LOW EMISSION CAPACITY BUILDING PROGRAMME

REPUBLIC OF LEBANON
MINISTRY OF ENVIRONMENT

Nationally Appropriate Mitigation Action in Lebanon's Municipal Solid Waste Sector

NAMA Proposal and Design Document

2017

UNDP Low Emission Capacity Building (LECB) Programme

The UNDP Low Emission Capacity Building (LECB) Programme is a country-driven initiative that promotes essential cooperation between relevant institutions, engaging the public sector and industry in a concerted effort to design and implement approaches to low emission development that are consistent with national development priorities. National counterparts are supported to strengthen technical and institutional capacities to identify and formulate Nationally Appropriate Mitigation Actions (NAMAs) and Low emission development strategies (LEDS) in the public and private sectors, and to strengthen the underlying greenhouse gas inventory management and Measurement, Reporting and Verification (MRV) systems.

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Abbreviations and Acronyms

BAU	Business As Usual
BDL	Banque Du Liban
BMUB	German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
BUR	Biennial Update Report
CCCU	Climate Change Coordination Unit
CDM	Clean Development Mechanism
CDR	Council for Development and Reconstruction
CE	Coordinating Entity
COM	Council of Ministers
DOC	Degradable Organic Carbon
EIA	Environmental Impact Assessment
ESIA	Environmental and Social Impact Assessment
FiT	Feed in Tariff
FOD	Fist Order Decay
GBA	Greater Beirut Area
GHG	Greenhouse Gas
GOL	Government of Lebanon
IE	Implementing Entity
IMF	Independent Municipal Fund
(I)NDC	(Intended) Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
ISWM	Integrated Solid Waste Management
LECB	Low Emission Capacity Building
LEDS	Low Emission Development Strategy
LFG	Landfill Gas
MAP	Mean Annual Precipitation
MAT	Mean Annual Temperature
MBT	Mechanical Biological Treatment
MCF	Methane Correction Factor
MOE	Ministry of Environment
MOF	Ministry of Finance
MOIM	Ministry of Interior and Municipalities
MSW(M)	Municipal Solid Waste (Management)
MRF	Material Recovery Facility
MRV	Measurement, Reporting, Verification
NAMA	Nationally Appropriate Mitigation Action
NFF	NAMA Finance Facility
NIMBY	Not In My Back Yard
NSDS	National Sustainable Development Strategy
O&M	Operation & Maintenance
OMSAR	Office of the Minister of State for Administrative Reform
PET	Potential Evapotranspiration
PPA	Power Purchase Agreement
PPP	Public Private Partnership
RDF	Refuse Derived Fuel
SA	Service Area
SDG	Sustainable Development Goal
SEA	Strategic Environmental Assessment
SNC	Second National Communication
SPV	Special Purpose Vehicle
StREG	Support to Reform Environmental Governance
SWDS	Solid Waste Disposal Sites
SWM	Solid Waste Management
TNC	Third National Communication
UNFCCC	United Nations Framework Convention on Climate Change
USD	US Dollar
WtE	Waste-to-Energy

1 Introduction to the NAMA in the Lebanese Waste Sector

1.1 Challenges of Lebanon's Solid Waste Management Sector

Lebanon has a population of around 5.8 million people and one of the highest population densities in the world with 560 people/km^2. Where the population density is high and population growth is rapid, public and sanitary services like waste management are very important and may come under pressure.

Lebanon suffers from specific and deep-rooted problems affecting waste collection, waste treatment and the disposal of municipal waste. Since 1997, the waste sector in Lebanon has operated under an emergency municipal solid waste management plan, which ended in July 2015. This culminated in the current national trash crisis, which was mainly triggered by the premature closure of Lebanon's largest sanitary landfill located in Naameh (Mount Lebanon) in July 2015. These problems have led to significant social, economic and environmental difficulties. In Lebanon, open dumping and open burning of municipal waste is a common and widely accepted practice. The main existing landfills, namely the Naameh landfill, the Zahle landfill, and the Tripoli controlled dumpsite, have only dealt with around 55 per cent of the total generated solid waste in Lebanon since 1998. The remainder is partially recycled/composted and partially disposed of in open dumpsites, by local authorities, such as municipalities and/or unions of municipalities. (MOE/GEF/UNDP, 2015)

The lack of an overarching and integrated waste strategy, including the provision of basic information (e.g. waste composition, waste amounts), the failure to implement relevant laws and regulations defining specific activities for improved waste management and waste utilization, and failure to coordinaten activities and stakeholders (including the allocation of roles and responsibilities for waste management between local and central level) have been identified as further key shortcomings in the sector.

Despite various studies describing the problems in Lebanon's waste sector and addressing specific aspects like feasibility studies and assessments of alternative technologies (CDR, 2012), no overarching and comprehensive strategy for improving the situation step by step has been developed. There is an urgent need for substantial improvements and sustainable solutions, as the current situation is leading to significant negative environmental, economic and social impacts in large parts of Lebanon. Only with an enabling environment in place (i.e. a solid information base and afunctional institutional and regulatory framework), will urgently needed investments for technical solutions in the waste sector be based on solid ground.

1.2 Background and Opportunities for NAMAs in Lebanon

Lebanon is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC), and as a Non-Annex I country has no official commitments under the Kyoto Protocol for reducing national GHG emissions. According to the requirements of all signatory countries for putting forward their INDCs as a key input to the 21st Conference of the Parties in Paris (COP21), Lebanon submitted its INDC to the UNFCCC in September 2015. The solid waste sector was explicitly mentioned as one of the sectors for which financial and capacity-building support as well as technology transfer and awareness raising are required to achieve the conditional GHG mitigation target under the INDC.

In the context of INDCs, a Nationally Appropriate Mitigation Action (NAMA) can be understood as a tool or implementation mechanism for countries to design and implement interventions and actions to achieve the goals and targets described under the INDC. The concept of NAMAs was first introduced in the Bali Action Plan as part of the Bali Road Map at the 13th UNFCCC Conference of the Parties (COP13) held in 2007 and was integrated into the Copenhagen Accord that came out of the UNFCCC COP15 in 2009. NAMAs are defined as a voluntary and non-binding set of policies or actions that should contribute to sustainable development and GHG emission reductions. As NAMAs can leverage national and international support for actions towards transformational change, sustainable development and GHG mitigation, many developing countries have engaged in the identification and development of NAMAs.

The Lebanese Ministry of Environment (MOE) has joined the Low Emission Capacity Building (LECB) programme, a global initiative with 25 developing countries participating. Under the LECB programme, national counterparts are supported to strengthen technical and institutional capacities to identify and formulate NAMAs and Low Emission Development Strategies (LEDS) in the public and private sectors, and to strengthen the underlying GHG inventory management and Measurement, Reporting and Verification (MRV) systems. Under the MOE, the Lebanese Climate Change Coordination Unit (CCCU), in consultation with relevant stakeholders, decided to use LECB support for the development of two NAMAs, one in the waste sector and one in the transport sector. This selection was the conclusion of a prioritization process in which it was determined that improved management of municipal solid waste (MSW) offers the greatest opportunity for GHG reductions compared with other waste streams and carries a high potential to bring transformational change to the sector.

The concept of a NAMA allows for the sector-wide and stepwise approach that is required to bring significant and far-reaching improvements for the solid waste sector in Lebanon. Based on a comprehensive sector assessment and an intensive consultation process with key local stakeholders of the MSW sector in Lebanon, the scope of the NAMA was defined.

1.3 Purpose and Objectives of the NAMA

The overall purpose of this NAMA is to identify and describe concrete actions needed for the MSW sector in Lebanon to improve the processes leading to higher efficiency and to achieve a transformational shift towards higher sustainable development standards and for reducing GHG emission. Furthermore, the NAMA should help leverage national and international support for establishing an enabling environment in the MSW sector and implement a defined set of technical interventions that help improve the current situation.

This NAMA will address a variety of key issues and challenges in Lebanon's solid waste sector, ranging from legislative support to achieve formal ratification of waste-related jurisdictions, the implementation of waste collection and management centers at which waste sorting can take place, LFG collection and utilization and implementing Waste to Energy (WtE) facilities based on waste incineration.

The overall objectives of the NAMA can be summarized as:

- Leading to scaled-up emission reductions;
- Resulting in co-benefits and aligning with Post- 2015 Sustainable Development Goals (SDGs);
- Leading transformational change for the MSW sector;
- Enabling private sector participation;
- Being financeable and bankable.

To achive these objectives the NAMA is designed and setup in a way that reflects the current situation and local circumstances and will use stepwise approach that should help buildthe necessary enabling environment first, before physical interventions are implemented. These are the main building blocks of the NAMA:

- Setting up and operating an institutional framework capable of managing and operating the NAMA with all necessary measures and interventions;
- Supporting awareness creation for waste management and source sorting among key institutions, stakeholders and the public;
- Establishing the necessary legal and regulatory framework for the MSW sector that enables technical interventions (LFG utilization and WTE) to be applied;
- Ensuring the collection and utilization (power generation) or flaring of LFG in up to eight (8) existing sanitary landfills and open dumps;

- Preparing and implementing solid waste management and collection centers (including waste stream diversion to disposal sites);
- Applying (preparing, implementing and operating) WtE technologies in Lebanon. This includes assessing and preparing the implementation of one WtE plant in the GBA and assessing the potential for additional WtE plants outside the GBA.

To ensure successful implementation of the building blocks, the NAMA is designed in a stepwise and phased approach, comprising two phases.

NAMA Phase 1 (2018-2021) focuses on the establishment of an institutional framework, providing support for the enactment of relevant laws, building the capacity of key stakeholders, increasing awareness of waste management and sustainable waste utilization and implementing waste collection and reception centers in the GBA to increase waste diversion and make preparations for WtE systems. The key technical intervention under Phase 1 leading to GHG emission reductions, isLFG management (including utilization or flaring) at four (4) priority landfills sites and open dumps.

NAMA Phase 2 (2022-2030) builds directly on the achievements of the NAMA Phase 1. The technical interventions of Phase 2 are the implementation and operation of one waste incinerator for producing energy from waste (WtE) and the LFG management (including utilization and flaring) at four (4) additional landfill sites and open dumps. These interventions will lead to significant GHG emission reductions under Phase 2. In addition, Phase 2 will extend the implementation of waste collection and waste reception centers to other service areas outside the GBA, assess the potential for further WtE opportunities in Lebanon and ensure awareness creation of source sorting and recycling.

A detailed overview of all activities under the full NAMA is provided in Chapter 5.

2 Background of the Waste Sector in Lebanon

Until mid-2015, and according to (MOE/GEF/UNDP, 2015), the MSW management situation in Lebanon was as follows:

- 55 % of the total waste stream is deposited in sanitary landfills;
- 30 % dumped in open dumpsites; and
- 15 % is recycled and/or composted.

In the GBA and Mount Lebanon[1], a solid waste management system was developed under the 1997 Emergency Plan, but ended in July 2015. During the summer of 2015, public outcry about the lack of accountability and transparency in the SWM sector and the continued operation of the Naameh landfill (the largest landfill in Lebanon and final destination for solid waste generated in Beirut and Mount Lebanon) well above its original design capacity, brought about a series of public protests and the permanent closure of the Naameh landfill. Outside Greater Beirut and Mount Lebanon, waste management systems are generally characterized by rudimentary "collect and dump" practices, except for a few cities and selected municipalities and federations.

Municipalities are generally responsible for the collection, treatment and disposal of municipal waste and should cover all related costs. Austerity measures by the Government of Lebanon (GOL) have prevented many municipalities from planning for and investing in proper solid waste systems, and they have optedrather for short-term solutions. Municipalities typically receive their budgetary allowances from the Independent Municipal Fund (IMF) several years behind schedule and therefore tend to resort to quick solutions, including open dumping. Several international development organizations (such as the European Union, the Italian Development Cooperation Agency, the Spanish Agency for International Development Cooperation and USAID) have stepped in by providing direct technical and financial support to individual municipalities and groups of municipalities.

Public awareness of and engagement in SWM is relatively weak in Lebanon. The people of Lebanon are angry about the lack of legislation and infrastructure provisions enabling basic waste collection and waste management and utilization. The "Not In My BackYard" (NIMBY) mentality has prevented proper planning and implementation of centralized SWM solutions, including the construction of new sanitary landfills and WtE facilities in the past, which has led to over 500 open dump sites across the country and fostered public scepticism about thermal conversion technologies, and incineration (considered as WtE under the NAMA).

An explicit fee system and cost recovery mechanism for SWM does not exist in Lebanon. This has led to significant budget overruns and deficits in the sector (MOE/UNDP/ECODIT, 2011). Financing of infrastructure is currently achieved through the allocation of budgets and funds from (i) the CDR; (ii) the IMF from which the government distributes funds to municipalities to meet capital and operational cost requirements; (iii) international loans and grants; and (iv) financing through local taxes. Private sector participation has been crucial in the provision of basic waste collection and disposal services in many towns and villages (see also private stakeholders as described in Section 2.2.2).

2.1 Current Situation and Trends of the Sector

2.1.1 Waste Generation and Composition of the Waste

Based on waste management data compiled by the MOE, Lebanon has an estimated daily waste generation of 0.85 kg/capita in rural areas and 0.95-1.2 kg/capita in urban areas, with a national weighted average of 1.05 kg/capita/day (GIZ/SWEEP-Net, 2014). Daily solid waste generation rates and trends are based on population and total waste collection and disposal. Figure 1: shows a 26% increase in the overall MSW generation rate in Lebanon between 1994 and 2011 (MOE/GEF/UNDP, 2015).

[1] excluding Jbeil

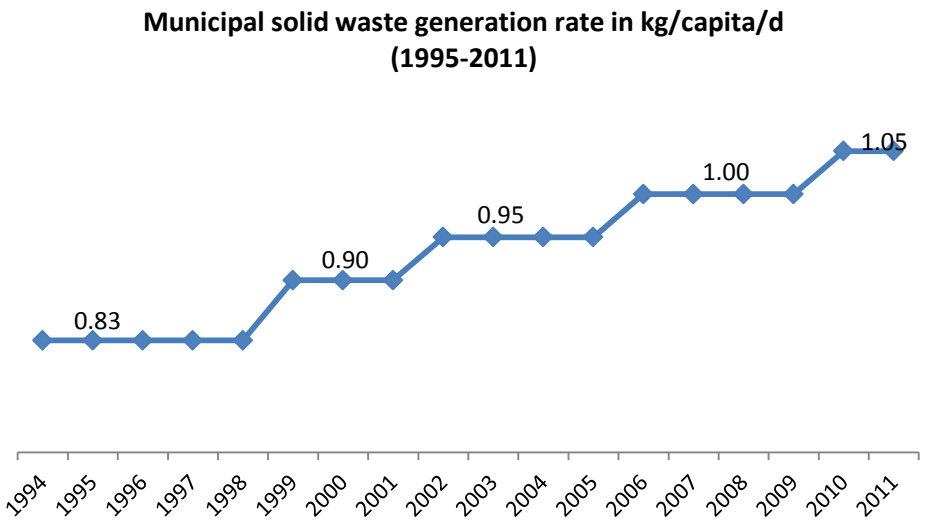


Figure 1: Per capita municipal solid waste generation rates for the years 1994-2011 (MOE/GEF/UNDP, 2015)

Lebanon's average waste composition is illustrated in Figure 2. The organic share is relatively high, exceeding 50% of total waste (and approaching 60% in rural areas), and a prevalent moisture content exceeding 60%, which is linked to the high organic wasteshare. The composition of solid waste changes marginally between geographical areas (cities and commercial centers produce much more paper and plastics than rural areas) and seasons (organic fraction and moisture content is highest in summer).

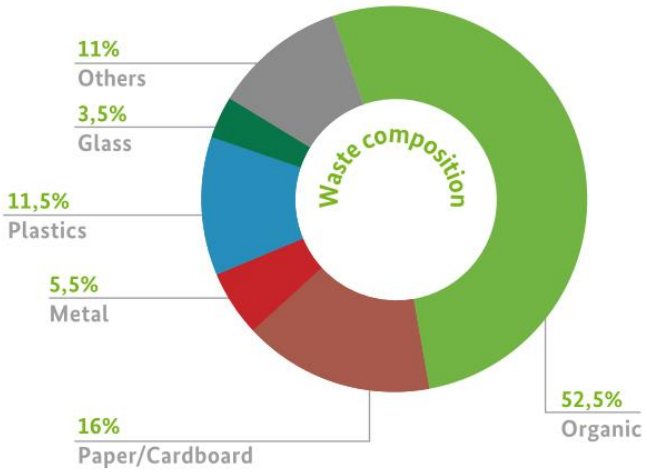


Figure 2: Waste composition in Lebanon (GIZ/SWEEP-Net, 2014)

A high organic share leads to comparably higher methane emissions (if waste is treated under anaerobic conditions, e.g. in an unmanaged and untreated landfill or dumpsite). This would have an effect on LFG utilization or flaring as planned under the NAMA. For the purpose of WtE based on waste incineration (also planned as a technical intervention under the NAMA), a high organic share compared with a high moisture content of the waste would tend to reduce the calorific value of the waste per tonne and hence would lower the energy output. To maximize waste utilization for LFG and WtE in Lebanon, a waste collection and waste diversion process (as planned under the NAMA) is therefore important.

2.1.2 MSWM Services in Beirut and Mount Lebanon

Following the forced closure of the Naameh Landfill, the Government of Lebanon came under pressure to terminate the 1997 Emergency Plan for MSW Management (MSWM) and discontinue its contracts with the private companies Sukleen (for waste collection) and Sukomi (for waste treatment and landfill). Although this development was expected, it occurred prematurely, i.e., before the implementation of an alternative SWM plan. The sudden closure of the Naameh Landfill has therefore resulted in the random and irregular disposal of up to 2,500 tonnes per day of MSW in uncontrolled dumpsites in Mount Lebanon and beyond. The Council of Ministers (COM) has held several emergency meetings to find alternative solutions. The results (policies/strategies) are described in Chapter 3. Meanwhile, a sizable proportion of Lebanon's population continues to endure the significant consequences of unsanitary waste disposal. The situation is aggravated by the rainy season (October 2015 – March 2016).

2.1.3 MSWM Services Outside Beirut and Mount Lebanon

Outside Beirut and Mount Lebanon, no comprehensive SWM plan exists and the areas are characterized by rudimentary collect and dump practices. However, full or partial SWM systems exist in the main cities (Saida, Tripoli, and Zahle) as listed below:

- **Saida:** The facility in Saida comprises a sorting plant - Material Recovery Facility (MRF) - with a design capacity of 300 tonnes/day and an anaerobic digestion unit Mechanical Biological Treatment (MBT), both of which are operated by IBC (International Business Consultants). More recently, IBC introduced a Refuse Derived Fuel (RDF) component. The plant has received a lot of attention and praise in recent months, as an alternative MSW system which has been endorsed and is financed by the municipality of Saida (not CDR).

- **Tripoli:** MSW collection is managed by the private company, Lavajet, and an unsanitary managed landfill is managed by the private company, Batco. The landfill reached its theoretical capacity in 2010 but continues to receive MSW. The landfill will be closed as soon as an alternative treatment and disposal site is secured and equipped with the necessary infrastructure.

- **Zahleh:** The Zahleh sorting plant (MRF) has a design capacity of 200 tonnes/day. It is also equipped with a windrow composting plant (MBT) and a sanitary landfill, which was until recently managed by the Sanitek company. The system was launched in 2004 through a loan from the World Bank.

Additionally, there is a mass of small-scale SWM interventions outside the major cities. For example, in the period 1999-2005, USAID helped finance the construction of dozens of small community-based composting plants in selected villages, some of which were later rehabilitated by Italian Cooperation funds. The USAID-funded plants were the subject of an independent technical evaluation in 2004, which was very critical of the outcome (MOE, 2004). The plants were extensively criticized for using unproven technologies, with inefficient or inadequate operation and maintenance procedures. It was also concluded that short-term solutions to Lebanon's waste issues lead to long-term problems.

In 2004, the OMSAR received a EUR14.2 million grant from the EU under the Assistance to the Rehabilitation of the Lebanese Administration (ARLA) programme to build 11 small-medium sorting/composting facilities. This was followed more recently by a €35 million grant extension under the EU Sustainable Water Management (SWAM I & II) programme. The EU-OMSAR SWM programme has gained traction and started to explore and implement more appropriate technologies including RDF. The distribution of EU-OMSAR approved infrastructures was the focus of several discussions during the NAMA process, to explore potential linkages and opportunities for leveraging.

Despite these investments in Lebanon's SWM sector, open dumping is widespread. To assess the extent of open dumping, the MOE in 2011 and in coordination with UNDP prepared a master plan for the closure and rehabilitation of uncontrolled dumps across Lebanon (MOE, UNDP, ELARD, 2011). The survey identified 504 MSW open dumps, with a total closure/ rehabilitation cost of USD52 million, of which USD32 million would be required for the top 20 priority sites. The dumpsite prioritization was not based on GHG emissions but rather on other environmental and social considerations. Following the closure of

the Naamah landfill in July 2015, municipalities returned to extraordinary measures for removing waste that started accumulating on the streets. This has resulted in numerous makeshift uncontrolled dumpsites in Mount Lebanon (previously in Sukleen's coverage area) and beyond. Therefore, the number of dumpsites today is vastly greater than the number reported in the 2011 survey.

2.1.4 Contribution of SMW to Overall National GHG Emissions

Results of the Second National Communication (SNC) 2011

Lebanon's Second National Communication (SNC) to the UNFCCC, in 2011, had estimated GHG emissions from the waste sector using a Mass Balance approach with year 2000 data (MOE/GEF/UNDP, 2011).

In 2000, Lebanon's total GHG emissions recorded 18.5 million tonnes of CO_2 equivalent (mt $CO_{2\text{-eq}}$). According to the SNC, the solid waste sector was the third highest emitting sector, with 1.74 million tonnes of $CO_{2\text{-eq}}$ (mt $CO_{2\text{-eq}}$) (9.4% of total national GHG emissions) and the largest source of methane (CH_4) in Lebanon (with 8.8% of total national CH_4 emission). Within the waste sector, solid waste disposal on land remains the highest emitting category, accounting for 94.3% of total waste emissions.

In the absence of actual targets for waste treatment, the SNC Report considered that necessary infrastructure and installations would need to be set up to execute the national SWM plan of 2006. The following assumptions were proposed, on the basis of which a baseline scenario could be constructed:

- open dumpsites will be rehabilitated therefore transferring the waste from unmanaged sites to proper sanitary landfills;
- solid waste disposal on land will be properly managed and will gradually decrease by an annual rate of 3.5%, while recycling and composting rates will increase to cover 32% of the total waste stream by 2030; and
- the per capita MSW generation rates were assumed to follow the GDP growth that is predicted for Lebanon at an annual average growth rate of 4.3%.

More recent analysis as part of Lebanon's draft Third National Communication (TNC) to the UNFCCC is presented below.

Salient findings from Lebanon's Third National Communication (TNC)

In the framework of Lebanon's Third National Communication (TNC) and the First Biennial Update Report (BUR) to the UNFCCC, the National Greenhouse Gas Inventory Report of the Waste Sector indicated a 47% increase in GHG emissions from the Waste Sector between the years 1994 to 2011, totalling 1,300,000 t of $CO_{2\text{-eq}}$ (MOE/GEF/UNDP, 2015). This covers waste and wastewater (see Figure 3). The waste sector is the largest source of CH_4 emissions in Lebanon, accounting for 90.28% of national CH_4 emissions. Overall, 2.7 mt $CO_{2\text{-eq}}$ were emitted in 2011, making it the second highest emitting sector with 11% of the national GHG emission. Solid waste disposal on land remains the highest emitting category in the complete waste sector, constituting 80% of GHG emissions in 2011, or 2.2 mt $CO_{2\text{-eq}}$ (MOE, 2015), with CH_4 being the main gas released. This number accounts for managed sites (landfills such as Naameh and Zahleh), unmanaged dump sites (open dumpsites with a depth of more than five meters such as Tyre, Saida, and Tripoli dumpsites) and other disposal methods on land.

Further GHG emissions are caused by the open burning of waste. Although there is no formal waste incineration in Lebanon, open burning is widely practiced at municipal waste dumps. Accurate records of waste burning and the resulting GHG emissions are not available.

Trend of GHG emissions in the waste sector

Figure 3 illustrates a linear increase in GHG emissions in $CO_{2\text{-eq}}$ between 1994 and 2011 (MOE/GEF/UNDP, 2015). This is attributable directly to population increase, assuming no change in waste and wastewater management practices, and irrespective of National GDP growth.

The GHG emissions in the following three figures are displayed in the unit Gigagramm (Gg) whereby 1 Gg is equivalent to 1000 metric tonnes.

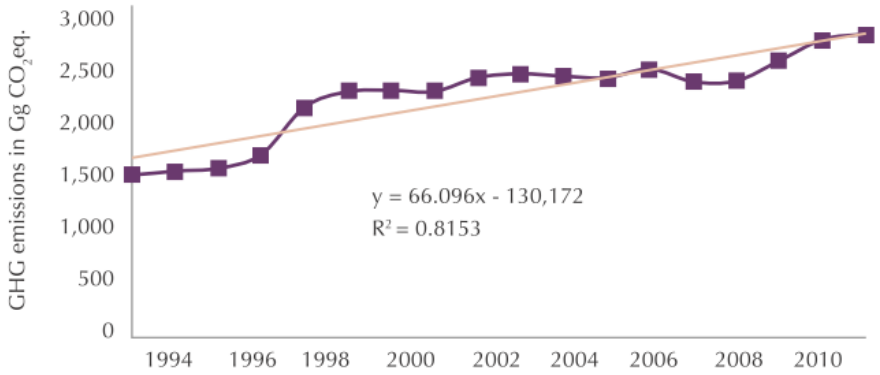


Figure 3: GHG Emissions in CO_2-eq from Waste Sector over the Inventory Period (1994-2011) (MOE/GEF/UNDP, 2015)

In Figure 4 below, the trend in GHG emissions versus population increase for the period 1994 – 2011 is illustrated (MOE/GEF/UNDP, 2015). The GHG emissions trend was performed following the procedures recommended by the Intergovernmental Panel on Climate Change (IPCC, 2006) for the waste sector to ensure consistency.

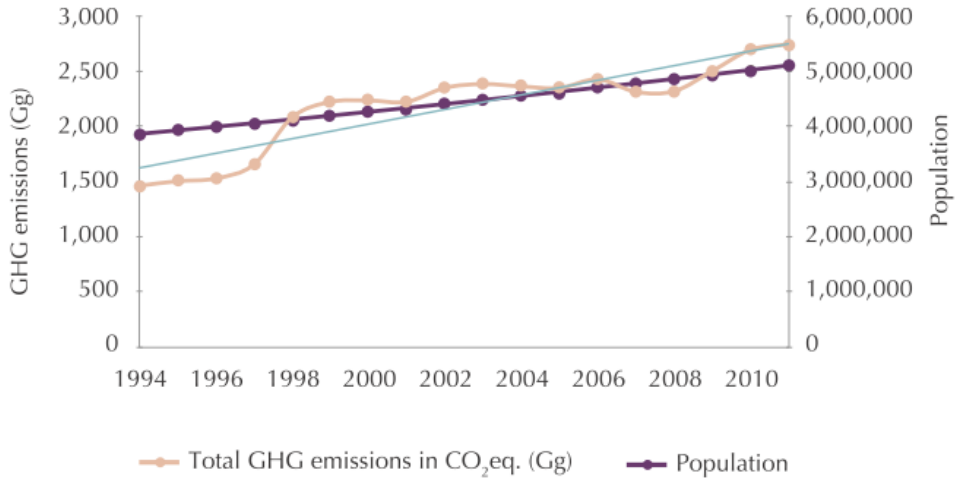


Figure 4: GHG emissions and population growth in Lebanon (1994-2011) (MOE/GEF/UNDP, 2015)

As for the GHG emissions from solid waste, a trend is observed in relation to the amount of waste disposed of in controlled dumpsites (sanitary landfills) as shown in Figure 5 (MOE/GEF/UNDP, 2015). The red line refers to total GHG emissions from solid waste, measured along the right vertical axis of the following figure. The two blue lines refer to the quantity of solid waste (left vertical axis).

A significant shift of solid waste quantities to controlled dumpsites is observed in 1997, the year when the Naameh Sanitary Landfill that serviced Beirut and Mount Lebanon under the Emergency Solid Waste Management Plan started and extended through July 2015. In addition, a small decrease in emissions is noted for 2007 which may be attributed to the displacement of populations from the Beirut suburbs during the 2006 Hezbollah-Israeli conflict.

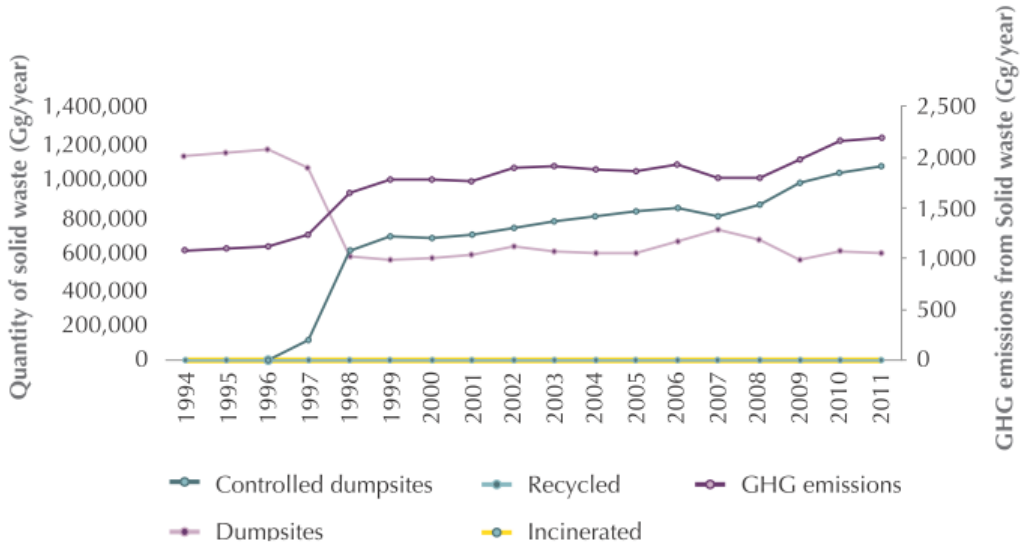


Figure 5: Evolution of GHG emissions by solid waste treatment technology (MOE/GEF/UNDP, 2015)

2.2 Relevant Stakeholders in the SWM Sector

There are many legal instruments that indirectly govern the management of solid waste in Lebanon, but there is to date no single overarching legislative framework for SWM, and no national solid waste management strategy for the country. As a result, there has been a lack of efforts by different authorities to improve SWM services and there are many operational challenges and inefficiencies. Law enforcement is generally weak and institutional responsibilities are not well defined. Many government institutions are involved in the planning and management of the solid waste sector with overlapping mandates and responsibilities that have led to ambiguous lines of authority. This section summarizes the role of key players in the public and private sectors and identifies other stakeholders, including civil society and recycling industries.

2.2.1 Public Sector Stakeholders

Relevant stakeholders in the public sector include the MoE, the CDR, the OMSAR, the Ministry of Interior and Municipalities (MOIM), and the Ministry of Finance (MOF). A short description of these key public sector stakeholders in the current SWM sector is provided in the table below.

Stakeholder	Short description
Ministry of Environment (MOE)	The MOE is the lead planning agency for SWM in Lebanon. Solid waste issues fall under the Service of Urban Environment, Department of Urban Environmental Pollution Control within the MOE. According to its organizational structure (Decree No. 2275, dated 15/6/2009), the Department should (1) review all studies and tender documents related to solid waste and wastewater treatment plants, (2) participate in committees for the oversight of works linked to solid waste treatment facilities and landfills, (3) prepare and formulate a masterplan for the management of Municipal Solid Waste (MSW), and (4) define environmental limit values for the disposal of non-hazardous solid waste (and liquid waste) in water bodies and on soil. The MOE is a key member of the Mitigation Working Group (MWG) for NAMA coordination in Lebanon and has hosted several institutional/governance

Stakeholder	Short description
	programmes such as the Support to Reforms-Environmental Governance (StREG).
Council for Development and Reconstruction (CDR)	The CDR is a public body which was established in 1977 to facilitate construction planning and execution with line ministries in Lebanon. It has extensive jurisdiction and reports directly to the COM through the Prime Minister. This is why it was in charge of a recent tender process reorganizing Lebanon's SWM into six service areas.
Office of the Minister of State for Administrative Reform (OMSAR)	The OMSAR was created in 1994 to develop solutions and reforms to meet the manifold challenges of the Lebanese administration in the post-civil war era. Under the EU-funded programme Assistance to the Rehabilitation of the Lebanese Administration, the OMSAR is the implementing organization for the Solid Waste Environmental Management programme covering (1) all solid waste categories (domestic, hospitals, slaughter-houses, agricultural, industrial, marketplaces), and (2) all stages of the waste management cycle: collection, sorting, transfer, recycling, and treatment (mechanical, biological, thermal), excluding landfill.
Ministry of Interior and Municipalities (MOIM)	In principle, municipalities in Lebanon are responsible for the collection and treatment/disposal of household wastes. Municipalities report to the local governor who reports to the MOIM. The ministry manages the allocation and distribution of funds from the IMF to the municipalities.
Ministry of Finance (MOF)	Involved in financing SWM services and managing the IMF and all related disbursements to Municipalities, in coordination with the MOIM.

Table 1: Public Sector Stakeholders in the SWM Sector in Lebanon

All NAMA activities in Lebanon are coordinated by the Mitigation Working Group (MWG), which consists of representatives from relevant ministries including MOE and OMSAR. The next paragraphs further describe the role of the Climate Change Coordination Unit (CCCU) at the MOE, the role of municipalities in the provision of SWM services, and the influence of the EU-funded programme Support to Reforms-Environmental Governance (StREG) on Lebanon's solid waste sector.

The CCCU is responsible for all climate change activities and programmes in Lebanon including Lebanon's reporting obligations under the UNFCCC, consolidating Lebanon's GHG inventories, and exploring and implementing climate change interventions such as the preparation of NAMAs.

