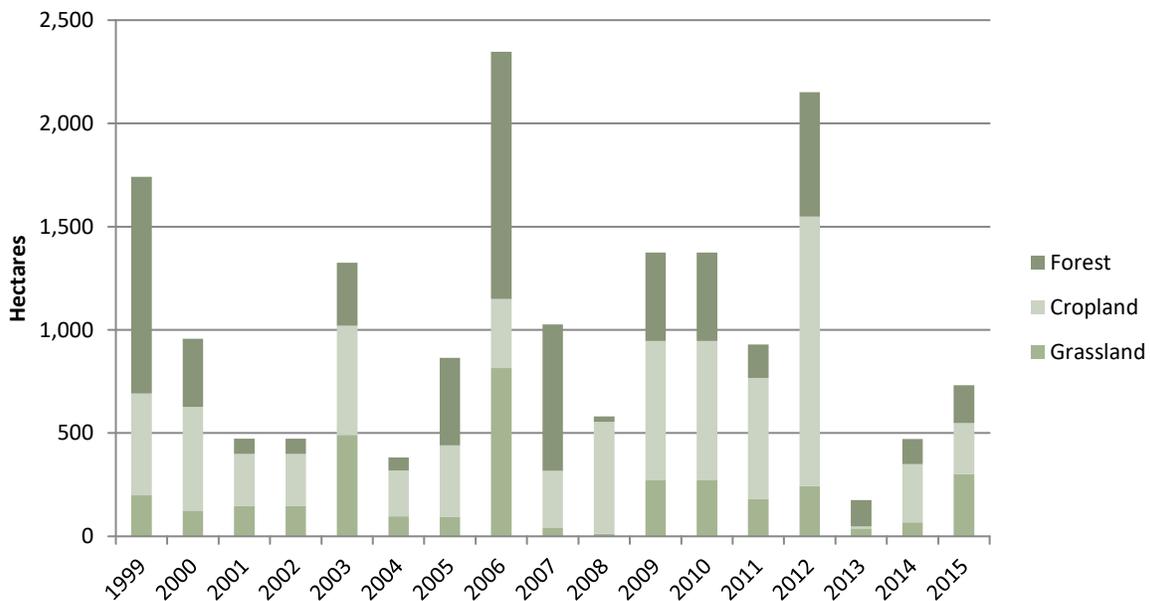


Figure 42: Areas burned by land categories

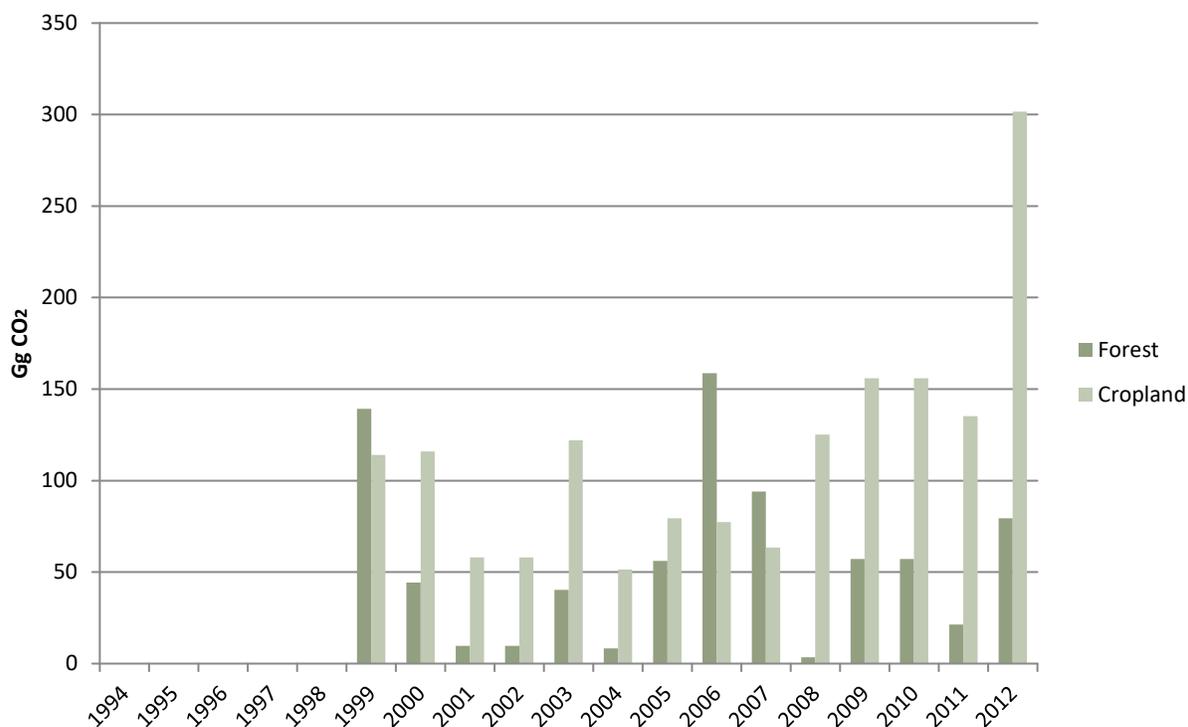


Figure 43: CO₂ emissions from burned areas

3.4 Waste and wastewater

Methodology

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 subcategories 4.D.2 Industrial Wastewater Treatment and Discharge is reported as Estimate Elsewhere (IE) as it is considered that industrial wastewater is discharged with domestic wastewater.

Difference between 1996 and 2006 IPCC GL

Major changes have occurred in the 2006 guidelines, in comparison with the previously used 1996 IPCC guidelines. New categories have been added which include biological treatment of solid waste (CH₄ and N₂O emissions), open burning of waste (CH₄) and septic tanks and latrines (CH₄ and N₂O). In addition, the 2006 guidelines replace the tier 1 method (mass balance) with a tier 1 version of the First Order Decay (FOD) method, which produced more accurate estimated of annual emissions.

3.4.1 Solid waste disposal (4.A)

Methodology

Since solid waste disposal sites (SWDS) on land has been identified as a key category (CH₄ 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 FOD method has been used with defaults parameters and country specific activity data, especially that CH₄ emissions from SWDS is a key category under the trend assessment.

The FOD method assumes that the transformation of degradable material in the SWDS to CH₄ and CO₂ is by a chain of reactions and parallel reactions, in turn governed by different half-lives for different types of waste. The CH₄ 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 CH₄ 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 CH₄ and CO₂. 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, i.e. 50 years from the reporting year 2015.

Activity data

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 were 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).

Activity data related to collected and treated waste is based on the annual reporting documents of the 4 main landfills in Lebanon and are therefore based on direct weighing and monitoring of collected solid waste from households and institutions.

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 73: Activity data and main assumptions for solid waste emissions calculations

Population	The population of Lebanon from 1965 to 2011 was adopted from the World Bank database (World Bank, 2019). For the years 2011-2015, population was calculated based on a 1.47% growth rate (World bank, 2019) with the addition of the Syrian displaced that started to settle in Lebanon starting 2011 (UNHCR, 2015). Although the population of the period 2011-2015 is available through the World Bank database, it wasn't clear whether the numbers were including Syrian displaced. Therefore, it was decided through stakeholder consultations to re-calculate the population number for this period.
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 other years, the rate was calculated by extrapolation and interpolation, and is estimated at in 2015 at 1.05 kg/cap/day, with a range from 302.95 kg/cap/year in 1965 to 383.25 kg/cap/year in 2015.

	<p>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).</p>
Municipal solid waste generation	<p>Waste generation for the years 1994 through 2015 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.</p>
Waste composition	<p>The national waste composition is adapted from the Integrated Solid Waste Strategy of the Ministry of Environment, published in 2019 (MoE, 2019) and from Office of the Minister of State for Administrative Reform (OMSAR) reports (OMSAR, 2018) and include rural and urban areas. Assumption is made that the waste composition remains the same across the time-series.</p>
Industrial waste	<p>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 (2019). The GDP of 1970 was kept the same for the period 1965-1970.</p> <p>Industrial waste is being disposed of with the regular waste stream.</p> <p>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 (Sweepnet, 2014) and a GDP of 47,833 million USD in 2014 (World Bank, 2019) and extrapolated for the rest of the years.</p>
Municipal solid waste disposed in Solid Waste Disposal Sites (SWDS)	<p>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.</p> <p>For the Naameh landfill (which receives more than 50% of the estimated waste generated), numbers have been adjusted to reflect waste received and treated within a calendar year and not a reporting year. Waste started to be collected and treated in June 1998, making the reporting year of the contractor from June 1 to May 31 of each year. Since there is no data available on monthly receipt of waste to reconstruct waste received in a calendar year (Jan 1 to Dec 31) and not in a reporting year (June 1-May 31), it is assumed that the quantity of waste received for Beirut and Mount Lebanon in one year is the sum of half the quantities of the previous and the current year.</p> <p>For the rest of the landfills, data was provided per annum by the facility operators, so no adjustment was required.</p> <p>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 of disposal site changed significantly during that year.</p> <p>Waste quantities generated by Syrian displaced were adopted from Lebanon Environmental Assessment of the Syrian Conflict (MoE/EU/UNDP, 2014).</p>

Open dumpsites	<p>It is assumed that prior to 1998, 96% of the waste generated was disposed of in open dumpsites, with the remaining 4% being recovered by scavengers and source sorting.</p> <p>After 1998 and with the start of the Naameh landfill operations in Mount Lebanon, the amount of waste being disposed in open dumpsites decreased significantly.</p> <p>Then the amount of Municipal Solid Waste (MSW) disposed in open dumpsites decreased further with the establishment of the Zahleh waste treatment plant (1999), Saida (2013) Bcharreh and Baalbeck (2015).</p> <p>Yet, around 900 open dumpsites are still operational to date across the country (MoE/UNDP/ELARD 2017).</p>
Percentage of recycle/reuse	<p>For the period 1965-1997, since no national data is available, it is assumed that 4% of the waste generated is being recovered through scavenging and reusing.</p> <p>For the period 1997-2015, and with the gradual establishment of waste treatment plants, the sorting and recycling percentages of waste were retrieved from the waste facilities operating entities annual reports. Therefore, the percentages are based on real weighing of the amounts of waste for the year period 1997-2015.</p>
Quantity of recovered gas	<p>The information of recovered gas in the operational landfills was provided from the supervising consultants' reports for each of the landfills through MoE.</p>
Exported quantities	<p>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 CH₄ emissions from waste disposal mainly due to their composition.</p>
Waste to energy	<p>Since 2013, Saida anaerobic digestion is generating 730,000 kWh/yr of electricity, 839,500 kWh/yr of heat and 32,000 m³/day of biogas from CH₄ recovered.</p>

Table 74: Main activity data collected and computed for solid waste generation and disposal

Year	Population	Total waste generated (Gg/yr)	Industrial waste generated (Gg/yr)	Clinical waste generated (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	4,655,817	1,784.34	0.17	0.07	14.39	82%	18%
2013	4,724,258	1,967.56	0.18-	0.06	18.15	80%	20%
2014	4,793,704	2,048.86	0.20	0.06	18.17	79%	21%
2015	1,158,995	2,059.45	0.21	0.06	18.71	84%	16%

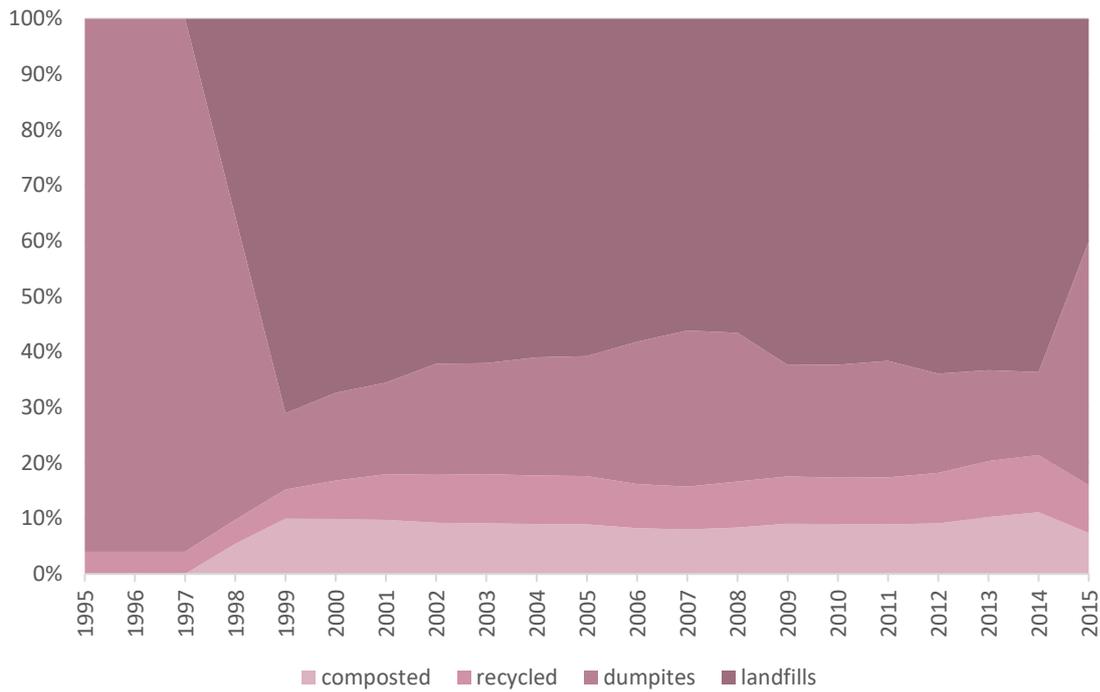


Figure 44: Solid waste disposal in Lebanon

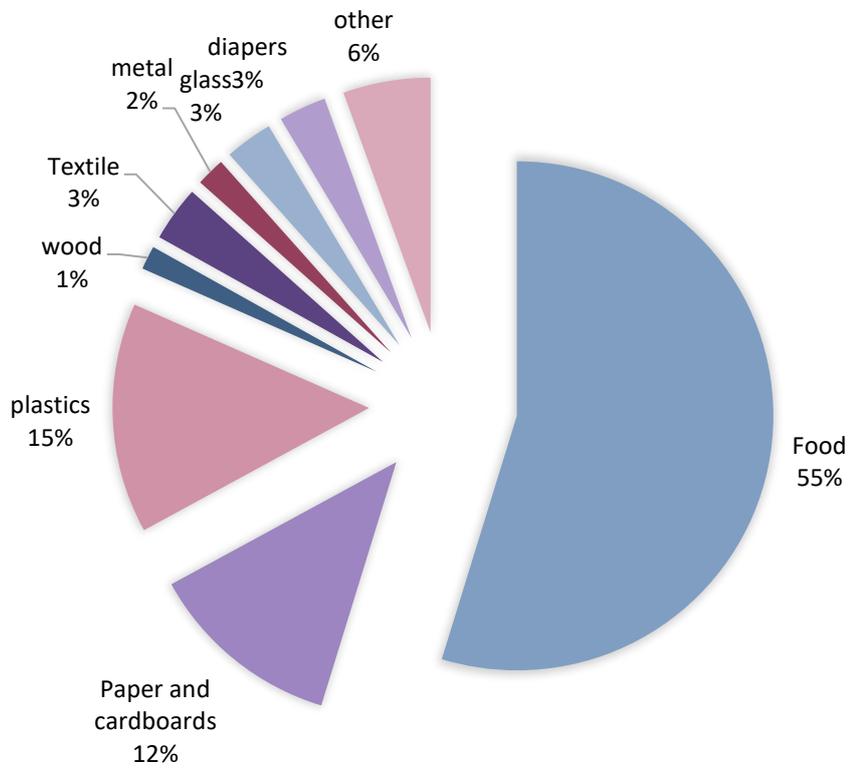


Figure 45: Waste composition in Lebanon (adapted from MoE, 2019 and OMSAR, 2018)

Emission factors

The calculation of methane generated from solid waste disposal sites is based on the use of the Methane Correction Factor (MCF) available by the IPCC 2006 GL taking into account the different SWDS categories. The CH₄ correction factor accounts for the fact that unmanaged SWDS produce less CH₄ 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 and/or with high water table, the fraction of waste that degrades aerobically should be smaller than in shallow SWDS. Semi-aerobic managed SWDS such as the Zahleh, Tripoli, Baalbeck, Nabatieh, and Minieh are managed passively to introduce air to the waste layer to create a semi-aerobic environment within the SWDS. The anaerobic SWDS such as the Naameh landfill are closed landfill with no active or passive aeration. The MCF in relation to solid waste management is specific to that area and should be interpreted as the waste management correction factor that reflects the management aspect it encompasses.

Total amounts of waste received by the different managed and unmanaged classes are presented in Table 75 and Table 76.

Table 75: 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.	Naameh
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.	Zahleh Tripoli Nabatieh Minieh Baalbeck
Unmanaged – deep (>5 m waste) and /or high-water table	3 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.
Unmanaged shallow	4 – 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

Table 76: Proportion of waste received by each category of unmanaged sites

	Managed anaerobic	Managed semi-aerobic	Unmanaged - deep	Unmanaged - shallow	Uncategorized SWDS
1965-1997	-	-	-	-	1.00
1998	0.000	0.395	0.188	0.418	-
1999	0.100	0.738	0.050	0.112	-
2000	0.106	0.704	0.059	0.131	-
2001	0.112	0.688	0.062	0.139	-
2002	0.116	0.640	0.076	0.168	-
2003	0.124	0.633	0.076	0.168	-
2004	0.123	0.618	0.080	0.179	-
2005	0.125	0.613	0.081	0.181	-
2006	0.124	0.570	0.095	0.211	-
2007	0.116	0.550	0.104	0.231	-
2008	0.111	0.568	0.100	0.222	-
2009	0.126	0.631	0.075	0.168	-
2010	0.120	0.634	0.076	0.170	-
2011	0.117	0.628	0.079	0.175	-
2012	0.139	0.643	0.068	0.151	-
2013	0.186	0.584	0.071	0.159	-
2014	0.172	0.603	0.070	0.155	-
2015	0.165	0.301	0.166	0.369	-

it is considered that 31% of open dumpsites are unmanaged-deep and 69% are unmanaged-shallow (by weight) (MoE/UNDP/ELARD, 2011).

3.4.2 Biological treatment of solid waste (4.B)

Methodology

Composting and anaerobic digestion of organic waste, such as food waste, garden (yard) and park waste and sludge are a new category under the 2006 IPCC guidelines, and it is considered for the first time as a separate activity in Lebanon. Composting is an aerobic process and a large fraction of the Degradable Organic Carbon (DOC) in the waste material is converted into carbon dioxide (CO₂). CH₄ is formed in anaerobic sections of the compost, but it is oxidised to a large extent in the aerobic sections of the compost. Composting can also produce emissions of N₂O, at range of 0.5 to 5% of the initial nitrogen content of the material.

Biological treatment of waste is usually linked to N₂O and CH₄ 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.

Anaerobic digestion of organic waste expedites the natural decomposition of organic material without oxygen by maintaining the temperature, moisture content and pH close to their optimum values. Generated CH₄ can be used to produce heat and/or electricity, with a small amount being emitted as leakage. The CO₂ emissions are of biogenic origin and should be reported only as an information item in the Energy Sector. N₂O emissions from the process are assumed to be negligible.

Activity data

Large scale composting activities occurred only in the greater Beirut area from 1997 to 2015. 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 m³/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 77: Amount of waste biologically treated and methane recovered

Years	Waste treated through biological treatment (Gg/year)		Methane Recovered from methane digestion (Gg/year)
	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	0.06
2014	189.49	38.79	0.07
2015	121.83	30.52	0.05

Emission factors

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 CH₄ and N₂O emissions from biological treatment for tier 1 method are used for this inventory.

It is assumed 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%. The emission factors for dry waste are estimated from those for wet waste assuming a moisture content of 60% in wet waste.

Table 78: Default emission factors for CH₄ and N₂O from biological treatment of waste

Year	CH ₄ Emission Factor (g CH ₄ /kg waste treated)	N ₂ O Emission Factor (g N ₂ O /kg waste treated)
Composting	10	0.6
Anaerobic digestion	2	0

3.4.3 Incineration and open burning of waste (4.C)

Methodology

Incineration and open burning of waste containing fossil carbon, e.g., plastics, are the most important sources of CO₂ 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 CO₂, methane (CH₄) and nitrous oxide (N₂O). Only CO₂ 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 CO₂ emissions estimate. The CO₂ 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

Incineration is only 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.

Table 79: Quantities of medical 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	0.08
2013	0.06
2014	0.06
2015	0.06

Source | MoE/UNEP/GEF, 2017

Table 80: 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	319,113.51	220,188.32
2013	322,834.63	222,755.89
2014	305,911.24	211,078.75
2015	904,805.19	624,315.58

Open burning of waste is widely adopted in Lebanon throughout the open dumpsites. A study conducted in by the Ministry of Environment in 2015 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 are open burned every year.

Emission factors

The common method for estimating CO₂ 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 CO₂. 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 CO₂ 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 CO₂ 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 81: Parameters for incineration and open burning

	Clinical 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%

CH₄ emissions from incineration and open burning of waste are a result of incomplete combustion. CH₄ 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 CH₄ 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 82: Emission factors for incineration and open burning

	Clinical waste incineration	Open burning MSW
CH ₄ emission factor	0 ¹	6,500
N ₂ O 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

3.4.4 Wastewater treatment and discharge (4.D)

Methodology

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

Wastewater can be a source of methane (CH₄) and nitrous oxide (N₂O) emissions when treated or disposed anaerobically. The extent of CH₄ 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 (N₂O) is associated with the degradation of nitrogen components in the wastewater, e.g., urea, nitrate and protein included in human sewage.

In Lebanon, there is no large-size Wastewater Treatment Plant (WWTP) that is currently operational in Lebanon. Some small size rural WWTPs are reported to be partially operational and/or their efficiency questioned. Therefore, it is considered that all generated wastewater is untreated in Lebanon. The tier 1 method is used since no country specific emission factors and activity data is available.

Activity data

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 assumptions and estimation that are either made for this inventory or adopted from other publications.

Table 83: Activity data and assumptions made for wastewater emissions calculations

Wastewater quantities	Wastewater quantities are estimated based on the estimated resident population in Lebanon. Calculations take into account Syrian displaced located in Lebanon, where it is assumed that the same wastewater discharge practices are adopted. (see Table 73 for more data on population)
Wastewater discharge fractions	<p>Even that there is not much information available in the country on waste water discharge, the regional defaults provided in table 6.5 of IPCC guidelines on the discharge systems were not followed. Instead, as per stakeholder consultations, national estimation was computed based on the available information.</p> <p>The discharge media of wastewater considers only 2 options: river/sea discharge and septic tank. Discharge percentages were computed based on the percentage of households' sewerage connections onto the networks leading to rivers or sea discharge and the percentage of connections to septic tanks (CAS, 2009). This was complemented by overlaying GIS layers showing population data in various regions in Lebanon to calculate the percentage of the wastewater discharged in the different media.</p> <p>It is assumed that the rural areas in Lebanon (12% of population) discharge 60% into rivers and 40% in septic tanks whereas urban areas (85% of population including high and low income), mostly located on the coast discharge 85% in the sea and 15% in septic tanks.</p>
Industrial Wastewater	<p>In Lebanon, quantities of industrial wastewater generated from the industrial sector are not available. Relevant studies estimate it as 20% of municipal wastewater generation, which is also the assumption made for this inventory (MoEW, 2010a)</p> <p>Industrial wastewater is generally discharged either in sewers that release wastewater directly in the sea without treatment or directly in rivers. Therefore, and based on the geographic distribution of industries between coastal and inland area, it is considered in this inventory that 85% of industrial wastewater is discharged in the sea and 15% in rivers (MoInd, 2015)</p> <p>Since there is limited information on the wastewater generation per type of industry, its Chemical Organic Demand content could not be determined. Therefore, the degradable organic component of municipal wastewater is used.</p>

Table 84: Types of discharge systems in Lebanon

Collected untreated	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 ₂ O.
	Sewers (closed and underground)	Not a source of CH ₄ /N ₂ O.
	Sewers (open)	Stagnant, overloaded open collection sewers or ditches/canals are likely significant sources of CH ₄ .
Uncollected	Septic tanks	Frequent solids removal reduces CH ₄ production.
	Open pits/Latrines	Pits/latrines are likely to produce CH ₄ Retention time are favourable.
	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 ₂ O.

Emission factors

The emission factor for a wastewater treatment and discharge pathway is a function of the maximum CH₄ producing potential (Bo) and the MCF for the wastewater treatment and discharge system. The Bo is the maximum amount of CH₄ that can be produced from a given quantity of organics, based on the BOD of wastewater. The MCF indicates the extent to which the CH₄ producing capacity (Bo) is realised in each type of discharge pathway and system. Expert judgment was used to estimate some of the below parameters.

Table 85: Wastewater parameters and conversion factors for CH₄ emissions

Parameters	Value	Source
Degradable organic component (kg Biological Oxygen Demand (BOD)/cap/yr)	23.7*	Expert judgment
Correction factor for industrial BOD discharge in sewers (uncollected)	1	IPCC, 2006
Maximum CH ₄ producing capacity (kg CH ₄ /kg BOD)	0.6	IPCC, 2006
Methane Correction factor MCF- Sea/river discharge	0.1	IPCC, 2006
Methane Correction factor MCF- Sea/septic systems	0.5	IPCC, 2006
Sea river discharge		
Sludge removed	0	(No treatment considered)
CH ₄ recovered or flared (%)	0	(No treatment considered)

*This was used as the degradable organic component of the wastewater, equivalent to around 65 g of BOD per liter of wastewater based on the design of treatment plants in Lebanon.

Nitrous Oxide (N₂O) emissions can occur as direct emissions from treatment plants or from indirect emissions from wastewater after disposal of effluent into waterways, or the sea. However, since no advanced wastewater treatment plants are operational in Lebanon, only indirect N₂O emissions from wastewater is discharged into aquatic environments is estimated using default emission factors.

Table 86: Wastewater parameters and conversion factors for N₂O emissions

Parameters	Value	Source
Per capita protein consumption (protein in kg/person/yr)	30.66	Food and Agriculture Organization (FAO)
Fraction of nitrogen in protein (kg nitrogen (N)/kg protein)	0.16	Default
Fraction of non-consumption protein in countries with NO garbage disposal	1.10	default for the year 1994-1997
Fraction of non-consumption protein in countries with garbage disposal	1.40	default for the years 1998-2015
Fraction of industrial and commercial co-discharge protein	1.25	Default
Indirect N ₂ O emission factor (kg N ₂ O-N/kg/N)	0.01	Default

3.4.5 Results of waste sector

As expected, CH₄ emissions are the most common greenhouse gas emitted from waste and wastewater discharge and treatment. Wastewater treatment and discharge the largest source of GHG emissions in the waste Sector, being responsible of 52% of CH₄ emissions and 69% of N₂O emissions.

Solid waste disposal (SWDS) on land is also a main source a CH₄ emissions due to the anaerobic and semi-anaerobic decomposition of the organic portion of the waste in landfills or open dumpsites. However, due to the change of methodology between the 1996 and 2006 IPCC guidelines, emissions from SWDS decreased significantly.

Incineration and open burning of waste containing fossil carbon, e.g., plastics, are the most important sources of CO₂ emissions in the Waste Sector. Decomposition of organic material derived from biomass sources (e.g., crops, wood) is the primary source of CO₂ released from waste. These CO₂ emissions are not included in national totals, because the carbon is of biogenic origin and net emissions are accounted for under the AFOLU Sector.

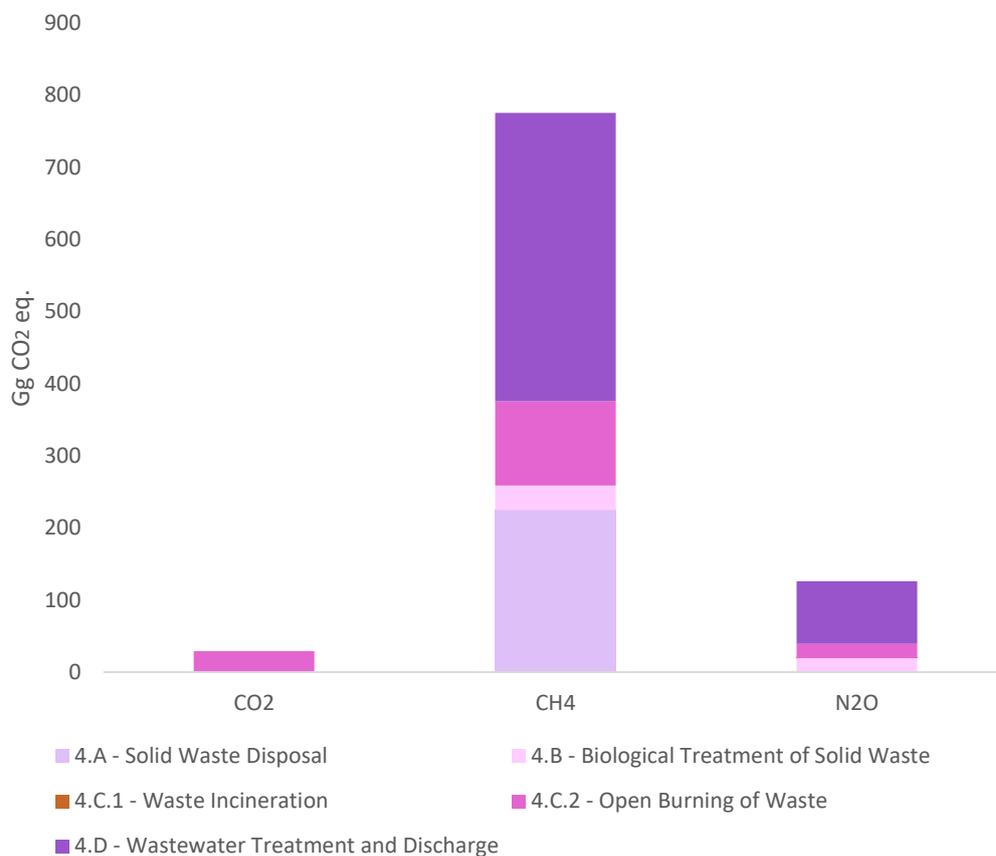


Figure 46: GHG emission from the Waste sector in 2015 per subcategory

In 2015, activities related to the generation and treatment of solid waste and wastewater emitted 930.64 Gg CO₂eq., thus contributing to 3% of Lebanon's total GHG emissions. CH₄ and N₂O emissions are mainly generated from the discharge of wastewater effluents into aquatic environments, while CO₂ gases are mainly emitted from the health care waste incineration.

The trend of GHG emissions from the waste sector is highly fluctuating, as presented in Figure 47. The drop in 2008 is closely related to the increase in the volume of flared methane during the same year, hence reducing CH₄ emissions to the air.

Emissions from wastewater discharge have increased steadily at an annual average of 3%, concurrently with the population growth and the absence of any plan to treat wastewater before its discharge.

