Republic of Lebanon

Lebanon's First Biennial Update Report

to the UN Framework Convention on Climate Change

Ministry of Environment
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Lebanon's First Biennial Update Report to the UNFCCC

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Foreword

Ministry of Environment

The submission of this First Biennial Update Report stems from the Government of Lebanon's decision to fully comply with the country's commitments under the United Nations Framework Convention on Climate Change. The firm decision to implement the various international environmental treaties ratified by the country is an integral part of the Government's environmental policy. This has driven the formulation of strategic guidelines in the area of climate change through the successful initiation of the climate change coordination activities, aiming at mainstreaming climate change in all sectoral policies and strategies. These arrangements also incorporate a program to regularly collect information needed to update the greenhouse gas inventory and report the national mitigation measures.

The Biennial Update Report is not only a diagnostic tool to assess the country´s present status in the area of climate change. It is also a tool on which decisions are based and the needs of developing countries to implement the commitments under the Convention are identified.

This Biennial Update Report is a direct expression of the will to update Lebanon's situation vis-à-vis climate change and to report on the various actions the country is planning and undertaking to reduce its greenhouse gas emissions. Thus, in order to reach these goals, the Ministry of Environment hopes to continue to have the financial support and technical assistance of the Global Environment Facility (GEF).

The Ministry of Environment hereby presents its First Biennial Update Report to the Convention, hoping that the information contained in this document will be useful and will contribute to achieve the objectives established in the country´s environmental policy.

Mohammad Al Mashnouk
Minister of Environment

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Acronyms

ABQUAR	Alleviating Barriers for Quarries Rehabilitation
AFDC	Association for Forests, Development and Conservation
ASK	Available Seat Kilometers
BIA	Beirut International Airport
BRT	Bus Rapid Transit
CA	Conservation Agriculture
CAS	Central Administration of Statistics
CCCU	Climate Change Coordination Unit
CCGT	Combined Cycle Gas Turbines
CDR	Council for Development and Reconstruction
CFL	Compact Fluorescent Lamp
CIMA	International Centre on Environmental Monitoring
CEDRO	Country Energy Efficiency and Renewable Energy Demonstration Project for the Recovery of Lebanon
CNRS	National Council for Scientific Research
CoM	Council of Ministers
COP	Conference of Parties
DAR-IAURIF	Dar Al Handasah – Institut d'Aménagement et d'Urbanisme d'Ile de France
DGUP	Directorate General for Urban Planning
DO	Diesel Oil
DSS	Decision Support System
EEZ	Exclusive Economic Zones
EIA	Environmental Impact Assessment
EDL	Electricité du Liban
FAO	Food and Agriculture Organization
FMD	Food and Mouth Disease
FSRU	Floating Storage And Regasification Unit
GBA	Greater Beirut Area
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIS	Geographic Information System
GIZ	The Deutsche Gesellschaft für Internationale Zusammenarbeit
GoL	Government of Lebanon
GPG	Good Practice Guidance
GPS	Global Positioning System
GWP	Global Warming Potential
HCW	Health Care Waste
HDV	Heavy-Duty Vehicles
HFO	Heavy Fuel Oil
HPS	High Pressure Sodium
HRSG	Heat Recovery Steam Generators

IFAD	International Fund for Agricultural Development
IMC	Instituto Mediterraneo Di Certificazione
INC	Initial National Communication
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
KP	Kyoto Protocol
LAF	Lebanese Army Forces
LARI	Lebanese Agricultural Research Institute
LDV	Light-Duty Vehicles
LCEC	Lebanese Center for Energy Conservation
LECB	Low Emission Capacity Building
LED	Light Emitting Diode
LIBNOR	Lebanese Standards Institution
LPG	Liquefied Petroleum Gas
LNG	Liquefied Natural Gas
LRF	Lebanon Recovery Fund
LRI	Lebanese Reforestation Initiative
LSD	Lumpy Skin Disease
LULUCF	Land Use, Land Use Change and Forestry
MEA	Middle East Airlines
MMS	Manure Management System
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MoEW	Ministry of Energy and Water
MoI	Ministry of Industry
MoIM	Ministry of Interior and Municipalities
MoPWT	Ministry of Public Works and Transport
MRV	Measuring, Reporting and Verifying
MSW	Municipal Solid Waste
NAMA	Nationally Appropriate Mitigation Action
NEEAP	National Energy Efficiency Action Plan
NEEREA	National Energy Efficiency and Renewable Energy Action
NCE	National Council for the Environment
NG	Natural Gas
NGO	Non-Governmental Organization
NIMBY	Not In My Back Yard
NMVOCs	Non-Methane Volatile Organic Compounds
NORAD	Norwegian Agency for Development Cooperation
NRP	National Reforestation Plan
PC	Passenger Cars
PEER	Partnerships for Enhanced Engagement in Research
PRP	Pasture Range and Paddock
PV	Photovoltaics

QA/QC	Quality Assurance/Quality Control
RISICO	RISchio Icendi e COordinamento
SLM	Sustainable Land Management
SNC	Second National Communication
SRS	Schedules Reference Service
SWH	Solar Water Heaters
TEU	Total Equivalent Unit
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USFS	United States Forest Service
WtE	Waste to Energy
WUI	Wildland-Urban Interface
WWE	Water and Wastewater Establishment
WWF	World Wide Fund for Nature
WWTP	Wastewater Treatment Plant

Executive Summary

National circumstances

Lebanon is located on the eastern basin of the Mediterranean Sea with a surface area of 10,452 km^2, characterized by mostly mountainous areas. The country's population is estimated to be 5,102,830 in 2011, including foreign workers and Palestinian refugees. Around 90% of the population resides in an urban environment, most of them concentrated in the biggest cities of the country along the coastal area.

Lebanon has a Mediterranean-type climate characterized by hot and dry summers (June to September) and cool and rainy winters (December to mid-March), with an average temperature of 15°C. The mean annual rainfall on the coast ranges between 700 and 1,000 mm.

Lebanon has a free market economy, with the costs of most goods and services determined mainly by supply and demand. The Government of Lebanon supports private investment, and public ownership has generally been limited to infrastructure and utilities. Current Gross Domestic Product (GDP) increased from USD 38 billion in 2010 to an estimated USD 47.5 billion in 2014. The largest sector in Lebanon is commercial trade accounting for 16% in 2011, followed by real estate at 14%. The sector with the lowest contributing share to GDP is the agriculture, forestry and fishing sector at 4% in 2011. Lebanon imports more than it exports and is largely dependent on imports for food and fuel. Due to the dependence on imports and services (including banking and tourism), economic productivity is highly influenced by regional and international shocks. Since 2009, the Lebanese economy has witnessed a reduction in growth due to political and security uncertainties. This economic decline has been accelerated by the Syrian crisis and refugee influx, which have had a negative impact on economic growth and service provision (ACAPS, 2013).

Lebanon is a sovereign state with a centralized political and administrative structure. The decision-making involves the Lebanese Parliament (128 seats) and the Council of Ministers (30 seats) which enacts regulations in the form of decisions and decrees. The Environmental Protection Law (law no. 444/2002) is the overarching legal instrument for environmental protection and management in Lebanon and the National Council for the Environment (NCE) chaired by the Ministry of Environment is the body responsible for providing environmental policy and planning. The Climate Change Coordination Unit (CCCU) serves as a technical advisory unit to the NCE.

Greenhouse gas inventory for 2011

The inventory of greenhouse gases in this report covers the year 2011. It has been compiled in line with the United Nations Framework Convention on Climate Change (UNFCCC) Biennial Update Reporting Guidelines for Parties not included in Annex I to the Convention, COP decision 2/CP.17. Emissions were calculated using the Intergovernmental Panel on Climate Change (IPCC) methodology, based on the reference manual of the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, the 2003 IPCC Good Practice Guidance for Land-Use, Land-Use Change and Forestry, and the 2000 Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. The database was built using Non-Annex I Inventory Software (NAAIS).

Lebanon's total gross emissions of CO_2eq. amounted to 24,652 Gg CO_2eq. 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 with 74% of Greenhouse Gas (GHG) emissions, followed by the waste sector (11%) and industrial processes (10%). CO_2 removals from the land-use, land-use change and forestry category amounted to 3,369.85 Gg CO_2, bringing Lebanon's net emissions down to 21,283 Gg CO_2eq.

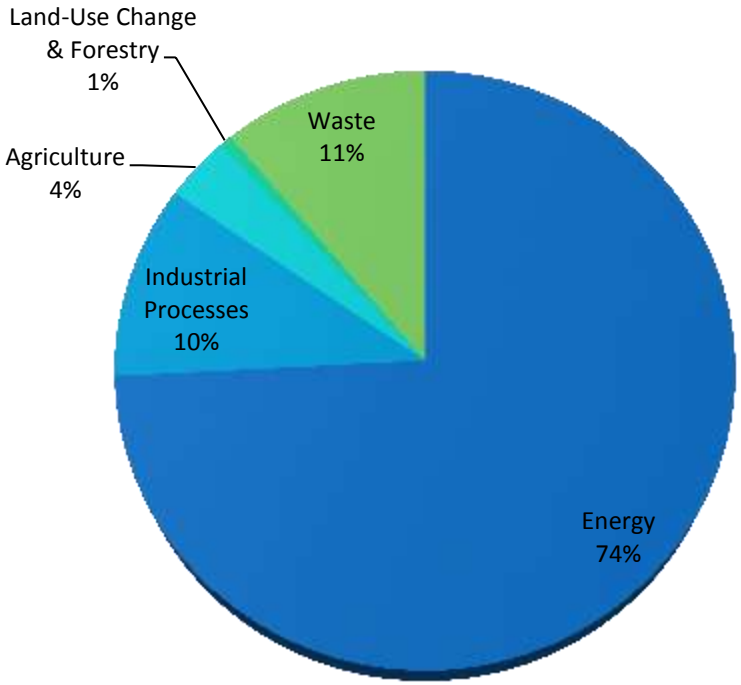

Figure i: Breakdown of gross GHG emissions subcategories for 2011

Climate change mitigation

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. The implementation of mitigation measures have induced an estimated 1,084,829 tonnes CO_2eq. abatement for the period 2005-2012, with Land-Use, Land-Use Change and Forestry (LULUCF) being the main source of these emission reductions or avoided emissions. If the described activities in Table I are well sustained, it is expected to have a minimum of 226,710 tonnes CO_2eq. reduction per year. This does not take into account the implementation of other additional planned activities across sectors.

Table i : Summary of mitigation activities for the period 2005-2012

Sector	Activity	Achieved outcome	Estimated reduction of GHG emissions ($t CO_2eq.$)	Yearly emission reduction ($t CO_2eq./year$)
Energy	Installation of Photovoltaics (PV)	Total of 1,936 kWp of capacity installed Annual savings of 2,877.12 MWh	5,046 for the period 2010 - 2012	1,682
Energy	Installation of Solar Water Heaters (SWH)	Total of 126,000 liters and 1,800m^2 installed	7,960 for the period 2005-2012	995
Energy	Light Emitting Diode (LED) street lighting	Annual savings of 10,965 MWh	7,434 for 2012	7,434
Energy	Mircowind and microwind-PV	16 kWp of capacity installed Annual savings of 23.77 MWh	36 for the period 2010-2012	12
Energy	Replacement of incandescent lamps with Compact Fluorescent Lamp (CFL)	3,025,000 incandescent lamps replaced in 1,415,000 households across Lebanon.	90,036 per year for 2012	90,036
Energy	Energy saving measures implemented - self-financed by the private sector	184,700 liters of SWH capacity installed 20,440 MWh saved every year from energy efficiency measures	152,200 for the period 2005-2012	19,025
Agriculture	Applying Conservation Agriculture (CA)	1,800 ha of rain-fed barley and wheat filed converted.	-	-
Agriculture	Improvement of cattle production	Milk production increased by 30% hence, reducing of the size of the herd to produce same amount of milk.	577.5 for the period 2009-2011	192.5

Agriculture	Recovery and rehabilitation of the dairy sector in Bekaa and Hermel	Milk production increased by 30% hence, reducing of the size of the herd to produce same amount of milk.	12,389 for the period 2009-2012	3,097.25
Agriculture	Composting of dairy manure	500 to 800 tonnes of compost produced every year.	3,060 for the period 2010-2012	1,020
Agriculture	Organic agriculture	Fields using organic agriculture increased by 300 hectares.	-	-
LULUCF	Reforestation activities	2,414 ha of reforested land	19,640 for the period 2009-2012	4,910
LULUCF	Forest fire management	50% of forest fires suppressed between 2009-2012 40% of forest fires suppressed between 2010-2012 20% of forest fires suppressed in 2012	786,450 for the period 2005-2012	98,306.25
Total known GHG emissions reduced during 2005-2012			1,084,829	
Yearly GHG emissions expected from sustaining the implementation of these activities				226,710

Institutional arrangements and Measuring, Reporting and Verification system

The Ministry of Environment is the institution responsible for the preparation of the BUR since it is the UNFCCC focal point of Lebanon. The preparation of this BUR was funded through Global Environment Facility's (GEF) enabling activity (USD 352,000) and was managed by the United Nations Development Programme in Lebanon. The Government of Lebanon through the Ministry of Environment provided in kind support for the project (USD 50,000) in order to realize this enabling activity.

The Ministry of Environment is in the process of designing a national-level Measuring, Reporting and Verifying (MRV) system that will provide a sustainable and structured data collection, maintenance, archiving and reporting processes. The MRV system is based on introducing new incentives and teaming up with the private sector through the issuance of the Minister of Environment's decision 99/1 (2013) to encourage private institutions to report their greenhouse gas emissions on an annual basis. It also builds on existing reporting procedures established at the Ministries of environment, industry and finance.

Lebanon has not yet presented any Nationally Appropriate Mitigation Action (NAMA) to the UNFCCC but has established a mechanism for preparing and approving NAMAs. The Ministry of Environment was appointed by the Council of Ministers (CoM) as the official national coordinator for NAMAs in Lebanon and in 2014, Decision 196/1 was issued, establishing and officialising a NAMA mechanism. A series of workshops and consultation meetings with stakeholders have been conducted and 6 NAMA ideas were prioritized in the energy and waste sectors. Currently, the Ministry of Environment is developing 2 NAMAs– one to transform waste into energy and another to promote fuel efficient and hybrid vehicle- through the United Nations Development Programme (UNDP) Low Emission Capacity Building (LECB) Programme which will be complete by 2016. In addition, the Ministry of Agriculture has started developing a forestry NAMA, to be completed by 2015.

Lebanon benefits from limited financial support (grants and loans) from various international donor agencies and foreign governments for the inception and implementation of climate change related projects. It is estimated that a total of 264 mitigation and adaptation projects have been implemented since 2005 in Lebanon, among which only 40 are directly linked to climate change (i.e. climate change is explicitly mentioned in the project's goal) and most of the activities are targeted for implementation of actions and interventions while a smaller fraction is targeted to research and capacity building.

As for the support received, it is estimated that USD 142 million have been invested in Lebanon for climate change related activities among which only USD 30 million for principal climate change projects. Top donors include the European Union, United States Agency for International Development (USAID) and the GEF and most of the funding is directed to the government through specific ministries and governmental institutions (Figure ii).

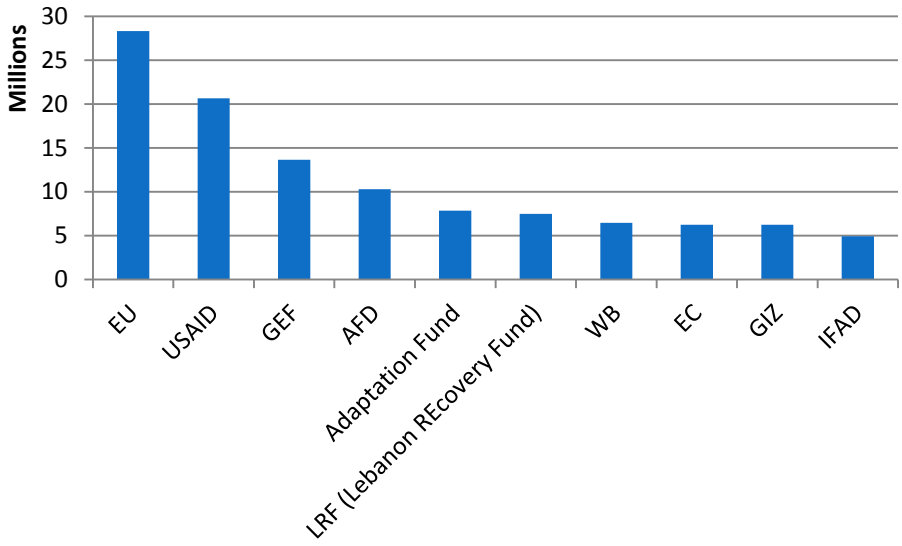

Figure ii: Top donors in climate change activities in Lebanon

There is no continuous tracking and updating of climate change related projects and budgets across stakeholders. Therefore, the establishment of a permanent climate change and MRV unit to better assess the progress and the gaps of national projects is crucial for the grounding of any MRV system. Such a unit would be responsible on looking exclusively at climate related activities and monitoring and evaluating the work of a wide range of national stakeholders, allowing a better understanding of common objectives across institutions and prioritizing effective climate change policy actions.

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

Numerous constraints and gaps still exist for Lebanon to report to the required standards and frequency to the UNFCCC. Constraint removal and filling of gaps will be possible in the medium and longer term with continuous national efforts and sustained support from bilateral and multilateral partners and donor agencies.

The main challenges faced in the preparation of the GHG inventory are still the same since the preparation of the country's first inventory in 1994 and are mainly related to unavailability, inaccessibility and inconsistency of activity data and emission factors. New challenges have arisen from the collection and consolidation of information related to existing mitigation actions and are mainly related to lack of reporting and coordination between institutions working directly or indirectly on climate change and the difficulty in quantifying the emission reduction achieved by the implementation of each action.

Lebanon has received support related to the preparation of the BUR mainly in the area of capacity building for individuals and institutions whose experts were trained on the preparation of GHG inventories. Capacity building activities were usually organized by international organizations through regional projects (Climasouth, LECB project, etc.) or by the secretariat of the UNFCCC. However, capacity to prepare the BUR still needs to be strengthened due to the fact that the BUR is a new requirement and the guidelines on its preparation are not very explicit.

Other types of support to tackle remaining technical and institutional constraints are very limited. The UNDP Low Emission Capacity Building project is supporting the Ministry of Environment to develop a national GHG inventory system and an MRV system, however, progress is slow and institutional arrangements take time given the unstable political situation of the country. As a result, Lebanon still does not have a clearly defined system for data collection and processing, quality assurance and control, or a reporting and monitoring system. Many initiatives have been established, however proper legal regulations that would fully define competences and responsibilities in this area are needed.

Direct financial support related to the preparation of the BUR is not sufficient to develop both a GHG inventory and mitigation action plan up to the standards required by the UNFCCC. The lack of funds impels the project management team to cut on expenses and eliminates any opportunity to undertake surveys or in-depth studies to generate new sectoral data. Therefore, there is an urgent need to increase the funds available for countries to prepare their BURs and encourage the initiation of new activities that aim at improving the quality of the report.

In addition, the discontinuity of funds threatens the sustainability of the team involved in the preparation of the BUR and increases the risk of losing the momentum and technical know-how that was amassed throughout the process. A permanent climate change and MRV unit is needed to ensure timely reporting that is not project bound and to put in place a sustainable flow of reliable data that meets UNFCCC requirements with solid institutional and legal arrangements.

1 National circumstances

1.1 Government structure

Since the 1990s, Lebanon has been witnessing a significant growth in environmental governance and related policies and institutions.

a. The Parliament and the Parliamentarian Committee for Environment (legislative level)

Lebanon's legislative body, represented by the Lebanese Parliament (128 seats), is organized into specialized committees. The Committee for Environment has 12 permanent Members of Parliament. The Committee meets at irregular intervals to discuss and review draft legislation and issues related to the environment, and to oversee the work of the executive body including contract decisions and public expenditure in green sectors. Discussion issues have included inter-alia the need to upscale the Ministry of Environment's (MoE) resources, air pollution from the transport sector, solid waste disposal sites, road safety, forest fires, water bodies pollution etc.

The Environmental Protection Law (law no. 444/2002) is the overarching legal instrument for environmental protection and management in Lebanon. It revolves around 11 main environmental principles:

- Precaution (cleaner production techniques)
- Prevention (best available technologies)
- Polluter-Pays-Principle (polluters pay for pollution prevention and control)
- Biodiversity conservation (in all economic activities)
- Prevention of natural resources degradation
- Public participation (free access to information and disclosure)
- Cooperation between central government, local authorities, and citizens
- Recognition of local mores and customs in rural areas
- Environmental monitoring (pollution sources and pollution abatement systems)
- Economic incentives to encourage compliance and pollution control
- Environmental Impact Assessment (EIA) process to control and mitigate environmental degradation

With respect to climate change, apart from law 359/1994 and law 738/2006 relating to the ratification of the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol (KP) respectively, no major legislation directly addresses climate change in Lebanon. However, a number of regulations have addressed issues that could be linked to climate change, such as the reduction of air pollution from transport (law 341/2001), the reduction of energy import by developing local energy including renewable energies (Council of Ministers, decision no. 13/2004), energy efficiency standards and labels, or other decisions relating to the ratification of conventions such as the United Nations (UN) Convention on Biodiversity or the UN Convention to Combat Desertification. Additionally, draft laws on the protection of air quality and on energy efficiency are currently being reviewed by the Council of Ministers (CoM) prior to enactment. Once issued, they will positively reflect on Greenhouse Gas (GHG) emissions in Lebanon.

b. The Council of Ministers (executive level)

Headed by the Presidency of the Council of Ministers, it enacts regulations in the form of decisions and decrees.

The Ministry of Environment

The mandate of the MoE, established by law 216/1993 and amended by law 690/2005, requires close coordination with many other relevant ministries, and public and private sector groups (environmental inspection and enforcement, climate change adaptation, sustainable management of natural resources, continuous monitoring of air quality, promotion of hazardous and non-hazardous waste management etc.).

MoE staff's size (around 60 employees) is still far below the prescribed staff size stipulated in Decree 2275/2009 (182 full-time employees). Human resources at MoE are bolstered by cooperation projects with international development partners.

Climate change issues fall under the mandate of the MoE which is the main national coordinator and the UNFCCC focal point.

The National Council for the Environment

In addition, the MoE is a member of several intergovernmental councils such as the Higher Council of Urban Planning (member), the National Council for Quarries (chaired by MoE), the Higher Council for Hunting (also chaired by MoE) and the Lebanese Standards Institution (LIBNOR).

The council with probably the most comprehensive mandate is the National Council for the Environment (NCE) (Decree 8157/2012), also chaired by the MoE. The NCE is made of 14 members representing 7 ministries (the Ministry of Environment; and the ministries of Finance, Interior and Municipalities, Agriculture, Public Works and Transport, Energy and Water, and Industry) and 7 non-public entities (Order of Physicians, Order of Engineers and Architects, The Bar Association, Association of Banks, Association of Insurance Companies, representative of Non-Governmental Organizations (NGOs), representative of the academic sector). The main role of the NCE, as stipulated by the decree, is to provide policy and planning suggestion in the following areas:

- Provision of input in policies and environmental strategies developed by the Ministry of Environment;
- Integration of environmental policy concepts in all development sectors in order to achieve sustainable development;
- Incorporation of environmental concepts and guidelines in national plans;
- Follow-up of treaties and international conventions and protocols and regional environmental policy commensurate with the public and the needs of the country;
- Preparation of plans, programs and projects needed in order to comply with the obligations stipulated in the treaties and international conventions and protocols ratified by Lebanon;
- Enactment the work of the national environmental fund as stipulated in articles 8 to 11 of law 444/2002;
- Development of financial incentives to facilitate environmental compliance by the polluting sectors.

The National Climate Change Coordination Unit (CCCU)

The CCCU serves as a technical advisory unit to the NCE. It is composed of 40 representatives from government agencies, NGOs, academic institutions, regional and international organizations that deal directly or indirectly with climate change. The CCCU's main role is to strategically align all national mitigation and adaptation activities by coordinating and bringing them under the NCE. Technically, this means that the CCCU actively works on:

- Mainstreaming climate change into national and sectoral development plans;

- Acting as a platform for exchange of information on project planning and implementation, existing institutional channels and on data needed to compile greenhouse gas inventories;
- Increasing Lebanon's engagement in UNFCCC and KP negotiations through ensuring endorsement by all stakeholders;
- Enhancing decision makers and general public's awareness and capacities related to climate change;
- Maximizing benefit from international climate change funding opportunities through sound allocation of funds, better communication and coordination, and avoidance of duplication of tasks;
- Pushing the climate change agenda on a national level.

1.2 Population profile

Lebanon's population is estimated to be 5,102,830 in 2011, including foreign workers and Palestinian refugees. With a surface area of 10,452 km^2, Lebanon's population density is high, with around 488 person/km^2. Around 90% of the population resided in an urban environment in 2011, most of them concentrated in the biggest cities of the country along the coastal area (ACAPS, 2013).

1.3 Geographic profile

Lebanon is located on the eastern basin of the Mediterranean Seaand is characterized by mostly mountainous areas constituted of the following parts (Walley, 2001):

- A narrow coastal plain composed of 2 plains, one in the north (Aakar) and one in the south (Tyre) and a succession of little narrow plains separated by rocky headlands in the center.
- The Mount Lebanon chain with an average elevation of about 2,200 m. Cut by deep canyons, and composed essentially of Jurassic thick carbonate sediments, the northern part of the chain is the higher region.
- The Anti Lebanon chain - subdivided into two massives: Talaat Moussa (2,629 m) in the north and Jabal el Sheikh or the Mount Hermon (2,814 m) in the south.
- The Bekaa valley - a flat basin with a length of about 120 km, located between the Mount Lebanon and the Anti Lebanon chains. Its elevation averages at 900 m, peaking at 1,000 m at its center.

Figure 1: Geographical location of Lebanon

1.4 Climate profile

Lebanon has a Mediterranean-type climate characterized by hot and dry summers (June to September) and cool and rainy winters (December to mid-March). Spring and autumn are warm and pleasant. The average annual temperature is 15˚C.

Along the coast, summers are hot and humid with temperatures crossing 35°C in August. But due to the moderating effect of the sea, the daily temperature range is narrower than it is inland. January is the coldest month, with temperatures around 5 to 10°C. The mean annual rainfall on the coast ranges between 700 and 1,000 mm (Asmar, 2011). About 70% of the average rainfall in the country falls between November and March and is concentrated during only a few days of the rainy season, falling in heavy cloudbursts or violent storms. Rainfall in inland Lebanon is higher with snow in the mountains (1,600 mm according to Asmar, 2011) than that along the coast. The amount of rainfall varies greatly from year to year (Karmalkar et. al, 2012).

1.5 Economic profile

Lebanon has a free market economy, with the costs of most goods and services determined mainly by supply and demand. The Government of Lebanon (GoL) supports private investment, and public ownership has generally been limited to infrastructure and utilities. The largest sector in Lebanon is commercial trade accounting for 16% of Gross Domestic Product (GDP) in 2011, followed by real estate at 14%. The sector with the lowest contributing share to GDP is the agriculture, forestry & fishing sector (at 4% in 2011). Lebanon imports more than it exports and is largely dependent on imports for food and fuel. Due to the dependence on imports and services (including banking and tourism), economic productivity is highly influenced by regional and international shocks. Since 2009, the Lebanese economy has witnessed a reduction in growth due to political and security uncertainties. This economic decline has been accelerated by the Syrian crisis and refugee influx, which have had a negative impact on economic growth and service provision (ACAPS, 2013).

Current GDP increased from USD 38 billion in 2010 to an estimated USD 47.5 billion in 2014, and is forecasted to increase to USD 65.7 billion in 2019. However, GDP growth is expected to decline from an average of 7.3% in 2008-2011 to 2.1% in 2012-2015 and 4% in 2016-2019 (IMF, 2014).

1.6 Energy

The Lebanese electricity sector is run by the Electricité du Liban (EDL), an autonomous state-owned (and therefore, a public monopoly) power utility that generates, transmits, and distributes electricity to all Lebanese territories. Most of the electricity is generated through 7 major thermal power plants and 3.5–4.5% through hydropower plants. When circumstances permit, direct power is purchased from Syria and Egypt (around 7 to 11%).