According to Decree-Law No. 8735 (dated 23/8/1974) on the maintenance of public cleanliness, municipalities are responsible for the collection and disposal of household waste. The location of waste disposal sites should be approved by the health council of the Mohafaza area. Additionally, the Municipal Law of 1977 (legislative decree No. 118, Article 49) authorizes municipal councils to build solid waste disposal facilities. Accordingly, several municipalities and unions of municipalities have assumed some level of responsibility for SWM services in recent years. Their role is expected to increase significantly after the closure of the Naameh Sanitary Landfill, which has left hundreds of municipalities without any immediate alternative SWM solutions.

The EU-funded StREG programme is implemented by the MOE. It was launched in 2014 to improve the environmental performance of the Lebanese public sector. Specifically, the StREG prepared a Strategic Environmental Assessment (SEA) of different waste management schemes and technologies. After multiple changes to the original scope (in response to shifting policy environments), as well as milestone meetings and focus groups with municipalities and Non-Governmental Organizations (NGOs) (in March 2015), the draft SEA was released in September 2015, the final documentis not yet available.

2.2.2 Private Sector Stakeholders

The private sector has played a significant role in the design and provision of SWM services in Lebanon. The most prominent example of private sector participation is linked to the 1997 Emergency Plan whereby multi-million dollar contracts for waste collection and treatment were awarded to the Lebanese contractors, Sukleen and Sukomi. They belong to the Averda Group, which has become a regional player in the SWM sector with operations across the Middle East and Africa. Elsewhere, unions of municipalities (such as Tripoli, Byblos and Zahle) also mobilized private sector companies to provide partial SWM services, such as street sweeping and landfilling. Beyond these large municipalities, the private sector is largely represented by the informal sector and waste "entrepreneurs" with no formal track record. Table 2 provides a summary overview of key private sector entities in the waste sector today in Lebanon.

Stakeholder	Roles, Responsibilities, and Achievements
Averda Group **(incl. Sukleen and Sukomi)**	The Averda Group is a holding company that emerged in Lebanon when the 1997 Emergency Plan for SWM was launched. It consists of several waste companies including Sukleen (responsible for waste collection) and Sukomi (responsible for waste treatment and landfill). These companies had exclusivity in Beirut and Mount Lebanon (excluding the Caza* of Byblos) until the forced closure of the Naameh landfill in July 2015. It should be noted that Averda did *not* participate in the recent CDR tenders. Averda has grown regionally, with business operations in the Gulf Cooperating Countries and Africa.
IBC, Inc.	IBC, Inc., a Lebanese company, designed and operates Saida's Solid Waste Treatment facility, which includes sorting, anaerobic digestion, and RDF.
Lavajet	Lavajet, a Lebanese company, is currently responsible for waste collection in Tripoli (north Lebanon).
Batco	Batco, a Lebanese company, is currently responsible for waste treatment/disposal in Tripoli.
Sanitek	Sanitek, a Lebanese company, had several waste management contracts in Lebanon including the operation of Zahleh Sanitary Landfill (Bekaa).
Various recycling industries	Lebanon has a vibrant recycling industry that mainly focuses on paper and cardboard, and plastics. Glass recycling is limited to only one facility (Soliver). A list of recycling industries can be downloaded from the MOE website Management of Recyclable Materials for Lebanese Municipalities: http://www.moe.gov.lb/The-Ministry/Reports/Management-of-Recyclable-Material-for-Lebanese-Mun.aspx More recently, and in response to the current national SWM crisis, the MOE issued Local Order 8/1, dated 16/11/2015. The Order presents environmental and operational guidelines for integrated MSW, focusing on the role of municipalities and Governors. The Order presents an updated list of recycling industries, including contract details and materials.

* "Caza" is an administrative unit and the building block of a governorate. Lebanon is divided into 6 governorates and 25 cazas.

Table 2: Private Sector Stakeholders in the SWM Sector in Lebanon

Additionally, in response to the cancelled CDR tender for SWM services in six Service Areas (SAs), CDR received bids from a number of Lebanese companies and Lebanese-international consortia. Many of the companies that submitted tenders have no or only limited waste management experience and are primarily known to operate in the construction sector and provide general contracting services. Nonetheless, the active participation of many local/international firms in the SWM tender reflects growing private sector interest in the waste sector in Lebanon.

2.2.3 Other Stakeholders

Although the public and private sectors have been the most important stakeholders in the waste sector, other stakeholders have also influenced the SWM sector by providing much-needed funding and/or by challenging the status quo and recommending alternative approaches to national SWM strategies. Table 3 lists those entities influencing the SWM sector in Lebanon including civil society organizations and donors.

Stakeholder	Roles, Responsibilities, and Achievements
Eco-Movement *(Civil Society / NGOs)*	A Lebanese coalition of environmental NGOs with a declared policy position on SWM (Trash to Cash campaign).
YouStink Campaign (coalition of activists against landfilling and incineration) *(Civil Society / NGOs)*	YouStink Campaign (coalition of activists against landfill and incineration): a self-declared grassroots pressure group that emerged during the onset of the current SWM crisis.
European Union *(Donor)*	Has financed and continues to finance medium-sized SWM facilities in Lebanon through OMSAR. Furthermore, the EU's Horizon 2020 Initiative aims to de-pollute the Mediterranean Sea by the year 2020 by tackling municipal waste, wastewater and industrial pollution (accounting for about 80% of overall pollution into the Mediterranean Sea).
World Bank *(Donor)*	The World Bank has been involved in several initiatives improving solid waste management practices in Lebanon, mainly aimed at setting up new landfills such as the currently operating Zahle Landfill. Other landfill initiatives were stopped or not finalized.
Italian Development Cooperation (IDC) *(Donor)*	IDC has funded and continues to fund several small-scale activities in the solid waste sector (including recycling activities) in Lebanon.
USAID *(Donor)*	USAID financed the construction of a number of small-scale SWM plants, mostly in South Lebanon (in 1999-2005). Following mounting challenges, USAID eventually opted out of the waste sector altogether and currently hasno active programme. The challenges were mainly due to the choice of technologies (small-scale, unproven, etc.) and the lack of long-term operation and management planning.

Table 3: Other Stakeholders in the SWM Sector in Lebanon

2.2.4 Stakeholder Consultation and Engagement Process

The idea of developing a NAMA focusing on the SWM sector was first identified by the CCCU at the MOE based on the SNC and the preliminary findings under the TNC. It was quickly determined that there are significant opportunities for GHG reduction in the SWM sector despite (and due to) the lack of clarity in the policy environment.

During the NAMA formulation process, the NAMA team within the CCCU organized several consultation meetings and two workshops. The consultation meetings were aimed at collecting and/or verifying information related to the SWM sector, including rapidly succeeding policy statements and to discuss the potential roles and responsibilities of the local stakeholders under the final NAMA set up (see Chapter 8 for further information on the NAMA specific roles and responsibilities).

A table identifying the stakeholders taking part in the consultation process as well as the discussion points is provided in in Annex 2: Stakeholder Consultations during the Design Phase.

3 Policy Analysis

This chapter describes the relevant national policies and regulations that have an impact on the NAMA or that have been considered in the design of its scope. If a NAMA is to be both nationally appropriate and appropriate for the waste sector, it is essential that it be aligned to the existing and planned national policies and strategies and to the regulations that affect the SWM sector.

3.1 Strategies and Policies Relevant for the SWM Sector in Lebanon

Lebanon´s SWM sector is characterized by constant change in terms of policies and regulations. Several attempts to develop and enact a master plan or road map for the sector have failed and left the sector exposed to ad-hoc activities and piecemeal regulations. In addition, Beirut and Mount Lebanon (Service Area 1), due to its high population and the related sanitary problems (including waste), has been treated differently than the rest of the country (Service Areas 2-6). For an overview of Service Areas (SAs) see Annex 3 Previous SWM initiatives are described below, followed by the most relevant current national and sectoral policies and regulations.

3.1.1 Most Relevant Policies, Strategies and Plans for the SWM Sector

Beirut and Mount Lebanon implemented the 1997 Emergency Plan, which ended in 2015. Other regions have experienced very little progress, with the exception of few secondary cities. The recent closure of the Naameh landfill has intensified the national discourse on SWM and put into question previous policy initiatives.

Policy/Plan/Strategy	Status	Legal Basis
1997 Emergency Plan for MSWM	Implemented until July 2015; under intense public pressure, Naameh Landfill was closed after exceeding its design capacity	COM Decision No. 58 (dated 2/1/1997) (Government of Lebanon, Council of Ministers, 1997)
2006 Master Plan for MSWM	Very limited degree of implementation (mostly through OMSAR)	COM Decision No. 1/4952 (dated 18/8/2005) (Government of Lebanon, Council of Ministers, 2005)
2010 Waste-to-Energy Plan	No implementation plan; SWM in Lebanon Phase 1 Report completed in December 2012 (CDR, 2012)	COM Decision No. 55 (dated 1/9/2010) (Government of Lebanon, Council of Ministers, 2010)
2014 MSWM Roadmap	No implementation plan; CDR prepared Tender Documents for the provision of SWM services; SWM in Lebanon Phase 2 commissioned (on-going)	COM Decision No. 46 (dated 30/10/2014) (Government of Lebanon, Council of Ministers, 2014)
2015 MSWM Plan (Six Service Areas)	CDR Tender(s) covering solutions for the full value chain of solid waste (from origin to utilization), were aborted	COM Decision No. 1 (dated 12/01/2015) (Government of Lebanon, Council of Ministers, 2015)

Table 4: Historical overview on policy initiatives tackling SWM in Lebanon

Only the 1997 Emergency Plan was actually implemented, and even this was implemented only partially, until the forced closure of the Naameh Landfill in July 2015. All the ensuing plans were endorsed by the relevant authority but not implemented for a variety of reasons including financial, technical, and political ones. These plans and policy initiatives are further explained below as they bear upon the current situation in Lebanon`s SWM sector.

The 1997 Emergency Plan for MSWM

The 1997 plan covered Beirut and all of Mount Lebanon, except for the sub-district (Caza) of Jbeil, and was effectively the *only* plan in place until the forced closure of the Naameh Sanitary Landfill on 17 July 2015. Since that date, there has been no new engineered treatment and/or disposal site for Beirut and Mount Lebanon. The 1997 plan had contracted two private companies, both part of the larger Sukkar Group: (1) Sukleen to provide street sweeping and collection services, and (2) Sukomi to treat and dispose of the solid waste. Sukomi has operated the following facilities:

- Two sorting plants (design capacity of 1,200 tonnes/day and 1,100 tonnes/day);
- One composting plant (design capacity of 300 tonnes/day), located in Karantina;
- One warehouse storage facility for solid waste;
- One landfill for the disposal of bulky waste located in Bsalim (Mount Lebanon); and
- One sanitary landfill for reject materials located in Naameh (Chouf Area; Southern of Beirut).

The Emergency Plan was partially implemented despite controversies linked to (1) system costs, and (2) the effectiveness of sorting and composting plants. The COM extended the management contracts for Sukleen and Sukomi several times after 1997. This plan represents the most significant infrastructure investment in Lebanon's SWM sectorto date.

The 2006 Master Plan for MSWM (CDR, 2006)

Following an explicit request from the COM (Decision 1/4952 (CDR, 2006)), the MOE and the CDR jointly prepared a 10-year national MSWM plan that involved collection and sorting, recycling, composting, and landfilling. The plan (proposed for the period 2006-2016) recognized four service areas: (1) North & Akkar, (2) Beirut & Mount Lebanon, (3) Bekaa & Baalbak-Hermel, and (4) South & Nabatiyeh. The Master Plan intended that each service area would be equipped with sanitary landfills (6-7 landfills in total) and that every Caza would have its own waste treatment facility for sorting and composting (about 12-14 plants in total). Although the plan was approved by the COM in June 2006, the subsequent war in July 2006 drained government resources and weakened the political will to implement it. Lack of public funding and consensus on the location of proposed facilities further eroded all prospects for implementation.

The 2010 Waste-to-Energy Plan

For the reasons outlined above, the 2006 Master Plan achieved very little in the period 2006-2010. Instead the GOL commissioned several small-scale facilities with grants from partner agencies (EU-OMSAR, EU-IMG, etc.). Recognizing this impasse, and acting pursuant to the Ministerial Declaration, the COM issued Decision 55 (Government of Lebanon, Council of Ministers, 2010) to amend and complement the 2006 Master Plan. The 2010 Waste-to-Energy Plan, based on a COM Decision, advocated Waste-To-Energy (WtE) technologies in large cities, and renewed the GOL's commitment to the 2006 Master Plan in the rest of the country, while also exploring the feasibility of WtE systems in these regions.

2014 MSW Management Roadmap

The COM Decision No. 46 (dated 30/6/2014), later amended by COM Decision No. 1 (Government of Lebanon, Council of Ministers, 2015) marks an important policy milestone for Lebanon's waste sector. Specifically, it commissioned the CDR to proceed with the national tender for the procurement of SWM services in six service areas and according to stringent requirements. In particular, the contractor is required to provide solutions for the whole value chain (from waste origin to utilization) in the SWM sector, including locating appropriate sites for landfills, and achieve ambitious waste diversion targets equivalent to 60% of total municipal solid waste generation in the first three years of operation and 75% in the following years. The contract service period was supposed to last seven years, after which WtE technologies would kick in. The tenders were aborted in the course of 2015.

The main pillars of the current policy framework relevant for the SWM sector are based on three decisions from the COM. These have also influenced (either directly or indirectly) the planning and design of the NAMA and need to be considered for its implementation.

The following three COM decisions are most relevant:

- COM Decision No. 46 of 30/10/2014 (Government of Lebanon, Council of Ministers, 2014);
- COM Decision No. 1 of 12/01/2015 (Government of Lebanon, Council of Ministers, 2015); and
- COM Decision No. 9 of 09/09/2015 (Government of Lebanon, Council of Ministers, 2015).

The six service areas described in COM Decision No. 46 (Government of Lebanon, Council of Ministers, 2014) and which were amended by COM Decision No. 1 (Government of Lebanon, Council of Ministers, 2015) are shown in Annex 3: Representation of the six Service Areas in Lebanon. In general, the service areas follow administrative boundaries. However, Beirut and Mount Lebanon, previously one service area under the 2006 Master Plan (MOE/ CDR, 2006), were now divided into three service areas, namely Beirut and it suburbs, Northern Mount Lebanon and Southern Mount Lebanon. The establishment of these service areas was supposed to promote decentralization of SWM services and thereby aimed to reduce some of the opposition linked to oversized and centralized systems. The delineation of service areas also provided the basis for estimating how many reception centers would be needed under this NAMA (at least one per service area).

The most relevant provisions of the three COM Decisions in relation to the NAMA are summarized below:

i. The CDR is to contract private sector entities for sweeping and collecting solid waste, and SWM services including separation, composting, energy recovery and landfilling of non-organic waste in the six service areas. The tender would require prospective bidders to present unit costs as USD/tonne of waste collected and treated/disposed of. Whereas COM Decision 46 (2014) requested the CDR to prepare the TORs for the tender, COM Decision 1 (2015) requested the CDR to implement the tender, and COM Decision 9 (2015) effectively cancelled the tender results, primarily on the basis of cost. ***Although the tender was annulled, it confirmed strong private sector interest in the provision of SWM services, as required under this NAMA***;

ii. The OMSAR, in coordination with the MoE, will continue to manage existing small scale waste separation and composting plants and construct new integrated solid waste management plants with EU funds. ***This is important because it will help improve composting experience and prepare the ground for regional bulk transfer centers as proposed under this NAMA***;

iii. The MoE is to supervise and follow the implementation of all decisions by the Council, and to follow-up on Parliament's endorsement of the draft law for integrated solid waste management and preparation of its application decrees and decisions. ***This is important because it reinforces the role of the MOE in resuming legislative efforts to finalize and approve the ISWM law (which is also a central element under the NAMA Phase 1)***;

iv. To achieve an annual basis of 60% waste diversion (away from landfilling) in the first three years and 75% in the following years through separation, recycling and composting, until thermal disintegration technologies come online. ***The Decision reinforces the gradual shift to WtE technologies, as proposed under this NAMA for selected service areas***;

v. Establish the headlines and guidelines of the MSW Treatment Plan by adopting the principle of treatment decentralization and giving the municipalities and union of municipalities a role in upholding responsibility of MSW for a sustainable period and in accordance with implementation mechanisms set for this purpose, as an intrinsic part of the transitional MSW treatment period;

vi. Establish and operate two sanitary landfills in accordance with environmental standards (i.e. in the area of Srar), after consulting with the union of municipalities, to service Beirut and Mount Lebanon. Additionally, to divert up to 250 tonnes of waste per day to the Saida waste treatment plant to handle part of Beirut's solid waste stream during the interim period. ***This presents a***

renewed opportunity for the rehabilitation of the Srar dumpsite proposed under this NAMA as well as introducing an effective LFG recovery system to further reduce GHG emissions*;*

Pursuant to Point (i) above, the CDR launched six tenders (March-April 2015) on the basis of having six service areas. After a lengthy tender and evaluation process, the tender results were formally announced in September 2015. Civil Society groups responded to those results by organizing extensive street protests demanding the cancelation of the tenders as from their perspective; (i) the tenders put too much emphasis on landfilling, (ii) did not sufficiently invest in recycling technologies, (iii) revealed prohibitively expensive system costs, and (iv) marginalized the role of municipalities contrary to Lebanese legislation.

Under pressure, the COM cancelled the tender and assigned a technical committee headed by the Minister of Agriculture to develop a new (emergency) national MSWM plan that is more inclusive and recognizes the role of municipalities. This resulted in COM Decision 1 (dated 9/9/2015) adopting the Shehayeb Plan, effective immediately. At the time of writing this NAMA report, the Plan was still unfolding and experiencing additional delays related to landfill locations and disbursement from the Independent Municipal Fund (IMF). In sum, the Shehayeb Plan recognizes two phases: (1) an 18-month transitional period, and (2) a long-term solution. While work to design and implement the long-term solution is continuing, the GOL is facing mounting obstacles to resolving the current crisis and removing hundreds of temporary and illegal disposal sites. In January 2016, the GOL approved a motion to export the waste in Phase 1, including the removal of haphazard disposal sites, to waste treatment facilities in Europe and/or Africa. If followed through, this would represent an exorbitant cost to Lebanese society as the unit cost for exporting waste to receiving countries would exceed the unit cost under the 1997 Emergency Plan by far.

3.1.2 National Strategies and Political Decisions Relevant for the SWM Sector and the NAMA

In Lebanon, there is currently no approved national level strategy for climate change, green growth or sustainable development. However, the following policy instruments and strategies are expected to affect the NAMA:

1) National Sustainable Development Strategy (Draft status, not published yet);
2) Law on Integrated Solid Waste Management (Draft status) (MOE, 2005)
3) Intended Nationally Determined Contribution (INDC) (Republic of Lebanon, 2015).

These policy instruments and strategies are described below.

National Sustainable Development Strategy (Draft status)

The GOL is currently preparing a final draft of the National Sustainable Development Strategy (NSDS) which may outline goals for sustainability in the waste sector. The draft NSDS text includes mentioning of certain waste sector components which need to be addressed to achieve sustainable development. Several activities, which are in line with the NAMA and its phased approach are treated in the NSDS (see Text box).

NAMA relevance:

- Establishment of a grid feed-in-tariff applied to installed Waste-to-Energy systems;
- Encouragement of waste-derived alternative fuels (fossil sources or biomass residues);
- In the case where landfilling is used, gas recovery projects for electricity generation should be applied to all current and future sanitary landfills and rehabilitated dumpsites, after performing economic feasibility studies on a site-by-site basis;
- National composting strategy aimed at reducing the amount of organic waste land-filled will be implemented;
- Waste that cannot be recycled or composted will be sent for incineration/combustion.

Although the amount of organic waste going to landfills should fall to avoid GHG emissions, it must be noted that organic waste composting to date is not producing high grade compost in the absence of waste separation at the source. Furthermore, in case of WtE plants (planned under NAMA Phase 2), the waste composition has to be maintained at a level, which shows a sufficiently high calorific value.

Law of Integrated Solid Waste Management (ISWM) (Draft Status) (MOE, 2005)

The Law of ISWM was originally prepared in 2005. It is still only in draft status. The draft ISWM law is an extensive law focusing on the entire system for SWM, in terms of mandates, regulation and strategy. The overarching principles and important guidance in this ISWM law are the creation of a legal framework for the SWM, and the management of solid waste, beginning at its source, and the promotion of state of the art technology like sorting, recycling, etc. The prevention of open dumping and the introduction of the polluter pays principle are also covered in the draft law.

The timeline for approving the Draft Law on ISWM in parliament remains uncertain. This presents a potential obstacle for future planning and designing of the NAMA and requires capacity building efforts.

The content of the draft ISWM law would in many aspects support the objectives of the Waste NAMA and its main components. In the following text box, the major aspects of the ISWM and its relevance to the NAMA are set out.

NAMA relevance:

- A legal and institutional framework for ISWM, with the responsible party for planning, monitoring, and setting standards of the ISWM being the MoE;
- Manage solid waste from source of production to final disposal, without increasing social and economic burdens. To include management via the private sector in accordance with national laws;
- Use of sorting, recycling, re-use and recovery of energy resources in solid waste as long as the process is possible and economically acceptable, and does not cause negative impacts on the environment;
- The prevention of the use of open dumps and other unauthorized means of disposal;
- The polluter pays principle, i.e. the party responsible for the pollution from waste should bear the costs associated with SWM and all actions necessary to address waste-related problems in terms of quantity and quality of waste. Noting that fees can be direct or indirect in nature.

One of the central elements for the first phase of the NAMA is to support the enactment of the ISWM law or at least the relevant parts that are important to enable the interventions planned under the NAMA (see Chapter 5 for further information on the scope of the planned NAMA).

Intended Nationally Determined Contribution (INDC) (Republic of Lebanon, 2015)

Even though the INDC is not a policy instrument, it presents a long term strategy for GHG mitigation and sustainable development. The INDC is considered relevant for the NAMA: NAMAs can be understood as implementation mechanisms for parts of the INDC of a country. Therefore, NAMA targets should also be aligned with the INDC of a country and also to future National Determined Contributions (NDCs).

The INDC of Lebanon submitted to the UNFCCC in September 2015 summarizes Lebanon's intended targets related to voluntary GHG emission reduction. It presents two reduction scenarios, compared with the Business-As-Usual (BAU) scenario up to 2030, as summarized in the table below. The planned NAMA in the SWM sector would contribute towards achieving the Conditional Target, which would require international funding.

The Unconditional Target	**A GHG emission reduction of 15% compared with the BAU scenario in 2030.**
The Unconditional Mitigation Scenario includes the impacts of mitigation actions which Lebanon is able to implement without additional international support.	15% of the power and heat demand in 2030 is generated by renewable energy sources. 3% reduction in power demand through energy-efficiency measures in 2030 compared with the demand under the BAU scenario.
The Conditional Target	**A GHG emission reduction of 30% compared with the BAU scenario in 2030.**
The Conditional Mitigation Scenario covers mitigation actions under the unconditional scenario, as well as further mitigation actions which can be implemented upon the provision of additional international support.	20% of the power and heat demand in 2030 is generated by renewable energy sources. 10% reduction in power demand through energy-efficiency in 2030 compared with the demand under the BAU scenario.

Table 5: Lebanon's INDC Targets in 2030 compared to Business As Usual

The technical interventions (LFG capturing and flaring or utilization, and WtE plants) planned under the NAMA would directly contribute to the GHG mitigation target. In addition, the power generation from LFG (LFG utilization) and the energy produced from WtE would contribute to the target of increasing the share of renewable energy sources.

In the following text box, the major aspects of the INDC that are relevant for the NAMA are outlined.

NAMA relevance:

The INDC covers the waste sector, as also a variety of other IPCC sectors. The following targets relevant for the solid waste sector are mentioned in the INDC:

- Implementation of the latest agreed SWM strategy by the MOE, including waste management through energy recovery, equivalent to avoiding emissions from landfilling 1000 tonnes of solid waste per day (both under the conditional and unconditional target);
- A recycling rate of 25% (unconditional target) and 30% (conditional target) by 2030.

3.1.3 Relevant National Level Guidance on GHG Mitigation

To date all national level guidance on GHG mitigation targets has been focused on the indicated mitigation potential described in the SNC submitted by the GOL to the UNFCCC in 2011. In the case of a NAMA, which affects a whole sector at the national level, targets need to be integrated into national activities and processes for GHG inventories and GHG reporting procedures. At the same time, the results of the NAMA, including GHG emission reductions (monitored as part of the MRV System), should be used by the Government or relevant institutions for developing and updating sectoral and national GHG inventories and for international reporting requirements (i.e. to the UNFCCC). Each country needs to develop Biennial Update Reports (BURs) and National Communications to the UNFCCC on a regular basis.

First Biennial Update Report (MOE, 2015)

Lebanon's first BUR was published in October 2015. It describes the development of GHG emissions across various sectors (energy, transportation, industry, waste, agriculture and land use, land use change and forestry for 2011. The BUR reports emissions from the waste sector and also recommends the implementation of a NAMA in the waste sector.

NAMA relevance:

- Provides an update of Lebanon's greenhouse gas (GHG) national inventories;
- The BUR directly relates to the waste sector: description of the existing situation in the waste sector with all its issues and the measures envisaged to improve the environmental impacts of the sector;
- Proposes NAMA activities in the waste sector.

Third National Communication (Waste Sector) (MOE/GEF/UNDP, 2015)

The TNC for Lebanon is currently under preparation and will be submitted to the Conference of Parties (COP) in accordance with the guidance of the UNFCCC, with an overall goal to maintain and strengthen national capacity for continuous fulfillment of its commitments under the Convention. The TNC has already assessed total emissions from the waste sector and determined potential GHG mitigation from the sector in case of carbon reduction technologies.

NAMA relevance:

- Update Lebanon's greenhouse gas (GHG) national inventories for the year 2005 and time-series covering the period from 1994 to 2012;
- Update the analysis of potential GHG mitigation measures using two scenarios in the solid waste sector: (1) Waste incineration with energy production in Beirut and Mount Lebanon and landfilling in the rest of Lebanon; (2) Waste incineration with energy production on the coastal zone of Lebanon and landfilling in the Bekaa region;
- Update the assessment of potential impacts of climate change on food security, social development, and poverty; and
- Propose adequate adaptation measures.

3.2 Alignment with National and Sector Strategies and Policies

A long-term vision can help ensure policy coherence and unify different actors behind a common goal. As the NAMA intends to bring a positive long-term transformation to the SWM sector, leading to GHG emission reductions and higher sustainable development standards, a central component of the NAMA is to support the establishment of a regulatory framework for the SWM sector.

It is critical to align the NAMA closely with both national and sectoral level policies, plans and targets (both qualitative and quantitative). This is especially important in the case of Lebanon, where there is currently a "trash crisis" caused by limited solid waste disposal options and limited capacities in the country, compounded by (1) lack of coordination and planning by the GOL, (2) lack of transparency, and (3) the need for institutional reform.

The number of past approaches to develop strategies and plans for the SWM sector clearly shows the relevance of the sector for Lebanon and the urgent need for solutions. Nevertheless, the relevant laws like the ISWM law or NSDS are not yet ratified. The three recent COM decisions mainly dealing with specific aspects like waste collection and waste diversion (including transport of waste) to the disposal sites and do not address> the erection of new disposal sites or the implementation of other ways of disposal.

At the sectoral level there is no overreaching policy or regulatory framework for SWM in place. To date all national level guidance on mitigation has been focused on the indicated potential mitigation actions outlined in the SNC and the TNC. Thus, the NAMA must rely upon draft policies and regulations (see Section 3.1) as well as planning decisions by the COM in 2014-2015. The following table summarizes how the existing and relevant plans, decisions and draft laws align with the intended NAMA scope and planned components.

Policy, Strategy, Plan	**NAMA Outcomes**				
	A. Institutional framework for waste management is established	B. Regulatory framework for Municipal Solid Waste (MSW) management is established	C. Landfill gas is collected and utilized or flared	D. Solid waste is collected and waste streams are diverted to appropriate disposal sites	E. Waste-to-Energy is applied
National Sustainable Development Strategy (Draft)			The NSDS states that in the case where landfilling is used, gas recovery projects for electricity generation will apply to all current and future sanitary landfills and rehabilitated dumpsites, after economic feasibility studies on a site-by-site basis were conducted. This supports the activities planned to capture and utilize or flare the LFG under the NAMA.	The NSDS proposes a national composting strategy aimed at reducing the amount of organic waste land-filled. The NAMA, with the set up and operation of reception centers, would help to increase the amount of waste being composted.	Proposes the establishment of a feed-in-tariff applied to WtE systems and that waste that cannot be recycled or composted will be sent for incineration. This is in line with the NAMA activities planned and would be a pre-condition for WtE implementation.
Law on Integrated Solid Waste Management (Draft)	Proposes to include management via the private sector in accordance with national laws. The NAMA clearly plans to strengthen the private sector's role in the operation and management of SWM facilities (incl. landfill sites, reception centers and WtE plants).	Proposes the use of sorting, recycling, re-use and recovery of energy resources. In addition, the law outlines the polluter pays principle, where the party causing the pollution bears the costs associated with SWM. These principles are also taken into account in the NAMA in the activities related to source sorting (awareness creation) and the financing approach of the NAMA (see Chapter 7).	Proposes to include management via the private sector and to prevent the use of open dumps and other unauthorized means of disposal. This is in line with the NAMA, as it plans to prevent open and unmanaged dumps and instead apply LFG capture facilities where LFG is flared or utilized. In addition, the private sector is supposed to manage and operate these sites in the form of (Public Private Partnerships (PPPs).	Proposes to manage solid waste from source of production to final disposal, and to use sorting, recycling, re-use and recovery of energy resources in solid waste. The NAMA has the clear objective to improve waste collection and waste diversion processes in Lebanon through the implementation of waste reception centers.	
COM Decision 46 (30/10/2014) (Ratified)	The MOE is supposed to mobilize international funding to implement the ISWM road map, to implement an	The MOE is to follow up on Parliament's endorsement of the Draft ISWM law. One of the core elements of the	The CDR is supposed to contract services to build a LFG recovery system to generate electricity from Naameh landfill.	OMSAR to continue to manage existing waste separation and composting plants and build new plants with EU funding and CDR to prepare tender	CDR to activate Phase 2 of Ramboll Waste to Energy study. The NAMA supports the

	environmental monitoring programme and to follow-up on Parliament's endorsement of the Draft ISWM law. It indicates the relevance of the MOE for the SWM sector. The NAMA includes the MOE as the key institution for the NAMA.	NAMA is to provide the support necessary to enact the ISWM (or parts of it) and establish the regulatory framework necessary for the NAMA.	The NAMA with its LFG collection and LFG utilization and flaring activities is aligned to the target mentioned under the COM Decision.	documents for private sector entities to provide street sweeping, waste collection and treatment /disposal services in five areas. The NAMA considered the improved waste collection as a central element for transformational change and as a necessary pre-requisite for WtE technologies.	preparation for the implementation of one WtE facility and the assessment of further WtE technologies in Lebanon. This will include the assessment of information required, the conduct of a feasibility study and the implementation and operation of one WtE incineration plant.
COM Decision 1 (12/1/2015) (Ratified)			Includes a tender to cover all stages of SMW (sweeping, collection, transport, treatment, landfilling and energy recovery). This supports the NAMA and is in line with the NAMA approach to cover the different stages of SWM from the source, the collection, the treatment and the LFG utilization (including energy production).	Includes a waste diversion target of 60% in the first 3 years and 75% beyond and a tender to cover all stages of SMW (including waste collection). The NAMA aims to improve the amount of waste collected through building of reception centers.	Includes a tender to cover all stages of SWM including energy recovery. This is in line with the NAMA approach which covers the different stages of SWM from the source, the collection, the treatment and the utilization.
COM Decision 1 (9/9/2015) (Ratified)	Delegate greater SWM authority to municipalities and federations. The NAMA includes the MOE and municipalities as key stakeholders and includes several capacity-building activities, helping involved institutions to strengthen their capacities and capabilities for SWM.		To establish two new sanitary landfills and to explore the feasibility of reopening another dumpsite as part of a wider rehabilitation plan. These activities have been considered under the NAMA for selecting the priority sites for Phase 1 of the NAMA. It further shows that the LFG collection and utilization is one of the priorities and hence the NAMA can support this target.		
INDC			The NAMA with its GHG mitigation targets would be a central implementation mechanism for the GOL to achieve the GHG mitigation targets outlines in the INDC (at least for the waste sector).		

Table 6: NAMA alignment with existing policies, plans and strategies

4 Baseline Information and Mitigation Targets

As the NAMA is structured in a phased approach with specific technical interventions starting in Phase 1 and additional interventions starting in Phase 2, the GHG baseline and the mitigation targets are described for each NAMA Phase separately. In Phase 1 the main intervention is to manage LFG at four priority solid waste dump sites (SWDS), flare the LFG and utilize it for power generation where feasible. In Phase 2 LFG at four additional landfill or dump sites will be managed and LFG flared or utilized for power generation. In addition, one large waste incineration plant for energy production (WtE) will be constructed and operated.

4.1 Baseline Boundary and Assumptions

4.1.1 Sector/Sub-Sector Boundary

The NAMA focuses exclusively on the MSW sector. In general, solid waste refers to "municipal, industrial and healthcare waste". In Lebanon, this definition is not consistently applicable due to the absence of well-defined legislation and stringent controls. Accordingly, some industrial and hazardous wastes are being mixed with the MSW. MSW normally includes residential, institutional, and commercial waste. Agricultural waste is not considered as MSW according to the TNC and hence is excluded from the NAMA.

4.1.2 Geographical Boundary

The NAMA will apply to the entire geographical area of Lebanon. Given that 50% to 60% of the population lives in Beirut and its surroundings, the main emission sources might be predominantly associated with Greater Beirut Area (GBA) and Mount Lebanon. Some of the technical interventions leading to GHG emission reductions (e.g. the implementation of a WtE facility under NAMA Phase 2) will first focus on these regions because of the amount of MSW there and the urgent need to find solutions thanks to public pressure. However, the NAMA covers the entire country and includes activities across all regions. Most of the open dumps are located outside of the GBA. Furthermore, the only three landfills currently managed service three different regions, namely Beirut and Mount Lebanon (excluding the Caza of Byblos), Tripoli, and Zahleh. That is why the source of MSW under the NAMA can be urban, peri-urban, and rural.