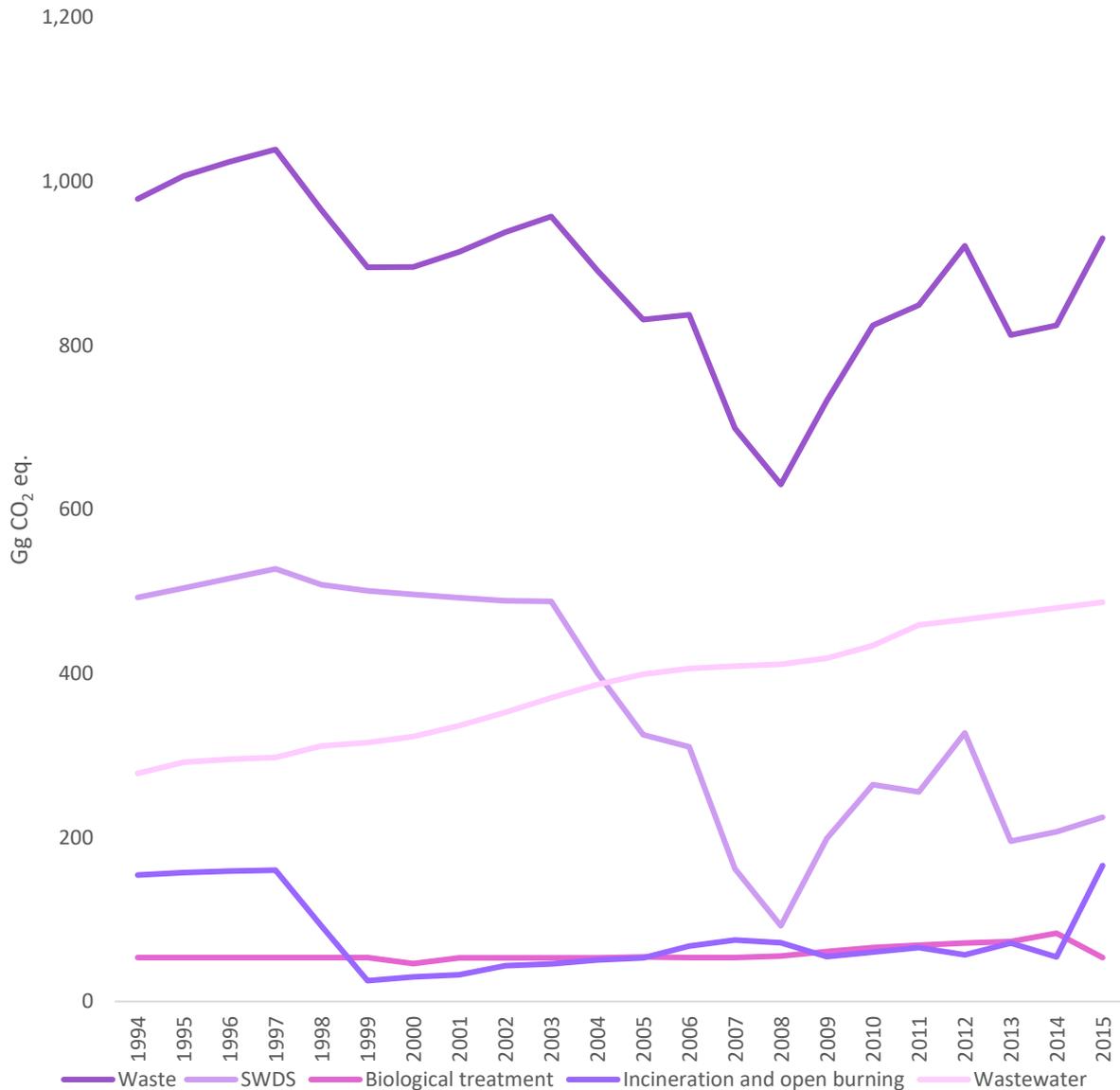


Figure 47: GHG emission from the waste sector

4 Gaps and constraints and planned improvements

Throughout the compilation and the preparation of the Greenhouse Gas (GHG) inventory contained in BUR3, identification of improvements made and of gaps and constraints was easily and systematically compiled thanks to the format of the documentation templates, which is considered a considerable improvement in documentation of GHG inventory processes.

This section presents:

- The improvements made to the GHG inventory submitted in BUR3,
- The general and sectoral gaps and constraints identified during the compilation cycle of the GHG inventory in BUR3,

- The planned improvements to be implemented in the next GHG inventory compilation cycle and beyond.

Improvements made to the GHG inventory submitted in BUR3

At the general and cross cutting level, accuracy, transparency and comparability of the inventory were improved through:

- Adopting the 2006 IPCC guidelines and the AR5 Global Warming Potentials (GWP),
- Documentation of all data and emission factors sources in a disaggregated manner,
- Documentation of assumptions and adjustments made to data series,
- Documentation of changes resulting from recalculations using the 2006 IPCC guidelines methodologies,
- More comprehensive and targeted QC measures compared to previous GHG inventories,
- Sectoral QA activities for the external review of emission calculation for the AFOLU and waste sectors
- Systematic monitoring of improvement and identification of gaps,
- Enhancement of capacities which led to enhanced involvement of experts outside the BUR compilation team in the data collection and validation process,
- Detailed reporting of all the above in the BUR3, which allows reconstruction of the inventory using the communicated information.

In addition, category specific improvements were made as presented in Table 87.

Table 87: Category specific improvements made to the GHG inventory presented in BUR3.

#	Category	GHG inventory principle	Improvements made	Year
1	All sector	Time series consistency	Re-construction of time-series	1994-2015
2	1.A.1 Energy industries	Accuracy	Obtained fuel specific Net Calorific Value as opposed to default values	1994-2015
3	1.A.1 Energy industries	Accuracy	Obtained fuel consumption per power plant instead of using the bulk amount delivered annual to EDL	2014-2015
4	1.A.1 Energy industries	Accuracy	Obtained fuel stock per power plant- this was not considered before, and assumption was made that all fuel delivered are consumed within one calendar year	2014-2015
5	2.A.2 Lime production	Accuracy	Obtained data series on paper from a primary source as opposed to estimations via personal communication in previous inventories.	1999-2015
6	3.A Livestock	Accuracy	Included imported beef in data series. These were not accounted for in the previous inventory.	1994-2015
7	3.C.4 emissions from managed soils	Direct from Accuracy, Consistency	Reconstructed F_{SN} related data compiled in previous inventories in an aggregate form and completed the trend using primary data sources, rather than extrapolation.	1994-2015
8	4. Waste generation, composition and management data	Consistency with 2006 IPCC GL	Updated the distribution of waste management practices based on new available reports that provide more accurate data – use of minimum assumptions and interpolations	1997-2015
9	4.B Biological treatment of SW	Completeness	Obtained more accurate and complete activity data for composting	1997-2015
10	4.C Incineration and open dumping	Completeness	Obtained more accurate and complete activity data for incineration of medical waste and open dumping	2004-2015

Gaps and constraints identified during the compilation of the GHG inventory

Despite the continuous improvements that Lebanon is bringing to each new GHG inventory, some constraints persist. In addition to these, new methodologies and new arrangements bring new challenges. Gaps are compiled in Table 88 along with a short analysis of the remaining barriers to bridge them. In addition, they were prioritized on a scale of 1 to 3 (1 being the highest priority) according to the urgency of implementation, while taking into consideration the actual foreseen feasibility of implementation. For example, the gap “enlarging the GHG compilation team” was ranked 3 although the urgency of involving more GHG inventory experts is high. However, there are no foreseen plans to fund additional GHG inventory experts outside the budgets provided by projects. Therefore, technical work on implementing this measure will be deprioritized.

Table 88: Gaps and constraints identified during the compilation of the GHG inventory

Gap	Tackled in BUR3	Remaining barriers	Priority	
	Since the staff responsible for GHG inventory compilation is project based, which does not currently allow for an expansion of the team, experts from line institutions were trained to support in carrying out some data collection and validation, Quality Assurance/ Quality Control QA/QC, and computation tasks. This approach is more sustainable compared to hiring external consultants for support.	Staff for GHG inventory compilation is project based.	3	
Institutional arrangements and inventory system	Working according to compilation plan*	Roles, responsibilities and deadlines were assigned and prioritized among compilation team members, with identification of tasks to be carried out by experts outside the team.	<ul style="list-style-type: none"> - Staff members are assigned too many roles due to the small size of the team, which hinders some parts of the plan like, QA/QC, timeliness etc. - Delays in access to project funds. - Limited control on delivery of tasks assigned to partners outside the team. 	1
	Establishing an institutionalized repository for documentation and archiving*	A short-term solution consisted in storing GHG inventory data on cloud, which made it accessible by all team members (therefore avoiding conflicted copies on individual computers) and supported by a back-up.	Difficulty in obtaining access to government servers.	2
	Establishing legal or institutional framework to obtain activity data*	Data is collected and supplied through official requests to relevant governmental institutions	Absence of legal or institutional framework to reach out to the private sector such as industries, municipalities, waste operators, farmers and fuel importer companies	

General technical	Implementing the 2006 IPCC guidelines	Familiarization with the 2006 GL was time consuming since it entailed: collection of new activity data, recalculations due to new methodologies and EF. Involved experts attended trainings on the 2006 GL as reported in chapter II.	<i>Detailed in sectoral parts of this table.</i>	1
	Using the IPCC software	Familiarization with the software was time consuming. Bugs in the functions related to time series and KCA were identified and communicated to the IPCC software help desk.	<ul style="list-style-type: none"> - Finding alternative solution to overcome the bugs in the system - Documentation templates do not incorporate functions that are not provided by the software. 	1
	Implementing a general and sectoral QA/QC plan*	Due to heavy load entailed with different tasks, QA/QC measures presented in BUR3 were implemented in an ad-hoc manner and upon availability of experts, as opposed to systematic implementation.	<ul style="list-style-type: none"> - Difficulty in planning appropriately and manage workload - Difficulty in and allocating responsibilities to stakeholders 	1
	Conducting uncertainty assessment*	Due to unavailability of information on uncertainty at the level of data providers, and due to time constraints, this activity was deprioritized.	Complexity of uncertainty analysis a posteriori of data collection	1
	Reporting indirect GHGs	Due to time constraints, this activity was deprioritized.	Absence of separate sheets in the IPCC model to compute indirect GHGs	1
1 Energy	Uncertainty in estimation methods for power demand and amount of fuel consumed for private power generation *	<ul style="list-style-type: none"> - Used estimation of demand from official sources at EDL during time windows for which no power was supplied - Used the assumption of 80% use of private generator (from Energy policy paper). 	<ul style="list-style-type: none"> - Absence of national energy balance - Absence of disaggregated data on quantities of fuel consumed and distribution of private generators in residential building and neighborhoods to validate assumption made - Uncertainty in demand estimation is still high 	1
	Information on allocation of fuel use to different categories obtained by only one member of APIC (IPT)*	Not tackled	<ul style="list-style-type: none"> - Absence of national energy balance - Difficulty in engaging other fuel importers and operators to share fuel-related data per end-user. 	1
	Conflicting fuel stocks values between EDL and fuel purchases and consumption*	Stock quantities of fuel have been provided officially by EDL for each power plant for each year for the period 2014-2017	<ul style="list-style-type: none"> - Absence of national energy balance - Difficulty in validating the amounts with the absence of national energy balance 	3
	Absence of country-specific	Tier 1 was adopted.	Lebanon does not have an accredited laboratory to	1

emission factors*		measure carbon contents of fuels	
Absence of information on fuel consumption for domestic aviation by army*	Not tackled	Information marked as confidential by Army.	3
Estimating bottom up approach fuel use for industries*	Not tackled	- Absence of national energy balance - Significant cost of undertaking a study to estimating fuel used from MIC category	1
Frequency of provision of information on newly registered cars*	Vehicle fleet only for the years 2012 and 2015 has been provided officially by the Ministry of Interior and Municipalities. Interpolation with correlation to GDP and population have been undertaken through FORFITS	Car registration service outsourced to a private entity which is not contractually bound to provide new information.	2
Inaccuracy of information on diesel consumed in road transport*	Not tackled	- Absence of national energy balance - Difficulty in engaging fuel importers and operators to share fuel-related data per end-user	1
Inaccuracy of information on kilometers driven*	Kilometers driven estimated based on sample surveys and some studies carried out in the country.	Absence of complete and accurate odometer data in the car inspection process	1
Obtaining complete data time series prior to 2000 for: clinker production, lime production, soda ash used, paraffin wax use*	The activity data series for these subcategories were completed by extrapolation.	Inaccessibility of data from primary sources i.e. factories.	1
Obtaining complete data on glass production and lubricants	There is no disaggregated information on soda ash use and lubricant use. Emissions from glass production and lubricants use were therefore Included Elsewhere (IE), the former in the other uses of carbonates category, the latter in the Energy category.	Inaccessibility of data from primary sources i.e. factories.	2
Obtaining disaggregated data on ceramics	Data on ceramics was reported as Not Estimated (NE)	Inaccessibility of data from primary sources i.e. factories.	1
Obtaining data on fluorinated GHGs used as ODS replacements*	Data on ODS replacements were reported as NE.	Absence of national survey for data collection in cooperation with the NOU.	2

	Obtaining data on indirect GHG emitting sources: food production and asphalt*	Data collection for these subcategories required high efforts and the data remained highly uncertain. Since these categories only emit indirect GHGs, they were deprioritized.	Inaccessibility of data from primary sources i.e. factories.	3
	Obtaining consistent livestock data series*	Data series for different species provided by MoA were completed either by interpolation or from FAOSTAT.	-	
	Obtaining data on manure management systems	Information adopted in previous inventories was adopted, although manure management systems categories as listed in the 2006 IPCC GL are more detailed compared to the 1996 GL.	Absence of survey or research on manure management systems	1
3 AFOLU	Obtaining accurate data on nitrogen fertilizers	Assumptions adopted in previous inventories based on data from customs were adopted.	- Different reporting and categorization systems between customs and MoA	1
	Obtaining data on waste generation per capita and waste composition	Estimations on the waste generation per capita per day were made based on different scientific studies in Lebanon.	- Existing estimations do not differentiate between urban and rural population and between seasons - Significant cost for undertaking nation-wide study to estimate waste generation quantities	2
	Obtaining information on amounts landfilled, biological treatment, recycling amounts*	- Information on waste landfilled and composted from 5 main waste operators has been collected through official reports - Activity data for other waste management facilities was collected through Environmental Impact Assessments (EIAs) and other baseline studies prepared as part of international projects	- Absence of waste mass balance for Lebanon - Absence of complete database on waste operators and recyclers, especially in rural areas - Absence of legal and institutional framework to make local authorities report waste management methods - Absence of complete historical data on amounts of clinical waste being incinerated	1
4 Waste	Obtaining amounts of methane captured and treated for all landfills. Data currently available for only one landfill*	Quantities of landfill gas have been collected from other landfills an not just one.	- Absence of legal and institutional framework to make waste operators report quantities of methane recovered - Different methodologies and requirements for calculating of methane flaring and recovery - Not all landfills might be contractually required to measure the amount of methane captured/flared/used for waste to energy purposes.	1

Obtaining information on industrial waste and wastewater*	Industrial waste has been estimated through using correlations with GDP	<ul style="list-style-type: none"> - Absence of legal and institutional framework to make industries report the quantities waste and wastewater generation and management methods - Significant cost for undertaking nation-wide study to estimate such data 	2
	Industrial wastewater has been reported under domestic wastewater by estimating an additional wastewater quantity of 20%		
Centralizing and completing information on domestic wastewater generation rate and discharge methods*	Not tackled	<ul style="list-style-type: none"> - Absence of legal and institutional framework to make local authorities report the quantities waste and wastewater generation and management methods - Significant cost for undertaking nation-wide study to estimate such different wastewater discharge methods 	1

*Pre-existing gap mentioned in previous BURs

Planned improvements

Based on the gaps and constraints encountered during the compilation of the GHG inventory submitted in Lebanon's 3rd BUR, potential improvements were identified and documented in Table 89.

Table 89: Short term and long term planned improvements for Lebanon's GHG inventory

Sector	Planned improvement	Short term	Long term
General	Improve compilation plan including timeline and allocation of responsibilities based on lessons learned from current GHG inventory compilation	x	
	Improve documentation templates based on experience from current GHG inventory cycle	x	
	Systematically implement and document general and sectoral QA/QC plan, including timeline and allocation of responsibilities.	x	
	Conduct tier 1 uncertainty assessment	x	
	Document expert judgements as per the protocols published in the 2006 IPCC GL	x	
	Report indirect GHGs	x	
	Have latest reporting year be no more than three years prior to the submission of the GHG inventory	x	
1 Energy	Obtain carbon content of imported fuel to use tier 2 methodologies in all sub-categories	x	
	Conduct survey on fuel consumption for generators in main cities in Lebanon	x	
	Improve accuracy in distribution of gas/diesel oil by end use category		x
	Collect relevant data to calculate emissions of precursor gases from all sub-categories	x	
	Improve accuracy of fuel economy estimations per vehicle type		x
	Improve accuracy of travelled kilometers estimations per vehicle type		x
	Obtain data on fuel consumed in road transport, navigation and aviation from the Lebanese army		x
Obtain data on fuel consumed in yacht clubs to improve accuracy of emissions from national navigation		x	

	Obtain data on fuel consumed by tankers in Beirut and Tripoli ports		x
2 IPPU	Improve accuracy in activity data time series prior to 2000 for: clinker production, lime production, soda ash used, paraffin wax use through collecting data from primary sources		x
	Obtain disaggregated data on glass production and lubricants		x
	Obtain disaggregated data on ceramics		x
	Obtain data on fluorinated GHGs used as ODS replacements. If this is not possible through a complete survey, examine the possibility of performing preliminary estimates.	x	
	Obtain data on indirect GHG emitting sources: food production and asphalt		x
	Update national emission factor for cement production as CaO content in clinker can change over time depending on the type of cement produced	x	
	Improve consistency in livestock data series	x	
3 AFOLU	Improve completeness of livestock data through obtaining data on buffalo	x	
	Conduct a survey on manure management systems		x
	Homogenize nitrogen fertilizer data between customs and MoA		x
	Develop country specific emission factors and enhanced livestock characterization for main livestock species (i.e. poultry, cattle, sheep and goat)		x
	Obtain information on compost applied to soils	x	
4 Waste	Conduct study on waste composition in Lebanon, taking in consideration rural and urban areas as well as seasonal changes in waste characterization.	x	
	Improve accuracy of municipal waste generation quantities and distribution of waste management methods	x	
	Improve accuracy of clinical waste generation per year and distribution of management methods		x
	Produce statistical data on industrial waste generation waste composition and management practices per industry type and region		x
	Improve accuracy and completeness of activity data on waste treated through composting and anaerobic digestion	x	
	Improve accuracy of recovered methane quantities in waste and wastewater treatment and estimation of energy produced	x	
	Produce statistical data on industrial wastewater generation rate, characterization, and discharge methods per industry type and region		x
	Produce statistical data wastewater and develop country-specific BOD and COD to be able to use higher tier methodologies for key categories	x	

III. Information on mitigation policies and actions

As a party to the UNFCCC, Lebanon has made efforts to implement activities that lead to emission reduction based on its capabilities and taking into account its national circumstances. This chapter outlines Lebanon's commitment to address the challenges of climate change in the context of sustainable development and provides quantitative information on actions undertaken till 2015 to mitigate anthropogenic emissions by sources and removals by sinks. 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. Wherever possible, information on emissions reductions has been calculated.

Currently Lebanon has no specific methodology for monitoring the progress of actions described. Consultations with main stakeholders helped identify the extent to which each mitigation action was implemented and accordingly, percentages of completion were used to calculate emission reductions achieved. Consequently, capacity building is much needed on the national level to improve monitoring and reporting of sectoral mitigation activities.

The current section captures the mitigation measures that have been implemented in the energy, transport, agriculture forestry and waste sectors. Emission reductions have been estimated from some of the activities depending on data availability, while other have only been described qualitatively. Therefore, it is crucial to note that the list of measures reported in this section is not exhaustive, which underestimates the emission reduction that Lebanon has undertaken to combat climate change. 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.

The methodology adopted for the calculation of emission reduction of the identified mitigation actions is based on the 2006 IPCC revised guidelines, as already adopted in the preparation of the inventory. Consequently, and similar to how emissions are aggregated in national inventories, emissions reduction levels were also aggregated by sector.

1 Nationally Determined Contribution targets

Lebanon submitted its Nationally Determined Contribution (NDC) to the United Nations Framework Convention on Climate Change (UNFCCC) on September 30, 2015. The preparation of the NDC document was led by the Ministry of Environment (MoE) with a strong involvement of stakeholders. The Minister of Environment presided over a series of meetings with the main stakeholders to ensure a participatory and transparent approach in the development of the I/NDC. Consulted stakeholders include: 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).

In 2016, an official NDC committee was established with the objective of following up the NDC implementation and reporting (Council of Ministers' decision 185/2016, dated 7/10/2016) and in 2017, the Council of Minister's decision 33-2017 mandated the MoE to coordinate the NDC's implementation. In 2019, the government issued Law 115 for the ratification of the Paris Agreement.

Table 90: Lebanon's Nationally Determined Contribution

Unconditional Target¹	<ul style="list-style-type: none"> • A GHG emission reduction of 15% compared to the Business-As-Usual (BAU) scenario in 2030. • 15% of the power and heat demand in 2030 is generated by renewable energy sources. • A 3% reduction in power demand through energy-efficiency measures in 2030 compared to the demand under the Business-As-Usual scenario. <p>The unconditional mitigation scenario includes the impacts of mitigation actions which Lebanon is able to implement without additional international support.</p>
Conditional Target	<ul style="list-style-type: none"> • A GHG emission reduction of 30% compared to the BAU scenario in 2030. • 20% of the power and heat demand in 2030 is generated by renewable energy sources. • A 10% reduction in power demand through energy-efficiency in 2030 compared to the demand under the BAU scenario. <p>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.</p>
Implementation Period	2020-2030
Sectoral coverage	The NDC covers the following IPCC sectors: Energy, industrial processes and other product use, agriculture, land-use, land-use change and forestry, and waste.
Coverage of greenhouse gases	The following gases are covered: CO ₂ , CH ₄ , and N ₂ O. Fluorinated greenhouse gases (HFCs, PFCs and SF ₆) play a limited role in Lebanon's overall GHG emissions. Furthermore, they have not been assessed at the level of detail required to estimate their emissions with the necessary accuracy needed to include them in the GHG inventory. Such assessments are currently being undertaken. Lebanon plans to include emissions from fluorinated GHGs in an updated version of its NDC.
Adaptation targets	<p>Biodiversity</p> <p>Overarching objective: By 2030, adaptation plans for ecosystems vulnerable to climate change have been developed and implemented. This will be achieved by:</p> <ul style="list-style-type: none"> • Conducting needs assessment and defining pilot national monitoring sites and species. Coastal zones are considered a priority. • Designing and implementing pilot action plans. <p>Agriculture and Forestry</p> <p>Overarching objective: Towards sustainably managed forest resources, safeguarded ecological integrity, and economic and social development for the benefit of present and future generations. This will be achieved through the implementation of the National Forest Programme including, among others:</p> <ul style="list-style-type: none"> • Raising tree nurseries' productivity. • Planting of trees. • Implementing the forest fire fighting strategy. • Rehabilitating irrigation canals. • Promoting Good Agricultural Practices through the support of organic farming and obtaining quality certificates. • Applying forest integrated pest management. • Developing an early warning system for agricultural pests and climatic conditions.

Water resources

Overarching objective: Increase water availability and improve water usage to decrease the sector's vulnerability to climate change impacts by:

- Improving water security such as through increasing artificial recharge of groundwater aquifers and increasing surface storage dams and hill lakes.
- Optimizing the use of the current water resources through the rehabilitation of the existing network and the installation of water meters.
- Increasing wastewater collection and treatment.
- Increasing water reuse, especially after wastewater treatment.
- Improving water efficiency and decrease water loss in irrigation.

Lebanon considers that its unconditional target presumes:

- 1- The reinstatement, as soon as possible, of the prevailing national circumstances prior to the latest regional crisis, a matter considered as Lebanon's legitimate right.
- 2- The absence of the emergence of any new crisis which could adversely affect Lebanon's national circumstances.

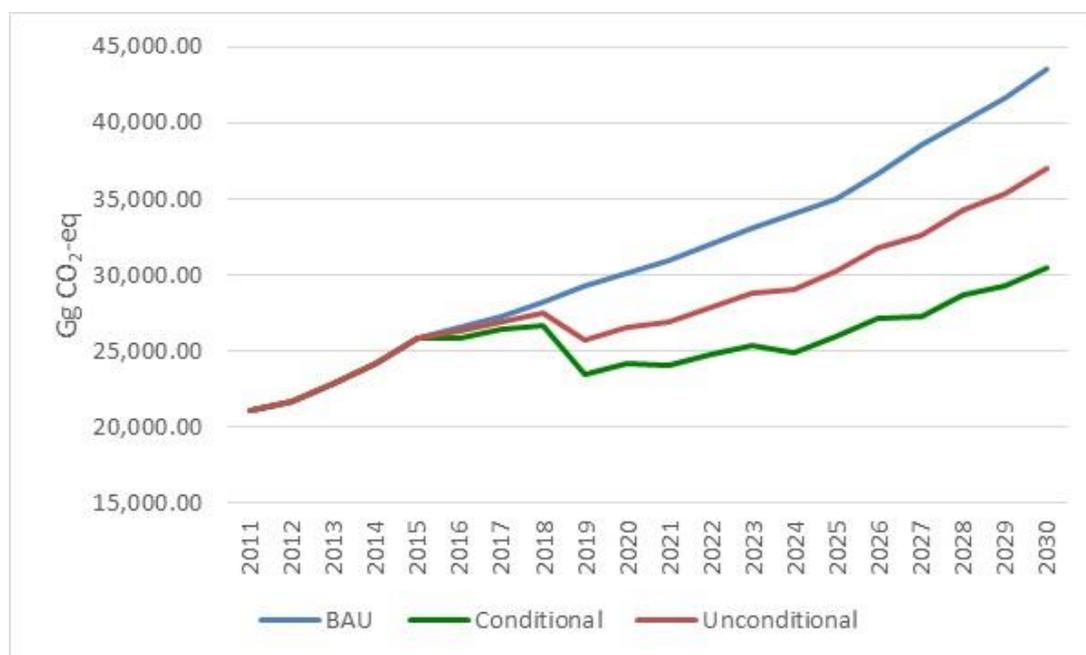


Figure 48: Greenhouse gas developments at the national level

2 Low Emission Development Strategy

Lebanon is preparing its low emission development strategy (LEDS) with the support of UNDP (LECB and NDCSP projects). Gap analysis indicates that many LEDS related activities are underway by the Government of Lebanon across ministries and third-party institutions. With enhancement and expansion, the LEDS can help improve national objectives for fiscal, macroeconomic, investment, energy security, environmental sustainability, and equity gains. Many of these sector-based efforts are not explicitly tied to the national LEDS program at this time. However, they provide direct opportunities for coordination of policy and program development across issue areas and ministries. As a result, Lebanon's LEDS plan will create an untapped opportunity for synchronization of a range of national goals. The consolidation of studies and proposals across ministries and sectors resulted in a detailed framework of sector-based policies and programs in Lebanon that cut across all sectors and could be integrated into a future LEDS plan.

3 Sectoral mitigation actions and policies

3.1 Energy

As reported in the national greenhouse gas inventory, the majority of Lebanon's emissions are from the energy sector. Energy is a strategic resource for Lebanon as the country is almost completely reliant on the import of oil for energy needs. Therefore, climate mitigation in this sector plays an important role in achieving positive environmental, economic, and social impact through demand side management and cleaner energy production.

Derisking the renewable energy sector can promote private sector investment in large-scale wind energy and solar PV in Lebanon to achieve more significant emission reductions and accelerate the implementation of the NDC targets. Making renewable energy investments cost-competitive, will contribute positively to Lebanon's power sector, increasing the reliability of the supply, decreasing the country's dependence on fuel imports, improving the affordability of the energy mix, and reducing the need for subsidies to EDL. Figure 49 and Figure 50 summarize the derisking instruments that should be put in place to catalyse around USD 914 million in private sector investments, generate USD 318 million of economic saving and reduce Lebanon's GHG emissions by 15.2 million tonnes over 20 years (UNDP, 2017).

To date, two financing mechanisms have been put in place to further engage the private sector in energy projects. The National Energy Efficiency and Renewable Energy Action (NEEREA) is a national financing mechanism initiated in 2010 by the Central Bank of Lebanon. It provides the private sector with long-term loans at low interest rates for any type of renewable energy or energy efficiency project. This financing mechanism encourages the private sector to invest in energy efficiency and renewable energy initiatives and consequently, decrease the demand on thermal electricity production. NEEREA has a loan ceiling of 20 million USD per project and is offered at low interest rates for periods that should not exceed 14 years including a grace period between 6 months and 4 years. These loans are provided through any of the Lebanese commercial banks to directly reach the end user.

The Lebanon Energy Efficiency and Renewable Energy Finance Facility (LEEREFF), launched in 2018, complements NEEREA. LEEREFF aims at contributing not only to energy savings and supply security of businesses but also at supporting energy conservation, carbon emission reduction and climate change mitigation. Developed by European Investment Bank (EIB), the French Development Agency (AFD) and Banque du Liban (BDL), this financial mechanism also offers low interest loans to Lebanon's private sector to install energy efficiency and renewable energy projects. It is funded by a EUR 80 million line of credit, EUR 50 million from the EIB and EUR 30 million from the French AFD. Lebanon's Central Bank BDL provides interest rate subsidies, and the European Union finances technical assistance to projects. LEEREFF loans are provided through five local commercial banks.

Derisking Solar Energy investments in Lebanon



What does it mean?

To create cost-efficient public instruments to promote private investment in renewable energy

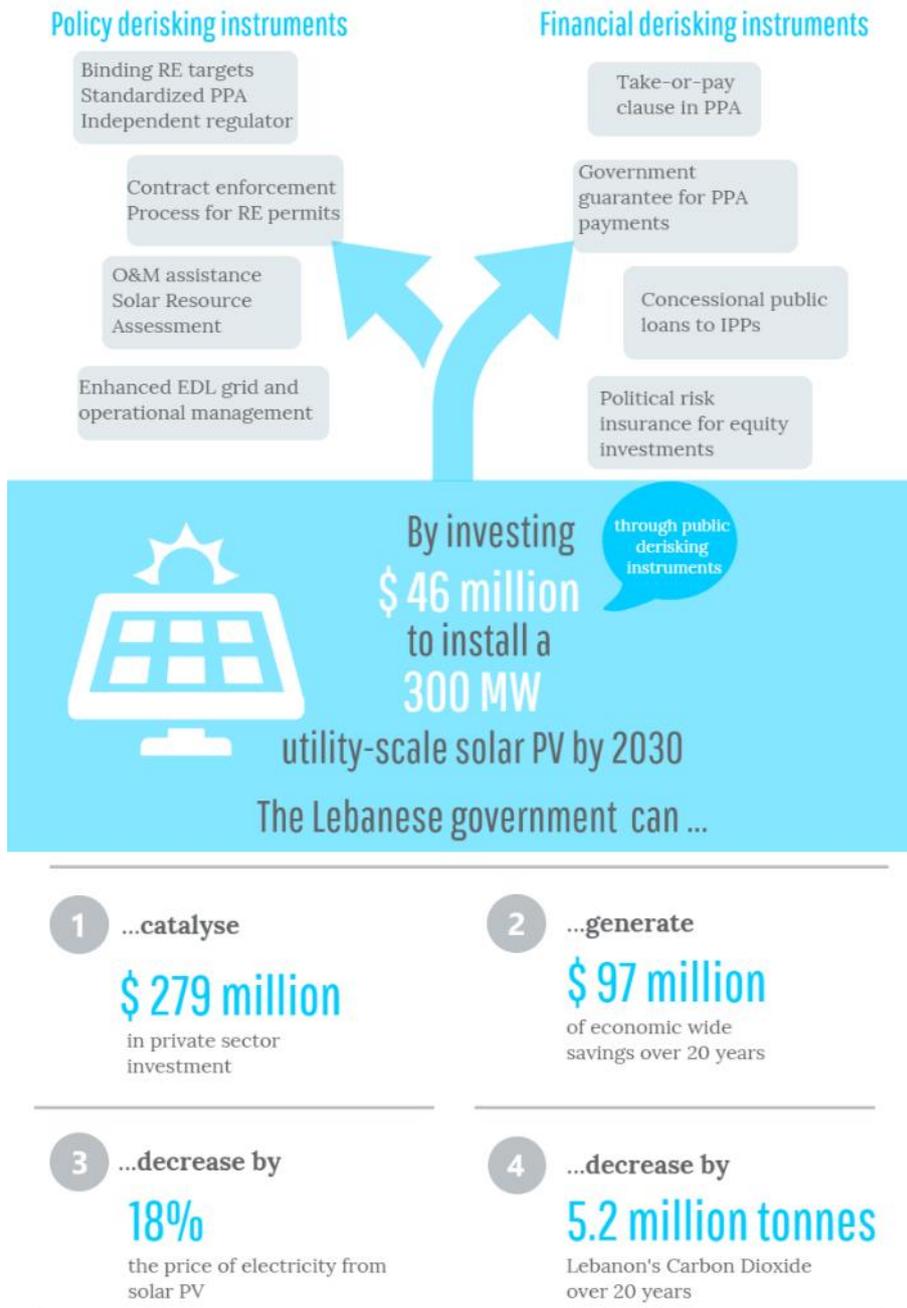


Figure 49: Derisking solar energy investment in Lebanon

Derisking Wind Energy investments in Lebanon



What does it mean?