Almost all of Lebanon's primary energy requirements are imported, since the country does not have any indigenous energy sources with the exception of a small share of hydropower. Out of the 7 thermal power plants in Lebanon, 3 operate on Heavy Fuel Oil (HFO) and 4 on gas diesel oil. The Deir Aamar and Zahrani power plants use the Combined Cycle Gas Turbines (CCGT) and can therefore operate on Natural Gas (NG) once available. Currently, there is no supply of natural gas to Lebanon although a gas pipeline has been connected and a natural gas station has been constructed at the Tripoli installations. Natural gas was only imported for one year during 2010. Recent studies and surveys conducted in the deep offshore Exclusive Economic Zones (EEZ) have shown very promising seismic conditions for hydrocarbon deposits, mainly natural gas with some oil. As a result of that, Lebanon had already started the development phase for the exploration and production era which is expected to have a positive economic impact on the country.

Although available capacity reached 2,670 MW, actual availability of electricity has varied from as low as 1500 MW to a maximum of 2,000 MW due to several shortcomings. In the case of the thermal

plants, these include plant failures and rehabilitation work, fuel supply and interruption of imported electricity from both Syria and Egypt. In the case of hydropower, rainfall variations, and subsequently water levels variations as well (Kabakian et al., 2015). In addition, the transmission and distribution networks face 3 types of problems: technical losses in the range of 15%, non-technical losses (e.g., theft) amounting to 20% and uncollected bills in the range of 5%.

Due to these shortages, power cuts average at around 6 hours/day at the country level, with rationing hours unevenly distributed between cities. The energy not supplied by public utilities is being supplied by privately owned generators. Self-generation plays an essential role in electricity supply and demand in Lebanon, and is estimated at 33% of total electricity demand (World Bank, 2009). This share has reached 37% in 2012 (Kabakian et al., 2015).

Given the current condition of electricity supply in Lebanon, the share of renewable energy is slowly but steadily increasing. The major contributor to the renewable energy mix in the country is hydropower, producing around 4.5% of the country's total energy production. In addition, Lebanon has a significant wind potential, especially in the north with wind speeds of 7-8 m/sec and an abundant solar resource with an average annual insolation of 1,800 – 2,000 kWh/m^2 (Table 1). Solar water heating is well established in the country. Although technologies for solar power generation are becoming cheaper and more competitive, they are still relatively expensive and are currently only used at the micro level and for specific applications like street lighting, water heating and other municipal use.

Table 1: Renewable energy capacity in Lebanon

	Potential Capacity (MW)	**Available Capacity (MWh)**
Wind	5,408	12,139,145
Solar Photovoltaics (PV)	109,547	182,662,073
Concentrated Solar Power (CSP)	8,065	18,274,000
Hydro (existing plants)	134	498,500
Hydro (potential plants)	371	1,370,823

Source| MoE/UNDP (2015)

1.7 Transportation

The Lebanese transport sector encompasses land, marine and air mobility subsectors.

Land transport

The land transport sector consists only of road-motorized vehicles, since no appropriate infrastructure for non-motorized vehicles exists (i.e. bicycle lanes, safe storage, and convenient and affordable bike rentals) and the entire rail network is currently derelict (Lebanon used to operate four rail lines: (1) Beirut-Damascus, (2) Naqoura-Tripoli, (3) Tripoli-Homs and (4) Rayak-Aleppo).
Road-motorized vehicles rely mainly on personal-owned Passenger Cars (PC). The 2012 vehicle fleet database shows a total of 1.58 million registered vehicles, with a distribution presented in Figure 2. The age distribution of PC (public and private) illustrated in Figure 3 reflects the old nature of the fleet, with 71% older than 10 years. Moreover, the engine distribution of the PC fleet in 2007 shows that the fleet is mostly inefficient, since 60% of the cars have engine displacements exceeding 2.0 liters, while only 8% have engines less than 1.4 liters (MoE/URC/GEF, 2012).

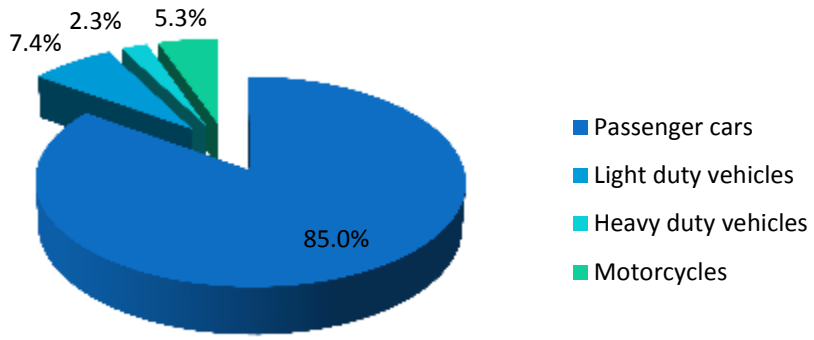

Figure 2: The 2012 vehicle fleet distribution in Lebanon per type of vehicle

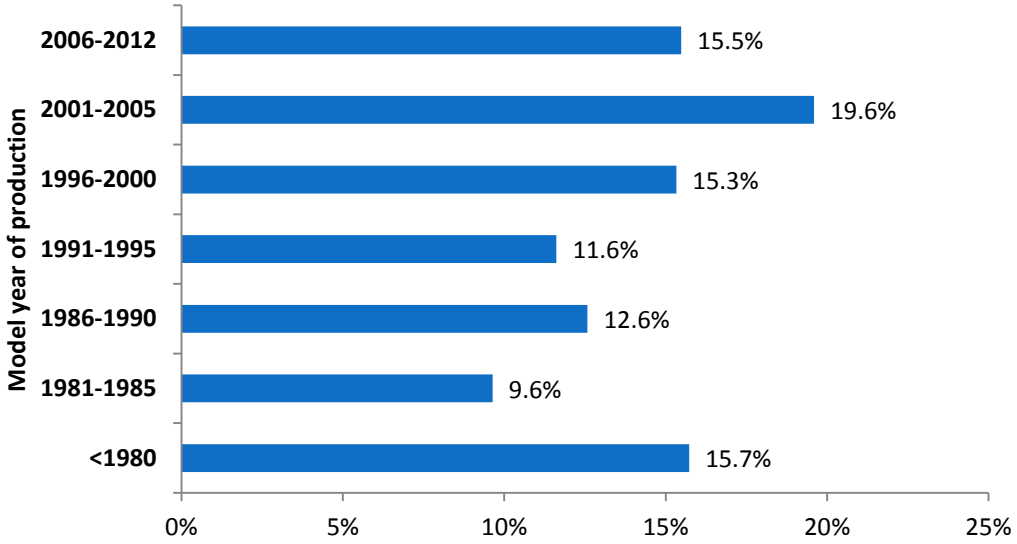

Figure 3: Vehicle percentage distribution per model year of production

Mass transport consists of public and private buses, minivans and exclusive- and shared-ride taxis, all operating on an ad-hoc basis without any coordination, resulting in very poor occupancy rates of about 1.2 passengers per vehicle for taxis, 6 for vans and 12 for buses (MoE/URC/GEF, 2012). In 2002, the mass transport market share in Greater Beirut Area (GBA) was 31%, split between modes as illustrated in Figure 4 (Baaj, 2002), clearly illustrating the level of underdevelopment of mass transportation in Lebanon. This limited share of the market continues today due to the impracticality, lack of safety and restricted reach of public transportation compared to the attractiveness of owning a private automobile, an alternative that is still promoted over mass transportation in Lebanon through bank loan facilities and affordable new and used car imports.

This reality is due in large part to the chaotic, inefficient and unreliable management of the transportation sector, preventing the modernization and growth of the system and allowing the market to be controlled by private operators. For example, the system is oversupplied with 50,000 taxi licenses (known as "red plates"), where an estimated 17,000 of these are illegally procured and operated, with a similar situation of poor forecasting and control of the number of shared taxis and minibuses relative to actual market demand.

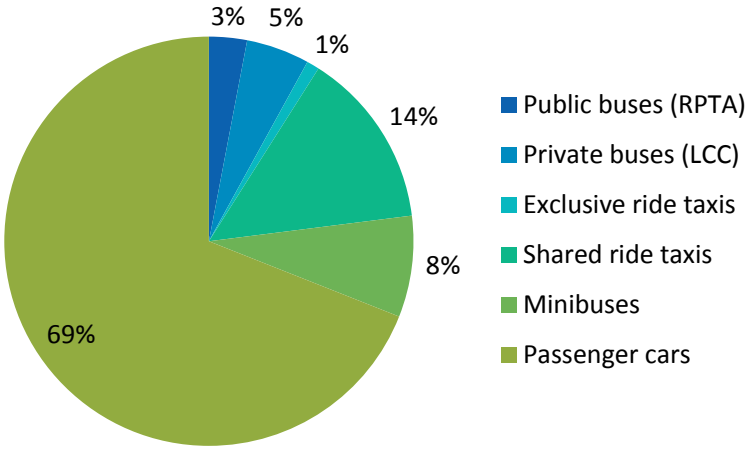

Figure 4: Market share of transport systems in GBA in 2002

Based on collected data from on-road measurements in the GBA with a Global Positioning System (GPS)-guided survey of typical driver habits, the driving patterns in 2011 can be characterized by a relatively low driving range with a high rate of congestion and frequent stops at short time intervals. In fact, it was found that 50% of trips have a distance lower than 5 km, 25% of stops are below 2 seconds and the total stop time per trip corresponds to more than 15% of travel time. Moreover, observed results reflect the continuous stop-and-go driving patterns, therefore resulting in the inefficient operation of internal combustion engines, and a high rate of fuel consumption and pollutant emissions as a result.

The main road transport legislations are law 341 (6-08-2001) and decree no. 7858/2002, banning the use of private and public cars of diesel engines starting from 15/6/2002, and the use of public buses of 16 to 24 passengers of diesel engines starting from 31-10-2002.

Aviation

Middle East Airlines (MEA) is the national air carrier of Lebanon and Beirut International Airport (BIA,) the only operational commercial airport in the country. In 2012, the number of flights at the BIA reached over 60,000 commercial flights with around 5.9 million incoming and outgoing passengers (BIA statistics, 2014). The BIA is designed to host a maximum of 16 million passengers per year by 2035.

MEA flies to 21 countries serving a total of 30 different airports with 62 departures daily. Data is based on Schedules Reference Service (SRS) Analyser database on 31 December 2013. It has a fleet consisting mainly of A320 and A330 that stands at 18 aircrafts operating at 68% capacity according to data on Available Seat Kilometers (ASK) and Total Revenue Passenger-Kilometers (Zouein, 2014).

The other remaining airports in Lebanon such as the Riyak and the Kleyaat airports are reserved for military services. Regarding domestic flights in Lebanon, they show very limited activity since aircrafts are of small propeller engine types, used only for training.

Marine transport

Legal harbors in Lebanon are limited to five: Beirut, Tripoli, Saida, Tyre and Jounieh. Beirut and Tripoli are the two largest commercial ports. In fact, the port of Beirut hosts around 78% of the incoming ships to Lebanon and the port of Tripoli hosts around 16% (CAS, 2014). The number of yearly incoming ships and oil tankers to Beirut port ranges between 2,000 and 2,400 ships, with a total capacity of around 700,000 containers Total Equivalent Unit (TEU) per year (Beirut port statistics, 2014). Moreover, Beirut port also observes transit traffic with an average value of 1.8 million tonnes

of goods per year. As for Tripoli, its port hosts around 350 to 450 yearly incoming container and cargo ships, and 50 to 90 oil tankers (Tripoli port statistics, 2014).

The fisheries host a fleet of around 2,860 boats with a yearly catch of around 9,000 tonnes, insufficient to cover the local fish consumption of 35,000 tonnes; consequently, 74% of the fish is imported. About 98% of the fleet is constituted of open woody boats with length less than 12 m (EastMed, 2012). The fleet is old (e.g. average age of 17 years at the port of Tyre) and spread over 44 harbors, most of which requiring major infrastructure maintenance intervention.

1.8 Industry

The industrial sector in Lebanon remains an important pillar of the economy contributing to roughly 7.2% of the country's GDP in 2011 although this rate was much higher in the nineties and was estimated to 12.5% in 1997. The Lebanese industrial establishments are considered as new industries. 61.7% of the 4,033 establishments surveyed were established between 1990 and 2007.

According to the Ministry of Industry (MoI) census conducted in 2007, the total industrial output for 4,033 industrial establishments (establishments employing more than 5 workers) reached USD 6.8 billion[1]. As such, the industrial sector productivity has significantly increased compared to 1998, whereby the industrial output was equivalent to USD 3.1 billion (for 5,082 industrial establishments employing more than 4 workers). This is a significant increase in productivity of the industrial sector as a whole reflected by the fact that the average value of output per enterprise has increased to USD 1,686,162 in 2007 compared to USD 542,326 in 1998.

The key industrial sectors in Lebanon are food products and beverages, fabricated metal products and other non-metallic mineral products. These constitute 50% of the economic activity of the industries in the country. Other sectors are also present including the chemical sector, furniture manufacturing and electrical machinery manufacturing. The distribution by sector is presented in Figure 5.

[1] Value of electricity generated by companies for their own consumption was equal to USD 192.3 million and represented 2.8% of the total output. This value is computed based on the cost of the fuel used to generate electricity and not on the market value of electricity. Enterprises generate electricity for their own production, and the latter is considered to be part of industrial output.

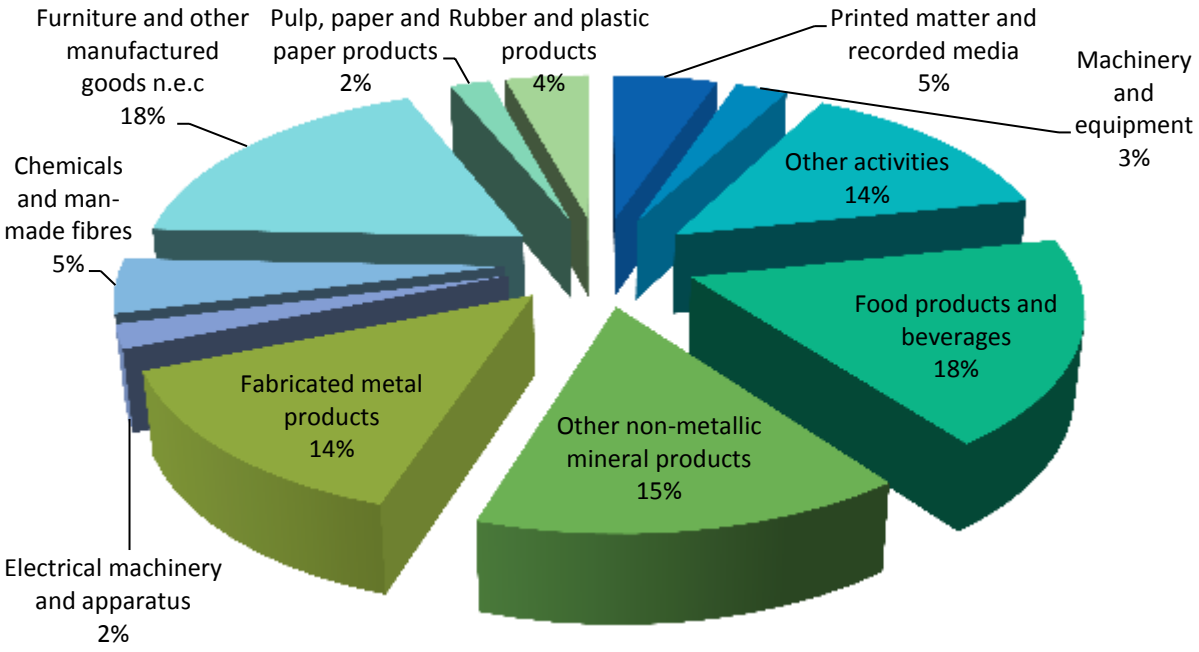

Figure 5: Distribution of industrial establishments by economic activity in 2007 in Lebanon

The industrial sector hosts large units in the rural and remote areas, mainly manufacturing activities using large surface areas for their operations. The largest industrial establishments are located out of the central Mohafaza of Beirut and Mount Lebanon, especially in North Lebanon and Bekaa.

The Ministry of Environment is responsible of environmental compliance of industrial establishments through the implementation of the Environmental Compliance Decree 8471/2012 and its related decisions (202/1, 203/1 & 271/1 - 2013). Depending on the size and type of each industrial establishment, water and air pollution abatement measures have to be undertaken to comply with the decree.

1.9 Waste

Solid waste management

The legal framework for the management of solid waste in Lebanon remains to be defined. A draft Law prepared by the MoE was endorsed by the CoM in 2012 and approved by the inter-parliamentary committee. The main chapters addressed in the proposed draft law include:

1. Provision of a legal and institutional framework of Integrated Solid Waste Management in Lebanon for protection of the environment.
2. Assignment of the responsibility of preparing strategies to a specific ministerial committee headed by the MoE.
3. Adoption of the "Polluter Pays Principle" and assignment of responsibilities of managing solid waste to the local authorities in general.
4. Provision of guidelines for the management of hazardous solid waste.
5. Provision of guidelines for financing solid waste management including cost recovery and incentives.
6. Provision of enforcement mechanisms.

On the other hand, the MoE, Council for Development and Reconstruction (CDR) and Ministry of Interior and Municipalities (MoIM) prepared a national solid waste management plan that was

submitted to the CoM in March 2013. This plan is based on the adoption of Waste to Energy (WtE) for the treatment of solid waste after conducting necessary sorting for recyclables and organic materials.

In 2014, the Council of Ministers agreed on the contracting services to build the infrastructure to generate power from the gas emitted from the Lebanon's main and launched the tendering procedures for private sector entities to contract sweeping, collection and treatment of solid waste (including separation, composting, energy recovery and landfilling) in five areas across Lebanon. Accordingly, the Ministry of Environment was assigned to undertake pilot studies for separation from the source and decentralized solid waste management, to prepare a strategic environment assessment and supervise the proper implementation of the solid waste management strategy.

Data on solid waste generation is not readily available 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. Furthermore, solid waste amounts are generally estimated based on population and generation rate per capita estimations and not on direct weighing and monitoring of collected solid waste from households and institutions. Surveys and assessment conducted for the years 1994 (El Fadel & Sbayti, 2000), 2006 (CDR, 2006), and 2010 (MoE, 2010) produced generation rates for these respective years. For other years, the per capita generation rates were computed by extrapolation as noted in Figure 6.

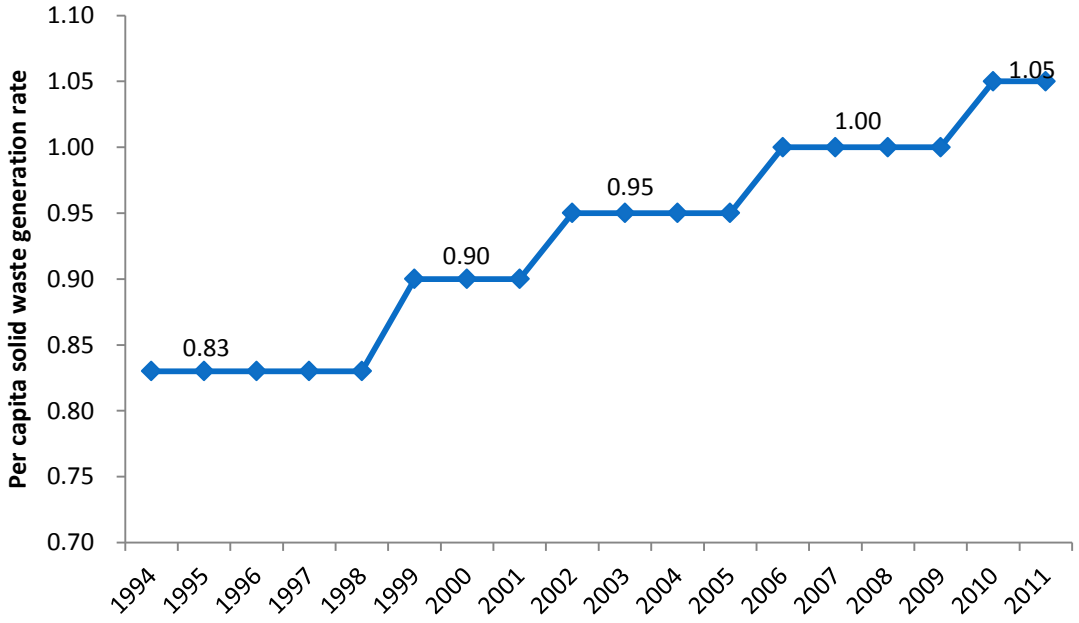

Figure 6: Per capita municipal solid waste generation rates for the years 1995-2011 in Lebanon

While solid waste generally refers to municipal, industrial and Health Care Waste (HCW), in Lebanon this segregation is generally inapplicable due to the absence of a well-defined legislation and more stringent controls. Accordingly, most of the industrial and hazardous wastes are being mixed with the municipal wastes. The disposal of health care waste is carried in the municipal waste bins, after being autoclaved where available and disposed of in landfills or dumpsites.

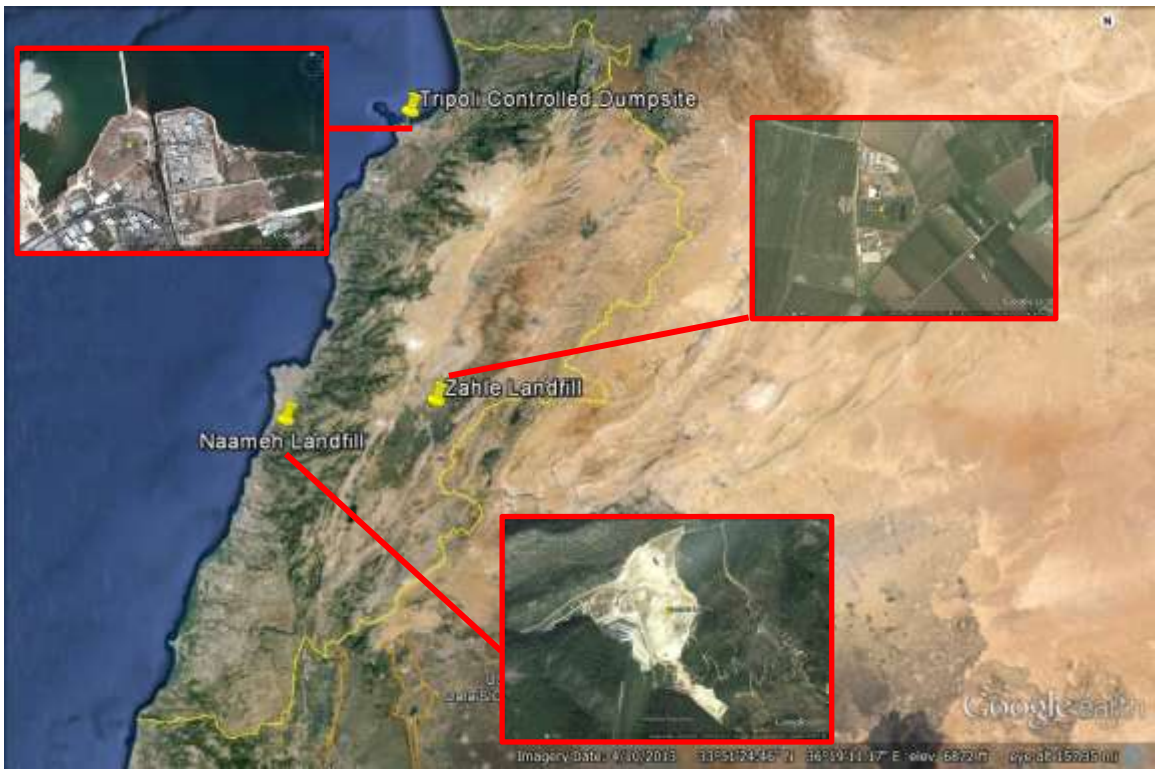

Figure 7: Distribution of solid waste disposal sites in Lebanon

Source| Google Earth

There are three main landfills in Lebanon namely the Naameh landfill, the Zahle landfill, and the Tripoli controlled dumpsite (Figure 7). These "official" solid waste disposal sites in Lebanon have been receiving since 1998 around 55% of the total generated solid waste in Lebanon as shown in Figure 8. The remaining portion of the generated solid waste in Lebanon is partially recycled/composted while the rest is being disposed in open dumpsites by the local authorities such as municipalities and/or Unions of Municipalities.

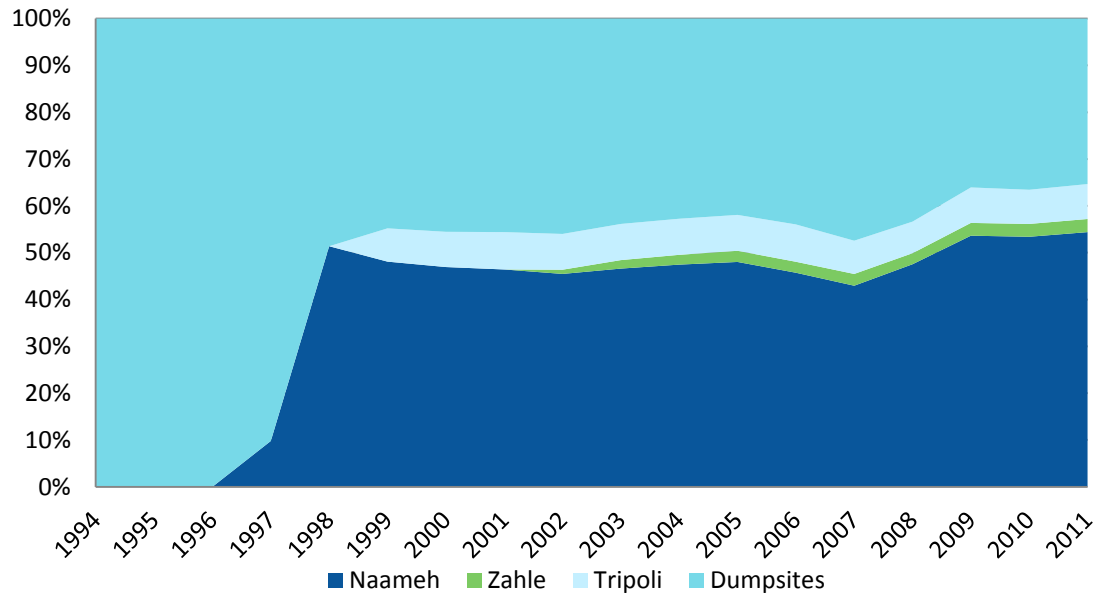

Figure 8: Evolution of solid waste final disposal in Lebanon (1994 – 2011)

The Naameh landfill was constructed in 1997 as an emergency to stop the open dumping of waste especially in the Normandy and Bourj Hammoud dumpsites. The Naameh landfill has been operational since then and has received some 10 million cubic tonnes of Municipal Solid Waste (MSW) after sorting and composting. The Naameh landfill is equipped with methane flaring systems and the quantities recovered can reach 4,000 times the levels of the remaining 2 sites (Figure 9).

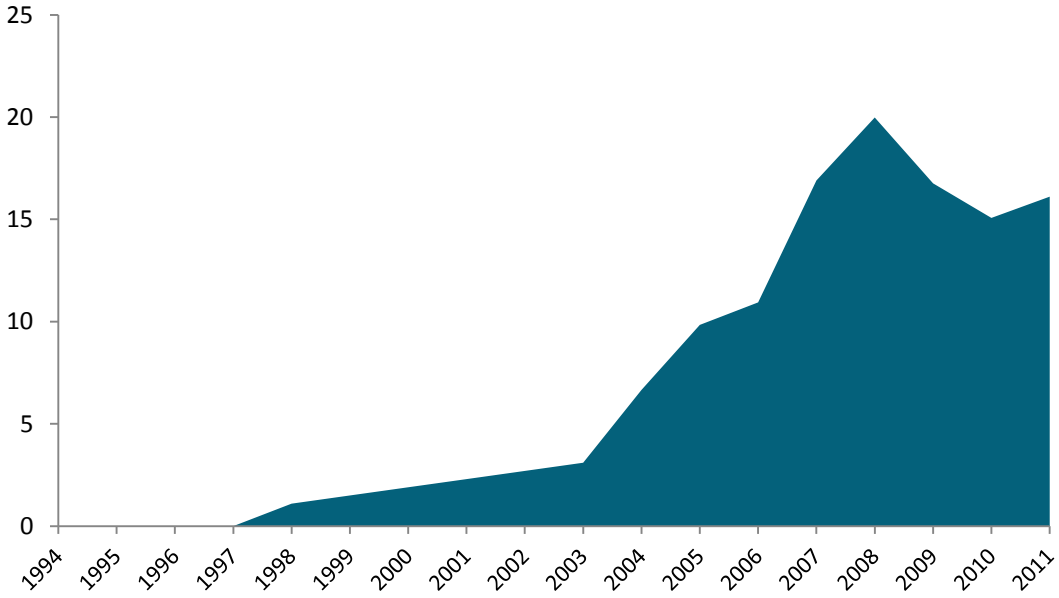

Figure 9: Quantity of recovered CH_4 from the Naameh landfill (Gg/year)

The Zahle landfill was opened in 2002 in the Bekaa valley in the Caza of Zahle and it was designed and built to receive 150 tonnes per day, serving 15 out of 29 municipalities in the Caza of Zahle. The landfill is complemented by a sorting facility since 2008 but no composting activities are taking place. As for methane recovery, one flaring unit is installed since 2003 where collected gas is directly flared on site. However, the quantity of gas flared is minimal as compared to the Naameh landfill and this is mainly due to the quantity of waste collected in Zahle which is less than 5 % of the waste collected in Beirut and Mount Lebanon (Figure 10).