4.1.3 General Assumptions for the Baseline Scenario

The baseline scenario is used as a reference for a comparison with the scenario under the NAMA. The baseline scenario or BAU scenario for the SWM sector describes the situation in the absence of the NAMA or the expected interventions. To calculate the GHG emission baseline and assess the co-benefits, certain trends and assumptions are used to develop the BAU for the full NAMA period (2018-2030).

The BAU scenario for the NAMA is based on the current situation, short term trends and already planned activities that would occur even in the absence of the NAMA.

Generally, the national solid waste crisis in Lebanon is likely to continue. The Government will have to address the closure and rehabilitation of hundreds of new dumpsites and disposal sites that emerged after the closure of the Naameh Landfill in July 2015. Those will have to be surveyed and transferred into sanitary landfills, or the waste has to be exported to avoid further environmental degradation. The Government will continue to be confronted with public opposition against building and operating new large landfill sites. In addition, Lebanon is a rather small and densely populated country and land availability remains one of the main obstacles to opening new waste disposal sites. That is why waste management and waste diversion systems will need to be prioritized in the near term.

Based on recent trends and on the current situation it is assumed that uncontrolled disposal of MSW will continue and management of landfill sites and dumps (including flaring of LFG or LFG utilization) would

not be applied at those sites that would be targeted under the NAMA (LFG is released into the atmosphere without any form of mitigation or utilization). Furthermore, it is assumed that the waste incineration plant, planned under the NAMA for energy production (WtE), would not be implemented in the absence of the NAMA. The following table shows additional aspects and activities that are planned or likely to happen in the short-term (within 2 years) in the SWM sector and that are under consideration in determining the baseline of GHG emissions.

Solid Waste Activity	**Relevant aspects to be considered for the baseline**
Waste Collection	
Beirut and Mount Lebanon	- Continuation of waste collection contract (short-term) with the Sukleen company until a new collection system has been approved. - Increased haulage distance (up to 100km) when Srar landfill starts operation, leading to increased GHG emissions. The date of commencement was not clear at the point in time of finalization of this NAMA report. It can be assumed that this "quick fix" will come into operation very soon due to the waste crisis.
Waste collection outside Beirut and Mount Lebanon	- Waste collection is done by municipalities or private waste haulers under a contract with municipalities and/or unions of municipalities - No impact of waste collection service on GHG emission reductions
Waste Treatment	
Sorting and recovery	- Small scale facilities for MSW sorting and recovery (e.g. by OMSAR, civil society) being implemented, leading to very limited waste diversion
Composting	- Discontinuation of "Sukomi" MSW composting operation in Beirut (300 tonnes/day), leading to increased waste disposal
Waste-to-Energy	- Improved operation of Lebanon's first RDF facility in Saida (by waste contractor IBC for Saida Municipality) and growing interest from other regions and municipalities; public acceptance of proposed transfer of MSW from Beirut to Saida remains low - Other facilities for RDF (under OMSAR) will start operation in up to five regions: Baalbeck, Nabatieh, Ain Baal, Hbaline, Tripoli - Overall impact of RDF facilities (IBC and OMSAR) on net GHG emissions remains unknown until actual emissions from RDF production and combustion are assessed; low market demand for RDF due to lack of corresponding regulation and know-how - No policy and regulatory progress on WtE systems in Lebanon despite formal endorsement of WtE by the COM in 2010
Waste Disposal	
Managed Landfills	- Full closure and coverage plan for "Naameh" Landfill with increased LFG recovery and utilization (6 MW), and consequent emission avoidance - Continuation of releasing methane emissions at the landfill sites in Zahle and Tripoli - New landfill starts operating in Srar (Akkar) to handle MSW from Beirut and Mount Lebanon with the opportunity for LFG utilization
Unmanaged landfills and dumpsites	- Increased number of uncontrolled dumpsites across the country due to the closure of Naameh Landfill in July 2015 with no alternatives in place - Continuation of GHG emissions from major dumpsites (Hamat, Srar, and Hbaline) as well as hundreds of new/smaller dumpsites, leading to increased GHG emissions

Table 7: Short-term aspects in the SWM sector to be considered under the baseline scenario

4.2 GHG Baseline and Mitigation Targets for the NAMA Phase 1

4.2.1 Overview of Interventions Leading to GHG Emission Reductions

The GHG emissions baseline for Phase 1 of the NAMA focuses on four priority landfill sites or open dumps at which LFG is going to be flared and/or utilized.

4.2.2 Site Selection for LFG Flaring and Utilization

The baseline GHG emissions for the LFG flaring and utilization depend on the specifics of the landfill sites and dumpsites that will be targeted under the NAMA. It should be noted that the current information base for the landfill sites and open dumps in Lebanon is not accurate or sufficient for proper GHG emission calculations. As described in Chapter 5, it is highly recommended that before the start of the NAMA (Step 0), all large landfills and dumpsites in Lebanon are examined for possible inclusion in the proposed LFG management and utilization process and four sites should be selected as priority sites (those with the highest GHG emission reduction potential). Also before the NAMA, it is recommended that a feasibility study be conducted at each priority site to gather necessary information about the sites and calculate the baseline emissions and potential emission reductions for those sites accurately.

Even though information on the sites is currently insufficient, the following approach for assessing potential sites was applied to arrive at ex-ante estimates of the GHG reduction potential of LFG flaring and utilization under the Phase 1 of the NAMA.

At present, Lebanon has three landfills (managed and/or sanitary), namely Naameh, Tripoli, and Zahle, and more than 500 open dumpsites across the country (MOE, UNDP, ELARD, 2011). It is assumed that only Tripoli, and Zahle will be among the four priority sites under the NAMA Phase 1. The Naameh site, Lebanon's largest solid waste dumpsite, was dropped from the list because it is already subject to a separate feasibility study (funding for the project is secured and the proposed gas recovery system will extend over 10 years with direct grid connection).

Before the design of the NAMA and following a 2011 survey of dumpsites in Lebanon, further dumpsites with the highest theoretical GHG emission reduction potential were identified. These dumpsites were selected, based on two main criteria: (1) Height of dump site > 5m, and (2) no (known) active burning practice at dump site. Based on the preliminary GHG estimations, eight sites were selected, of which the two open dumps with the highest GHG emission reduction potential were selected to be included in the NAMA Phase 1. These two sites are Srar (in North Lebanon) and Hbaline (in Mount Lebanon).

As a result, the GHG baseline for the NAMA Phase 1 is based on these four sites. All four are currently operational and are summarized in the table below. They range in depth from 15 to 33 meters and, as of 2014, held up to 2.4 million m^3 of solid waste. The waste disposal history of each site served as a basis for the ex-ante estimation of baseline GHG emissions.

Site	Type	Depth (m)	Volume (m^3)	Start Year	Status	Type of waste
Tripoli	Managed Landfill (coastal)	33	1,200,000	1998	Operational	MSW
Zahle	Sanitary Landfill (inland)	24	700,000	2002	Operational	MSW
Srar[1]	Unmanaged (dumpsite)	15	150,000	1998	Operational	MSW
Hbaline[2]	Unmanaged (dumpsite)	15	375,000	1986	Operational	MSW

[1] Rehabilitation planned/ongoing (financing secured); expansion/upgrade works in progress
[2] Rehabilitation planned/ongoing (financing secured)

Table 8: Summary of pre-selected LFG sites for NAMA Phase 1

Each of the selected sites is further described below, including their history and waste profile.

The Tripoli Managed Landfill

The Tripoli controlled dumpsite is located on the Tripoli seafront and serves the city of Tripoli as well as the neighboring towns of Al-Mina, Biddawi and Qalamoun representing a total population of approximately 400,000 inhabitants. In 2000, the CDR contracted BATCO, a local waste contractor, to improve waste disposal practices and manage the dumpsite by retrofitting it with gas extraction wells and flaring units. In 2003 a study commissioned by CDR recommended building a waste sorting and composting plant and building a wall around the dump (9-10m high) to contain the waste and prevent breakage into the sea. The CDR constructed the sea wall in 2006 and the EU-funded a SWM programme, under which the OMSAR tendered the construction of a 150 tonnes/day sorting plant in 2009, which was contracted but is still not operational. At the Tripoli dumpsite, one flaring unit has been installed since 2000, where collected gas is supposed to be directly flared on site. This system has so far failed due to the high levels of oxygen in the gas stream. This indicates either the presence of a defective gas collection system or inappropriate compaction of waste piles producing air pockets within the landfill[2]. The Tripoli landfill is planned for closure as it has reached its maximum capacity. The closure would require alternative SWM solutions.

The Zahle landfill

The Zahle landfill was opened in 2002 in the Bekaa Valley in the Caza of Zahle. It was designed to receive 150 tonnes of MSW per day. It was designed and built under the World Bank-funded Solid Waste Environmental Management Project. In 2006, USAID signed a USD 2.4 Million agreement with the municipality of Zahle to expand the existing sorting plant and build a composting plant adjacent to the landfill. The sorting plant was completed in 2007 with a design capacity of 300 tonnes of waste daily and started operation in 2008. The compost plant (90 tonnes/day) has yet to start operation. The landfill today comprises five cells (average height of 24 meters) and receives about 150 tonnes/day, i.e. around 55,000 tonnes per year. The landfill site is equipped with one flaring unit installed in 2003 (the LFG flaring system appears to be broken, as methane amounts collected are very low or inexistent).

Srar and Hbaline dumpsites

Srar and Hbaline open dumps were established in 1998 and 1986 respectively. Hbaline is located alongside a seasonal river whereas Srar is located in agricultural land. Funding for the rehabilitation of both sites was recently secured from an EU-funded programme (SWAM programme). Both sites receive typical MSW, but disposal of other waste types including waste from construction and demolition and healthcare cannot be avoided. In Lebanon, there is generally very little control of and documentation about the type of incoming waste at open dumpsites, including the sites in Srar and Hbaline. The Hbaline dumpsite however, was the subject of a LFG capture and flaring study in 2009 which identified three potential options for gas management (MORES, 2009).

Site	Waste Deposal Assumptions
Tripoli Managed LF	Constant (from1998) then full closure in 2015
Zahle Sanitary LF	Constant (from2003) then full closure in 2022
Hbaline Unmanaged	Constant (from1986) then full closure in 2020
Srar Unmanaged[1]	Constant (from 1998) then planned expansion (2015) and full closure in 2020

[1]*Planned expansion of Srar dumpsite into a managed landfill is based on COM Decision No. 1 (dated 9/9/2015).*

Table 9: Waste deposal profile at targeted solid waste dumpsites under NAMA Phase 1

[2] Personal communication between Ecodit and Mr. Edward Bahout, Solid Waste Expert, Batco

4.2.3 GHG Baseline Emissions

GHG emission reductions under Phase 1 of the NAMA will be achieved through (i) avoidance of methane emissions, and (ii) by replacing fossil- fuel- based electricity with power generated from utilizing LFG.

The overall emissions of the dump/ landfill cannot be measured exactly. Therefore, an ex-ante calculation of the expected emissions applying a model calculation is done (First Order Decay Model, FOD) to derive the baseline emissions. This ex-ante approach is used to show the emission reduction potential at this stage. As the entire amount of LFG cannot be collected, the baseline assumes an amount of methane collected in the project activity and an amount of methane flared.

The following figure describes the baseline scenario for the landfills and dumps (UNFCCC, 2015a) under Phase 1 of the NAMA.

Figure 6: Baseline scenario for landfill and dump sites under NAMA Phase 1

In the baseline scenario, the waste is disposed of at the landfills or open dumps, leading to LFG formation. This LFG, which contains a large share of methane (CH_4) is released to the atmosphere.

The intervention under Phase 1implements landfill gas collection and utilization, whereby the emission reductions will result from the following two effects:

(i) Avoidance of methane emissions through LFG flaring, i.e. the destruction of the collected LFG by flaring, and
(ii) Electricity generation from burning the collected LFG in a power generator.

Activity (i) will avoid methane emissions through the collection of the LFG in a piping system via wells and the operation of a fan, which extracts the LFG from the landfill/dump. The collected LFG will be flared, or utilized. Activity (ii) also replaces power production for the electricity grid. The following sketch from the CDM Methodology handbook pictures the project scenario under the NAMA (UNFCCC, 2015a).

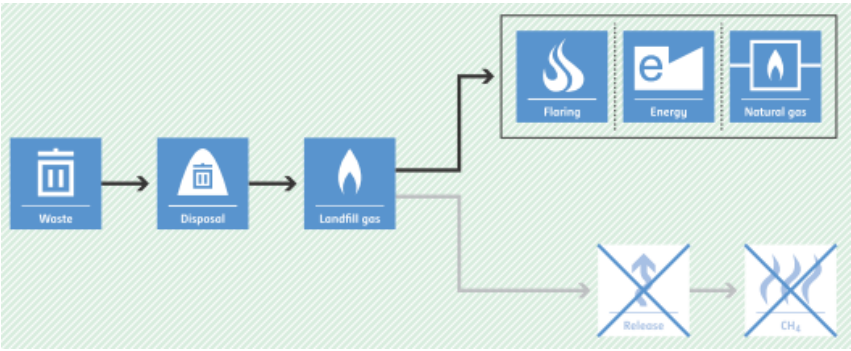


Figure 7: Project scenario for avoidance of LFG

The following paragraphs describe the baseline for these two emission reduction activities under the NAMA Phase 1.

(i) Avoidance of methane emissions through LFG flaring

The actual levels of emission reduction for the NAMA will need to be assessed through ex-post calculations. To obtain preliminary data on the approximate baseline emissions, an ex-ante estimation is required. This ex-ante approach is described in the following paragraphs.

For the avoidance of methane, which would have been emitted to the atmosphere in the absence of the NAMA interventions (project scenario), the baseline emissions are calculated as follows.

Baseline emissions

Baseline emissions are determined according to the equation below and comprise the following sources:

(a) Methane emissions from the SWDS in the absence of the project scenario;

(b) Electricity generation using fossil fuels or supplied by the grid in the absence of the project activity.

$$BE_y = BE_{CH4,y} + BE_{EG,y} \quad (1)$$

Where:

BE_y = Baseline emissions in year *y* (t $CO_{2\text{-eq}}$/yr)

$BE_{CH4,y}$ = Baseline emissions of methane from the landfill in year *y* (t $CO_{2\text{-eq}}$/yr)

$BE_{EG,y}$ = Baseline emissions associated with electricity generation in year *y* (t $CO_{2\text{-eq}}$/yr)

Baseline emissions of methane from the landfills ($BE_{CH4,y}$)

Baseline emissions of methane from the landfills are determined as follows, based on the amount of methane that is captured under the project activity and the amount that would be captured and destroyed in the baseline (given this is required by regulation). In addition, the effect of methane oxidation that is present in the baseline and absent in the project is taken into account:

$$BE_{CH4,y} = (1 - OX) \times \left(F_{CH4,PJ,y} - F_{CH4,BL,y}\right) \times GWP_{\mathrm{CH4}} \quad (2)$$

Where:

$BE_{CH4,y}$ = Baseline emissions of methane from the SWDS in year *y* (t $CO_{2\text{-eq}}$/yr)

OX = Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless), value to be applied: 0.1

$F_{CH4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project scenario in year *y* (t CH_4/yr)

$F_{CH4,BL,y}$ = Amount of methane in the LFG that would be flared in the baseline in year *y* (t CH_4/yr)

GWP_{CH4} = Global warming potential of CH_4 (t $CO_{2\text{-eq}}$/t CH_4), value to be applied: 25

Ex-ante estimation of $F_{CH4,PJ,y}$

An ex ante estimate of $F_{CH4,PJ,y}$ is required to estimate baseline emissions of methane from the SWDS (according to equation (2)) in order to estimate the emission reductions in the NAMA ex-ante. It is determined as follows:

$$F_{CH4,PJ,y} = \eta_{PJ} \times \sum_{j} F_{CH4,SWDS,j,y} \quad (3)$$

Where:

$F_{CH4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project scenario in year *y* (t CH_4/yr)

$F_{CH4,SWDS,j,y}$ = Amount of methane occurring in year *y* that would be generated in the baseline scenario from the disposal of waste of type *j* at a SWDS during a time period ending in year *y* (t CH_4/yr)

η_{PJ} = Efficiency of the LFG capture system that will be installed in the project scenario

Emissions from waste decomposition include CH_4, N_2O, and CO_2. The baseline emissions calculation however focuses on CH_4 only because methane represents the largest source of emission. N_2O emissions are negligible and CO_2 emissions from decomposition of organic waste are not included, since CO_2 also occurs under the NAMA project scenario.

To calculate baseline emissions from the four SWDS (two managed and two unmanaged landfills), the First Order Decay (FOD) method, which is described in the CDM methodological tool Emissions from solid waste disposal sites (UNFCCC, 2015b) was adopted. This method is applied in the waste sector by applying activity data and emission factors, which are obtained from national sources for several years. The following information and parameters were used for FOD calculation:

- age of the SWDS (landfill or dumpsite);
- climatic data at SWDS;
- amount of waste disposed (total and annual amount disposed);
- waste composition;
- depth of SWDS (vertical thickness);
- parameters of the FOD equation for every SWDS (see below);
- geographical information on SWDS; and
- information on how well the SWDS was managed.

The baseline methane generation potential was estimated ex-ante for all four SWDS using the FOD model and applying the following equation:

$$F_{CH4,SWDS,j,y} = Y \times \sum_{i=1}^{y} \left(e^{-k_j(i-1)} \times \left(1 - e^{-k_j}\right) \times m_{j,i} \times DOC_j \times \frac{16}{12} \right) \quad (4)$$

Where:

$F_{CH4,SWDS,j,y}$ = Methane generated in baseline scenario, see equation (3) (t CH_4)

k_j = Decay rate for the waste type *j* (1/yr)

$m_{j,i}$ = Amount of waste type *j* disposed in the dump site in the year *i*, *i*=1, …,*y* (t)

DOC_j = Content of degradable organic carbon (DOC) in the waste type *j* (weight fraction)

Parameter Y aggregates a number of correction factors tailored to the specific conditions occurring in the SWDS as follows:

$$Y = DOC_f \times MCF \times f_{LFG} \times (1 - OX) \times \left(1 - f_{CH4,BL}\right) \times \varphi \quad (5)$$

Where:

DOC_f = Fraction of the degradable organic carbon (DOC) that is susceptible to decomposition in the SWDS (weight fraction)

MCF = Methane Correction Factor

f_{LFG} = Fraction of methane in LFG (volume fraction)

OX = Oxidation factor

$f_{CH4,BL}$ = Fraction of methane captured in the baseline scenario

φ = Model correction parameter to account for uncertainties

In principle, the correction factors in Eq. (5) can vary over time according to changing conditions at the SWDS. For the FOD calculations in this present NAMA, those factors were assumed to be constant over time.

The conditions and parameters for the FOD calculations are explained in more detail in Table 10. The choices of conditions and numerical parameter values applied are presented. Generally, conservative assumptions and factors were used. The complete set of parameters for the four selected SWDS targeted by this NAMA (Phase 1) is listed in Annex 8: Characteristics of the Selected SWDS for Phase I and of the WtE for Phase II.

FOD Parameter	Description and Assumptions
Waste conditions (*wet* or *dry*)	The FOD calculation used *wet* because the moisture content of MSW in Lebanon is very high, largely because of thehigh organic waste fraction (about 52-55%).
Regional climatic conditions (*boreal/temperate* or *tropical*)	Lebanon is neither boreal/temperate nor tropical, but mesothermal to subtropical with dry summers. Precipitation is high on the western slopes of Mount Lebanon (800-1200mm) and much lower inland (about 400-500mm). The Mean Annual Temperature (MAT) on the coastline is 20°C, with occasional cold spells in winter. Temperature fluctuations are much higher inland (Bekaa), with sub-zero temperatures during short winter periods. Accordingly, *boreal/temperate* or *tropical* climatic conditions were used to reflect the specific conditions of each SWDS.
Regional Precipitation Conditions (*wet* or *dry*)	The FOD calculation used *dry* because for *boreal/temperate* climate, the ratio between the Mean Annual Precipitation and the Potential Evapotranspiration (MAP/PET) is less than 1 and for *tropical* climate, the MAP is less than 1000 mm.
Decay rate, k_j	The decay rate for each type of waste type *j* (*wood/wood-products*, *pulp/paper/cardboard*, *food/food-waste/beverages/tobacco*, *textiles*, *garden/yard/park-waste*, *glass/plastic/metal/other-inert*). The rate depends on the regional climatic and precipitation conditions at the SWDS.
DOC content, DOC_j	Content of degradable organic carbon (DOC) in each type of waste type *j*. This content depends on the waste condition (wet or dry waste).
Degradable DOC fraction, DOC_f	Fraction of the DOC that is susceptible to decomposition under the conditions prevailing in the SWDS. The FOD calculation used 0.77 to reflect Lebanese conditions (MOE/GEF/UNDP, 2015).
Methane Correction Factor, MCF (1, 0.8, 0.5, 0.4)	The FOD calculation used two values to match the conditions of each SWDS: (i) MCF = 1.0 for *anaerobically managed SWDS with controlled placement of waste* (such as in Tripoli and Zahle), and (ii) MCF = 0.8 for *deep (>= 5m waste) unmanaged SWDS or sites with a high water table* (such as Hbaline and Srar).
Fraction of methane in the LFG, f_{LFG}	The FOD calculation used the default value of 0.5.
Oxidation factor, OX (0.1,	The FOD calculation used 0.1 for managed landfills that are covered with

0)	oxidizing material such as soil or compost (Tripoli and Zahle) and 0.0 for other types of SWDS (Srar and Hbaline).
Fraction of methane captured in the baseline, $f_{CH4,BL}$	The FOD calculation used 0.6, which assumes, that 60% of the produced LFG can be captured in the collection system.
Model correction parameter for uncertainties, Phi	The FOD calculation used 0.9 to reflect the level of uncertainty in the waste volume and composition data for Lebanon.

Table 10: Applied FOD Parameters and assumptions for baseline emission calculation

The FOD method was then used to estimate the baseline methane generation potential for each site during Phase 1 (2018-2021) and Phase 2 (2022-2030) of the NAMA (Table 11). In accordance with the CDM methodology, the baseline only takes the gas amount which can be collected into account. This is considered via the parameter f_{LFG}. The total baseline emissions in Phase 1 amount to about 0.7 million $tCO_{2\text{-}eq}$.

Phase 1 Baseline Emissions ($tCO_{2\text{-}eq}$)	
Solid Waste Disposal Site	**Cumulative Phase 1**
Years	**2018-2021**
Tripoli (Managed LF)	203,838
Zahle* (Sanitary LF)	103,834
Hbaline (unmanaged)	64,392
Srar (unmanaged)	317,118
Total by Phase	**689,182**

*Operation of LFG collection starting 2019

Table 11: Estimated total Baseline GHG Emissions ($tCO_{2\text{-}eq}$) from priority SWDS in Lebanon (2018-2030)

(ii) Baseline emissions associated with electricity generation ($BE_{EG,y}$)

The baseline emissions associated with electricity generation in year *y* ($BE_{EG,y}$) will be calculated using the CDM Tool to calculate baseline, project and/or leakage emissions from electricity consumption. When applying the tool: $EC_{BL,k,y}$ in the tool is equivalent to the net amount of electricity generated using LFG in year *y* ($EG_{LFG,y}$).

For the power production, the level of baseline emissions for the replaced power is based on Lebanon's specific emission factor for the power grid and is calculated as follows:

$$BE_{EG,y} = EG_{LFG,y} * EF_{CO2,EL} \quad (6)$$

Where:

$BE_{EG,y}$ = Baseline emissions of the replaced grid electricity per year (t $CO_{2\text{-}eq}$/yr)

$EG_{LFG,y}$ = Electricity generated from the landfill gas per year (MWh_{el}/yr)

$EF_{CO2,EL}$ = CO_2 emission factor for displacement of electricity in the Lebanese power grid (t $CO_{2\text{-}eq}$/MWh_{el}). This value is taken from a registered CDM project activity and set at 0.715 t $CO_{2\text{-}eq}$/MWh_{el}. This factor needs to be updated upon NAMA implementation (MOE/GEF/UNDP, 2015).

As the power production potential for the landfills is not yet known and needs to be assessed in detailed feasibility studies for each site during Step 0 (see Chapter 5), no estimate of the emission reduction potential can be shown yet.

4.2.4 GHG Mitigation Targets

The mitigation target for Phase 1 is the collection of LFG from the four assumed priority disposal sites.

Emission reductions from Landfill gas collection and utilization

Estimating the emission reductions applies the following 3-step approach.

1. Definition of the baseline emissions BE: the baseline scenario can either be the continuation of the existing situation or any other hypothetical scenario.
2. Determination of the project scenario: the project scenario may create project emissions PE.
3. Calculation of the emission reductions ER.

Emission reductions from LFG collection and destruction shall follow the CDM Methodology ACM0001 and can be calculated as the difference between the baseline emissions from the LFG collected and flared plus the LFG collected and utilized minus the project emissions from power consumption:

$$ER_y = \left(BE_{CH4,,y} + BE_{EG,y}\right) - PE_y \quad (7)$$

Where:

ER_y	=	Emission reductions in year *y* (t $CO_{2\text{-eq}}$/yr)
$BE_{CH4,y}$	=	Baseline emissions of methane from the SWDS in year *y* (t $CO_{2\text{-eq}}$/yr)
$BE_{EG,y}$	=	Baseline emissions associated with electricity generation in year *y* (t $CO_{2\text{-eq}}$/yr)
PE_y	=	Project emissions in year *y* (t $CO_{2\text{-eq}}$/yr)

Baseline emissions

The Phase 1 baseline emissions BE are described in Section 4.2.3 above, whereby the factor $F_{CH4,PJ,y}$ needs to be determined ex-post. The amount of methane flared in the project activity needs to be measured continuously and then aggregated for each monitoring period. During the monitoring period, $F_{CH4,PJ,y}$ is determined as the sum of the quantities of methane flared and/or used in the power generators, as follows:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} \quad (8)$$

Where:

$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4/yr)
$F_{CH4,flared,y}$	=	Amount of methane in the LFG which is destroyed by flaring in year *y* (t CH_4/yr)
$F_{CH4,EL,y}$	=	Amount of methane in the LFG which is used for electricity generation in year *y* (t CH_4/yr) (determined using the Tool to determine the mass flow of a greenhouse gas in a gaseous stream)

Under the application of this equation, the hypothetical baseline for the project scenario, which would result in emissions if the LFG is not flared can be calculated, based on which the actual emission reductions can be calculated.

The Project emissions PE_y are descried in the subsequent paragraph. After the monitoring, the emission reductions will be calculated based on the actual gas amount collected, applying baseline emissions calculation with ex-post values.

Project emissions

Project emissions at the dumpsites targeted under the NAMA Phase 1 will accrue from the operation of the fans (power consumption) and from transportation of the waste. Transportation of the waste creates emissions but is considered as being outside the boundary of the Waste NAMA.

Project emissions are calculated as follows:

$$PE_y = PE_{EC,y} \quad (9)$$

Where:

PE_y = Project emissions in year *y* (t $CO_{2\text{-eq}}$/yr)

$PE_{EC,y}$ = Emissions from consumption of electricity due to the project activity in year *y* (t $CO_{2\text{-eq}}$/yr)

The project emissions from consumption of electricity by the project activity ($PE_{EC,y}$) shall be calculated using the latest version of the CDM Tool to calculate baseline, project and/or leakage emissions from electricity consumption, building on the monitoring parameter $EC_{PJ,k,y}$, as well as the flare efficiency. For the ex-ante estimation of the emission reductions, the difference between baseline and project emissions is driven by the assumed flare efficiency of 90%.

Emission reductions

The expected emission reductions from the LFG collection for the four landfills selected for Phase 1 have been estimated using the approach described and are listed in the table below. Emission reduction from potential power production, as well as PE_y for power consumption are omitted from forecast, as (i) the values shown are based on the FOD model calculation without any detailed investigations on site (desk assessment) and (ii) the project emissions from electricity consumption are considered to be minor (in the 1% range) compared with the achieved emission reductions.

Phase 1 Emission Reductions ($tCO_{2\text{-eq}}$)	
LFG collection from Solid Waste Disposal Sites	**Cumulative Phase 1**
Years	**2018-2021**
Tripoli (Managed LF)	183,454
Zahle* (Sanitary LF)	93,450
Hbaline (unmanaged)	57,953
Srar (unmanaged)	285,407
Total by Phase	**620,264**

*Operation of LFG collection starting 2019

Table 12: GHG emission reductions from flaring of landfill gas under NAMA Phase 1

4.3 GHG Baseline and Mitigation Targets for the NAMA Phase 2

4.3.1 Overview of Interventions Leading to GHG Emission Reductions

In Phase 2, there are three interventions which lead to emission reductions.

- In addition to the **LFG collection systems** installed under NAMA Phase 1, four additional dump/ landfill sites will be selected and LFG collection and flaring or power production will be installed.
- The baseline emissions from the large **incinerator (WtE facility)**, which is planned to serve the GBA and Mount Lebanon, have been estimated under the following assumptions: The Ramboll report foresees one WtE facility with two blocks with a capacity of 2 x 40 tonnes of waste per hour. This leads to a waste amount of approximately 590,000 tonnes per year, which will be incinerated and hence lead to emission reductions from methane avoidance and to emission reductions from the power produced compared with the related baseline emissions. This WtE plant is expected to be built during the NAMA Phase 2 and commissioned by 2025. This NAMA intervention is based on the findings of the first comprehensive feasibility study on thermal conversion technologies for waste management for Lebanon. The study was commissioned by the CDR in order to assess the calorific value of MSW in Lebanon, exploring alternative scenarios based on the proposed delineation of service areas, and estimating the CAPEX (Capital expenditure) and OPEX (Operating Expenditure) of each scenario (CDR, 2012).
- In the rural areas, the main intervention is the waste treatment, whereby the **composting component** is relevant for the emission reduction part. This baseline has not been forecast at this point in time, as no appropriate data basis is available to calculate the amount of compost which could be generated.

4.3.2 Site Selection for LFG Flaring and Utilization

Similar to the site selection described in Section 4.2.2, the four second most attractive dump sites for an application of LFG collection and flaring are determined. The basic data for this decision are already gathered, in Step 0, in the preparatory phase before the start of the NAMA. However, it is recommended that the information be updated before the start of the NAMA Phase 2, as the situations at dump sites may have changed over time and other dump sites may be more appropriate and have higher emission reduction potential.

In Phase 2, the detailed engineering for LFG collection on these sites will be undertaken. To provide an estimation of the emission reduction potential, very preliminary data have been used from a desk review that was conducted in the preparation of the NAMA document. Four sites have been selected and the FOD model was fed with the approximateannual waste amounts disposed of. An average waste composition for Lebanon's rural areas, according to (CDR, 2012) was used. The sites used for the estimations are Ghaziye and Qurayet Saida (Governorate of South Lebanon), as well as Adweh (Governorate of North Lebanon) and Aayta Ech Chaab (Governorate of Nabatiye).

The following table shows the characteristics of these four selected sites.

Site Location	Depth (m)	Start Year	Annual disposed waste amounts (t/a)	Status	Type of waste
Adweh	10	2000	14,600	Operational	Multiple
Ghaziye	10	1998	10,950	Operational	Multiple
Aayta Ech Chaab	7	2000	3,285	Operational	Multiple
Qraiyet Saida	8	2000	1,825	Operational	MSW

Table 13: Summary of assumed LFG sites for NAMA Phase 2

As the data for waste amounts and the age of the landfills are only estimates, the following description of the baseline emissions and the emission reduction calculation in Section 4.3.3 only provide an order of magnitude and would need to be comprehensively recalculated once better information is available (before the start of Phase 2 of the NAMA).

4.3.3 GHG Baseline Emissions

In Phase 2 different baseline emissions apply.

(i) The baseline emissions for the **LFG collection and utilization**, which can be calculated using the approach shown in Section 4.2.3, whereby the baseline for the four additional sites for LFG collection and destruction needs to be determined.

(ii) The baseline emissions for the **WtE** and composting activities need to be determined.

Both of these activities result in methane avoidance.

(iii) Further, baseline emissions for the **replacement of grid electricity** by partly renewable electricity with a lower emission factor through the WtE facility need to be described.

(i) Avoidance of methane emissions from LFG collection and flaring/utilization

The baseline emissions for the methane avoidance which occurs from the LFG collection and flaring at four additional disposal sites (Phase 2 of the NAMA) is by means of the same approach as for the four sites described in Section 4.2.3 (NAMA Phase 1). The following table provides an overview of the total Phase 2 baseline emissions including the four landfill sites (implemented in Phase 1) and the additional four sites which are to be implemented in Phase 2.

Phase 2 Baseline emissions (in tCO_{2-eq}) for LFG collection		
	Solid Waste Disposal Site	**Cumulative Phase 2**
	Years	**2022 - 2030**
Phase 1 sites	Tripoli (Managed LF)	423,044
	Zahle (Sanitary LF)	274,212
	Hbaline (unmanaged)	136,854
	Srar (unmanaged)	687,722
Sum Phase 1 sites		**1,521,831**
Phase 2 sites	Adweh	84,695
	Ghaziye	65,555
	Aayta Ech Chaab	19,056
	Qraiyet Saida	10,587
Sum Phase 2 sites		**179,893**
Total		***1,701,724***

Table 14: Baseline GHG emissions for LFG collection during Phase 2

(ii) Avoidance of methane emissions through waste incineration(WtE) and composting

To date, and with the exception of one small-scale RDF facility in Saida, Lebanon has no WtE systems in place. Thermal conversion was formally endorsed by the GOL in 2010 (see COM Decision No. 55 dated 1/9/2010), but there has since been little progress.