To create cost-efficient public instruments to promote private investment in renewable energy

Policy derisking instruments

- Binding RE targets
- Standardized Power Purchase Agreement
- Independent regulator

- Process for RE permits
- Contract enforcement

- O&M assistance
- Wind resource assessment

- Enhanced EDL grid and operational management

Financial derisking instruments

- Take-or-pay clause in PPA

- Government guarantee for PPA payments

- Concessional public loans to IPPs

- Political risk insurance for equity investments



By investing **\$ 98 million** through public derisking instruments to reach the target of **450 MW** from wind farms by 2030

The Lebanese government can ...

1 ...catalyse

\$ 635 million

in private sector investment

2 ...generate

\$ 221 million

of economic wide savings over 20 years

3 ...decrease by

18%

the price of electricity from wind farms

4 ...decrease by

10 million tonnes

Lebanon's Carbon Dioxide emissions over 20 years

Figure 50: Derisking wind energy investment in Lebanon

To date, two financing mechanisms have been put in place to further engage the private sector in energy projects. The National Energy Efficiency and Renewable Energy Action (NEEREA) is a national financing mechanism initiated in 2010 by the Central Bank of Lebanon. It provides the private sector with long-term loans at low interest rates for any type of renewable energy or energy efficiency project. This financing mechanism encourages the private sector to invest in energy efficiency and renewable energy initiatives and consequently, decrease the demand on thermal electricity production. NEEREA has a loan ceiling of 20 million USD per project and is offered at low interest rates for periods that should not exceed 14 years including a grace period between 6 months and 4 years. These loans are provided through any of the Lebanese commercial banks to directly reach the end user.

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Energy mitigation actions are classified into 11 major categories, covering both energy efficiency and renewable energy, as presented below.

Table 91: Types of energy mitigation measures

Category	Description
Decentralized Solar Photovoltaics (PV) Installations	Solar PV installations in residences, commercial institutions, and industrial facilities for power generation
Solar-Powered Water Pumping	Solar PV installations for agricultural applications and water pumping
Solar-Powered Public Street Lighting	Solar PV for public streetlights. Includes addition of new poles and replacement of existing poles
Energy-Efficient Public Street Lighting	Replacement of existing HPS and LPS street lamps with LED street lamps and the use of photocells and timers
Solar Water Heating	Solar water heating systems in residential, commercial, industrial, and public institutions
Certified Green Buildings	Certified green buildings under the BREEAM and LEED schemes
Energy Conservation Measures (ECM)	Implemented energy conservation measures by energy audit companies and ESCOS, including measures related to lighting, cooling, heating, etc.
Biomass Space Heating	Biomass and pellet stoves for space heating
Other Renewables	Other renewable technologies including wind, hydro, geothermal, and others
Other Energy Efficiency	Energy efficiency measures undertaken by the public and private sector including energy efficient lighting, equipment, and others
Energy efficiency in power plants	Implemented measures such as upgrades and increase capacity in thermal power plant to increase efficiency of production.

Based on the data collected from the Ministry of Energy and Water, private entities, donor agencies and international organizations, a significant number of initiatives are being undertaken in the energy sector. A detailed and comprehensive database was designed by the Ministry of Environment for the BUR2 to report all the energy-related mitigation actions in Lebanon. The database has been updated to capture additional activities undertaken for the period 2014-2015. The collected information include data on implementing body, funding source, budget, timeframe, energy savings and emission reductions for each initiative, which have all been aggregated and compiled in Table 92 and in reporting tables presented in Annex VI.

It is worth noting that emission reductions from Energy Conservation Measures (ECMs) were excluded from the overall calculation due to the lack of comprehensive data required to perform necessary calculations. Additional research and surveys are therefore needed to reflect the real scale of ECMs. Further data will be gathered from the National Energy Efficiency Action Plan (NEEAP) evaluation expected to be delivered by the end of 2020 for this purpose. ECMs projects were however captured in the Support Received section of this BUR, as per the available funding data. Moreover, emissions reductions calculations for all other categories were reviewed against USAID, OECD and AFD databases, and additional activities implemented between 2011-2015 were identified; therefore, recalculation of the previously reported emission reduction (BUR2) was recalculated.

The database structure and related data collection process have served in further developing the Management and Information System for Climate Action (MISCA) platform that was developed under the UNDP LECB project in partnership with the Ministry of Energy and Water and the EU-funded ClimaSouth Project. Indeed, MISCA contains a section on collecting information and calculating emission reductions from the implementation of mitigation actions in the energy sector.

Table 92: Summary of mitigation activities in Lebanon in 2015, taking into consideration donor, private sector, NEEREA and government funding from 2011 to 2015

Activity	GHG emission reduction in 2015 (Gg CO₂)	Cumulative GHG emission reduction by 2015 (Gg CO₂)
Installation of Solar Water Heaters (SWH)	227.76	728.27
Other Energy Efficiency measures	171.91	689.66
Biomass Space heating	10.84	19.99
Decentralized solar PV installations	9.79	19.9
Certified green building	9.67	14.93
Solar-powered water pumping	1.66	3.16
Solar powered public street lighting	1.58	3.39
Energy-efficient public street lighting	0.16	0.56
Other renewables	0.07	0.18
Total known GHG emissions reduction	433.44	1,480.04

As presented in the table above, mitigation measures implemented in the energy sector contributed in reducing emissions by 433.44 Gg of CO₂eq. in 2015, which constitutes an increase of 35% from 2013. The emission reductions have been achieved in 2015 by RE and EE projects already under implementation in Lebanon since 2008 (with the assumptions that they are still operational since their construction) and by projects initiated in the year 2015.

This progress in emission reductions is mainly attributed to the expansion of solar water heaters, followed by the significance of other energy efficiency measures, biomass space heaters, as well as solar PV installations in the residential, commercial and industrial sectors for electricity generation.

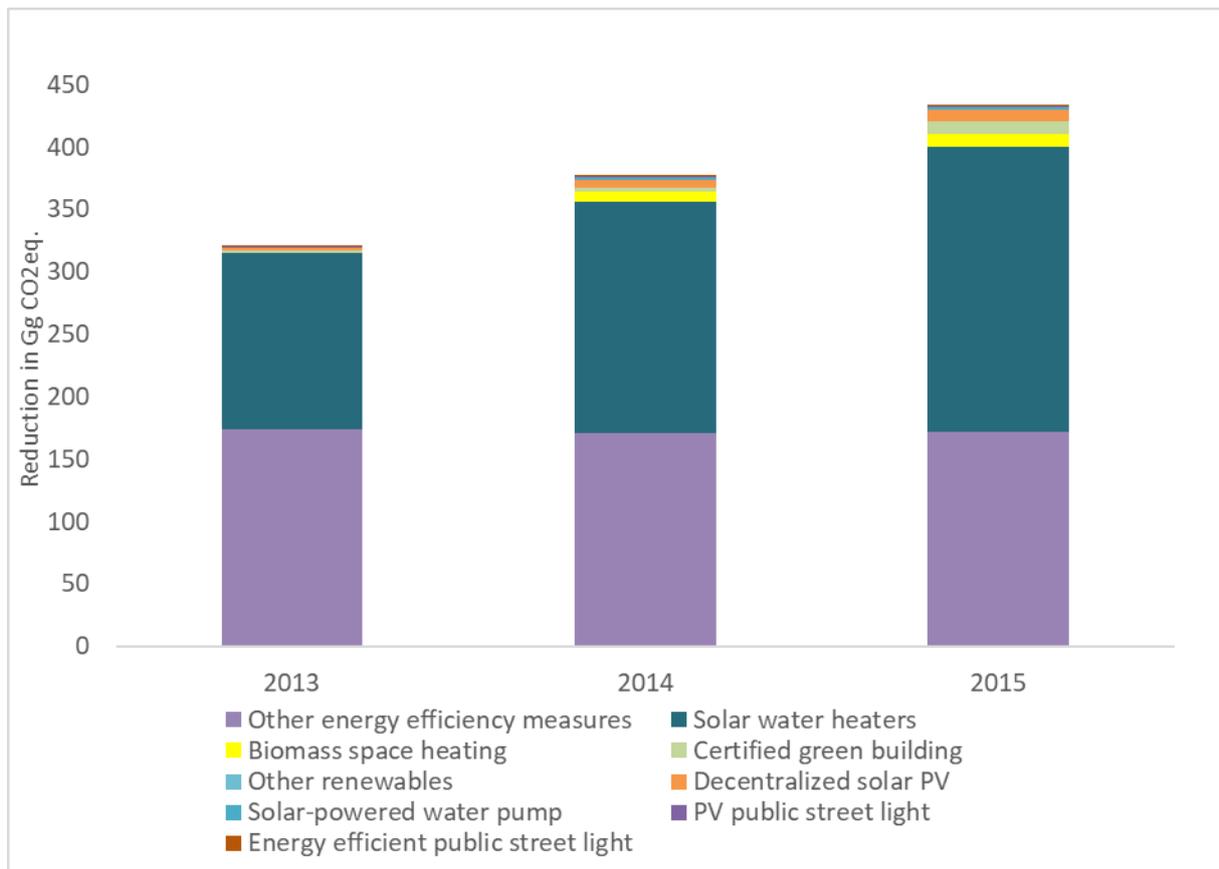


Figure 51: Emission reductions from the implementation of mitigation actions in the energy sector between 2013-2015

Solar water heaters, which remain by far the most developed renewable energy technology in Lebanon, represented around 53% of the estimated emissions that have been reduced in 2015. Indeed, more than 21,000 solar heaters were installed in the country by 2015, reducing electricity demand by 61,992 MWh for the same year.

Another initiative with a high emission reduction is the “3 million Lamp” initiative launched in 2011 by the Ministry of Energy and Water to distribute 3 million CFLs to 1.5 million households across the country to replace incandescent lamps. This project remained impactful in 2015, as it is estimated to have saved 172 Gg of CO₂, representing around 40% of reported emission reductions during that year (assumption is made that the 3 million lamps are still in service or has been replaced with similar CFL lamps).

Emission reductions from other activities, namely biomass, solar PV installations for electricity generation in the residential, commercial and industrial sectors, and certified green buildings witnessed a significant growth between 2014 and 2015. Examples of significant projects include the addition of 875 donor-funded solar PV home systems in host communities and 178 solar PV installations for electricity (total of 3.40 MW installed capacity) in the private sector in 2015, together

reducing 5,160 MWh, what is equivalent to 3,500 tonnes of CO₂ eq. By 2017, the total solar PV installed capacity reached 35.45 MWp, generating 52,846 MWh and reducing an additional 35.19 Gg CO₂ eq. (adapted from DREG, 2017).

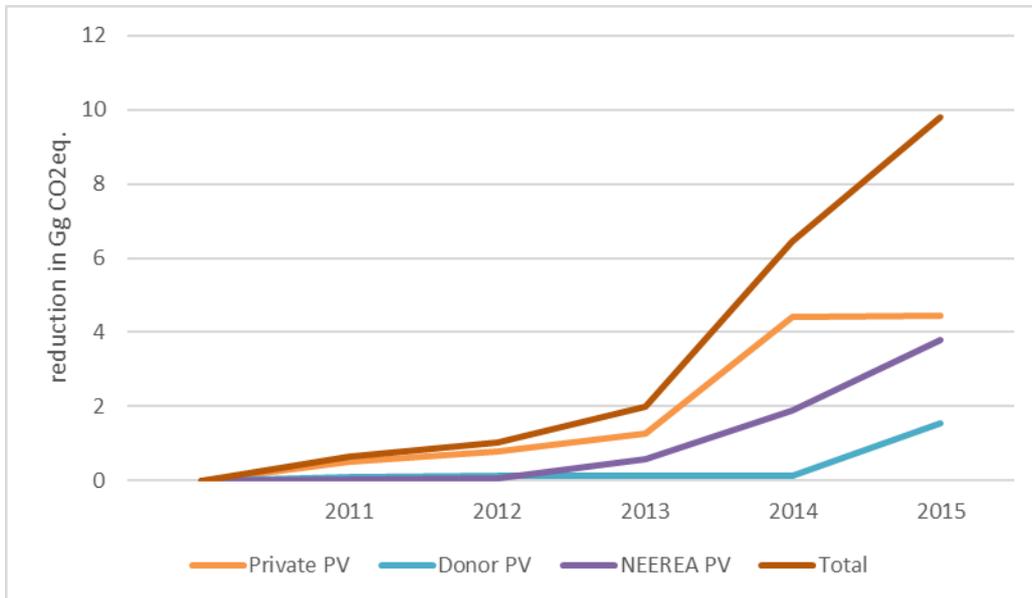


Figure 52: Emission reduction from the growth in the market for PV

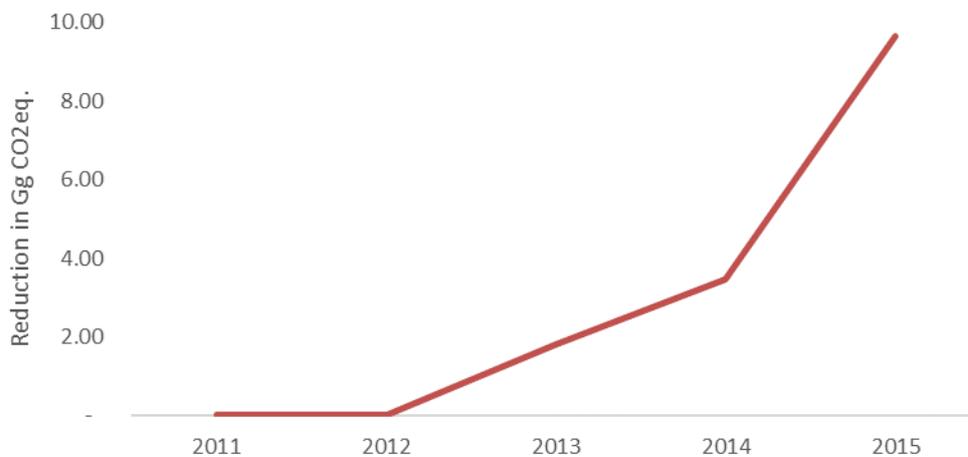


Figure 53: Growth in emission reduction measures in green building

Projects aiming to improve the energy efficiency of thermal power plants also significantly contributed to emissions reductions or avoided in 2015. GHG emissions have been avoided through energy efficiency measures such as the utilization the energy in the exhaust gases and the hot cooling water from the engines, installation of indoor gas turbine plants with NO_x control system and a mini hydro unit at the condenser outlet and the upgrade of design, material and coatings or power plants, which leads to improvement in turbine performance, and increases the overall power output and efficiency of the gas turbine. The plan for the HFO conditioning of the Zouk power plant has been cancelled and the construction of the Deir Amar Plan (DACCPP II 539.2 MW- HFO) is still in process and it is expected to enter in service in 2021.

Table 93: Increasing energy efficiency and introducing energy efficiency in public power production in 2015

Activity	Description	Expected GHG reduction/year (tonnes CO ₂ eq.)
Zouk ICE 194 MW (HFO)	Construction of new power plant completed in 2015 (start date 2013)	250,032
Jiyeh ICE 78.2 MW (HFO)	Construction of new power plant completed in 2015 (start date 2013)	100,788
ZCCPP 33.5MW Upgrade (DO)	Upgraded in 2013	177,315
DACCP I 29.5MW Upgrade (DO)	Upgraded in 2013	156,143
PV Beirut River Snake Project	In service since 2015	974
Total		685,252

3.2 Transport

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. It encloses a set of actions to be implemented on the short and medium terms, shifting the passenger transport demand to mass transit systems. The main actions with 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.

The Greater Beirut Public Transport Project

As a follow-up of the master plan, a new project was signed in 2018 between the Government and Lebanon and the World Bank for the improvement of public transport for passengers in Greater Beirut and at the city of Beirut Northern entrance. The project, with total cost USD 345,000,000 of consists of:

- BRT infrastructure, fleet and systems: including the design, construction and management of BRT road infrastructure from Tabarja to Charles Helou (22 km) and Beirut Outer Rind road (15 km), widening of key sections of the highway, acquisition and operationalization of a BRT bus fleet and the installation of ITS and fare collection systems
- Feeder and regular bus services and integration in Urban environment: including the design, construction and management of bus stops (30 stations) and control center, acquisition and operationalization of a feeder, park and ride facilities, development of non-motorized transport plan, road safety plan and urban transport master plan.

- Capacity building and project management: including the strengthening the capacity of the Project Implementing Entity and Railway and Public Transport Authority (RTPA) for project implementation, supervision and management.

The project is expected to yield high GHG emission savings compared to similar projects globally given its high modal shift potential from private vehicles. The total savings amount to 1,200,000 tonnes CO₂ over the 20 years of the project lifetime with Euro V diesel buses (60,000 tonnes CO₂ on average per year) and can reach to 1,440,000 tonnes CO₂ with Hybrid and Compressed Natural Gas (CNG) buses. More details of the project is provided in Annex VII.

The project is also expected to create around 2 million labor-days of direct jobs in the in the construction industry, additional jobs are created in supply industries and in transport services and 3,000 regular and permanent jobs (Nakat, 2018).

Nationally Appropriate Mitigation Action for the Transport sector

Through the UNDP LECB project, Lebanon has prepared and endorsed in 2017 two Nationally Appropriate Mitigation Actions (NAMA) for the waste and transport sectors, as prioritized by national stakeholders

The NAMA for the transport sector aims at reducing GHG emissions through changing the prevailing practice of high fuel consumption and high car emission levels and supporting a systematic change towards Fuel Efficient Vehicles (FEVs).

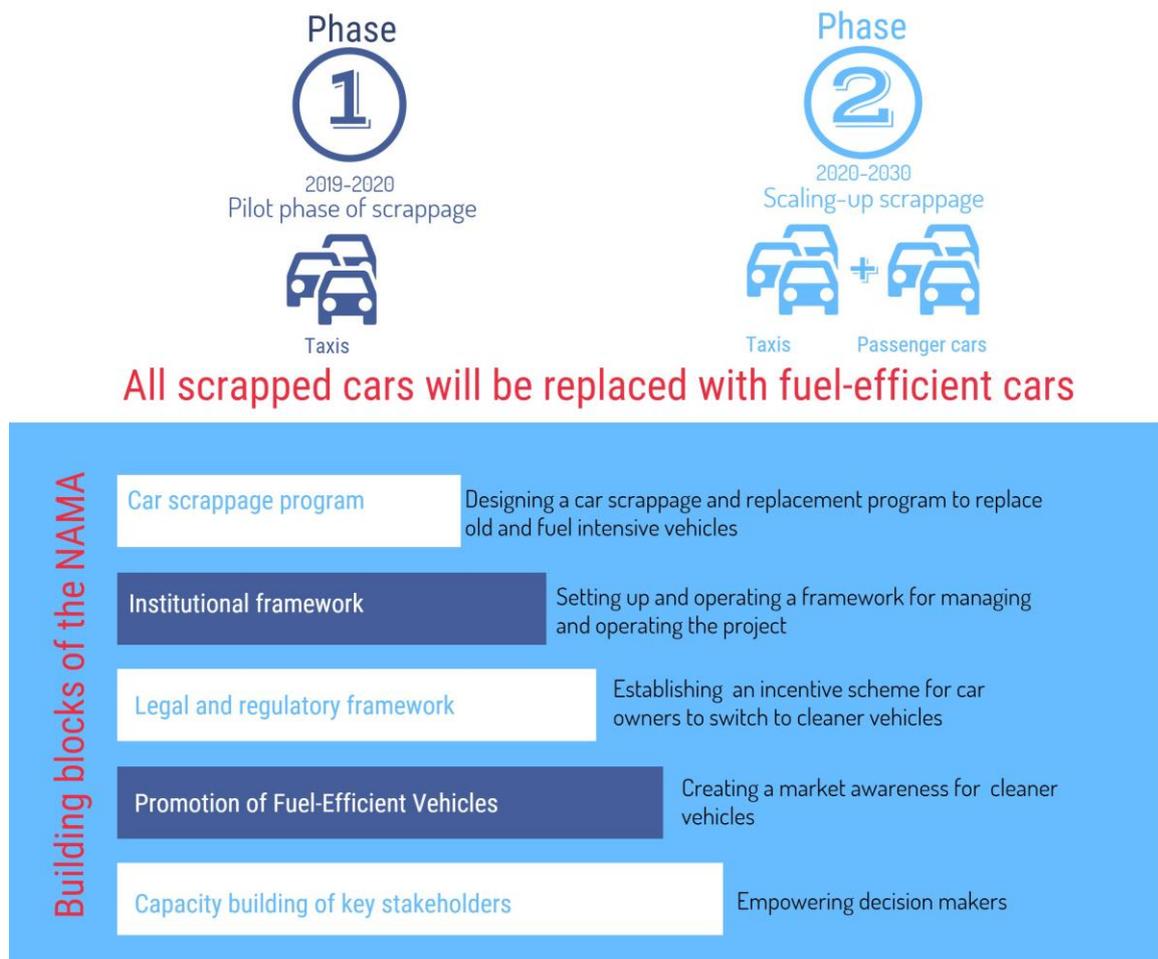


Figure 54: Main Components proposed for the Transport NAMA

The implementation of the NAMA is expected to reduce around to 11,000,000 tonnes of GHG emissions by 2030, and the majority of emission reductions occurring under Phase 2 with a steady increase correlating with the increase in cars being replaced. The assumption that 100% of cars that are older than 15 years would be replaced by the NAMA is made.

As a first step, a tax incentive scheme has been issued by the Government in the budget Law of 2018 79/2018 (article 55) and renewed in 2019 (Law 144/2019 – article 25.c) 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.

The NAMA has been endorsed by the Council of Ministers decision number 14/2017 and the government of Lebanon is seeking technical and financial support for its full implementation.

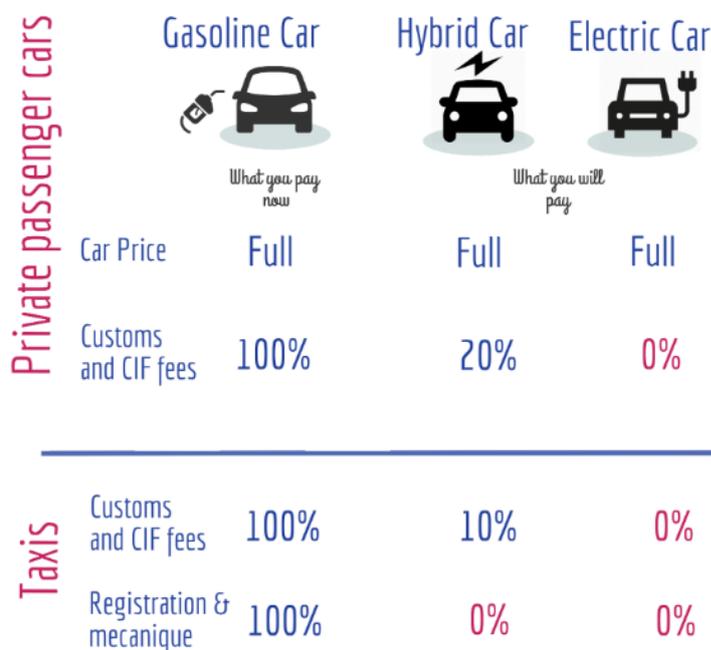


Figure 55: Tax incentives for hybrid and electric vehicles

3.3 Agriculture

Limited activities with an emission reduction potential have been implemented in Lebanon. Pilot projects related to water pumping and irrigation using renewable energy have recently been initiated across the country, with no quantifiable emission reductions yet. Other activities are being explored through research and knowledge generation, capacity building and 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.

An indicative list of climate change projects implemented in Lebanon related to the agriculture sector are presented in Table 98.

3.4 Forestry and Land Use

In the identification of climate mitigation measures related to Forestry and Land Use Change and Forestry that have the potential to significantly contribute to emission reduction or sink enhancing, 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 CH₄ and N₂O, from land use interventions on from fire management

This section updates the mitigation actions published in the second Biennial Update Report in the Land Use, Land Use Change and Forestry (LULUCF) sector by adding the relevant activities implemented during the period 2013-2015. The methodology adopted for the calculation of CO₂ removals and emission reductions in these projects is described in Annex VII.

In 2012 and 2013, afforestation and reforestation activities were sustained and increased by the Ministry of Agriculture and leader organizations in the country such as the Association for Forest Development and Conservation and Jouzour Loubnan, increasing the total amount of GHG emissions that has been removed from mitigation actions in LULUCF to 18.996 Gg CO₂eq. by 2013 according to the second BUR. Emission reductions from afforestation and reforestation activities persisted in the following years as presented in Table 94 While emission reductions witnessed a slight dip in 2014 due to the absence of new projects and the slower impact of previous ones, new projects undertaken in 2015 escalated emission removals to -5.258 Gg CO₂eq. that year. 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. 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.

Table 94: Summary of achieved removals in forestry by 2015

Title of mitigation action	GHG removals in 2015	Cumulative GHG removals by 2015
Toumet Niha, Jezzine reforestation project	-0.1618	-0.1618
ARDAC project	-0.0647	-0.0647
Deir el Ahmar and Ainata reforestation / afforestation project	-0.0259	-0.0259
Development and implementation of pilot landscape restoration plans	-0.388	-1.55
Hasbaya, Kawkaba, Baalbeck & Aramoun reforestation / afforestation project	-0.0741	-0.0741
AFDC afforestation / reforestation projects	-0.0324	-0.3886
The reforestation initiative of the MoE		-5.4
Jouzour Loubnan's reforestation and afforestation activities		-3.4628
Lebanon Reforestation Initiative	-0.605	-13.4827
Managing wildfire risk in the Wildland-Urban Interface	-0.34	-0.34
Total GHG removals and emissions reductions (Gg CO₂eq.)	-1.6919	-24.9506

3.5 Solid waste and wastewater

Nationally Appropriate Mitigation Actions for the waste sector

The NAMA for the solid waste sector aims at identifying concrete actions needed for in Lebanon to improve the processes in waste management leading to higher efficiency and reducing GHG emissions. The reduction of emissions estimated to around 3,600,000 tonnes of by 2030, will be achieved through the collection and utilization of landfill gas in landfill sites and open dumps and the implementation of a Waste-to-Energy facility, which shall serve the GBA. In addition, future GHG emissions from landfills in rural areas of Lebanon, will be reduced by waste sorting and composting of the organic substances.

These main building blocks of the NAMA are proposed as following:

- Setting up and operating an institutional framework capable of managing and operating the NAMA with all necessary measures and interventions
- Supporting awareness creation for waste management and source sorting among key institutions, stakeholders and the public;
- Establishing the necessary legal and regulatory framework for the Municipal solid waste sector that enables technical interventions (Landfill Gas utilization and Waste-To-Energy) to be applied
- Ensuring the collection and utilization (power generation) or flaring of landfill gas in up to 8 existing sanitary landfills and open dumps
- Preparing and implementing solid waste management and collection centers (including waste stream diversion to disposal sites);
- Applying (preparing, implementing and operating) Waste-to-Energy technologies in Lebanon.

Table 95: Main Components proposed for of the Waste NAMA

NAMA Phase 1 (2018-2021)	NAMA Phase 2 (2022-2030)
Landfill Gas management, including utilization or flaring, at 4 priority landfills sites and open dumps	Implementation and operation of 1 waste incinerator for producing energy from waste
Establishment of an institutional framework	Landfill Gas management, including utilization and flaring at 4 additional landfill sites and open dumps.
Building the capacity of key stakeholders	Implementation of waste collection and waste reception centers to other service areas outside the Greater Beirut Area
Implementing waste collection and reception centers in the Greater Beirut Areas	Assess the potential for further Waste-to-Energy opportunities in Lebanon and ensure awareness creation of source sorting and recycling.
Preparing for Waste- to-Energy systems	

Solid Waste Management Strategy and its roadmap

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, a 10-year solid waste management roadmap was proposed by the Ministry and adopted by the Cabinet on August 2, 2019. The main actions of the road map are as following:

- Preparation and submission of Strategic Environmental Assessment for the ISWM
- Finalizing the template tender documents for the collection and sweeping of solid waste at municipal level
- Approval of solid waste facilities in 10 locations across the country where facilities already exist

- Launching a bid for the construction of new treatment facilities in line with the proposed roadmap
- Preparing an Environmental Impact Assessment for 2 locations (Deir Amar and Beirut) for the construction of a waste to energy facility (thermal disintegration). This will be in addition to the waste to energy facility that is being considered for the Municipality of Beirut.
- Preparing a draft cost-recovery Law for sweeping, collection and treatment
- Conducting a communication and awareness raising campaign for the upcoming 5 years

4 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 CO₂ equivalent per annum (as stated by the project participants)

5 MRV of mitigation actions and policies

As mentioned in the introduction of this section on mitigation policies and actions, currently Lebanon has no specific methodology for monitoring the progress of actions described. Consultations with project proponents and main stakeholders helped identify mitigation actions being implemented. However, 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, mainly through implementation of renewable energy and energy efficient projects. 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 is currently conducting a mapping of all climate actions, including mitigation actions, as part of the NDC Partnership Plan, in order to assess needs and gaps. The Partnership Plan is a document that 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.

Concretely, the structure of the document will include relatively high-level desired outcomes, delivered through a number of lower level outputs, which are tracked using Key Performance Indicators (KPI). This results-based logic at three levels forms the core of the plan. It is complemented with other elements offering the opportunity to capture and track additional important information including specific activities, costings, responsible actors, types of support, progress status, sectors covered, area of focus (adaptation, mitigation, cross cutting), linkages with sectoral plans and strategies, etc.