The Tripoli controlled dumpsite is located on the Tripoli seafront and serves the city of Tripoli as well as the neighboring towns with an estimated population of 400,000 inhabitants. The dumpsite is annexed by a sorting facility however it is not operational yet. Methane is recovered and flared by one flaring unit since 2000. Similar to the Zahle dumpsite, the quantity of gas flared is minimal as compared to the Naameh landfill and this mainly due to the quantity of waste collected in Tripoli which is less than 15 % of the waste collected in Beirut and Mount Lebanon (Figure 10).

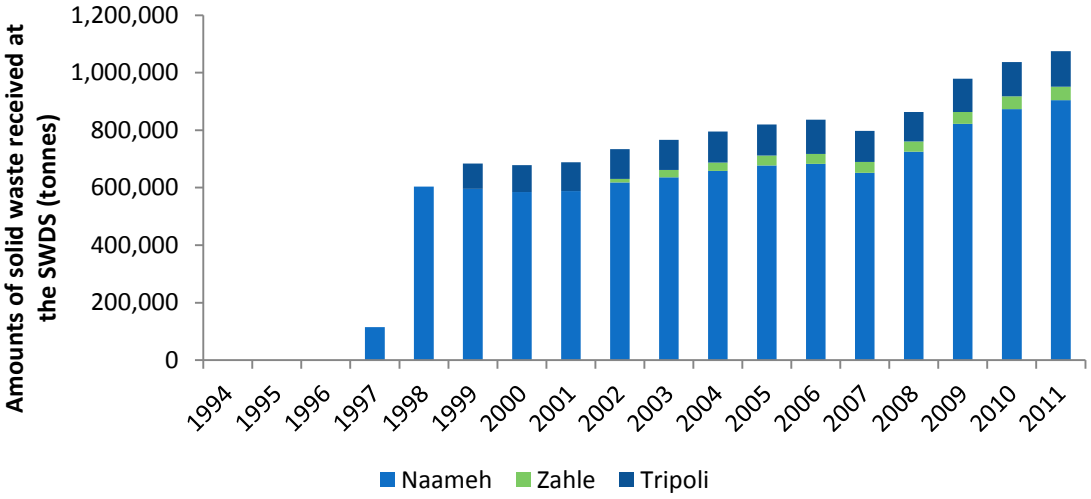

Figure 10: Evolution of the amounts of solid waste deposited at the Naameh, Tripoli, and Zahleh disposal sites from 1997 to 2011

Open dumping sites in Lebanon

Open dumping and open burning of MSW are still practiced in Lebanon. Around 670 dumpsites have been reported in 2010 (MoE/UNDP/ELARD, 2011), out of which 504 are MSW dumpsites and the rest is construction and demolition dumpsites.

To this date, MSW incineration is not practiced in Lebanon. Only a small quantity of health care waste is being incinerated by hospitals. Industrial solid waste is still dumped with MSW since no industrial waste treatment facilities exist in the country.

A number of municipalities have received technical and/or financial assistance from international development organizations to improve their solid waste management services by building small and medium sized solid waste sorting and composting plants. The projects have known limited success due to lack of financing of the operation and maintenance services and lack of technical capabilities of the municipalities to ensure efficient solid waste management.

Health Care Waste

Assuming 60% occupancy and an average generation rate of 1.0-1.5 kg per bed per day, Lebanon's 164 public and private hospitals (about 15,342 hospital beds) produce daily about 9.2-13.8 tonnes of HCW (about 3,358-5,037 tonnes per year). Starting 2002, and after the enactment of decree 8006 (date 11/6/2002) on the proper management of the HCW in Lebanon, several hospitals and organizations started managing their HCW in an environmentally-appropriate manner. A local NGO called Arcenciel started in 1998 collecting and treating the HCW through autoclaving. As of 2010, Arcenciel is treating 55-60% of the total HCW stream (about 90% of the waste stream in Beirut), collected from 81 public and private hospitals. The remaining portion (around 35- 40%) of the HCW is being incinerated at the hospitals without permits or dumped illegally with MSW.

In this report, it is considered that around 1.25 Gg per year of HCW in 2004 is being incinerated (MoE/ELARD, 2004). An extrapolation was used to determine quantities incinerated during the period covered by the study, assuming that Arcenciel started its autoclaving operations in 1998 in Beirut and then it expanded towards the Bekaa region in 2003.

Wastewater generation and management

Currently, most of the generated wastewater is discharged in nearby surface water without prior treatment. Small septic tanks are still widely adopted in rural areas. Industrial wastewater is rarely treated at the industry level prior to its discharge in the environment or in the public sewer network.

The management of wastewater is the responsibility of the Ministry of Energy and Water (MoEW) who developed the National Water Sector Strategy adopted by the GoL in 2012. The strategy sets a number of targets on wastewater management including but not limited to:

- Collection and treatment to at least preliminary level of 80% of generated wastewater quantities by 2010 and 95% by 2020.
- Pre-treatment of all industrial wastewater by 2020.
- Reuse of 20% of treated wastewater by 2015 and 50% by 2020.
- Secondary treatment and reuse of all inland wastewater by 2020 and secondary treatment by 2020 of coastal wastewater where reuse is economically justified.

To date, the collection and treatment of wastewater is under the responsibility of the four Water and Wastewater Establishments (WWEs) as per law no. 221 of the year 2000 and its subsequent amendments. However, the WWEs still lack the technical and financial capabilities to efficiently and effectively manage the sector although international donors are providing financial and institutional support.

Although many Wastewater Treatment Plants (WWTPs) were built in the recent years through grants and/or loans, only few of them are currently operational and at various treatment levels due to lack of financing of operation and maintenance services and lack of technical capabilities of the municipalities or WWEs to ensure efficient wastewater management. Table 2 summarizes the number of treatment plants currently operational in Lebanon.

Table 2: Status of WWTPs in Lebanon

Location	**Total Number**	**Status**			
		Planned	Under construction	Constructed but not operational	Operational
Beirut and Mount Lebanon	9	4	2	2	*Ghadir: preliminary treatment*
Bekaa	9	2	1	-	*Aitanit, Baalbeck, Fourzol, Jib Jannine, Saghbine, Iaat: all secondary treatment*
North Lebanon	7	3	-	4	0

Source |MoE, 2013 (personal communication); CDR, 2014

The construction of wastewater network systems is lagging behind. With the exception of Beirut administrative region, all districts have large gaps in the wastewater network connections even though extensive developments to wastewater infrastructure have been made since 1998 with an annual growth of 7.2% on average. The households which are not yet connected to the sewerage system either use the septic tanks or the cesspools or simply discharge the wastewater directly into the environment.

1.10 Agriculture

Agriculture is a vital part of the Lebanese economy and its social and cultural heritage. Even though the sector's share of the GDP, is relatively low (4% in 2011), agriculture employs 20-30% of the active work force and constitutes 17% of the total exports (MoA, 2010a). In rural areas, however, agriculture is reported to contribute up to 80% of the local GDP and represents the major income-earning and employment opportunity (Verner et al.; 2013). In comparison with its neighbors, agriculture production in Lebanon is characterized by a higher value added per square kilometer, reflecting a higher intensity of production and greater focus on higher value fruits and vegetables (FAO, 2011a). Compared to 1970 when agriculture share of the GDP reached 9% (Kubursi, 1999), agricultural contribution to the GDP has been steadily decreasing. There are many reasons for this decline including the post-war economic crisis, urban encroachment that changed the rural landscape of the country, government economic policies favoring other sectors, emigration of young generation of farmers and the switch from farming to higher-paid jobs, and climate change with its concomitant effect on crops, pastures, and water resources.

According to FAOSTAT (FAO, 2011a) the total agricultural area is estimated at 638,000 ha (62% of total surface area). As indicated in Figure 11 below, pastures and meadows constitute approximately 39% of the total area, permanent crops 12%, arable land 11%, and forests 14% of the total surface area of Lebanon.

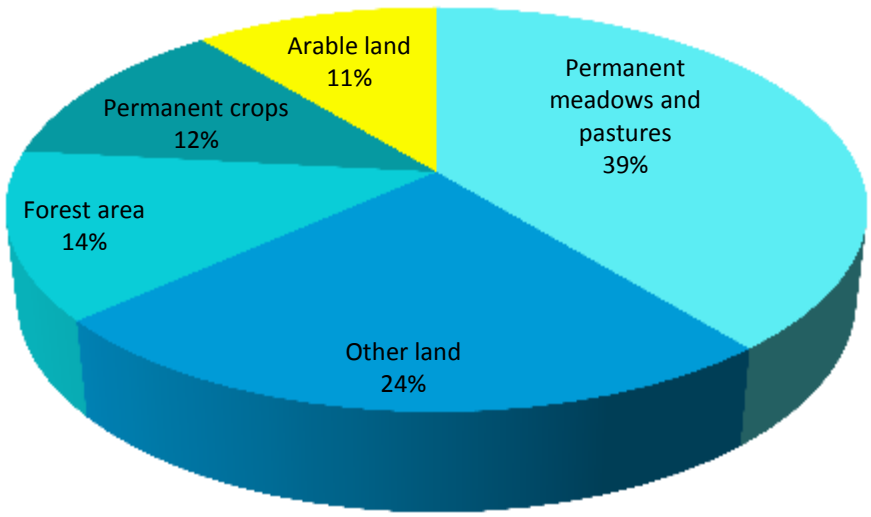

Figure 11: Agricultural land use in Lebanon (% of total agriculture area)-2011
Source| FAOSTAT, 2011a

According to the Ministry of Agriculture (MoA) 2010 census, the utilized agricultural area was approximately 231,000 ha, which is lower by 6% in comparison with the value from previous census in 1998. Of these, 106,272 ha were dedicated for seasonal crops (grains, vegetables, legumes, root crops, industrial crops, and forages) including 3,800 ha of greenhouse crops, and 125,928 ha for permanent crops (olives, fruit trees, citrus, and grapes).

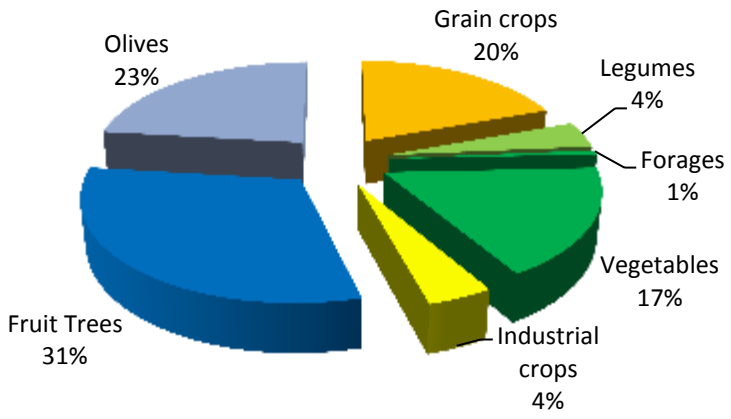

Figure 12: Agricultural production in Lebanon
Source| MoA, 2010b

Of the total utilized agricultural land, approximately half is irrigated, and increased by 8% compared to irrigated areas in 1998. Flood and furrow irrigation comprise 50% of irrigated land, while approximately 30% is through drip and 20% through sprinkler irrigation.
Agricultural production in Lebanon is diverse reflecting a Mediterranean climate with variable temperature and precipitation regimes, and distributed in the following regions of the country:
1. The Bekaa: Once regarded as the 'bread basket of the Roman Empire", the Bekaa valley is the most important production area and accounts for the highest percentage of seasonal crops (60%) as in cereals, potatoes, and vegetables, and in stone fruits, and grapevine. It also contains the highest percentage of cattle population (43%), sheep (72%), goats (51%) and poultry layers (60%).
2. The north and Akkar Plain: Olives, cereals, potatoes, vegetables, cattle and poultry broilers production.
3. South and Nabatieh: Olives, cereals, vegetables, and tobacco production.
4. Mount Lebanon: Fruits, vegetables, poultry broilers, and swine production.

In addition, the geographical coastal strip along the Mediterranean coast from the North of the country to the South is home for intensive vegetable greenhouse production, citrus fruits, and bananas.

Animal production
The livestock sector contributes to around 30% of the total value of production (FAO; 2011a). Although animal production is considered secondary with respect to crop production, Lebanon's poultry and dairy sectors both hold importance in terms of production and quality. The poultry sector is the only agriculture sector that satisfies domestic demand and is dominated by few companies utilizing closed systems producing quality broilers and egg products. Cattle are mainly raised for milk production with the majority of stocks raised in large farms as well as small-sized holdings (FAO, 2011b). Beef production is limited and imported live animals (in addition to imported chilled and frozen cuts) provide a major source for local consumption. The size of sheep and goat herds has fluctuated since 1994 but decreased in recent years mainly due to decrease in the number of shepherds and due to competition from imported meat from Australia, Turkey and Syria (Fady Asmar, personal communication). 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. Swine production has decreased steadily since 1994 due to a shift in consumer preferences towards poultry, mutton and beef, and due to fear from the swine flu.

Crop production
Lebanon's main agricultural crops are fruits, vegetables, olives, cereals, tubers, and legume crops. Pressure on the land base has led to a decline in cereal production in favor of high-value crops such

as vegetables. Lebanon is self-sufficient in fruits and vegetables, although competition from open markets is leading to import of these commodities as well.

The most important cereals cultivated are wheat and barley, with some production of forage crops such as alfalfa, vetch, corn, oats, and sorghum. Most of the barley grown in the arid parts of Bekaa (Hermel and El Qaa) is left as pasture for grazing animals. It is anticipated that forage crop production would increase after recent incentives introduced by the MoA to encourage milk and forage production by farmers with small animal holdings.

In 2010, wheat, barley, and potato production decreased due to a combination of drought and reduction in the areas planted. Although wheat and barley production recovered in 2011 and 2012, potato crop production remained at least 80% less compared with 2005, mainly due to the shrinkage in hectares planted (20,000 ha in 2005 vs. 12,000 ha in 2012). Also, imports from Saudi Arabia and Egypt rendered potato farming, once a profitable and prominent enterprise, vulnerable to open markets.

Fertilizer use

Statistics on fertilizer consumption in Lebanon are sporadic and contradictory. The Lebanese customs provide extensive data about imports but these could not be corroborated from the major agricultural importing companies. The amount of fertilizers used in Lebanon has been decreasing since 1994: approximately 122,000 tonnes of total nitrogenous fertilizers were used in 1994 (average of 31,000 tonnes of Nitrogen (N)), while in 2006 total nitrogenous fertilizers used were approximately 50,000 tonnes (average of 9,500 tonnes N). However fertilizer consumption increased in recent years to reach 85,000 tonnes (19,000 tonnes of N) in 2012. Most of the nitrogenous fertilizers used were Nitrogen-Phosphorus-Potassium (NPK) fertilizer, (17-17-17; and 15-15-15, and other combinations), Ammonium Sulphate, Ammonium Nitrate and Urea. Application rates of nitrogen fertilizers far exceed the recommended agronomic rates (Al-Hassan; 2011). For example potato growers apply on average 590 Kg N/ha while the suggested agronomic rate is 220 kg N/ha. For vegetables, growers apply the average of 900 kg N/ha while the agronomic rate is 500 kg N/ha. Unfortunately soil testing for soil nutrient content is not widely practiced and growers apply nitrogen rates based on experience or on the recommendation of agents from fertilizer distributors.

1.11 Land use, land use change and forestry

In Lebanon, the lack of land management plans and/or inadequate urban regulations has strongly affected the natural and built environment. This has facilitated unplanned urban sprawl at the expense of natural landscapes (MoE/UNDP/ECODIT, 2011). The construction of new roads and highways in mountain areas has affected landforms, vegetation cover, and ecosystems.

Several initiatives have been conducted to document and map land cover attributes in Lebanon. Accordingly, the first land cover attributes were produced in the form of a topographic map (scale 1:20,000) in 1961 by the Lebanese army in partnership with the French "Institut Géographique National". A land use/ land cover map of Lebanon was produced by the Ministry of Environment in cooperation with the National Center for Remote Sensing of the National Council for Scientific Research (CNRS) in 2002. This involved the use of satellite remote sensing data acquired in 1998. The final map disaggregated land use and land cover into seven main categories (Figure 13) and 23 subcategories. According to this map, Lebanon's forested lands covered 2,588 km^2 while the artificial/built up area covered 648 km^2. An updated version of the 1998 land cover/ land use map was recently completed by the CNRSusing satellite remote sensing data acquired in 2005. In 2004, the CDR and Reconstruction published the National Land Use Master Plan for Lebanon. The Master Plan was approved by the Council of Ministers in 2009 (decree 2366 dated 20-06-2009).

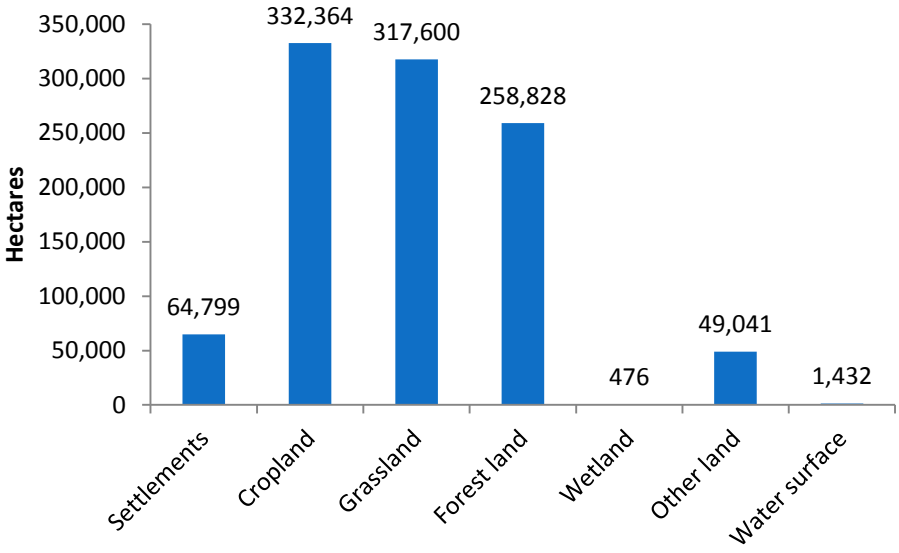

Figure 13: The 1998 land use/ land cover categories

The first national forest resources assessment was realized in 2005 by the MoA with the assistance of the Food and Agriculture Organization (FAO). The results showed that forests occupied around 13% of the total area of the country. In addition, 10% of the Lebanese territory was found to be covered by other wooded land (MoE/UNDP/ECODIT, 2011; FAO, 2010). Broadleaved forest made up 57% of the total forest cover whereas coniferous forests made up 32%, and the other 11% are mixed forests. The most abundant forests were oak forests covering 52% of total forested areas, while pine forests made up 15% and Juniper about 9%. Cedar and fir forests were much less abundant but nonetheless they represent habitats to many endemic and threatened plant species (MoE/UNDP/ECODIT, 2011; FAO, 2005).

Increasingly, Lebanon's forests, which include valuable broad-leaved trees, conifer forests and evergreen trees that cover the mountains in patches, are exposed to degradation due to quarries, urbanization, pests and diseases, fires, wars, human neglect, improper management, outdated laws, and poor law enforcement. Like other Euro-Mediterranean countries, fires have been especially damaging Lebanon's forests in recent years, representing one of the most important elements that destroy Lebanon's natural resources. Moreover, the absence of a national forest management strategy and the lack of human and technical resources contribute to the degradation of Lebanon's forests.

The problem of forest fires in Lebanon is complex. At the administration level, it is a problem having several authorities involved and a problem of forest policy and legislation, as much as it is a problem of equipment and capacity building. Despite the increased efforts, fire issues increasingly threaten forest ecosystems and economic development in Lebanon. Accordingly, a National Strategy for Forest Fire Management (AFDC/MoE, 2009) was developed and endorsed by the Lebanese CoM in 2009 (decision no. 52/2009). The aim of this strategy was to reduce the risk of intense and frequent forest fires whilst allowing for fire regimes that are socially, economically and ecologically sustainable. Currently, the MoA is in the process of developing a National Forest Plan supposed to take into account what has been agreed on in Lebanon's National Strategy for forest fire management. Until present, data on fire occurrence and affected surfaces in Lebanon is still not mutually consistent, homogenized and unified at the national level. However, an attempt has been made in 2008 to adopt the forest fire common ID card based on the decision no. 256 dated on 1/3/2008 taken by the Presidency of CoM.

Overall, the lack of land management in Lebanon is the cause for the over-exploitation and degradation of lands in many areas. It is estimated that 84% of the Lebanese territory still does not have adequate master plans, which has allowed for a lot of chaos when it comes to construction or any activities that change land cover and land use (MoE, 2012). It is estimated that there are about 1,278 quarries in Lebanon covering an area of 5,267 ha (MoE, 2012). Most recently, an indicative research study conducted showed that the largest area of artificialization on the coastal zone of Lebanon between 1998 and 2010 affected grasslands followed by forests and agricultural lands, consecutively (UNEP/MoE, 2013). Furthermore, it was found that wetlands decreased by 47%, grassland by 27%, and forests by 9%. Further investigation showed that most of artificialization in grassland affected moderately to highly dense vegetation, while most of the artificialization in forested lands affected shrublands.

In an attempt to tackle deforestation and to preserve what is left of natural areas, Lebanon has created, until now, 10 Nature Reserves, 3 Biosphere Reserves, 16 Protected Forests, 16 Protected Natural Sites/Landscapes, 4 Ramsar Sites, 5 World Heritage Sites, and 15 Important Bird Areas (MoE/UNDP/ECODIT, 2011). Reforestation and afforestation combined with the implementation of Lebanon's National Strategy for Forest Fire Management are some of the main activities that can help in maintaining and increasing Lebanon's forest cover. Pioneer reforestation projects have started during the late 1960s and early 1970s. During the past decade, Lebanon has initiated a number of programs/initiatives to restore forested lands. Such programs/initiatives included 1) the development of the National Reforestation Plan (NRP) by MoE in 2001, 2) the development of the National Action Plan to Combat Desertification by the MoA in 2003, 3) the development of the project "Safeguarding and Restoring Lebanon's Woodland Resources" to complement what has been started under the NRP in 2009, 4) the launching of Lebanese Reforestation Initiative (LRI) in 2012 with the support of the International Program of the US Forest Service to provide needed support in large-scale reforestation activities across the county, 5) the launching of the project "planting four million forest trees" by the MoA in 2012 and 6) the simultaneous implementation of several initiatives by local NGOs.

2 The national GHG inventory (greenhouse gas emissions and removals)

The most significant GHG emitted in Lebanon is Carbon Dioxide (CO_2), primarily produced from the burning of fossil fuels to generate energy for the power and transport sectors. Greenhouse gas emissions from agriculture, waste, land use change and forestry sectors are negligible in comparison with the scale of emissions from the energy sector.

2.1 Methodology

The inventory of greenhouse gas emissions in this report covers the year 2011. The emissions of Carbon Dioxide (CO_2), Methane (CH_4), and Nitrous Oxide (N_2O) were estimated using the methodology of the Intergovernmental Panel on Climate Change (IPCC) in line with the UNFCCC Biennial Update Report (BUR) Guidelines for Parties not included in Annex I to the Convention, Conference of the Parties (COP) decision 2/CP17. More specifically, the inventory was prepared based on the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 1997), the Good Practice Guidance (GPG) on Uncertainty Management and National Greenhouse Gas Inventories (IPCC, 2000) and the Good Practice Guidance for Land-Use, Land-Use Change and Forestry (IPCC, 2003). The UNFCCC Non-Annex I Greenhouse Gas Inventory System, version 1.3.2. was used for the computation exercise.

The tier 1 approach was employed in most of the calculation of sectoral emissions since no country-specific emission factors were available for the adoption of a higher tier methodology. Despite the lack of data, a tier 2 methodology was used in the following subcategories:

- Transport, road transport: the tier 2 methodology was based on the number of vehicles per category and their activity in terms of distance and/or fuel consumption.
- Industrial processes, cement production: the tier 2 methodology was used to calculate CO_2 emissions based on detailed information on clinker composition and technology used.
- Land Use, Land Use Change and Forestry (LULUCF): the approach 3 was adopted using change detection mapping, which allowed the generation of detailed data about land use and land use change. In addition, country-specific emission/removal factors were derived from global databases, surveys and expert consultations.

The sectoral activity data was collected from primary sources such as ministries and governmental research institutions and from secondary sources such as international organizations and scientific publications (Table 3). Proxy data, interpolations, extrapolations and estimations were used in the cases where data was unavailable.

In order to allow the aggregation and total overview of national emissions, emission of CH_4 and N_2O were converted to CO_2 equivalent using the Second Assessment Report IPCC Global Warming Potential (GWP) values based on the effects of greenhouse gases over a 100-year time horizon (N_2O = 310, CH_4 = 21).

Table 3: Sources of activity data

Activity data	Main sources of data
Energy (including transport)	Ministry of Energy and Water Ministry of Public Works and Transport International Energy Agency Directorate General of Civil Aviation Ministry of Interior and Municipalities - Traffic, Truck and Vehicle Management Authority Fuel importers
Industrial processes	Industrial establishments Ministry of Economy and Trade Ministry of Agriculture Ministry of Energy and Water Industries' Syndicates
Agriculture	Ministry of Agriculture Directorate General of Customs Food and Agriculture Organization Lebanese Syndicate of Cattle Importers Surveys and personal communications
Land use, land use change and forestry	Ministry of Agriculture Food and Agriculture Organization Satellite Imageries Scientific publications Surveys and personal communications
Waste	Ministry of Environment Central Administration of Statistics (CAS) Council for Development and Reconstruction Waste contractors Scientific publications Local NGOs

2.2 Lebanon's greenhouse gas emissions and removals for 2011

In 2011, Lebanon emitted 24,652 Gg CO_2eq. 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 with 74% of GHG emissions, followed by the waste sector (11%) and industrial processes (10%). CO_2 removals from the land use, land use change and forestry category amounted to 3,369.85 Gg CO_2, bringing Lebanon's net emissions down to 21,283 Gg CO_2eq. Table **4** and Figure 13 present the results of the inventory.

Table 4: Lebanon's GHG emissions and removals for 2011 per gas and category

Greenhouse gas source and sink categories	CO_2 emissions	CO_2 removals	CH_4	CH_4	N_2O	N_2O	Total
	Gg	Gg	Gg	Gg CO_2eq.	Gg	Gg CO_2eq.	Gg CO_2 eq.
Total national emissions and removals	**20,825.50**	**-3,369.85**	**136.86**	**2,874.06**	**3.08**	**953.32**	**24,652.88**
1 energy	**18,071.19**		**1.91**	**40.07**	**0.56**	**173.56**	**18,284.82**
Energy industries	7,853.04		0.32	6.66	0.06	19.66	7,879.36
Manufacturing industries and construction	2,675.10		0.07	1.37	0.02	6.08	2,682.55
Transport	5,645.42		1.21	25.41	0.46	142.60	5,813.43
Other sectors	1,897.63		0.32	6.63	0.02	5.22	1,909.48
Fugitive emissions from fuels			NO	NO			
2 Industrial processes	**2,584.18**		**0.00**	**0.00**	**0.00**	**0.00**	**2,584.18**
Mineral products	2,584.18						2,584.18
Chemical industry	NE		NE	NE	NE	NE	-
Metal production	NO		NO	NO	NO	NO	-
Other production	NA		NA	NA	NA	NA	-
Production of halocarbons and sulphur							
Consumption of halocarbons and sulphur							
3 Solvent and other product use	**NE**				**NE**	**NE**	**-**
4 Agriculture			**11.37**	**238.79**	**2.04**	**633.36**	**872.15**
Enteric fermentation			9.58	201.11			201.11
Manure management			1.79	37.68	0.50	153.59	191.27
Rice cultivation			NO	NO			0.00
Agricultural soils					1.55	479.77	479.77
Prescribed burning of savannas			NO	NO	NO	NO	-
Field burning of agricultural residues			0.00	0.00	0.00	0.00	0.00
5 Land use, land use change and forestry	**169.08**	**-3,369.85**	**0.01**	**0.31**	**0.00**	**0.07**	**169.46**
Changes in forest and other woody biomass stocks	0.00						0.00
Forest and grassland conversion	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abandonment of managed lands		0.00					-
CO_2 emissions and removals from soil	0.00	0.00					0.00
6 Waste	**1.05**		**123.55**	**2,594.89**	**0.47**	**146.33**	**2,742.27**
Solid waste disposal on land			104.49	2,194.43			2,194.43
Wastewater handling			19.06	400.46	0.47	146.33	546.79
Waste incineration	1.05						1.05

NA: not applicable – NE: not estimated – NO: not occurring
Numbers may reflect rounding.