The baseline scenario is the dumping of waste in landfill sites (without a gas collection system) or in open dumps. The CDM Methodology Booklet sketches the baseline scenario as follows (UNFCCC, 2015a):

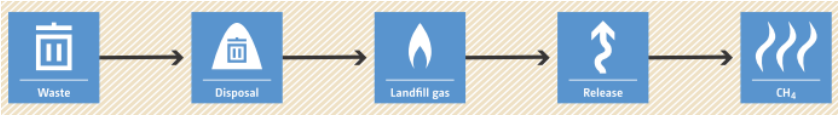


Figure 8: Baseline situation for Phase 2 of the Waste NAMA

The CDR WtE study had assessed the calorific value of MSW in Lebanon (CDR, 2012). Based on actual waste composition data from Beirut and Mount Lebanon, it was determined that the average moisture content of MSW is 53% and its calorific value is approximately 7.4 MJ/kg. The calorific value varies seasonally from 6.6 to 8.2 in the wet season, and from 6.7 to 7.6 in the dry season. The study concluded that 'even though waste with a calorific value of 7.4 MJ/kg would be able to be incinerated in a common WtE facility, it is not recommended to incinerate the waste directly.' The study further recommends some level of waste preparation by removing up to 15% of the organic waste to reduce the biogenic fraction as well as the moisture content, and thereby increase the calorific value to 8.0 MJ/kg. For this reason, the urban area of Beirut and its surroundings will be the focus for this intervention, as some sorting of the waste takes place here already.

The same study further explored three alternative WtE scenarios (see table below). In all three scenarios, it was determined that the Bekaa area (Service Area 5) would not have a WtE facility because the waste generation volume was insufficient and/or knowledge of waste composition was unreliable. Baseline emissions for the Bekaa are therefore not included in the FOD calculation. This NAMA has selected scenario 3 as the most appropriate scenario.

Scenario	Number of WtE Facilities	Service Area(SA)*
1	3	Beirut and Mount Lebanon, North, South
2	2	Beirut and Mount Lebanon, North, South
3	1	Most of Beirut and Mount Lebanon

**SA re-defined according to COM Decision 45 (2014) and Decision 1 (2015) (see Chapter 3)*

Table 15: CDR WtE scenarios

Baseline emissions in Phase 2 in the absence of the NAMA assume that all solid waste from SA 1 (Beirut and its suburbs), SA 2 (North Mount Lebanon), SA 3 (South Mount Lebanon), SA 4 (North Lebanon and Akkar), and SA 5 (South Lebanon and Nabatiyeh) is deposited in landfills or open dumps without prior waste sorting and/or treatment and without capturing LFG. See Annex 3: Representation of the six Service Areas in Lebanon.

In terms of waste generation, the FOD method was used with the annual amounts reported in the CDR WtE study in 2010 (CDR, 2012) and with an annual increase of 2% (Figure 9). In summary, annual waste generation in the Beirut and Mount Lebanon (SA 1, 2, and 3) increased from 1 million tonnes in 2010 to 1.28 million tonnes in 2022 and would reach 1.50 million tonnes by 2030 (end of NAMA Phase 2). By contrast, annual waste generation in the North and Akkar (SA 4) would increase from 261,000 tonnes in 2010 to 331,000 tonnes in 2022 and reach 388,000 tonnes by 2030. Finally, annual waste generation in the South and Nabatiyeh (SA 6) would increase from 161,000 tonnes in 2010 to 204,000 tonnes in 2022 and reach 239,000 tonnes by 2030. The FOD method used 'urban' waste composition for Beirut and Mount Lebanon, and 'rural' waste composition for the other SAs.

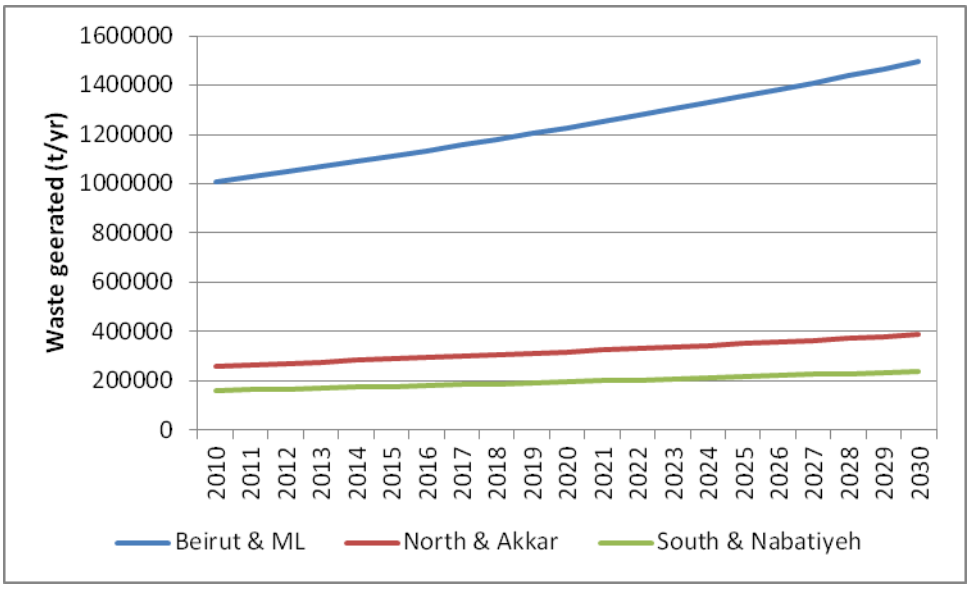


Figure 9: Projected waste generation quantities during the period 2010-2030 (t/yr)

Following the discussions and decision to prioritize WtE in SA 1 (GBA), the baseline emissions for the planned WtE facility are based on a plant capacity of 2 x 40 t/hr, as suggested in Ramboll's study. Without this WtE facility, 590,000 tonnes of waste would continue to be landfilled. Under the NAMA, these waste amounts would be incinerated and hence no methane generation would accrue from these amounts. The baseline emissions from methane avoidance for the incinerated waste were again calculated using the FOD model as introduced in Section 4.2.3. The result is presented in Table 16 and the complete list of FOD parameters used for the GBA conditions are listed in Annex 8: Characteristics of the Selected SWDS for Phase I and of the WtE for Phase II.

Baseline emissions for waste incineration in one big incinerator in GBA						
Year	1	2	3	4	5	6
	2025	**2026**	**2027**	**2028**	**2029**	**2030**
Amount of waste incinerated (t/yr)	590,000	590,000	590,000	590,000	590,000	590,000
BL emissions from methane avoidance (t $CO_{2\text{-eq}}$/yr)	49,742	96,963	141,795	184,364	224,788	263,179
Sum 2025-2030 (t $CO_{2\text{-eq}}$)						**960,831**

Table 16: Baseline GHG emissions in SA 1 without WtE facilities

(iii) Baseline emissions from power production

For the power production from waste, the baseline emissions for the replaced power are based on Lebanon's specific emission factor for the power grid and calculated as follows:

$$BE_{EL,y} = EG_{WtE,y} * EF_{CO2,EL} \quad (10)$$

Where:

$BE_{EL,y}$ = Baseline emissions of the replaced grid electricity per year (t $CO_{2\text{-eq}}$/yr)

$EG_{WtE,y}$ = Electricity generated from the WtE facility per year (MWh_{el}/yr), calculated using the factor 0.5 MWh_{el}/t waste (provided in (CDR, 2012))

$EF_{CO2,EL}$ = CO_2 emission factor for displacement of electricity in the Lebanese power grid (t $CO_{2\text{-eq}}$/MWh_{el}). This value is taken from a registered CDM project activity and set at 0.715 t $CO_{2\text{-eq}}$/MWh_{el}. This factor needs to be updated upon NAMA implementation (MOE/GEF/UNDP, 2015).

The following table summarizes the estimated baseline GHG emissions for the NAMA Phase 2. Due the time required for planning and implementation of the WtE facility, it is assumed that the WtE facility will be operational from 2025 onwards.

Baseline emissions for power production from waste incineration						
Year	1	2	3	4	5	6
	2025	**2026**	**2027**	**2028**	**2029**	**2030**
Electricity generation (MWh_{el}/yr)	295,000	295,000	295,000	295,000	295,000	295,000
BL emissions from power production (t $CO_{2\text{-eq}}$/yr)	210,925	210,925	210,925	210,925	210,925	210,925
Sum 2025-2030 (t $CO_{2\text{-eq}}$)						**1,265,550**

Table 17: Baseline GHG emissions for power production in a WtE facility

4.3.4 GHG Mitigation Targets

The mitigation targets for Phase 2 include GHG emission reductions from the following activities:

1) LFG collection and destruction via flaring or utilization on 4 landfill sites (continuation of Phase 1);

2) LFG collection and destruction via flaring or utilization on 4 additional landfill sites (implemented under Phase 2);

3) One big incinerator (WtE) plant serving the GBA;

4) Waste sorting and composting at the reception centers before landfilling.

All of the activities described above have a methane avoidance component from the reduced practice of landfilling organic substances. Additional GHG emission reductions occur from (partly) renewable power production from waste.

The approach for GHG emission reduction calculation for 1) and 2) is already described in Section 4.2.4. In the following paragraphs the approach for GHG emission reductions calculation for the WtE and the composting activities (3 and 4) are described.

The current practices of landfilling in landfill sites (without gas collection system), or dumping waste in the open field, needs to be urgently replaced by waste management practices which are environmentally sound and produce fewer GHG emissions. In the case of this NAMA, waste treatment is envisaged, which would result in mineralized organic substance via composting, and waste incineration (incl. power production in one large WtE plant). The applicable CDM Methodology for both of these practices is ACM0022. The following sketch from the CDM Methodology handbook pictures the project scenarios (UNFCCC, 2015a):

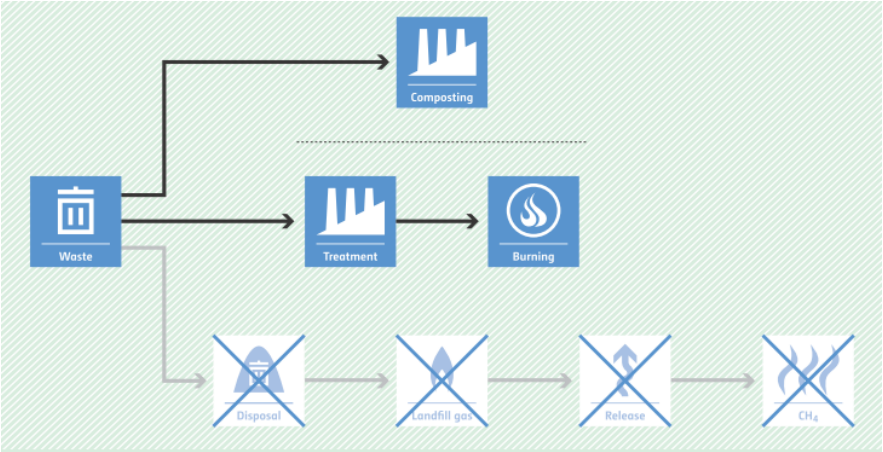


Figure 10: Project scenario for a WtE facility according to ACM0022

The approach for determining the emissions reductions is according to the following equation:

$$ER_y = BE_y - PE_y \quad (11)$$

Where:

ERy = Emission reductions (t $CO_{2\text{-eq}}$/yr)
BE_y = Baseline emissions (t $CO_{2\text{-eq}}$/yr)
PE_y = Project emissions (t $CO_{2\text{-eq}}$/yr)

Baseline emissions (BE_y)

The Phase 2 baseline emissions are described in Section 4.2.3. These include the emissions of the continued waste disposal on landfills, as well as the power production with the current grid emission factor.

Project emissions (PE_y)

The project emissions in year *y* are calculated for each alternative waste treatment option implemented in the project activity as follows:

$$PE_y = PE_{COMP,y} + PE_{INC,y} \quad (12)$$

Where:

PE_y = Project emissions in year *y* (t $CO_{2\text{-eq}}$/yr)
$PE_{COMP,y}$ = Project emissions from composting or co-composting in year *y* (t $CO_{2\text{-eq}}$)
$PE_{INC,y}$ = Project emissions from incineration in year *y* (t $CO_{2\text{-eq}}$)

For the calculation of the project emissions, parameters like the grid emission factor, waste composition, the power-generation efficiency of the WtE plant, etc. need to be measured or updated ex-post.

Project emissions from composting or co-composting ($PE_{COMP,y}$)

For the composting, project emissions will accrue from:

- CH_4 and N_2O emission from composting;
- CO_2 emissions from consumption of fossil fuels and electricity associated with composting; and

- CH_4 emissions from run-off wastewater associated with co-composting.

Project emissions associated with composting or co-composting ($PE_{COMP,Y}$) are calculated according to the latest version of the CDM methodological tool Project and leakage emissions from composting (UNFCCC, 2011).

Project emissions from incineration ($PE_{INC,Y}$)

Project emissions from incineration include emissions from combustion within the project boundary. If associated with the incineration process, then project emissions shall also include for electricity consumption, fossil fuel consumption and wastewater treatment. Project emissions are therefore determined according to the CDM Methodology Alternative waste treatment processes (UNFCCC, 2014), whereby only the project emissions from the non-biogenic part of the waste are considered. Project emissions in this calculation have been assumed to accrue solely from the combustion of the non-biogenic waste. The share of the latter was obtained from the waste characteristics for the GBA provided in the Ramboll report, as shown in the table below (CDR, 2012).

Waste stream	Wood	Paper & card-board	Organic waste	Textiles	Metals, minerals, Plastics	Others	Sum
Total share (w.r.t amount)	1.0%	15.6%	51.4%	3.0%	19.1%	10.0%	100.0%
Assumed biogenic fraction (w.r.t composition)	100%	95%	100%	30%	0%	30%	
Biogenic share, (w.r.t amount)	1.0%	14.8%	51.4%	0.9%	0.0%	3.0%	**71.1%**
Non-biogenic share (w.r.t amount)	0	0.8	0	2.1	19.1	7.0	**28.9%**

Table 18: Waste characteristics for the Greater Beirut Area WtE facility

The waste streams displayed in the table above are selected according to the sampling data presented in the Ramboll report. The Intergovernmental Panel on Climate Change (IPCC) guidelines suggest a more detailed split, in which, for instance, plastics are listed separately and organic waste is understood as mainly food waste. Because no other data were available for Lebanon all assumptions and calculations for this NAMA have been based on the shares listed above. For more accurate data before the start of the NAMA Phase 2, a detailed assessment of waste amounts and waste composition is planned under the NAMA Phase 1 (see Chapter 5; Activity E.1.1). In addition, it is recommended that a comprehensive Assessment study on waste streams and waste compositions be conducted before the start of the NAMA in Step 0 (see also Chapter 5).

Without further knowledge about the calorific value of the individual waste streams, the emission factor from incineration (i.e. the amount of non-biogenic CO_2 generated per MWh_{el} from incineration) was estimated using:

$$EF_{INC} = f_{non} \times \left(f_{non} \times EF_{non,th} + f_{bio} \times EF_{bio,th}\right) \times \frac{1}{\eta_{WtE}} \times \frac{3.6}{1000} \quad (13)$$

Where:

EF_{INC} = Emission factor from incineration (t $CO_{2\text{-eq}}/MWh_{el}$)

f_{non} = Share of non-biogenic waste

$EF_{non,th}$ = Emission factor of non-biogenic share in municipal solid waste (= 91.7 t $CO_{2\text{-eq}}/TJ_{th}$, see compilation of emission factors in (IPCC, 2006)

f_{bio} = Share of non-biogenic waste

$EF_{bio,th}$ = Emission factor of biogenic share in municipal solid waste (= 100 t $CO_{2\text{-eq}}/TJ_{th}$, see compilation of emission factors in (IPCC, 2006)

η_{Wte} = Electric efficiency of the WtE facility, taken as 22.5% as suggested in (CDR, 2012)

This emission factor multiplied by the annual amount of electricity generated by the WtE facility (i.e. 295,000 MWh/yr, see Table 17: Baseline GHG emissions for power production in a WtE facility) leads to the project emissions from incineration:

$$PE_{INC,y} = EF_{INC} \times EG_{WtE,y} \quad (14)$$

Emission reductions

Emission reductions from the interventions in Phase 2 have three components, which are summarized in the following three tables and paragraphs.

(i) Emission reductions from the continued operation of the LFG collection and destruction implemented in Phase 1

The data presented in the table below are based on data enumerating waste amounts and waste compositions from the Ramboll report (CDR, 2012) and provide a rough estimate.

Phase 2 Emission reductions for LFG collection (in $tCO_{2\text{-eq}}$)		
	Solid Waste Disposal Site	**Cumulative Phase 2**
		2022 - 2030
Phase 1 sites*	Tripoli (Managed LF)	380,739
	Zahle (Sanitary LF)	246,791
	Hbaline (unmanaged)	123,168
	Srar (unmanaged)	618,950
Sum Phase 1 sites		**1,369,648**

* Continued operation 2022-2030

Table 19: Expected GHG emission reductions from continued operation of LFG sites implemented in Phase 1

(ii) Emission reductions from the implementation of LFG collection at four additional landfills

The data presented in the table below are based on the selection of four additional sites according to the preliminary data available. Only a rough estimate for the emission reductions potential can be provided at this stage. Based on the feasibility study in Step 0, other, more attractive sites may be selected and emission reduction data may deviate from the presented numbers.

The emission reduction potential was calculated with the approximate waste amounts disposed in these dumps per year and the waste composition for rural areas taken from the Ramboll 2012 report (CDR, 2012). Based on this, four additional sites were selected, which are deemed to have the highest emission reduction potential.

Phase 2 Emission reductions for LFG collection (in tCO_{2-eq})		
	Solid Waste Disposal Site	**Cumulative Phase 2**
		2022 - 2030
Phase 2 sites**	Adweh	76,226
	Ghaziye	58,999
	Aayta Ech Chaab	17,151
	Qraiyet Saida	9,528
Sum Phase 2 sites		**161,904**

** Operation starts 2024

Table 20: Expected GHG emission reductions from LFG collection and destruction at 4 additional sites in Phase 2

(iii) Emission reductions from alternative waste treatment and the WtE plant

Emission reductions of the **composting component** have not been forecastat this point, as no appropriate data are available.

Emission reduction from the big incinerator **(WtE facility),** serving the GBA and planned to be commissioned in 2025, have been estimated under the following assumptions based on the Ramboll report. The report foresees one WtE facility with two blocks with a capacity of 2 x 40 tonnes of waste per hour. This would lead to a waste amount of 590,000 tonnes per year, which will be incinerated and hence would lead to emission reductions from methane avoidance and from incineration (i.e. from the electricity generated).

Application of the emission factor for the Lebanese power grid of 0.715 t CO_{2-eq}/MWh_{el} (MOE/GEF/UNDP, 2015), would lead to the estimated emission reductions provided in the table below.

The emission reductions from methane avoidance have been derived on the basis of the FOD model using parameters for the Beirut region, the total waste amount, which would otherwise be landfilled (590,000 t/yr) and the waste composition shown in Table 18.

Emission reductions (ER) (in tCO_{2-eq}) from waste incineration in a big incinerator (WtE plant)						
Year	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Annual ER from incineration	77,744	77,744	77,744	77,744	77,744	77,744
Sum 2025-2030	**466,464**					
Annual ER from methane avoidance	49,742	96,963	141,795	184,364	224,788	263,179
Sum 2025-2030	**960,831**					
Annual total emission reductions	**127,486**	**174,707**	**219,539**	**262,108**	**302,532**	**340,923**
Cumulative ER for the NAMA period 2025-2030	**1,427,296**					
Cumulative ER over lifetime of the WtE plant (30 years, i.e. beyond the duration of the NAMA)	**17,323,646**					

Table 21: Estimated GHG emission reductions from (WtE plant)

The annual increase in the emission reductions from methane avoidance is caused by the increased cumulative disposal of waste in each year, which would in the baseline situation lead to increased methane emissions.

4.4 Summary of Mitigation Targets of the NAMA

The overarching goal of the NAMA is to reduce GHG emissions from the disposal of waste containing organic substances in landfill sites and open dumps. This practice will be discontinued by the implementation of LFG collection and utilization at the major emitters among all landfills and dumps, as well as the implementation of a big waste incinerator (WtE facility), which shall serve the GBA. In addition, future GHG emissions from landfills in rural areas of Lebanon, will be reduced by waste sorting and composting of the organic substances. The interventions described in Chapter 5 will achieve the emission reductions which are summarized in the following table. The numbers presented in Sections 4.2 and 4.3 are summarized here to provide an overview of the expected baseline emissions and the GHG emission reductions under the NAMA.

Summary of emission reductions per intervention of the waste NAMA (in tCO_{2-eq})	**Cumulative Phase 1**	**Cumulative Phase 2**	**SubTotal**
Years	**2018-2021**	**2022-2030**	**2018-2030**
LFG collection and destruction – 4 priority sites (Phase 1)	620,264	1,369,648	1,989,912
LFG collection and destruction – 4 additional sites (Phase 2)		161,904	161,904
Waste incineration in WtE plant - (Phase 2)		1,427,296	1,427,296
Total NAMA emission reductions			**3,579,111**

Table 22: Summary of expected total GHG emission reductions per intervention of the NAMA

4.5 Sustainable Development Baseline and Co-Benefit Targets

The NAMA in the SWM sector provides Lebanon with additional sustainability co-benefits for the public and the private sector. Sustainable development aspects, such as poverty reduction, local economic development, and improved health services constitute key development goals. In addition, for most donors and private sector stakeholders, the potential of the NAMA interventions and measures to deliver tangible co-benefits forms a basis on which to make the investment decision or provides additional justification for the decision to invest in the NAMA.

Prevailing SWM practices in Lebanon typically consist of end-of-pipe solutions, such as open dumping and uncontrolled landfilling, which not only lead to methane emissions from untreated waste streams, but also to significant environmental, social and economic impacts. Unmanaged waste is a potential source of environmental and health hazards including significant air, water and soil pollution, especially in densely populated urban areas.

Because of the limited current information about the theenvironmental and social effects caused by the solid waste sector in Lebanon, it is recommended that an Environmental and Social Impact Assessment (ESIA) be conducted before the start of the NAMA (see Chapter 5 for further details). This ESIA should assess the potential positive and negative environmental and social impacts expected from the NAMA. A detailed baseline determination for SD co-benefits should be based on the results of the ESIA.

The NAMA's role in achieving SWM co-benefits will be assessed in terms of its contribution to the relevant Sustainable Development Goals (SDGs).

If the proposed NAMA is fully implemented with all activities as described in Chapter 5, it would contribute to a number of SDGs. The table below describes the expected co-benefits of the NAMA (first column) and how these co-benefits would relate to certain SDGs (second column). As the SGDs consist of a number of sub-targets, only those targets that are directly relevant to the NAMA in the SWM sector are listed.

Co-benefit of the NAMA	Expected contribution to SDGs and its targets
- Reduce hazardous pollution of air, soil and water - Reduce the practice of open dumping and non-sanitary landfills	SDG 3: Good Health and Well-Being Target 3.9: Substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination
- Reduce hazardous pollution of air, soil and water - Encourage recycling/ reuse of waste and valorize waste - Provide capacity-building and awareness-creation to key local stakeholders for waste management and waste avoidance	SDG 6: Clean Water and Sanitation Target 6.3: Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally Target 6.a: Expand international cooperation and capacity-building support to developing countries in water-and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies Target 6.b: Support and strengthen the participation of local communities in improving water and sanitation management
- Promote and produce energy from renewable energy sources - Promote environmentally sound technologies and clean energy technologies	SDG 7: Affordable and Clean Energy Target 7.2: Increase substantially the share of renewable energy in the global energy mix Target 7.a: Enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology

- Provide incentives for local private sector engagement that lead to growth of local enterprises, job creation and access to financial services - Provide capacity-building and support for local financial institutions to support the NAMA	SDG 8: Decent Work and Economic Growth Target 8.3: Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services Target 8.10: Strengthen the capacity of domestic financial institutions to encourage and expand access to banking, insurance and financial services for all
- Provide incentives to the local private sector that lead to local enterprises, job creation and access to financial services (incl. PPP) - Provide capacity-building and awareness-creation among key local stakeholders - Encouragerecycling / reuse and thus valorize waste	SDG 11: Sustainable Cities and Communities Target 11.3: Enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management Target 11.6: Reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
- Provide capacity-building and awareness-creation among key local stakeholders for waste management and waste avoidance - Reduce the practice of open dumping and non-sanitary landfills - Encourage recycling/ reuse and thus valorize waste	SDG 12: Responsible Consumption and Production Target 12.4: Achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment Target 12.5: Substantially reduce waste generation through prevention, reduction, recycling and reuse Target 12.8: Ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature
- Improve the regulatory framework and SWM policies in favor of strategic planning and sustainable development	SDG 13: Climate Action Target 13.2: Integrate climate change measures into national policies, strategies and planning
- Improve the regulatory framework and SWM policies in favor of strategic planning and sustainable development - Support the improvement/establishment of an incentive scheme for domestic resource mobilization in the SWM sector - Mobilize additional financial sources - Provide incentives to local private sector engagement that lead to growth of local enterprises, job creation and access to financial services (incl. PPP)	SDG 17: Partnerships for the Goals Target 17.1: Strengthen domestic resource mobilization, including through international support to developing countries, to improve domestic capacity for tax and other revenue collection Target 17.3: Mobilize additional financial resources for developing countries from multiple sources Target 17.14: Enhance policy coherence for sustainable development Target 17.17: Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships

Table 23: Co-benefits of the NAMA and contribution to SDGs

The table below describes the different co-benefits of the NAMA and the assumed baseline situation of each co-benefit. The currently available information basis in the SWM sector in Lebanon is insufficient to develop a reliable and quantifiable baseline scenario regarding SD co-benefits. The ESIA to be conducted prior to the NAMA is highly recommended to help quantifying the baseline situation for the different co-benefits.

Co-benefit of the NAMA	Baseline situation
- Reducehazardous pollution of air, soil and water	- Open dumping and disposal in non-sanitary landfills is practised and waste is not collected and pre-treated - Hazardous wastes are not collected separately and often disposed of in the same open dumps or non-sanitary landfills
- Reduce the practice of open dumping and non-sanitary landfills	- Open dumping and disposal in non-sanitary landfills is practised and waste is not collected and pre-treated
- Encourage recycling / reuse and thus valorize waste	- Limited number of official recycling sites exist and awareness among stakeholders is low (to be assessed)
- Provide capacity-building and awareness- creation among key local stakeholders for waste management and waste avoidance - Provide capacity- building and support for local financial institutions to support the NAMA	- No capacity- building has been conducted - Waste generation per capita is increasing year by year
- Promote and produce renewable energy sources	- Production of renewable energy from waste is not being done at the sites/plants targeted under the NAMA
- Promoteenvironmentally sound technologies and clean energy technologies	- The utilization of LFG (flaring or power generation) as well as WtE is not common a (detailed information to be assessed)
- Provide incentives for local private sector engagement that lead to growth of local enterprises, job creation and access to financial services (including Public Private Partnerships - PPPs)	- Private sector engagement in the solid waste sector is very limited and no PPP exists (to be assessed)
- Support the improvement and/or establishment of an incentive scheme for domestic resource mobilization in the solid waste sector	- Only limited incentives exist (to be assessed) - There is no common system on taxes or fees for waste disposal, the polluter pays principle is not implemented
- Improve the regulatory framework and solid waste management policies in favor of strategic planning and sustainable development	- Targeted laws and regulations relevant for the NAMA currently not enacted (incl. ISWM)
- Mobilize additional financial sources	- The mobilization of addition financial sources available for the interventions and measures describes under the NAMA has not occurred

Table 24: Baseline situation of NAMA co-benefits

The procedures and parameters for the measurement and reporting of the described co-benefits are described in the Chapter 9.

4.6 Transformational Change

Besides its contribution to long-term low-carbon development and sustainable development in the targeted sector and country, the NAMA should also demonstrate how it supports transformational change. This should include: the provision of innovation to the sector; the support and encouragement of positive changes to the enabling environment of the sector (including strengthening institutional capacities and helping to overcome systemic or regulatory barriers); ensuring a high level of local ownership by showing how the NAMA is supported by relevant authorities; and showing how the NAMA is aligned with the strategies of the country and sector. Furthermore, the NAMA should consider the role of the private sector and the replicability and scale-up potential of the activities planned and implemented.

The SWM sector in Lebanon needs a long-term strategy and coordinated efforts to improve the enabling environment and to ensure public and private sector investments for necessary technical interventions. This NAMA in the SWM sector of Lebanon has been developed with the clear intention to foster long term transformational change. The whole process of assessing the potential for a NAMA in the SWM sector, the design and development of the NAMA scope in close coordination with local stakeholders, the involvement of public and private sector entities, the chosen interventions and measures, the close alignment of the NAMA with existing country and sector strategies and the applied technologies and capacity-building measures, have the clear objective of bringing significant positive transformational changes to the SWM sector in Lebanon.

In the following sections the specific contributions of the NAMA to transforming the SWM sector are described.

Leading to Innovation: Innovative approaches are a key concept of this NAMA. Besides the generally innovative approach of providing a rather holistic and mid- to long term concept to tackle the current problems of the SWM sector, the specific outcomes under the NAMA will bring several innovations. These include state-of-the-art technologies for LFG utilization, waste management and source sorting, innovation for the entire waste collection and treatment processes and innovative technologies for applying WtE technologiesmore widely. In addition, the capacity-building activities and awareness-creation campaign will provide knowledge to the relevant stakeholders and to society in a manner and to a scale that has the potential to stimulate waste avoidance and waste sorting at the source.

Private sector involvement will happen at various stages of the NAMA. Waste collection and transportation will be under the responsibility of the municipalities, who may contract delivery of these services to the private sector. The operation of technical appliances and facilities under the NAMA, including the reception centers, the operation of the LFG utilization facilities and the WtE facility is expected to be undertaken by the private sector. The NAMA puts a specific emphasis on the engagement and strengthening of the private sector, by supporting the development of mandates and regulation for Public Private Partnerships (PPP) and Independent Power Producers (IPP) business models, including transparent procurement processes under competitive bidding. Furthermore, the NAMA has the objective to further support the already existing strategy to strengthen the private sector and to increase the trend towards a more decentralized structure in the SWM sector with the clear aim to strengthen the engagement of the private sector.

Impacts beyond the scope of the project: With the establishment of the institutional framework and the provision of capacity-building, knowledge transfer and the support to create a better information base, the NAMA will provide benefits across the institutions and local stakeholders (e.g. municipalities) that go beyond the sector and the scope. The awareness campaign about waste sorting and recycling, for example, will help to increase awareness of recycling and waste sorting among the public and the stakeholders in general. Support for the enactment of relevant laws and regulations will also have impacts beyond the scope of the NAMA, even though the objective is first to help support interventions under the NAMA. Acomprehensive master plan for the SWM sector, including incentives to invest in technical solutions, will provide the fundamental basis and knowledge for further decisions that may go beyond the scope of activities planned under the NAMA.

Replicability and Scaling up: The current NAMA scope has been designed in a way that reflects both, the current situation of the SWM sector in Lebanon and the limited domestic and international financial sources. That is why the number of technical interventions is limited. Despite the limited number of interventions, the full NAMA is designed in a way that will allow for replicatation of interventions and for extending the scope of activities.

The NAMA Phase 1 will establish an enabling environment to allow for further interventions beyond its scope. The number of LFG utilization sites (the NAMA currently plans to install 4 in Phase 1 and further 4 in Phase 2) can be extended further across Lebanon. The same holds true for the WtE applications (currently one WtE plant to be installed under Phase 2) and for the waste collection at reception centers. The NAMA also prepares for potential expansion to other interventions, by including activities like potential assessment studies for further reception centers and WtE plants across the whole of Lebanon under Phase 2. Furthermore, the awareness-building campaign and training programmes developed and applied can be used and applied in other regions of the country and by other stakeholders (e.g. private operators of LFG utilization plants in the future).

5 Measures and Interventions under the NAMA

This chapter describes the key elements of the NAMA, namely the interventions or physical actions that lead to direct GHG emission reductions and the measures (supporting activities) that will help to prepareand support the physical/technical interventions to be implemented.

All actions under the NAMA are defined in a logical framework with Outcomes, Outputs and Activities. The Outcomes are the main achievements of the NAMA. To reach the Outcomes, the full NAMA is broken down into a number of Activities. Each Output consists of a certain set of Activities. The successful completion of all these Activities leads to an Output. These Outputs are necessary to achieve the final Outcomes. This structure allows the progress and success of the NAMA to be monitored.

The following figure shows the general approach of Activities, Outputs and Outcomes.

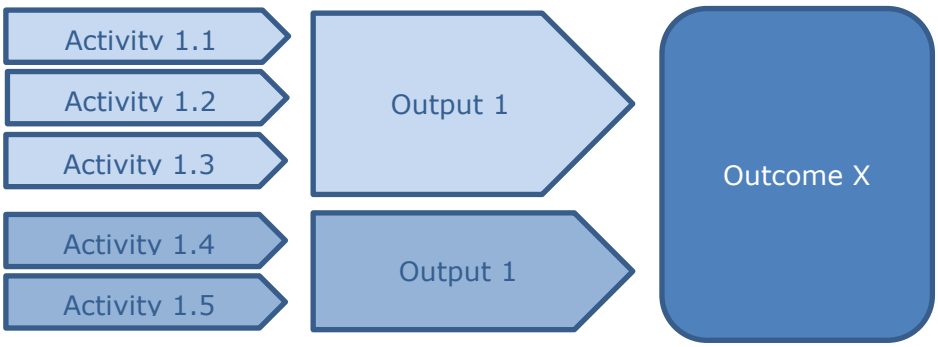


Figure 11: General principle of Activities, Outputs and Outcomes

In the following sections within this chapter the full NAMA, with its proposed measures and interventions and the Outcomes, Outputs and Activities is described.

During the preparation of this NAMA design document, it became clear that the information basis in the solid waste sector is not sufficient to assess the feasibility of the proposed interventions comprehensively. In addition, it became clear that a basic enabling environment (institutional and regulatory framework) would be needed before the planning and implementation of concrete technical interventions. To account for these needs, it is recommended that a set of studies be conducted before the start of the NAMA. These studies will provide the required information base on which to assess the technical interventions in detail, including financial needs, technical feasibility, emission reduction potential and incentives (political and financial) required. The studies recommended for this step are described in Section 5.1.

Section 5.2 will then give an overview of the key elements of the NAMA (interventions and measures). A more detailed description of Activities and Outputs leading to the achievement of the NAMA Outcomes is provided in Section 5.3.