The partnership plan is designed with a rolling 3-year timeframe and can include different programming cycles.

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

As part of the upcoming CBIT project, a Measuring, Reporting and Verifying Coordinating Entity (MRVCE) is planned to be established at the Ministry of Environment with the aim to build a systemized approach for collecting information on mitigation. Part of this systemization already started with the development of the Management Information System for Climate Action (MISCA) platform with the energy sector. The CBIT activities also include the expansion of the MISCA platform to include other sectors.

In addition, the CBIT project will pick up on the work related to synchronization of NDC and Sustainable Development Goal (SDG) targets by analyzing and linking indicators of policies that make up the NDC with the global SDG indicator database. The CBIT project will work on further developing these indicators to inform NDC progress. The consultative process to institutionally adopt indicators will include the potential synchronized SDG indicators to avoid duplication of efforts in reporting.

IV. Constraints and gaps, and related financial, technical and capacity needs, including a description of support needed and received

1 Information on support received

1.1 Support for NDC related projects and institutional arrangements

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.

The Ministry of Environment is the National Designated Authority to the Green Climate Fund (GCF). Lebanon has submitted one Readiness proposal for "Strengthening and enhancing Lebanon's institutional arrangements and capacity to enable and optimize access to the Green Climate Fund" and is expected to launch the project by 2020. In addition, Lebanon is currently seeking support from the

GCF to prepare its National Adaptation Plan (NAP) through the readiness programme and is working with the UNDP-UNEP NAP-GSP programme to prepare and submit the proposal.

Building on the progress of UNFCCC negotiations related to transparency of reporting on climate finance, and based on recommendations from the ICA process, Lebanon has attempted in every BUR to improve the collection of information about support received. Currently, no single entity is 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. In addition, identified funds do not include domestic support from the government, including loans, for the implementation of mitigation measures due to unavailability of complete data.

Table 96: Financial and technical support for general climate change related projects

Donor	Project/initiative	Expected outputs	Budget *	Timeframe
Global Environment Facility	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
European Union, Spain Germany	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 – 2019
European Union – ClimaMED project		- 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 Euros 6.9 Million (Lebanon's share is Euros 1 Million)	2018 - ongoing
Sweden	The MENA Region Initiative as a Model of NEXUS Approach and Renewable Energy Technologies (MINARET)	- 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
Kigali Cooling	Energy Efficiency in	- Improve energy efficiency and	USD 407,000	2019-

Efficiency Programme (KCEP)	Cooling in Lebanon	<p>avoiding HFCs</p> <ul style="list-style-type: none"> - Develop cooling standards to enable retirement of inefficient equipment - Develop efficiency cooling plan - Assess the potential incremental costs for improved energy efficiency in refrigeration. - Develop a roadmap for accelerating market transformation in domestic refrigeration and air conditioning sector - Integrate knowledge on applications of EE principles and interventions applied in the HPMP projects 		ongoing
UNFCCC	Needs Based Finance	Conduct a climate finance needs assessment within the framework of costing energy-related NDC initiatives and identifying the gaps and challenges in accessing climate finance	NA	2019-2020
UNDP/UNEP Global Support Program for National Communications and Biennial Update Reports	<p>Implementation of an Enhanced Transparency Framework in Armenia and Lebanon</p> <p>A South-South exchange platform</p>	Exchange experiences with the Armenia BUR/NC team on lessons learned and good practices	NA	2018
World Bank	The Greater Beirut Public Transport Project	Establish and operate a Bust Rapid Transit (BRT) infrastructure and stations for parts of Beirut	USD 345,000,000 (Loan and concessional funding)	2018-ongoing
International Finance Corporation	Green Bonds Programme at Fransabank	Issue green bonds in Lebanon and the Levant region to boost the green economy, promote environmentally-friendly projects and help fight climate change	USD 75,000,000 (green bonds)	2018
European Bank for Reconstruction and Development	Green Bonds Programme	Issue green bonds in Lebanon and the Levant region to boost the green economy, promote environmentally-friendly projects and help fight climate change	USD 15,000,000 (green bonds)	2018-current
European Bank for Reconstruction and Development and Taiwan ICDF	Green Economy Financing Facility (GEFF)	Finance green projects related to diversifying energy supply, reducing the use of energy and water and improving energy efficiency.	USD 100,000,000 (Loan and concessional funding)	2018-current

European investment bank and France	Lebanon Energy Efficiency and Renewable Energy Finance Facility (LEEREFF)	Support investments in energy efficiency, renewable energy and green Building by private companies in Lebanon.	USD 80,000,000 (credit line)	2018-current
Luxembourg	Green for Growth Fund (GGF)	Support investments in energy efficiency and renewable energy for industries, green building, vehicles and ESCOs	USD 15 million	2019-

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

During the period 2014-2015, support in the form of grants has also been channelled from OECD countries to Lebanon for policy formulation, institutional support and education and awareness in the fields of forestry, energy, water supply and sanitation, which are directly and indirectly related to climate change (as identified by OECD Rio markers methodology).

Table 97: Financial and technical support for energy related climate change projects from OECD countries (OECD, 2019)

Donor	Project/initiative	Expected outputs	Climate change related Budget*	Timeframe
France	Education and training in renewable energy (FASEP 983B)	Conduct Education and training programmes in renewable energy	USD 85,000	2015-
France	Agriculture Education and training	Conduct Education and training programmes in agriculture	USD 22,185	2015-
Germany	Water sector policy and administrative management	Institutional support for the water sector to improve services on water supply and effluent disposal	USD 13,176	2015 -
Italy	Disaster Prevention & Preparedness	Support and maintenance of the RISICO system for prediction and prevention of forest fire in Lebanon and Design of an early warning system for the flood risk	USD 583,000	2014-
Italy	Environmental policy and administrative management	Enhance the management of the buffer zone of the Shouf cedar reserve	USD 554, 630	2015-
Italy	Development of the marine environment to serve the needs of the coastal communities – CANA plus	- Strengthen research on the marine and coastal environment in Lebanon - Promote the development of coastal communities	USD 776,500	2015-
Japan	Water resources conservation	Improve water preservation and management at Hima Kfar Zabad wetlands and springs	USD 69,674	2014-
Norway	Lebanese Red Cross Disaster prevention and preparedness	- Establish a community-based Disaster Risk Reduction programme to strengthen the most vulnerable communities' resilience to natural and man-made hazards and disasters. - Capacity building of Search & Rescue for urban and rural response.	USD 1,092,689	2014-

*Climate-related development finance - Current USD as per OECD classification

Based on the information available, it is estimated that a slight majority of the climate change related projects are categorized as mitigation projects and most of the climate change budgets are targeted for implementation of actions and interventions while a smaller fraction is targeted to research and capacity building.

In terms of sectoral concentration of funds, the energy sector has been clearly attracting the bulk of grant funding due to its high emission reduction potential compared to other sectors. More than USD 18 million were granted by international donors for the implementation of energy mitigation projects in 2014-2015 from donors. PV installations for electricity generation received the bulk of funds, followed by one small-scale hydropower project at the Jouz river under by Italy (Figure 56). Most of the funding has been provided by the EU mainly through the ENPI MED project and by Italy through the Jouz river hydropower plant (Figure 57).

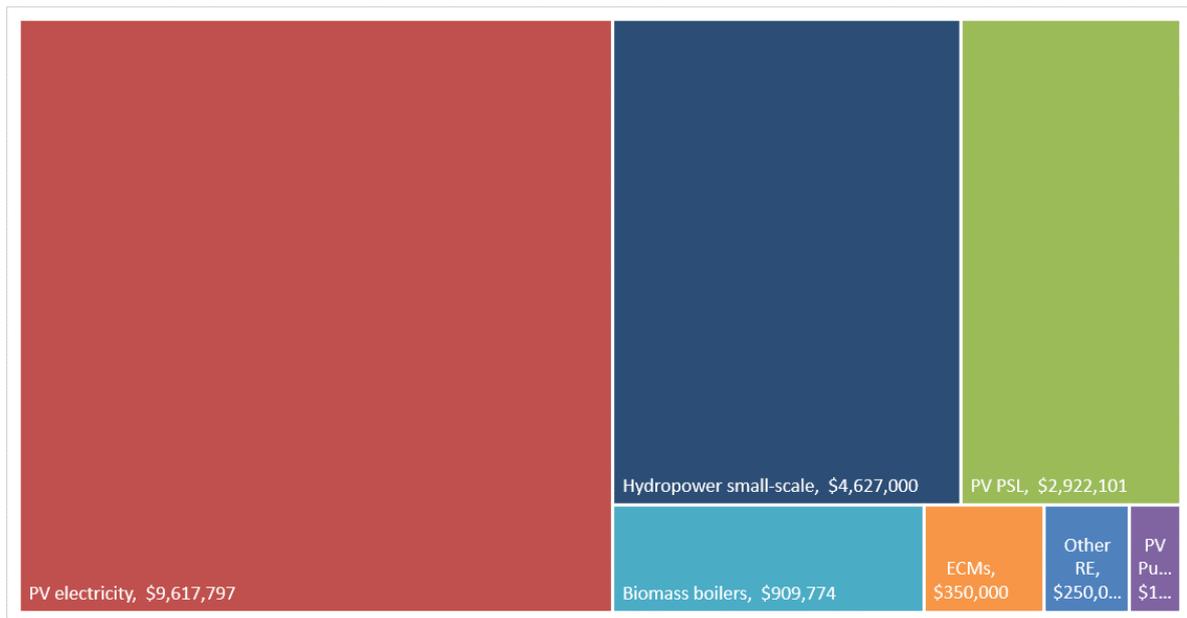


Figure 56: Support received in the energy sector by type of activity in 2014- 2015 (in USD)

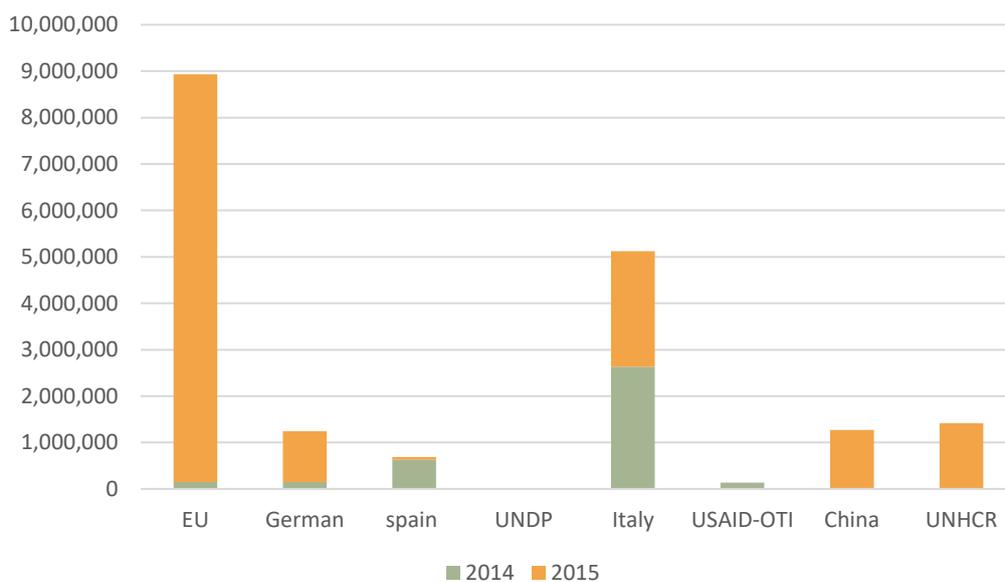


Figure 57: Energy-related funding provided in donors in 2014-2015

As for agriculture and forestry, funding extended to both mitigation and adaptation measures. Support received in these sectors was therefore reported for both types of climate action since the two are often interconnected. These funds were mainly provided by international bodies such as GEF, Adaptation Fund, the EU, and European Governments amongst others, implementing actions in forestation, forest fire fighting, renewable energy and water scarcity, supporting policy development, raising awareness and building capacities of national institutions. As expected, most of the funding (53%) is geared to concrete implementable actions, which costs cannot be secured by the government or local communities and which produce immediate results and increase visibility of funding. In addition, there is more appetite from the donor community to support projects with an integrated approach to climate change and tackling policy, capacity building, knowledge generation and interventions at a pilot scale.

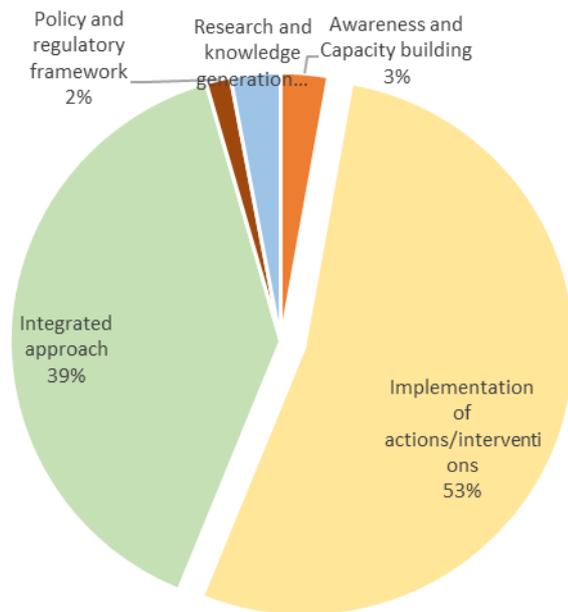


Figure 58: Targeted categories in AFOLU by international funding and support

As presented in the subsequent tables, most of the funding is geared to the agriculture sector given its high environment and social value and its infrastructure requirements. Support to increase the adaptative capacity of agricultural systems is increasing in Lebanon, with more focus on water demand management for irrigation and smart agricultural practices.

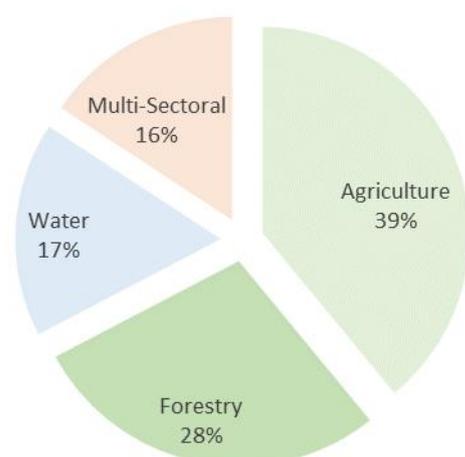


Figure 59: Targeted sub-sector in AFOLU by international funding and support

Table 98: Funding received for adaptation and mitigation measures in the agriculture sector in since 2013

Donor	Project/initiative	Expected outputs	Budget *	Timeframe
Global Environment Facility (SGP)	Smart Agricultural Consumption of Energy	Achieve self-sufficiency in the rural agricultural sector in Baalbeck through technological innovation, introducing of renewable energy in the agricultural sector, and reducing the use of fuel	USD 43,000	2015-2017
Global Environment Facility (SGP)	Establishing a rainwater harvesting pond for "Ferzol" farmers.	Establish a rainwater harvesting pond in the village of "Ferzol" to irrigate almost 2,500 tree/year	USD 25,000	2015-2017
Global Environment Facility- Small Grant Program (SGP)	Alternative energy production project to support farmers in Aarsal	- Increase acreages of wheat by 33% of the area currently under cultivation Aarsal -Raise awareness and motivation on alternative and renewable energy usage.	USD 43,000	2013-2014
Global Environment Facility- Small Grant Program (SGP)	Water, Waste and Climate Change	- Train 60 NGOs to advocate on the local government level to promote sustainable ways of managing waste and water - Develop a local observatory for waste and water related problems.	USD 28,317	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 and increasing its quantity	USD 1,900,000	2015-2018

Crop trust	Selection of new cultivars adapted to climate change	Select new cultivars for 10 crops: oat, pea, chickpea, wheat, grass pea, barley, lentil, alfa-alfa, rye and vetch	NA	2019-current
Adaptation Fund and Italy	Climate Smart Agriculture: Enhancing Adaptive Capacity of the Rural Communities in Lebanon (AgriCAL).	Enhance the agricultural sector's adaptation capacity to climate change	USD 9,282,720	2018-2020
ENPI and Italy	Adaptation to Climate Change through Improved Water Demand Management in Irrigated Agriculture by Introduction of New Technologies and Best Agricultural Practices - ACCBAT	Reduce the use of freshwater in irrigated agriculture	USD 5,648,815	2013-2016
the Netherlands	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 8,250,000	2016 - 2019

*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 99: Funding received for adaptation and mitigation measures in the forestry and land use sector in since 2013

Donor	Project/initiative	Expected outputs	Budget *	Timeframe
Global Environment Facility- Small Grant Program (SGP)	Forest protection in Qobeiyat, Zgharta	- Establish trees trimming technique for forests and produce biomass fuel in Qobeiyat -Facilitate access to the burned areas and organizing and developing 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 1,900,000	2015-2018

The European Union	Assisting reforestation and forest development activities in partnership with local communities (ARDAC)	Reforestation and sustainable forest management activities in Menjez, Akkar – 10 hectare in 2015	USD 333,427	2014-2018
The European Union	Deir el Ahmar, Ainata and al-Barqua reforestation/afforestation activities	Reforestation and sustainable forest management activities Deir el Ahmar and Ainata- 4 ha in 2015	NA	2014-2018
The European Union	Hasbaya, Kawkaba, Baalbeck and Aramoun reforestation/afforestation activities	Reforestation and sustainable forest management activities – 11.45 ha in 2015	NA	2014-2018
Private sector – banking sector	Development and implementation of pilot landscape restoration plans	Reforestation and sustainable forest management activities in al Shouf biosphere reserve - 60 ha in 2015	NA	2013-2015
Private sector – banking sector	AFDC afforestation/reforestation projects	Reforestation and sustainable forest management activities in Jesr el Kadi, Deir el Amar, Ashash, Btater, Shartoun, Anjar, Rashaya, Bqerzala,	NA	2013-2016
Germany	Implementation of forest management related livelihoods activities in the North and Beqaa	Implementation of 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
Germany	Adapting forest policies to climate change in the Near East and North	Combating climate change	USD 4,000,000	2010-2017
Italy	Support national policies to prevent forest fires	Increasing forest cover and preventing forest fires	USD 950,000	2010-2015
USAID and USFS	Lebanon Reforestation Initiative	- 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 19,500,000	2011-2018
USAID - PEER	Managing wildfire risk in the wildland-urban interface	Improve assessment and management of wildfire risk	USD 134,635	2012-2016
Italy	Early warning system for forest fires in Jbeil and Keserwan	Promote community-based management of forest fires	USD 19,000	2012-2013
World Food Programme	Forest Management and Reforestation Activity	Contribute to the rural development of the North Akkar region	USD 272,200	2018-2019

Japan	Improving forest fire management operations in Dmit & 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
USAID	Lebanon Forests Protection Partnership	Build the capacities of local communities to manage forest fire and forest resources. Raise awareness through media campaign and school events	USD 226,196	2012-2014
France	Restauration des surfaces dégradés et assistance à la population vulnérable de Rashaya Et Chmistar par des activités de reboisement et de sensibilisation	Contribute to increasing the green cover through reforestation of 150 ha of degraded lands in Rashaya and 50 ha in Chmistar.	USD 1,279,160	2018-2021
Global Environment Facility-Special Climate Change Fund (GEF-SCCF)	Smart Adaptation of Forest Landscapes in Mountain Areas (SALMA)	<ul style="list-style-type: none"> - 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 7,145,635	2016 - 2021
Norway	National Center for Forestry Seeds of Lebanon	<ul style="list-style-type: none"> - 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
Germany Korea Sweden	The Paris Agreement in action: upscaling forest and landscape restoration to achieve nationally determined contributions	<ul style="list-style-type: none"> - 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
Germany	Technical assistance facility for Forest and Land Restoration and Management (FLRM) projects	<ul style="list-style-type: none"> - 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-current

1.2 MRV of finance

The MoE is aiming to develop a Measuring, Reporting and Verification (MRV) of support system which captures climate finance flows from domestic and international sources. This system aims to also fulfil the following needs:

- Reporting under the United Nations Framework Convention on Climate Change (UNFCCC) on support received and support required.
- Understanding, whether support received is in line with Lebanon's priorities.
- Tracking progress towards the NDC targets with regards to international support received and domestic support provided
- Enabling better planning of mitigation and adaptation activities under the NDC with regards to funding required.

To do so, the system needs to provide a level of detail which allows differentiating between

- adaptation and mitigation-related support – ideally aligned with classification used by donors
- financial support, capacity building and technology transfer
- bilateral and multilateral support
- activities addressing the various sectors covered in the NDC, to support sectoral planning

Based on a study undertaken by the Ministry of Environment on finance flows and instruments, this section provides an overview on the current legal and institutional framework relevant for the tracking of support and an overview of key stakeholders and the relevant data they hold. The MRV of support system to be developed will be based on these structures and resources to the extent feasible. A summary of the analysis is presented in (Figure 60).

Climate support flows are categorized into four broad categories: public international, public domestic, private domestic and private international. The most relevant financial instruments used to disperse climate finance are: loans (concessional or non-concessional), grants (in cash or in-kind), national budget contributions, Foreign Direct Investment (FDI).

Legal framework and institutional structures

Law 28/2017 on right to access information: The Law tackles the right to access government-related information to all without intermediary. It grants any person and/or entity the right to access administrative information and documents which are held at any governmental and municipal authorities. This Law however, still needs to be operationalized through Decrees.

Minister of Environment's decision 99/1: The Minister of Environment's decision 99/1 (2013) provides an incentive to the private sector (commercial, institutional and industrial enterprises) to report on a voluntary basis their GHG emissions and related activity data to the Ministry of Environment using a MS Excel-based simple tool. As a quality assurance measure, the reported data is verified and certified by an auditor or accountant (from the submitter's side) prior to its submission and is further checked for completeness and consistency by the Ministry of Environment. This scheme is designed with an awareness raising approach in instigating a reporting culture (GHG emission reporting) by the private sector and to provide a self-tracking tool to be used by participating companies to monitor their GHG emission growth/reduction.

Lebanon Climate Act (LCA): The Lebanon Climate Act is an initiative that has been launched in 2016 by the Green Mind NGO in cooperation with the UNDP, the Central Bank of Lebanon, the Federation of Chamber of Commerce, Industries and Agriculture and the Ministry of Environment to engage the private sector and non-state actors in climate action. A series of trainings labelled as Business Knowledge Platforms have been conducted and a business guide on climate change was developed to support companies in determining their level of engagement, and developing implementation, monitoring and reporting plan for their climate actions. To date, around 100 companies and non-state actors have joined this initiative with different level of engagements.

Decree 167/2017: the Decree provides tax credits and customs tariff reduction on energy efficient equipment and environmental services for all commercial, industrial and institutional sectors. The Decree is still awaiting the issuance of a decision by the Minister of Finance.

Proposed climate change and MRV unit for the implementation of Lebanon's NDC: The establishment of an MRV Unit which will be responsible for tracking climate change finance flows, measuring the progress of climate policies through its NDC goals and identifying needs to strengthen climate reporting processes in Lebanon.

A Monitoring Information System of Climate Action (MISCA): The Ministry of Environment designed and developed an online information system to facilitate the exchange of data between Ministries and track progress of implementation of Lebanon's Nationally Determined Contribution. The system targets the energy sector as priority sector for the first phase to enhance data sharing between the Ministry of Environment and the Ministry of Energy and Water and improve the preparation of the energy sector's GHG emission inventory and mitigation action reporting. MISCA is also designed to help the ministry to track its own progress and automatically calculate resulting CO₂ reductions. The success of the system lies in the engagement and commitment of the Ministry of Energy and Water, which in turn serves towards meeting the energy sector's emission reduction targets, the country's most significant target of its NDC.

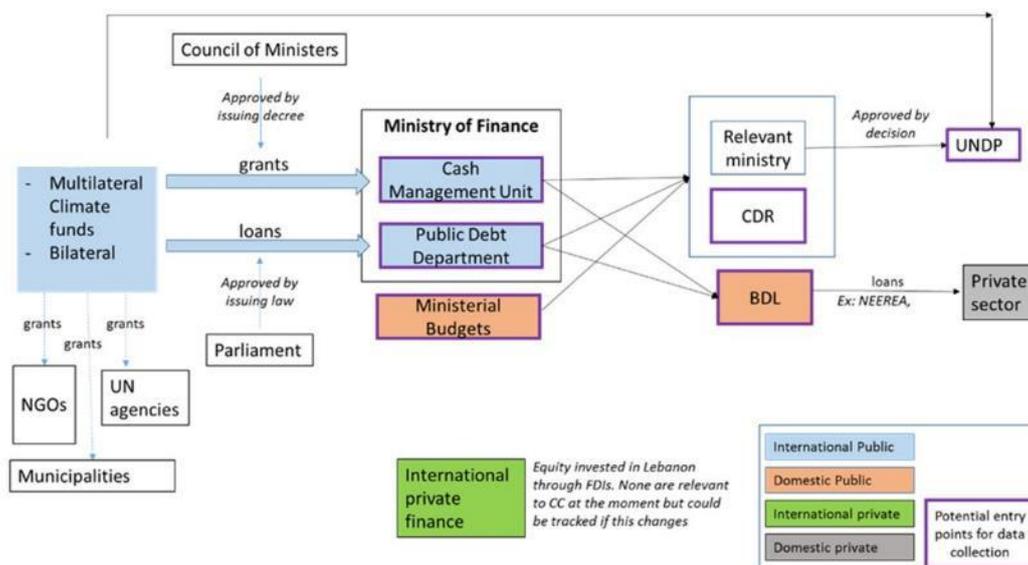


Figure 60: Overview of key channels and stakeholders of climate finance flows in Lebanon

Key data sources – Public international support

Cash Management Unit (CMU) at the Ministry of Finance (MoF)

The aim of the cash management unit is to follow up the registration of cash grants that are registered in the budget in accordance with the public finance Law. All grants that Lebanese public institutions receive are approved by the Council of Ministers issuing a Decree which is then published in the official gazette. Information on grants is at present saved in an excel spreadsheet that is updated manually.

Grants that are not received in cash (i.e. grants in kind) are not registered. The unit focuses on the financial aspect of the grant and therefore does not have detailed information on aims or tasks. Only the title of the grant can be used to understand aims, tasks, whether it relates to mitigation or adaptation, etc. Publicly available information is limited to the aggregated amount of all cash grants received.

Disaggregated information per grant can be potentially provided upon receipt of an official data request letter and where this data request is approved by the Ministry of Finance.

Public Debt Department at the MoF

The public debt department (PDD) is responsible for tracking and capturing all loans received by the government of Lebanon. Loans are usually approved by the Parliament issuing a Law which is then published in the official gazette. Tracking takes place using a Debt Management and Financial Analysis System (DMFAS) developed by the United National Conference on Trade and Development (UNCTAD). DMFAS provides functionality to fulfil the operational, statistical and analytical needs of debt management and external financial planning. It includes information on the value of the loan, the amortization schedule, disbursement, economic sector, creditor state etc. Again, only the title of a loan provides insight into aim, tasks, etc. DMFAS only captures loans which have to be paid back by the Lebanese Government. Loans received directly by the BDL – not a common event – are not captured. The same applies for loans directly received by the private sector.

Currently, only the Council for Development Reconstruction (CDR), the MoF, and the Banque Du Liban (BDL). can view information in DMFAS, but do not have write-access. Information on DMFAS can only be shared with the MoE if an official data request is sent and approved by the MoF.

Council for Development and Reconstruction (CDR)

The Council for Development and Reconstruction is an implementing agency directly under the Council of Ministers, which receives directly support flows after the Council of Minister (CoM) approval. The CDR uses a data management system referred to as JD Edwards system which is oracle based and captures loans and grants for projects that are implemented by the CDR as well as by other institutions marked as 'implemented by others' in the system. It tracks grants received in cash but also in-kind. If there is a CDR domestic component to these grants/loans they will also be captured in the system. It therefore breaks down the contract value of the project by grant, loan, and local CDR funding.

Information captured includes: title, financial instrument (i.e. grant/loan), conditions, sub-components, sector, and payment, administrative milestones from administrative perspective, Decree, date, effectiveness, and disbursements. It does not capture money that is transferred directly between the government and a specific ministry. The system also does not use the same classification as that of the MoF (GFSM, 2001). Support flows are classified by sector, but not using climate-related jargon (adaptation/mitigation, etc.). However, the system provides a degree of flexibility allowing to add new information categories.

Information on individual support flows can be shared based on an official data request.

Other stakeholders

The MoE is an important source of information on flows as it the National Designated Entity of the Green Climate Fund (GCF), the Global Environment Facility (GEF) focal point, and the NAMA coordinating entity at the national level. The MoE is yet to explore in coordination with other partners how to best capture the information on support received.

The CoM archives the grants and loans that have been released in the official gazette. The CoM system scans the information from the gazette and includes it in their system as an image. The information is therefore not easily searchable.

United Nations (UN) agencies and international organizations are sometimes directly provided with some grants. These funds however are unaccounted for in the Lebanese public sector.

Municipalities may receive grants directly under certain condition. Such grants would not be registered by the cash management unit or the CDR.

The Organisation for Economic Cooperation and Development (OECD) statistics offer information about Overseas Development Assistance (ODA) provided on a bilateral basis. ODA is defined as government aid designed to promote the economic development and welfare of developing countries. This aid also includes funding towards climate change relevant projects. OECD statistics website tracks bilateral funding of OECD countries to Lebanon regarding climate change projects. It provides the following relevant information for each project: donor, sector, marker (mitigation adaptation), year, flow type (loan, grant), amount, agency name, project title and description.

Non-Governmental Organizations (NGOs) in Lebanon receive grants related to climate change from development agencies and other sources. These flows are not captured by the government. Options for capturing such information would include signature of an MoU for voluntary reporting or disclosure through the development agencies or the Ministry of Environment. While some NGOs report their budget and expenditure on their website, this is not the case for all. With a large number of small-scale NGOs, the effort for data collection through both routes is potentially high, while only a small to moderate amount of support is covered. The OECD statistics capture bilateral flows going to NGOs for climate change purposes. This might be a more efficient way to capture which needs to be explored.

Key data sources – Public domestic support

Budget unit at the MoF

The national budget is not a relevant source of information to analyse climate finance flows for the following reasons:

- 1- Budgets are developed to provide forward anticipation of the government's expenditures and revenues. If a project is captured in the budget, it means that the amount of money allocated cannot be spent on anything else, unless a specific request and justification is sent to the budget unit to make the changes. Moreover, if unexpected grants and loans are received throughout the year, these will not be captured by the budget. These changes will only show when the budget is adjusted retrospectively. There is a need to clarify if retrospective budgets are publicly available or even compiled with relevant disaggregated information.
- 2- Every expenditure in the budget has its own classification and sub-classification. Only very few subcategories might be related to mitigation or adaptation activities. It is however not possible to understand the share related to climate change, let alone adaptation or mitigation.
- 3- The expenditure items provided in the budget does not clarify whether the money spent is coming from domestic sources or are from received grants or loans. This is because funds are not ear-marked in Lebanon and the pool of funds dictates revenues and expenditures and the resulting deficit is financed through debt. The funding of this deficit through debt is split amongst different type of foreseen borrowing which include debt (treasury bills in Lebanese Pounds, Eurobonds in non-local currency, mainly US dollars, and multilateral financing i.e. loans or grants). This means that any given project described in the budget could be financed by one or combination of those three tools.