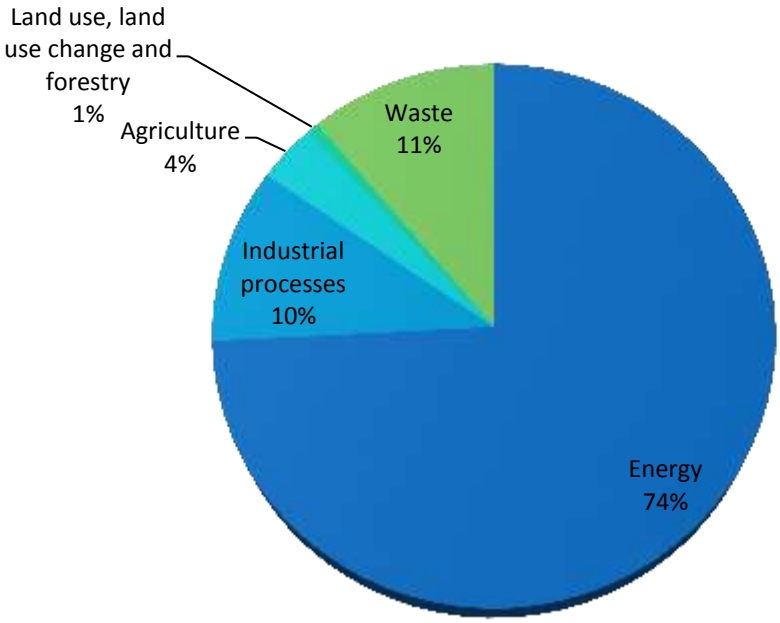

Figure 14: Breakdown of gross GHG emissions subcategories for 2011 in Lebanon

2.3 Breakdown of emissions by IPCC sector

2.3.1 Energy

In 2011, the energy sector's GHG emissions were estimated at 18,284.82 Gg CO_2eq. (18.2 million tonnes CO_2eq.), representing 74% of the total greenhouse gas emissions in Lebanon. Energy is mainly responsible for carbon dioxide emissions (98.83%), while it also contributes to methane and nitrous oxide emissions with 0.22% and 0.95% respectively. The contribution of each subcategory to the total of the energy sector is presented in Table 5 and Figure 15.

Table 5: GHG emissions from energy by source category and gas for 2011

Categories	**Emissions**			
	CO_2 (Gg)	**CH_4 (Gg CO_2eq.)**	**N_2O (Gg CO_2eq.)**	**Total (Gg CO_2eq.)**
Total energy	18,071.19	40.07	173.56	18,284.82
Energy industries	7,853.04	6.66	19.66	7,879.36
Manufacturing energy and construction	2,675.10	1.37	6.08	2,682.55
Transport	5,645.42	25.41	142.6	5,813.43
Other sectors	1,897.63	6.63	5.22	1,909.47
Commercial/Institutional	*1,293.72*	*3.75*	*3.32*	*1,300.79*
Residential	*513.67*	*2.62*	*1.67*	*517.96*
Agriculture/Fishing/Forestry	*90.23*	*0.26*	*0.23*	*90.72*

Numbers may reflect rounding.

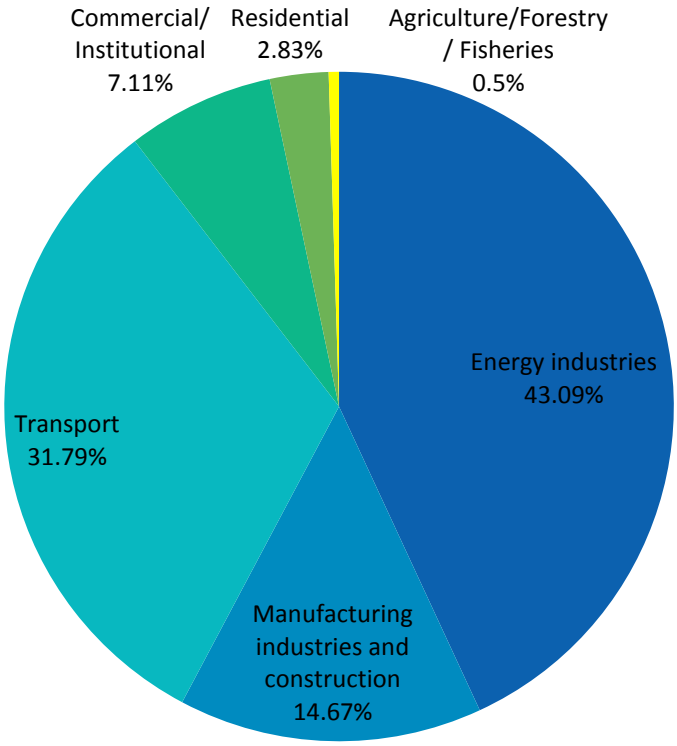

Figure 15: Contribution of energy emission sources to the sector's total for 2011

Energy industries

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 2011 amounted to approximately 254,252 TJ. Since electricity generation from public power plants (energy industries) is the main fuel consumer, it is responsible for 43.09% of the sector's emissions followed by transport (31.79%) and manufacturing industries (14.67%) as illustrated in Figure 15.

Indeed, public electricity generation is the largest contributor to the sector's emission due to the fact that more than 88% of imported fuel oil and 53% of imported gas diesel oil are used in thermal power plants for public electricity generation (Figure 16).

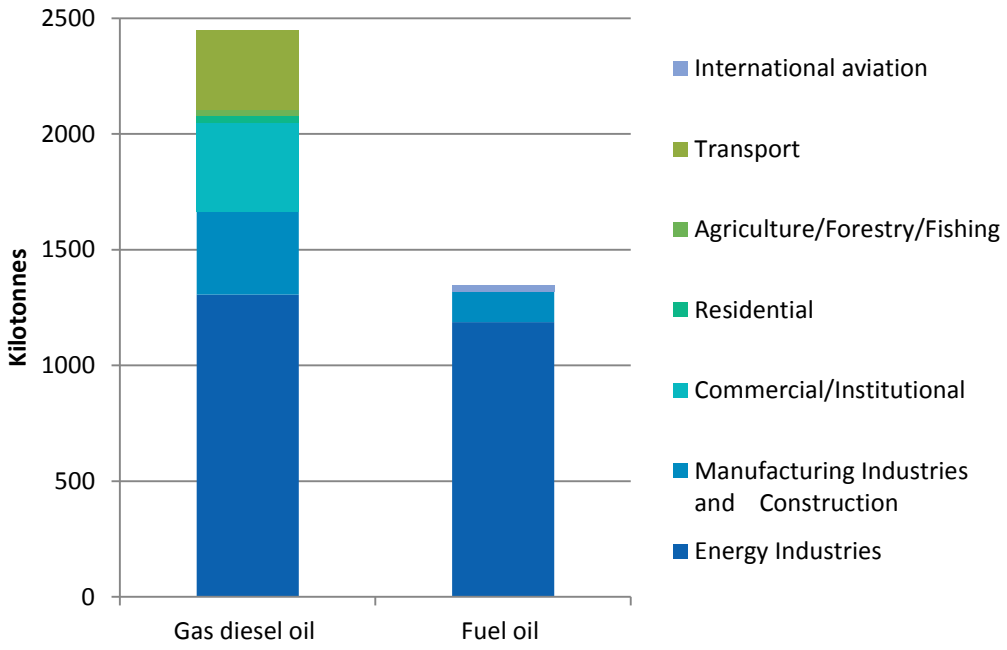

Figure 16: Amount of gas diesel oil and fuel oil consumed per subcategory

Transport

Transport is also considered to be a main source of emissions in the energy sector, emitting in 2011 5,813.43 Gg CO_2eq., including road transport and domestic aviation (emissions from off road transport and fishing boats have been accounted under the agriculture/forestry/fisheries subcategory). Carbon dioxide, methane and nitrous oxide respectively contribute to 97.1%, 0.44%, and 2.45% of total CO_2eq. from transport (Table 6).

Table 6: Transport sector GHG emissions in 2011 per gas

	CO_2	CH_4	N_2O	Total GHG emissions
Emissions (Gg)	5,645.42	1.21	0.46	-
Emissions (Gg CO_2eq.)	5,645.42	25.41	142.6	5,813.43
Contribution	***97. 1%***	***0.44%***	***2.45%***	**-**

Numbers may reflect rounding.

GHG emissions from road transport were calculated using the tier 2 methodology with EU emission factors as the Lebanese fleet is mostly constituted of European vehicles. The contribution of the different vehicle categories to GHG emissions shows that Private Cars (PC) have the highest share of the 2011 emissions, with 58.38% of the total road transport emissions (CO_2eq.), while Light-Duty Vehicles (LDV), Heavy-Duty Vehicles (HDV), and motorcycles account for 17.46%, 23.81%, and 0.35% respectively. PC is the main emitting subcategory of all GHG. LDV is the second most important contributor to CH_4 and HDV to CO_2 and N_2O, as illustrated in Figure 17.

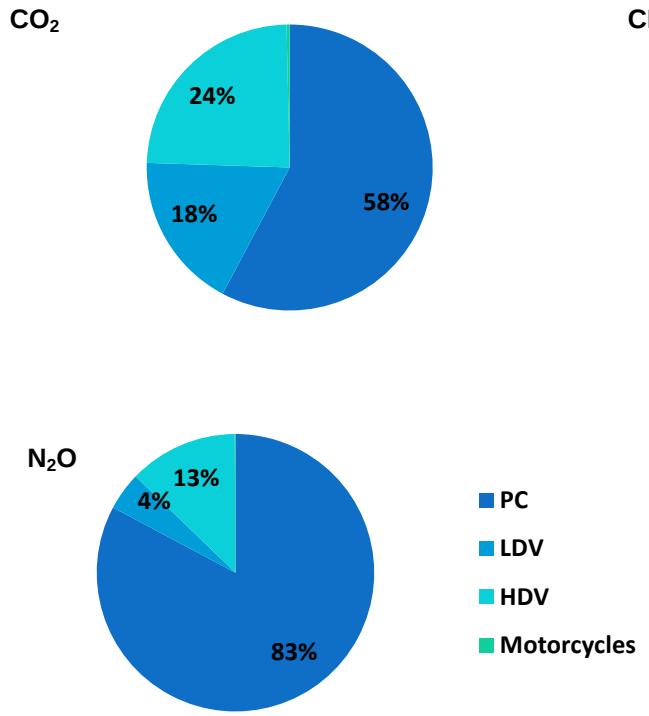

Figure 17: Contribution of the different vehicle categories to the direct GHG emissions for 2011

GHG emissions from domestic aviation are not significant, contributing only to 0.17% of emissions from transport. In Lebanon, domestic flights consist of the limited usage of small propeller-type aircrafts, used only for training. The fleet includes around 5 Cessna aircrafts operating on gasoline with an annual consumption ranging between 2 and 3 ktonnes.

Manufacturing industries and construction and commercial/institutional sectors

Other high-emitting subcategories in the energy sector are manufacturing industries and construction and the commercial/institutional sectors since they cover all combustion activities related to the private generation of electricity. Due to high difference between electricity supply and demand, private generation in industries, commercial institutions or at the community level consume considerable amounts of gas diesel oil. In 2011, 741,651 tonnes of gas diesel oil were used for private electricity generation, representing more than half the amount used in EDL diesel-fired power plants and constituting 30% of total import of gas diesel oil (Figure 18).

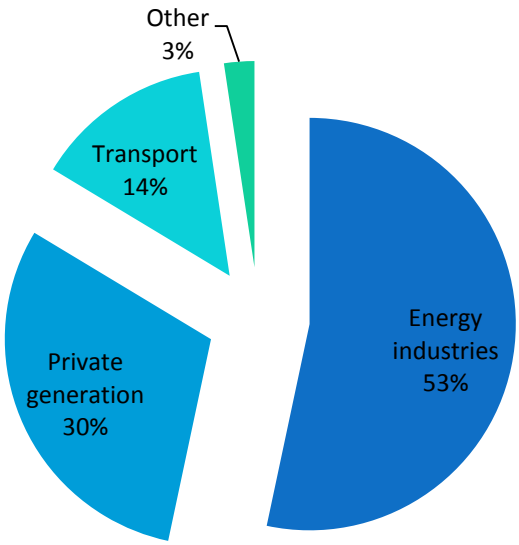

Figure 18: Consumption of gas diesel oil per end use

Out of 3,983.34 Gg CO_2eq. emitted from the manufacturing industries and construction and commercial/institutional sectors in 2011, private electricity generation emitted 2,370 Gg CO_2eq. accounting for 13% of total GHG emissions from energy activities. These emissions are tightly linked to the quantity of gas diesel oil used in the generators. As illustrated in Table 7 and Figure 19, it is estimated that on average generating electricity from private generators emits on average less than generating electricity from public thermal power plants. Indeed, while public power plants emit on average 847 tonnes CO_2eq. per GWh produced, private generators emit only 713 tonnes CO_2eq. per GWh. In addition, in absolute terms, public energy generation produces more GHG emissions than private generation since it produces more electricity and consumes more fossil fuel (Figure 19 and Figure 20).

Table 7: Fuel consumption and GHG emissions of private generation for 2011

	Gas diesel oil consumed (tonnes)	**GHG emissions (tonnes CO_2eq.)**	**Estimated production (GWh)**	**Emission intensity (tonnes/GWh)**
Private generation	741,651	2,370,931	3,326	713

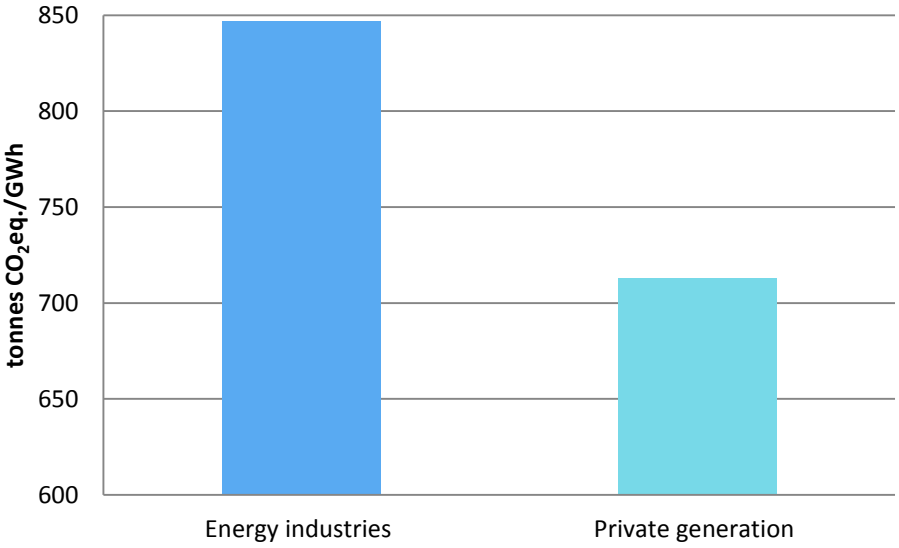

Figure 19: Emission intensity in tonnes CO_2eq./GWh of energy industries versus private generation in Lebanon

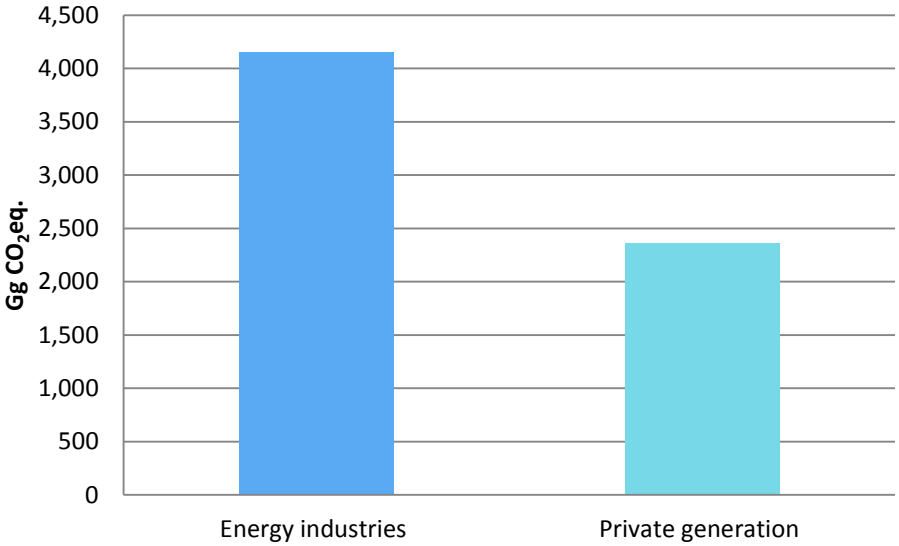

Figure 20: GHG emissions of energy industries versus private generation in Lebanon in 2011

Residential sector

In the residential sector, Liquefied Petroleum Gas (LPG) is estimated to be the main source of GHG emissions (421 Gg CO_2eq.), followed by gas diesel oil that is used for space and water heating in households (Figure 21). 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.

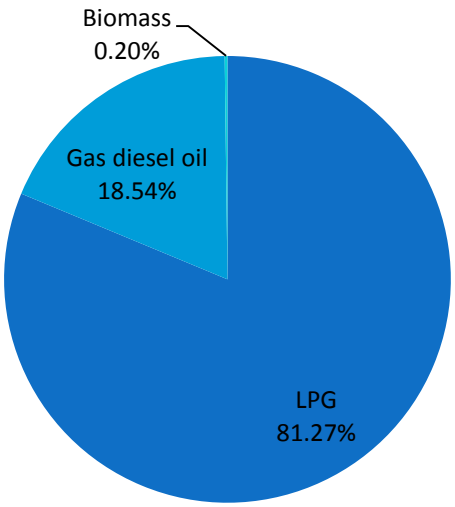

Figure 21: Distribution of GHG emissions in 2011 per fuel type used in the residential sector

Comparison between the sectoral approach and the reference approach

According to the IPCC guidelines, carbon dioxide emissions from the energy sector should be calculated using both the reference and the sectoral approach. The reference approach is based on detailed data on primary energy consumption, which leads to the calculation of apparent consumption of fuel and to the consequent calculation of emissions, while the sectoral approach is based on a detailed disaggregation of energy consumption by sector and fuel for the calculation of CO_2 emissions. The application of the reference approach can be considered as a quality control procedure, as the deviation of estimations should not be significant (deviations in the order of ±2%) or else explanations should be provided.

In Lebanon, carbon dioxide emissions for the energy sector are calculated according to the two methodologies. As shown in Table 8, the difference between the 2 approaches is -1.92%, which is within the threshold defined by the IPCC guidelines. The existing difference results mainly from statistical differences in fuel consumption and the use of tier 2 methodology in the transport sector.

Table 8: Difference between the reference and sectoral approach for 2011

	CO_2 emissions (Gg)	Difference
Reference approach*	18,426.25	-1.92%
Sectoral approach*	18,071.19	

Numbers may reflect rounding.

International bunkers

For international bunkers, the total direct GHG emissions from aviation and marine amounted to 792 .02 Gg of CO_2eq. in 2011. Around 90% of these direct GHG emissions originated from aviation. The results of GHG emissions from international bunkers are given in **Table 9**.

Table 9: Direct GHG emissions from international bunkers in Gg/year for 2011

Category	CO_2 (Gg)	CH_4 (Gg)	N_2O (Gg)	*Total emissions CO_2eq. (Gg)*
Aviation bunkers	707	0.005	0.006	*708.60*
Marine bunkers	83	0.005	0.0006	*83.40*

Numbers may reflect rounding.

2.3.2 Industrial processes

Emissions from industrial processes in Lebanon were estimated at 2,584 Gg CO_2 in 2011, representing 10% of national emissions. The main source of emissions is cement production since most of the categories included in the industrial processes category of the IPCC do not occur in Lebanon. Lime production and soda ash use have a very minimal contribution to CO_2 emissions in the sector. Other categories emit precursors, with Non-Methane Volatile Organic Compounds (NMVOCs) being the highest emitted precursor, mainly from the food and beverage category and from the use of asphalt for road surface. Figure 22 below illustrates emissions of direct and indirect greenhouse gases per category for the year 2011.

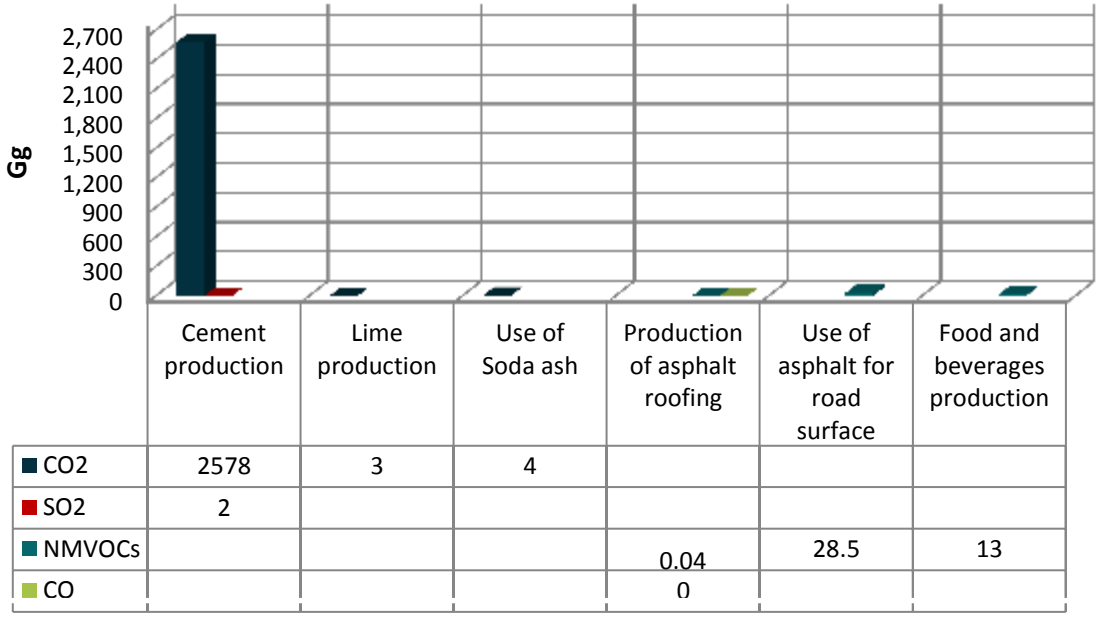

Figure 22: Emissions of direct and indirect greenhouse gases per industrial processes subcategory per gas for the year 2011

Cement industries are the major contributors to CO_2 emissions from this sector, with 99.76% of emissions due to the booming in the construction activities in Lebanon. Indeed, according to data from the Lebanese Order of Engineers, the surface area of new construction permits reached 16.5 million m^2 in 2011, constituting an increase of 144.8% from the 6.7 million m^2 in 2000. Since cement industries are a main source of emissions, calculations were based on tier 2 methodology and country specific emission factors.

Lime production is not a major industrial activity in Lebanon although it does contribute to GHG emissions from its manufacturing processes. There is only one plant that produces lime as a final product. The remaining production is covered in cement industries and used directly in the manufacturing process therefore their related emissions have been accounted for under cement and not lime production.

As for emissions originating from the use of soda ash, these are mainly caused by glass manufacturing, soap and detergents manufacturing as well as water treatment. No disaggregate information is available to allocate emissions to each of these industries.

Emissions from some categories were not estimated due to the absence of reliable activity data (namely glass production and phosphate fertilizers). However, it is assumed that these will not highly impact overall GHG emissions from the sector, as the quantity produced is believed to be very minimal compared to the highest emitter, i.e., cement industries. On the other hand, emissions from the consumption of halocarbons and SF_6, which have a high GWP, may significantly affect the overall emissions from the sector in terms CO_2 equivalent, even with small quantities. National consumption of halocarbons and SF6 could not be determined for this inventory due to absence of national data.

2.3.3 Agriculture

In 2011, agricultural activities contributed only to 4% of national emissions, with a total of 872.15 Gg CO_2eq. The main source of emissions was agricultural soils where N_2O emissions constituted over half of the total emissions from agriculture. Table 10 presents the main GHG emission results of the agriculture sector.

Table 10: CH_4 emissions and N_2O emissions by main source categories for the agriculture sector for 2011

	Methane emission/Gg CH_4			**Nitrous oxide emission/Gg N_2O**		
	Enteric fermentation	Manure management	Total	Manure management	Agricultural soils	Total
Gg	9.58	1.79	**11.37**	0.50	1.55	**2.05**
Gg CO_2eq.	201.11	37.68	**238.79**	153.59	479.77	**633.36**
Contribution to total agriculture emissions	23%	4%		18%	55%	

Almost 48% of N_2Oemissions are due to direct emissions from agricultural soils, which originate from the use of synthetic nitrogen fertilizers, biological nitrogen fixation, crop residues, and animal manure applied to soils. 38% are due to indirect emissions from agricultural soils caused by atmospheric deposition of NH_3 and NO_x and by leaching and runoff of nitrogen and 14% are caused by grazing activities.

CH_4 emissions from enteric fermentation (201.11 Gg CO_2eq) represented 23% of the sector's total emissions, with dairy and non-dairy cattle contributing to 62% of emissions and sheep and goats contributing to 34%.

As for the rest of emissions, manure management was accountable for generating 191.27 Gg of CO_2eq., contributing to 32% of the sector's total emissions, with N_2O being the main greenhouse gas. Nitrous oxide emissions from manure management depends on the Manure Management System (MMS) adopted for each animal species. As summarized in Figure 23, cattle manure was largely managed in solid storage and drylot, whereas sheep and goats manure was distributed between Pasture Range and Paddock (PRP) (67%) and solid storage and drylot (33%). Poultry manure was mainly managed with bedding (77%) and to a lesser extent without bedding (19%) (traditional chicken manure is included under PRP). Emissions from daily spread and from PRP are considered under emissions from agricultural soils and therefore not included in the calculations of N_2O emissions from manure management.

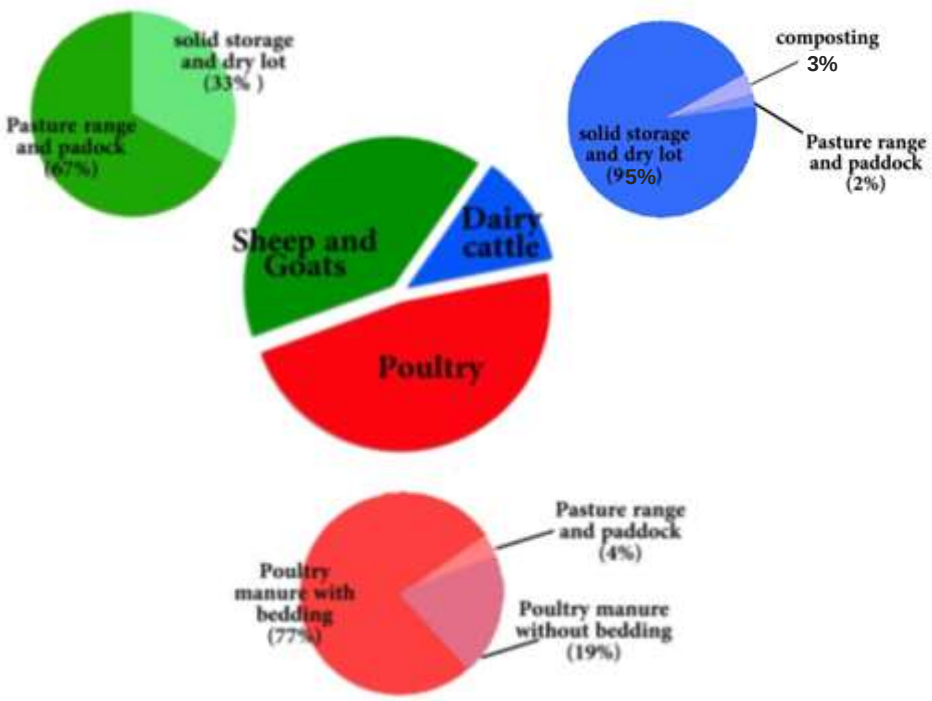

Figure 23: Manure management systems utilized for major animal species in Lebanon

Nitrogen excretions from manure managed in solid storage and drylot (sheep, goat, dairy cattle) and from poultry manure with bedding represented almost 90% of the total excretions. The remaining is largely caused by poultry manure without bedding (Table 11).