5.1 Step 0: Preparatory Steps/Assessments (Prior to the NAMA Start)

The current situation in the solid waste sector in Lebanon necessitates the conducting of a number of specific studies before the start of the NAMA. These studies have deliberately not been considered as coming within the scope the NAMA. This is because the results of the studies are considered as important basic information for comprehensive planning of the technical interventions as well as for assessing funding for the planned measures and interventions. These studies will further reduce the risks of successful NAMA implementation and operation and hence improve the probability for accessing funding for the different elements of the NAMA.

It is recommended that the following studies are developed before the start of the NAMA (Figure 12).

Figure 12: Measures leading to interventions

In the following the four studies are briefly described.

0.1 Identification and feasibility study of priority landfill and dump sites

This study will provide more details and facilitate identification of the big emitters among all the landfills and open dumps in Lebanon that could be considered as sites for the NAMA (Outcome C: Landfill gas is collected and utilized or flared). So far, only four priority sites have been identified. The concrete emission reduction potential at all of the sites is uncertain and can only be estimated under application of the FOD model ex-ante. Currently the composition and burning history of the deposited waste are not known, the waste amounts have not been recorded and therefore estimates of the emission reduction potential are only approximate at present.

To come closer to the actual emission reduction potential, feasibility assessments for LFG collection and flaring or power production have to be undertaken for the biggest landfill and dump sites. The initial goal is to identify eight (8) priority sites, out of which four (4) are to be implemented in Phase 1 and the remaining four (4) implemented in Phase 2 of the NAMA. Only the 4 sites covered under Phase 1 should be part of this study. The assessments need to be accompanied by pumping tests, which allow more realistic estimation of the emitted gas amounts.

0.2 Assessment study on waste streams and waste compositions

The assessment study of waste streams and waste compositions will provide information to better understand the current situation in the solid waste sector in Lebanon. Information about waste composition would allow for an improved assessment of the actual emissions caused by solid waste and to assess the emission reduction potential. Furthermore, this information on waste streams will provide the basis for defining where reception centers would be most appropriate and where they would be economically feasible and effective. The study should account for regional and seasonal differences in waste composition.

0.3 Environmental and Social Impact Assessment (ESIA) of the NAMA interventions

The ESIA for the technical interventions planned under the NAMA will focus on the interventions under Phase 1, as they are currently more concrete than those foreseen under NAMA Phase 2. The ESIA will include the analysis and estimating of the intended and unintended environmental and social impacts, both positive and negative, of the planned interventions under the NAMA. The specific content of the ESIA should be defined by the GOL. The ESIA will assess environmental impacts (i.e. air, water and soil pollution), impacts on biodiversity and ecosystems and social impacts (i.e. public health, safety), impacts on stakeholders and gender- related impacts. In general, the ESIA should cover the impacts caused during the planning phase, the construction and the operation phase of the interventions.

As already described in Chapter 4, this ESIA will also be used to define and quantify the baseline values for assessing and evaluating the co-benefits (sustainability and transformational change) of the NAMA.

0.4 Policy Needs Assessment (incl. recommendation to the Lebanese Government)

The current situation in the solid waste sector in Lebanon is rather complex according to existing laws and policies. The regulatory framework has been marked by constant change in recent years.

For a successful implementation of the interventions under the NAMA, clear but minimal set of regulations is considered relevant to ensure an enabling environment for investment decisions in the sector. A good knowledge and understanding of the current political environment and of current policies and regulations is required in order to assess which specific regulations are needed to facilitate the interventions proposed under the NAMA.

The result of the policy needs assessment should be a report that provides clear recommendations to the GOL on what regulations, incentives and specific laws would best suite to ensure that the interventions occur. This report and the recommendations should be the basis for the activities under the NAMA that are planned to establish the regulatory framework required for the NAMA interventions.

5.2 Interventions, Measures and Phased Approach

The NAMA has been designed to take a phased approach to allow for a gradual improvement in the current situation and to develop an enabling environment for involving the private sector and for ensuring a mid- to long-term positive transformative approach in the solid waste sector leading to GHG emission reductions and sustainable development. The actual NAMA proposal includes 2 Phases, with the first phase (2018-2021) focusing on landfill gas capturing and solid waste collection, as well as the preparation of WtE measures in GBA. The second phase (2022-2030) focuses on solid waste sorting (a pre-requirement for WtE) and the application of WtE. This phased approach will facilitate a transition from International Partner finance, which will support Phase 1, to domestic/national finance and private sector involvement, which will be the chief source of funding in Phase 2. This transition from international support to national funding for the operation of all Activities in Phase 2 needs preparation in Phase 1.

The main interventions of the NAMA are:

- Landfill gas is collected and utilized or flared;
- Solid waste is collected and waste streams are diverted to appropriate disposal sites; and
- Waste-to-Energy is applied.

To ensure that the interventions can be implemented and operated, a number of measures are considered that help prepare for and support the interventions. These measures need to address the institutional side (establishing an institutional framework), improve awareness about waste management, waste sorting and waste utilization, assess and improve the political and legal framework in the sector, and enable capacity-building for key stakeholders engaged in the activities under the NAMA.

The following chart shows the proposed Outcomes and Outputs of the NAMA. The items numbered with capital letters A to E are the Outcomes, the subsequent items A.1 to E.3 are the Outputs, all of them leading to the addressed Outcomes. All Outputs scheduled for Phase 1 of the NAMA are colored in blue and all scheduled for Phase 2 are colored in orange.

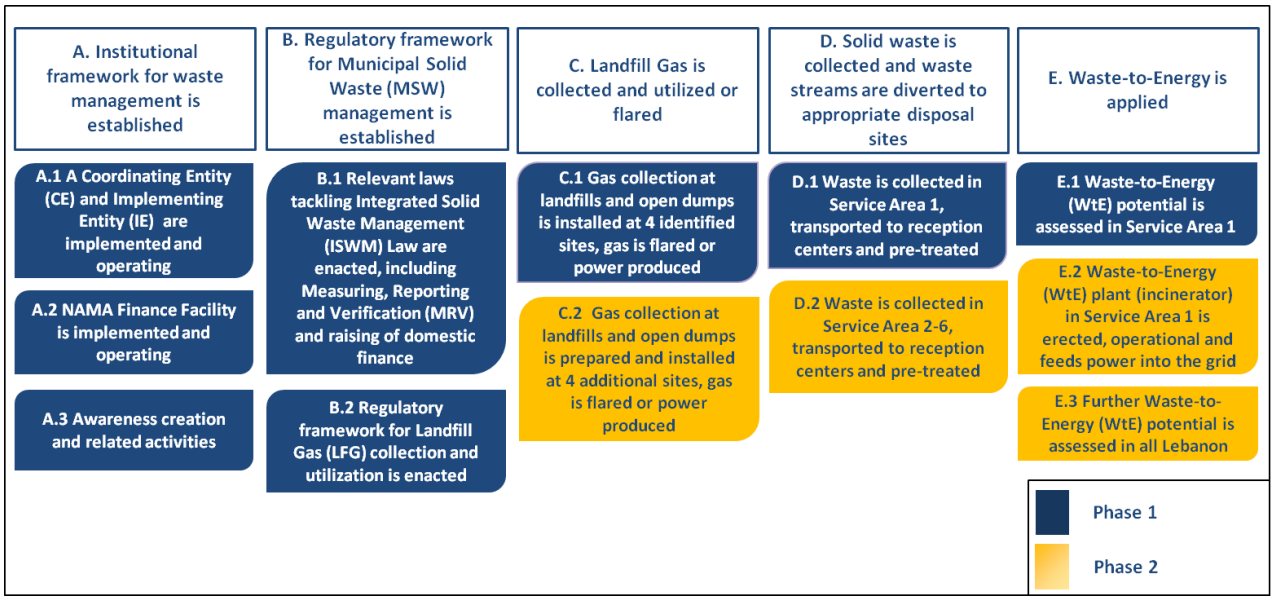


Figure 13: Outcomes and Outputs of the NAMA

The full list of the proposed Outcomes, Outputs and detailed Activities per Output can be found in Annex 1: NAMA Measures and Interventions and their Outputs, Activities and Inputs.

The following figure shows all measures and interventions and how the measures support the interventions in both Phases of the NAMA.

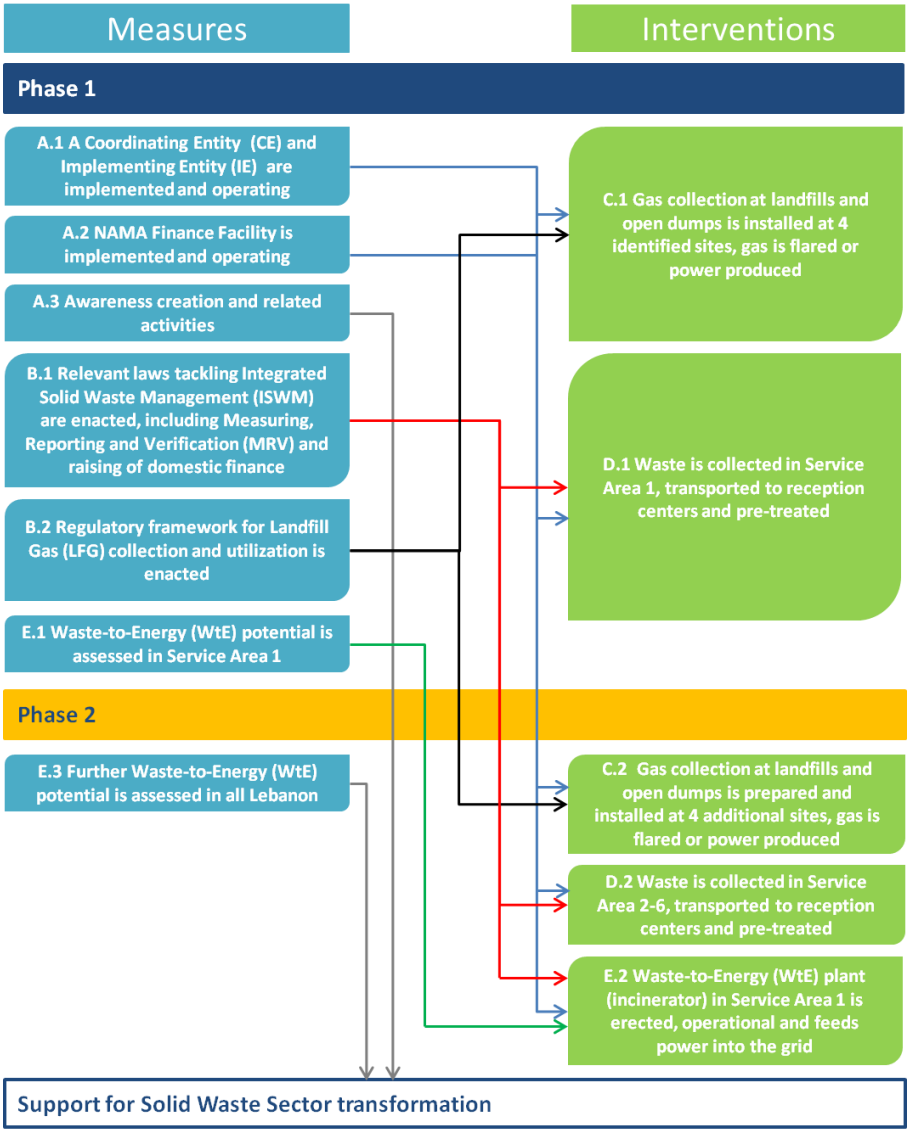


Figure 14: Measures leading to interventions

Measures, which suggest the creation of the institutional framework (A.1 and A.2) are a key element of the enabling environment for the NAMA and relevant for all interventions. Measures creating a regulatory framework (i.e. B1 and B.2) are also relevant for all interventions, but tailored more specifically. B.1 (ISWM law) is most relevant for the interventions related to waste collection (D.1 and D.2) and the erection of a WtE plant (E.2). Measure B.2 is relevant for all Activities related to interventions dealing with LFG collection, flaring and utilization (C.1 and C.2).

The awareness creation and preparation of source sorting activities, which is tackled in measure A.3 (Awareness creation and related activities) as well as the measure E.3, do not lead directly to specific interventions defined under the NAMA, but rather considered to help transforming the entire sector.

5.3 The Proposed NAMA Scope in Detail

Based on the Outcomes and Outputs presented above, the detailed activities planned under the NAMA are described below. For a detailed overview of the NAMA Outcomes, Outputs and Activities, see Annex 1: NAMA Measures and Interventions and their Outputs, Activities and Inputs.

5.3.1 Outcome, Outputs and Activities under NAMA Phase 1

The NAMA Phase 1 (2018-2021) focuses on the establishment of an institutional framework, providing support for the enactment of relevant laws, building the capacity of key stakeholders and increasing awareness of waste management and sustainable waste utilization and implementing waste collection and reception centers in Greater Beirut Area to increase waste diversion and make preparations for WtE systems. The key technical intervention under Phase 1 leading to GHG emission reductions, is LFG management (including utilization or flaring) at four (4) priority landfills sites and open dumps.

Outcome A: Institutional framework for waste management is established

Output A.1 (Measure): A Coordinating Entity (CE) and Implementing Entity (IE) are implemented and operating

A Coordinating Entity and an Implementing Entity need to be defined and made operational. These two entities are of the utmost importance for the NAMA, as they host the NAMA management (CE) and the implementation and monitoring side (IE).

The Activities planned to ensure the achievement of Output A.1 include:

- Activity A.1.1 and A.1.4 describe the formation of a Coordinating and an Implementing entity, and ensure that these are staffed, have an office and are operational;
- Activity A.1.2 and A.1.5 ensure that the CE and IE are trained on relevant issues like MRV, facilitation of sharing of know-how in solid waste management practices within government institutions, municipalities, and the private sector;
- Activity A.1.3 is related to the NAMA implementation, to develop the mandates and regulation for PPP and Independent Power Producer (IPP) business models as applicable. Further, a transparent procurement process under competitive bidding will be followed.

Output A.2 (Measure): Establishment of a NAMA Finance Facility (NFF)

The NAMA will create a variety of financial flows. Donor money from different sources needs to be managed and disbursed and relevant national funding needs to be raised and managed. Revenues like tipping fees need to be monitored in collaboration with the relevant authorities, i.e. the MoF and the IMF. The detailed roles and responsibilities of both institutions is described in Chapter 8.

The Activities planned to ensure the achievement of Output A.2 include:

- Activity A.2.1 is to identify, establish, and operate the Financial Trustee to manage the financial instruments under the NAMA Finance Facility (NFF), e.g. the NAMA Loan Facility and the Grant Subsidy Scheme. The activity is to identify the candidates to act as the Financial Trustee, to prepare an evaluation and selection process to decide on the Financial Trustee, and execute any procurement process which may be required to secure agreement with the Trustee. Then to establish a mandate, operational by-laws and evaluation mechanisms for the NFF.
- Activity A.2.2 is to establish and operate the NAMA Loan Facility and Grant Subsidy Scheme under the Financial Trustee. The core of this Activity is to determine the source(s) of capital for the financial instruments (grants, guarantees) needed for the Financial Trustee to offer grants and loans to the private sector operated interventions. The Financial Trustee will need to structure the investment agreement(s) and operate by-laws with each agency/institution

providing international or national support to the NAMA. In addition, the Trustee shall design eligibility criteria and perform due diligence of private sector businesses (Private Parties) who seek to gain grants. The Financial Trustee will also need to devise a risk mitigation strategy and evaluation mechanism for all types of finance instruments.

Output A.3 (Measure): Awareness creation and related activities

The inception of source sorting will be emphasized from the very beginning of this NAMA, especially in the rural areas (SA 2-6). This shall help to reduce the waste amount which needs to be landfilled and enhance recycling of valuable materials like metal, glass, cardboard, paper, some plastics, etc.

The Activities planned to ensure the achievement of Output A.3 include:

- Activity A.3.1 is support for the development of material for trainings and public campaigning. Key players (municipalities, disposal firms, etc.) will be educated about waste management and source sorting.
- Activity A.3.2 helps on the marketing of waste management improvements as a pilot and the launching of an information campaign.

Further awareness creation is provided under Phase 2 of the NAMA.

Outcome B: Regulatory framework for MSW Management is established

Output B.1 (Measure): Relevant laws tackling ISWM are enacted, including MRV and raising domestic finance

This Output is related to the legal situation around the NAMA and should provide support to the GOL to develop the required regulatory framework for the interventions planned under the NAMA. One of the focus areas is to tackle the GOL's long-term vision on SWM via newly ratified laws.

The Activities planned to ensure the achievement of Output B.1 include:

- Activity B.1.1 offers strategic support to devise short- and long-term master planning under the ISWM law and to harmonize policies, regulations and laws.
- B.1.2 will provide policy and institutional support to enact the ISWM law (or its parts).
- B.1.3 discusses support to develop the mandates and regulation for the national level finance for implementing interventions under the NAMA, eventually under a private sector framework with built-in transparency and accountability mechanisms. These financial mechanisms include tipping fees, other direct/indirect fees, loan facilities and subsidies.
- B.1.4 stands for the implementation of these new laws. After completion of this Activity, the law is drafted and presented to the Parliament and the COM.

Output B.2 (Measure): Regulatory framework for landfill gas (LFG) collection and utilization is enacted

For the LFG collection and flaring, the regulatory framework needs to be established first, as the related intervention C (Landfill gas is collected and utilized or flared) will start soon after inception of the NAMA.

The Activities planned to ensure the achievement of Output B.2 include:

- Activity B.2.1 focusses on approaching the relevant authorities in a capacity- building exercise which will lead to a set of rules for LFG collection, e.g. to make LFG treatment (e.g. in flares) mandatory. Further, IPPs need to be permitted and feed-in tariffs need to be established, so that Power Purchase Agreements (PPA) can be negotiated.

Outcome C: Landfill gas is collected and utilized or flared

Output C.1 (Intervention): Gas collection at landfills and open dumps is installed at 4 identified sites, gas is flared or power produced

Output C.1 is an intervention dealing with the physical installation of the LFG collection systems at four (4) pre-selected sites. The concrete emission reduction potential at all of the sites is uncertain and can only be estimated under application of the FOD model, as the composition of the disposed waste and the burning history are currently not known, the waste amounts have not been recorded and hence the estimate is approximate. Depending on the conditions of the sites, the collected LFG is either flared (to avoid methane emissions to the atmosphere) or utilized for producing electricity. When electricity is produced, there will be additional emission reductions through the replacement of grid electricity with electricity produced by landfill gas (renewable).

The Activities planned to ensure the achievement of Output C.1 include:

- Activity C.1.1 covers the engineering of these LFG collection systems at 4 pre-identified sites. Engineering companies are required to instruct the operators of the sites on how to operate and optimize LFG collection, the flares or the power generators to reduce the methane flux to a minimum;
- Activity C.1.2 deals with the physical implementation and operation of the installed systems on the 4 selected sites.

Outcome D: Solid waste is collected and waste streams are diverted to appropriate disposal sites

Output D.1 (Intervention): Waste is collected in SA 1, transported to reception centers and pre-treated

An important step to change the current disposal practices is to avoid the open dumping of waste. This can only be achieved if the entity collecting the waste is provided with options for dropping the collected waste. For that reason, bulk collection centers will be implemented and open dumping will be prohibited. As such activities are already partly undertaken in the SA 1 (GBA), the collection at reception centers will be continued and improved in this area first to ensure full capture of all waste streams in the GBA. The activities under NAMA Phase 1 will be built on already existing reception centers.

The second reason for the introduction and improvement of the bulk reception centers is that for any future measure and its feasibility assessment, be it recycling, incineration or landfilling, the waste amounts and composition need to be known.

The Activities planned to ensure the achievement of Output D.1 include:

- Activity D.1.1 is the implementation or improvement of the described bulk collection centers and their management and operation;
- Activity D.1.2 supports the transport of all waste streams in SA 1 to these sites;
- Activity D.1.3 deals with the sorting, pre-treatment, recycling and disposal of the waste.

Construction and Demolition waste, as well as other inert materials, will be separated from the waste (some recyclable materials may also be separated). Where possible, compost can be one product of these sorting activities.

Output E: Waste-to-Energy is applied

Output E.1 (Measure): Waste-to-energy (WtE) potential is assessed in SA 1

To prepare the swift implementation of Phase 2 of the NAMA, some measures need to have been undertaken in Phase 1. This is particularly the case for assessment of the WtE potential in the GBA and the preparation of a campaign for sorting waste at the source to allow for recycling. It is important to

start the preparation for implementing WtE early (under Phase 1) as the planning and implementation process for a WtE facility takes several years. As mentioned earlier, the assessment of the WtE potential will be made possible through the successful implementation of Output D.1 for SA 1. This includes the determination of the calorific value of the waste, which is the key parameter for further planning of a waste incinerator.

The Activities planned to ensure the achievement of Output E.1 include:

- Activity E.1.1 Waste amounts and composition are monitored at the existing reception centers. This builds on the practice of waste collection at the bulk reception centers and suggests recording of the waste amounts and frequent waste samplings.

- E.1.2 "A feasibility study for one big incinerator is undertaken and site and size of the plant are clear (in SA 1)". The feasibility study can start once the specific waste fractions and their share per SA are clear.

5.3.2 Outcome, Outputs and Activities under NAMA Phase 2

The NAMA Phase 2 (2022-2030) builds directly on the achievements of the NAMA Phase 1. The technical interventions of Phase 2 are the implementation and operation of one waste incinerator for producing energy from waste (WtE) and the LFG management (including utilization and flaring) at four (4) additional landfill sites and open dumps. These interventions will lead to significant GHG emission reductions under Phase 2. In addition, the NAMA Phase 2 will extend the implementation of waste collection and waste reception centers to other service areas outside the GBA, assess the potential for further WtE opportunities in Lebanon and ensure awareness creation of source sorting and recycling.

The WtE facility (waste incinerator) for the GBA will be planned soon after the start of Phase 2, in view of the approximately 5 years needed for engineering and construction. Without the WtE facility, neither the achievement of emission reductions, nor the avoidance of other environmental impacts can be guaranteed to last, as sanitary landfills have a limited capacity. Preparatory steps, like the ratification of SWM policies in Lebanon, which are part of Outputs A., B., and C. are a precondition for the successful commencement of this Phase 2.

Based on the successful implementation of Phase 1, the following Outcomes, Outputs and Activities will be achieved in Phase 2.

Outcome A: Institutional framework for waste management is established

Output A.3 (Measure): Awareness creation and related activities

In Phase 2 the source sorting of waste shall further be promoted all over Lebanon. Additional to the awareness creation Activities under NAMA Phase 1, Output A.3 will prepare for source sorting of the waste to enable recycling of certain fractions. Although the actual source sortingand the process of informing the population about it will not be a part of this NAMA, the aim is to prepare for source sorting, as source sorting and recycling, combined with avoidance of waste are considered most the sustainable ways of managing waste.

The Activities planned to ensure the achievement of Output A.3 include:

- Marketing of the source sorting initiative is undertaken and an information campaign is launched in Activity A.3.3;

- In Activity A.3.4, a country-wide campaign for source sorting is being prepared, leading to an increased acceptance of recycling and hence to less waste being disposed. Key players (municipalities, disposal firms, etc.) will be educated about source sorting and willthen step in as a means of spreading knowledge about it.

Outcome C: Landfill gas is collected and utilized or flared

Output C.2 (Intervention): Gas collection at landfills and open dumps is prepared and installed at *4* additional sites and gas is flared or power produced

Output C.2 is an intervention dealing with the physical installation of the landfill gas collection systems at four additional sites. These additional sites may be among those sites for which an assessment in a desk review was undertaken during the development of this NAMA in 2015, or they may be identified during the study conducted in Step 0.1 before the NAMA begins to be implemented. However, it is recommended that a site assessment and feasibility study for potential sites is conducted as a first step under Output C.2, as the emission reduction potential and technical details of the sites might change in the period between finalizing Step 0.1 and the start of the NAMA Phase 2.

The Activities planned to achieve Output C.2 include:

- Activity C.2.1 suggests a feasibility study and Environmental Impact Assessment on landfills and big open dumps to be undertaken at the four most feasible additional landfill sites/dumps. Without a feasibility study, it cannot be determined, at which landfills this intervention shall happen. The potential for landfill gas utilization is likely to be available, nevertheless, the emission reductions on these sites cannot be estimated at this point in time.

- Activity C.2.2 covers the engineering of the LFG collection system undertaken at these 4 additional sites and the implementation of the LFG collection system. Engineering companies are required to instruct SWDS operators on how to operate and optimize LFG collection, flares or power generators after installation.

- Activity C.2.3 focuses on the physical implementation and operation of the installed systems on the 4 selected sites.

Outcome D: Solid waste is collected and waste streams are diverted to appropriate disposal sites

Output D.2 (Intervention): Waste is collected in SA 2-6, transported to reception centers and pre-treated

Output D.2 deals with the second pillar of this Phase 2, which will not directly lead to GHG emission reductions, but will transform the waste sector by opening bulk reception centers all over Lebanon (the current plan is to implement one reception center per service area). This will ensure proper collection, treatment and disposal of the collected wastes. The private sector will be involved on the side of waste collection and transport, in the operation of the bulk reception centers and the operation of the existing and newly erected waste disposal facilities (landfills, WtE facilities, etc.).

The Activities planned to achieve Output D.2 include:

- In Activity D.2.1 the locations of reception centers in SA 2-6 are identified. This will be a critical milestone and needs proper preparation, including deciding on their design and function;

- Activity D.2.2 ensures the erection and operation of the identified sites;

- In Activity D.2.3 transport of the waste to these reception centers is provided;

- Activity D.2.4 proposes the establishment and operation of one showcase pre-treatment facility for household and garden waste for the purpose of sorting out recyclables and possibly providing inputs for WtE. This pilot facility will test sorting and composting and should be a rather simple facility with manual sorting. In the pre-treatment facility, the solid waste will be sorted, so that recyclables and organic substances will be separated. The organic substances will be composted and thereby mineralized, which avoids methane emissions. Recyclables like glass, metal, plastics, cardboard, etc. will be separated and sold to companies which can use these materials as an

input. The pilot will not produce RDF, for which the potential may be assessed after Phase 2 of the NAMA;

- In Activity D.2.5 the waste is pre-treated, certain waste fractions are recycled if applicable and the rest is transported to disposal sites.

Outcome E: Waste-to-Energy is applied

Output E.2 (Intervention): WtE plant (incinerator) in SA 1 is erected, is operational and feeds power into the grid

Output E.2 envisages the utilization of the WtE potential contained in the waste from the GBA, where space is a scarce good and hence WtE is an obvious choice. To achieve this goal, the WtE potential of the waste needs to be assessed, which was done under Output E.1 in the NAMA Phase 1. Waste streams need to be routed from the bulk collection centers to this WtE facility, which will also be ensured by Activities conducted under NAMA Phase 1 (Output D.1 and E.1). The waste will be incinerated in a large waste incineration plant with a capacity of approximately 80 tonnes of waste per hour (590,000 tonnes of waste per year). With the produced heat from the incinerated waste, steam turbines with a capacity of about 40 MW_{el} will produce around 295.000 MWh of power per year. This power is produced by the partly renewable waste and hence is expected to have a lower emission factor than the grid emission factor in the Lebanese power grid.

The Activities planned to ensure the achievement of Output E.2 include:

- In Activity E.2.1 one site shall be identified and legal requirements fulfilled;
- In Activity E.2.2 the waste incinerator will be designed, financed, and erected. This procedure will take approximately 4 to 5 years and hence the incinerator may not be commissioned until 2025;
- In Activity E.2.3 the incinerator, once operative, will feed power into the grid.

Output E.3 (Measure): Further waste-to-energy (WtE) potential is assessed in all Lebanon

To support the transformation of the solid waste sector beyond the technical interventions planned under the NAMA (LFG management in 8 sites and operation of one WtE plant), the NAMA includes the assessment of further WtE potential across Lebanon.

The Activities planned to realise Output E.3 include:

- Activity E.3.1: A precondition for the further assessment of WtE opportunities is knowledge about waste amounts and waste composition, which will be monitored at reception centers in Lebanon according to the Measurement, Reporting and Vertification requirements of the NAMA;
- Activity E.3.2: To achieve transformative change in the waste sector, the feasibility of different WtE technologies (RDF, large incinerators) and the number of potential RDF plants and waste incinerators shall be assessed.

6 Capacity Building

As outlined in the previous Chapter 5, the NAMA scope includes a number of activities that prepare for and support the successful implementation of the NAMA interventions. There are a number of barriers in the solid waste sector in Lebanon that currently hinder the implementation of concrete interventions. The NAMA includes a variety of capacity building components that are embedded in the full NAMA. The NAMA includes a number of stakeholders and groups of stakeholders (i.e. government agencies, private companies, banks, municipalities) involved in the different stages of the NAMA. The capacity building components will help to ensure that the stakeholders are well prepared for the activities and to ensure that the information basis is sufficient for stakeholders to engage in the planned activities. The capacity building for the NAMA can be divided into thefollowing general components:

- Capacity building for local stakeholders conducted by international consultants (incl. training and workshops);
- Capacity building for local stakeholders conducted by local consultants (incl. training and workshops);
- Feasibility/Assessment Studies and Surveys to enhance the information basis and know-how;
- Working group meetings to facilitate the coordination and exchange of information between of stakeholder groups;
- Awareness creation activities.

As capacity building is an important and integral part of the logical framework of the NAMA, with Activities and Outputs leading to the Outcomes of the NAMA, this chapter describes the different capacity building components and how these components are embedded in the overall NAMA.

Capacity building within NAMA Phase 1 focuses on providing strategic, policy, institutional and regulatory support to fosteran improved regulatory framework in the solid waste sector, establish the institutional framework for the NAMA, ensure the training of operators of the technical intervention planned under Phase 1 (LFG flaring and utilization) and plan and conduct awareness creation activities. Capacity building in Phase 2 of the NAMA focuses on the feasibility assessment and potential analysis of potential WtE technologies, the training of key stakeholders (e.g. municipalities, plant operators) for the operating the technical interventions planned under Phase 2 (LFG flaring/utilization and WtE) and supporting marketing and education programmes on waste source sorting.

The following sections will describe those activities that involve capacity building components and how these activities will help to achieve the outputs and outcomes of the NAMA. For a detailed overview of Outcomes, Outputs and Activities, see Chapter 5 and Annex 1: NAMA Measures and Interventions and their Outputs, Activities and Inputs.

6.1.1 Capacity Building under NAMA Phase 1

The majority of capacity building comes under Phase 1 of the NAMA and is a central component of all 5 Outcomes of the NAMA. Due to very specific gaps in the waste sector in Lebanon at present, these capacity building activities in Phase 1 willhelp set the foundation and create the enabling environment for the activities under Phase 2.

Capacity Building within Outcome A: Institutional framework for waste management is established

Activity A.1.2: The CE is trained about issues related to its role and responsibility in the NAMA

The focus is to help implementing and operating the CE of the NAMA. The CE is supposed to coordinate and mediate between the Government and the private sector and facilitate knowledge transfer between different stakeholders. Currently such coordination and exchange of information and know-how between different actors is missing or inadequate. The capacity building component will include training of staff of

the CE about areas that the CE is responsible for and that are most relevant to the operation and management of the NAMA.

Activity A.1.3: Support to develop the mandates and regulation for PPP and IPP business models as needed, including transparent procurement processes under competitive bidding

This capacity building component is directed to the CE and the IE to establish a PPP mechanism and IPP business models for the LFG operations (under Outcome C) and the WTE plant (under Outcome E). Determining if, and in what form, a PPP can be utilized for those operations in Lebanon will require both local and international technical assistance in determining risk and the functional allocations of partners, appropriate financial institutions and structures, sound legal frameworks, and appropriate mechanisms for fiscal responsibility.

For the development of IPP business models, an assessment is required to identify potential private sector players that could be part of the NAMA and enter into PPP agreements for the operation of landfill sites and the WtE plant in Lebanon. Furthermore, the conditions under which the operation would be economically feasible need to be assessed. This will include the investment costs and continuing costs for operation, maintenance and management (OMM), but also the revenues (e.g. tipping fees, feed in tariffs) required for an economically feasible operation. This information is important for developing an effective incentive scheme for the private sector to participate under the NAMA in form of PPPs or as an IPP. In addition to that, the information gathered can feed directly into the process of developing a regulatory framework for the landfill gas capture and utilization (Output B.1).

Activity A.1.5: The IE is trained on relevant issues related to its role and responsibility under the NAMA

This capacity building component focuses on providing support to help establish and operatethe IE of the NAMA. As an IE for the NAMA does not exist yet and it is currently anticipated that the tasks of the IE will be shared among the MoE and OMSAR, this capacity building component is considered as important precondition to install an IE that will be capable of fulfilling the tasks required under the NAMA. The capacity building provided will be mainly training of IE staff.

Activity A.2.1: Agreement with the Financial Trustee (FT) is established including mandate, operational by-laws and evaluation mechanisms for the Trustee

The capacity building will help identifythe appropriate institution to assume the the role of NFF for the NAMA, the support required for establishing the facility, for the training of staff and for fulfilling the required tasks under the NAMA. The focus will be on financial incentives, management of financial flows, MRV of finance aspects and the allocation of finance.

Activity A.3.1: Support for development of material for trainings and public campaigning. Key players (municipalities, disposal firms, etc.) are educated about waste management and source sorting

The capacity building includes an initial assessment of required material for conducting training and for increasing awareness of source sorting and recycling among key stakeholders, identifying stakeholders and providing support in developing and provision of the training and material. In increasing awareness, support will be provided to develop the required content and structure for appropriate campaigning (e.g. posters, brochures, radio spots). In addition, a series of trainings will be conducted using the training materials prepared to educate the key stakeholders, including municipalities and private sector players involved in the solid waste sector about the relevance of source sorting and recycling.

This capacity building is a central component for increasing awareness of source sorting, recycling and waste management among the public in general. It is a key element towards a transformation of the solid waste sector among different groups of stakeholders (incl. the public society).

Outcome A under Phase 1 includes the following capacity building components.