Expenditure unit at the MoF

Alternatively to the budget, a detailed expenditure report could present the amount of funds that was spent on specific projects during the period in question. For example, a water infrastructure project originally captured in the budget, implemented by CDR or another partner, and funded locally or multilaterally would be detailed and registered by the expenditure department. Cross-checking such information with the implementation agent i.e. CDR would confirm the nature of the project, its

relevance to climate finance, and the domestically disbursed funds. Treasury bills and Eurobonds only will be considered domestic funding.

The information available online does not provide the data in a way that would be useful to capture domestic climate financing as it is presented in an aggregated way. Given the way the budget is presented, and the information available online, it was assumed that the expenditure unit reports would not be useful for the purposes of this task. A MoU between the MoE and the MoF could facilitate the sharing of information in a detailed and disaggregated manner.

Ministerial budgets

With the national budget and online expenditure information deemed not relevant for the purpose of this project, the ministerial budgets seem to be the best place to capture domestic public flows.

Key data sources – Domestic private finance

In August 2017, the parliament ratified the Public Private Partnership (PPP) Law under which the Higher Council for Privatization will be authorized to approve, launch, and manage projects, and will act as the liaison between the private sector and government bodies. This might be an important tool to incentivize private sector involvement in funding climate change projects. Below are various options that were assessed to capture private domestic finance.

1. BDL provides various loans that are relevant to climate change. Most relevant is the National Energy Efficiency and Renewable Energy Action (NEEREA) loan, dedicated to the financing of green energy projects in Lebanon. The mechanism provides interest-free long-term loans to residential, commercial, non-profit and industrial users for all energy efficiency and renewable energy projects for new and existing facilities. The loan has a ceiling of 20 million USD and is offered at an interest rate of 0.6% for period that should not exceed 14 years including a grace period of 6 months to 4 years. The green loans are provided through all the Lebanese commercial banks to directly reach the end user. The NEEREA loans are therefore private finance, taken up by the private sector through commercial banks. The BDL allows the reduction of “reserves” of each commercial bank (that are deposited at the BDL) with the condition of investing that amount in NEEREA. Therefore, the public instrument is the reduction of deposit required by BDL; the funds are private (banks) while loans are taken up by the private sector with very low interest rates. Conversations with both NEEREA and the commercial banks will provide insights into how best these private funds can be tracked.
2. Detailed information on private financing might be obtained through cooperation with the Ministries obtaining private sector information, like the Ministry of Industry (MoI) and the Ministry of Finance (MoF). The former issues certificates for industrial establishments to allow import and export of their products based on filled applications. Taking advantage of this frequent reporting of the industrial sector, the MoE succeeded in requesting GHG inventory activity data from industries as part of the information they need to provide to renew their license. A Memorandum of Understanding was signed between both ministries to institutionalize this cooperation and secure systematic annual sharing of data. The mainstreamed list of questions could potentially be extended to cover climate related spending in the long-term. Income Tax declarations to the Ministry of Finance could also provide another similar entry point.
3. Under Decree 167 a tax reduction incentive for the investment in renewable energies is in place, which requires businesses to provide information on the investment. This reporting process could be built on to understand the climate related spending of these businesses.

Key data sources – International private finance

The Investment Development Authority of Lebanon (IDAL) is responsible for tracking Foreign Direct Investments (FDI) into Lebanon. IDAL indicated that there are no FDIs linked to climate change, energy, agriculture, environment or any relevant sectors that exist so far. The flows they capture are linked mostly to the service sector such as hotel or retail. Tracking international private finance received to Lebanon is not recommended as a short-term aim of the system, but might become relevant in the future, once estimation methodologies have been developed.

Next steps and recommendations

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.

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.). Therefore, there is a need to adopt standardised data sets to be completed by all institutions.

In capturing climate finance flows, there is a need to balance between the level of detail captured and the effort in data collection. Therefore, efforts will be concentrated on where the bulk of the finance is since not all flows can be tracked in the short-term. Tracking public international support is an aim of the short term of the system. However, not all flows will be captured given the additional layer of complexity required such as the flows going to the various UN agencies, municipalities and NGOs which are not registered centrally. Reaching out to every single municipality, UN agency and NGO to enquire about projects that have climate relevance is time consuming, not cost-effective and they do not constitute the bulk of climate finance flows.

Double counting is another challenge. Some of the above-mentioned data sources cover the support received and other cover the support disbursed. For example, when cross-comparing the data between the CDR grants (classified as implemented by other agencies) and the Cash Management Unit, there are only two grants that overlap. The expectation was to find a much larger overlap, as both entities capture grants that have been released in the official gazette. Furthermore, the CMU indicated that one of the projects was implemented by CDR, whereas CDR listed the project under the category "implemented by other agencies". Therefore, extensive quality control measures will have to be developed and applied to reduce uncertainty in reported information for the support received.

Roles and responsibilities of institutions will have to be defined and institutionalized. A suggested general system design is presented in figure (Figure 61). It consists of a coordinating entity (probably located at the Ministry of Environment) which role will be 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.

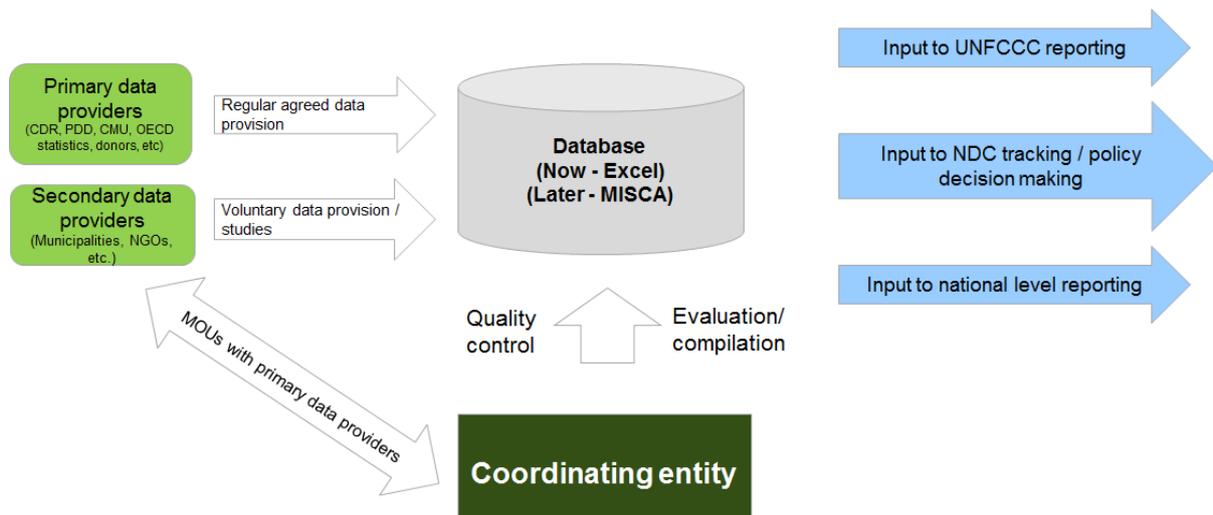


Figure 61: Suggested basic structure of MRV of finance system

2 Gaps, constraints and needs

Throughout the chapters on the greenhouse gas inventory, mitigation actions, and support received of Lebanon's 3rd Biennial Update Report, progress and improvement made thus far on assessing, reporting and institutional arrangements 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 capacity building and financial needs is yet to be developed and implemented. However, Lebanon is confident that the present BUR is the most comprehensive document to date to capture the full extent of climate related studies and activities in the country, for two reasons:

1. the BUR compilation team has strategically prioritized completeness and transparency of BUR3 to make it the reference assessment on climate action nationally. Indeed, the compilation process was used as an opportunity to gather and centralize all available information on the different activities and assessments undertaken by and spread among different national partners. This means that the array of topics covered is wide, but its depth should be improved.
2. the momentum created by adoption of the Paris Agreement has trickled down on regional and national stakeholders, opening a significant number of communication channels among them, thus increasing the availability of support and information to complete and improve the BUR.

This section gathers information from all available assessments on the needs to improve reporting, mitigation implementation, adaptation implementation, finance quantification, non-state actors action, and 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.

2.1 Reporting

At the 24th Conference of the Parties, the Modalities, Procedures and Guidelines (MPG) for the transparency framework referred to in Article 13 of the Paris Agreement were adopted along with other decisions to form the Enhanced Transparency Framework.

Lebanon used the preparation process of the BUR3 as an opportunity to prepare itself to transition from Biennial Update Report to Biennial Transparency Report (BTR), due, as per the MPGs, by December 2024 at the latest.

In the BTR, each party, in accordance with the MPGs:

- shall provide a national inventory report of anthropogenic emissions by sources and removals by sinks of greenhouse gases (GHGs),
- shall provide the information necessary to track progress in implementing and achieving its NDC,
- should provide information on financial, technology transfer and capacity-building support needed and received.

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. Finally, there are mandatory provisions with no flexibility which Lebanon is planning to abide by in the first BTR, such as having the latest reporting year no more than three years prior to the submission (for developing parties). Note that these planned improvements are envisioned to be part of a transparency strategy under the Capacity Building Initiative for Transparency (CBIT), in order to prioritize actions and have a clear way forward for all relevant stakeholders. Table 101 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. Most of these listed needs are still valid, even though many of them have been tackled in at least one of Lebanon's 3 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.

In terms of support needed on reporting national GHG inventories is the most detailed and complete, reflecting the efforts that have been concentrated over the different reporting cycles on improving Lebanon's GHG inventory.

Table 101 summarizes the main provisions of the Annex of decision 18/CMA.1 on Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement. Highlighted cells refer to provisions where flexibility is not provided. The last columns provide information on the status of Lebanon with respect to implementing each provision in the present BUR.

Besides the support needed to track mitigation action, support is specifically needed to track progress against the mitigation targets of Lebanon's NDC detailed in section III.1. The Government of Lebanon will therefore need to prepare itself to do so as stipulated in the MPGs by the first BTR.

Table 100: Gaps and needs identified by the technical team of experts during the ICA of BUR1 and BUR2

	Gaps and needs	Tackled in BUR 2	(Further) Tackled in BUR3
General	Enhance the capacity of experts in the different ministries and agencies involved to prepare the BUR in accordance with the relevant guidelines, through one-to-one, targeted training*	X	Partially - please refer to section II.1.6 1.6
	Design and implement a national GHG inventory system through formalizing processes and protocols to ensure the continuous involvement of relevant national institutions in the systematic collection, compilation and verification of AD and information required to be included in the BUR, with clear roles for sectoral stakeholders***	X	Partially – please refer to section II.1.2
	Develop a reporting management system that includes inventory documentation and archiving procedures**	Not applicable	Yes – please refer to section II.1.3
	Develop and implement QA/QC protocols**	Not applicable	Partially – please refer to section II.1.4
	Undertake an uncertainty assessment of the GHG inventory***		No – efforts were prioritized on the shift to the 2006 IPCC GL
	Develop the technical capacity of sectoral data providers to estimate and report on the uncertainty of key AD, EFs and other parameters**	Not applicable	No – efforts were prioritized on the shift to the 2006 IPCC GL
GHG emissions and removals	Improve the key category analysis, taking into account the aforementioned uncertainty assessment*		Partially – both level and trend assessments are presented. Uncertainty assessment was not taken into account.
	Develop an online AD and EF database and enabling its use by those providing data for the GHG inventory*	X	Partially – please refer to sections II.1.2
	Develop processes and incentives to facilitate the collaboration of the private sector on data collection for the GHG inventory*	X	Partially – please refer to section II.3
	Collect data and develop specific studies to obtain key data needed for the calculation of emissions from key sectors and assistance in developing country-specific EFs where possible for a greater number of key emission categories, especially agriculture, transport, energy, waste and fluorinated gases***		Partially – data quality and accuracy has improved in many categories (please refer the activity data information in section II.3. Additional country specific emission factors were not produced. Note that ICA of BUR2 mentions a list of specific data to be improved, all of which are tackled in section II.4 on improvements.
	Develop the technical capacity in the country to improve assumptions on the stock of fuels and AD on end uses of diesel as preliminary steps towards establishing an annual national energy balance**	Not applicable	Partially – fuel stock has been provided directly from EDL power plants, as presented in section II. 3.1.1. collection of AD on end use of diesel consumption is yet to be improved.
	Implement a mechanism that allows for systematic spatial monitoring and reporting of all land-use subcategories contained in the IPCC guidance and management practices, particularly for cropland and grassland**	Not applicable	No

	Enhance the capacity of the inventory team and mentoring additional experts outside the team by means of customized training*	X	Yes - please refer to section 1.6II.1.6
	Enhance the capacity of the relevant institutions involved in the planning, preparation and analysis of the GHG inventory, including data collection***	X	Yes – please refer to section II.1.6
	Enhance the capacity of sectoral experts and the project management team to analyze and report on mitigation actions for the energy sector through MISCA, and replicate for other sectors***		No
	Enhance technical capacity to develop progress indicators and establish a mechanism to facilitate the systematic collection of information among stakeholders to enable the tracking of progress of mitigation actions in all sectors**	Not applicable	No
Mitigation	Develop progress indicators to calculate emission reductions resulting from incomplete projects*	X	Partially – some progress indicators have been developed for the energy sector - please refer to section III.3.3.1
	Support the quantification of emission reductions resulting from: soft projects, such as combating forest fires, forest conversation or good agricultural practices; national strategies (such as in the transport or waste sector)*	X	Partially – some progress indicators have been developed by the World Bank for the transport sector please refer to section III.3.3.2
	Support the linkage of mitigation actions with the intended nationally determined contribution*	X	Partially – linkages have been drawn between mitigation actions and NDCs for the update of the NDC in 2020. The results have not been finalized yet to be reported in the current BUR.
	Enhance the capacity of experts working in the different ministries and agencies involved in the preparation, development and monitoring of NAMAs*	X	No
	Enhance technical capacity to document and collect information on steps taken or envisaged specific to each mitigation action for all sectors**		No
	Support the identification of gaps and constraints in a more institutional manner and better translating them into concrete financial, technology and capacity-building needs***		No
	Identify and characterize climate change projects at the national level in order to improve knowledge on the tracking of climate change financial resources*	X	Partially – to the extent reflected throughout BUR 3
Identification of gaps and related support needed	Develop and implement clear criteria to differentiate climate from non-climate funding of projects*	X	Yes–non-climate related projects were not included in the report support received. Please refer to section IV.1.1.1
	Identify and quantify support needed*	X	Partially – the quantification is yet to be made
	Quantify the support aimed at climate change within projects that have only one component relevant to climate change*	X	Partially – please refer to section IV.1
	Enhance the methodology for the data gathering and reporting process**		No
	Improve the capacity of the technical staff responsible for providing data**		No

Map roles and responsibilities of relevant actors and defining their roles in the data gathering/reporting process in order to avoid duplication and/or inconsistencies between actors**		Partially – please refer to section IV.3
Complement the MRV of finance analysis by following up on key recommendations for further steps to track support received**		No
Track the technology transfer carried out within the country *		No
Develop a methodology or systemic approach in order to estimate the costs of actual technologies and to conduct cost–benefit analysis**	Not applicable	No
Develop indicators for technology projects and an approach to report comprehensively on different types of support**	Not applicable	No

*Identified in ICA of BUR1

** Identified in ICA of BUR2

*** Identified in ICA of BUR1 and BUR2

Table 101: Status of Lebanon in implementing MPGs on National Inventory Report as reflected in the GHG inventory submitted within BUR3

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. 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;	Yes
Reporting format	(e) Developing country Parties should provide information on financial, technology transfer and capacity-building support needed and received.	Yes
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. 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;	Yes

Methods	(d) processes for the official consideration and approval of the inventory.	
	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;	No.
	Those developing country Parties that need flexibility have the flexibility to instead provide, at a minimum, a qualitative discussion of uncertainty for key categories.	
	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 ₂ eq), 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.	No	
Elaborate an inventory quality assurance/quality control (QA/QC) plan in accordance with the IPCC guidelines, including information on the	Partially	

	<p>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.</p> <p>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.</p>	Partially
	<p>Compare the national estimates of CO₂ emissions from fuel combustion with those obtained using the reference approach, as contained in the IPCC guidelines.</p>	Yes
Metrics	<p>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.</p>	Yes
	<p>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.</p>	Yes
	<p>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.</p>	Yes
	<p>Describe the key categories, including information on the approach used for their identification, and information on the level of disaggregation used.</p>	Yes
	<p>Report the individual and cumulative percentage contributions from key categories, for both level and trend.</p>	Yes
	<p>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.</p>	Yes
Reporting guidance	<p>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</p>	No
	<p>Report information on the reasons for lack of completeness, including information on any methodological or data gaps.</p>	Yes
	<p>Report the QA/QC plan and information on QA/QC procedures already implemented or to be implemented in the future.</p>	Yes
	<p>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.</p>	Yes
	<p>Report seven gases (CO₂, CH₄, N₂O, HFCs, PFCs, SF₆ and NF₃); those developing country Parties that need flexibility have the flexibility to instead report at least three gases (CO₂, CH₄ and N₂O) as well as any of the additional four gases (HFCs, PFCs, SF₆ and NF₃) that are included in the Party's NDC.</p>	Partially
	<p>Sectors and gases: Each Party reporting HFCs, PFCs, SF₆ and NF₃ shall report actual emissions of the gases, providing disaggregated data by</p>	No

chemical (e.g. HFC-134a) and category in units of mass and in CO ₂ eq. 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.	No
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 ₂ O emissions from sources other than those in the agriculture and LULUCF sectors as a memo item. Those estimates of indirect N ₂ O shall not be included in national totals.	No
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

2.2 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 and in preparation for the elaboration of Lebanon's partnership plan, a preliminary but detailed list of gaps and needs has been prepared in consultation with stakeholders and based on national strategies from the following sectors: energy, transport, waste, forestry, agriculture and water. The outcomes of this analysis are presented in this section in tabular format. At this stage, the information is presented with 3 levels of detail: the type of gap, the gap itself and its corresponding need and request. After the completion of the work under the NDC partnership, the need for request will become more specific in the format presented in section III.5, i.e. needs will be prioritized, quantified, valued and assessed for eligibility of support by the international community.

Table 102: implementation gaps and needs for the energy sector

	Gap	Corresponding need and request
Financial and technical	Energy insecurity: Lebanon heavily depends on imported petroleum products to meet its energy demand	<ul style="list-style-type: none"> - Increase local energy production and increase clean energy production - Need for a modality to connect renewable energy to the grid
	Low renewable energy integration: high-risk investments, NEEREA status, lack of needed infrastructure (legally and technically)	<ul style="list-style-type: none"> - licensing of renewable energy IPP licensing - Adopt Law 462 - Operationalize Law 288 - Derisk renewable energy investments
	High technical losses: on the transmission and distribution grid reaching around 16.5% in 2019 in spite of the investments made by the Ministry of Energy and Water, EDL, and service providers to rehabilitate and upgrade it regularly	<p>Improving transmission through:</p> <ul style="list-style-type: none"> - Completing the ring in Mansourieh - Completing the line of Bikfaya-Feytroun-Halat in Juret Bedran - Completing the Bared-Halba line - Completing the Qobayat-Hermel line - Completing the Tyre-Wadi Jilo line
	High non-technical losses: reaching around 21% because of infringements of the distribution grid and the inability of EDL employees to remove them	<p>Improving distribution through:</p> <ul style="list-style-type: none"> - Reducing losses by removing infringements and impose fines - Completing the electric distribution projects and the smart grid to limit losses and control billing and collection - Installing smart meters all over Lebanon by the end of 2021

	<p>High energy demand: lack of standards, high-consumption lifestyle because of low awareness</p>	<p>Decrease energy demand through:</p> <ul style="list-style-type: none"> - Adopting the energy conservation Law, standards for green buildings, green public procurement, standards for retrofitting - Launching the national plan for energy conservation - Wide spreading of CFLs and LEDs - Increasing the rate of SWH penetration and establishing financial - Encouraging street-light PV - Establishing a reporting mechanism for energy conservation and renewable energy and developing ESCO operations - Solving the concessions problem - Respecting and complying with international standards in the areas of consumption guidance, environment and public safety
Market failures	<p>Poor market infrastructure for transit bus systems:</p> <ul style="list-style-type: none"> - 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 	<ul style="list-style-type: none"> - Stimulate passenger demand through the design of a complete bus network covering all boroughs within the Greater Beirut Area. - Deploy effective infrastructure measures like an optimized land use planning. - Deploy effective operation measures like 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, etc..)
	<p>Lack of HEV reference projects in Lebanon</p>	<p>Require all government vehicles to switch to HEV when buying new cars to take the lead as a reference project.</p>
	<p>Well-established alternatives to public transit systems</p>	<p>Manage the transport demand by deploying a combination of access, personal travel planning, and parking spots to lock the benefits from the aimed operational and infrastructural measures</p>
Policy, legal, regulatory Institutional	<p>Inability to change electricity tariffs</p>	<ul style="list-style-type: none"> - Adopting more appropriate tariffs to decrease the deficit - Study to revise the tariff so that it has the least impact on low-voltage consumers
	<p>Low efficiency of institutional architecture: no implementation of Law 462 and 288</p>	<ul style="list-style-type: none"> - Increasing EDL's human resources - Concluding the legal study to transform EDL into a company and preparing the necessary legal steps - Drafting and implementing a roadmap to transform EDL into a company - Implementing Law 462/2002 - Implementing Law 288/2012

Table 103: Implementation gaps and needs for the transport sector

	Gap	Corresponding need and request
Financial	High purchase cost of bus technologies; High implementation cost of mass transit bus system, lanes reservation and parking towers.	-Exempt mass transit buses from custom and excise fees, registration fees, and other fees. -BRT/Feeder Buses in Greater Beirut Area.
	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	-Give incentives to taxi drivers to get involved in the bus system in order -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.
	Tax on maintenance and repair of imported spare parts in mass transit bus systems	Exempt spare parts from custom and excise fees
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 Greater Beirut Area. - Deploy effective infrastructure measures like an optimized land use planning. - Deploy effective operation measures like 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, etc..)
	Lack of HEV 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 aimed operational and infrastructural measures
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 the global mass transit sector
	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 the deployment of bus transit systems -Enforce legislative reforms in urban planning Laws, expropriation Laws and traffic Laws - Restructure, empower and enhance the role of the traffic management organization (TMO).
	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.
	No 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 converters on conventional gasoline cars.
Human skills	Limited capacity to promote and enhance market of transit bus systems due to understaffing	Recruit and train: <ul style="list-style-type: none"> - bus drivers on ecodriving and safety. - specialized maintenance technicians. - management and control staff
	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
Institutional	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: <ul style="list-style-type: none"> -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 (MMI) to support transport studies aiming at the development of sustainable transportation strategies.
	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.
Social, cultural		
Awareness	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 104: Implementation gaps and needs for the waste sector

	Barrier	Corresponding need and request
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.
	Collection is expensive 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. The National budget continues to subsidize waste management operations. However, the allowances are several years back creating a cash flow problem for the municipalities.	-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
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
	Many non-sanitary landfills and dumpsites are still in operation, or not in operation but still not rehabilitated: high risk of pollution for ground and underground water and atmosphere. Some of them also create marine litter due to their location on the coast.	-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.
	Waste burning is still practiced causing severe health and environmental effects	Introduce a penalty system for uncontrolled disposal
Human skills	Waste management operators lack financial and human resources 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
	Poor public awareness around waste segregation	Improve public awareness on waste segregation at the source, and organize awareness campaigns for waste prevention
Awareness	Concept of integrated solid waste management and waste management principles used internationally are not sufficiently promoted (e.g. circular economy, resource efficiency, waste hierarchy)	Education and public awareness around uncontrolled disposal, special waste streams management, and training programmes for waste prevention. National public awareness campaign for the provisions of the Strategy.
	Vague and chaotic roles and responsibilities	Redefine roles and responsibilities by strengthening administrative capacities
Institutional	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 organized effort for implementation of source separation system 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

Policy, legal regulatory	Absence of a grid feed-in-tariff and proper regulatory text related to the operation of waste incineration facilities for waste-to-energy applications	Issue proper regulation to allow selling electricity to the grid from waste-to-energy facilities
	Lack of a single and empowered regulatory body responsible for the solid waste sector	Establish a regulatory body for the successful management of waste (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 or inexistent environmental permitting procedures, monitoring of waste management activities enforcement	Establish recycling, treatment and disposal targets and how they are measured, as well as a 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 a 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 - Establish regional service areas - Organize competent authorities
	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
Social, cultural	Identification of locations for new landfills is problematic especially in the coastal areas – NIMBY and BANANA syndromes are governing social reactions	Follow the set of criteria (including social) introduced in the Strategy when selecting a location for waste management facilities
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	Technology transfer is needed. Develop a ToR for waste collection equipment, and set standards and specifications for waste collection equipment

Table 105: Implementation gaps and needs for the forestry sector

	Gap	Corresponding need and request
Technical	Intense and large forest fires	-Develop forest management plans -Provide infrastructure and equipment for forest fire fighting -Update and implement the national fire strategy
	Absence of a monetary valuation of forestry services.	Perform valuation of forest goods and services and develop studies on economics of land degradation
Institutional	Absence of sustainable forest management	-Develop forest management plans -Provide infrastructure and equipment for forest fire fighting -Update and implement the national fire strategy
	Poor land management: lack of enforcement of zoning Decrees.	Update zoning Decrees, complete zoning, and complete land cadastral survey map
Legal	Inconsistencies in land classification. For	Develop guidelines for restoration of these

	example, when a forest cover exists on abandoned agricultural land and Land owners are legally able to cut existing trees	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
	The weak enforcement of Law on controlled grazing in newly reforested lands (Law 1949, Article 88)	
	The legislative framework lacks an integrated approach and should be accompanied by a national policy or strategy for forest management	
Financial	Limited financial resources for reforestation activities to restore forest cover	Mobilize funding for reforestation on public lands and increase urban forests

Table 106: Implementation gaps and needs for the agriculture sector

	Barrier	Corresponding need and request
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 to access SAVR.
Human skills	Lack of human skills in the following: - skilled extension service in Good Agriculture Practices (GAP) - 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 for Conservation Agriculture (CA) and Selection of Adaptive Varieties and Rootstocks (SAVR) and GAP, and on the introduction of climate resilient cultivars and rootstocks for CA. -Recruit competent technicians, researchers, and initiate civil servants recruitment procedures in GAP
	Lack of vocational training, weakness of training programs, scarcity of applied research and lack of information on ecosystem services and forest values	
Information & awareness	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 about the importance of SAVR.

Institutional and Policy	Constraints related to 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
	Inappropriate land tenure system and deficiency in institutional arrangements for subsidies	Need long-term renting, and lobby to get ministerial proposal to shift from crop-oriented to practice-oriented subsidies
	Deficiency in institutional arrangements for crediting system, subsidies and Intellectual Property Right in Lebanon for appropriate technologies	<ul style="list-style-type: none"> - Undertake the necessary decisions and Laws allowing subsidies for SAVR. - 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
	<ul style="list-style-type: none"> - Inadequate land tenure system - Import difficulties for equipment - Absence of quality control and institutional and financial arrangements to guarantee the quality of GAP products - Inappropriate crediting system from banks 	<ul style="list-style-type: none"> - 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. - Enhance agriculture crediting system for small farmers to access SAVR.
Social, cultural	Inherited behavior affecting farmer's perception of no-till and the export of agriculture residues Difficulties in changing food and agriculture habits.	<ul style="list-style-type: none"> - Arrange field visits to demonstrating plots and conduct seminars and TV programme for farmers to show the comparative advantage of no-till, GAP, SAVR. - Launch marketing campaigns, tasting, and awareness about SAVR products.
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	<ul style="list-style-type: none"> - 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

Table 107: Implementation gaps and needs for the water sector

	Gap	Corresponding need and request
Economic and financial	Water storage - cost for infrastructure; High cost of land acquisition (private land); Scarcity of funds	Conducting arrangements for budget allocation and creation of a financial mechanism
	Inadequacy of the tariff system hinders water conservation	Review current approaches to institutionalize the polluter's pay principle.
	Inadequate supply of safe water to some communities	<ul style="list-style-type: none"> Conduct survey to identify waterless communities. Construct new water supply infrastructure for these communities. Review financing, tariffs, and incentives that reflect the full cost of providing safe water equitably. Develop a public financing system for water supply

	Absence of supply and demand analysis under different climatic and hydrologic conditions	infrastructure rehabilitation and development 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 due to - Reserved water pricing - Limited financial arrangements for infrastructure and university curricula - Low revenues of users - Deficit funds	Preparation of feasibility study and financial mechanism for Water users associations
	Lack of budget for capital investments	Explore public-private financing mechanisms
Human skills	Lack of organization among users sharing a common water resource - Scarce human skills to run water user associations Limited experience in artificial recharge, watershed management and maintenance of water monitoring systems	Capacity building of farmers
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. Targeted awareness campaign, through seminars, field visits and TV programmes.
	Drainage and storage not accounted in public works	Training of technicians Elaboration of adapted tender documents Control construction works
	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
	Lack of coordination between different ministries on key water issues and common priorities	Establish a Water board to activate inter-ministerial communication mechanisms 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.
Institutional and policy	Lack of enforcement in permitting and control of groundwater abstraction, making it an illegal activity	Stricter control of wells increase staffing within water establishments and build the capacity of staff on monitoring of unlicensed wells. Smoother 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	Establishment of water users association becomes mandatory and their mandate determined
	Little attention to water harvesting, recycling and reuse in policies	Update existing guidelines for rainwater harvesting. 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
	Management processes of water supply	Develop policies for water conservation, allocation,

	systems do not reflect the potential impact of climate change	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
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
Market failure	Limited spread of technology in market	Integrating new technologies and specifications
Research	Limited Research and development on new innovative technologies for increasing water storage	Conducting 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
Social, cultural	Limited social acceptance for water pricing or to change inherited sharing rights, absence of communal thinking; lack of trust among users	Establishing the water distribution infrastructure
Technical	Inappropriate road design for drainage and storage; Limited available land for water storage Inappropriate urban planning or land use management; Insufficient financial and institutional arrangements	Elaborating terms of references with technical specifications for new road designs including appropriate drainage
	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.
	Weak knowledge of Integrated Water Resources Management (IWRM) at basin and local levels	Capacity building of key technical staff on IWRM
	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.

2.3 Finance

Quantifying the finance needed for the implementation of climate change related components of strategies and infrastructure projects remains an urgent need and a big challenge. There is no specific earmarking for climate change activities in national budgets, and a lack of incentives to encourage planning of activities that are specifically marked as low emission activities or activities that enhance climate change resilience.

The most recent and comprehensive Capital Investment Plan (CIP) developed under the CEDRE conference (Conference Economique pour le Developpement par les Reformes avec les Entreprises), considered a key pillar of the Government's vision for stabilization and development against the background of the Syrian crisis and the effects this has had on Lebanon, is not climate proofed (GoL, 2018). The CIP comprises a list of infrastructure needed investment that will eliminate the gaps that exists between the demand and need for infrastructure services and the supply and reduce the cost to the economy of the lack of adequate infrastructure. It tackles the following sectors: electricity, transport, solid waste, wastewater, telecom, tourism and industry. The CIP is limited to projects in the physical infrastructure sectors for which funding from external lenders and donors or private investors are sought.