Table 11: Nitrogen excretion and nitrous oxide emissions from animals different manure management systems in 2011

Manure management systems	Nitrogen excretion (tonnes N/year)	Nitrous oxide emissions (Gg N_2O)
Anaerobic lagoons	28.11	0.04×10^{-3}
Liquid system	14.06	0.02×10^{-3}
Solid storage and dry lot	7,464.35	0.23
Poultry manure without bedding	1,928.63	0.02
Poultry manure with bedding	7,816.03	0.25
Total	17,251.18	0.49

Numbers may reflect rounding.

Based on consultations with the Lebanese Agricultural Research Institute (LARI) and with various growers and experts in the field, it was estimated that burning of agricultural residues is not practiced anymore in Lebanon, at least during the period 2005-2011, thus emissions of CO_2 did not occur from this sector.

2.3.4 Land use, land use change and forestry

In 2011, LULUCF acted as a greenhouse gas sink in Lebanon, with net removals equal to 3,200 Gg CO_2 (Table 12). Indeed Lebanon's wide forest cover still represents a significant CO_2 sink, although a downward trend in sink capacities have been observed in recent years due to deforestation, forest fires and most importantly, urbanization.

A new methodology was adopted for the calculation of emissions/removals adopted a new methodology for this BUR, based on recent available data and more detailed approach. The improvement in the methodology for activity data collection (the use of periodical and sometimes multi-temporal satellite and remote sensing data) resulted in country-specific estimates in comparison with previous inventories which used rough estimates from global and national databases and literature reviews.

Table 12: Lebanon's GHG emissions/removals summary from the LULUCF sector for 2011

	CO_2 emissions Gg	CO_2 removals Gg	CH_4 emissions Gg	N_2O emissions Gg	Total emissions Gg CO_2 eq.
Land use, land use change and forestry	169.08	-3369.85	0.0147	0.0002	169.46
A. Forest land	**0.00**	**-2,282.35**	**0.0132**	**0.0002**	**0.33**
1. Forest land remaining forest land		-2,212.53			0.00
2. land converted to forest land		-69.82			0.00
B. Cropland	**0.00**	**-1,087.50**	**0.0015**	**0.0001**	**0.05**
1. Cropland remaining cropland		-1,087.50			
2. Land converted to cropland					
C. Grassland	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
1. Grassland remaining grassland					
2. Land converted to grassland					
D. Wetlands	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
1. Wetlands remaining wetlands					
2. Land converted to wetlands					
E. Settlements	**169.08**	**0.00**	**0.00**	**0.00**	**169.08**
1. Settlements remaining settlements					
2. Land converted to settlements	169.08				169.08
F. Other land	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
1. Other land remaining other land					
2. Land converted to other land					

Results reflect calculations of emissions from LULUCF based on 2003 GPG for LULUCF.
Numbers may reflect rounding.

The inventory results show that in 2011, forests had the largest contribution to CO_2 emissions/removals in LULUCF. However, further data (when available) on areas of wetlands (namely hill lakes) and grassland 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.

The changes in land cover/land-use resulted in gains and losses in biomass and carbon stocks in soils and litter and the comparison of emissions and removals shows that emissions from land conversions, burning of biomass and fuelwood gathering are much 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 LULUCF were still high and couldn't be compensated by the afforestation activities.

GHG emissions and removals reported from LULUCF in Lebanon are respectively caused by biomass losses and increments and by variation in soil carbon stocks from the different land use and land use change categories which were taken into consideration in this report (Table 13).

Table 13: Causes of GHG emissions and removals reported for LULUCF in Lebanon.

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

Changes in CO_2 removals

In general, it was observed that the changes in CO_2 removals in 2011 were mainly attributed to the decrease/increase in vegetation cover within forest lands, cropland, and grassland. For instance, areas of lands converted to settlements were estimated at almost 1,200 hectares in 2011. It is important to note that the reported numbers of annual conversion to settlement accounted only for the annual sum of any conversion that is above 90 m^2. This is mainly due to the spatial resolution of the employed satellite imagery. Counting the changes that are below 90 m^2 can slightly increase the total areas of conversion to settlement.

In general, variations in areas of land converted to settlement might be related to a number of factors including the active market of the real estate sector, the quality of the image classification results, and the general socio-economic situation, among others. In addition, such type of changes might be related to certain policies and public plans contributing to changes in these lands (e.g. expansion and improvement of the road networks, development of areas of public and private services).

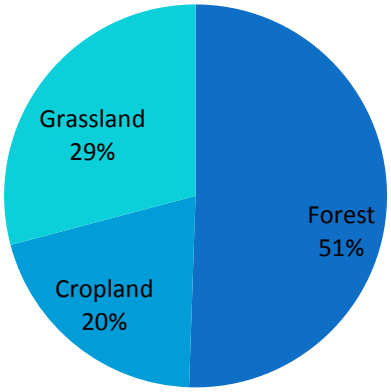

Figure 24: Areas of land categories converted to settlements

It was also observed that broadleaf forests were the most affected by this type of conversions (Figure 25). 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.

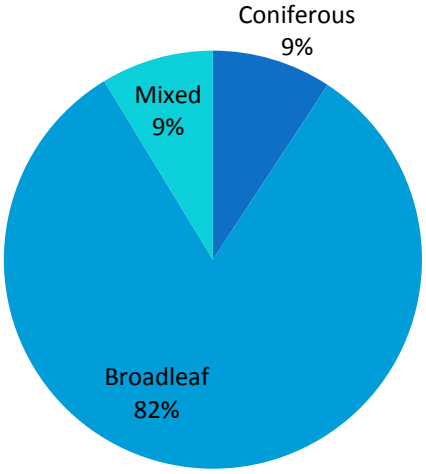

Figure 25: Areas of forest lands converted to settlements by subcategory

Conversions to settlements have also negatively affected cropland and grassland. It is usually easier and more beneficial to convert annual crops than removing perennial crops (mainly comprising fruit trees and orchards). Conversions of cropland and grassland to settlement might be related to the lack of interest of owners in keeping such type of lands (e.g. increase in land prices related to an increasing number of population, increasing demand for development projects), high costs of labors and lack of a market for the agricultural products, and degrading financial situation of citizens (selling agricultural lands and grassland which were eventually converted to urbanized areas). This has been at least confirmed for artificialized cropland on the Lebanese coast (UNEP/MoE, 2013).

Fuelwood gathering is another cause of decrease in vegetation from forest lands. Estimates for fuelwood gathering were quite constant over the inventory time period resulting in an average CO_2 emissions of about 27 Gg/yr .

Also, afforestation activities resulted in an increase in CO_2 removals. 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.

Changes in CO_2 emissions

The main source of GHG emissions is 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 2011.

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 spread across the vegetated landscape.

In a recent study conducted by Salloum and Mitri (2013), it was found that the length of the fire season has been increasing on an average of 5.2 days during the past decade. Fire occurrence was positively correlated with mean monthly temperatures, and the length of the fire season was negatively correlated with mean annual precipitation. In addition, an increasing fire occurrence risk was observed in association with high maximum temperatures and long dry seasons.

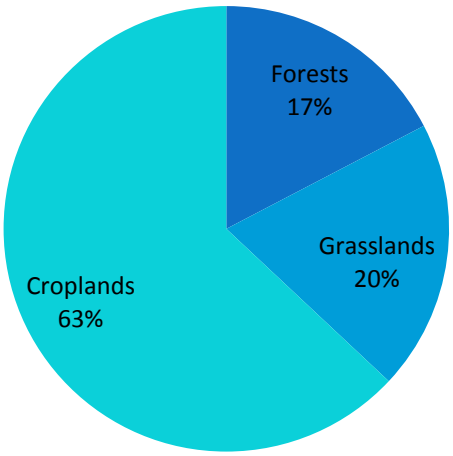

Figure 26: Burned areas in 2011

2.3.5 Waste

In 2011, activities related to the generation and treatment of solid waste and wastewater emitted 2,742.27 Gg CO_2eq., thus contributing to 11% of Lebanon's total GHG emissions. CH_4 emissions are mainly generated from solid waste disposal, N_2O emissions from the discharge of wastewater effluents into aquatic environments, while CO_2 gases are mainly emitted from the health care waste incineration. A summary of greenhouse gas emissions from the waste sector is presented in Table 14.

Table 14: Greenhouse gas emissions from solid waste and wastewater per gas in 2011

	CO_2	CH_4		N_2O		Total $CO_2eq.$
	Gg	Gg	Gg $CO_2eq.$	Gg	Gg $CO_2eq.$	Gg $CO_2eq.$
Solid waste	1.05	104.50	2,194.43	0.00	0.00	2,194.43
Wastewater	0.00	19.07	400.46	0.47	146.33	546.79
Total	1.05	123.56	2,594.89	0.47	146.33	2,742.27

The results of the inventory show that GHG emissions are highly dependent on emissions from solid waste generation and management activities, constituting more that 80% of the sector's emissions. The waste generated in Lebanon is characterized by a high organic content, and is mostly disposed in landfills and open dumpsites where methane gas is emitted from anaerobic decomposition waste material.

CH_4 is the main greenhouse gas emitted by these activities due to high proportion of waste being disposed in dumpsites coupled to low methane recovery rates. As for the CO_2 emissions from incineration, they are insignificant compared to emissions from other disposal methods since autoclaving has become the most used method for treating health care waste in Lebanon.

Emissions of N_2O are mainly linked to wastewater generation and disposal, whether it is discharged in rivers, sea or septic tanks.

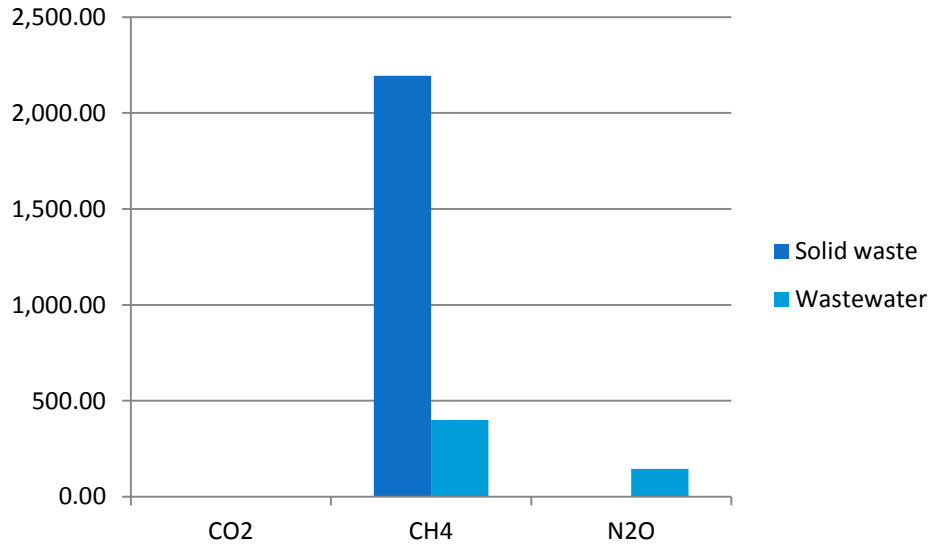

Figure 27: Contribution of subcategories to GHG emissions per gas in the waste sector for 2011

2.4 Key category analysis

Key category analysis is performed for both results including and excluding LULUCF in accordance with GPG 2000 and GPG-LULUCF 2003 guidelines. Key categories under the guidelines are sectors whose emissions when summed in descending order of magnitude, add up to 95% of total greenhouse gas emissions. 8 categories have been identified as key in the analysis, with CO_2 being

the main gas and the energy sector being the main key category. The results of key category analysis are shown in Table 15.

Table 15: Key category analysis for 2011

Sector	Source categories	Greenhouse gas	Emission estimate (Gg CO_2)	Level assessment (%)	Cumulative total (%)
Energy	CO_2 mobile combustion: road vehicles	CO_2	5,635.0	33.9%	33.9%
Energy	CO_2 emissions from manufacturing industries and construction	CO_2	2,675.1	16.1%	50.0%
Industrial processes	CO_2 emissions from cement production	CO_2	2,577.6	15.5%	65.5%
Waste	CH_4 emissions from solid waste disposal sites	CH_4	2,194.4	13.2%	78.7%
Energy	Other sectors: commercial CO_2	CO_2	1,293.7	7.8%	86.5%
Energy	Other sectors: residential CO_2	CO_2	513.7	3.1%	89.6%
Agriculture	N_2O (direct and indirect) emissions from agricultural soils	N_2O	479.8	2.9%	92.5%
Waste	CH_4 emissions from wastewater handling	CH_4	400.5	2.4%	94.9%

3 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.

Lebanon has mainstreamed and integrated climate change, including mitigation, in its development plans and has to date implemented numerous mitigation measures in various sectors to curb down emissions. Additionally, Lebanon has promoted removals through various measures adopted in the forestry sector.

The implementation of these mitigation measures have induced an estimated 1,084,829 tonnes CO_2eq. abatement for the period 2005-2012, with LULUCF being the main source of these emission reductions or avoided emissions. If the described activities are well sustained, it is expected to have a minimum of 226,710 tonnes CO_2eq. reduction per year. This does not take into account the implementation of other additional planned activities across sectors.

A summary of the measures developed and implemented during the period 2005-2012 is provided in Table 16. Full sectoral information including information on objectives and goals, coverage, budget, GHG reduction potential, and any other information on the progress of implementation of the mitigation action is provided in tabular format as per decision 2/CP.17 in Annex II. It is worth pointing out that the list of measures is not exhaustive due to the short timeframe available to prepare the BUR. Work is still continuing to collect and analyze further data for reporting to the UNFCCC. Concurrently, the country is preparing a Measuring, Reporting and Verifying (MRV) system which would facilitate the identification and reporting of new initiatives and enhance the qualitative and quantitative assessment of these mitigation activities.

Table 16: Summary of mitigation activities in Lebanon for the period 2005-2012

Sector	Activity	Achieved outcome	Estimated reduction of GHG emissions ($t CO_2$ eq.)	Yearly emission reduction ($t CO_2$ eq./year)
Energy	Installation of PV	Total of 1,936 kWp of capacity installed Annual savings of 2,877.12 MWh	5,046 for the period 2010 - 2012	1,682
Energy	Installation of Solar Water Heaters (SWH)	Total of 126,000 liters and 1,800m^2 installed	7,960 for the period 2005-2012	995
Energy	Light Emitting Diode (LED) street lighting	Annual savings of 10,965 MWh	7,434 for 2012	7,434

Energy	Mircowind and microwind-PV	16 kWp of capacity installed Annual savings of 23.77 MWh	36 for the period 2010-2012	12
Energy	Replacement of incandescent lamps with Compact Fluorescent Lamp (CFL)	3,025,000 incandescent lamps replaced in 1,415,000 households across Lebanon.	90,036 per year for 2012	90,036
Energy	Energy saving measures implemented - self-financed by the private sector	184,700 liters of SWH capacity installed 20,440 MWh saved every year from energy efficiency measures	152,200 for the period 2005-2012	19,025
Agriculture	Applying Conservation Agriculture (CA)	1,800 ha of rain-fed barley and wheat filed converted.	-	-
Agriculture	Improvement of cattle production	Milk production increased by 30% hence, reducing of the size of the herd to produce same amount of milk.	577.5 for the period 2009-2011	192.5
Agriculture	Recovery and rehabilitation of the dairy sector in Bekaa and Hermel	Milk production increased by 30% hence, reducing of the size of the herd to produce same amount of milk.	12,389 for the period 2009-2012	3,097.25
Agriculture	Composting of dairy manure	500 to 800 tonnes of compost produced every year.	3,060 for the period 2010-2012	1,020
Agriculture	Organic agriculture	Fields using organic agriculture increased by 300 hectares.	-	-
LULUCF	Reforestation activities	2,414 ha of reforested land	19,640 for the period 2009-2012	4,910

LULUCF	Forest fire management	50% of forest fires suppressed between 2009-2012 40% of forest fires suppressed between 2010-2012 20% of forest fires suppressed in 2012	786,450 for the period 2005-2012	98,306.25
Total known GHG emissions reduced during 2005-2012			1,084,829	
Yearly GHG emissions expected from sustaining the implementation of these activities				226,710

3.1 Energy

Energy production through fossil fuel heavily contributes to GHG emissions. Climate mitigation measures in this sector play an important role in achieving positive environmental, economic, and social impact through demand side management and clean energy production. The implementation of mitigation measures helps in reducing the country's GHG emissions through reducing the electricity purchased from EDL, reducing fuel consumption from onsite generation of electricity as well as water and space heating.

This has been achieved during the period of 2005 to 2012 through:

- Shifting electrically driven hot water systems to renewable energy/solar thermal systems;
- Producing electricity through renewable resources such as solar, wind, geothermal, biomass, and hydro;
- Demand side management through the implementation of energy efficiency measures such as energy efficiency lighting, green roofs, boiler performance enhancement, and other energy performance measures.

In the BUR, most of the activities initiated and/or funded either by the government or by international organizations have been captured in the reporting tables (Annex II). However, in the absence of any data related to privately funded energy efficiency and renewable energy projects, only a limited number of activities completed by major commercial institutions was considered.

A number of measures related to fuel sourcing, renewable energy and increased production have been planned in the 2010 energy policy paper but have not yet been implemented. Once achieved, these activities are expected to induce significant GHG emission reductions from the energy sector.

Fuel sourcing

The policy paper came in to resolve the future fuel debate and had selected Natural Gas (NG) as the primary strategic energy source for the country. The fuel sourcing statement as provided in the policy is based on diversity and security where 2/3 of the fuel mix is based on natural gas with multiple

sources of supply, 12% are renewable energies, and the remaining from other sources of fuel while selecting power generation technologies that work on both natural gas and fuel oil.

As per the energy policy paper, NG will be imported from multiple sources, to reduce the risk of supply outages. The strategy is to consider both NG through pipelines from neighbouring countries and NG imported through Liquefied Natural Gas (LNG). To accommodate this, the policy defined the infrastructure requirements as follows:

1. Pipeline along the coast: The pipeline will feed all power plants from Deir Aamar to Tyre and will be used for industrial and residential gas distribution as well as for potential NG vehicles. The pipeline will be laid to follow the railway track to cut expropriation costs. the considered sources of NG are, among others, Turkey, former Soviet republics, Russia, Syria, Egypt, Qatar, Algeria. This is not withstanding that the potential of finding natural gas in the territorial waters of Lebanon may be considered for domestic use, especially for power generation.

2. LNG terminal (Floating Storage And Regasification Unit (FSRU) or onshore terminal): According to Poten and Partners (2012), offshore FSRU is the preferred technology for Lebanon LNG imports and Deir Aamar is the preferred location. The rental of an FSRU will be done for a limited period of 12 years, allowing domestic natural gas to eventually supply the gas demand in Lebanon during the next decade if the coming offshore drillings are successful. It is estimated that Lebanon will require up to 3.5 million tonnes per year of LNG to meet longer-term power generation requirements, including at the existing Zahrani and Deir Aamar plants (870 MW), new CCGT at Beddawi (450 MW), reciprocating engines at Zouk and Jieh (278 MW), and additional 1.6 GW Independent Power Producer (IPP) development as required to sustain electricity demand growth in Lebanon. Poten and Partners have also estimated the expected LNG prices. At projected oil prices of around 90 USD/barrel in 2015, Lebanon can expect to pay long-term LNG prices in the 11 to 14 USD/MMBtu range. At 120 USD/barrel oil price, the range increases to 13 to 16 USD/MMBtu. The main competition to Lebanon for the next 10 years will come from Asia and Continental Europe.

According to the paper, the FSRU is expected to be deployed by the end of 2016 and thus the GoL should act promptly targeting the first delivery of LNG in early 2017. This date is in line with the development of the pipeline and the IPP power plants and any delay may cause cascaded damage on the planned projects.

Renewable energy

For the past few years, Lebanon witnessed some acceptable developments in the energy efficiency and renewable energy sectors. The Ministry of Energy and Water had provided subsidized loans for the citizens to install solar water heating systems and remove electric heaters from the grid. Another initiative was the replacement of 3 million incandescent lamps with compact fluorescent lamps, an investment worth USD 7 Million.

In 2012, MoEW announced the national action plan for energy efficiency and renewable energy, (referred to as NEEAP: National Energy Efficiency Action Plan) which was considered a strategic document to pave the way for the overall national objective of 12% of renewable energy by 2020. A new NEEAP was prepared in 2015 to prepare the roadmap of the energy sector from 2015 to 2020. Roughly, the expected savings from both primary energy and end-used energy amount to above 700 GWh.

Other initiatives have been put in place by the Government of Lebanon in order to increase the share of renewable energy, and meet the 12% target by 2020. Currently, the Ministry of Energy and

Water is in the final stages of the evaluation of a 50-100 MW wind farm project tender, which will subsequently be submitted to the CoM for approval. In addition, the market of small, decentralized, grid-connected renewable energy power generation is being developed with a target to facilitate the installation of at least 1.75 MW of new decentralized renewable energy and to pave the way for larger renewable energy power plants (UNDP, 2015).

Increased production

As part of the policy paper's short term immediate and urgent plan, MoEW was able to start the investment process of increasing the installed capacity by 1,200 MW at a cost of USD 1 billion. This is the first large scale investment Lebanon has experienced in the power sector in 15 years. This capacity is a mix of rental power for a limited period of time, upgrades of existing units and new power plants of different technologies. The completion of this short term expansion plan is foreseen to be by the end of 2015.

In the summer of 2012, the GoL represented by MoEW entered into a contract agreement with KARKEY, a Turkish subsidiary of Karadeniz Holding, for renting 270 MW of reciprocating engines mounted on floating barges. The first power barge, moored at the existing Zouk thermal station, started operation in the winter of 2013 and is supplying a total capacity of 188 MW to the 150 kV network. The second barge, moored at Jieh thermal station, started operation in the summer of 2013 and is supplying a total capacity of 82 MW to the 150 kV network. According to the contract, this is an Energy Conversion Agreement under which the risk and security of fuel supply are on the GoL's behalf. According to the policy, these rental units are aimed at supplying the required additional power in the summer as well as to act as a standby capacity needed for 2 – 3 years to rehabilitate the existing units at Zouk and Jieh.

Currently, there are two reciprocating engines power plants under construction at the sites of Zouk and Jieh. The Danish Engineering, Procurement and Construction (EPC) contractor, Burmeister & Wain Scandinavian Contractor (BWSC), in alliance with engines OEM MAN BandW started the procurement process for the erection of a 194 MW at the site of Zouk and 78.2 MW at the site of Jieh. The engines are designed to run on tri-fuel basis of HFO, Diesel Oil (DO) and NG when available. To boost efficiency, these units will run in combined cycle mode, Heat Recovery Steam Generators (HRSG) will be installed at the exhaust of the engines collecting waste heat to generate steam and run small steam turbine. According to the contract this is a fast track construction job were the full capacity is expected to be online 18 months after the official starting date.

MoEW had also entered into an EPC contract agreement with a Greek company, J&P Avax, for the erection of 565 MW CCGT power plant at the land extension of the existing Deir Aamar CCGT. The plant is composed of three GE frame 9E units, three heat recovery steam generator and one steam turbine. The plant is designed to run on a dual fuel basis and shall fire HFO at a de-rated capacity of 539 MW until NG is available to the plant. Actual construction works are expected to start soon. Similar to previous contracts this is a fast track construction job where the full capacity is expected to be online within 26 months after the official starting date.

As part of an operation and maintenance contract awarded to a Malaysian YTL Power Services, EDL had managed to upgrade packages sequentially for the V94.2 gas turbine's at Zahrani and Deir Aamar. The upgrade plan was completed by the end of summer 2013. The upgrades added up a capacity of at least 63 MW in total in addition to enhancements in efficiency and lifetime extensions.

After the completion of the short term plan which aims to re-enforce the generation infrastructure providing confidence for the private sector in the utility capability, and enhancing creditworthiness of the sector to attract senior debits and reliable financiers, MoEW is planning to start the process of increasing the installed capacity by 1,500 MW and later by an additional 1,000 MW using the modality of IPP.

Amongst the projects that are still under the development phase are the rehabilitation of the existing units at Jieh and Zouk thermal stations and the conversion of the Tyre and Baalbeck open cycle power plants into combined cycle.

3.2 Transport

Unfortunately, no mitigation action that addressed the problems pertaining to the transport sector were implemented during the last decade. Most decrees and laws that were enacted during 2005-2012 were concerned with improving air quality and reorganizing the land public transport sector.

Some initiatives indirectly tackled reducing GHG emissions from the transport sector, such as decree no. 8243/2003 requiring mandatory annual vehicle inspection, which consequently forces drivers to annually control the engine operation; and the Lebanese customs restriction on used car, banning the import of vehicles older than 8 years.

In 2014, the Ministry of Public Works and Transport (MoPWT) presented to the CoM the 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 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 full implementation of the master plan would eventually indice significant emission reductions.

A Transport NAMA is under preparation, which consists of replacing old cars in all of Lebanon (national scale). The main measure planned is a car scrappage program where owners of old cars would voluntarily submit their cars for scrappage, and purchase a replacement Fuel Efficient Vehicle, after receiving a package of incentives including a cash-for-scrappage amount (down payment on new car), reduced interest rate on the new car loan, and various exemptions (such as exemptions from registration fee and first mandatory vehicle inspection fee, as well as customs fee for taxi drivers). If implemented, (aiming at 60% scrappage coverage of the targeted car population over a 15-year period), an approximate of 6,250,00 tCO_2eq reduction can be achieved by 2030.

3.3 Agriculture

Recent initiatives to strengthen agriculture have included the development of the 2004 Agriculture Strategy, which was prepared with FAO and the World Bank, and the 2006 Agricultural Strategy Implementation program. However the strategy and the program could not be implemented, as

priorities shifted towards the relief and rehabilitation efforts of the sector which was severely affected by the July 2006 war. The total damage in the agriculture sector was estimated at USD 298 million. The past few years have been marked by further major developments in support of agricultural and rural development. In January 2010, the MoA issued an updated Strategic Plan 2010–2014 and, with assistance from the International Fund for Agricultural Development (IFAD), will revise the implementation plan to reflect the new Strategic Plan.

As part of this strategy, MoA created a platform where all actors (public, private, civil society) could interact, as well as exchange information and experience, with the establishment in 2010 of more than 30 national technical committees. Several activities were initiated, more than 200 technical staff were recruited and 28 agricultural centers were established across all regions. Total public spending on agriculture increased almost threefold. A program to increase cereal and legume production has been introduced in 2010 with a total budget reaching USD 14 million yearly. In addition, a new programme to promote fodder production and develop the dairy sector was launched in February 2012 with a total budget of USD 19 million. Finally, a programme to increase agricultural exports and improve agricultural products quality (Export Plus Programme) was reinstated in 2012 with a total budget of USD 33 million annually.

Mitigation measures related to the agriculture sector in Lebanon include cropland management, livestock management, manure management, organic farming and grazing land management/pasture improvement. These measures contribute to mitigation by reducing emissions of CH_4 and N_2O from agriculture and by enhancing removal of atmospheric GHGs. Table 17 outlines the activities and technologies associated with these mitigation measures as adopted from a classification provided by Smith et al.(2007).

Table 17: Summary of mitigation measures and associated technology practices

Mitigation measure	Technology practices
A. Cropland management	
1. Agronomy	-Improved crop varieties -Crop rotation -Cover crops
2. Nutrient management	-Organic fertilizers -Soil N tests -Fertigation -Slow release fertilizers
3. Tillage and residue management	-Conservation Agriculture (CA)
4. Water management	-Irrigation efficiency (drip/sprinkler irrigation)
	-Water supply (rainwater harvesting)
B. Livestock management	
1. Improving feeding practices	-Feed optimization
2. Animal breeding	-Improve animal performance
C. Manure management	
1. Manure storage and handling	-Cover piles of manure, avoid addition of straw, apply immediately onto lands and incorporate into soil
2. Manure treatment	-Anaerobic digestion (biogas)
	-Composting
D. Organic agriculture	
E. Grazing/pasture management	
	Introduce new grass species and legumes into pastures
	Improve grazing intensity

The following is a brief description of each measure as it pertains to the agriculture sector in Lebanon (adapted from Smith et al; 2007):

A. Cropland management

1. Agronomy: Improved agronomic practices that increase crop yields, use nitrogen fixing plants in rotations, and allow for maximum return of plant residues to soils to lead to increased soil carbon storage. Such practices include: i) improved crop varieties that are resistant to disease and insects leading to increased residues available for sequestration, ii) adopting techniques that could lower the use of pesticides and nitrogenous fertilizers by using crop rotation with legumes, iii) using cover crops that can add carbon to the soil and uptake unused nitrogen, thus reducing N_2O emissions.