NAMA Output	NAMA Activity	Capacity Building components
A.1 A Coordinating Entity (CE) and Implementing Entity (IE) are implemented and operating	A.1.2 The CE is trained on relevant issues related to its role and responsibility under the NAMA	✓ One International Technical Advisor ✓ One Local Technical Advisor ✓ Facilitation of internal working group meetings (2) ✓ Two training programmes for CE staff
	A.1.3 Support to develop mandates and regulation for PPP and IPP business models	✓ One International Technical Advisor ✓ One Local Technical Advisor ✓ Facilitation of internal working group meetings (1) ✓ One training programme for CE and IE staff
	A.1.5 The IE is trained on relevant issues related to its role and responsibility under the NAMA	✓ One International Technical Advisor ✓ One Local Technical Advisor ✓ Facilitation of internal working group meetings (2) ✓ Two training programmes for IE staff
A.2 NAMA Finance Facility is implemented and operating	A.2.1 Agreement with the Financial Trustee (FT) is established	✓ One International Financial Advisor ✓ One Local Financial Advisor ✓ Two training programmes for Finance Facility staff
A.3 Awareness creation and related activities	A.3.1 Support on development of material for trainings and public campaigning	✓ One International Technical Advisor ✓ One Local Technical Advisor ✓ Support for marketing and training material

Table 25: Capacity building under NAMA Phase 1 (Outcome A)

Capacity Building within Outcome B: Regulatory framework for MSW Management is established

Activity B.1.1: Strategic support for short and long term master planning under the ISWM law and for harmonization of policies, regulations and laws

The capacity building will follow the Policy Needs Assessment conducted before the start of the NAMA (see Chapter 5) and will provide strategic support for a master plan to cover the SWM sector, in the short and in the long term. One of the Phase 1 milestones is to support the enactment of the the relevant laws tackling ISWM. This will be achieved by providing advisory support to the GOL and other key stakeholders (i.e. municipalities), coordinating and facilitating the interaction of different key stakeholders and supporting information and knowledge transfer (i.e. strategy and policy papers, assessment reports) to define effective measures for the SWM master plan. The specific areas where capacity building is required would be assessed during the Policy Needs Assessment before the NAMA starts.

This capacity building activity will further support the harmonization of policies, laws and regulations, which is considered necessary before Phase 2 of the NAMA.

Activity *B.1.2: Policy and institutional support to enact the (or parts of) ISWM law*

The capacity building activity B.1.2 provides capacity building support to the key institutions that are in charge of defining and developing the laws to be enacted.

The focus is on supporting the key institutions. It will include support to ensurethat sufficient institutional capacities are available to enact the ISWM law (or parts of it) and to establish and implementithe domestic financing instruments that will help steer the reform process in the SWM sector. The capacity building will comprise training of staff and direct knowledge transfer.

Ensuring that a master plan for the SWM sector exists and that the ISWM law is enacted is considered a pre-condition for larger investments in the sector and for the involvement of the private sector in the technical interventions (LFG capture and utilization and WtE technologies).

Activity B.1.3: Support to develop the mandates and regulation for the national level finance needed to implement interventions under the NAMA and other ISWM actions

The capacity building will focus on providing advisory support in the areas of legal support, policy enactment and finance/national budgeting. Once the laws and regulations are enacted, the relevant institutions need to develop and obtain the mandates to apply the finance needed for the NAMA. In addition, it will require coordination among different stakeholders (e.g. MoE, MoF and NAMA institutions).

Activity B.1.4: The law is drafted and presented to the Parliament and the COM

Support for drafting the law will be provided as part of the capacity building. The focus is to provide legal support to the Ministry/Ministries in charge of the law. This can include drafting and reviewing the law and strategic advice.

Activity B.2.1: The relevant authorities are approached to issue a regulation permitting LFG collection, IPPs, negotiation of PPAs and setting of feed in tariffs

The specific activities include knowledge transfer and support that will lead to the acceptance and creation of IPPs. This will allow e.g. landfill operators or owners to capture the methane and produce electricity that can be fed into the power grid of Lebanon. This would also require regulations for setting up feed-in tariffs for such facilities. To improve private sector engagement in the SWM sector, capacity building will support the Government and the private sector to foster a supporting environment for negotiating PPP business models and agreements. This will help to increase the participation of the private sector and hence leadto transformational change in the SWM sector.

Outcome B under Phase 1 includes the following capacity building components.

NAMA Output	NAMA Activity	Capacity Building components
B.1 Relevant laws tackling ISWM are enacted, including MRV and raising of domestic finance	B.1.1 Strategic support for short and long term master planning under the ISWM law and for harmonization of policies, regulations and laws	✓ Two studies or surveys ✓ Two International Advisors (Technical and Political/Financial) ✓ One Local Advisor (Technical) ✓ Facilitation of internal working group meetings (2)
	B.1.2 Policy and institutional support to enact the (or parts of) ISWM law	✓ One International Technical/Legal Advisors ✓ One Local Technical/Legal Advisor ✓ Facilitation of internal working group meetings (2) ✓ Two training programmes for institutions in charge
	B.1.3 Support to develop the mandates and regulations for the national level finance needed to implement interventions under the NAMA and other ISWM actions	✓ Two International Financial/Legal Advisors ✓ One Local Financial/Legal Advisor ✓ Facilitation of internal working group meetings (2) ✓ One training programme for institutions in charge
	B.1.4 The law is drafted and presented to the Parliament and the COM	✓ One Local Legal Advisor ✓ Facilitation of internal working group meetings (2)
B.2 Regulatory framework for landfill gas (LFG) collection and utilization is	B.2.1 The relevant authorities are approached to lead to a regulation permitting LFG collection,	✓ One International Financial/Technical Advisors ✓ One Local Financial/Technical Advisor ✓ Facilitation of internal working group meetings (1)

enacted	IPPs, negotiation of PPAs and setting of feed-in tariffs	✓ One training programme for institutions in charge

Table 26: Capacity building under NAMA Phase 1 (Outcome B)

Capacity Building within Outcome C: Landfill gas is collected and utilized or flared

Activity C.1.1: Engineering of the LFG collection system is undertaken at 4 identified sites, implementation of the LFG collection system has happened

This capacity building activity is a necessary component to ensure the appropriate operation of the landfill gas sites, the capturing of LFG, and that flaring and power production are conducted according to the requirements of the NAMA.

It is assumed that this capacity building component will be part of the contract between the engineering company/technology provider and each operator of the landfill gas utilization plant. For this capacity building, the engineering companies will be in charge of providing in-depth instructions to the landfill operators on how to operate and optimize the LFG capturing, the flaring and the operation of the power generators (in case electricity is produced). The operators of the landfill sites will receive guidance on how to operate the site to ensure that the site is operated in a most efficient way and that methane emissions are avoided to the extent possible. The instruction process should be supervised or monitored by the CE or IE of the NAMA.

It is assumed that the engineering company/technology provider will be informed about the specific requirements under the NAMA by the staff of the IE.

Outcome C under Phase 1 includes the following capacity building components.

NAMA Output	NAMA Activity	Capacity Building components
C.1 Gas collection at landfills and open dumps is installed at 4 identified sites, gas is flared or power produced	C.1.1 Engineering of the LFG collection system is undertaken at 4 identifiedsites, implementation of the LFG collection system has happened	✓ Support provided by the staff of the Implementing Entity (IE) ✓ Facilitation of internal working group meetings (4)

Table 27: Capacity building under NAMA Phase 1 (Outcome C)

Capacity Building within Outcome D: Solid waste is collected and waste streams are diverted to appropriate disposal sites

Activity D.1.1: Location, design and function of reception centres in SA 1 are identified, based on existing facilities

The focus of the capacity building is to help identify the most appropriate location, design and function of the reception center in GBA (SA 1) where the WtE plant is going to be implemented under NAMA Phase 2. This capacity building component will include a detailed technical assessment study to identify the most appropriate location, design and function of waste reception centers in SA 1.

Activity D.1.2: Transport to these reception centers is ensured

This component will include knowledge transfer and training of stakeholders in charge of the transportation of waste to the reception centers. This capacity building should be provided by local

consultants to the private companies in charge of the transportation and should be overseen and coordinated by the CE or IE.

Outcome D under Phase 1 includes the following capacity building components.

NAMA Output	NAMA Activity	Capacity Building components
D.1 Waste is collected in SA 1, transported to reception centres and pre-treated	D.1.1 Location, design and function of reception centres in SA 1 are identified, based on existing facilities.	✓ Two Local Technical Advisors ✓ Technical assessment study ✓ Facilitation of internal working group meetings (1) ✓ One training programme for institutions in charge
	D.1.2: Transport to these reception centers is ensured	✓ Two local Technical Advisors ✓ One training programme for private companies in charge of transportation of waste

Table 28: Capacity building under NAMA Phase 1 (Outcome D)

Capacity Building within Outcome E: Waste-to-Energy is applied

Activity E.1.1: Waste amounts and composition are monitored at existing reception centres

The capacity building is directed to the IE and the operators of the reception centers. The capacity building components should ensure that the measurement and reporting procedures that are required under the NAMA are properly applied by the responsible persons.

Support to set up the monitoring system and continuing support of the monitoring process are assumed to be provided by local consultants.

Activity E.1.2: Feasibility study for one WtE plant (incinerator) is undertaken and site and size of the plant are clear

To assess the technical and economic potential of the WtE plant that is planned to be implemented in GBA (SA 1) under NAMA Phase 2, capacity building in NAMA Phase 1 focuses on a feasibility study for one big WtE plant for waste incineration. As a result, the location with the best potential, the optimal size and the potential costs of the plant should be known. This information is a pre-condition for the design and construction of the WtE plant under NAMA Phase 2.

Outcome E under Phase 1 includes the following capacity building components.

NAMA Output	NAMA Activity	Capacity Building components
E.1 Waste-to-energy (WtE) potential is assessed in SA 1	E.1.1 Waste amounts and composition are monitored at existing reception centres	✓ Two Local Technical Advisors for the set up ✓ One Local Technical Advisor for supporting the monitoring ✓ Facilitation of internal working group meetings (2) ✓ One training programme for institutions in charge
	E.1.2 Feasibility study for one WtE plant (incinerator) is undertaken and site and size of the plant are clear	✓ Two International Financial/Technical Advisors ✓ Two Local Financial/Technical Advisors ✓ Facilitation of internal working group meetings (2) ✓ One training programme for institutions in charge

Table 29: Capacity building under NAMA Phase 1 (Outcome E)

6.1.2 Capacity Building under NAMA Phase 2

The capacity building components under the NAMA Phase 2 focus on the expansion of marketing and continuing awareness creation for source sorting, providing capacity building for stakeholders involved in implementing and operating LFG flaring and utilization sites and the WtE plant, and the preparation and assessment of additional WtE facilities across Lebanon.

Capacity Building within Outcome A: Institutional framework for waste management is established

Activity A.3.3: Marketing of the source sorting initiative is undertaken, information campaign is launched in SA 1-6

The marketing campaign about source sorting will be supported by capacity building components under activity A.3.3. The focus will be to update the marketing material based on the experience obtained during the pilot (under activity A.3.2) and provide support to the institution in charge of the marketing campaign in launching the information campaign.

Activity A.3.4: A country-wide campaign for source sorting is being undertaken

The capacity building will be provided by local consultants to the institution in charge of the campaign and will include support for the preparation of the campaign material, the conduct of the campaign and/or evaluation of its results.

Outcome A under Phase 2 includes the following capacity building components.

NAMA Output	NAMA Activity	Capacity Building components
A.3 Awareness creation and related activities	A.3.3 Marketing of the source sorting initiative is undertaken, information campaign is launched in SA 1-6	✓ One Local Technical Advisor ✓ Support for the launch of the campaign (printing, material, etc.) ✓ Facilitation of internal working group meeting (1)
	A.3.4 A country-wide campaign for source sorting is being undertaken	✓ One Local Technical Advisor required annually ✓ Support for advertisement material (printing, material, etc.) per annum ✓ Facilitation of internal working group meetings (1 per annum)

Table 30: Capacity building under NAMA Phase 2 (Outcome A)

Capacity Building within Outcome C: Landfill gas is collected and utilized or flared

Activity C.2.1: Technical feasibility studies and EIAs on landfills and big open dumps are undertaken for the 4 second most attractive LFs/dumps

The focus of the capacity building is a comprehensive feasibility assessment and Environmental Impact Assessment (EIA) for the 4 dump sites to be implemented under NAMA Phase 2 (in addition to the 4 sites implemented in Phase 1). With the current information a comprehensive technical-economic analysis for individual dump sites is not possible and dump sites cannot be prioritized in terms of gas capture potential and technical and economic feasibility. The studies will be one of the first elements under NAMA Phase 2 to increase knowledge about the sector (i.e. waste composition), to further support the transparency of the sector in terms of data and information and appropriately assess the technical and economic potential of the dump sites under NAMA Phase 2.

Activity C.2.2: Engineering of the LFG collection system is undertaken at 4 additional sites, implementation of the LFG collection system has happened

The engineering companies will be in charge of providing in-depth instructions to the landfill operators on how to operate and optimize the LFG capture, flaring and the operation of the power generators (in case electricity is produced). The operators of the landfill sites will receive guidance on how to operate the site to ensure that it is operated in a most efficient way and that methane emissions are avoided to the extent possible. Knowledge of gas LFG capture, flaring and power production from LFG is very limited in Lebanon, so the engineering companies providing the technologies are considered the most appropriate to give the required instructions. The instruction process should be supervised or monitored by the CE or IE.

It is assumed that this capacity building component will be part of the contract between the engineering company/technology provider and each operator of the landfill gas utilization plant. It is assumed that the staff of the IE will inform the engineering companies/ technology providers about the specific requirements under the NAMA.

Outcome C under Phase 2 includes the following capacity building components.

NAMA Output	NAMA Activity	Capacity Building components
C.2 Gas collection at landfills and open dumps is prepared and installed at 4 additional sites, gas is flared or power produced	C.2.1 Technical feasibility studies and EIA on landfills and big open dumps are undertaken for the 4 second most attractive LFs/dumps	✓ Two International Financial/Technical Advisors ✓ Two Local Financial/Technical Advisors ✓ Landfill assessment at up to 20 sites ✓ LFG pumping tests at up to 10 sites ✓ One training programme for relevant local stakeholders
	C.2.2 Engineering of the LFG collection system is undertaken at 4 additionalsites, implementation of the LFG collection system has happened	✓ Support provided by the staff of the Implementing Entity (IE) ✓ Facilitation of internal working group meetings (4)

Table 31: Capacity building under NAMA Phase 2 (Outcome C)

Capacity Building within Outcome D: Solid waste is collected and waste streams are diverted to appropriate disposal sites

Activity D.2.1: Locations of reception centres in SA 2-6 are identified

The focus of the capacity building is to help identify the most appropriate locations in SA 2-6 for additional waste reception centers for potential additional WtE plants. This capacity building component will include a detailed technical assessment study to identify the most appropriate location, design and function of waste reception centers in SA 2-6.

Activity D.2.3: Transport to these reception centers is ensured

This capacity building component will include knowledge transfer and training of stakeholders in charge of the transportation of waste to the reception centers. This capacity building should be provided by local consultants to the private companies in charge of the transportation and should be overseen and coordinated by the CE or IE.

Outcome D under Phase 2 includes the following capacity building components.

NAMA Output	NAMA Activity	Capacity Building components
D.2 Waste is collected in SA 2-6, transported to reception centers and pre-treated	D.2.1 Locationsof reception centers in SA 2-6 are identified	✓ Two Local Technical Advisors ✓ One Technical assessment study ✓ Facilitation of internal working group meetings (2) ✓ One training programme for institutions in charge
	D.2.3 Transport to these reception centers is ensured	✓ Two local Technical Advisors ✓ One training programme for private companies in charge of transportation of waste

Table 32: Capacity building under NAMA Phase 2 (Outcome D)

Capacity Building within Outcome E: Waste-to-Energy is applied

Activity E.2.1: A site is identified and legal requirements fulfilled

The capacity building will help to prepare the technical and legal aspects of implementing the WtE plant in SA 1. This will include support for the institutions involved in contracting and applying the results of the assessment of waste information and feasibility assessment conducted under NAMA Phase 1 (Output E.1) and for the stakeholders involved in the implementation and operation of the plant.

Activity E.3.1: Waste amounts and composition are monitored at reception centers

The capacity building is directed to the IE and the operators of the reception centers. The capacity building components should ensure that the measurement and reporting procedures that are required under the NAMA are properly applied at the reception centers. This will include support in setting up, implementing and operating the MRV systems.

Activity E.3.2: Feasibility studies of different WtE technologies are undertaken (RDF, big incinerators)

Within this capacity building component anin-depth feasibility assessments of different potential WtE technologies will be conducted. The feasibility studies will increase the level of knowledge about WtE opportunities in Lebanon, their technical and economic potential and the required size and location of such technologies. This in turn is considered a pre-condition for the private sector to invest in WtE technologies in Lebanon and/or to attract the private sector into PPP agreements for the operation and maintenance of those technologies.

Outcome E under Phase 2 includes the following capacity building components.

NAMA Output	NAMA Activity	Capacity Building components
E.2 WtE plant (incinerator) in SA 1 is erected, operational and feeds power into the grid	E.2.1 A site is identified and legal requirements fulfilled	✓ Two Local Technical/Legal Advisors ✓ Two International Technical/Legal Advisors ✓ Facilitation of internal working group meeting (1) ✓ Two training programmes for stakeholders
E.3 Further WtE potential is assessed in all Lebanon	E.3.1 Waste amounts and composition are monitored at reception centers	✓ Two Local Technical Advisors for the set up ✓ Two Local Technical Advisors per annum ✓ Facilitation of internal working group meeting (1 per annum) ✓ Two training programmes for stakeholders
	E.3.2 Feasibility studies of different WtE technologies	✓ Three Local Technical/Financial Advisors ✓ Two International Technical/Financial Advisors

	are undertaken (RDF, big incinerators)	✓ Facilitation of internal working group meetings (3) ✓ Two training programmes for stakeholders

Table 33: Capacity building under NAMA Phase 2 (Outcome E)

Detailed information about the costs for the capacity building components are included and described in Chapter 7: NAMA Financial Requirements and Mechanisms.

7 NAMA Financial Requirements and Mechanisms

This chapter describes the financial requirements and finance sources for the NAMA. Effective financial mechanisms are needed in order to ensure the long-term success and sustainability of the NAMA in the waste sector in Lebanon. Therefore, financial participation by both national and international stakeholders will be detailed as well as the specific financial instruments to be used to achieve the NAMA outcomes.

7.1 Assessment of Financial Needs for the NAMA

Within this section, the basis for determining the financial needs of the NAMA is presented, including key parameters and inputs to the model. Based on the description of the primary cost components, a summary of total costs is presented in accordance with the general NAMA scope (Outcomes and Outputs) as described in Chapter 5. The perspective of the National Government (and population in affected areas) is taken in this model when determining the costs of the NAMA Activities (both investment costs and operating costs). Where appropriate, the viewpoint of the private sector is also considered.

Cost estimates for capacity building, operation of entities, and consultancy in this NAMA are developed based on current domestic and international labour costs, and specific costs for office budget, workshops and materials. All estimates considered here do not account for the cost of taxes and inflation, and are subject to change due to exchange rates. For infrastructure projects (the interventions), initial investment as well as operation and maintenance (O&M) are determined through available international and domestic sources. Similarly, for all other costs a set-up fee (consisting of investment capital or capacity building) is usually required (typically larger than any subsequent recurring fees). In all cases, O&M (or recurring) costs begin the year following capital expenditure except for the CE and IE, which are operated for the full NAMA timeframe right from the start of Phase 1 (i.e. 2018). Indeed, these key entities must be operational as early as possible to ensure NAMA implementation and monitoring. It is noted that all costs are estimated in 2016 U.S. Dollars (USD).

As was detailed in Chapter 5, the individual measures and interventions will be delivered by means of a series of key Activities, either of the capacity building, technology or finance type. Capacity building among stakeholders, as well as developing financial and regulatory processes, is vital to ensure NAMA objectives are met. Table 34 presents expected costs to this NAMA for capacity building activities, with a total of USD 4.7 million over NAMA Phases 1 and 2 (2018-2030).[3] When taking into account Step 0 (not part of the NAMA and implemented before the NAMA start – see Chapter 5), it is evident that a particular emphasis in capacity building is placed on feasibility studies and environmental impact assessments for the waste management infrastructure to be built, in particular the LFG collection and WtE facility. The management entities referred to represent the CE, the IE as well as the Financing Facility (see Section 7.2.4), and capacity building funds targeted towards these entities aim to support their establishment. The costs of operating these entities are provided by other sources (see Section 7.2.1).

[3] Note that for Activities started within Phase 1 but extending into Phase 2 as well, all costs will be accounted for fully within Phase 1 (see timeline of NAMA Activities in Section 8.4).

Capacity Building Activities	Phase 0	Phase 1	Phase 2	Total
Preparatory assessments and feasibility studies (prior to NAMA start)	USD 730,000			**USD 730,000**
Management Entities Established and Operated		USD 222,000	USD 0	**USD 222,000**
Mechanisms for Establishing & Implementing Policies, Laws, Regulations, and MRV		USD 926,000	USD 353,000	**USD 1,279,000**
Feasibility Studies and Assessments (within the NAMA)		USD 472,000	USD 694,000	**USD 1,166,000**
Stakeholder Education, Marketing and Awareness Building		USD 120,000	USD 1,459,000	**USD 1,579,000**
Technical, Legal & Advisory Support for Waste Management Infrastructure Implementation		USD 70,000	USD 336,000	**USD 406,000**
Total (not including Phase 0)		**USD 1,810,000**	**USD 2,842,000**	**USD 4,652,000**

Table 34: Total costs for capacity building for the waste sector NAMA in Step 0, Phase 1 and Phase 2

The most significant expenses for this NAMA, however, result from the activities related to the technical interventions including the engineering, procurement, construction and operation of the waste sector infrastructure. In order to facilitate the implementation of these interventions, and alleviate the burden on the NAMA of evaluating their potential and viability, several key assessment studies and impact assessments are targeted in Step 0 (2016-2017, i.e. beforethe start of the NAMA). These include technical, social and policy analyses and will form the basis from which launch the NAMA interventions. As presented in Table 34, the costs of these studies will amount to USD 730,000 over the two-year preparatory period. As outside of the NAMA scope, this cost will not be included in the NAMA financials presented in this chapter.

When launched, the NAMA will support the implementation of several solid waste management and treatment facilities. The quantities and total investment of each of these key Activities are indicated in Table 35 below and are represented by the NAMA Phase in which they occur. The specific business models for each project will be dealt with in Section 7.2.3.

Landfill gas collection and utilization systems:

In NAMA Phase 1, flaring of LFG will be implemented at the Srar and Hbaline dumpsites, whereas LFG collection will be deployed for power generation at Tripoli and Zahle sites. The total investment required for these four facilities over the NAMA timeframe is inferred based on the calculated emission reduction potential of each site as well as investment and O&M costs for validated LFG projects under CDM with a similar scope (see Annex 5: Cost Estimates for Landfill Gas Collection and Utilization). With capital / investment expenditure occurring in 2018 and 2019 to implement the LFG collection systems, and operation running between 2019 through 2030, these four initial facilities will require a total of USD 5,400,000 in investment capital, and USD 9,840,000 in operating costs (total of USD 15,240,000). The operating costs for these sites do not account for the revenue potential from electricity sales.

In NAMA Phase 2, the additional landfill sites to be selected for implementation of flaring (3 sites) and power generation (1 site) will achieve fewer emission reductions in comparison to Phase 1, as the most attractive sites for GHG mitigation are included in Phase 1 already. As the sites under Phase 2 are expected to be of smaller scale as well as having a shorter operation time within the NAMA timeframe (2023-2030) due to their later start, the four additional LFG systems are expected to require USD 1,300,000 in investment capital, and USD 1,281,000 in operating costs between 2023 and 2030 (total cost of USD 2,581,000). Similarly, as above, the operating costs for these sites do not account for the revenue potential from electricity sales.

Reception centers and pre-treatment facility:

In Phase 1, existing reception centers will be used in SA 1.

In NAMA Phase 2 new basic reception facilities will be implemented in the rest of the country. Due to the uncertain scope of this specific intervention, at this time, it is estimated that 5 reception centers (one per SA) are included in the costs for a total amount of USD 4,000,000 in investment capital, and USD 1,400,000 in operating costs between 2023 and 2030 (total cost of USD 5,400,000). The cost of transporting collected waste to these reception centers is not included in the operating costs as these costs are incurred by waste collection companies in Lebanon and are therefore considered outside of the NAMA scope.

Also in Phase 2, one showcase pre-treatment facility will be set up (see Section 5.3.2) to test recycling and composting of household and garden waste. Due to current uncertainties about the specific operating parameters of this facility, costs were estimated based on existing facilities in Lebanon as well as in Europe. For a mechanical pre-treatment facility - including sorting, recycling and compositing - with an estimated annual capacity of 80,000 tonnes of treated waste, the capital expenditure required amounts to USD 4,000,000 and operating costs to USD 9,600,000 between 2024 and 2030 (total of USD 13,600,000)[4]. The operating cost for this plant does not include any revenue from sales of treated waste.

Waste-to-Energy facility:

With one planned WtE facility serving the Beirut and Mount Lebanon region, the costs of engineering, procurement, construction and operation represent the single largest expense of this NAMA. A PPP model is envisioned to be applied to implement this intervention. For an expected annual capacity of 590,000 tonnes of waste, capital investment expenditure for the plant (activated over the 2022-2024 timeframe) amounts to USD 500,000,000. From the start of operation in 2025 through 2030, total operational costs will amount to USD 282,000,000. This includes revenues from electricity sales, finance costs (loan interest), return on equity and normal O&M.[5] The table below summarizes the estimated total costs (investment and O&M) for the technical interventions for the full NAMA period (2018-2030). It should be noted, that figures for NAMA Phase 2 are represented for indicative purposes only.

[4] Note that a CAPEX of USD 50 per unit of capacity (t/yr) was estimated based on completed EU funded facilities in Lebanon (various projects, including Assistance to the Rehabilitation of the Lebanese Administration, SWAM I, SWAM II). Furthermore, a lifetime cost of 25 USD/(t/yr) was taken from (Arina, Klavenieks, & Burlakovs, 2014).

[5] Note that the CAPEX and OPEX costs are taken from (CDR, 2012) and the financial analysis is performed by the authors of this document. With main assumptions including an investment source breakdown of Grants – 2%, Private Equity – 28%, and Loan – 70%. The loan is expected to be applied in a phased approach with backend refinancing, with a three-year grace period during construction, ten-year payback, and 8% interest rate. The interest rate includes an international credit guarantee and commercial fees. The financial analysis cost basis does not take into account depreciation, taxes, or duties.

Activities	Total No. Phase 1	Total No. Phase 2	Investment Cost	Operation Cost
Landfill Gas Collection Systems Implemented and Operated	4	4	USD 6,700,000	USD 11,121,000
New Reception Centers Identified and Implemented and Operated	0	5	USD 4,000,000	USD 1,400,000
Showcase Pre-Treatment Facility Implemented and Operated	0	1	USD 4,000,000	USD 9,600,000
Waste-to-Energy Facility Implemented and Operated	0	1	USD 500,000,000	USD 282,000,000
			USD 514,700,000	**USD 304,121,000**

Table 35: Total estimated costs for infrastructure projects throughout Phase 1 and Phase 2 of the NAMA (2018-2030)

With these cost inputs defined, a summary of the estimated total NAMA costs is presented in the table below. For each of the NAMA Outcomes and Outputs the total estimated cost is presented over the complete NAMA timeframe (2018-2030). The preliminary Step 0 is also represented (2016-2017).

		Total	Domestic	International
Step 0: Preparatory steps/assessments (prior to the NAMA start)				
TOTAL - Cash Flow Preparatory steps/assessments		730,000	730,000	-
Outcome A	Institutional framework for waste management is established			
Output A.1	A Coordinating Entity (CE) and Implementing Entity (IE) are implemented and operating	6,285,000	6,030,000	255,000
Output A.2	NAMA Finance Facility is implemented and operating	160,000	90,000	70,000
Output A.3	Awareness creation and related activities	1,769,000	230,000	1,539,000
TOTAL - Cash Flow: Outcome A		8,214,000	6,350,000	1,864,000
Outcome B	Regulatory framework for Municipal Solid Waste (MSW) Management is established			
Output B.1	Relevant laws tackling Integrated Solid Waste Management (ISWM) Law are enacted, including Measuring, Reporting and Verification (MRV) and raise of domestic finance	539,000	-	539,000
Output B.2	Regulatory framework for Landfill Gas (LFG) collection and utilization is enacted	103,000	-	103,000
TOTAL - Cash Flow: Outcome B		642,000	-	642,000
Outcome C	Landfill Gas is collected and utilized or flared			
Output C.1	Gas collection at landfills and open dumps is installed at 4 identified sites, gas is flared or power produced	15,252,000	9,840,000	5,412,000
Output C.2	Gas collection at landfills and open dumps is prepared and installed at 4 additional sites, gas is flared or power produced	2,953,000	1,281,000	1,672,000
TOTAL - Cash Flow: Outcome C		18,205,000	11,121,000	7,084,000
Outcome D	Solid waste is collected and waste streams are diverted to appropriate disposal sites			
Output D.1	Waste is collected in Service Area 1, transported to reception centers and pre-treated	113,000	55,000	58,000
Output D.2	Waste is collected in Service Areas 2-6, transported to reception centers and pre-treated	19,176,000	11,015,000	8,161,000
TOTAL - Cash Flow: Outcome D		19,289,000	11,070,000	8,219,000
Outcome E	Waste-to-Energy is applied			
Output E.1	Waste-to-energy (WtE) potential is assessed in Service Area 1	735,500	82,500	653,000
Output E.2	Waste-to-energy (WtE) plant (incinerator) in Service Area 1 is erected, operational and feeds power into the grid	432,203,000	422,000,000	10,203,000
Output E.3	Further Waste-to-energy (WtE) potential is assessed in all Lebanon	927,000	240,000	687,000
TOTAL - Cash Flow: Outcome E		433,865,500	422,322,500	11,543,000
TOTAL - Cash Flow: ALL NAMA (excluding preparatory phase)		480,215,500	450,863,500	29,352,000

Table 36: Summary cost assessment based on NAMA Outputs and Outcomes

A more detailed table with all costs per Activity under the NAMA, is presented in Annex 7: Detailed NAMA Cost Assessment. The distinction between domestic and international financing will be discussed at length in the following sections.

7.1.1 GHG Mitigation Costs

Based on the total investment and operation costs required for infrastructure and the expected emission reductions of those interventions, the mitigation costs of the LFG and WtE interventions can be calculated for both NAMA Phases. The results indicated below reflect the NAMA-specific mitigation costs and do not represent mitigation costs over the entire project lifetime.

NAMA Phase 1:

For Output C.1 (Gas collection at landfills and open dumps is installed at 4 identified sites, gas is flared or power produced), Chapter 4 presented the emission reduction potential for the 4 facilities over the 2018-2021 timeframe, totaling 620,000 $tCO_{2\text{-}eq}$. In association with total costs (investment and operation) of USD 7,860,000 over the same period, the expected mitigation cost can be evaluated at 12.7 USD/ $tCO_{2\text{-}eq}$.[6] This value is an initial indicator of the financial viability of the NAMA as it lies at the lower end of the typical marginal abatement costs spectrum when comparing with alternative projects such as PV or wind (McKinsey & Company, 2010). Furthermore, when considering the mitigation cost of these facilities for the full duration of the NAMA (2018-2030), the abatement cost drops to approximately 7.7 USD/$tCO_{2\text{-}eq}$ (1,990,000 $tCO_{2\text{-}eq}$ emission reductions and USD 15,240,000 in total investment).[7]

NAMA Phase 2:

For Output C.2 (Gas collection at landfills and open dumps is prepared and installed at 4 additional sites, gas is flared or power produced), Annex 5: Cost Estimates for Landfill Gas Collection and Utilization provides the estimated annual emission reduction potential of each site. Over the 2023-2030 timeframe, indicative total emission reductions amount to160,000 $tCO_{2\text{-}eq}$. Thus, with a total cost (investment and operation) of USD 2,581,000, the mitigation cost can be evaluated at 16.1 USD/ $tCO_{2\text{-}eq}$.

For Output E.2 (One WtE incinerator in SA 1 is erected, operational and feeds power into the grid), emission reductions were estimated over the operating period covered by the NAMA (2025-2030).[8] With emission reductions of 1,430,000 $tCO_{2\text{-}eq}$ and total costs (investment and operation) of USD 782,000,000, the mitigation cost amounts to 546.9 USD/$tCO_{2\text{-}eq}$. It should be noted that the lifetime of the WtE plant is expected to be at least 25-30 years, therefore GHG mitigation will extend well beyond 2030 and the overall mitigation costs - considered over the lifetime - will be considerably lower (i.e. 179.5 USD/$tCO_{2\text{-}eq}$ until 2039 considering 5,940,000 $tCO_{2\text{-}eq}$ and USD 1,066,000,000.

Overall for the 8 LFG collection and utilization plants and the WtE facility over the 2018-2030 timeframe, the GHG mitigation (3,580,000 $tCO_{2\text{-}eq}$) and cost (USD 799,821,000 – see Table 35) combine for a NAMA mitigation cost of 223.4 USD/$tCO_{2\text{-}eq}$.

[6] Abatement costs per site for Phase 1 are (in USD/$tCO_{2\text{-}eq}$): Zahle, 22.4; Tripoli, 19.5; Hbaline, 11.7; and Srar, 5.3.
[7] Abatement costs per site for entire NAMA are (in USD/$tCO_{2\text{-}eq}$): Zahle, 12.2; Tripoli, 12.5; Hbaline, 6.7; and Srar, 3.1.
[8] A lifetime of 30 years is considered for the facility and emission reduction calculations are based on 590,000 tonnes of waste incinerated annually. Furthermore, waste is not considered to be sorted beforeentering the incinerator. Without the WtE facility, waste would otherwise be disposed according to common practice in Lebanon, i.e. in a sanitary landfill without gas collection.

7.2 National and International Finance: Sources and Distribution Mechanisms

The waste sector NAMA is a co-financed effort between international and domestic financial sources. The purpose of this design is to construct a robust, reliable and transparent financial framework that addresses the needs of the different NAMA Phases while ultimately enabling the transformational change expected from the NAMA. The financial system presented here accounts for all the costs of supporting the execution of these individual Activities and provides tools to secure the needed funds and distribute them as appropriate.