The projects in the CIP were selected in compliance with the sectors' strategies, aimed at bridging the gaps and meeting the sustainable development goals, particularly ensuring decent work and economic growth, reducing inequality, ensuring clean water and sanitation, affordable and clean energy, building resilient infrastructure and promoting sustainable industrialization and innovation, making cities inclusive, safe, resilient, and sustainable.

Projects were prioritized based on their readiness for implementation and their expected positive impacts to provide adequate basic services to households, enable sustainable urban development, and improve social security, stability and wellbeing.

In addition to climate proofing all strategies and infrastructure projects to quantify the needed financial support for climate change, there is also a need to develop and implement institutional arrangements that would enable national stakeholders to cost their climate change related needs, in particular those related to Lebanon's NDC conditional targets.

The Ministry of Environment is expected to benefit in the near future from the GCF readiness support to enable it to formulate and cost needed projects and drive the general process of programming of resources. It will also assist the Ministry in building a foundation for results-oriented, transformational and efficient usage of international climate finance, and in particular for the GCF. The readiness programme will also support the process of developing the capacity of national stakeholders to plan for, access, manage, and monitor climate change finance.

Currently in Lebanon, the availability of climate related finance support/scheme that would encourage implementation of emission reduction projects are limited to renewable energy and energy efficiency, with an upper ceiling of 20 million USD, hindering larger investments in the renewable energy and energy efficiency sector, and implementation of mitigation actions in the remaining sectors with emission reduction potential.

The establishment of a Green Investment Facility that would accelerate the implementation of Lebanon's NDC and SDGs, fast-tracking the transition to a green economy through financing and technical assistance; and scale-up investment through blending various financial tools and leveraging additional finance, with the effective engagement of all actors would thus be beneficial to enhance Lebanon's effective emission reductions. In addition, the potential Lebanon's Green Investment Facility (LGIF) would provide a single entity to channel climate finance that would also serve for the MRV of finance received and MRV of mitigation action. A request was issued to the NDC Partnership's Climate Action Enhancement Package (CAEP) to support the establishment of the facility and both the World bank and the Islamic Development Bank have indicated their readiness to engage on this task.

The LGIF will be designed keeping in mind four areas of work:

- **Governance:** The LGIF's mandate will be strategic and in line with the goals of the government's climate and sustainable development strategies. Since the nature of the NDC and SDGs is cross-sectoral and inter-ministerial in nature, the LGIF will ensure inclusivity through close coordination to secure complementarity and cohesiveness among national initiatives. The LGIF's mode of work will be results-oriented with well-defined objectives and a clear set of targets to ensure timely and meaningful NDC implementation.
- **Utilization:** Access to finance and technical assistance will be set through the investment modalities (grants, soft loans, interest rate subsidies, loan guarantees, etc.). The LGIF instruments will consider delivery modalities; the LGIF can distribute grants but might need partnership agreements with other financial institutions to administer loan instruments, depending on its legal structure. On technical assistance, the LGIF might include a Technical Assistance Facility to be open to all beneficiary types, supporting activities ranging from proposal development to project implementation, awareness raising and training.
- **Capitalization:** Depending on the strategic objectives, the capitalization needs will be estimated. A capitalization strategy will consequently be established, and list options in the short, medium and long-term. For example, in the short-term, bilateral and multilateral development partners are the most feasible sources of capitalization of the LGIF. This will also open the possibility of having an 'anchor donor' who will champion capitalization and fast-track replenishment. Additionally, national contributions to the LGIF generally are an important key that helps 'unlock' resources from diversified sources. Sustainable revenue sources separate from replenishments will need to be identified to further anchor the sustainability of the LGIF.
- **Oversight:** Transparency and accountability will be fundamental principles by ensuring broad representation in management and decision-making, maintaining effective accounting, M&E systems, strengthening independent review and oversight mechanisms, improving public access to information, and boosting capacity-building and good governance practices.

An integral operational role will be to apply derisking principles to the LGIF, as outlines in III.3.3.1.

2.4 Non-state actors

Climate change action

Almost 4 years after the establishment of the Lebanon Climate Act (LCA) initiative and the adoption of the Paris Agreement on climate change under the United Nations Framework Convention on Climate Change (UNFCCC), more than 100 non-state actors, mainly from the private sector, have joined the climate fight in Lebanon. In addition, many opportunities through funded projects and technical assistance support have allowed to lock the engagement of non-state actors through a multitude of ad-hoc self-initiated activities. There is therefore a need to coordinate the efforts of non-state actors to ensure a targeted implementation that would simultaneously serve national climate targets including the NDC and international reporting requirements.

Table 108 summarizes the gaps and the needs related to enhancing and targeting climate action by non-state actors, as identified by the Ministry of Environment.

Table 108: 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, 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. Business knowledge platforms organized by the LCA have been a great source of information for participants. Developing further training material should be based on lessons learned from the several BKPs organized under the LCA.
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.	
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.	The Ministry of Environment is implementing a pilot project focused on the private sector on the methodology of drafting and implementing a climate action plan. Outcomes and recommendations of this activity should be replicated.
Lack of sustainable funds dedicated for an integrated non-state actors climate action coordination	Financial support for the enhancement of the non-state actors framework.	

Climate education, awareness and research

Besides creating an enabling environment to further encourage formulation and implementation of climate action plans and climate mitigation and emission projects, there is a need to engage other non-state actors that play a key role in spreading climate change awareness and education and producing knowledge. For example, there is a need to assess and coordinate climate change related research among academic institutions and research institutes, to update and further mainstream the teacher's guidebook on climate change referred to in section I and to spread awareness on the impacts of daily actions on GHG emissions and on the impacts of climate change on livelihood and businesses.

2.5 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.

To understand how gender roles are distributed and inform climate change policies in this regard, there is a need to launch a national survey, in close coordination with institutions that already perform surveys and census:

- 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)
- Distribution of men and women by type of activity and position (managerial, assistant, director, etc.)
- 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
- Level of education by sex and area of residence (urban / rural areas)
- 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.

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Annexes

Annex I. GHG inventory for 2015

Lebanon's GHG inventory - summary report for national GHG inventory 2015

Categories	Emissions (Gg)			Emissions CO ₂ Equivalents (Gg)			
	Net CO ₂	CH ₄	N ₂ O	HFCs	PFCs	SF ₆	Other halogenated gases with CO ₂ equivalent conversion factors
Total National Emissions and Removals	21,805.424	47.353	2.51	NE,NO	NE,NO	NE,NO	NA,NO
1 - Energy	22,803.2643	2.2171	0.557				
1.A - Fuel Combustion Activities	22,803.2643	2.2171	0.557				
1.A.1 - Energy Industries	83,38.84226	0.3304	0.066				
1.A.2 - Manufacturing Industries and Construction	45,49.45947	0.1682	0.034				
1.A.3 - Transport	59,99.98072	1.1781	0.429				
1.A.4 - Other Sectors	39,14.98156	0.5405	0.028				
1.A.5 - Non-Specified	NO	NO	NO				
1.B - Fugitive emissions from fuels	NO	NO	NO,NA				
1.B.1 - Solid Fuels	NO	NO	NO				
1.B.2 - Oil and Natural Gas	NO	NO	NA				
1.B.3 - Other emissions from Energy Production	NO	NO	NO				
1.C - Carbon dioxide Transport and Storage	NO	NO	NO				
1.C.1 - Transport of CO ₂	NO						
1.C.2 - Injection and Storage	NO						
1.C.3 - Other	NO						
2 - Industrial Processes and Product Use	2284.354791	NA,NO	NA,NO	NE,NO	NE,NO	NE,NO	NA,NO
2.A - Mineral Industry	2283.489457						
2.A.1 - Cement production	2276.356399						
2.A.2 - Lime production	2.11875						
2.A.3 - Glass Production	IE						
2.A.4 - Other Process Uses of Carbonates	5.0143082						
2.A.5 - Other (please specify)	NO	NO	NO				
2.B - Chemical Industry	NO	NO	NO	NO	NO	NO	NO
2.B.1 - Ammonia Production	NO						

2.B.2 - Nitric Acid Production	NO		NO				
2.B.3 - Adipic Acid Production	NO		NO				
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production	NO		NO				
2.B.5 - Carbide Production	NO	NO					
2.B.6 - Titanium Dioxide Production	NO						
2.B.7 - Soda Ash Production	NO						
2.B.8 - Petrochemical and Carbon Black Production	NO	NO					
2.B.9 - Fluorochemical Production	NO			NO	NO	NO	NO
2.B.10 - Other (Please specify)	NO	NO	NO	NO	NO	NO	NO
2.C - Metal Industry	NO	NO	NO	NO	NO	NO	NO
2.C.1 - Iron and Steel Production	NO	NO					
2.C.2 - Ferroalloys Production	NA	NA					
2.C.3 - Aluminum production	NO				NO		
2.C.4 - Magnesium production	NO					NO	
2.C.5 - Lead Production	NO						
2.C.6 - Zinc Production	NO						
2.C.7 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO
2.D - Non-Energy Products from Fuels and Solvent Use	0.865333333	NO	NO	NO	NO	NO	NO
2.D.1 - Lubricant Use	IE						
2.D.2 - Paraffin Wax Use	0.86533						
2.D.3 - Solvent Use							
2.D.4 - Other (please specify)	NO	NO	NO				
2.E - Electronics Industry	NO	NO	NO	NO	NO	NO	NO
2.E.1 - Integrated Circuit or Semiconductor				NO	NO	NO	NO
2.E.2 - TFT Flat Panel Display					NO	NO	NO
2.E.3 - Photovoltaics					NO		
2.E.4 - Heat Transfer Fluid					NO		
2.E.5 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO
2.F - Product Uses as Substitutes for Ozone Depleting Substances	NE,NO	NO	NO	NE	NO,NA		
2.F.1 - Refrigeration and Air Conditioning				NE			
2.F.2 - Foam Blowing Agents				NE			
2.F.3 - Fire Protection				NE	NA		
2.F.4 - Aerosols				NE			
2.F.5 - Solvents				NO	NO		
2.F.6 - Other Applications (please specify)				NO	NO		
2.G - Other Product Manufacture and Use	NO	NO	NO	NO	NO	NO	NO

2.G.1 - Electrical Equipment					NO	NO	
2.G.2 - SF ₆ and PFCs from Other Product Uses					NO	NO	
2.G.3 - N ₂ O from Product Uses			NO				
2.G.4 - Other (Please specify)	NO	NO	NO	NO	NO	NO	NO
2.H - Other	NO/NA	NO/NA	NO	NO	NO	NO	NO
2.H.1 - Pulp and Paper Industry	NO	NO					
2.H.2 - Food and Beverages Industry	NA	NA					
2.H.3 - Other (please specify)	NO	NO	NO				
3 - Agriculture, Forestry, and Other Land Use	-3311.17	17.441	1.477	NA	NA	NA	NA
3.A - Livestock		17.427	0.399	NA	NA	NA	NA
3.A.1 - Enteric Fermentation		14.141					
3.A.2 - Manure Management		3.2862	0.399				
3.B - Land	-3,311.38	NA	NA				NO
3.B.1 - Forest land	-795.121						
3.B.2 - Cropland	-1,165.71						
3.B.3 - Grassland	NE						
3.B.4 - Wetlands	NE		NE				
3.B.5 - Settlements	-1,350.5						
3.B.6 - Other Land	0						
3.C - Aggregate sources and non-CO₂ emissions sources on land	0.2068	0.0139	1.078	NO	NO	NO	NO
3.C.1 - Emissions from biomass burning		0.0139	0.0009				
3.C.2 - Liming	NO						
3.C.3 - Urea application	0.2068						
3.C.4 - Direct N ₂ O Emissions from managed soils			0.723				
3.C.5 - Indirect N ₂ O Emissions from managed soils			0.265				
3.C.6 - Indirect N ₂ O Emissions from manure management			0.089				
3.C.7 - Rice cultivations		NO					
3.C.8 - Other (please specify)		NO	NO				
3.D - Other	NO	NO	NO	NA	NA	NA	NA
3.D.1 - Harvested Wood Products	NO						
3.D.2 - Other (please specify)	NO	NO	NO				
4 - Waste	28.98106732	27.695	0.476				
4.A - Solid Waste Disposal	NO	8.0223	NO				
4.B - Biological Treatment of Solid Waste	NO	1.2214	0.073				
4.C - Incineration and Open Burning of Waste	28.98106732	4.1751	0.075				
4.D - Wastewater Treatment and Discharge	NO	14.276	0.328				

4.E - Other (please specify)	NO	NO	NO				
5 - Other	NO	NO	NO				
Memo Items (5)							
International Bunkers	732.7138262	0.0138	0.02	NA	NA	NA	NA
1.A.3.a.i - International Aviation (International Bunkers)	628.6905482	0.0044	0.018				
1.A.3.d.i - International water-borne navigation (International bunkers)	104.023278	0.0094	0.003				
1.A.5.c - Multilateral Operations	NO	NO	NO	NA	NA	NA	NA

Annex II. Activity data for Energy sector – MIC and Other sectors

1,000 tonnes	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
total DO imported	818.12	901.04	983.96	1,066.88	1,149.80	1,748.09	1,315.65	1,533.28	1,562.97	1,444.32	1,407.61	1,346.72	1,596.27	1,363.19	1,802.75	2,595.35	2,252.02	2,448.07	3,268.81	3,075.58	3,251.76	3,670.82
DO in EDL power plants	48.65	215.14	381.64	548.13	714.62	881.12	532.81	573.07	745.41	825.98	842.35	781.74	1,057.70	848.86	1,259.56	1,132.72	994.29	1,305.67	1,320.20	1,174.53	1,245.41	1,295.18
transport	65.64	72.63	89.92	113.64	134.60	152.43	165.22	180.10	198.45	216.68	239.86	260.91	282.25	302.10	325.29	363.23	410.87	442.87	458.45	479.50	500.54	521.58
remaining DO	703.84	613.27	512.41	405.12	300.59	714.54	617.62	780.12	619.10	401.66	325.39	304.07	256.32	212.23	217.90	1,099.41	846.86	699.53	1,490.15	1,421.55	1,505.82	1,854.06
MIC	319.19	270.59	216.85	159.88	104.30	287.35	256.18	328.73	247.03	143.06	106.39	98.17	64.31	51.59	36.84	445.89	333.35	251.84	614.32	587.75	622.84	780.20
CI	319.19	270.59	216.85	159.88	104.30	287.35	256.18	328.73	247.03	143.06	106.39	98.17	64.31	51.59	36.84	445.89	333.35	251.84	614.32	587.75	622.84	780.20
R	40.91	45.05	49.20	53.34	57.49	87.40	65.78	76.66	78.15	72.22	70.38	67.34	79.81	68.16	90.14	129.77	112.60	122.40	163.44	153.78	162.59	183.54
fishing	8.18	9.01	9.84	10.67	11.50	17.48	13.16	15.33	15.63	14.44	14.08	13.47	15.96	13.63	18.03	25.95	22.52	24.48	32.69	30.76	32.52	36.71
offroad	16.36	18.02	19.68	21.34	23.00	34.96	26.31	30.67	31.26	28.89	28.15	26.93	31.93	27.26	36.05	51.91	45.04	48.96	65.38	61.51	65.04	73.42
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
MIC	39%	30%	22%	15%	9%	16%	19%	21%	16%	10%	8%	7%	4%	4%	2%	17%	15%	10%	19%	19%	19%	21%
CI	39%	30%	22%	15%	9%	16%	19%	21%	16%	10%	8%	7%	4%	4%	2%	17%	15%	10%	19%	19%	19%	21%
R	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
fishing	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
offroad	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%

Annex III. Land-use classification, definitions and disaggregation

	Definition according to IPCC	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 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
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	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	Field crops in large area Field crops combined with olive Field crops combined with vines Field crops combined with deciduous fruit trees Field crops combined with citrus trees Field crops combined with greenhouses	Annual Annual Annual Annual Annual Annual

	Definition according to IPCC	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 recommendations
	definitions.	trees, and greenhouse cultivations.	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
			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

	Definition according to IPCC	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 recommendations
			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
			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, subdivided 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	This category included the following:	Dense pine forests (mainly <i>Pinus brutia</i> and <i>Pinus pinea</i>)	Coniferous
			Dense cedre forests (<i>Cedrus libani</i>)	Coniferous
			Dense fir forests (<i>Abies Cilicia</i>)	Coniferous
			Dense cypress forests (<i>Cupressus ssp.</i>)	Coniferous
			Dense oak forests (<i>Quercus ssp.</i>)	Broadleaf
			Dense broadleaves forests (<i>Platanus, Populus, Salix</i>)	Broadleaf
			Mixed dense forests	Mixed
			Urban sprawl on dense forest	Mixed
			Low density pine forests (<i>Pinus brutia</i> and <i>Pinus pinea</i>)	Coniferous
			Low density cedre forests (<i>Cedrus libani</i>)	Coniferous
			Low density Juniper forests (<i>Juniperus ssp.</i>)	Coniferous

	Definition according to IPCC	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 recommendations
	falls below, but is expected to exceed, the threshold of the forest land category. Managed forest: All forests subject to some kind of human interactions (notably commercial management, harvest of industrial roundwood (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 fir forests (<i>Abies, Cilicia</i>)	Coniferous
			Low density cypress forests (<i>Cupressus ssp.</i>)	Coniferous
			Low density oak forests (<i>Quercus ssp.</i>)	Broadleaf
			Low density broadleaves forests (<i>Platanus, Populus, Salix</i>)	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-pastoral 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
Wetland	This category includes land	This category includes land	Continental humid zone	Flooded areas (Artificial

	Definition according to IPCC	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 recommendations
	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.	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.	<u>Marine humid zone</u> <u>Water plane (reservoir)</u> <u>Hill lake</u> <u>Stream or river</u> Harbor basin	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	<u>Bare rock</u> <u>Urban sprawl on bare rock</u> <u>Bare soil</u> <u>Beach</u> <u>Sand dune</u> Burned area	No need for disaggregation

Annex IV List of activity data for AFOLU

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
FF-Total	258,475	258,304	258,131	257,957	257,890	257,628	257,172	257,142	257,113	257,059	256,906	256,544	256,237	256,088	255,775	255,575	255,375	254,771	254,463	254,106	254,063	254,010
Coniferous	35,257	35,240	35,222	35,205	35,216	35,188	35,121	35,117	35,112	35,103	35,084	35,063	35,028	35,022	34,977	34,960	34,943	34,888	34,871	34,822	34,822	34,819
Broadleaf	196,518	196,376	196,234	196,091	196,008	195,792	195,452	195,431	195,410	195,367	195,245	194,924	194,682	194,544	194,300	194,131	193,963	193,467	193,184	192,925	192,889	192,844
Mixed	26,701	26,688	26,675	26,662	26,666	26,648	26,599	26,595	26,591	26,590	26,578	26,557	26,526	26,522	26,497	26,483	26,469	26,417	26,408	26,358	26,353	26,347
GG-Total	318,023	317,915	317,806	317,697	317,600	317,497	317,237	317,212	317,188	317,158	317,019	316,756	316,574	316,558	316,315	316,180	316,045	315,697	315,518	315,181	315,168	315,149
CC-Total	333,070	332,896	332,721	332,545	332,364	332,082	331,857	331,819	331,782	331,670	331,280	331,167	330,804	330,777	330,505	330,082	329,658	329,415	328,959	328,365	327,987	327,431
Perennial	160,646	160,591	160,536	160,480	160,354	160,288	160,243	160,230	160,217	160,186	160,127	160,101	160,048	160,041	159,938	159,720	159,502	159,376	159,235	158,970	158,885	158,786
Annual	172,423	172,305	172,185	172,065	172,010	171,794	171,613	171,589	171,565	171,484	171,153	171,067	170,757	170,736	170,567	170,362	170,156	170,039	169,724	169,395	169,102	168,645
FF-Burned	NE	NE	NE	NE	-	1,049	330	73	73	304	63	424	1,197	708	26	428	428	161	603	128	121	183
Coniferous	NE	NE	NE	NE	-	123	54	6	6	31	5	37	127	83	7	60	60	15	38	5	7	15
Broadleaf	NE	NE	NE	NE	-	870	217	54	54	252	53	348	1,013	568	17	312	312	134	548	44	97	114
Mixed	NE	NE	NE	NE	-	56	59	13	13	21	4	39	58	56	3	56	56	13	17	79	17	54
FF-Burned	NE	NE	NE	NE	-	1,049	330	73	73	304	63	424	1,197	708	26	428	428	161	603	128	119	183
Fuel Type 3	NE	NE	NE	NE	-	281	99	6	6	205	34	164	632	158	14	185	185	58	262	79	34	65
Fuel Type 4	NE	NE	NE	NE	-	483	98	31	31	60	17	135	380	213	8	156	156	53	185	44	45	83
Fuel Type 5	NE	NE	NE	NE	-	7	15	5	5	13	4	2	33	25	-	7	7	3	10	-	1	13
Fuel Types 6 and 7	NE	NE	NE	NE	-	279	119	31	31	27	7	124	153	313	4	81	81	47	145	5	38	21
GG-Burned	NE	NE	NE	NE	-	198	126	148	148	492	96	96	815	43	13	271	271	182	243	38	68	302
Fuel Type 1	NE	NE	NE	NE	-	148	79	76	76	287	50	75	639	28	6	207	207	109	185	38	48	227
Fuel Type 2	NE	NE	NE	NE	-	50	47	72	72	205	46	21	176	15	6	64	64	73	58	-	20	76
CC-Burned	NE	NE	NE	NE	-	494	502	251	251	529	223	344	334	275	542	675	675	585	1,306	10	283	247
LS-Total	451	454	456	459	-	647	942	91	91	196	682	738	852	191	829	758	758	1,195	943	1,248	430	624
FS	171	172	173	174	-	262	456	29	29	54	153	362	307	148	313	200	200	604	308	357	43	53
Coniferous	17	17	17	18	-	28	67	5	5	9	19	21	35	6	45	17	17	56	17	49	1	3
Broadleaf	141	141	142	143	-	216	341	21	21	44	122	321	242	138	244	169	169	496	283	259	37	45

Mixed	13	13	13	13	-	18	49	4	4	2	12	21	30	4	25	14	14	53	9	50	6	5	
GS	108	108	109	110	-	103	260	25	25	30	139	263	182	16	244	135	135	348	179	297	9	15	
CS	173	174	175	176	-	282	225	37	37	112	390	113	363	27	272	424	424	243	456	595	378	556	
Perennial	55	55	55	56	-	66	45	13	13	31	59	26	53	7	103	218	218	126	141	265	85	98	
Annual	118	119	119	120	-	216	181	24	24	81	331	87	310	21	168	206	206	117	315	329	293	457	
LF-Total	NE	NE	NE	NE	-	305	305	305	305	278	278	278	278	278	52	52	148	52	381	303	140	209	
FAO, 2010 and MOE, 2013	NE	NE	NE	NE	-	305	305	305	305	278	278	278	278	278	-	-	96	-	96				
AFDC	NO	NO	NO	NO	-	-	-	-	-	-	-	-	-	-	52	52	52	52	52				
LRI	NO	NO	NO	NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	233			
LW-Total	NE	NE	NE	NE	-	NE	37	NE	NE	NE	NE	NE	3,598	3,737	3,946								
OW	NE	NE	NE	NE	-	NE	37	NE	NE	NE	NE	NE	4	4	4								
LC	NE	NE	NE	NE	-	NE	NE	NE															
LG	NE	NE	NE	NE	-	NE	NE	NE															
LO	NE	NE	NE	NE	-	NE	NE	NE															

NE: Not Estimated (No activity data available)

NO: Not Occurring

- FF = forest land remaining forest land
- GG = grassland remaining grassland
- CC = cropland remaining cropland
- WW = wetlands remaining wetlands
- SS = settlements remaining settlements
- OO = other land remaining other land
- LF = lands converted to forest land
- LG = lands converted to grassland
- LC = lands converted to cropland
- LW = lands converted to wetlands
- LS = lands converted to settlements
- LO = lands converted to other land

Annex V. Recalculations

Sector	Categories	Recalculated Year (in addition to 2014-2015)	Parameters	Changes
1. Energy	Reference and sectoral	1994-2013	Net Calorific Value	Country specific NCV: NCV for gas diesel oil changed from 43.33 TJ/1000 tonnes to 41.6 TJ/1000 tonnes NCV for heavy fuel oil changed from 40.19 TJ/1000 tonnes to 41.1 TJ/1000 tonnes NCV for gasoline changed from 44.8 TJ/1000 tonnes to 43.5TJ/1000 tonnes NCV for jet kerosene changed from 44.6 TJ/1000 tonnes to 42.8 TJ/1000 tonnes NCV for petroleum coke changed from 31 TJ/1000 tonnes to 35.4 TJ/1000 tonnes
				1994-2013
	1.A.2 Manufacturing Industries and Construction	1994-2013	CO ₂ EF for petcoke	Changed from 10,0833 kg/TJ to 9,7500 kg/TJ
			CH ₄ EF for GDO, HFO, Petcoke and Bitumen	Changed from 2 kg/TJ to 3 kg/TJ
			CH ₄ EF for LPG	Changed from 2 kg/TJ to 1 kg/TJ
			N ₂ O EF for LPG	Changed from 0.6 kg/TJ to 0.1 kg/TJ
			CO ₂ EF for passenger cars	Changed from 74,890-74,923 kg/TJ to 69,300 kg/TJ
	1.A.3 Transport	1994-2013	CO ₂ EF for LDV	Changed from 74,238 kg/TJ to 69,300 kg/TJ
			CO ₂ EF for HDV diesel	Changed from 66,808 kg/TJ to 74,100 kg/TJ
			CO ₂ EF for motorcycles	Changed from 73,781-73,096 kg/TJ to 69,300 kg/TJ
			CH ₄ EF for passenger cars	Changed from 7.31-26.85 kg/TJ to 3.8-33 kg/TJ
			CH ₄ EF for LDV	Changed from 18.27 kg/TJ to 3.8-33 kg/TJ
			CH ₄ EF for HDV diesel	Changed from 5.8 kg/TJ to 3.9 kg/TJ
			CH ₄ EF for motorcycles	Changed from 116-129 kg/TJ to 33 kg/TJ
			N ₂ O EF for passenger cars	Changed from 1.39-18.27 kg/TJ to 3.20-8 kg/TJ

	1994-2013	N ₂ O EF for LDV	Changed from 1.37 kg/TJ to 3.20 kg/TJ	
	1994-2013	N ₂ O EF for HDV diesel	Changed from 2.9 kg/TJ to 3.9 kg/TJ	
	1994-2013	N ₂ O EF for motorcycles	Changed from 1.22-1.55 kg/TJ to 3.20 kg/TJ	
	1994-2013	CO ₂ EF for jet gasoline	Changed from 68,610 kg/TJ to 70,000 kg/TJ	
	1994-2013	CO ₂ EF for jet kerosene	Changed from 70,790 kg/TJ to 71,500 kg/TJ	
	1994-2013	CO ₂ EF for HFO (international navigation)	Changed from 76,600 kg/TJ to 77,400 kg/TJ	
1.A.4 Other sectors	1994-2013	CH ₄ EF for LPG	Changed from 10 kg/TJ to 5 kg/TJ	
	1994-2013	N ₂ O for LPG	Changed from 0.6 kg/TJ to 0.1 kg/TJ	
2. IPUU	2.A.2 Lime production	1994-2013	CO ₂ EF for lime production	Changed from 0.79 Tonnes to 0.75 Tonnes CO ₂ /tonne of lime produced
		1994-2013	Activity data for lime production	Revised primary data obtained from plant manager
	2.A.4 Other processes Uses of carbonates	1994-2013	CO ₂ EF for soda ash used	Changed from 415 kg CO ₂ /t soda ash used to 0.41492 tonnes CO ₂ /t soda ash used
	2.D.2 Paraffin wax	1994-2013	Activity data and emission for paraffin wax	Not estimated in previous inventories
3. AFOLU	3.A.1 Enteric fermentation	1994-2013	CH ₄ - dairy cattle	Changed from 100 kg/head/year to 117 kg/head/year
		1994-2013	CH ₄ - nondairy cattle	Changed from 48 kg/head/year to 57 kg/head/year
		1994-2013	CH ₄ - dairy cattle	Changed from 19 kg/head/year to 35 kg/head/year
		1994-2013	CH ₄ - nondairy cattle	Changed from 13 kg/head/year to 18 kg/head/year
		1994-2013	CH ₄ - swine	Changed from 7 kg/head/year to 11 kg/head/year
		1994-2013	CH ₄ - sheep	Changed from 0.16 kg/head/year to 0.15 kg/head/year
		1994-2013	CH ₄ - camels	Changed from 1.9 kg/head/year to 1.92 kg/head/year
		1994-2013	CH ₄ - horses	Changed from 1.6 kg/head/year to 1.64 kg/head/year
	3.A.2 Manure Management	1994-2013	CH ₄ - poultry	Changed from 0.018 kg/head/year to 0.02 kg/head/year
		1994-2013	N ₂ O direct - Liquid system	Changed from 0.001 Kg N ₂ O/Kg of Nitrogen excreted to 0 N ₂ O/Kg of Nitrogen excreted
		1994-2013	N ₂ O direct - Poultry manure without bedding	Changed from 0.005 Kg N ₂ O/Kg of Nitrogen excreted to 0.001 N ₂ O/Kg of Nitrogen excreted
		1994-2013	N ₂ O direct - Poultry manure with bedding	Changed from 0.02 Kg N ₂ O/Kg of Nitrogen excreted to 0.001 N ₂ O/Kg of Nitrogen excreted

	1994-2013	N ₂ O Anaerobic lagoons	Changed from 0.001 Kg N ₂ O/Kg of Nitrogen excreted to 0 N ₂ O/Kg of Nitrogen excreted
	1994-2013	Fraction of manure per manure management system of poultry	Changed from aggregate fractions for all types of poultry to fractions allocated to different manure management systems per type of poultry
	1994-2013	N excretion rate - dairy cattle	Changed from 70 kg/animal/year to 0.48 kg of N per 1,000 kg of animal mass per day
	1994-2013	N excretion rate - other cattle	Changed from 50 kg/animal/year to 0.36 kg of N per 1,000 kg of animal mass per day
	1994-2013	N excretion rate- sheep	Changed from 12 kg/animal/year to 1.17 kg of N per 1000 kg of animal mass per day
	1994-2013	N excretion rate - goat	Changed from 12 kg/animal/year to 1.37 kg of N per 1,000 kg of animal mass per day
	1994-2013	N excretion rate - camels	Changed from 40 kg/animal/year to 0.46 kg of N per 1,000 kg of animal mass per day
3.A. General parameters – Livestock	1994-2013	N excretion rate - horses	Changed from 40 kg/animal/year to 0.46 kg of N per 1,000 kg of animal mass per day
	1994-2013	N excretion rate - mules and asses	Changed from 40 kg/animal/year to 0.46 kg of N per 1,000 kg of animal mass per day
	1994-2013	N excretion rate - swine	Changed from 16 kg/animal/year to 0.42 kg of N per 1,000 kg of animal mass per day
	1994-2013	N excretion rate - poultry (laying hens)	changed from 0.6 kg/animal/year to 0.96 kg of N per 1,000 kg of animal mass per day
	1994-2013	N excretion rate - poultry (broilers)	Changed from 0.6 kg/animal/year to 1.1 kg of N per 1,000 kg of animal mass per day
	1994-2013	N excretion rate - poultry (traditional chicken)	Changed from 0.6 kg/animal/year to 0.83 kg of N per 1,000 kg of animal mass per day
	1994-2013	typical animal mass per type of animal	Parameter nonexistent in 1996 IPCC GL and added in new 2006 IPCC GL methodology
	1994-2013	FraC _{Gas} m	Changed from 0.2 for all manure management systems to values specific to type of animal per manure management system
	1997	Number of dairy cows	Changed from 34,223 to 34,279
3.A Activity Data- livestock	1994-2013	Number of non-dairy cows	All increased because of inclusion of imported beef
	1994-2013	Number of camels	Was not estimated in previous inventories.