2. Nutrient management: Growers in Lebanon apply far more fertilizer nitrogen than the amount used efficiently by crops. The surplus N increases the amount of direct and indirect N_2O emissions from soils. Consequently, improving N use efficiency can reduce N_2O emissions and indirectly reduce GHG emissions from N fertilizer manufacture. Practices that improve N use efficiency include the use of organic fertilizers (manure, compost), adjusting application rates based on precise estimation of crop needs (via soil N tests), and applying N via fertigation which ensures that N is less susceptible to loss and places N more precisely into the soil to make it more accessible to crops roots.

3. Tillage and residue management: Adopting minimum or no tillage and leaving crop residues in the field are proven CA techniques which increase carbon sequestration in soils, decreases CO_2 emissions (due to less mechanization), and less fertilizer use due to an increase in soil fertility and soil organic matter. However the effect on reducing N_2O emissions is not conclusive especially under cool and moist climates.

4. Water management: Using more effective irrigation measures can enhance carbon storage in soils through enhanced yields and residue returns. Drip irrigation can reduce energy use and when combined with fertigation, less fertilizer N is used and higher fertilizer use efficiency results, thus lowering GHG emissions.

B. Livestock management

Ruminant animals such as cattle and sheep are important sources of CH_4 which is released through enteric fermentation. The emissions of CH_4 from enteric fermentation account for about one-third of global anthropogenic emissions of this gas (Smith et al, 2007). All livestock also generate N_2O emissions from manure as a result of excretion of N in urine and feces. Practices for reducing CH_4 and N_2O emissions from this source fall into three general categories: improved feeding practices, use of specific agents or dietary additives, and longer-term management changes and animal breeding. Methane emissions can be reduced by feeding more concentrates, normally replacing forages. Maintaining the health of livestock and choosing a fast growing breed and higher milk producing cows will reduce GHG emissions. By improving health and decreasing mortality, less gas is emitted per production unit.

C. Manure management

Animal manures can release significant amounts of N_2O and CH_4 during storage. Covering the manure with either permeable or impermeable cover will retain the nutrients within the manure rendering it more valuable for land application. However, it can also create anaerobic conditions within the manure pile leading to emissions of CH_4. In such cases, different factors affect the GHG emissions such as manure pH, temperature, and moisture contents. Another convenient solution for animal manure is to collect the methane and convert it into biogas, thus reducing CH_4 emissions as well as avoiding CO_2 emissions from the replaced fuel. Handling manures in solid form (e.g., composting) rather than liquid form can suppress CH_4 emissions, but may increase N_2O formation and, if aeration is inadequate, CH_4 emissions during composting can still be substantial. Composting is gaining widespread use and one company in Lebanon is already producing compost from cow and poultry manure (GreenCo, Lebanon) to be used on orchards, vines and field crops.

D. Organic agriculture

Organic agriculture prohibits the use of synthetic products (pesticides, fertilizers, and growth regulators) for crop or animal production. It relies on crop rotation, crop residues, animal manure, and legumes for soil and crop management. For fertilizer, organic farmers use a variety of sources: compost, green manure, organic fertilizers, and the integration of animals in crop production. Besides reducing the emissions of N_2O, organic farming improves soil fertility, increases soil water content, and reduces water and air pollution. Organic farming is practiced on more than 2,800 ha in Lebanon, increasing at the rate of 15% yearly (Yousef El Khoury, IMC, personal communication).

E. Grazing land management/pasture improvement

One of the major GHG emissions contributions from livestock production is from forage or feed crop production and related land use (IFAD, 2009). Proper pasture management through rotational grazing would be the most cost-effective way to mitigate GHG emissions from feed crop production. Animal grazing on pastures helps reduce emissions attributable to animal manure storage. Introducing grass species and legumes into grazing lands can enhance carbon storage in soils. Improving grazing intensity improves carbon sequestration as overgrazed or under grazed land sequesters less carbon than optimally grazed one.

Annex II lists the current mitigation actions in the agriculture sector in Lebanon, as initiated and implemented by public and private institutions. Even though most if not all of these projects are primarily focused on sustainable crop and animal production and/or adaptation to climate change, it is envisioned that each activity or technology used would eventually contribute to GHG mitigation. The expected GHG mitigation potential of these projects are estimated in a qualitative or semi-quantitative approach. Unfortunately, there is not enough information to assess more accurately the expected GHG reduction potential of such actions.

3.4 Land-Use, Land Use Change and Forestry

LULUCF climate mitigation measures can have highly variable environmental and socioeconomic impacts depending on the measures and the means by which they are implemented. LULUCF-based interventions that have the potential to significantly contribute to climate change mitigation options comprise the following main categories, among others (Trexler and Gibbons, 1998):

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

Mitigation actions related to LULUCF during the 2005-2012 period were almost uniformly distributed over the different Lebanese Governorates (Figure 28) and were categorized under two types of activities, namely, 1) reforestation/afforestation and forest landscape restoration activities, and 2) forest fire management activities. Annex II lists the details of each projects/actions undertaken.

Overall, the total GHG reduction from reforestation/afforestation activities conducted between 2005 and 2012 is 19.64 Gg of CO_2 eq. and the total GHG reduction from forest fire management activities within the same time frame is 786.45 Gg of CO_2 eq. (taking into account all assumptions presented in Annex II).

Figure 28: Distribution of main recorded mitigation actions for LULUCF in Lebanon between 2005 and 2012

3.5 Waste

Since 2005, no major developments took place in solid waste management in Lebanon. The national solid waste management plan proposed in 2006 consisted of establishing regional sanitary landfills, sorting and composting facilities while rehabilitating the existing dumpsites at the same time. The proposed plan wasn't adopted due to various reasons related mainly to the difficulty in finding the locations for construction of solid waste facilities without having public or political oppositions. Early 2014, protests by the inhabitants of the Naameh and neighbouring villages stirred the status quo requesting the closure of the landfill. As a consequence, the GoL set a date for the final closure of the Naameh landfill in 2015 but did not propose any disposal/treatment alternatives. The sanitary landfill of Naameh was supposed to represent a model to be adopted throughout Lebanon, however, although engineered and sanitary, landfills have become a major debate and concern at the national level due to the Not In My Back Yard (NIMBY) effect and to the lack of land availability.

Currently, the MoE is pursuing its efforts to prepare a strategy for the management of solid waste in an attempt to find a sustainable solution for solid waste management. The various drafts of the strategy always consider landfilling and WtE as main treatment/disposal methods.

A NAMA in the waste sector is under preparation, and includes mainly, gas recovery and power production at current landfills and at large open dumpsites that are to be closed, and the application of waste-to-energy (WtE) technologies as enhancement for existing initiatives in the solid waste sector. This is estimated to result on a reduction of 1,470 Gg CO_2eq./yr. Also, depending on the outcomes of the current efforts in finding a suitable solution for the solid waste management, additional activities might be included in the NAMA once more details are available.

Similarly, no major changes have been identified in the management of wastewater in Lebanon. Since 2005, several wastewater treatment plants were constructed but unfortunately, despite investments made, only few of them are currently operational and at various treatment levels. This is due to lack of financing of operation and maintenance services and lack of technical capabilities of the municipalities or water and wastewater establishments to ensure efficient wastewater management, which did not allow a significant reduction of GHG emissions from wastewater.

4 Institutional arrangements and MRV system

4.1 The BUR preparation process

The Ministry of Environment is the institution responsible for the preparation of the BUR since it is the UNFCCC focal point in Lebanon. The preparation of the BUR was funded through the Global Environment Facility's (GEF) enabling activity (USD 352,000) and was managed by the UNDP in Lebanon. The GoL through the MoE provided in kind support for the project (USD 50,000) in order to realize this enabling activity. The overall coordination of the project was handled by the climate change office at the MoE, which works under the Service of Environmental Technology.

The preparation of the GHG inventory and mitigation actions was outsourced to local consultants except for the energy and industrial processes chapters that were prepared by the climate change team at MoE. The completion of the GHG emission inventory and mitigation actions was the result of the work of a number of individuals and institutions that were directly or indirectly involved in providing data and validating results. The GHG inventory was reviewed by an external reviewer and amendments were introduced to improve consistency, transparency, accuracy completeness and comparability of the results. Finally, the climate change team at MoE compiled all the results of the sectoral inventories and mitigation actions and drafted the synthesis and analysis part of the BUR.

4.2 GHG inventory system

As the national focal point to the UNFCCC, the MoE in Lebanon is responsible for the coordination, compilation and submission of national communications, biennial update reports and related GHG inventories.

In addition to the present BUR, Lebanon has submitted two national communications and associated national GHG inventories to the secretariat of the UNFCCC. The first was submitted in 1999 and the second in 2011.

During the preparation of the present BUR and the Third National Communication (to be submitted in 2016), the lack of institutional memory from compiling previous inventories, difficulties in sharing data between agencies, and a greater involvement from the private sector (where an important part of the data is available) were highlighted as the major MRV challenges facing the GoL.

Based on the above, the MoE has been focused since January 2013 on designing a national-level MRV system that will provide more sustainable and structured data collection, maintenance, archiving and reporting processes. Progress is highlighted in the subsequent sections.

4.2.1 Introducing new incentives, teaming up with the private sector

- **Minister of Environment's decision 99/1**

The Minister of Environment's decision 99/1 of April 2013 provides incentives for direct reporting of GHG emissions and related activity data to the MoE by the private sector, namely commercial, institutional and industrial enterprises. In exchange for their cooperation, reporting companies are awarded a reporting certificate signed by the Minister.

Incentives for a wider participation by the private sector to the reporting mechanism stipulated by 99/1 are twofold.

- By reporting their GHG emissions, complying entities are enabled to identify and generate information that can be useful to their business. Indeed, data reported by companies includes kWh of electricity used, private generators specifications, gas/diesel oil, LPG, HFO and gasoline and diesel as well as raw materials used for industrial processes and quantity of

industrial production. The entities' greenhouse gas emissions are then calculated by applying IPCC default emission factors. The functionality to calculate GHG emissions (carbon footprint) at a firm level provides businesses with a useful external metric against which to compare their business and measure their performance over time and identify cost reduction potential or gained efficiency.

- In addition, the private sector usually promotes this activity as a Corporate Social Responsibility initiative.

In order to assist firms in their reporting, the MoE has developed a simple and standardized excel model, where default IPCC emission factors and equations are used for the energy and industrial processes sectors. Reporting entities hence only have to input relevant activity data in the appropriate cell. The model automatically calculates GHG emissions of the company per category and per gas.

As a quality assurance measure for the new data collection, the decision stipulates that entities must have the reported data certified by an auditor or accountant prior to its submission to the MoE. In addition, reported data is subject to internal quality control assessment by MoE staff who review the completeness and consistency of the activity data. The reporting certificate is issued only once the data and results have been cleared. The list of certified companies is shared with the CAS, the Ministry of Economy and Trade, and the Ministry of Industry. As a way to address any potential confidentiality concerns, the data provided by reporting entities is not shared with these other government agencies.

The MoE uses the information collected through the decision 99/1 process to verify disaggregate data used in the national GHG inventory, specifically in the energy sector. Indeed, the energy data currently available is the aggregate overall energy consumption in the country. However, in order to use both the reference and sectoral approaches in calculation of GHG emissions from the energy sector, separate data should be available on the energy consumption in the commercial and institutional sector, manufacturing industries and construction and residential. Through decision 99/1, the MoE will be able to estimate the percentage of energy consumption from each of the first two categories, and by deduction from the residential sector.

Importantly, the Minister of Environment's decision 99/1 also ensures a sustainability in reporting by establishing a continuous flow of information for GHG emissions reporting, which replaces the rather ad hoc and sector-specific existing processes.

4.2.2 Benefiting from existing formal procedures

In Lebanon, the private sector has traditionally been reluctant to provide information directly to the MoE. In addition, collecting data on a regular basis and maintaining and archiving the information requires dedicated financial and human resources. However, due to the current institutional limitations of the MoE, joining efforts with other ministries and benefiting from existing established reporting mechanisms is a necessity to guarantee the sustainability of MRV arrangements.

Cooperation with the Ministry of Industry

In Lebanon, the MoI is responsible for certifying industrial businesses to allow import and export of their products. Therefore, industrial establishments apply annually to the MoI to register and renew their 'industrial certificate'. The application involves responding to a list of basic questions about the business' operations.

Taking advantage of this frequent reporting of the industrial sector, the MoE succeeded in requesting basic 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 MoE has been supporting the MoI in updating the existing database of industrial establishments and including the additional information related to GHG emissions. At present the industries' database is not linked to any other inventory database. However, work is being done to put in place a GHG inventory system to connect all databases to the MoE and consequently generate more frequently national inventories.

Cooperation with the Ministry of Finance

The MoE is currently exploring the possibility of replicating the joint reporting system established at the MoI with the Ministry of Finance by asking commercial, institutional and industrial entities to report additional information related to GHG emissions while declaring their annual VAT information via the already established online system. This initiative is still in the pipeline at the time of the drafting of this report.

Environmental compliance decree (8471-2012)

The MoE is also implementing a process through the decree on Environmental Compliance of Establishments that could provide valuable activity data. The decree, which is expected to come into force end 2015, defines the responsibilities of the private and public sectors in complying with national emissions standards and stipulates the preparation and reporting of regular environmental audits to the MoE. A certificate of compliance will be issued to entities complying with the requirements. This decree provides an opportunity to include the reporting of GHG emissions in environmental audits in order to unify and verify data collection.

4.2.3 Quality Assurance/Quality Control (QA/QC)

New data brings additional challenges not just for their collection, but also for their verification, cleaning and archiving. This is particularly the case where new mechanisms/processes are established. A time series with consistent assumptions that are regularly collected is vital for the quality of GHG activity data. The long-term sustainability of MRV systems is therefore an important consideration.

The MoE is currently conducting a range of quality control procedures for GHG activity data and emissions calculations for information used in the national GHG inventory. This includes checking formulas, checking for outlier numbers, comparing against industry average, comparing bottom up data collected to aggregated data available at national level and undertaking expert consultations to validate data. In addition, expert judgement is deployed to quality control activity data and emissions estimates. The need to apply sound QA/QC techniques such as those currently employed will only increase as the quantity of data increases through the new collection processes being established and as the Ministry begins to better access data from other sources.

4.3 Preparation of Nationally Appropriate Mitigation Actions (NAMAs)

In 2009, Lebanon presented to the international community the country's voluntary target of introducing 12% renewable energy in the national emerge mix. Since then, momentum has endured and Lebanon is well on its way to producing advanced NAMAs to help meet its renewable energy target.

In 2013, the Ministry of Environment was appointed by the CoM as the official national coordinator for NAMAs in Lebanon and in 2014, the Ministry of Environment issued Decision 196/1 that established and officiated a mechanism for approving and submitting NAMAs to the UNFCCC NAMA registry (Table 18). The purpose of this mechanism is to record the demand for international support for the implementation of NAMAs and to facilitate the matching of financial resources, technology and capacity building support with these measures.

Table 18: NAMA process in Lebanon

Step 1: GHG emissions inventories and assessment of presiding framework conditions Identification of the main GHG emission sources and sectors and preparation of baseline and business-as-usual scenarios for the different sectors.
Step 2: NAMA identification and scoping Identification of opportunities for mitigation actions that can be packaged as potential NAMAs for Lebanon based on their emission reduction potential, associated costs at both national and sectoral levels, co-benefits, and feasibility of implementation.
Step 3: NAMA prioritization and selection Prioritize the most feasible options to be further elaborated according to specific selection criteria and based on a national consensus.
Step 4: NAMA preparation Development of fully detailed NAMA proposals by concerned ministries/institutions and submission to the MoE to be a basis for negotiation of support and implementation conditions between the government and sources of support.
Step 5: NAMA registry After approval of the MoE and the National Council for the Environment, submission of NAMA proposals to the NAMA registry.
Step 6: Implementation and MRV Implementation of the NAMA within the relevant sectors once funding is secured and terms of the implementation agreed upon with the supporting countries.

A series of workshops and consultation meetings with stakeholders have been conducted by the MoE where 5 NAMA ideas were prioritized in the energy and waste sectors. These included 2 proposals from the MoE – one to transform waste into energy and another to promote fuel efficient and hybrid vehicles, both of which are currently under development through the UNDP Low Emission Capacity Building (LECB) Programme and will be complete by 2016.

With a nod to sustainability during the initial selection process, it was also made clear that NAMAs outside the initial short list can and should be developed in the future, as long as they pass the agreed criteria. Indeed, the MoA has started developing a forestry NAMA, bringing the total number

of NAMAs currently under development up to 3. Once ready , these NAMAs will be submitted to the NAMA Registry, seeking funds for implementation.

4.4 MRV of required and received support

Lebanon benefits from wide financial support (grants and loans) from various international donor agencies and foreign governments for the inception and implementation of numerous environmental projects and policies in the country. In addition, some environmental initiatives are being funded from the national budget. While the Ministry of Environment hosts and implements many of those projects, many more are carried out by other public institutions or NGOs. Currently, no single entity is responsible for tracking and reporting on climate change projects and related expenditures. These could be related to climate change but their implementation is not always known to the MoE where the climate change office is.

Based on the above, the MoE has attempted to identify and track climate change related activities in Lebanon and their related financing. The results of this survey showed that a total of 264 projects related to climate change have been implemented since 2005 in the country, among which only 40 are directly linked to climate change (i.e. climate change is explicitly mentioned in the project's goal) (Figure 29). A slight majority of the projects are categorized as mitigation projects (Figure 30) and most of the climate change activities are targeted for implementation of actions and interventions while a smaller fraction is targeted to research and capacity building (Figure 31).

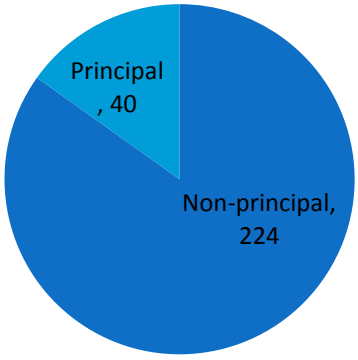

Figure 29: Number of climate change related projects categorized as principal and non-principal

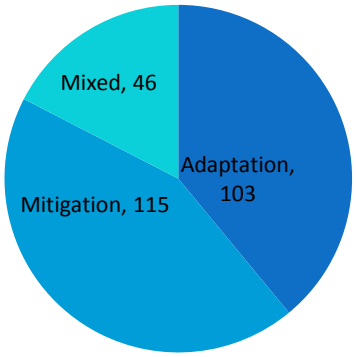

Figure 30: Number of climate change related projects targeting mitigation, adaptation or both

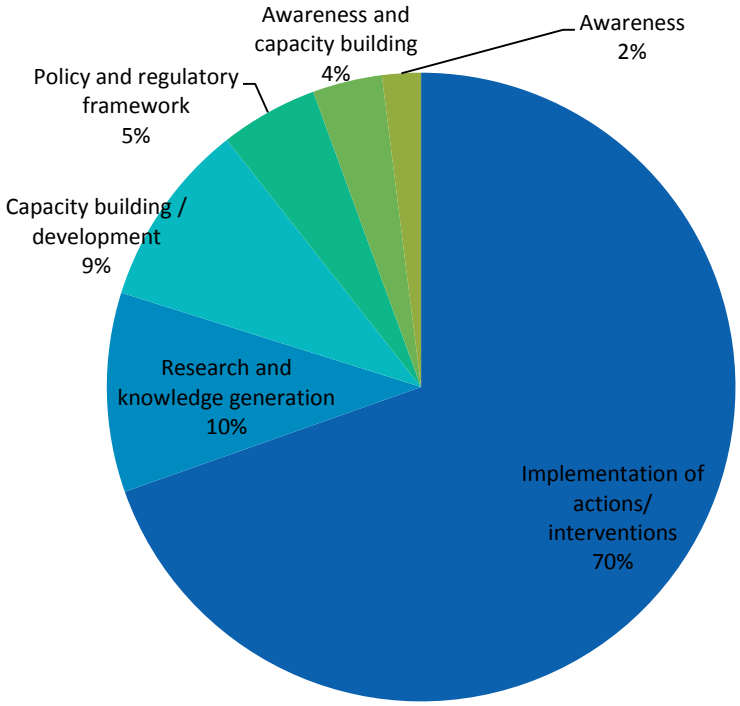

Figure 31: Aim of direct and indirect climate change projects

As for the support received, the survey showed that USD 142 million have been invested in Lebanon for climate change related activities among which only USD 30 million for principal climate change projects. Top donors are the European Union, United States Agency for International Development (USAID) and the GEF and most of the funding is directed to the government through specific ministries and governmental institutions (Figure 32).

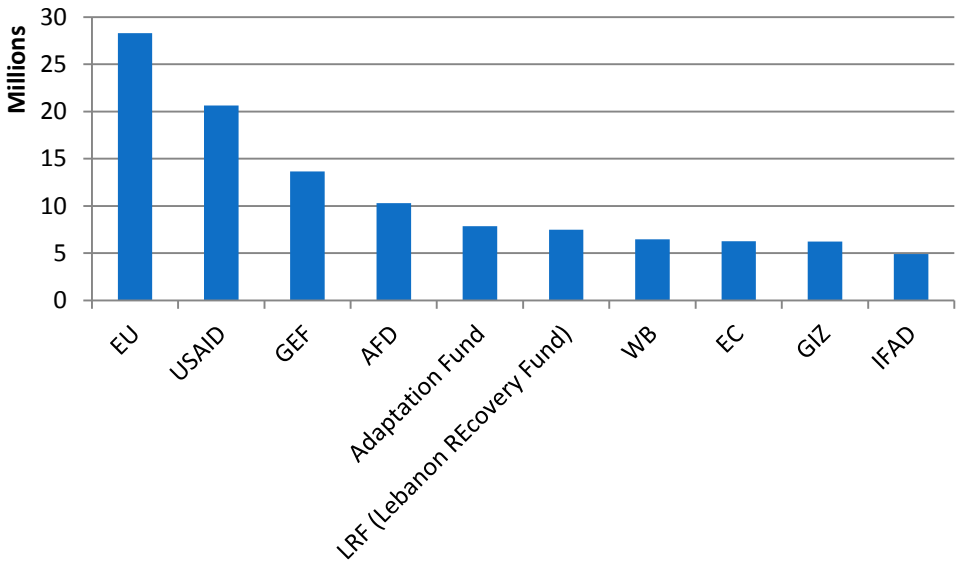

Figure 32: Top donors in climate change activities in Lebanon

The climate change mapping exercise is a one-time initiative that captured most of the climate change activities being implemented in Lebanon since 2005. However, it does not allow a continuous tracking and updating of projects and budgets across stakeholders. Although the CCCU is providing a good communication platform between the various institutions that deal directly or indirectly with climate change, it does not institutionalize any reporting or tracking mechanism.

Therefore, the establishment of a permanent climate change and MRV unit to better assess the progress and the gaps of these national projects is crucial for the grounding of any MRV system. The unit would be managed by the current climate change office at MoE and would include shared staff with other ministries such as the Ministries of Finance, Energy and Water, Industry, Agriculture, etc. The unit will also be responsible on looking exclusively at climate related activities and monitoring and evaluating the work of a wide range of national stakeholders. This will allow a better understanding of common objectives across institutions and will prioritize effective climate change policy actions. Table 19 presents an overview of the proposed tasks of the climate change and MRV unit.

Table 19: Tasks of the proposed MRV unit in Lebanon

MRV of emissions: - Improve the basis of information. - Identify areas and quantify potential for further mitigation action. - Clearly define roles and institutional responsibilities to ensure the smooth flow and standardization of information to all entities producing, reporting and verifying GHG estimates.
MRV of actions: - Account and assess the overall effectiveness of mitigation actions (i.e. emission reductions and progress to achieving objectives and co-benefits). - Identify challenges and opportunities. - Coordinate individual mitigation activities of bottom-up actions (private sector) and policies and top-down goals. - Develop and assign indicators for each activity, whether it seeks to measure GHG reductions or other benefits.
MRV of finance: - Provide a clearer overview of technology transfer, capacity building, financial flows, trends, sources, and purposes of international and domestic climate support. - Assess impacts of the provided support and allocated funds. - Calculate mitigation costs based on proven or credible methods and using the best available data.

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

5.1 Gaps and constraints

Numerous constraints and gaps still exist for Lebanon to report to the required standards and frequency to the UNFCCC. Constraint removal and filling of gaps will be possible in the medium and longer term with continuous national efforts and sustained support from bilateral and multilateral partners and donor agencies.

The main challenges faced in the preparation of the GHG inventory are still the same since the preparation of the country's first inventory in 1994 and are mainly related to unavailability, inaccessibility and inconsistency of activity data and emission factors. New challenges have arised from the collection and consolidation of information related to existing mitigation actions and are mainly related to lack of reporting and coordination between institutions working directly or indirectly on climate change and the difficulty in quantifying the emission reduction achieved by the implementation of each action.

Table 20 presents the key challenges identified in the preparation of the BUR and Annex III provides more details on sectoral constraints and proposed measures to overcome them.

Table 20: Key gaps and constraints in the preparation of Lebanon's first BUR

Administrative constraints
- Time lapse between the submission of the project proposal and the receipt of funds to launch the preparation of the BUR - Lack of clarity on the type of information to be presented in the BUR, namely concerning mitigation actions
Technical constraints
- Unavailability of activity data - Lack of disaggregated activity data - Inconsistency of data between different official sources - Underdeveloped sectoral databases - Deficiencies in technical expertise - Discontinuity in data series - Difficulty in estimating uncertainty for activity data and emission factors - Inaccuracy of emission factors to reflect national circumstances - Difficulty in estimating emission reductions induced by the implementation of mitigation activities
Institutional constraints
- Lack of institutional arrangements for data monitoring and reporting - Scattering of data throughout national agencies - Absence of willingness to share data between public/private institutions - Time delays in accessing and compiling data - Overlapping mandates of different agencies - Lack of consistency in assigning contact persons in governmental institutions - Lack of sufficient documentation on data sources from previous national communications reports - Lack of cooperation between different research bodies - Lack of knowledge of the main institutions about Lebanon's commitments under the UNFCCC

5.2 Information on the level of support received and needed to enable the preparation and submission of biennial update reports

In order to fulfill Lebanon's obligations to the UNFCCC in submitting biennial update reports, further support is needed to continue to develop and consolidate existing technical and institutional capacities.

Since the preparation of the Second National Communication, progress has been observed only in the area of capacity building for individuals and institutions whose experts were trained on the preparation of GHG inventories. Capacity building activities were usually organized by international organizations through regional projects (Climasouth, LECB project, etc.) or by the secretariat of the UNFCCC. However, capacity to prepare the BUR still needs to be strengthened due to the fact that the BUR is a new requirement and the guidelines on its preparation are not very explicit.

Other types of support to tackle other technical and institutional constraints are very limited. The UNDP LECB project is supporting the Ministry of Environment to develop a national GHG inventory system and an MRV system, however, progress is slow and institutional arrangements take time given the unstable political situation of the country. As a result, Lebanon still does not have a clearly defined system for data collection and processing, quality assurance and control, or a reporting and monitoring system. Some initiatives have been established, namely with the Ministry of Industry and decision 99/1 to institutionalize reporting of data, however the system is still in its foetal phase. Proper legal regulations that would fully define competences and responsibilities in this area are needed. In addition, the sustainability in the involvement of dedicated and competent individuals in all relevant institutions is crucial to ensure good quality reporting. Currently, institutions do not have sufficient technical equipment (in terms of appropriate software and hardware) and human resources to undertake the preparation of their relevant parts of the BUR.

Direct financial support related to the preparation of the BUR is not sufficient to develop both a GHG inventory and mitigation action plan up to the standards required by the UNFCCC. The lack of funds impels the project management team to cut on expenses and eliminates any opportunity to undertake surveys or in-depth studies to generate new sectoral data. Therefore, there is an urgent need to increase the funds available for countries to prepare their BURs and encourage the initiation of new activities that aim at improving the quality of the report.

In addition, the discontinuity of funds threatens the sustainability of the team involved in the preparation of the BUR and increases the risk of losing the momentum and technical wealth that was amassed throughout the process. A permanent climate change and MRV unit is needed to ensure timely reporting that is not project bound and to put in place a sustainable flow of reliable data that meets UNFCCC requirements with solid institutional and legal arrangements. Table 21 presents the key needs to streamline the process of compiling data for the BUR.