In Table 37, the allocation per phase of the two broad financing streams for the NAMA is indicated. The NAMA Phase 1 funding will be a combination of grant support from International Support Partners and allocations from the National Government Budget in order to build up waste sector capabilities in Lebanon. Due to the current crisis in this sector, deriving financially viable business opportunities for the private sector in the next 5 years will remain a challenge. Therefore, NAMA Phase 1 will ensure the establishment of an enabling environment for significant private sector contributions. Thus, financial participation (i.e. direct investments) of private entities is not expected before NAMA Phase 2. Throughout Phase 2, revenue-generating mechanisms for the National Government are expected to be launched, providing an income stream to support National Government Budget disbursements and ensure the sustainable management of the waste sector.

Funding Source	Phase 1 (2018-2021)	Phase 2 (2022-2030)
Domestic	National Government Budget	National Government Budget, Private Sector (Equity)
International	International Support Partners (Grants)	International Support Partners (Grants), International Support (Loan/Credit Guarantee)

Table 37: Overview of funding sources for each phase of the NAMA

7.2.1 National Government Support

The National Government of Lebanon and all relevant ministries and authorities represent the purveyors of national support within the context of this NAMA. In the NAMA Phases 1 and 2, different approaches will be implemented from a domestic finance point of view due to the difference in the NAMA Outcomes described earlier in this document.

Currently, domestic funds for the waste sector in Lebanon come from the country's national budget, from the Independent Municipal Fund as well as municipal budgets. In the short-term, until 2021, the approach calls for drawing on this existing pool of funds to support, through the National Budget, the operation costs of the key NAMA institutions (CE and IE) as well as the operation costs of the LFG collection plants launching in 2019. In addition, smaller allocations will also be required in Phase 1 for operation of reception centers and to run a pilot marketing and public information campaign to highlight the improvements and benefits of SWM. All these costs represent operating expenses only and will be funded solely by National Government Support. This will help alleviate the difficulties anticipated in soliciting the private sector to run the required facilities independently in Phase 1.

To support the broader ambition of Phase 2 (2022-2030), several tax mechanisms will be legally implemented to generate revenue and guarantee the sustainable management of Lebanon's SWM sector (see Table 38). Collected and disbursed by the National Government, these funds will support the continued and expanded operation of Phase 1 Activities mentioned above, as well as the newly implemented reception centers and a showcase pre-treatment facility. The instruments under

consideration would be built on the public sector budget and then made available to fund both public and private sector activities. Many of the policies and regulatory frameworks needed to secure and distribute these funds currently do not exist and, therefore, capacity building support for their development before Phase 2 is included in the NAMA (see Section 7.2.2).

Instrument	Description
General taxation	The most powerful instrument to support the national finance component in Phase 2 of the NAMA will probably be national-level taxes imposed on private individuals and businesses. The purpose of this taxation will be to support a tipping-fee system paid to private sector companies implementing the NAMA interventions. The taxes collected will be allocated to municipalities for disbursement to the private sector, but it is also planned that these funds help support the operating budget of the CE and IE. Tipping fees may also be partially funded by International Support Partners to lower the effective cost to the population. Furthermore, the amount of the fee will be scaled based on the type of waste treated, where segregated waste would, for instance, pay a lower tipping fee.
Green tax	Currently, private producers do not have the right to feed their electricity directly to the grid. However, a change in legislation could enable such a mechanism for the NAMA Phase 2. A green tax will be imposed on all electricity generated and delivered to the national grid in Lebanon to raise funds for an electricity feed-in tariff. The subsidy could then be applied for grid connected and non-grid connected electricity generation from waste-derived sources. Furthermore, the tax collected could also support related Activities, including assessing the potential of WtE technologies by monitoring waste amounts and composition at reception centers. In order to alleviate the burden on power producers, these entities may transfer the costs of the tax downstream to private individuals and businesses.
Fines	Starting in NAMA Phase 2, fines will be imposed and enforced on private individuals, businesses and industry for illegal dumping of waste. These fines will guarantee a revenue stream, which may, through collection by the National Government, help in managing the pilot marketing and public awareness campaign. The fines will be equal to or greater in value than the costs of waste disposal (for example greater than tipping fees) and will have the added benefit of promoting the SWM programme by dis-incentivizing abuses.

Table 38: Taxation and fines to be implemented by the National Government

Table 39 presents a summary of the costs incurred by the National Government for the implementation of NAMA Activities from 2018 until 2030. The groups of Activities highlighted in the table only reflect the components of the NAMA supported by the National Government. In Phase 1,[9] USD 16.3 million will be allocated, whereas in Phase 2, with the help of revenue generation from taxation and fines, USD 294.5 million will be injected into the public and private sectors to support the implementation of NAMA Activities. Overall, the National Contribution to the NAMA, from a public sector viewpoint, amounts to

[9] Note that for Activities started within Phase 1 but extending into Phase 2, all costs are accounted for fully within Phase 1.

USD 310.9 million. It should be noted that the NAMA Phase 2 costs are provided for indicative purposes only.

Type	Phase 1	Phase 2	Total
Support for Entity Operation Costs (CE, IE, Finance Facility)	USD 6,120,000	USD 0	USD 6,120,000
Marketing and Public Information Campaign Operation costs	USD 230,000	USD 0	USD 230,000
LFG Collection Systems Operation Costs	USD 9,840,000	USD 1,281,000	USD 11,121,000
Reception Center Operation Costs	USD 137,500	USD 1,655,000	USD 1,792,500
Showcase Pre-Treatment Facility Operation Costs	USD 0	USD 9,600,000	USD 9,600,000
Waste-to-Energy Facility Operation Costs[10]	USD 0	USD 282,000,000	USD 282,000,000
National Government Total	**USD 16,327,500**	**USD 294,536,000**	**USD 310,863,500**

Table 39: Overview of National Government costs for the waste sector NAMA

7.2.2 International Finance

The definition of international finance encompasses financial flows originating outside of Lebanon and consisting of support from international partners.

Support from international partners is vital for implementation of the NAMA and will be the major source of capacity building funds in Phase 1 and Phase 2. Whether from an institution or a programme, these grants will facilitate training programmes, provide technical and legal consultancy for creating the enabling environment, enable feasibility studies and environmental impact assessments, and launch public awareness as well as education campaigns. A Finance Facility specially set up for this purpose will have the responsibility of managing and disbursing these funds (see Section 7.2.4).

Early-stage support from International Support Partners is particularly essential for this NAMA in order to develop the critical and pressing capabilities needed in the SWM sector. Even though outside the NAMA scope, the assessment studies and impact assessments of Step 0 before the start of the NAMA, can also be funded by International Partners to further benefit the NAMA. Furthermore, international funds will help validate the attractiveness of this sector to outside investors, which in turn will draw in the support needed from the private sector in the second phase of the NAMA.

In addition to knowledge transfer, International Support Partners will be the driving force behind technology and infrastructure improvements under the NAMA. Through grant mechanisms, funding will be provided for the investment costs of LFG collection and utilization in NAMA Phase 1, and of reception centers, one showcase pre-treatment facility, one WtE plant (incinerator) and additional LFG units in NAMA Phase 2. The grant towards the implementation of the incinerator (2% of plant capital expenditure) - allocated via the Grant Subsidy Scheme (see Section 7.2.4) - will serve to reduce equity risk and lower the loan requirements of this intervention. All these capital investments are also to be allocated via the NAMA Finance Facility.

[10] See explanation in Section 7.1

An additional and significant pillar of International Support Partner involvement in Phase 2 will be through its role as purveyor of loan guarantees to the private entities or special purpose company managing the WtE installation. Indeed, it is anticipated that debt financing will account for about 70% of the technical interventions and be provided, based on an expected credit guarantee from international support, by commercial banks. The loan itself is outside the scope of this NAMA, however it is to be paid back over a 10-year time frame and at estimated 8% interest. This interest rate includes the expected cost of the credit guarantee incurred by the International Support Partner.

Table 40 presents a summary of costs incurred by International Support Partners throughout the NAMA. The groups of Activities shown, only reflect the components of the NAMA supported by these partners and are categorized according to their type. In Phase 1,[11] funds for capacity building account for 25% of total international finance, whereas, due to increased support for capital expenditure in Phase 2, this ratio decreases to 13%. Altogether, support from International Partners is expected to amount to USD 29.4 million from 2018 to 2030. It should be noted that in the table below, the costs for the NAMA Phase 2 are provided for indicative purposes only.

	Type	Phase 1	Phase 2	Total
Capacity Building Grants	Support for entity development (CE, IE, Finance Facility)	USD 222,000	USD 0	USD 222,000
	Mechanisms for Establishing & Implementing Policies, Laws, Regulations, and MRV	USD 926,000	USD 353,000	USD 1,279,000
	Feasibility Studies and Assessments (within the NAMA)	USD 472,000	USD 694,000	USD 1,166,000
	Stakeholder Education, Marketing and Awareness Building	USD 120,000	USD 1,459,000	USD 1,579,000
	Technical, Legal & Advisory Support for Waste Management Infrastructure Implementation	USD 70,000	USD 336,000	USD 406,000
	Sum of Capacity Building Grants	**USD 1,810,000**	**USD 2,842,000**	**USD 4,652,000**
Finance & Technology Grants	LFG Collection Systems Engineering and Investment Costs	USD 5,400,000	USD 1,300,000	USD 6,700,000
	Reception Center Investment Costs	USD 0	USD 4,000,000	USD 4,000,000
	Showcase Pre-Treatment Facility Investment Costs	USD 0	USD 4,000,000	USD 4,000,000
	Waste-to-Energy Facility Investment Costs	USD 0	USD 10,000,000	USD 10,000,000
	Sum of Finance & Technology Grants	**USD 5,400,000**	**USD 19,300,000**	**USD 24,700,000**
Guarantee	Waste-to-Energy Facility Investment Costs	USD 0	**Included in the loan interest rate**	**Included in the loan interest rate**
	Sum of Loan/Credit Guarantee[12]	**USD 0**	**Included in the loan interest rate**	**Included in the loan interest rate**
	Total	**USD 7,210,000**	**USD 22,142,000**	**USD 29,352,000**

Table 40: Overview of costs to International Support Partners in the waste sector NAMA

[11] Note that for Activities started within Phase 1 but extending into Phase 2 as well, all costs are fully accounted for within Phase 1.

[12] Note that the credit guarantee is expected to be in the magnitude of USD 350,000,000, however the cost of this guarantee is factored into the annual interest rate of the loan. The credit guarantee cost is expected to be 2-3% of the total 8% loan interest.

7.2.3 Private Sector

The national private sector has been intimately involved in the waste sector in Lebanon and its role will continue to be strengthened through PPP agreements in this NAMA. Indeed, the conditions under which it would be economically feasible for the private sector to manage and operate the technical facilities without public support remain uncertain. As a result, capacity building efforts in the NAMA Phase 1 will support the development of the regulatory, technical and financial basis needed for private sector players to engage in PPP agreements and IPP business models.

The PPP business model forms the foundation of the NAMA interventions for (1) LFG collection and utilization, (2) reception centers, (3) pre-treatment facility and (4) the WtE plant. A PPP business model (see

Annex 6: Overview of Public Private Partnership models) consists of the operation of the ventures as private businesses. The model is established where the private sector has adequate incentives to operate and where the GoL wishes a more experienced party to handle the intervention activities in a cost effective way.

Under a PPP for LFG collection and utilization, for reception centers, and for the pre-treatment facility, the municipal or national government has the title/ownership of the land and waste assets (collection and distribution system), and the private party would operate, maintain, and manage the technical facilities as a contracted service for the municipal or national government. In this manner, the private party would have:

1) The mandate and/or concession to collect and utilize LFG or sort waste; and

2) The right to collect service fees from the municipal or national government.

Under a PPP for the WtE plant, the municipal or national government has the title / ownership of the land and waste assets (collection and distribution system), and the private party would enter into a concessionary agreement to finance and design-build-operate-maintain (DBOM) the plant under an IPP framework agreement. The private party would have:

1) The concessionary right to use land provided by the municipal or national government;

2) The first right to treat a pre-defined amount of waste (based on net calorific value) under a tipping fee; and

3) The PPA signed for guaranteed offtake of exported electricity with a specific renewable energy Feed-in-Tariff.

With the basis for PPP business models established following NAMA Phase 1, private sector entities or special purpose vehicles will be enabled to operate key waste sector infrastructure in NAMA Phase 2, namely the WtE facility in Service Area 1. In this case, the private sector will provide an equity stake amounting to 28% of capital expenditure for this plant as shown in Table 41. For illustrative purposes, the breakdown of the remaining 72% is also highlighted.[13]

Type	Phase 1	Phase 2	Total
Private Sector Equity for Waste-to-Energy Facility Investment Costs	USD 0	USD 140,000,000	USD 140,000,000
International Support Partner Grant for Waste-to-Energy Facility Investment Costs	USD 0	USD 10,000,000	USD 10,000,000
Loan (credit guarantee) for Waste-to-Energy Facility Investment Costs	USD 0	USD 350,000,000	USD 350,000,000
Total Investment Cost for Waste-to-Energy Facility	**USD 0**	**USD 500,000,000**	**USD 500,000,000**

Table 41: Overview of investment costs for the WtE facility, including private sector equity

[13] As detailed in Section 7.2.2, the remainder of the capital expenditure is sourced as follows: 2% grant from international support partners and 70% loan from commercial banks with loan guarantees provided by international support partners.

A number of additional mechanisms are considered by the National Government to directly support private sector finance needs. These could include the provision of loans to and investments in private sector companies seeking to operate and own waste management infrastructure.

- A loan credit guarantee and soft loan mechanism could be established within the Loan Facility to provide credit for private companies to institute the interventions under the NAMA. This facility would be designed in a way to be expanded through injection of additional non-NAMA finance.

- A national investment facility could be implemented as another option to provide public finance to private sector companies instituting the interventions under the NAMA. This facility would provide partial equity (up to 50%) into special purpose vehicles (SPVs) and the private companies would then be required to buy out the state's share within a specified time frame (typically 3 to 7 years).

7.2.4 Financial Distribution Mechanisms

For NAMA implementation purposes, the CE will be the responsible party for coordination and enabling of private sector and international involvement. This entity will be established in Phase 1 of the NAMA and operated throughout the end of Phase 2 with an operating budget allocated by National Government grants (covered in Phase 2 by taxes collected). It is assumed that the MOE would fill this role by formulating a working group consisting of 3 full-time staff.

Similarly, the IE will be established in the NAMA Phase 1 and be operated through the end of NAMA Phase 2 with National Government Budget allocations (covered in Phase 2 by taxes collected). The specific role of this entity is different, as it will oversee the implementation of the NAMA Activities and measure the progress of the NAMA.

Despite their central roles in the NAMA management system, the CE and IE are not legally entitled to manage funds and thus allocation and distribution of finance will be the responsibility of the national government. For this reason, a NAMA Finance Facility will be established to financially support the interventions leading to GHG mitigation. While the Trustee of this Facility is yet to be determined, it will oversee the Grant Subsidy Scheme, the Loan Facility and the Capacity Development Grants. This means that the Trustee physically allocates and directs the transfer of funds (to government institutions, consultants, contractors, operators of facilities, and/or banking institutions), based on direction from the NAMA CE. Grant Subsidies and Capacity Building Grants are granted by one or more International Support Partners, whereas the Loan Facility will be supported by both International Support Partners and national funds (see Section 8.1.3, NAMA Finance Facility). The purpose of each is as follows.

The **Loan Facility scheme** will provide credit guarantees in order to secure the needed loan for the waste incinerator (WtE plant) in the NAMA Phase 2 and may also be expanded in this phase to finance other interventions, typically through soft loans with low interest rates.

The **Grant Subsidy Scheme** would provide a fixed grant of capital for the WtE based intervention to contribute to lowering the risk of equity as well as lower interest rates on the finance loan.

Capacity Building Grants are designed to contribute to the costs of proving the Institutional and Sectoral Capacity Development.

In addition to the CE, IE, Finance Facility, National Government and International Support Partners, the remaining stakeholders of the waste sector NAMA are represented in the proposed flow chart in Figure 15. This overview presents the disbursement of grants (solid red lines) via the NFF for Phase 1 and Phase 2 Activities as well as financial flows and income streams for the National Government Budget (solid blue lines). Furthermore, the additional financial mechanism considered (National Investment Facility) for Phase 2 is also represented, with its intended purpose.

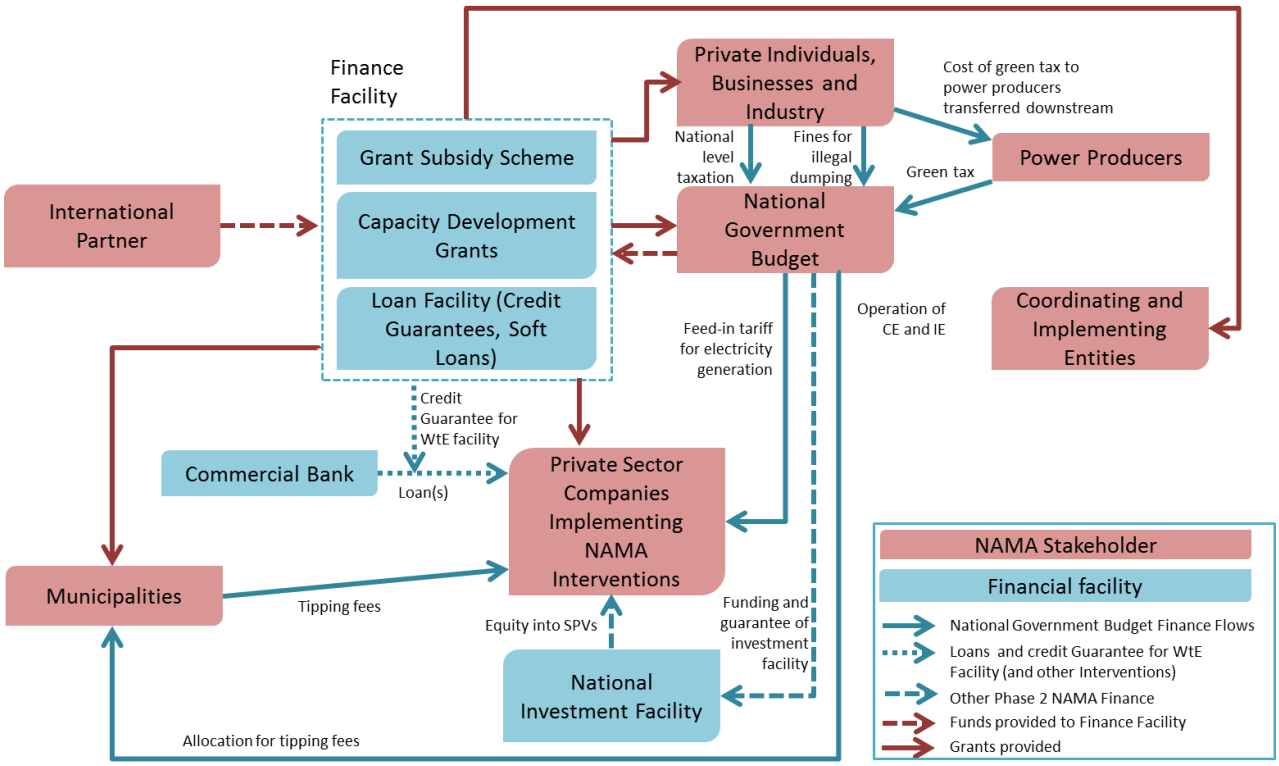


Figure 15: Financial flows for the waste sector NAMA

As evidenced by this diagram, the NAMA financial flows include revenue generation for the National Budget (through private individuals, businesses, industry and power producers), funding for the NFF (by International Support Partners and the National Budget), as well as specific financing mechanisms (loan credit guarantees for WtE facility, tipping fees, feed-in tariffs).

7.2.5 Financing Needs

The estimated financial needs for the NAMA Phase 1 (taking into account the assumptions made) correspond to the minimum financing necessary to enable the NAMA to be launched. Due to the limited information available, the figures for the NAMA Phase 2 are at this point provided for indicative purposes only.

Based on the co-financing model described in the chapters above, a detailed representation of the full costs of the NAMA can be found in Annex 7: Detailed NAMA Cost Assessment). Table 42, below, presents a summary of this assessment in the form of a breakdown of funds needed among international and national sources. In NAMA Phase 1, grants from International Support Partners and allocations from the National Government will be deployed to achieve the planned NAMA Outcomes and Outputs, leading to a total requirement of USD 23.5 million and a National Government co-financing ratio of 69%. Such a distribution will ensure significant involvement from the GOL in this Phase 1 while maximizing support from International Partners.[14]

In NAMA Phase 2, the implementation of a WtE facility will drive the majority of the costs. Private sector involvement in the form of equity and National Government support for plant operation costs will kick in to fund (starting 2022) and operate (starting 2025) this plant. The indicative financial requirements of this NAMA Phase 2 amount to USD 456.7 million, bringing the total expected financial need of the full scope of the NAMA to USD 480.2 million. These estimates do not account for discounting, inflation, and

[14] Note that for Activities started within Phase 1 but extending into Phase 2 as well, all costs are fully accounted for within Phase 1.

adjustments for foreign exchange fluctuations or taxation applied to the values. For the figures in the table below it should be noted that for Activities starting within NAMA Phase 1, but whose operation extends into NAMA Phase 2, all costs are fully accounted for within NAMA Phase 1. Adjustments will need to be made accordingly.

Type	Phase 1	Phase 2	Total
National Government Budget[15]	USD 16,327,500	USD 294,536,000	**USD 310,863,500**
National Private Sector Equity Investment	USD 0	USD 140,000,000	**USD 140,000,000**
International Support Partners (Grants)	USD 7,210,000	USD 22,142,000	**USD 29,352,000**
Total Expenditures	**USD 23,537,500**	**USD 456,678,000**	**USD 480,215,500**
National Government Co-Financing	69%	64%	
Additional: International Support Partners – Loan/Credit Guarantees	USD 0	USD 350,000,000	**350,000,000**

Table 42: Cost breakdown by financing source for the waste sector NAMA

At this point, the critical barrier to the viability of this NAMA is the ability of the National Government to secure the funding needed in NAMA Phase 1 for the allocation of the grants planned. Analysis of the waste sector in Lebanon reveals a complex system where financing flows are unsystematic and difficult to ensure in the longterm. Without this National Government involvement, however, the co-financing would be at risk, as this would reduce the likelihood of securing support from International Partners.

[15] As a reminder, National Government Budget includes operating costs in terms of required tipping fees, renewable energy power tariffs, etc. to operate the interventions under the NAMA in the time period.

8 NAMA Implementation Structure

In order to understand the mechanisms and plans for implementation of the NAMA, an implementation pathway has been developed that adequately takes into account the current situation in the SWM sector in Lebanon and the practical needs and requirements for management, governance and the establishment of the interventions and measures under the NAMA.

NAMAs are important instruments for translating GHG mitigation targets into concrete actions. The concrete actions (interventions and measures) outlined in this NAMA must not only be aligned to national and sectoral policies and strategies, but they must also be implemented and coordinated by an organization(s) with sufficient legal and regulatory authority to ensure that the activities are fully integrated, coordinated, and carried out. As in all modern governments, authorities and responsibilities are functionally and structurally delegated to various ministries and organizations based on the Constitution and the government's executive and legislative laws, orders, and decrees. Identifying the most appropriate governance and management structure is a critical task at the very beginning of the NAMA planning process.

8.1 Key Institutions and Implementing Partners

The management structure and the key institutions for the NAMA are based on the existing stakeholders in the SWM sector in Lebanon (see Section 2.2 for further description of stakeholders currently involved). For the purposes of this NAMA, management and governance is split between two distinct organizations, the CE and the IE. The respective responsibilities of each of these two organizations are outlined below.

The two key Ministries for taking on an exceptional role under the NAMA in the SWM sector are the MOE, which is supposed to host the NAMA CE and the MOF, responsible for coordinating and overseeing the overall financing allocation within the NAMA and hosting the NFF. Due to their extensive experience of the SWM sector, it is recommended that the offices of OMSAR and CDR take an important role in the implementation of the NAMA. They should take on the role of the NAMA IE.

Other key stakeholders on the national level are the municipalities, where the LFG capturing, the waste management and sorting, the reception centers and the WtE plant will be implemented and operated. Further to that the BDL is expected to play an important role in the financing of the NAMA through the provision of loans to private sector participants.

8.1.1 Coordinating Entity

The CE is expected to be organized within the MOE. An office with a functional staff, a working group of relevant inter-ministerial contacts and a secretariat for the coordination of activities under the NAMA are anticipated. The working group should consist of persons from the relevant Departments of key Ministries (e.g. MoE and MoF), the OMSAR, the CDR, and qualified civil society groups. A broad based membership is expected to help build and maintain confidence in the national solid waste sector. The secretariat can be the CCCU or another unit from MoE. The CE will hold the mandate to:

- Develop, implement and oversee NAMA strategy and planning;
- Coordinate all international support;
- Coordinate and facilitate government finance mechanisms;
- Facilitate actions encouraging private sector involvement;
- Coordinate capacity development activities;
- Facilitate actions encouraging policy and regulation changes;
- Oversee and coordinate the implementation of MRV processes;
- Linking of NAMA MRV with national/international required MRV (NC, BUR, INDC).

8.1.2 Implementing Entity

The IE is not defined at this point in time, but given past actions and the current situation of the SWM sector in Lebanon, it appears that responsibilities for the IE may be split based on functional requirements. The specific tasks of the IE need to be further defined together with the CE and respective stakeholders of the NAMA. Currently the tasks of the IE are considered to include i.e the following:

- Provide technical inputs into the decision-making process (e.g. for developing the inventive scheme);
- Apply and ensure consideration of policies and regulatory changes;
- Ensure the support of and control the physical implementation of the technical interventions under the NAMA (LFG utilization and WtE);
- Manage the procurement process for the interventions;
- Coordinate and mediate between the Government and the private sector;
- Facilitate knowledge transfer between the different involved institutions (Government, municipalities, private sector, other stakeholders);
- Support the MRV of the NAMA as link between the operators and the Coordinating Entity.

It is currently expected that the tasks are split between the MOE, the OMSAR and the CDR. The MOE will focus on the implementation of policies and regulatory changes, coordinate and mediate as link between the GOL and the implementing entities and initiate knowledge transfer and MRV coordination (e.g. by hosting the MRV database), whereas the OMSAR will ensure the support and control of the physical implementation of technical interventions and provide technical inputs and knowledge transfer. The CDR will be responsible for managing and coordinating the procurement process of interventions.

8.1.3 Financial Trustee of the Finance Facility

The Financial Trustee is to execute and manage the NFF, which includes the Grant Subsidy Scheme and NAMA Loan Facility. The Financial Trustee has a critical role in this NAMA of financial oversight of the capital used within the NAMA activities. This means that the Trustee physically allocates and directs the transfer of funds (to government institutions, consultants, contractors, operators of facilities, and/or banking institutions), based on direction from the NAMA CE. A reliable Trustee must be determined at the start of the NAMA. The Trustee should be incentivized through: (1) a primary mandate to ensure sustainable development and operations under an international standard of practice, and (2) be allocated funds to support the functions of the Financial Trustee. The Trustee shall have a mandate originating from the GOL and International Support Partners, be seen as acting on their behalf, and shall be evaluated at least annually and notified of any shortcomings by the NAMA CE. It is noted that the Trustee may be an International Support Partner, or a banking institution. There are a number of organizations who have the capability and capacities to act as the Financial Trustee in the context of this NAMA.

The Financial Trustee will need to structure the investment agreement(s) and would be operational by-laws and interact with each agency/institution that are providing international or national support to the NAMA. In addition, the Trustee shall design eligibility criteria and perform due diligence of private sector businesses (Private Parties) who seek grants and/or loans for operating the ventures under the NAMA. The Financial Trustee will also need to devise a risk mitigation strategy, plus a monitoring and evaluation mechanism for all types of finance instruments and use of funds to be integrated into the NAMA MRV.

8.1.4 Stakeholders Roles and Responsibilities

The recommended institutional structure of the NAMA ensures a strong involvement of national stakeholders to create country ownership and political commitment. It further utilizes existing and experienced entities and organizational systems which are already in place and allow for a prompt and smooth implementation of the NAMA (see existing stakeholders described in Section 2.2). In that way,

the institutional structure supports receiving and allocating domestic and international private and/or public donor finance.

The following table provides an overview of the intended institutions/stakeholders involved in the NAMA with their anticipated roles and responsibilities. It should be noted that Section 7.2.4 includes a more specific overview of stakeholders involved in the financing of the NAMA and Chapter 9 includes an overview of stakeholders involved in the MRV process and how the reporting of information is being conducted among those stakeholders. Therefore, the following table provides a more general overview of involved stakeholders.

Stakeholder/ Institution	Role(s)	Responsibilities	Level
MOE	- Host the CE - Part of the IE	- Host the CE, including the hired personnel - Report to the GOL and the UNFCCC	National (Public)
MOF	- Manage all incoming and outgoing financing for the NAMA	- Support the operating budget of the CE and the IE	National (Public)
CE	- Coordinate stakeholder involvement, including international and private sector	- Coordinate all international support - Coordinate capacity building activities - Coordinate tender processes - Coordinate and facilitate government finance mechanisms -Receive aggregated monitoring data - Create final monitoring reports - Undertake internal QA/QC procedures	National (Public)
IE	- Coordinate the NAMA implementation	- Oversee the implementation of NAMA interventions and implementation of policies and regulatory changes - Coordinate and mediate between the GOL and implementing entities (incl. private sector) - Initiate knowledge transfer and MRV coordination - Facilitate actions, encouraging private sector involvement, including launching and managing the implementation process - Data gathering from MRV and aggregation from operational level - Internal QA/QC procedures - Provide capacity building to specific stakeholder groups	National (Public/ Private)
NFF	- Trustee for the financing of the NAMA	- Collect revenue generated from fines, national tax and green tax - Supervise the collection of tipping fees and the IMF - Co-finance capacity building efforts - Support private companies in implementing NAMA interventions through loan and investment facilities and a tipping- fee scheme - Provide security for international donors for finance provided to the NAMA	National (Public/ Private)
OMSAR	- Part of the Implementing Entity	- Ensure the support and control of the physical implementation of technical interventions - Provide technical inputs and knowledge transfer - Contribute to the implementation of waste reception centers and the sorting facility	National (Public)
CDR	- Part of the Implementing Entity	- Contribute to the implementation of interventions by means - Managing and coordinating the procurement process of interventions	National (Public)
Municipalities	- Disbursement of tipping fees	- Manage the collection and disbursement of tipping fees to the private sector from domestic and international allocations - Provide local support on the implementation of interventions and application of regulatory framework	National (Public)
Waste collection companies	- Collection and transfer of waste	- Collection and transfer of waste from municipalities/ households to the bulk collection centers	National (Private)

		- In Phase 2, transport the separately collected waste fractions	
Landfill Operators	- Operation of landfills	- Receive waste amounts and record waste data - Operate the landfills - Collect landfill gas and flare or utilize the same - Reporto the IE	National (Private)
Power producers	- Produce power form LFG	- Power production and sales to the grid - Report to the IE	National (Private)
Operators of reception centers	- Receive and process the waste	- Reception of waste, operation of sorting facilities - Transfer of waste to final disposal at landfills and incinerators - Recordof waste amounts - Regular waste sampling and recording - Report to the IE	National (Private)
Operators of WtE plant	- Receive and incinerate waste	- Receive waste - Incinerate the waste environmentally sound - Gather and report monitoring data - Report to the IE	National / International (Private)
Infrastructure and project investors	- Provision of finance to fund key technical interventions	- Support the lion's share of investment in Phase 1 (LFG utilization) and Phase 2 (WtE), in order to build and operate these facilities	International (Public / Private)
Banque du Liban (BDL)	- Provide loans and guarantees	Jointly with the MoF, BDL operate a loan guarantee and soft loan facility and national investment facility	National (Public)
International Donors	- Support the funding of Phase 1 and 2, capacity building and implementation activities (Measures)	- Co-finance activities under the NAMA	International (Public)

Table 43: Roles and responsibilities of involved institutions and stakeholders under the NAMA

8.2 NAMA Operational and Management System

The operation and management system of the NAMA requires an institutional structure, which will meet the following requirements:

- It is embedded in national and sectoral policies and strategies;
- It ensures effective communication and reporting as required by international agencies (e.g. the UNFCCC);
- It provides interface to international bilateral and multilateral NAMA funding entities (e.g. the Green Climate Fund);
- It ensures proper management of financial flows between the NAMA funding entities and the recipients;
- It ensures the achievement of NAMA targets in terms of energy savings, GHG mitigation, and sustainable co-benefits;
- It allows transparent monitoring of GHG emission reductions and Sustainable Development indicators.

The operational and management structure of the NAMA in the SWM sector in Lebanon must recognize the unique political, strategic, financing, execution, and MRV aspects of the proposed NAMA as outlined below.

Political Aspects

The key institutions would play a role in providing policy direction and oversight. They would look into overall NAMA supervision in Lebanon by providing feedback to the relevant line ministries.

Strategic Function

The key institutions will ensure successful implementation of NAMA projects by coordinating all financing, execution, and MRV functions as well as being the point of contact for international reporting to the UNFCCC.

Financing Function

The key institutions (NFF, CE, IE) will play a major role in the area of budgetary allocation and disbursement of funds from the public purse for NAMA-related projects. Private sector institutions and financial institutions are relevant for mobilizing private funds for NAMA investments. Development Partners are an important source of international public funds.

Executing Function

The execution function will be undertaken by entities that will be responsible for implementing action plans with respect to specific NAMA projects on the ground.

MRV Function

The responsibilities of MRV functional entities among others, will involve;

- Establishing standards, guidelines, and procedures for the monitoring & reporting of GHG and non-GHG indicators;
- Establishing systems and procedures for the verification of reported indicators;
- Establishing guidelines to ensure the quality control and quality assurance of collected data.

The list of stakeholders in the table above shows the relevance of the NAMA for the private sector in Lebanon. Private sector involvement under this NAMA encompasses the collection of waste, the operation of landfill sites (including capturing of LFG and its utilization), the management and operation of waste reception centers and the WtE plant, and the involvement in the MRV process of the NAMA.