	2013	Number of swine	Changed from 5,300 (estimation) to 7,900 (survey)
	1994-2013	EF for Urea applications	EF not applicable to 1996 GL and is included as a new category in 2006 IPCC GL
	1994-2013	EF 1 for N input types	Changed from 0.0125 Kg N ₂ O-N per Kg N to 0.01 Kg N ₂ O-N per Kg N
	1994-2013	EF 3 for N inputs by PRP	Changed from 0.02 Kg N ₂ O-N per Kg N for all to 0.02 for Kg N ₂ O-N per Kg N cattle, poultry and pigs, and 0.01 Kg N ₂ O-N per Kg N for the rest
	1994-2013	EF 5 for leaching and runoff	Changed from 0.025 Kg N/ Kg N leached to 0.0075 Kg N/ Kg N leached
3.C Aggregate sources and non-CO ₂ emissions source on land - Agricultural soils	1994-2013	F _{SN}	Equation for calculation of FSN changed from 1996 IPCC GL to 2006 IPCC GL. The former used to account for quantity of N volatilized. Hence the F _{SN} data is different
	1994-2013	F _{CR}	Methodology and equation changed- in the 2006 GL, the equation to calculate FCR has been modified to account for the contribution of below ground nitrogen to the total input of nitrogen from crop residues, which was ignored in the 1996 GL
	1994-2013	Dry matter	Number of for all crops
	1994-2013	Carbon fraction of dry matter Cf	Number of from 0.5 tonnes C/tonnes dm to 0.74 tonnes C/dm
3.B. Land	1994-2013	Biomass conversion and expansion factor for conversion of removals in merchantable volume to biomass removals BCEFr	Changed from 1.4 tonnes biomass removal/m ³ of removals to 2.11 for broadleaf
	1994-2013	Average biomass in forest Bw	Changed from a range of 122-130 tonnes DM/ha to 134
	1994-2013	Aboveground biomass growth in forest Gw	Changed from a range of 3-4 tonnes dm/tonnes shoot to 1.5 tonnes dm/tonnes shoot
	1994-2013	Carbon fraction of dry matter Cf	changed from 0.5 tonnes C/tonnes dm to 0.74 tonnes C/dm (2014/2015)
3.C.1 Biomass burning	1994-2013	Combustion factor (Grassland land)	Changed from 0.5 to 0.72 g
	1994-2013	EF CH ₄ for biomass burning forestland	Changed from 9 to 4.7 g/kg burnt

	1994-2013	EF N ₂ O for biomass burning forestland	Changed from 0.7 to 0.26 g/kg burnt	
	1994-2013	EF CH ₄ for biomass burning grassland	Changed from 3 to 2.3 g/kg burnt	
	1994-2013	EF N ₂ O for biomass burning grassland	Changed from 0.11 to 0.21 g/kg burnt	
	1994-2013	EF CH ₄ for biomass burning cropland	Changed to 2.7 g/kg burnt	
	1994-2013	EF N ₂ O for biomass burning cropland	Changed to 0.07 g/kg burnt	
4. Waste	General Parameters	1965-2013	Municipal Solid Waste generation	Population has been updated as per the World Bank Database (2019) Population growth rate changed from 1.65% to 1.47%
		1965-2013	Industrial waste generation	New methodology has been adopted to calculate industrial waste generation based on industrial Waste generation per GDP. The GDP of 1970 was kept for the period 1965-1970.
		1965-2013	Waste composition	New parameters to be taken into consideration in the 2006 methodology.
		2004-2014	Clinical waste incinerated amounts	New activity data available from POPS report (MoE/UNEP/GEF,2017)
	4.A Solid waste disposal	1997-2013	% recycling and composting	All percentages changed as per the availability of new AD
		1997-2013	Waste landfilled	New AD available per landfill
	4.B Biological treatment of solid waste	1994-2013	Water treated biologically	New category under 2006 IPCC guidelines
		4.C incineration and open burning of waste	2004-2015	Clinical waste incineration
	1994-2013		Open burning	New category added
	4.D Wastewater	all	Distribution of WW in discharge system	New methodology where river and sea discharge are combined into one category
		all	MCF	New methodology with MCF for sea changed from 0.2 to 0.1 and MCF of septic tank changed from 0,3 to 0.5
		all	N effluent	New methodology with new fractions for non-consumption of protein

Annex VI. Mitigation actions of energy sector

1. Data collection

Data has been collected per sub-category and split by year, using official publications and references from governmental authorities, in addition to personal interviews and online questionnaires submitted to implementing agencies and local suppliers. The references used and stakeholders consulted provide a comprehensive overview of the energy mitigation initiatives undertaken during the period 2012-2015. The collected information has then been merged to report progress by year, and by initiative-leader (private sector, donor or government).

Data collection for Mitigation actions in the energy sector

Category	Data Collection	Calculation Reference
1 Decentralized PV Installations	MoEW/UNDP/GEF, 2016 CEDRO, 2017 LCEC, 2016	MoE, 2017c Jordan and Kurtz, 2012 Expert judgement
2 Solar Water Pumping	MoEW/UNDP/GEF, 2016 UNDP, 2015 LCEC, 2016	MoE, 2017c Jordan and Kurtz, 2012 Expert judgement
3 Solar Street Lighting	MoEW, 2015 MoEW/LCEC, 2011 CEDRO, 2017 CEDRO, 2015	MoE, 2017c Jordan and Kurtz, 2012 Expert judgement
4 Efficient Street Lighting	MoEW, 2015 MoEW/LCEC, 2011 CEDRO, 2017 CEDRO, 2015	MoE, 2017c LCEC, 2017a
5 Solar Water Heating	UNEP, 2016 CEDRO, 2017	MoE, 2017c
6 Certified Green Buildings	USGBC, 2017 BREEAM, 2017	MoE, 2017c ASHRAE, 2009 Expert judgment
7 Energy Conservation Measures	CEDRO, 2017 LCEC, 2017b Shehadeh, 2017 Bsaibes, 2017 Diab, 2017	MoE, 2017c Expert judgment
8 Biomass Space Heating	CEDRO, 2017 Sfeir, 2017	MoE, 2017c Expert judgment
9 Other Renewables	CEDRO, 2017	MoE, 2017c Expert judgment Jordan and Kurtz, 2012
10 Other Energy Efficiency Measures	MoE, 2017a	MoE, 2017a
11 Power plants	MoEW, 2015	MoEW, 2015

2. Assumptions and calculation methodology

Emission factor

Quantification of greenhouse gas emission reductions is done using national grid emission factors as calculated by the Ministry of Environment. The emission factors are provided for the years 2011 to 2015, split into three sources as presented in the following table. GHG reductions are calculated on yearly basis with the relevant emission factors per year, and the source of power used for the affected systems. For example, GHG emission reductions for street lighting use the EDL grid emission factor, while that for decentralized PV generation uses the EDL and Private Generation grid emission factor.

Grid Emission Factor (Tonnes CO ₂ eq/ KWh)	2011	2012	2013	2014	2015
EDL	0.668	0.657	0.673	0.662	0.666
Private Generation	0.711	0.711	0.701	0.689	0.689
EDL + Private Generation	0.678	0.676	0.683	0.671	0.674

Budget calculation

In most cases, budgets are provided by the implementing agency, the donor, or the supplier. In case this data is not made available, the following assumptions are used:

Category	Assumptions	References
PV	The average yearly system budget as reported in the 2015 Solar PV Status Report for Lebanon (MoEW/UNDP/GEF, 2017) is used. This is provided in USD/kWp for years prior to 2010, where no cost per kWp is available, the 2010 average is used.	MoEW/UNDP/GEF, 2017 MoE, 2017
PV Public Street Lights	For some installations, average pole price for the installation year is used	UNEP, 2016
Certified Green Buildings	Green building energy measures are not presented with budgets. The implementation cost is estimated using average payback period of 10 years and average energy cost of 12 USC/kWh.	ASHRAE, 2009
Energy Conservation Measures	When energy efficiency measures are not presented with budgets, the implementation cost is estimated using average payback period of 5 years and average energy cost of 12 USC/kWh. This value is a result of more than 200 energy efficiency measures studies and financial feasibility analysis.	CEDRO, 2017

Capacity and energy efficiency factors

Energy generation potential for renewable energy sources is dependent on the deployed technology and the available resources in the country. In order to quantify the generated energy, capacity factors (kWh/kW) rates are used for the different technologies. These factors are collected from national and international reports and publications. The capacity factor is only used when there is no reported energy savings for the undertaken initiative.

Capacity factors of RE systems

Category	kWh/kW	Reference
PV	1,500	MoEW/UNDP/GEF, 2017
Wind	1,727	CEDRO, 2017
SWH	1,006	UNEP, 2016
PVPSL	2,920	LCEC, 2017a
PV Pumping	1,350	MoEW/UNDP/GEF, 2017
PV-Wind	1,433	CEDRO, 2017
Hydro	3,000	Expert judgment
Biomass	2,000	Expert judgment

In order to calculate savings energy efficiency factors, lifespan, degradation and other parameters are estimated as per the following assumptions:

Assumptions for calculating savings from energy efficiency

Category	Assumptions	References
Energy Efficient Street Lighting	Photosensor and timers installed on a public street lighting pole save an average of 74.47 kWh/year. This value is reported by LCEC in the NEEAP	MoEW/LCEC, 2016
Certified Green Buildings	Quantification of energy savings is done collecting the following information: <ul style="list-style-type: none"> - Building size in m2 (from company website or USGBC database) - Business as usual consumption based on ASHRAE standards (Ref #6) - Energy consumption reduction is based on the EAC1 score, which identifies the % of energy consumption reduction compared to BAU" 	ASHRAE, 2009
Energy Conservation Measures	Green roofs save an average of 5.26 kWh/m ² per year. This value is a result of an energy modeling performed to a conditioned last roof floor.	CEDRO, 2017

Assumptions for calculating lifespan and degradation

Category	Lifespan	Degradation	Market Characteristics
Solar PV Panels	Lifespan of PV panels is considered 25 years (MoEW/UNDP/GEF, 2017; MoE, 2017)	Efficiency degradation of 0.4% per year for PV panels (MoEW/UNDP/GEF, 2017; MoE, 2017)	
Solar Public Street Lighting	The lifespan used is only four years. Although these systems live longer, but it has been observed that systems are no longer in operation after 4 years, due to the need for new batteries that cannot be afforded by municipalities (UNEP, 2016)		Data available is related to number of poles but not power capacity. In order to quantify the power capacity

			of the system, averages of 120 W/pole and 240 W/pole are used (UNEP, 2016)
Energy Efficient Street Lighting	LED Lamps live for around 50,000 hours. With an average of 10 hrs of operation a day (MoEW, 2015)		
Solar Water Heaters	Lifespan of SWH systems is considered 25 years (MoEW/LCEC, 2011)	Efficiency degradation of 0.25% per year for solar thermal panels (MoEW/LCEC, 2011)	Average system cost: USD 370/m ² Average system collection area: 4.12 m ² kW capacity per m ² : 0.7 kW/m ² Energy saving potential: 704 kWh/m ² (MoEW/LCEC, 2011)
Biomass Boilers	Lifespan of stoves is considered 25 years (Jordan and Kurtz, 2012)		
Other Renewable Energy	The installed micro-hydro system worked for 2 years only and then stopped operation (expert judgment)		

For installations taking place before 2012, and in order to quantify the energy saving potential, cumulative installed capacity is assumed to be installed in the middle of the timeframe of the initiative. Collected data is provided on yearly basis not monthly basis, so there is no exact reference of the period of initiative implementation (beginning of year or end of year). An assumption that it is being implemented on the 1st of July, thus multiplying kWh and GHG emissions by 0.5.

2. Individual Factsheets on energy mitigation actions

Decentralized Solar PV Installations				
<i>Solar PV installations in residences, commercial institutions, and industrial facilities for power generation.</i>				
Source of funding	Private	NEEREA	Donor	Government
Implementing agency	Private Companies	LCEC-BDL	CEDRO-UNDP	-
Geographic Coverage	Lebanon	Lebanon	Lebanon	-
Budget (USD)	14,648,293	12,342,796	13,787,835	0
Capacity (kW)	4,092	3,758	1500	0
kWh Saving/yr	6,524,468	5,651,280	2,297,625	0
Gg CO₂ Reduction/yr	4.43	3.82	1.84	0.000
kWh Avoided/yr	0	0	0	0

Gg CO ₂ Avoided/yr	0.000	0.000	0.000	0.000
Timeframe	2000 - 2015			
Goals	Reduction of GHG emissions by EDL and private generation			
	Spread of decentralized power generation			
	Promotion of renewable energy as an alternative source of power to diesel generators			
	Cum. Energy Savings (kWh)	Cum. CO₂ Reduction (Gg of CO₂eq.)	Cum. Energy Avoided (kWh)	Cum. CO₂ Avoided (Gg of CO₂eq.)
By 2015	27,764,952	19.90	0	0.000
Methodology and Assumptions	Initiative budget is calculated using yearly system budget (USD/kWp) as reported in Ref #1			
	Cost rate for years prior to 2010 are not available, thus 2010 average is used for earlier years.			
	Lifespan of PV panels is considered 25 years (according to market data)			
	Efficiency degradation of 0.4% per year for PV panels as reported by NREL (Ref #8).			
	Average capacity factor for PV generators is considered 1500 kWh/kW			
	Emission factor used for EDL with private generation, varying by year based on the energy mix in that year (Ref #2)			
	Collected data is provided on yearly basis not monthly basis, so there is no exact reference of the period of initiative implementation (beginning of year or end of year). An assumption that it is being implemented on the 1st of July, thus multiplying kWh and GHG emissions by 0.5			
	For installations taking place before 2012, and in order to quantify the energy saving potential, cumulative installed capacity is assumed to be installed in the middle of the timeframe of the initiative			
Gaps and Constraints	Installations before 2012 are available in cumulative numbers. Thus, the average emission factor and budget estimate for the year 2010 and 2011 are used			
	Data collected for PV installations are supposed to be covering the whole Lebanese market, yet the survey performed does not cover 100% of the suppliers in Lebanon			
	Donor funded projects include CEDRO implementations only. Other donor-funded installations that might have taken place are within the privately-installed cumulative values			

Solar-Powered Water Pumping				
<i>Solar PV installations for agricultural applications and water pumping</i>				
Source of funding	Private	NEEREA	Donor	Government
Implementing agency	Private Companies	LCEC-BDL	USAID-OTI and UNDP	-
Geographic Coverage	Lebanon	Lebanon	Bekaa	-
Budget (USD)	USD 1,251,915	USD 10,478,096	USD 151,000	USD 0
Capacity (kW)	507	1,220	91	0

kWh Saving/yr	684,450	1,647,000	122,850	0
Gg CO₂ Reduction/yr	0.461	1.10	0.087	0.000
kWh Avoided/yr	0	0	0	0
Gg CO₂ Avoided/yr	0.000	0.000	0.000	0.000
Timeframe	2000 - 2015			
Goals	Reduction of GHG emissions by EDL and private generation			
	Promotion of solar pumping as an alternative solution to onsite diesel generators			
	Cum. Energy Savings (kWh)	Cum. CO₂ Reduction (Gg of CO₂eq.)	Cum. Energy Avoided (kWh)	Cum. CO₂ Avoided (Gg of CO₂eq.)
2015	3,631,00	3.16	0	0.000
Methodology and Assumptions	Initiative budget is calculated using yearly system budget (USD/kWp) as reported in Ref #1			
	Lifespan of PV panels is considered 25 years (according to market data)			
	Efficiency degradation of 0.4% per year for PV panels as reported by NREL (Ref #8)			
	Average capacity factor for PV generators is considered 1350 kWh/kW			
	Emission factor used for EDL with private generation, varying by year based on the energy mix in that year (Ref #2)			
	Collected data is provided on yearly basis not monthly basis, so there is no exact reference of the period of initiative implementation (beginning of year or end of year). An assumption that it is being implemented on the 1st of July, thus multiplying kWh and GHG emissions by 0.5			
	For installations taking place before 2012, and in order to quantify the energy saving potential, cumulative installed capacity is assumed to be installed in the middle of the timeframe of the initiative			
Gaps and Constraints	Data collected for PV installations are supposed to be covering the whole Lebanese market, yet the survey performed does not cover 100% of the suppliers in Lebanon			
	Donor funded projects include USAID and UNDP implementations only. Other donor-funded installations that might have taken place are within the privately-installed cumulative values			

Solar-Powered Public Street Lighting				
<i>Solar PV for public streetlights. Includes addition of new poles and replacement of existing poles</i>				
Source of funding	Private	NEEREA	Donor	Government
Implementing agency	-	-	UNDP, UNIFIL	MPW, MEW
Geographic Coverage	-	-	Lebanon	Lebanon
Budget (USD)	USD 0	USD 0	USD 2,807,000	USD 4,853,533
Capacity (kW)	0	0	354	433
kWh Saving/yr	0	0	0	1,264,360

Gg CO₂ Reduction/yr	0.000	0.000	0.000	0.837
kWh Avoided/yr	0	0	1,032,979	0
Gg CO₂ Avoided/yr	0.000	0.000	0.616	0.000
Timeframe	2012 - 2015			
Goals	Reduction of GHG emissions by EDL and private generation			
	Improving safety and enhancing security levels in rural areas			
	Promotion of decentralized street lighting solutions			
	Cum. Energy Savings (kWh)	Cum. CO₂ Reduction (Gg of CO₂eq.)	Cum. Energy Avoided (kWh)	Cum. CO₂ Avoided (Gg of CO₂eq.)
2015	5,102,673	3.39	585,968	0.267
Methodology and Assumptions	Budget data are collected from publications when available. If not available, average pole price for the year is used			
	Data available is related to number of poles but not power capacity. In order to quantify the power capacity of the system, averages of 120 W/pole and 240 W/pole are used			
	Lifespan of 4 years is used. Although these systems live longer, but it has been observed that systems are no longer in operation after 4 years, due to the need for new batteries that cannot be afforded by municipalities			
	Efficiency degradation of 0.4% per year for PV panels as reported by NREL (Ref #8)			
	Average capacity factor for PV street lights is considered 2920 kWh/kW			
	Emission factor used for EDL, varying by year based on the energy mix in that year (Ref #2)			
	Collected data is provided on yearly basis not monthly basis, so there is no exact reference of the period of initiative implementation (beginning of year or end of year). An assumption that it is being implemented on the 1st of July, thus multiplying kWh and GHG emissions by 0.5			
	Data about installed systems are collected from UNDP, MEW, Newspapers, and the PSL report			
For installations taking place before 2012, and in order to quantify the energy saving potential, cumulative installed capacity is assumed to be installed in the middle of the timeframe of the initiative				
Gaps and Constraints	Installations before 2012 are available in cumulative numbers. Thus, the average emission factor and budget estimate for the year 2010 and 2011 are used			
	There is no national report that provides accurate numbers about installations			
	Donor funded projects include CEDRO, UNIFIL, and Live Lebanon implementations only. Other donor-funded installations that might have taken place are within the privately-installed cumulative values			

Energy-Efficient Public Street Lighting				
<i>Replacement of existing HPS and LPS street lamps with LED street lamps and the use of photocells and timers</i>				
Source of funding	Private	NEEREA	Donor	Government
Implementing agency	-	-	CEDRO-UNDP	-

Geographic Coverage	-	-	Lebanon	-
Budget (USD)	USD 0	USD 0	USD 242,000	USD 64,345
Capacity (kW)	0	0	44	0
kWh Saving/yr	0	0	127,195	109,843
Gg CO₂ Reduction/yr	0.000	0.000	0.085	0.072
kWh Avoided/yr	0	0	0	0
Gg CO₂ Avoided/yr	0.000	0.000	0.000	0.000
Timeframe	2012 - 2015			
Goals	Reduction of GHG emissions by EDL and private generation			
	Improving safety and enhancing security levels in rural areas			
	Reduction of wasted energy and programming street lights to operate when needed only			
	Cum. Energy Savings (kWh)	Cum. CO₂ Reduction (Gg of CO₂eq.)	Cum. Energy Avoided (kWh)	Cum. CO₂ Avoided (Gg of CO₂eq.)
2015	838,316	0.56	0	0.000
Methodology and Assumptions	Emission factor used for EDL with private generation, varying by year based on the energy mix in that year (Ref #2)			
	LED Lamps live for around 50,000 hours. With an average of 10 hrs of operation a day			
	Collected data is provided on yearly basis not monthly basis, so there is no exact reference of the period of initiative implementation (beginning of year or end of year). An assumption that it is being implemented on the 1st of July, thus multiplying kWh and GHG emissions by 0.5			
	According to MEW and NEEAP, Photosensor and timers save 74.47 kWh/yr			
	For installations taking place before 2012, and in order to quantify the energy saving potential, cumulative installed capacity is assumed to be installed in the middle of the timeframe of the initiative			
Gaps and Constraints	Savings are calculated assuming all photosensor and timers are installed immediately and properly maintained. In fact, some were installed at a later stage, and others are not properly maintained, which reduces their performance and saving potential			

Solar Water Heating				
<i>solar water heating systems in residential, commercial, industrial, and public institutions</i>				
Source of funding	Private	NEEREA	Donor	Government
Implementing agency	Private Companies	LCEC-BDL	CEDRO, SIDA, Ital Coop	-
Geographic Coverage	Lebanon	Lebanon	Lebanon	-
Budget (USD)	USD 104,833,196	USD 6,666,304	USD 2,298,108	USD 0
Capacity (kW)	404,761	25,739	6,062	0

kWh Saving/yr	310,885,189	20,211,011	6,833,262	0
Gg CO₂ Reduction/yr	167.165	13.64	4.6	0.000
kWh Avoided/yr	0	0	0	0
Gg CO₂ Avoided/yr	0.000	0.000	0.000	0.000
Timeframe	2008 - 2015			
Goals	Reduction of GHG emissions by EDL and private generation			
	Spread of solar water heaters as an alternative solution to diesel boilers and electric heaters			
	Supporting the national program of a SWH to every house			
	Cum. Energy Savings (kWh)	Cum. CO₂ Reduction (Gg of CO₂eq.)	Cum. Energy Avoided (kWh)	Cum. CO₂ Avoided (Gg of CO₂eq.)
2015	1,036,981,467	728.27	0	0.000
Methodology and Assumptions	Using the GSWH report by UNEP and LCEC, the following factors are used: - Average system cost: USD 370/m ² - Average system collection area: 4.12 m ² - kW capacity per m ² : 0.7 kW/m ² - Energy saving potential: 704 kWh/m ²			
	Lifespan of SWH systems is considered 25 years (according to market data)			
	Efficiency degradation of 0.25% per year for solar panels is used			
	Emission factor used for EDL with private generation, varying by year based on the energy mix in that year (Ref #2)			
	Collected data is provided on yearly basis not monthly basis, so there is no exact reference of the period of initiative implementation (beginning of year or end of year). An assumption that it is being implemented on the 1st of July, thus multiplying kWh and GHG emissions by 0.5			
	For installations taking place before 2012, and in order to quantify the energy saving potential, cumulative installed capacity is assumed to be installed in the middle of the timeframe of the initiative			
Gaps and Constraints	Installations before 2012 are available in cumulative numbers. Thus, the average emission factor and budget estimate for the year 2010 and 2011 are used			
	Data collected for SWH installations are supposed to be covering the whole Lebanese market, yet the survey performed does not cover 100% of the suppliers in Lebanon			
	Donor funded projects include CEDRO, SIDA, and Italian Cooperation implementations only. Other donor-funded installations that might have taken place are within the privately-installed cumulative values			

Certified Green Buildings				
<i>Certified green buildings under the BREEAM and LEED schemes</i>				
Source of funding	Private	NEEREA	Donor	Government
Implementing agency	Private Companies	-	-	-

Geographic Coverage	Lebanon	-	-	-
Budget (USD)	USD 29,468,962	USD 0	USD 0	USD 0
Capacity (kW)	0	0	0	0
kWh Saving/yr	0	0	0	0
Gg CO₂ Reduction/yr	0.000	0.000	0.000	0.000
kWh Avoided/yr	24,557,468	0	0	0
Gg CO₂ Avoided/yr	16.752	0.000	0.000	0.000
Timeframe	2012 - 2015			
Goals	Reduction of GHG emissions by EDL and private generation			
	Promoting green building concepts in new constructions			
	Cum. Energy Savings (kWh)	Cum. CO₂ Reduction (Gg of CO₂eq.)	Cum. Energy Avoided (kWh)	Cum. CO₂ Avoided (Gg of CO₂eq.)
2015	0	0.000	22,143,229	14.93
Methodology and Assumptions	Data about certified buildings is collected from USGBC and BREEAM database (Ref #12, Ref #13)			
	Quantification of energy savings is done collecting the following information: - Building size in m ² (from company website or USGBC database) - Business as usual consumption based on ASHRAE standards (Ref #6) - Energy consumption reduction is based on the EAC1 score, which identifies the % of energy consumption reduction compared to BAU			
	Budget is estimated using average payback period of 10 years and average kWh cost of 12 USC			
	Emission factor used for EDL with private generation, varying by year based on the energy mix in that year (Ref #2)			
	Collected data is provided on yearly basis not monthly basis, so there is no exact reference of the period of initiative implementation (beginning of year or end of year). An assumption that it is being implemented on the 1st of July, thus multiplying kWh and GHG emissions by 0.5			
Gaps and Constraints	Budget related to energy saving measures cannot be made available			

Biomass Space Heating				
<i>Biomass and pellet stoves for space heating</i>				
Source of funding	Private	NEEREA	Donor	Government
Implementing agency	Private Companies	LCEC-BDL	CEDRO-UNDP	-
Geographic Coverage	Lebanon	Lebanon	Lebanon	-
Budget (USD)	USD 12,000	USD 0	USD 909,774	USD 0
Capacity (kW)	360	0	7,500	0
kWh Saving/yr	1,078,000	0	15,000,000	0

Gg CO₂ Reduction/yr	0.73	0.000	10.210	0.000
kWh Avoided/yr	0	0	0	0
Gg CO₂ Avoided/yr	0.000	0.000	0.000	0.000
Timeframe	2008 - 2015			
Goals	Reduction of GHG emissions by EDL and private generation			
	Avoiding diesel heaters and using pellets stove as an alternative and sustainable solution			
	Cum. Energy Savings (kWh)	Cum. CO₂ Reduction (Gg of CO₂eq.)	Cum. Energy Avoided (kWh)	Cum. CO₂ Avoided (Gg of CO₂eq.)
2015	26,830	19.99	0	0.000
Methodology and Assumptions	Data is collected from suppliers directly			
	Budgets and prices are collected from suppliers and implementing agencies			
	Lifespan of stoves is considered 25 years (according to market data)			
	Average capacity factor for pellet stoves is considered 2000 kWh/kW			
	Emission factor used for EDL with private generation, varying by year based on the energy mix in that year (Ref #2)			
	Collected data is provided on yearly basis not monthly basis, so there is no exact reference of the period of initiative implementation (beginning of year or end of year). An assumption that it is being implemented on the 1st of July, thus multiplying kWh and GHG emissions by 0.5			
	For installations taking place before 2012, and in order to quantify the energy saving potential, cumulative installed capacity is assumed to be installed in the middle of the timeframe of the initiative			
Gaps and Constraints	The major supplier of biomass pellets only is involved in this activity. There were no other major initiatives undertaken during the reporting period			
	It is not clear what these stoves are replacing, thus the emission factor used is for EDL and private generators. In some cases, these stoves might be replacing diesel heaters.			
	The average saving of 2000 kWh per installed kW is a rough estimate based on international market data. No similar data is available for these systems in Lebanon.			

Other Renewables				
<i>Other renewable technologies including wind, hydro, geothermal, and others</i>				
Source of funding	Private	NEEREA	Donor	Government
Implementing agency	-	-	CEDRO-UNDP	-
Geographic Coverage	-	-	Lebanon	-
Budget (USD)	USD 0	USD 0	USD 420,000	USD 0
Capacity (kW)	0	0	87	0
kWh Saving/yr	0	0	104,681	0

Gg CO₂ Reduction/yr	0.000	0.000	0.071	0.000
kWh Avoided/yr	0	0	0	0
Gg CO₂ Avoided/yr	0.000	0.000	0.000	0.000
Timeframe	2013 - 2015			
Goals	Reduction of GHG emissions by EDL and private generation			
	Spread of decentralized power generation			
	Promotion of renewable energy as an alternative source of power to diesel generators			
	Cum. Energy Savings (kWh)	Cum. CO₂ Reduction (Gg of CO₂eq.)	Cum. Energy Avoided (kWh)	Cum. CO₂ Avoided (Gg of CO₂eq.)
2013	267,043	0.18	0	0.000
Methodology and Assumptions	Data is collected from CEDRO-UNDP regarding implemented pilot projects			
	Lifespan of PV panels is considered 25 years (according to market data)			
	Efficiency degradation of 0.4% per year for PV panels as reported by NREL (Ref #8)			
	Average capacity factor for PV generators is considered 1500 kWh/kW			
	Average capacity factor for wind generators is considered 1433 kWh/kW			
	Average capacity factor for hydro generators is considered 3000 kWh/kW			
	Emission factor used for EDL with private generation, varying by year based on the energy mix in that year (Ref #2)			
	Collected data is provided on yearly basis not monthly basis, so there is no exact reference of the period of initiative implementation (beginning of year or end of year). An assumption that it is being implemented on the 1st of July, thus multiplying kWh and GHG emissions by 0.5			
	The installed micro-hydro system worked for 2 years only and then stopped operation			
Gaps and Constraints	Installations done by private sector could not be quantified. Yet they are expected to have minor effect on the cumulative values			

Other Energy Efficiency Measures				
<i>Energy efficiency measures undertaken by the public and private sector including energy efficient lighting, equipment, and others</i>				
Source of funding	Private	NEEREA	Donor	Government
Implementing agency	-	-	-	MEW
Geographic Coverage	-	-	-	Lebanon
Budget (USD)	USD 0	USD 0	USD 0	USD 7,000,000
Capacity (kW)	0	0	0	0
kWh Saving/yr	0	0	0	255,052,875

Gg CO₂ Reduction/yr	0.000	0.000	0.000	172.416
kWh Avoided/yr	0	0	0	0
Gg CO₂ Avoided/yr	0.000	0.000	0.000	0.000
Timeframe	2011 - 2012			
Goals	Reduction of GHG emissions by EDL and private generation			
	Spread of decentralized power generation			
	Cum. Energy Savings (kWh)	Cum. CO₂ Reduction (Gg of CO₂eq.)	Cum. Energy Avoided (kWh)	Cum. CO₂ Avoided (Gg of CO₂eq.)
2015	1,020,211,500	689.66	0	0.000
Methodology and Assumptions	Data is collected from MEW's NEEAP			
	Lifespan of CFLs is considered 10,000 hours (according to market data)			
	Average working hours per day is considered 3 hours (according to LCEC)			
	Emission factor used for EDL with private generation, varying by year based on the energy mix in that year (Ref #2)			
	Collected data is provided on yearly basis not monthly basis, so there is no exact reference of the period of initiative implementation (beginning of year or end of year). An assumption that it is being implemented on the 1 st of July, thus multiplying kWh and GHG emissions by 0.5			
	23W CFLs are distributed, to be replacing 100W lamps			
Gaps and Constraints	Installations done by private sector could not be quantified. Yet they are expected to have minor effect on the cumulative values			

Annex VII. Mitigation actions of transport sector

The Greater Beirut Public transport project				
General information:				
Implementing agency	World Bank			
Geographical coverage	Greater Beirut and Beirut Northern entrance			
Budget	USD 345,000,000 (USD 295,000,000 of loan)			
Timeframe	2018 - 2023			
Source of funding	World Bank (concessional and non-concessional loan)			
Goals	Improve the speed, quality and accessibility of public transport passengers in Beirut			
Activities	Bus Rapid Transit (BRT) infrastructure, fleet and systems Feeder and regular bus services and integration in urban environment Capacity building and project management			
Achievements or progress by 2015	Signature of contract ESIA preparation			
Expected CO₂ emissions reductions	Type of Bus	Total Emission Savings (tCO₂eq)	GHG	Average per Year (tCO₂eq)
	Diesel articulated bus	1,211,808		60,590
	Hybrid articulated bus	1,438,045		71,902
	CNG articulated bus	1,438,045		71,902
Methodology	-			
Assumptions	The computation does not account for the GHG savings related to improved congestion on general traffic lanes (improved speed).			