Table 21: Key needs for the preparation of BURs

Administrative needs
- Provide clear guidance on the modalities to follow to have early access to available funds for the preparation of the BUR. - Provide clear guidance on the expected content of the BUR. - Provide training to sectoral experts and project management team on methodology to analyze and report on mitigation actions. - Establish a permanent climate change and MRV unit.
Technical needs
- Conduct measurements campaigns in order to elaborate specific emission factors. - Develop GHG emission estimation models with local research institutes to create Lebanon-specific methodologies using advanced bottom-up approaches for inventory preparation. - Undertake surveys to determine missing activity data at the national level. - Develop research capacity and fund relevant research. - Conduct training for relevant institutions involved in planning, preparation, and analysis of GHG inventory. - Create a national GHG emission inventory review system by an independent team of experts.
Institutional needs
- Create a national system for the preparation of the GHG inventory, empowering the CAS, the relevant ministries and concerned public authorities to develop monitoring indicators. - Homogenize statistics between public, private, and international agencies. - Standardize/centralize data reporting and develop protocols for data accessibility. - Issue the necessary authorizations for the creation of individual emission databases in relevant institutions. - Provide continued investment in hardware and training of personnel for data collection, measurement and management .

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Annexes

Annex I: GHG inventory technical annex

Lebanon's GHG inventory - summary report for national GHG inventory 2011

Greenhouse gas source and sink categories		CO_2 emissions / removals CO_2 (Gg)	CO_2 removals	CH_4 CO_2 equivalent (Gg)	N_2O CO_2 equivalent (Gg)	NO_x (Gg)	CO (Gg)	NMVOCs (Gg)	SO_x (Gg)	HFCs (Gg)	PFCs* (Gg)	SF_6 * (Gg)	Other fluorinated (Gg)	Total gross CO_2 equivalent (Gg)
Total national emissions and removals 2011		20825.50	3,369.85	2,874.06	953.32	81.39	354.69	117.27	102.02	NE	NE	NE	NE	24,652.88
1. Energy		**18,071.19**		**40.07**	**173.56**	**81.38**	**354.45**	**71.83**	**100.29**					**18,284.82**
A. Fuel combustion	Reference approach[2]	18,426.25												
	Sectoral approach	**18,071.19**		**40.07**	**173.56**	**81.38**	**354.45**	**71.83**	**100.29**					**18,284.82**
1. Energy industries		7,853.04		6.66	19.66	21.14	1.59	0.53	72.12					7,879.36
2. Manufacturing industries and construction		2,675.10		1.37	6.08	6.53	0.33	0.16	18.91					2,682.55
3. Transport		5,645.42		25.41	142.60	51.00	352.00	71.00	0.00					5,813.43
4. Other sectors		1,897.63		6.63	5.22	2.71	0.54	0.14	9.26					1,909.48
5. Other (please		0.00		0.00	0.00	0.00	0.00	0.00	0.00					0.00

[2] The IPCC reference approach allows to validate the results of the sectoral approach, which considers energy consumption using a bottom up approach, whereas the IPCC reference approach considers energy suppusing top down approach This requires a balance of primary fuels produced, plus imports, minus exports, minus international bunkers and minus net changes in stocks.

Greenhouse gas source and sink categories	CO_2 emissions / removalsCO_2 (Gg)	CO_2 removals	CH_4 CO_2 equivalent (Gg)	N_2O CO_2 equivalent (Gg)	NO_x (Gg)	CO (Gg)	NMVOCs (Gg)	SO_x (Gg)	HFCs (Gg)	PFCs* (Gg)	SF_6 * (Gg)	Other fluorinated (Gg)	Total gross CO_2 equivalent (Gg)
specify)													
B. Fugitive emissions from fuels		-	NO		NO	NO	NO	NO					
1. Solid fuels			NO		NO	NO	NO	NO					
2. Oil and natural gas			NO		NO	NO	NO	NO					
2. Industrial processes	**2,584.18**		**0.00**	**0.00**	**0.00**	**0.00**	**41.48**	**1.73**					**2,584.18**
A. Mineral products	2,584.18				0.00	0.00	28.56	1.73					2,584.18
B. Chemical industry	NE		NE	NE	NE	NE	NE	NE					-
C. Metal production	NO		NO	NO	NO	NO	NO	NO					-
D. Other production	0.00				0.00	0.00	12.92	0.00					0.00
E. Production of halocarbons and sulphur hexafluoride									NO	NO	NO	NO	
F. Consumption of halocarbons and sulphur hexafluoride									NE	NE	NE	NE	
G. Other (please specify)	0.00		0.00	0.00	0.00	0.00	0.00	0.00					
3. Solvent and other product use	NE			NE			NE						-

Greenhouse gas source and sink categories	CO_2 emissions / removalsCO_2 (Gg)	CO_2 removals	CH_4 CO_2 equivalent (Gg)	N_2O CO_2 equivalent (Gg)	NO_x (Gg)	CO (Gg)	NMVOCs (Gg)	SO_x (Gg)	HFCs (Gg)	PFCs* (Gg)	SF_6 * (Gg)	Other fluorinated (Gg)	Total gross CO_2 equivalent (Gg)
4. Agriculture			**238.79**	**633.36**	**0.00**	**0.00**	**0.00**	**0.00**					**872.15**
1. Livestock			238.79	153.59			0.00						392.38
a. Enteric fermentation			201.11										201.11
b. Manure management			37.68	153.59			0.00						191.27
2. Rice cultivation			NO				NO						
3. Agricultural soils			0.00	479.77			0.00						479.77
4. Prescribed burning of savannas			NO	NO	NO	NO	NO						-
5. Field burning of agricultural residues			NO	NO	NO	NO	NO						-
6. Other (please specify)			0.00	0.00	0.00	0.00	0.00						0.00
5. Land use, land use change and forestry (LULUCF)**	**169.08**	- 3,369.85	**0.31**	**0.07**	**0.01**	**0.24**	**0.00**	**0.00**					**169.46**
1. Changes in forest and other woody biomass stocks	0.00	0.00											0.00
2. Forest and grassland conversion	0.00	0.00	0.00	0.00	0.00	0.00							0.00

Greenhouse gas source and sink categories	CO_2 emissions / removalsCO_2 (Gg)	CO_2 removals	CH_4 CO_2 equivalent (Gg)	N_2O CO_2 equivalent (Gg)	NO_x (Gg)	CO (Gg)	NMVOCs (Gg)	SO_x (Gg)	HFCs (Gg)	PFCs* (Gg)	SF_6 * (Gg)	Other fluorinated (Gg)	Total gross CO_2 equivalent (Gg)
3. Abandonment of managed lands		0.00											0.00
4. CO_2 emissions and removals from soil	0.00	0.00											0.00
5. Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00							0.00
6. Waste	**1.05**		**2,594.89**	**146.33**	**0.00**	**0.00**	**0.00**	**0.00**					**2,742.27**
A. Solid waste disposal on land			2,194.43										2,194.43
B.Wastewater handling			400.46	146.33	0.00	0.00	0.00						546.79
C. Waste incineration (and open burning)	1.05				0.00	0.00	0.00	0.00					1.05
D. Other (please specify)			0.00	0.00	0.00	0.00	0.00	0.00					0.00
7. Other (please specify)													
Memo items													808.05
International bunkers	**790**		**0.22**	**2.05**									792.02
A. Aviation	707		0.11	1.86									708.60

Greenhouse gas source and sink categories	CO_2 emissions / removalsCO_2 (Gg)	CO_2 removals	CH_4 CO_2 equivalent (Gg)	N_2O CO_2 equivalent (Gg)	NO_x (Gg)	CO (Gg)	NMVOCs (Gg)	SO_x (Gg)	HFCs (Gg)	PFCs* (Gg)	SF_6 * (Gg)	Other fluorinated (Gg)	Total gross CO_2 equivalent (Gg)
B. Marine	83		0.11	0.19									83.40
Multilateral operations													
CO_2 emissions from biomass	16												16.00
CO_2 captured													
Long-term storage of CO_2 in waste disposal sites													

Notes:

** Optional for Level 1 and Level 2 reporting*

*** Results reflect calculations of emissions from LULUCF based on 2003 GPG for LULUCF. Details of the calculation are presented in Table 12.*

N.B.: Shaded cells are not applicable.

Source: Table 1 and Table 2 in the annex to UNFCCC decision 17/CP.8 and Table A.15 in Ellis et al. 2011

Annex II: List of mitigation actions

Energy sector

Table A2- 1 Installed PV systems

Installed PV systems	
General information: PV systems are used to deliver electricity from solar power. The PV systems installed displace grid electricity and reduce the use of diesel backup generation. The systems were mostly installed in public schools, municipalities and community centers.	
Implementing agency	UNDP - CEDRO Project Lebanese Center for Energy Conservation (LCEC)
Geographical coverage	All regions of Lebanon
Budget	CEDRO: USD 1.05 million LCEC: USD 5.9 million
Timeframe	2007-2013
Source of funding	Spanish Government, via the Lebanon Recovery Fund (LRF) National Energy Efficiency and Renewable Energy Action (NEEREA)
Goals	Assist in establishing small-scale PV power in the market in Lebanon.
	Various capacity building and awareness raising initiatives on the technology
	Make various public institutions benefit from this technology.
Achievements or progress	All sites completed, equal to 1,936 kWp of capacity Annual savings around 2,877.12 MWh
GHG emission reduction expected	1,682 tonnes of CO_2eq./year
Methodology	Revised 1996 IPCC guidelines
Assumptions	GHG emission reduction is calculated from reduction of EDL usage and diesel electricity generation.
Enabling environment	The implementation of a Feed In Tariff is necessary for the PV installations development.

Table A2- 2: Installed Solar Water Heating

Installed Solar Water Heating

General information: SWH systems use solar energy to heat water for domestic and industrial uses. The collected heat is transferred to a storage tank through a fluid system, where water will be heated. The SWH systems are placed in parallel to existing conventional heating units or in series to reduce diesel consumption in the existing conventional boilers systems. Various initiatives were undertaken to provide hot water to schools, hospitals, jails and other public buildings / facilities.	
Implementing agency	UNDP - CEDRO Project Lebanese Center for Energy Conservation (LCEC)
Geographical coverage	All regions of Lebanon
Budget	CEDRO: USD 1.26 million LCEC: USD 1.44 million
Timeframe	2007-2011
Source of funding	Spanish Government, via the LRF National Energy Efficiency and Renewable Energy Action (NEEREA)
Goals	Assist in establishing commercial solar hot water market in Lebanon
	Various capacity building and awareness raising initiatives on the technology
	Make various public institutions benefit from the technology
Achievements or progress	Totally installed 126,000 liters and 1,800m^2
GHG emission reduction expected	995 tonnes of CO_2eq./year
Methodology	Revised 1996 IPCC guidelines
Assumptions	GHG emission reduction is calculated from the difference between using conventional fuel sources to produce hot water and producing it using renewable energy sources.
Enabling environment	The existing set-up being implemented by LCEC is giving very good results in terms of SWH market expansion.

Table A2- 3: LED street lighting

LED street lighting	
General information: LED street lighting fixtures replace High Pressure Sodium (HPS) street lighting fixtures. It reduces approximately 35% of electricity demand in comparison to the HPS.	
Implementing agency	UNDP - CEDRO Project Lebanese Center for Energy Conservation (LCEC)
Geographical coverage	All regions of Lebanon
Budget	CEDRO: USD 360,000 LCEC: USD 3.61 million
Timeframe	2007-2011

Source of funding	Spanish Government, via the LRF National Energy Efficiency and Renewable Energy Action (NEEREA)
Goals	Assist in establishing energy efficiency street lighting
	Make various public institutions benefit from this technology
Achievements or progress	All street lighting fixtures (replacing HPS) sites are completed. Annual savings around 10,965 MWh
GHG emission reduction expected	7,434 tonnes of CO_2eq./year
Methodology	Internal calculations
Assumptions	100 Watt LED replaces 150 Watt HPS (saving 50 W). Operational from 8 pm to 6 am (10 hours).
Enabling environment	The cost of LED Lighting is still very high and there are many brands in the market that have performances lower than the expectations. The market needs to be controlled by qualifying the good products and introducing incentives to foster the LED installations.

Table A2- 4 Microwind and microwind-PV

Microwind and microwind-PV	
General information: Microwind and microwind-PV systems are used to deliver electricity. The systems installed by CEDRO displace grid electricity and reduce the use of diesel backup generation. The systems mostly were installed in public schools, municipalities and community centers.	
Implementing agency	United Nation Development Program - CEDRO Project
Geographical coverage	All regions of Lebanon
Budget	CEDRO: USD 9.76 million Allocated to microwind and microwind PV: Approximately USD 100,000
Timeframe	2007-2013
Source of funding	Spanish Government, via the LRF
Goals	Assist in establishing small-scale microwind power in the market in Lebanon.
	Various capacity building and awareness raising initiatives on the technology.
	Make various public institutions benefit from this technology
Achievements or progress	All sites completed, equal to 16 kWp of capacity. Annual savings around 23.77 MWh
GHG emission reduction expected	12 tonnes of CO_2eq./year Assumed 8 years maximum (cumulative): 96 tonnes of CO_2eq.

Methodology	Internal calculations
Assumptions	GHG emission reduction is calculated from reduction of EDL usage and diesel electricity generation.
Enabling environment	The implementation of a Feed In Tariff is necessary for the PV installations development.

Table A2- 5 Replacement of CFL lamps

Replacement of CFL lamps	
General information: The purpose of the CFL replacement project is to replace 3,025,000 working incandescent lamps with 23 Watt (W) CFLs in approximately 1,415,000 households. CFLs were distributed door-to-door by the electricity bill collectors to residential electricity subscribers. Each household involved in the project received CFLs free of charge in exchange of working incandescent lamps in operation at the household up to a maximum of 3 CFLs. The project resulted in CO_2 emission reduction by saving electricity from the Lebanese power grid.	
Implementing agency	Ministry of Energy and Water (MoEW) Lebanese Center for Energy Conservation (LCEC)
Geographical coverage	All regions of Lebanon
Budget	USD 7 million
Timeframe	2012
Source of funding	Government of Lebanon
Goals	Replace incandescent lamps with CFL lamps
	Reduce GHG emissions
Achievements or progress	3,025,000 incandescent lamps replaced in 1,415,000 households across Lebanon
GHG emission reduction expected	90,036 tonnes CO_2eq. per year
Methodology	Internal calculations
Assumptions	-
Enabling environment	-

Table A2- 6 Replacement of CFL lamps

Energy saving measures implemented self-financed by the private sector	
General information: This includes energy efficiency measures and initiatives implemented by some institutions from the private sector through their own funding	
Implementing agency	Private Sector
Geographical coverage	All Lebanon

Budget	N.A
Timeframe	2005 - 2012
Source of funding	Private funding
Goals: Aims at reducing the electricity consumption at the facility through the implementation of various energy saving measures such as solar water heaters, energy efficient lighting, power factor correction, and other measures.	
Achievements or progress	Totally installed - Solar Water Heaters: 184,700 liters - Energy Efficiency Measures: 20,440 MWh/year
GHG reduction	**Annual GHG Emissions Reduction:** 19,025 tonnes CO_2
Emission reduction expected by completion of action	N.A.
Methodology	Revised 1996 IPCC guidelines
Assumptions	Emission factors: -EDL: 0.65 kg/MWh -Genset: 1.3 kg/kWh -Diesel Heating: 0.25 kg/kWh (Carbon trust) Water Heating: 70% electrical, 30% diesel & gas (LCEC 2014) Electricity: 65% EDL, 35% Genset (EDL data)

Agriculture

Table A2- 7 Conservation agriculture

Conservation agriculture	
General information: Introducing CA in the Bekaa to wheat and barley crop production in rain-fed areas. LARI, and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) successfully implemented demonstration trials at farmer's fields, showing lower cost, lower fuel consumption, higher soil moisture, and improved yield.	
Implementing agency	LARI
Geographical coverage	Bekaa
Budget	Not Available. 70% of seeder machine price (approximately USD 10,000)
Timeframe	Funded: 2007-2010; non funded: 2011-present
Source of funding	The Deutsche Gesellschaft für Internationale Zusammenarbeit , until 2010
Goals	
Goal 1: Reduce energy used and CO_2 emissions by reducing fuel use.	
Goal 2: Reduce fertilizer used and N_2O emissions.	
Goal 3: Conservation of water	
Goal 4: Increase total cost savings to farmer per ha.	
Achievements or progress	1,800 ha of CA by 2012
GHG reduction	Increase CO_2 sequestration and decrease N_2O emissions
Emission reduction expected by completion of action	Not Available
Methodology	1996 IPCC
Assumptions	By implementing CA, N_2O emissions will decrease.

Table A2- 8 Livestock Management- improvement of the cattle production

Improvement of the Cattle production sector	
General information: Improving the health status of cows in the North region. The project involved 107 farmers from 38 villages and treated around 1,922 cows. Around 80% of the farmers adopted the new technologies, milk production increased by 20-40%, and there was 70% improvement in the herd's health.	
Implementing agency	Moawad Foundation
Geographical coverage	Cazas of Akkar, Zgharta, Minnieh, Dennieh, Becharre, Koura, Batroun and Jbeil in North Lebanon

Budget	USD 633,000
Timeframe	Two years (2009-2011)
Source of funding	United States Department of Agriculture (USDA)
Goal 1 Development of cattle breeding	Create a training program for cattle breeders.
	Better herd health
Goal 2 Improvement of the cattle's nutrition	Pellet production
	Expansion of forage cultivation in Akkar/North Lebanon.
Achievements or progress	-Milk production increased by 20-40%. -Around 70% improvement in the herd's health -Artificial insemination for 484 cows belonging to 46 farmers
GHG emission reduction expected	CH_4 from enteric fermentation and MMS: 1,155 tonnes of CO_{2eq} during the two year period
Methodology	1996 IPCC
Assumptions	-Assuming 80% of the cow herd was improved (1,538 heads) since 80% of farmers adopted the new technology -Production of milk before this initiative: 1,538 x 20 kg milk/day = 30,760 kg milk/day -This initiative increased milk production by an average of 30%. -By implementing this initiative and in order to produce the same quantity of milk, the herd is reduced by an average of 461 cows thus leading to GHG emission reduction.

Table A2- 9 Livestock management - vaccination

Emergency vaccination and targeted feeding of livestock grazing in areas along the Syria-Lebanon border	
General information: Due to the war in Syria, Syrian shepherds have been crossing the border with their livestock, increasing the risk of disease transmissions. This project aims to benefit both Syrian and Lebanese farmers and shepherds.	
Implementing agency	Food and Agriculture Organization and the Lebanese Ministry of Agriculture
Geographical coverage	Lebanese-Syrian border
Budget	In 2012, MoA spent USD 6.44 million
Timeframe	Annually
Source of Funding	FAO and MoA
Goal 1 Improved delivery of veterinary service and for a higher percentage of sheep by: 1) Conducting rapid need assessments to identify livestock population and risk, 2) Undertaking emergency vaccination strategies for Lumpy Skin Disease (LSD) and Food and Mouth Disease (FMD), for sheep, goats and cattle, 3) Training professional veterinarians.	

Goal 2 Increase number of livestock keepers able to retain and make a living from their herds of sheep by: 1) Distributing feed to target beneficiaries, 2) Enabling farmers to adopt new technologies and practices on improving pasture/rangeland management.	
Achievements or progress	Increased number of sheep, goats and cattle adequately nourished and vaccinated against circulating serotypes of LSD and FMD. Veterinary and livestock extension services developed and functioning at the community level in remote areas along the Syrian border. Assessing risks and outbreaks for rapid containment of Transboundary Animal Disease (TAD).
GHG emission reduction expected	CH_4 and N_2O reduction. Not quantified.

Table A2- 10 Livestock management - recovery and rehabilitation of the dairy sector in Bekaa Valley and Hermel-Akkar uplands

Recovery and rehabilitation of dairy sector in Bekaa Valley and Hermel-Akkar uplands	
General information: This project covered the regions of North Lebanon, through Dairy Producers' Association covering 300 villages and 2,900 farmers. This project decreased cow diseases related to feeding excessive concentrate (by increasing forage distribution), thus increasing milk productivity by 15%.	
Implementing agency	Food and Agriculture Organization (FAO) and the Lebanese Ministry of Agriculture (MoA)
Geographical coverage	Akkar, Hermel and Bekaa
Budget	USD 2.5 million
Timeframe	Three years (2009 - 2012)
Source of Funding	Lebanon Recovery fund
Number of farmers helped	2,900 farmer
Goal Support the small and poor dairy farmers and producers in the Bekaa and Akkar and the goat and sheep farmers in Hermel and Akkar uplands.	Conducting training programs to improve farm management practices, milk hygiene, feeding and promoting fodder crops. Improving dairy cattle feeding, increasing milk production and maintaining livestock health.
Achievements or progress	The project was completed in 2012.
GHG emission reduction expected	CH_4 from enteric fermentation and MMS: 9,289 tonnes of CO_{2eq} reduced as a result of this project N_2O from MMS: 3,100 tonnes of CO_{2eq} reduced as a result of this project
Methodology	1996 IPCC
Assumptions	-According to MoA, 59% of dairy cattle are located in the North and Bekaa region.

	-Production of milk before this initiative: 24,780 x 20 kg milk/day = 495,600 kg milk/day -This initiative increased milk production by 15%. -By implementing this initiative and in order to produce the same quantity of milk, the herd is reduced by 3,717 cows leading to GHG emission reduction.

Table A2- 11 Manure management - composting of dairy manure

Composting of dairy manure	
General information: a private company is applying this project. Every year, 500-800 tonnes of high quality compost is produced and sold to farmers.	
Implementing agency	LibanLait
Geographical coverage	Bekaa
Cost of production	USD 25,000-40,000
Timeframe	Annually
Source of funding	LibanLait
Quantity of manure treated	2,800 tonnes
Goal Produce a high quality compost from dairy cow manure produced at the farm	
Achievements or progress	Increase in compost quantity by 10% on yearly basis
GHG reduction	CH_4 and N_2O
Emission reduction expected by completion of action	N_2O from MMS: 620 tonnes CO_2eq. reduced as a result of this project CH_4 from MMS: 400 tonnes CO_2eq.reduced as a result of this project
Methodology	1996 IPCC
Assumptions	The calculations were based on the assumption that manure from 1,000 cows is being converted to compost

Table A2- 12 Organic agriculture in Lebanon

Organic agriculture reduces GHG emissions through an appropriate combination of organic fertilizers, crop rotation, cover crops, less intensive tillage, and integrated pest management	
General information: Organic farming is increasingly utilized in crop and animal production in Lebanon in response to consumer demand for nutritious and safe products. This includes dairy, vegetables, fruits, citrus, olives, herbs and medicinal plants. Most organic farms are currently certified by Instituto Mediterraneo Di Certificazione (IMC).	
Certification agency	Instituto Mediterraneo Di Certificazione (IMC)
Geographical coverage	Currently 2,800 ha all over Lebanon

Achievements or progress	2,500 ha in 2005 increased to 2,800 ha by 2012.
GHG emission reduction mechanisms	Increase CO_2 sequestration and decrease CO_2, N_2O, and CH_4 emissions through: - Use of organic rather than synthetic fertilizer and prohibitive use of chemical herbicides or insecticides - Use of legumes (N-fixing from atmosphere) - Less use of fuel through less tillage - Use of less concentrate feed and increased grazing
GHG emission reduction potential	No local data Global (Niggli et al; 2009): - Reduce industrial N-fertilizer use that emits 6.7 kg CO_2eq. per kg N on manufacture and another 1.6% of the applied N as soil N_2O emission. - Sequestration rate of 200 kg C/ha/year for arable and permanent crops and 100 kg C /ha/year for pastures - Combining organic farming with reduced tillage on arable land sequesters 500 kg C/ha/year

Land use, land-use change and forestry

Table A2- 13 The reforestation initiative of the Ministry of Environment of Lebanon

The reforestation initiative of the Ministry of Environment of Lebanon	
General information: The Ministry of Environment was handled the prerogative of initiating the NRP, aiming at the restoration of the country's green cover loss throughout the years. Accordingly, the Ministry of Environment has executed from 2002 till 2006 (and later on from 2009 to 2014) reforestation activities in all Lebanese regions within the context of the NRP. 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, sometimes with contributions from NGOs.	
Implementing agency	Ministry of Environment of Lebanon
Geographical coverage	All Lebanese territories
Budget	In 2001, the Lebanese government allocated in the national budget LBP 25 billion (approximately USD 16.67 million) scheduled over five years for the execution of reforestation projects at the national level.
Timeframe	2002-2014
Source of funding	Government of Lebanon
Goals: To restore the country's green cover loss throughout the years	
Achievements or pogress	The reforestation of 834 hectares of forest lands fairly distributed in the five Muhafazat, as follows: **Mount Lebanon**: 60 ha: Faraya and Barouk - 45 ha: Hammana, Damour, Ehmej. **North Lebanon**: 60 ha: Akkar el Atiqa, Ehden, Bcharri, Tannourine - 54 ha: Kousba, Tannourine, Akkar el Atiqa **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 **South Lebanon**: 50 ha: Jezzine, Al Qraye, Abbassie, Majdelzoun. **Nabatieh**: 55 ha: Kfar Rummane, Rmeich, Ebel el Saki, Marjeyoun, Hasbaya - 75 ha: Al-Rihan, Zawtar Esharkieh, El-Merwanieh, Kherbit Selem, Markaba 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.
GHG reduction as of end 2012	11.116 Gg of CO_2
Emission reduction expected by completion of action	Not available
Methodology	IPCC GPG for LULUCF 2003
Assumptions	Assuming an annual average area of 104.25 ha was successfully planted and maintained from 2005 throughout 2012.

Table A2- 14 The 40 million forest trees initiative of the Ministry of Agriculture

The 40 million forest trees initiative of the Ministry of Agriculture	
General information: The NRP of the MoA is designed to meet the objectives of the MoA strategy while falling in line with the "Schema Directeur de l 'Amenagement des Territoires Libanais SDATL" developed earlier in time**.**	
Implementing agency	Ministry of Agriculture
Geographical coverage	All Lebanese Governorates
Budget	Approximate cost: USD 350,000,000 assuming 10 USD per tree and 500 trees per ha (i.e. USD 5,000 per hectare) for a total of 70,000 ha
Timeframe	20 years
Source of Funding	Not available
Goals: The NRP main objectives are summarized as follows: • Increase the total surface of forests to 20% in a 20 year period of time i.e. an increase of 70,000 hectares of the current areas while maintaining their resilience against numerous hazards such as urban encroachment, fire risks, and climate change effects, among others. • Protect the biodiversity of the national forests against climate change, overexploitation, and erosion. • Enhance and develop the forest economical environmental, social, cultural functions.	
Achievements or progress	Launching of the EU funded forestry actions in Lebanon in 2014 Official launching of the 40 million forest trees initiative's Mmaster plan on 10-12-2014
GHG reduction	Not available
Emission reduction expected by completion of action by 2034	933 Gg CO_2 eq.

Methodology	IPCC GPG for LULUCF 2003
Assumptions	Assuming that 1) a total of 3,500 ha is planted every year starting the year 2015 and ending the year 2034, and 2) the cumulative planted area is successfully maintained.

Table A2- 15 National physical master plan of the Lebanese territory

National physical master plan of the Lebanese territory	
General information: The master plan describes holistically the physical realities impacting land use, future challenges, alternative configurations for land use and development, land use principles, as well as sectoral action plans (transport, tourism, energy, water, environment, education, etc.). The plan presented a vision for national urban planning and critical recommendations for enhancing and harmonizing land uses in Lebanon while protecting the natural and cultural resource base. In 2002, the CoM requested the CDR to prepare a National Land Use Master Plan for Lebanon. Following an international tender, CDR contracted the consortium Dar Al Handasah – Institut d'Aménagement et d'Urbanisme d'Ile-de-France (DAR-IAURIF) to prepare the required studies and articulate the master plan.	
Implementing agency	Council for Development and Reconstruction
Geographical coverage	All Lebanon
Budget	USD 2,970,000
Timeframe	2002-2005
Source of funding	Government of Lebanon
Goals: To propose a unified set of land use categories covering the entire territory, and delineating several protection zones of ecological and patrimonial importance.	
Achievements or progress	The final analysis was published in 2004-2005 including a final report, maps, and a geo-database The Lebanese CoM approved the master plan (decree 2366 dated 20-06-2009) The master plan is a reference document for several administrations including the Directorate General for Urban Planning (DGUP) (which has to refer back to the master plan when preparing, reviewing or approving new urban master plans) and line ministries (agriculture, environment, public works and transport, water and energy, industry, economy and trade and culture/directorate general of antiquities). They should refer to the master plan when making decisions related to urban development, the provision of public services, and environmental heritage conservation.

GHG reduction	In reference to LULUCF, the master plan acknowledges that - Remarkable sites (mountains, valleys, landscapes and coastline) and natural areas (especially forested zones) constitute in Lebanon a unique asset that must be used for improving the quality of life and the tourism economy. The use of sites, as resources, should avoid their degradation. - The best agricultural lands constitute a national asset that should not be derelict. - There is a need to rationalize the use of land and resources in response to challenges of the future demographic growth and urban sprawl.
Emission reduction expected by completion of action	Not available
Methodology	Not available
Assumptions	Not available

Table A2- 16 Alleviating barriers for quarries rehabilitation

Alleviating Barriers for Quarries Rehabilitation (ABQUAR)	
General information: The ABQUAR project addressed the problem of quarries rehabilitation in Lebanon. Lebanon is spotted with over 1,000 quarries exploited with little consideration to the surrounding environment and its inhabitants thus causing among others: 1) destruction of vegetation and important natural habitats, and 2) permanent loss to biodiversity and natural resources. Decree no. 16456/2006 amended decree no. 8803/2002 where it brought further improvements and restrictions to the quarry sector (MoE/UNDP/ECODIT, 2011). For example, the decree bans quarrying inside protected areas. As of 31 December 2010, MoE had 135 bank guarantees on file worth LBP 4.6 billion (or USD 3.07 million). Despite widespread noncompliance by the vast majority of operators, MoE has yet to exercise its public right to deposit bank guarantees and use the money to finance site rehabilitation. Decree no. 1735/2009 also amended decree no. 8803/2002 where it explicitly requires the declaration (statement) that operators must obtain from the MoEW (general directorate of exploitation) to address the potential impacts of the proposed quarry on surface and groundwater and on transmission lines.	
Implementing Agency	Ministry of Environment
Geographical Coverage	All Lebanon
Budget	Euro 463,592
Timeframe	2005-2007

Source of funding	The European Commission through Life Third Countries program (EC-LIFE) and the Ministry of Environment (MoE)
Goals: 1) Alleviating all legal, technical and financial barriers impeding rehabilitation processes of quarries in Lebanon, and 2) Mitigating quarries environmental and socio-economic impacts.	
Achievements or progress	- Review of existing institutional and legal frameworks - Development of a Geographic Information System (GIS)-based Decision Support System (DSS) as a tool for prioritization of quarries rehabilitation - Identification of best rehabilitation practices for various kinds of quarries - Development of financial mechanisms and economic incentives for quarry rehabilitation - Strengthening institutional and human capacities through comprehensive training programs tailored to local needs - Drafting a new comprehensive law for quarries - Development of a national rehabilitation program - Increasing public participation and awareness of the benefits of rehabilitation - Communication and dissemination of project's outcomes and results
GHG reduction	It is believed that this project contributes to an improved understanding in rehabilitation of quarrying sites which in turn can help in reducing GHG when moving to implementation of the national rehabilitation program.
Emission reduction expected by completion of action	Not available
Methodology	Not available
Assumptions	Not available

Table A2- 17 Reforestation on degraded lands

Reforestation on degraded lands
General information: This project involved reforestation activities on degraded lands in rural areas**.**

Implementing agency	Association for Forests, Development and Conservation (AFDC) in partnership with the CDR
Geographical coverage	Aley (Il Jurd) and Aiha
Budget	USD 200,000
Timeframe	2006-2007
Source of funding	Council for Development and Reconstruction
Goals: to conduct rural empowerment activities including reforestation of degraded lands**.**	
Achievements or progress	Reforesting a total of 37 ha of degraded lands among other achievements.
GHG reduction	0.49 Gg of CO_2
Emission reduction expected by completion of action	Not available
Methodology	IPCC GPG for LULUCF 2003
Assumptions	Assuming that an area of 37 ha was successfully planted and maintained.

Table A2- 18 Regaining ecological integrity

Regaining ecological integrity of forests	
General information: This project worked towards regaining the ecological integrity needed through supporting rural development activities.	
Implementing agency	AFDC in partnership with World Wide Fund for Nature (WWF) Italy and the cooperative of beekeepers in the higher Metn and Qornayel
Geographical coverage	Ramlieh and Qornayel (Mount Lebanon)
Budget	USD 300,000
Timeframe	2006-2009
Source of funding	WWF
Goals: To support rural development activities	
Achievements or progress	- Establish a forest center in Qornayel village. - Create marketing packages for the rural products in both sites. - Reforestation of 4 ha in two sites in Ramlieh and Qornayel villages.

	- Increase the capacity of AFDC units in forest fire fighting and prevention by building capacities and provision of equipment. - Other achievements
GHG reduction	0.05 Gg of CO_2
Emission reduction expected by completion of action	Not available
Methodology	IPCC GPG for LULUCF 2003
Assumptions	Assuming that an area of 4 ha was successfully planted and maintained

Table A2- 19 Reforestation project in South Lebanon

Restoration and conservation of sensitive forest areas in Lebanon	
General information: This project worked towards restoring sensitive forest areas in South Lebanon after the 2006 war**.**	
Implementing agency	AFDC in partnership with WWF Italy
Geographical coverage	South Lebanon
Budget	USD 645,000
Timeframe	2007-2008
Source of funding	Italian Cooperation
Goals: Restore damaged lands among others	
Achievements or progress	- Restoration of 50 ha of damaged areas in South Lebanon based on the assessment in cooperation with local authorities and land owners. - Provide monitoring equipment to the forest guard, civil defense centers and army, and forest firefighting equipment and tools for AFDC fire fighters local units for early intervention in forest fires. - Design and implement a training program on forest management and forest fire fighting and control addressing the civil defense, the army and the forest guards. - Other achievements
GHG reduction	0.66 Gg of CO_2
Emission reduction expected by completion of action	Not available
Methodology	IPCC GPG for LULUCF 2003
Assumptions	Assuming that an area of 50 ha was successfully planted and maintained in 2008

Table A2- 20 Emergency reforestation intervention

Support the national early recovery efforts in restoring a part of the burned Lebanese forests	
General information: This project contributed to the national efforts for early recovery after the 2006 war.	
Implementing agency	AFDC in partnership with the Ministry of Environment
Geographical coverage	Various locations in Lebanon
Budget	Euro 200,000
Timeframe	2007-2008
Source of funding	Italian Cooperation
Goals: To support the national early recovery efforts in restoring a part of the burned Lebanese Forests.	
Achievements or progress	- 20 hectares of lands reforested - One tree nursery established - A tree nurseries assessment report produced
GHG reduction	0.266 Gg of CO_2
Emission reduction expected by completion of action	Not available
Methodology	IPCC GPG for LULUCF 2003
Assumptions	Assuming that the seedlings were successfully planted and maintained

Table A2- 21 Forest for peace

Forest for peace project	
General information: This project responded to the need for improving the quality of life of the rural population in South Lebanon.	
Implementing agency	AFDC in partnership with the Norwegian Agency for Developnebt Cooperation (NORAD), Friendship Organization Norway - Lebanon
Geographical coverage	Aarkoub-South Lebanon
Budget	USD 25,000
Timeframe	2008-2009
Source of funding	NORAD
Goals: To contribute to improving the quality of life of the rural population in South Lebanon**.**	
Achievements or progress	- Reforestation of 0.25 hectares of pine - Reforestation of 20 hectares in Fardis, South Lebanon - Other achievements
GHG reduction	0.269 Gg of CO_2

Emission reduction expected by completion of action	Not available
Methodology	IPCC GPG for LULUCF 2003
Assumptions	Assuming that the seedlings were successfully planted and maintained.

Table A2- 22 Development of a community forest

Reforestation: development of a community forest	
General information: This project recognized the need to involve the local communities in forest development	
Implementing agency	AFDC in partnership with Lebanese Dutch Business Association
Geographical coverage	Aley, Mount Lebanon Jezzine, South Lebanon
Budget	Euro 47,000
Timeframe	2008
Source of funding	Embassy of the Netherlands
Goals: Support the national early recovery efforts in restoring a part of deforested lands and in increasing the percentage of forest cover in Lebanon**.**	
Achievements or progress	- 4 hectares of land in the village of Jesr Elkadi (Aley, Mount Lebanon) were reforested with 2,000 seedlings of stone pine. - 2 hectares of land in the village of Qaitouly (Jezzine, South Lebanon) were reforested with 1,000 seedlings of stone pine. - 1 hectare of land in the village of Bkaseen (Jezzine, South Lebanon) was reforested with 500 seedlings of stone pine.
GHG reduction	0.093 Gg of CO_2
Emission reduction expected by completion of action	Not available
Methodology	IPCC GPG for LULUCF 2003
Assumptions	Assuming that the seedlings were successfully planted and maintained.

Table A2- 23 Management and sustainable development of forest areas

Management and sustainable development of forest areas	
General information: This project worked towards the management and sustainable development of forest areas in Andket- Akkar in North Lebanon	
Implementing agency	AFDC
Geographical coverage	Andket-Akkar
Budget	Euro 449,000
Timeframe	2008-2009
Source of funding	Italian Cooperation, Ross II
Goals: To manage forest areas in Andket - Akkar in the north of Lebanon**.**	
Achievements or progress	- Pilot forest areas in North Lebanon restored (10 ha) - Establishment of a forest center for multiple uses - Stronger and updated human and technical capacities on sustainable forest and agriculture management are available. - Fire prevention measures are implemented
GHG reduction	0.133 Gg of CO_2
Emission reduction expected by completion of action	Not available
Methodology	IPCC GPG for LULUCF 2003
Assumptions	Assuming that the seedlings were successfully planted and maintained.

Table A2- 24 Reforestation within an integrated forest fire management

Reforestation within an integrated forest fire management	
General information: This project addressed forest and forest fire management issues in Lebanon in an integrated approach	
Implementing agency	AFDC, Ministry of Environment, and FAO
Geographical coverage	Various locations in Lebanon
Budget	USD 2,600,000
Timeframe	2008-2011
Source of funding	Lebanon Recovery Fund
Goals: To improve Forest fire management in Lebanon through prevention, intervention, and restoration.	
Achievements or progress	- Identification of the forest sensitive areas to be targeted and the kind of intervention needed in each site - Installation of a new tree nursery. - Rehabilitation of infrastructure for combating fires and establishment of fire breaks, water ponds, and water outlets - Reforestation of 100 ha of degraded lands - Conduct training sessions on fire management and control to the civil defense, Lebanese army, forests guards and volunteers. - Implement national public awareness campaign on forests and fire prevention. - Produce awareness materials on fire prevention for dissemination to the public, targeting local communities.
GHG reduction	1.332 Gg of CO_2
Emission reduction expected by completion of action	Not available
Methodology	IPCC GPG for LULUCF 2003
Assumptions	Assuming that the seedlings were successfully planted and maintained.

Table A2- 25 Reforestation and afforestation activities conducted by Jouzour Loubnan

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	USD 946,659 (assuming an average cost of USD 7 per seedling)
Timeframe	2008-2014
Source of funding	Different sources of funding including the EU, the private sector, and USAID through Lebanese Reforestation Initiative (LRI).
Goals: 1) To 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) to empower local communities, and 3) to promote environmental awareness.	
Achievements or progress	A total of 135,237 seedlings were planted.
GHG reduction by 2012	1.37 Gg of CO_2
Emission reduction as of end 2014	2.57 Gg of CO_2
Methodology	IPCC GPG for LULUCF 2003
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 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 (in 2013), and 24,055 seedlings (in 2014).

Table A2- 26 Safeguarding and restoring Lebanon's woodland resources

Safeguarding and restoring Lebanon's woodland resources	
General information: This project works towards creating an enabling environment and capacity for Sustainable Land Management (SLM) as a contribution to greater ecosystem stability, reduced soil erosion.	
Implementing agency	UNDP-Lebanon in partnership with the Ministry of Environment
Geographical coverage	All Lebanese territories
Budget	USD 980,000 (assuming an average cost of USD 7 per seedling)
Timeframe	2009-2014
Source of funding	Global Environment Facility
Goals: - Development of a strategy for the safeguarding and restoring of Lebanon's woodland resources through capacity building and execution of appropriate SLM policies and practices; - Strengthening the capacity of the Ministry of Environment in the field of reforestation; - Support the Ministry of Environment in the implementation of the NRP; - Raising of funds for the implementation of reforestation activities in Lebanon; - Implementation of a set of innovative technologies and instruments for the rehabilitation of forests and woodlands, and their subsequent sustainable management.	
Achievements or progress	- Strengthening the capacity of local forest seedlings production nurseries through the introduction of modern technologies for the production of seedlings with good quality and low cost in coordination with foreign experts. - Reducing the cost of reforestation in Lebanon through the adoption of modern techniques tested by the project and found sound and viable. - Assisting the Ministry of Environment in the development of a new concept of direct contracting with municipalities, which was put in practice for the first time in Lebanon. - Launching a new reforestation project in coordination with USAID with a budget of USD 12,000,000 for the development of forest nurseries and the introduction of some modern techniques of reforestation in Lebanon. - A total of 30 ha of land was reforested during the lifetime of the project. - The project helped the Ministry of Environment reforesting a total of 191.5 ha during the third phase of the reforestation plan.
GHG reduction	Not available

Emission reduction as of end 2014	0.39 Gg of CO_2
Methodology	IPCC GPG for LULUCF 2003
Assumptions	Assuming that the seedlings were successfully planted and maintained. The reforested 191.5 ha with the help of the project were accounted for in the reforestation plan of the MoE.

Table A2- 27 Lebanon Reforestation Initiative

Lebanon Reforestation Initiative	
General information: The LRI, funded by the 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	LRI in partnership with local community groups
Geographical coverage	Tannourine, Bcharreh, Kfarzabad, Aanjar, Rashaya, El Qlaiaa, Ainata, Rmadyeh, and Maqne
Budget	USD 2,734,109 (assuming an average cost of USD 7 per seedling)
Timeframe	2011-2014
Source of funding	USAID
Goals: The LRI 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	A total of 390,587 seedlings were planted.
GHG reduction by 2012	3.87 Gg of CO_2
Emission reduction as end of 2014	7.43 Gg of CO_2
Methodology	IPCC GPG for LULUCF 2003
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 76,087 seedlings (in 2011), 127,536 seedlings (in 2012), 127,536 seedlings (in 2013), and 59,428 seedlings (in 2014).

Table A2- 28 Developing Lebanon's national strategy for forest fire management

Developing Lebanon's national strategy for forest fire management	
General information: After the disastrous fire of 2007 there was a need to develop a national plan for forest fire management at the national level.	
Implementing agency	AFDC in partnership with the Ministry of Environment
Geographical coverage	All Lebanon
Budget	Euro 350,000
Timeframe	2007-2008
Source of funding	EU
Goals: 1) Develop a national protocol of cooperation in forest fire management and control and reach a memorandum of understanding among the ministries of environment, agriculture, interior and defense. 2) Provide basic tools and equipment for forest guards and civil defense centers in sensitive forest areas for early intervention in fire fighting. 3) Produce and document uniform information and make it available to the Lebanese army for training its individuals, and upgrade the technical skills of officials from the civil defense, the forest guards, and the internal security forces about forest fire management and forensic fire investigations.	
Achievements or progress	- Lebanon's national strategy for forest fire management (decision no. 52/2009) - Operations room at a national scale for forest fire prevention and control - Effective tools and equipment for forest fire control provided and used by the forest guards and the civil defense - Professional and skilled forest fire fighters and improved forensic fire investigations conducted by Lebanese internal security forces
GHG reduction	484 Gg of CO_2 eq.
Emission reduction expected by completion of action	N.A.
Methodology	IPCC GPG for LULUCF 2003
Assumptions	Assuming that the strategy succeeded in suppressing 50% of the fires (out of the 5,828 ha that burned between 2009 and 2012) within the first 20 minutes from fire occurrence.

Table A2- 29 Strengthening Lebanese capabilities in forest fire control operations

Strengthening Lebanese capabilities in forest fire control operations	
General information: This project recognized the importance of strengthening the capabilities of Lebanese fire fighters in improved forest fire control operations.	
Implementing agency	Ministry of Interior and Municipalities (MoIM) – Lebanon, Lebanese civil defense, TRAGSA, and AFDC
Geographical coverage	Different locations in Lebanon
Budget	USD 144,100
Timeframe	2010
Source of funding	Spanish government
Goals: - To increase the human capacities and technical means of forest fire brigades, adapting their capacities to work efficiently in the forest. - To provide advanced technical assistance for the concerned institutions, the team of national fire operations room, fire brigades and land users. - To enhance the functionality and the managerial capacities and technological preparedness of the national operation room.	
Achievements or progress	- The human capacities and technical means of forest fire brigades have been increased and adapted to work efficiently in the forest. - The technical forest fire managerial capacities of the concerned institutions and national forest fire groups are adapted and further strengthened. - The managerial capacities and technological preparedness of the national operation room are strengthened.
GHG reduction	150.66 Gg of CO_2 eq.
Emission reduction expected by completion of action	Not available
Methodology	IPCC GPG for LULUCF 2003
Assumptions	Assuming that the action succeeded in suppressing 20% of the fires (out of the 4454 ha that burned between 2010 and 2012) within the first 20 minutes from fire occurrence.

Table A2- 30: **RISchio Icendi e COordinamento** (RISICO) system for forest fire forecasting

RISICO system for forest fire forecasting	
General information: This project initially entitled: "risk prevention and management of the Shouf cedar reserve" worked at transferring and testing in Lebanon the Italian system RISICO for forest fire forecasting.	
Implementing agency	Italian national civil protection department, International Centre on Environmental Monitoring (CIMA) research foundation, Lebanese general directorate of civil defense – MoIM; collaboration with: Al-Shouf Cedar Nature Reserve; LARI; AFDC
Geographical coverage	All Lebanon
Budget	EUR 890,000
Timeframe	2010-2011
Source of funding	Ministry of Foreign Affairs with technical support from the Italian embassy in Lebanon and the Italian cooperation office in Beirut
Goals: One of the main fire-related activities of the project aimed at transferring to Lebanon the system RISICO used by the department of civil protection (DPC) for predicting forest and rural fire risk at national scale.	
Achievements or progress	- Transfer of the operating system RISICO at the headquarters of the Lebanese civil defense. - The issuance of a daily bulletin for prediction and prevention of forest and rural fires. - The realization of different training sessions aimed at the general understanding of the system. - A full-scale exercise that allowed to test the chain of command and control starting from the issue of the bulletin, the activation of the prevention activities (patrolling, monitoring and preparedness) and forest fires fighting activities.
GHG reduction	Not available
Emission reduction expected by completion of action	75.33 Gg of CO_2 eq.
Methodology	IPCC GPG for LULUCF 2003
Assumptions	Assuming that the action succeeded in suppressing 10% of the fires (out of the 4,454 ha that burned between 2010 and 2012) within the first 20 minutes from fire occurrence.

Table A2- 31: Managing wildfire risk in the Wildland-Urban Interface (WUI)

Managing wildfire risk in the WUI	
General information: This project worked towards a better assessment and management of wildfire risk in the WUI through gaining from the US experience.	
Implementing agency	University of balamand
Geographical coverage	All Lebanon
Budget	USD 104,635
Timeframe	2012-2014
Source of funding	USAID- Partnerships for Enhanced Engagement in Research (PEER)
Goals: To develop the capacity of stakeholders in Lebanon to assess and manage wildfire risk in Lebanon's 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	- Development of a wildfire-climate model and maps for Lebanon - Incorporation of wildfire risk assessment and management in educational materials - Development of a web-application for improved decision making in forest fire risk management
GHG reduction	Not available
Emission reduction expected by completion of action	38.23 Gg of CO_2 eq.
Methodology	IPCC GPG for LULUCF 2003
Assumptions	Assuming that the action succeeded in suppressing 10% of the fires (out of the 2,151 ha that burned in 2012) within the first 20 minutes from fire occurrence.

Table A2- 32 Partnership for protection of forests in Lebanon

Partnership for protection of forests in Lebanon	
General information: This project established partnership with the LRI and the United States Forest Service for improved protection of forests in Lebanon especially against wildfires.	
Implementing agency	AFDC in partnership with the LRI and United States Forest Service
Geographical coverage	Different locations in Lebanon
Budget	Not available
Timeframe	2012-2014
Source of Funding	USAID
Goals: To provide training and equipment for forest fire control.	
Achievements or progress	- Training of 60 volunteers from different forest areas on forest fire fighting tools and techniques - Equipping the trained volunteers with equipment for early forest fire intervention

	- Training of trainers for 120 members Lebanese Army Forces (LAF) on forest fire fighting - Equipping the trained LAF forces with equipment for early forest fire intervention
GHG reduction	Not available
Emission reduction expected by completion of action	38.23 Gg of CO_2 eq.
Methodology	IPCC GPG for LULUCF 2003
Assumptions	Assuming that the action succeeded in suppressing 10% of the fires (out of the 2,151 ha that burned in 2012) within the first 20 minutes from fire occurrence.

Annex III: Gaps and constraints

In order to fulfill Lebanon's obligations to the UNFCCC in submitting national GHG inventories in line with the IPCC guidelines, further support is needed to continue to develop and consolidate existing technical and institutional capacities.

Many challenges still exist since the preparation of the country's first GHG inventory in 1994 and they are mainly related to unavailability, inaccessibility and inconsistency of activity data and emission factors.

Below is a series of tables presenting the gaps and constraints that were encountered during data collection for the preparation of the inventory of each sector and the proposed measures to address these constraints in the future.

Table A3- 1 Gaps and needs identified in the calculation of GHG emissions from the energy sector

Gaps and constraints	Proposed measures for improvement
Underdeveloped data collection for the inventory - Lack of institutional arrangement for data monitoring and reporting - Absence of an energy balance - Absence of disaggregation of fuel use per subcategory - Missing of activity data on some fuel used - Need to improve the uncertainty calculation methodologies in the QA/QC procedure	- Create a national institutional arrangement for the preparation of the GHG inventory, empowering the CAS, the relevant ministries and concerned public authorities to develop monitoring indicators (such as the mobility monitoring indicator), in charge of collection, measuring, reporting and verifying of energy activity data. - Establish a mobility monitoring indicator platform that should include all activity data needed to estimate Lebanon's energy sector GHG emissions using tiers 2 and 3 of the IPCC guidelines. - Activity data should be reported with uncertainty assessments in order to have statistically acceptable data. - Standardize/centralize data reporting and develop protocols for data accessibility.
Unavailable and/or unshared specific data for tiers 2 and 3 calculations - Missing road transport activity data on annual fuel consumption per type of fuel and yearly average vehicle mileage per category - Activity data of off-road vehicles not considered - Unshared activity data between public/private institutions due to lack of coordination and/or confidentiality	
Use of IPCC default emissions factors since there are no fuel-specific emission factors elaborated for Lebanon.	- Develop Lebanon's fuel-specific emission factors and methodologies. - Conduct measurement campaigns in order to elaborate specific emission factors representative of the Lebanese used fuel and transportation fleet. - Develop GHG emissions estimation models with local research institutes to create Lebanon-specific methodologies using advanced bottom-up approaches for inventory preparation.

Table A3- 2 Gaps and needs identified in the calculation of GHG emissions from industrial processes

Gaps and constraints	Proposed measures for improvement
Activity data organization - Scattered data on fish, meat, chicken, lime, soda ash, asphalt, wine (customs, factories, ministries). - Lack of uniformity in data between different official sources (i.e. meat and poultry production). - Lack of sufficient documentation on data sources in both the Second National Communication (SNC) and Initial National Communication (INC).	**For current inventory:** - Collection of numbers and figures from various sources and research on detailed description of categories considered in each number. Most comprehensive data were adopted for the inventory. - Validation of available data through expert judgment. - Detailed archiving on sources of data. **Suggestions for future inventories:** - Centralization of data compilation management: cooperation initiated with Ministry of Industry in order to update industrial database and launch systematic data collection process from industries.
Activity data availability - Lack of data on bread, cakes and biscuits, and coffee beans. - Lack of data on halocarbons (HFCs and PFCs). - Lack of data for refining inventory to higher tier levels (except for cement).	**For current inventory:** - Wheat production is used to estimate production of bread, cakes and biscuits (based on ratios given by bakeries). - Emissions from HFCs and coffee beans were not estimated. Higher tiers for categories other than cement were not used.
Activity data accessibility - Lack of institutional arrangements for data sharing. - Time delays in accessing and compiling data.	**Suggestions for future inventories:** - Establish protocols and effective networking with data providers (Memorandums of Understanding already signed with various institutions, including the Ministry of Industry).
Activity data compilation Emissions from poultry, meat, fish, bread and cakes and biscuits were calculated using only national production. Emissions from processing of imported poultry, meat fish and wheat were not included (as well as subtraction of exported production).	**For current inventory:** - Consider import and export in final activity data compilation for cakes and biscuits and bread. - Imported poultry and meat was not added to national production since important discrepancies were noted in national production figures of SNC and TNC. Adding import numbers would increase this discrepancy. It is noteworthy that since NMVOCs emitted from the food sector are not included in GHG trend analysis, this discrepancy is not projected to the final figures of the inventory.
National circumstances - Lack of sufficient, updated and homogeneous literature on the industrial sector in Lebanon. - Lack of academics and researchers in the industrial field.	**For current inventory:** - Reliance on personal communications with practitioners and ministry staff. **Suggestions for future inventories:** - Nationwide survey has been launched on a sample of 180 industries from each category in order to capture the general situation of the industrial sector in Lebanon.

Table A3- 3 Gaps and needs identified in the calculation of GHG emissions from agriculture

Gaps and constraints	Proposed measures for improvement

Activity data organization - Scattering of data throughout agencies - Lack of uniformity in data between different official resources	- Centralize data management. - Homogenize statistics between public, private, and international agencies. - Establish an advisory scientific team to facilitate data coordination and ensure data uniformity.
Activity data availability - Lack of data on fertilizer consumption, MMS, and utilization of crop residues in different regions - Lack of data for refining inventory to higher tier levels	- Undertake field surveys to improve data depths. - Establish a monitoring for manure management and crop residue utilization. - Undertake research to refine data for higher tier levels.
Activity data accessibility - Lack of institutional arrangements for data sharing. - Time delays in accessing and compiling data.	- Establish protocols and effective networking with data providers. - Involve industry and monitoring institutions.
Data on emission factors - Inadequate data for country specific emission factors	- Undertake research to conduct measurements to develop local emission factors.
Absence of technical and institutional capacity	- Conduct training for relevant institutions involved in planning, preparation, and analysis of GHG inventory. - Conduct workshop on data management for agriculture. - Conduct training on new inventory and mitigation softwares.

Table A3- 4 Gaps and needs identified in the calculation of GHG emissions from land use, land use change and forestry

Gaps and constraints	Proposed measures for improvement
- Lack of information and records of data changes in forestry and other woody biomass stocks at the institutional level - Lack of comprehensive studies of forests - Lack of studies on annual growth rate for fruit trees - Lack of data related to urban trees - Lack of data on illegal forest and grassland conversion to cropland - Lack of quantitative data on the abandoned terraced lands, and systematic monitoring for ecological indicators - Lack of technology and monitoring equipment - Lack of proper data dissemination - Inconsistency of information for terrestrial observations - Discontinuity in data since they are based on ecological observations that are specific to projects (limited in time and objectives) - Absence of national monitoring system - Lack of sufficient funding for research - Lack of consistency in data collection - Deficiencies in technical expertise and	- Develop growth models for different forest types. - Update forest map to a scale of 1/20,000 showing distribution per forest type. - Acquire equipment including installation of gauging stations, monitoring stations, and maintenance of the existing ones. - Disseminate of data including building database, standardization of reporting procedures, cooperation between public and private sectors, and the use of monthly bulletins. - Centralize data management. - Organize or standardize inventory systems. - Modernize and reorganize the climate monitoring services. - Build capacity in climate modeling and data handling. - Improve access to data and information. - Develop systematic observation systems. - Identify key indicators and vulnerable areas. - Establish monitoring system for snow. - Establish a specialized scientific coordination

cooperation between different research bodies - Overlapping mandates of different agencies - Lack of data management systems - Lack of specific emission factors of greenhouse gases	body. - Enhance terrestrial and ecological systematic monitoring.

Table A3- 5 Gaps and needs identified in the calculation of GHG emissions from the waste sector

Gaps and constraints	Proposed measures for improvement
- Inconsistency of data related to population number - Absence of field surveys for the quantification of waste generation - Inconsistency of data on methane recovery - Industrial wastewater is not clearly addressed and related information is missing. - Inaccuracy of emission factors to reflect national circumstance due to the absence of country-specific emission factors - Absence of data related to wastewater handling and treatment	- Undertake official census on population in Lebanon. - Assign an official institution responsible for disseminating information on population characteristics. - Undertake research on detailed waste characterization and generation. - Institutionalize the reporting of methane recovery rates from solid waste dumpsites. - Undertake research to determine national emission factors for solid waste and wastewater. - Undertake survey on the quantification and characterization of wastewater handling and treatment systems