Annex VIII. Mitigation actions of LULUCF

This section presents the factsheets for mitigation actions conducted between the years 2013 and 2015.

Toumet Niha, Jezzine reforestation project			
General information: This project is executed in partnership with the Ministry of Agriculture (MoA) within the framework of the 40 million tree program, under the EU Agriculture and Rural Development Program (ARDP) and is financed by the EU and Jouzour Loubnan.			
Implementing agency	Jouzour Loubnan and the Municipality of Jezzine		
Geographical coverage	Toumet Niha in Jezzine		
Budget	N.A.		
Timeframe	October 2014- October 2018		
Source of funding	European Commission through MoA		
Goals: Within the scope of this project, Jouzour Loubnan plans to increase the woodland area in Toumet Niha and participate in the restoration of its degraded high mountain ecosystem in close partnership with the Jezzine municipality by planting 32,000 trees of native species and 4,000 seeds on a total site area of approximately 40 ha on a municipal land.			
Achievements or progress	Year	Area (ha)	Yearly CO₂ removal (Gg of CO₂eq.)
	2015	25 (i.e., 17,502 seedlings)	0.1618
Methodology	IPCC 2006		
Assumptions	Assuming that each ha of planted land comprised 700 seedlings. Also, assuming a total area of 25 ha of land was successfully planted and maintained in 2015 and a total cumulative area of 50.24 ha of land was successfully planted and maintained by 2016.		

Assisting Reforestation and forest Development Activities in partnership with local Communities (ARDAC)			
General information: The overall objective of this action is to address deforestation and local development through conducting state-of-the-art reforestation and sustainable forest management activities in line with the 40 million trees programme of MoA.			
Implementing agency	University of Balamand and the Municipality of Menjez		
Geographical coverage	Menjez, Akkar		
Budget	333,427 euro		
Timeframe	2014-2018		
Source of funding	European Commission through MoA		
Goals: Within the scope of this project, the University of Balamand aims to implement and promote pilot reforestation/afforestation activities in line with the 40 million trees programme. Other activities include capacity building and management of existing vegetation cover.			
Achievements or progress	Year	Area (ha)	Yearly CO₂ removal (Gg of CO₂eq.)
	2015	10	0.0647
Methodology	IPCC 2006		
Assumptions	Assuming a total area of 10 ha of land was successfully planted and maintained.		

Deir el Ahmar, Ainata and Barqua reforestation/afforestation project	
General information: Project implemented within the framework of the 40 million tree programme	

Implementing agency	Forest Sciences Centre of Catalonia (CTFC) and the Municipalities of Deir el Ahmar, Ainata and SEED		
Geographical coverage	Deir el Ahmar and Ainata		
Budget	N.A.		
Timeframe	2014-2018		
Source of funding	European Commission through MoA		
Goals:	Contribute to foster the joint participation of non-state actors and Lebanese Municipalities in reforestation projects.		
Achievements or progress	Year	Area (ha)	Yearly CO ₂ removal (Gg of CO ₂ eq.)
	2015	4 ha	0.0259
Methodology	IPCC 2006		
Assumptions	Assuming a total area of 4 ha of land was successfully planted and maintained in 2015 and additional area of 9 ha of land was also successfully planted in 2016.		

Development and implementation of pilot landscape restoration plans			
General information:	Reforestation and afforestation projects are conducted in the Shouf Biosphere Reserve to build resilience to climate change through adaptive forest landscape restoration. One of these projects is implemented within the framework of the 40 million trees programme, while the others are implemented with private sponsorships.		
Implementing agency	Al Shouf Cedar Society		
Geographical coverage	Barouk and the Municipalities of Barouk, Maasser el Shouf, Mristi (Mount Lebanon) and Saghbine (Beqaa)		
Budget	N.A.		
Timeframe	2013-2015		
Source of funding	MM1, Byblos bank, HSBC bank, European Commission (through MoA), Middle East Airlines, and the private sector.		
Goals:	Increase resilience to climate change in an altitudinal and continental gradient, from the inner Bekaa Valley to the Mount Lebanon western range, connecting forest patches.		
Achievements or progress	Year	Area (ha)	Yearly CO ₂ removal (Gg of CO ₂ eq.)
	2013	48.5	0.314
	2014	17	0.11
	2015	60	0.388
Methodology	IPCC 2006		
Assumptions	Assuming that each ha of planted land comprised 700 seedlings. Also, assuming that the seedlings were successfully planted and maintained over a total cumulative area of 125.5 ha by 2015.		

Hasbaya, Kawkaba, Baalbeck and Aramoun reforestation/afforestation project			
General information: This project comes within the framework of the 40 million trees programme and includes the establishment of a network of pilot field trials for assessing sustainable and innovative techniques enhanced forest restoration techniques.			
Implementing agency	Lebanese University		
Geographical coverage	Municipalities of Hasbaya, Kawkaba (South Lebanon), Baalbeck (Beqaa), and Aramoun (Mount Lebanon).		
Budget	N.A.		
Timeframe	2014-2018		
Source of funding	European Commission through MoA		
Goals: Provide a technical basis for the 40 million trees program in Lebanon including capacity building and social inclusion of local actors in the Municipalities of Baalbeck, Hasbaya, Kawkaba and Aramoun.			
Achievements or progress	Year	Area (ha)	Yearly CO ₂ removal (Gg of CO ₂ eq.)
	2015	11.45	0.0741
Methodology	IPCC 2006		
Assumptions	Assuming that each ha of planted land comprised 700 seedlings. Also, assuming that the seedlings were successfully planted and maintained over an area of 11.45 ha in 2015 and over an area of 2.74 in 2016.		

AFDC afforestation/reforestation projects			
General information:			
Implementing agency	Association for Forests, Development and Conservation (AFDC)		
Geographical coverage	Jesr El Kadi, Deir Aamar, Ashash, Btater, Shartoun, Anjar, Rashaya, Bqerzala, and Kfar Qouk.		
Budget	N.A.		
Timeframe	2013-2016		
Source of funding	Various sources including private sponsorships		
Goals: Restore degraded land and increase forest cover in Lebanon			
Achievements or progress	Year	Area (ha)	Yearly CO ₂ removal (Gg of CO ₂ eq.)
	2013	16	0.1036
	2014	3.5	0.0227
	2015	5	0.0324
Methodology	IPCC 2006		
Assumptions	Assuming that each ha of planted land comprised 700 seedlings. Also, assuming that the seedlings were successfully planted and maintained over a total area of 24.5 ha by 2015 and a total cumulative area of 82.5 ha by 2016.		

The Reforestation Initiative of the Ministry of Environment of Lebanon	
General information:	MoE was handled the prerogative of initiating the National Reforestation Plan, aiming at the restoration of the country's green cover loss throughout the years. Accordingly, MoE has executed from 2002 till 2006 (and later on from 2009 to 2014) reforestation activities in all Lebanese regions within the context of the National Reforestation Plan. These activities were achieved through two consecutive phases and have covered the reforestation of approximately 834 hectares of forest lands in all the Lebanese Governorates with contributions in some place from NGOs.
Implementing agency	MoE
Geographical coverage	All Lebanese territories
Budget	In 2001, the Lebanese government allocated in the national budget 25 billion Lebanese Pounds fund (approximately 16.67 million USD) scheduled over five years for the execution of reforestation projects at the national level.
Timeframe	2002-2014
Source of funding	Government of Lebanon
Goals: Restore the country's green cover loss throughout the years	
Achievements or progress	<p>The reforestation of 834 hectares of forest lands fairly distributed in the five Muhafazat, as follows:</p> <p>Mount Lebanon: 60 ha: Faraya and Barouk - 45 ha: Hammana, Damour, Ehmej</p> <p>North Lebanon: 60 ha: Akkar el Atiqa, Ehden, Bcharri, Tannourine - 54 ha: Kousba, Tannourine, Akkar el Atiqa</p> <p>Bekaa: 80 ha: Lala-Baaloul, Khirbet-Anafar, Qaa el Reem, Ras Baalbeck, Chaat, Hermel, Rachaya, Jdita - 104 ha: Tajammoh Baladiyat El –Sahl*, Bouday, Chmestar, Al-Qaa, Al-fakeha-El Jadida, Baalbeck, Rachaya El-Wadi, El-Hermel, Sehmor</p> <p>South Lebanon: 50 ha: Jezzine, Al Qraye, Abbassie, Majdelzoun</p> <p>Nabatieh: 55 ha: Kfar Rummane, Rmeich, Ebel el Saki, Marjeyoun, Hasbaya - 75 ha: Al-Rihan, Zawtar Esharkieh, El-Merwanieh, Kherbit Selem, Markaba</p> <p>Other reforestation activities for a total of 251 ha involved NGOs. Some of which involved large scale air seeding operations in coordination with the Lebanese Army and some NGOs. Airplane seeding of pine and oak seeds over a total area of 80 hectares in the regions of Jran, Jrabta, Kfifan, Rechmaya, Karm Saddeh, Kobeyat, Deir El-Kamar and Andkit was performed. Based on the promising initial results obtained, this operation was followed with similar applications in the regions of Dahr El-Ahmar, Karaoun and Bkifa over another area of 80 hectares.</p>
Annual total GHG removal by completion of action in 2014	5.4 Gg of CO ₂ eq.
Methodology	IPCC 2006
Assumptions	Assuming that each ha of planted land comprised 700 seedlings. Also, assuming an annual average area of 104.25 ha was successfully planted and maintained from 2005 throughout 2014.

Jouzour Loubnan's reforestation and afforestation activities			
General information: Reforestation/afforestation activities were conducted between 2008 and 2014. Local community groups were involved in reforestation activities which involved the use of native tree species.			
Implementing agency	Jouzour Loubnan		
Geographical coverage	Chabrouh, Ehmej, Ainata, Harf Shlifa and Btedi in the Bekaa valley, Ibl Es Saki, Ehden, and Kfardebiane.		
Budget	946,659 USD (assuming an average cost of 7 USD per seedling for plantation and maintenance)		
Timeframe	2008-2014		
Source of funding	Different sources of funding including the EU, the private sector, and United States Agency for International Development (USAID) through Lebanon Reforestation Initiative		
Goals: 1) Intervene mainly in arid mountainous regions as, on one hand, they are very often dismissed in forestation programs and, on the other hand, the benefits of such forestation are tremendous, and 2) empower local communities, and 3) to promote environmental awareness			
Achievements or progress	Year	Area (ha)	Yearly CO₂ removal (Gg of CO₂eq.)
	2008-2011	56.67	0.3669
	2012	46.22	0.2993
	2013	55.93	0.3626
	2014	34.36	0.222
Methodology	IPCC 2006		
Assumptions	Assuming that 1) the seedlings were successfully planted and maintained, 2) each ha of planted land comprised 700 seedlings, and 3) the cumulative area of plantations consisted of 193.183 ha by 2014 distributed as 185 seedlings (in 2008), 5,680 seedlings (in 2010), 11,795 seedlings (in 2010), 22,009 seedlings in (2011), 32,358 seedlings (in 2012), 39,155 seedlings (i.e., 55.93 ha in 2013), and 24,055 seedlings (i.e., 34.36 ha in 2014).		

Lebanon Reforestation Initiative			
General information: The Lebanon Reforestation Initiative, funded by USAID and implemented by the United States Forest Service (USFS), works towards providing a successful framework for longer-term technical and financial assistance to expand and protect Lebanon's forests for a sustainable future. The project favors a decentralized approach to engaging communities at the municipal level and focuses on 1) assisting native tree nurseries with technical improvements and enhanced business planning, 2) developing comprehensive forest mapping, 3) promoting the importance of reforestation and biodiversity through community-led activities that foster local ownership and forest sustainability, 4) supporting the planting of quality native seedlings, and 5) strengthening capacities to prevent respond to wildfires.			
Implementing agency	Lebanon Reforestation Initiative in partnership with local community groups		
Geographical coverage	Tannourine, Bcharreh, Kfarzabad, Aanjar, Rashaya, El Qlaiaa, Ainata, Rmadyeh, and Maqne		
Budget	3,192,000 USD by 2015 (assuming an average cost of 7 USD per seedling for plantation and maintenance)		
Timeframe	2011-2018		
Source of funding	USAID		
Goals: The Lebanon Reforestation Initiative aims to restore Lebanon's native forests and to install commitment to reforestation and wildfire prevention and response, through capacity building of local communities and organizations.			
Achievements or progress	Year	Area (ha)	Yearly CO₂ removal (Gg of CO₂eq.)
	2011	108.69	0.7037
	2012	182.19	1.18
	2013	182.19	1.18
	2014	84.89	0.5496
	2015	93.44	0.605
Methodology	IPCC 2006		
Assumptions	Assuming that 1) the seedlings were successfully planted and maintained, 2) each ha of planted land comprised 700 seedlings, and 3) the cumulative plantations consisted of a total area of 651.42 ha by 2018 distributed as 76,087 seedlings (i.e., 108.69) in 2011, a total of 127,536 seedlings (i.e., 182.19) in 2012, a total of 127,536 seedlings (i.e., 182.19 ha) in 2013, a total of 59,428 seedlings (i.e., 84.89 ha) in 2014, and a total of 65,413 seedlings (i.e., 93.44 ha) in 2015.		

Managing wildfire risk in the Wildland-Urban Interface	
General information: This project worked towards a better assessment and management of wildfire risk in the wildland-urban interface through gaining from the US experience	
Implementing agency	University of Balamand
Geographical coverage	All Lebanon
Budget	134,635 USD
Timeframe	2012-2016
Source of funding	USAID-PEER
Goals: Develop the capacity of stakeholders in Lebanon to assess and manage wildfire risk in Lebanon's Wildland-Urban Interface (WUI) in light of future climate change and human development in wildland areas and improve knowledge and understanding among university students, local community groups, and municipalities about the nature and risks of wildfire in Lebanon's WUI.	
Achievements or progress	<ul style="list-style-type: none"> • Development of a wildfire-climate model and maps for

	<p>Lebanon</p> <ul style="list-style-type: none"> • Incorporation of wildfire risk assessment and management in educational materials • Development of a web-application for improved decision making in forest fire risk management 2015 • A fire danger forecast system (9 day forecast) was developed and made available to the public in 2016
Annual GHG emission reductions in 2015	0.34 Gg of CO ₂ eq.
Methodology	IPCC GPG for LULUCF 2003 (Appendix 1)
Assumptions	Assuming that the project succeeded in preventing 10% of the fires in forest land (out of the 182.56 ha of burned forest land in 2015 and resulting in a total of GHG emissions of 24.8374 Gg of CO ₂ eq.)

Annex IX. Documentation sheets for waste sector

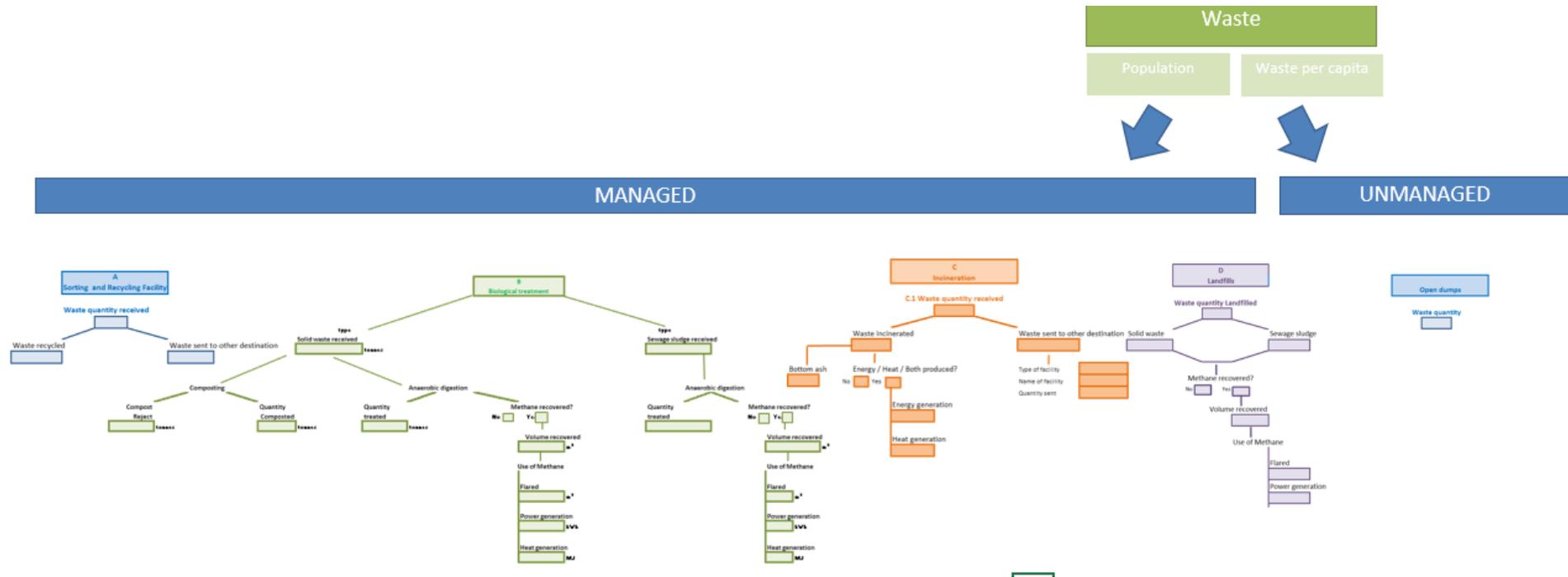
Please complete sections 1 and 2 below. The tab 'overview' provides a visual to contextualise this data collection process

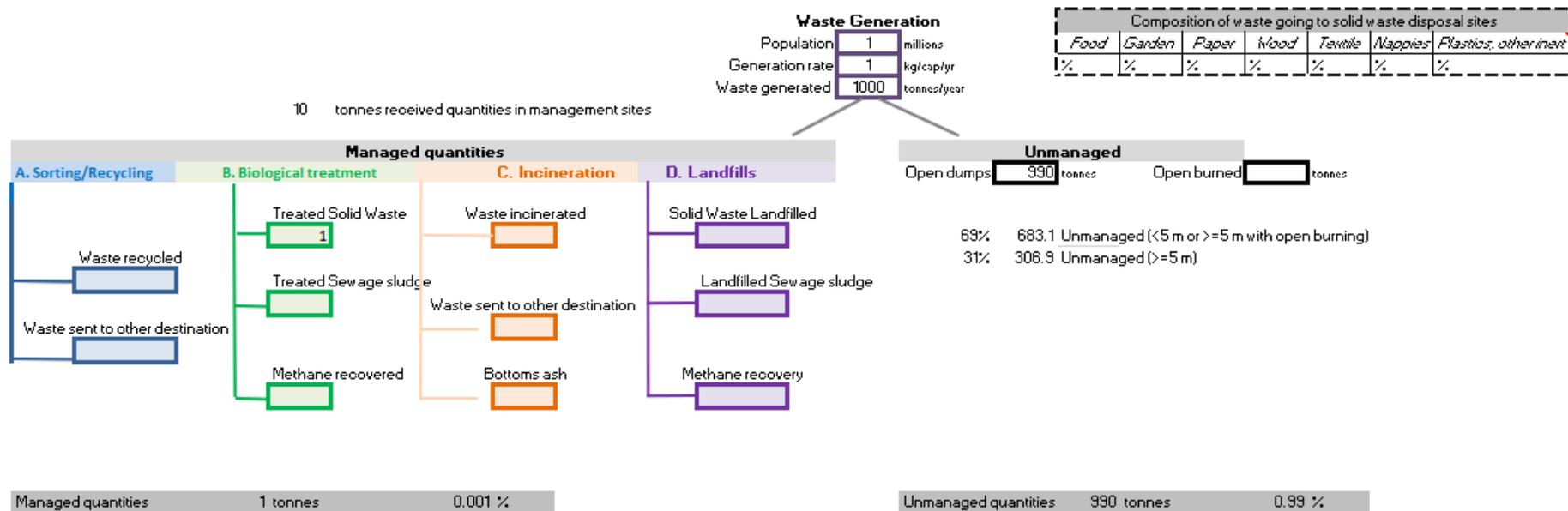
1) Please complete the following information regarding the facility

Name of facility:	
Name of operator:	
Type of waste management facility: <i>Please tick relevant box(es)</i>	<i>Sorting and recycling facility</i>
	<i>Composting/Biological treatment</i>
	<i>Incinerator</i>
	<i>Landfill</i>
Financed by: <i>Please tick relevant box(es)</i>	<i>CDR</i>
	<i>OMSAR</i>
	<i>Municipality</i>
	<i>Union of Municipality</i>
	<i>Private</i>
	<i>Other:</i>
Location	
Contact person name at facility	
Contact details	

2) Please indicate in the table which activity(ies) your facility undertakes, and complete the relevant tabs in order

Activity	Yes / No	If yes, please complete tab:
Sort and/or recycle waste		A_Sort_Recycle
Biological treats solid waste		B_Biological Treatment
Incinerate waste or fossil liquids		C_Incineration
Landfill waste		D_Landfills



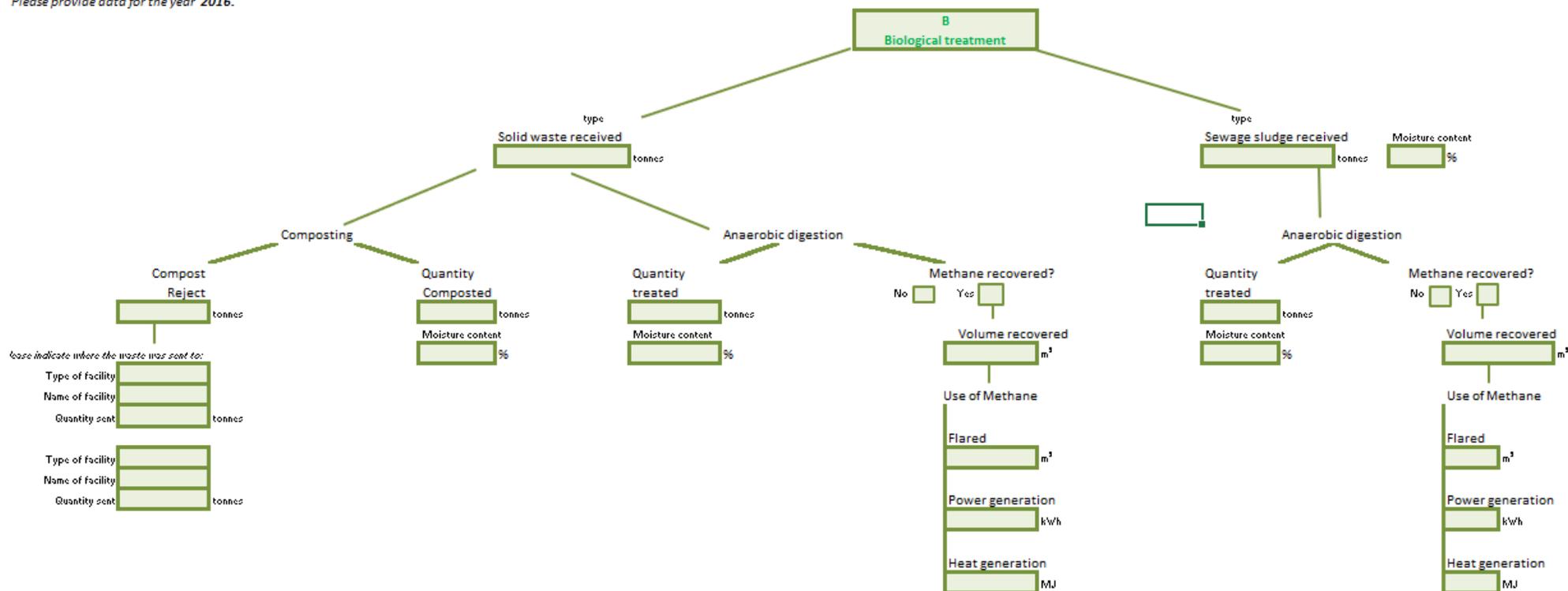


Please provide data for the year 2016.

A Sorting and Recycling Facility					
Waste quantity received tonnes					
Waste recycled tonnes		RDF sent to other destination		Waste sent to other destination tonnes	
<i>If available, break recyclables down into types</i>		<i>if available Please indicate where the waste was sent</i>		<i>if available Please indicate where the waste was sent to:</i>	
Paper	<input type="text"/> tonnes	Type of facility	<input type="text"/>	Type of facility	<input type="text"/>
Wood	<input type="text"/> tonnes	Name of facility	<input type="text"/>	Name of facility	<input type="text"/>
Textile	<input type="text"/> tonnes	Quantity sent	<input type="text"/> tonnes	Quantity sent	<input type="text"/> tonnes
Plastics	<input type="text"/> tonnes	Type of facility	<input type="text"/>	Type of facility	<input type="text"/>
Metals	<input type="text"/> tonnes	Name of facility	<input type="text"/>	Name of facility	<input type="text"/>
Other ¹	<input type="text"/> tonnes	Quantity sent	<input type="text"/> tonnes	Quantity sent	<input type="text"/> tonnes
		Type of facility	<input type="text"/>	Type of facility	<input type="text"/>
		Name of facility	<input type="text"/>	Name of facility	<input type="text"/>
		Quantity sent	<input type="text"/> tonnes	Quantity sent	<input type="text"/> tonnes

Comment box:
1. If other, please specify type here:

Please provide data for the year 2016.



Assumptions box

1. Assumes that all waste received is not industrial. If otherwise, please state so in the comment box
2. Assumes that all waste data is provided on a wet basis

Please provide data for the year 2016.

**C
Incineration**

C.1 Waste quantity received

tonnes

Waste incinerated

tonnes

Identified by source
If available, break down into types

Municipal	tonnes
Industrial Waste	tonnes
Sewage Sludge	tonnes
Hazardous Waste	tonnes
Clinical Waste	tonnes
Other	tonnes

Energy / Heat / Both produced?

No Yes

Energy generation

kWh

Heat generation

kWh

Waste sent to other destination

tonnes

Please indicate where the waste was sent to:

Type of facility	
Name of facility	
Quantity sent	tonnes
Type of facility	
Name of facility	
Quantity sent	tonnes
Type of facility	
Name of facility	
Quantity sent	tonnes

Bottom ash

tonnes

Fly ash

m3

C.2 Fossil liquid incineration?

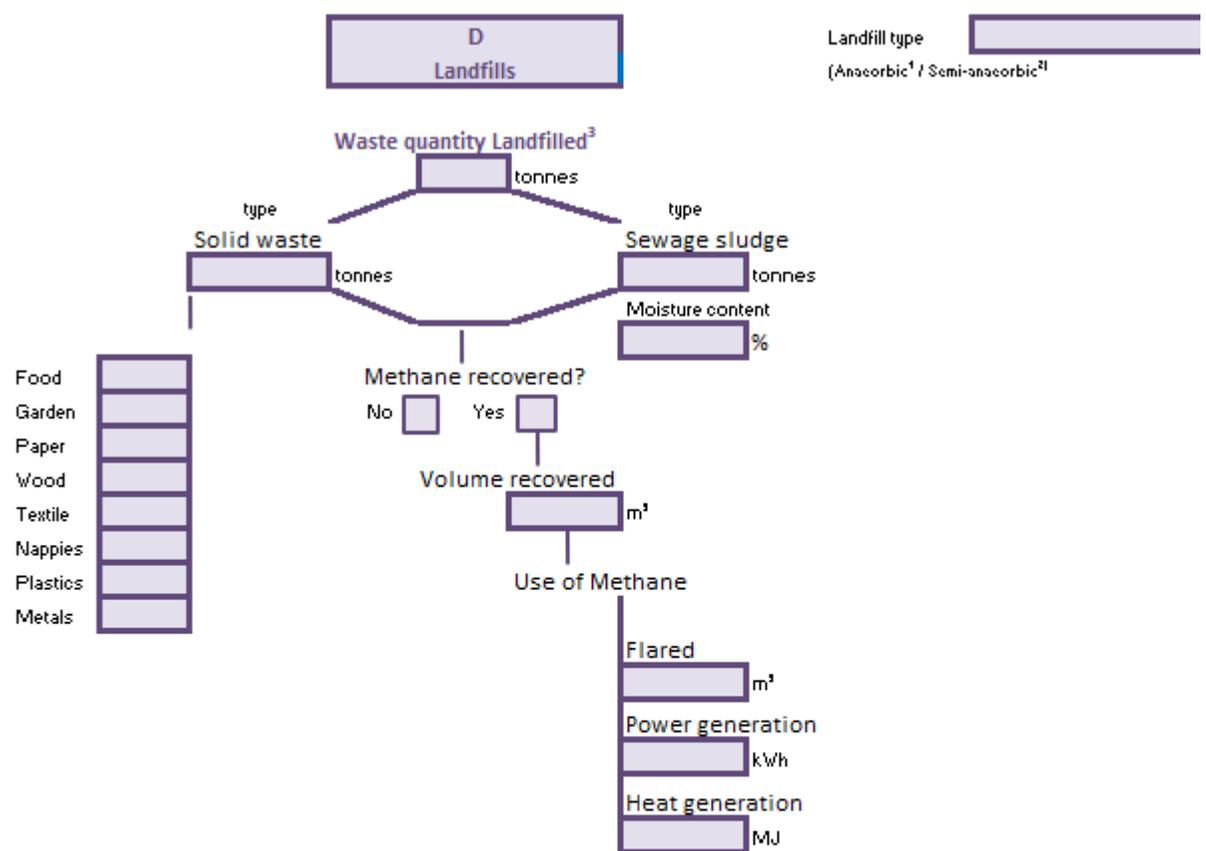
No Yes

Lubricants	tonnes
Solvents	tonnes
Waste oil	tonnes
Other (please specify)	tonnes

Fuel used for incineration

type of fuel	
tonnes	

Please provide data for the year 2016.



Definitions

1. 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.
2. 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.
3. This amount of waste is what is received at the door of the landfill. All other waste that was received by the facility and sorted should be included in tab A_Sort_Recycle

The end .

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