The diagram below summarizes the stakeholders involved and depicts the hierarchy for decision-making under the NAMA.

With the MOE as CE and the national public entities, the OMSAR and CDR functioning as the IE, the key management institutions are national public institutions. Private sector stakeholders will play an important part in the implementation, operation and financing of the technical interventions under the NAMA in the form of PPP agreements. This will include the design, implementation, operation and maintenance of the LFG sites and reception centers (NAMA Phase 1 and 2) and the WtE plant (NAMA Phase 2).

The IE will, either through the municipalities or directly, engage with the private sector stakeholders (e.g. landfill or WtE operators, operators of reception centers or IPPs). The CE will provide guidance and coordination to the IE and the Finance Facility. Furthermore, the CE will be in charge of fulfilling the external/international reporting requirements (to the UNFCCC or international donors).

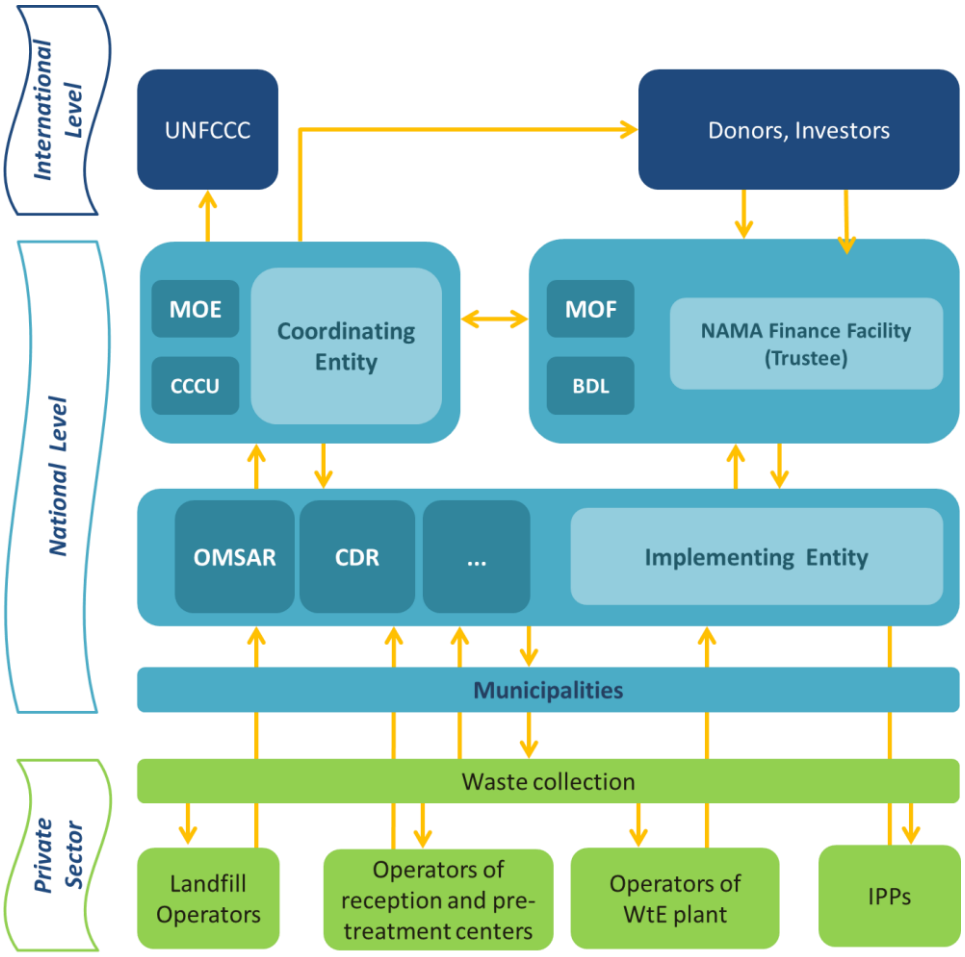


Figure 16: Interrelations between key stakeholders in the NAMA

8.3 Phased Implementation Plan

(1) Phase 1 of the NAMA (2017-2021) focuses on the establishment of an institutional framework, providing support for the enactment of relevant laws (establishment of the regulatory framework), building the capacity of key stakeholders and increasing awareness of waste management and sustainable waste utilization. Waste collection and reception centers in GBA are implemented to increase waste diversion and prepare for the WtE facility planned under Phase 2 of the NAMA. The key technical intervention under Phase 1 leading to GHG emission reductionsis LFG management (including LFG collection, flaring and utilization) in four priority landfill sites and open dumps.

(2) Phase 2 (2022-2030) builds directly on the achievements Phase 1. The technical interventions of Phase 2 are the implementation and operation of one waste incinerator for producing energy from waste (WtE) and the LFG management (including LFG collection, flaring and utilization) at four (4) additional landfill sites or open dumps (to be identified). These interventions will lead to significant GHG emission reductions under Phase 2. In addition, the NAMA Phase 2 will extend the implementation of waste collection and waste reception centers to other service areas outside the GBA, assess the potential for further WtE opportunities in Lebanon and ensure awareness creation for source sorting and recycling.

Figure 17 provides a graphical overview of the two different NAMA Phases with the specific interventions and measures and the related NAMA Outputs for each phase.

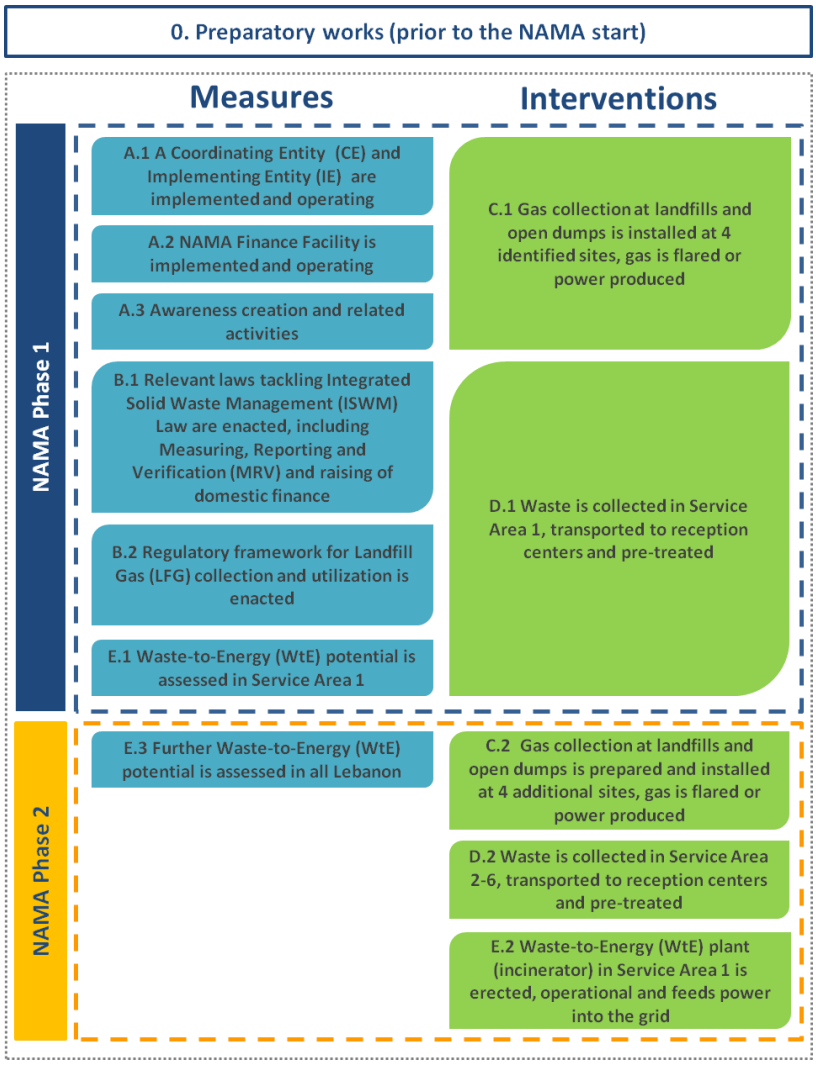


Figure 17: Phased NAMA Approach

The full NAMA scope with all Activities is described in more detail in Chapter 5.

8.4 Implementation Schedule

As outlined, the NAMA will be implemented in two phases. Phase 1 will start in the year 2018 and the Outputs of Phase 1 should be completed by 2021. However, it should be noted that the measures and interventions established and developed under Phase 1 (e.g. establishing the institutional framework, the operation of the LFG capture and utilization plants) will continue throughout the lifetime of the NAMA (until 2030) and even beyond. Phase 2 will start in 2022 and continue until 2030. The detailed timelines for NAMA Outputs are provided in the following implementation schedule.

The main purpose of the implementation schedule is to provide information about the time that is required to achieve the Outputs and the Outcomes of the NAMA. As some of the Activities, once implemented, will continue to operate or function even after the NAMA Output is achieved, the continuation of the operation or functioning over time is depicted in grey.

		Step 0	Phase 1				Phase 2								
		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Step 0	**Preparatory works (prior to the start of the NAMA)**														
Step 0.1	Identification and feasibility study of priority landfill and dump sites														
Step 0.2	Assessment study on waste streams and waste compositions														
Step 0.3	Environmental and Social Impact Assessment (ESIA) of the NAMA interventions														
Step 0.4	Policy Needs Assessment (incl. recommendation to the Lebanese Government)														
Outcome A	**Institutional framework for waste management is established**														
Output A.1	A Coordinating Entity (CE) and Implementing Entity (IE) are implemented and operating														
A.1.1	CE is defined, staffed and is operating														
A.1.2	CE is trained on relevant issues related to their role and responsibility under in the NAMA														
A.1.3	Support to develop mandates and regulation for PPP and IPP business models														
A.1.4	IE is defined, staffed and is operating														
A.1.5	IE is trained on relevant issues related to their role and responsibility under the NAMA														
Output A.2	NAMA Finance Facility is implemented and operating														
A.2.1	Agreement with the Financial Trustee (FT) is established														
A.2.2	The Grant Subsidy Scheme is established and operational under the FT														
Output A.3	Awareness creation and related activities														
A.3.1	Support on development of material for trainings and public campaigning														
A.3.2	Marketing of waste management improvements is undertaken as a pilot, information campaign is launched														
A.3.3	Marketing of the source sorting initiative is undertaken, information campaign is launched in SA 1-6														
A.3.4	A country-wide campaign for source sorting is being undertaken														
Outcome B	**Regulatory framework for Municipal Solid Waste (MSW) Management is established**														
Output B.1	Relevant laws tackling Integrated Solid Waste Management (ISWM) Law are enacted, including Measuring, Reporting and Verification (MRV) and raise of domestic finance														
B.1.1	Strategy support for short and long term master planning under the ISWM law and for harmonization of policies, regulations and laws														
B.1.2	Policy and institutional support to enact the (or parts of) ISWM law														
B.1.3	Support to develop the mandates and regulation for the national level finance needed to implement interventions under the NAMA and other ISWM actions														
B.1.4	The law is drafted and presented to the Parliament and the COM														
B.2	Regulatory framework for Landfill Gas (LFG) collection and utilization is enacted														
B.2.1	The relevant authorities are approached to lead to a regulation permitting LFG collection, IPPs, negotiation of PPAs and setting of feed in tariffs														
Outcome C	**Landfill Gas is collected and utilized or flared**														
Output C.1	Gas collection at landfills and open dumps is installed at 4 identified sites, gas is flared or power produced														
C.1.1	Engineering of the LFG collection system is undertaken at 4 identified sites, implementation of the LFG collection system has happened														
C.1.2	LFG collection systems including flares or genset are operating at the 4 identified sites														
Output C.2	Gas collection at landfills and open dumps is prepared and installed at 4 additional sites, gas is flared or power produced														
C.2.1	Technical feasibility studies and EIA on landfills and big open dumps are undertaken for 4 second most attractive LFs/dumps														
C.2.2	Engineering of the LFG collection system is undertaken at 4 additional sites, implementation of the LFG collection system has happened														
C.2.3	LFG collection systems including flares or genset are operating at the 4 identified sites														
Outcome D	**Solid waste is collected and waste streams are diverted to appropriate disposal sites**														
Output D.1	Waste is collected in Service Area 1, transported to reception centers and pre-treated														
D.1.1	Location, design and function of reception centers in SA 1 are identified, based on existing facilities														
D.1.2	Transport to these reception centers is ensured														
D.1.3	Waste is pre-treated, fractions recycled if applicable and rest is transported to disposal sites or WtE plant														
Output D.2	Waste is collected in Service Area 2-6, transported to reception centers and pre-treated														
D.2.1	Location, of reception centers in SA 2-6 are identified														
D.2.2	Reception centers are erected at the identified sites and operating														
D.2.3	Transport to these reception centers is ensured														
D.2.4	Establishment and operation of one showcase pre-treatment facility for household and garden waste to sort recyclables and process fuel for WtE														
D.2.5	Waste is pre-treated, fractions are recycled if applicable and rest is transported to disposal sites														
Outcome E	**Waste-to-Energy is applied**														
Output E.1	Waste-to-energy (WtE) potential is assessed in Service Area 1														
E.1.1	Waste amounts and composition are monitored at existing reception centers														
E.1.2	Feasibility study for one WtE plant (incinerator) is undertaken and site and size of the plant are clear														
Output E.2	Waste-to-energy (WtE) plant (incinerator) in Service Area 1 is erected, operational and feeds power into the grid														
E.2.1	A site is identified and legal requirements fulfilled														
E.2.2	The incinerator is engineered financed and erected														
E.2.3	The incinerator is operational and produces power														
Output E.3	Further Waste-to-energy (WtE) potential is assessed in all Lebanon														
E 3.1	Waste amounts and composition are monitored at reception centers														
E 3.2	Feasibility studies of different WtE technologies are undertaken (RDF, big incinerators)														

Figure 18: NAMA Implementation schedule

9 Measuring, Reporting & Verification

The aim of this section is to present the principles and general approach of the Measuring, Reporting, and Verification (MRV) system for the SWM NAMA, including data requirements and monitoring procedures for the four dimensions: GHG mitigation; sustainable development benefits; the implementation and transformation process; and financial management.

The MRV system for the SWM NAMA in Lebanon is as much as possible based on existing structures (i.e. available information, reporting structures, and involvement of existing local stakeholders) and built in a way that the majority of required MRV parameters are based on the information that would be available by the operation of the technical interventions.

The principal objective of the MRV system is to communicate progress and provide credibility for the interventions and measures under the NAMA. This should be done in a manner that is transparent and preferably internationally comparable with efforts other parties report to the UNFCCC, like determining an appropriate baseline approach, identifying the methodology for the estimation of the emission reductions, etc. The MRV system should establish the environmental integrity of mitigation actions and ensure that no double-counting occurs.

The objective of MRV systems is to measure and ensure the effectiveness of the proposed interventions and measures, e.g. meeting the required standards and expectation (also as a proof for the stakeholders), to provide a credible and transparent approach for quantifying and reporting GHG emission reductions, sustainable development benefits and the support being provided.

At present, the data base in the solid waste sector in Lebanon is very weak. A MRV system for a sector-wide NAMA, provides the the opportunity to help improve the data and enhance transparency.

A MRV system for a NAMA should be comprehensive and reliable, but at the same time as simple and practical as possible. The MRV should not overburden the stakeholders involved. This should be considered when designing and setting up an MRV system.

To build a sound MRV system, the following criteria should be considered:

- Transparency: All processes are to be documented, data flows shall be verifiable;
- Cost-efficiency: Data gathering is to be undertaken in a cost effective way by electronic and automatic recording procedures. Data should be gathered in a database;
- Sound institutional framework: Roles and responsibilities are to be defined and a sound institutional structure established;
- Comparability: Gathered data and results calculated shall be in line with approved methodologies, e.g. from the CDM and data recording needs to adhere to accuracy levels in line with industry practices;
- Completeness: Gathered data shall be complete. In case data is not collected, reasons need to be provided.

The successful achievement of each Activity or Output should be described and reported through MRV parameters. The parameters can either be qualitative (e.g. whether a measure was undertaken or not), or quantitative (e.g. amount of LFG flared). For each parameter, the frequency of reporting, as well as the type of measurement needs to be defined.

9.1 Stakeholders, Tasks and Responsibilities

The MRV requirements and the related tasks and responsibilities of the different stakeholders involved in the MRV are described in this section. Responsibilities for the individual measurement parameters are listed in Table 51 in Section 9.3.

Coordinating Entity (CE) within the MOE/CCCU

This CE will be embedded in the CCCU (MOE). The CE will be responsible for oversight of NAMA progress. This involves the preparation of reports which can be shared with the International Partners. The CE will interact with the NAMA Finance Facility for disbursement of support funds and will report to international donors and to the UNFCCC about the progress of the NAMA implementation and achievements (incl. GHG emission reductions).

Implementing Entity (IE)

The IE assumes the central role overseeing the physical implementation and operation and thus measuring the performance of the NAMA. The IE is in direct contact with the operators of the technical sites and gathers the site specific data from them. The gathered data will be stored in a central database, which is operated and hosted by the IE. Active players in the waste sector like the OMSAR and the CDR will play anactive role in this IE and support operations with their experience.

The IE will receive data from the operators of technical interventions (i.e. LFG sites, reception centers, and WtE plant), aggregate and process the data, which can then be reported to the CE. Furthermore, the IE will monitor expenditures for the implementation and operation of the sites, report to the MOF and supervise and coordinate the implementation of the interventions.

The MOF will also have an oversight role in monitoring on the financial flows of the NAMA.

NAMA Finance Facility (NFF)

The NFF, which will act as the Finance Trustee for the NAMA and is responsible for the disbursement of funds and the management of national finance flows for the NAMA, will monitor these financial streams and be informed about use of the allocated funds. This information will be received directly from the operators and will also be reported to the IE.

Operators of technical interventions

The operators of LFG collection systems, waste reception centers, the pilot waste sorting facility and the WtE plant need to measure and report data about the collected LFG, waste amounts handled, compost produced, etc. to the IE (database). Data verification and plausibility checks will l happen automatically within the database where feasible, and plant operators will be informed as soon as problems with the recorded data occur.

Central MRV database:

The IE will operate a central database in which all the NAMA related information shall be stored. This database needs to be capable of receiving continuous data readings from the operators of the relevant plants and facilities. Data like the achievement of milestones, the NAMA progress, the finance collected and disbursed shall be gathered in this database, too. Automatic data verification procedures shall be implemented in this database to allow for immediate reaction if data is erroneous or plants stop operation.

This will be necessary to allow for rapidreactions in the case of failure and to minimize the data failure and the periods in which plants may not be operational due to technical problems. The recorded data will form the base for the emission reduction calculation. Data reported by the waste collection companies, which should be reported directly to the IE, will allow for double-checking of the waste amounts treated

and disposed by automatic plausibility checks at the IE (inside the MRV database) and hence is a necessary verification step inside the MRV.

9.2 Measurement

9.2.1 Parameters to be Measured

Table 46 provides an overview of the relevant parameters. Parameters are numbered from M1 to M35 and abbreviated names have been allocated. Each of the parameters will provide information on the achievement of the different goals of the NAMA, i.e. be relevant for:

1. Emission reduction (ER);
2. Sustainable development (SD);
3. Transformational change; and
4. The progress of the NAMA implementation.

Details of each parameter, including descriptions and the reporting periods are listed in Annex 4: MRV Parameters.

Waste NAMA MRV Parameters			
Para-meter nr.	**MRV parameter description**	**Name of parameter**	**Unit**
Outcome A. Institutional framework for waste management is established			
Output A.1 - A Coordinating Entity (CE) and Implementing Entity (IE) are implemented and operating			
M1	The Coordinating Entity is defined, the operation of Coordinating Entity is financed	OP_CE	-
M2	The Implementing Entity is defined, the operation of Implementing Entity is financed	OP_IE	-
M3	Number of capacity building exercises conducted	N_CB held	-
M4	Number of persons trained	N_PE trained	-
Output A.2 - NAMA Finance Facility is implemented and operating			
M5	The NAMA Finance Facility is defined, the operation of the NAMA Finance Facility is financed	OP_NAMA finance facility	-
M6	International Finance spent on NAMA activities	IntFin_spent	USD
Output A.3 - Awareness creation and related activities			
M7	Tranings on source sorting for multipliers (disposal firms, municipalities, etc.) are held	N_CB held, source sorting	-
M8	Information material for public campaigning is developed and prepared	N_material prepared	-
Outcome B. Regulatory framework for Municipal Solid Waste (MSW) Management is established			
Output B.1 - Relevant laws tackling Integrated Solid Waste Management (ISWM) Law are enacted, including MRV and raise of domestic finance			
M9	ISWM support has been successful, ISWM law is prepared and presented to the relevant decision-makers	DRAFT_ISWM	-
M10	ISWM law (or parts) are enacted	ENACTED_ISWM	-
M11	Level of collected tipping fees in each month	T_collected, month	LBP
Output B.2 - Regulatory framework for Landfill Gas (LFG) collection and utilization is enacted			
M12	Permission for IPPs is available	ENACTED_IPP	-
M13	An offical PPA template is available	DRAFT_PPA	-
Outcome C. Landfill Gas is collected and utilized or flared*			
M14	Number of LFG collection systems financed and implemented	N_LFGcollection implemented	-
M15	Amount of methane collected	F_CH_4,PJ,y	t CH_4/yr
M16	Amount of methane in the LFG which is destroyed by flaring in year y	F_CH_4,flared	t CH_4/yr
M17	Amount of methane in the LFG which is used for electricity generation in year y	F_CH_4_electricity	t CH_4/yr
M18	Eectricity consumed by the project activity in year y	EC_PJ,k,y	kWh/yr

M19	Electricity generated	EG_LFG	kWh/yr
M20	Grid emission factor	GEF	tCO2e/MWh
Output C.1 - Gas collection at landfills and open dumps is installed at 4 identified sites, gas is flared or power produced			
Output C.2 - Gas collection at landfills and open dumps is prepared and installed at 4 additional sites, gas is flared or power produced			
Outcome D. Solid waste is collected and waste streams are diverted to appropriate disposal sites*			
M21	Number of operational reception centres in Lebanon as a result of the NAMA	N_operational reception centres	-
M22	Amount of waste received and treated in reception centres	t_waste_received	t/yr
M23	Waste amount composted	t_compost	t/yr
M24	Project emissions from composting	PE_comp,y	t CO2e/yr
M25	Waste amount treated	t_treated	t/yr
Output D.1 - Waste is collected in Service Area 1, transported to reception centers and pre-treated			
Output D.2 - Waste is collected in Service Area 2-6, transported to reception centers and pre-treated			
M26	Establishment and operation of one showcase large pre-treatment facility for household and garden waste for the purpose of sorting out recyclables and processing fuel for waste-to-energy.	OP_Showcase pre-treatment facility	-
Outcome E. Waste-to-Energy is applied			
M27	Calorific Value of the waste**	NCV_waste	MJ/kg
Output E.1 - Waste-to-energy (WtE) potential is assessed in Service Area 1			
M28	Average fraction of the waste type in the waste	p	weight % per fraction
M29	Feasibility Study for large incinerator is completed	FS_incinerator	-
Output E.2 - Waste-to-energy (WtE) plant (incinerator) in Service Area 1 is erected, operational and feeds power into the grid			
M30	Site for large waste incinerator is defined	N_site incinerator	-
M31	Amount of waste incinerated	t_waste_incinerated	t/yr
M20	Grid emission factor	GEF	tCO2e/MWh
M32	Project emissions from incineration	PE_inc,y	t CO2e/yr
M33	Amount of power produced	EG_incinerators	kWh/yr
Output E.3 - Further Waste-to-energy (WtE) potential is assessed in all Lebanon			
M34	Amount of waste received and treated in reception centres	t_waste_received	t/yr
M35	Feasibility Study for WtE technologies and RDF is completed	FS_WtE	-

* Monitoring parameters listed directly under the Outcome are valid for all Outputs under the Outcome.

** The calorific value is monitored at all existing and new reception centres being part of the NAMA and is important for Feasibility Studies on WtE.

Table 44: Full list of MRV parameters

9.2.2 Parameters to Determine the Emission Reductions

Emission reductions (ER) are achieved by activities which collect LFG and flare or utilize it, by composting and by waste incineration and power production. There are different components of emission reductions, which will be achieved in the NAMA. In Phase 1 only emission reductions from LFG avoidance at existing landfills and dumps are estimated. In Phase 2, the LFG collection will be extended to four additional sites and complemented by the emission reductions accruing from the WtE facility and via sorting and composting the waste. The selected parameters need to reflect all activities and data required for the ex-post calculation of emission reductions. The approach for the ER calculation is described in detail in Section 4.2 and the following sections.

Parameters for LFG collection and flaring/ utilization (Outputs C.1 and C.2)

The parameters selected generally follow the approach described in the CDM Methodology ACM0001. The measurement of general, non-site-specific parameters like the grid emission factor, will start within the NAMA Phase 1 and continue throughout the entire NAMA period. Measurement of parameters at the sites where LFG collection and flaring are introduced will start after the implementation of each intervention. The following parameters need to be measured and reported.

Waste NAMA MRV Parameters relevant for Landfill gas collection and flaring/ utilization			
Para-meter nr.	**MRV parameter description**	**Name of parameter**	**Unit**
M15	Amount of methane collected	F_CH_4,PJ,y	t CH_4/yr
M16	Amount of methane in the LFG which is destroyed by flaring in year y	$F\_CH_4,flared$	t CH_4/yr
M17	Amount of methane in the LFG which is used for electricity generation in year y	$F\_CH_4\_electricity$	t CH_4/yr
M18	Eectricity consumed by the project activity in year y	EC_PJ,k,y	kWh/yr
M19	Electricity generated	EG_LFG	kWh/yr
M20	Grid emission factor	GEF	tCO2e/MWh

Table 45: MRV parameters for calculating the emission reductions from LFG collection and flaring/ utilization

Parameters for waste collection and sorting/composting (Outputs D.1 and D.2)

The emission reductions achieved by the sorting and composting of the MSW can be calculated byapplication of the CDM Methodology ACM0022 (Alternative waste treatment processes -Version 2.0). The following parameters need to be measured and reported, as summarized in the table below. The measurement of the general parameters, i.e. the amount of operational reception centers as a result of the NAMA, will start with Phase 1 of the NAMA and continue throughout the entire NAMA period. Parameterswhich are specific to this Phase 2 intervention shall be measured directly from each site/intervention once implemented and operational.

Waste NAMA MRV Parameters relevant for waste collection and sorting/ composting			
Para-meter nr.	**MRV parameter description**	**Name of parameter**	**Unit**
Outputs D.1/ D.2 Waste is collected in Service Area 1, transported to reception centers and pre-treated			
M21	Number of operational reception centres in Lebanon as a result of the NAMA	N_operational reception centres	-
M22	Amount of waste received and treated in reception centres	t_waste_received	t/yr
M23	Waste amount composted	t_compost	t/yr
M24	Project emissions from composting	PE_comp,y	t CO2e/yr
M25	Waste amount treated	t_treated	t/yr

Table 46: MRV parameters for calculating the emission reductions from waste collection and sorting/ composting

Parameters for waste incineration (WtE) facility (Outputs E.1 and E.2)

The emission reductions achieved by the incineration of waste can also be calculated by application of the CDM Methodology ACM0022 (Alternative waste treatment processes -Version 2.0). The following parameters need to be measured and reported, as summarized in the table below. The measurement of the general parameters, i.e. the calorific value of the waste, the average fraction of waste type in the waste, and the grid emission factor will start within Phase 1 of the NAMA and continue throughout the entire NAMA period. Parameters which are specific to this Phase 2 intervention will be measured from the site/intervention directly, once implemented and operational.

Waste NAMA MRV Parameters relevant for WtE			
Para-meter nr.	**MRV parameter description**	**Name of parameter**	**Unit**
M28	Average fraction of the waste type in the waste	p	weight % per fraction
M27	Calorific Value of the waste	NCV_waste	MJ/kg

Output E.2 - Waste-to-Energy (WtE) potential is assessed in Service Area 1			
M27	Calorific Value of the waste	NCV_waste	MJ/kg
M31	Amount of waste incinerated	t_waste_incinerated	t/yr
M20	Grid emission factor	GEF	tCO_{2e}/MWh
M32	Project emissions from incineration	PE_inc,y	t CO_{2e}/yr
M33	Amount of power produced	EG_incinerators	kWh/yr
Output E.3 - Further Waste-to-Energy (WtE) potential is assessed in all Lebanon			
M27	Calorific Value of the waste	NCV_waste	MJ/kg
M34	Amount of waste received and treated in reception centres	t_waste_received	t/yr

Table 47: MRV parameters for calculating the emission reductions from the waste incineration (WtE) facility

9.2.3 Parameters for Sustainable Development

To assess and quantify the specific impacts of the NAMA for sustainable development and environmental and social co-benefits, it is recommended that an Environmental and Social Impact Assessment (ESIA) be undertaken before the start of the NAMA (see Chapter 5 for further description of this study under the Step 0 Preparatory work prior to the start of the NAMA).

For an ex-ante assessment sustainable development co-benefits, the MRV focuses on the contribution to the UN Post 2015 Sustainable Development Goals (SDGs). The NAMA in the SWM Sector of Lebanon would directly contribute to the following SDGs:

SGD 3 Good Health and Well-Being

SGD 6 Secure water and sanitation for a sustainable world

SGD 7 Ensure access to affordable, sustainable and reliable modern energy services for all

SGD 8 Decent Work and Economic Growth

SGD 11 Build inclusive, safe and sustainable cities and human settlements

SGD 12 Promote sustainable consumption and production patterns

SGD 13 Climate Action

SGD 17 Strengthen and enhance the means of implementation and global partnership for sustainable development

The main co-benefits of the NAMA under these SDGs are:

(1) Stopping the practice of open dumping and non-sanitary landfills;

(2) Encouraging recycling / reuse of waste and helpincrease the value of the disposed goods;

(3) Reduction of land use pressures;

(4) Production of renewable energy;

(5) Reducing GHG emissions and other air, water and soil pollutants;

(6) Mobilization of additional financial sources; and

(7) Promoting environmentally sound technologies.

The NAMA will have significant capacity building benefits which will help to institute changes in policy & regulation, SWM practices and individual behavior (awareness creation).

Measuring and reporting of meeting NAMA objectives and attaining SD co-benefits will be done via a process of national level reporting, and verification via a national scheme, which is a part of this MRV system, as described in Sections 9.3 and 9.4.

Most of the SD co-benefits can be measured using the parameters listed and described in Section 9.2.1 (Table 44). As not all the environmental impacts of the current waste management practice of disposal in

poorly managed landfill sites or open dumps are currently measured, reporting on the achievement of the SGDs will be partly based on the avoidance of these current practices. This holds especially true for the SGDs No. 6 (Secure water and sanitation for a sustainable world) and No. 12 (Promote sustainable consumption and production patterns). SDG No. 11 (Build inclusive, safe and sustainable cities and human settlements) will be measured indirectly by the number of bulk reception centers, which directly provide information on the functional waste management system.

Progress on SDG No. 7 (Ensure access to affordable, sustainable and reliable modern energy services for all) and No. 13 (Climate Action) can be measured directly, as the produced power from renewable sources as well as the achieved emission reductions will be measured based on MRV-parameters. SDG No. 17 (Strengthen and enhance the means of implementation and global partnership for sustainable development) will be measured indirectly via the amount of collected tipping fees. Details of the selected monitoring parameters are shown in the table below.

Goal Nr.	Goal Aim	SDG Target	Contribution of the Waste NAMA	Parameter Nr.	Name of parameter
3	Good Health and Well-Being	3.9: Substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination	Stopping the practice of use of open dumping and non-sanitary landfills leading to reduced leachate.	M14 M21 M22 M31	N_LFGcollection implemented N_operational reception centres t_waste_received t_waste_incinerated
6	Secure water and sanitation for a sustainable world	6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	Stopping the practice of use of open dumping and non-sanitary landfills leading to reduced leachate.	M14 M21 M22 M23 M25 M31	N_LFGcollection implemented N_operational reception centres t_waste_received t_compost t_treated t_waste_incinerated
7	Ensure access to affordable, sustainable and reliable modern energy services for all	7.2 By 2030, increase substantially the share of renewable energy in the global energy mix	Electricity generation from landfill gas, as well as waste incineration to produce power (production of renewable energy)	M19 M33	EG_LFG EG_incinerators
8	Decent Work and Economic Growth	8.3: Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services 8.10: Strengthen the capacity of domestic financial institutions to encourage and expand access to banking, insurance and financial services for all	(1) Implementation of an Integrated Solid (2) Waste Management law. (3) Implementation of a law permitting IPPs. (4) Introduction of tipping fees to secure funding levels. (5) Provide opportunities for banks to provide finance for the newly introduced facilities.	M9 M10 M11 M12 M14 M26	DRAFT_ISWM ENACTED_ISWM T_collected, month ENACTED_IPP N_LFGcollection implemented OP_Showcase pre-treatment facility
11	Build inclusive, safe and sustainable cities and human settlements	11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	Improved waste collection and waste management	M21 M31	N_operational reception centres t_waste_received

12	Promote sustainable consumption and production patterns	12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment 12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse 12.a Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production	(1) Encouraging recycle / reuse of waste and value creation for waste (2) Improved air quality and odour reduction through reduced landfill gas emissions (3) Reduced soil and water pollution through reduced leachate. (6) Promotion of environmentally sound technologies	M16 M17 M23 M25 M31 M7 M10	F_CH4,flared F_CH4_electricity t_compost t_treated t_waste_incinerated N_CB held, source sorting ENACTED_ISWM
13	Climate Action	13.2: Integrate climate change measures into national policies, strategies and planning	(1) Integration of emission reductions in the reporting lines of the NAMA (2) Consideration of the achieved emission reductions of the NAMA in the INDC and other governmental strategies	M15 M16 M17 M18 M19 M20 M21 M22 M23 M24 M25 M27 M28 M31 M32 M33 M34	F_CH4,PJ,y F_CH4,flared F_CH4_electricity EC_PJ,k,y EG_LFG GEF N_operational reception centres t_waste_received t_compost PE_comp,y t_treated NCV_waste p t_waste_incinerated PE_inc,y EG_incinerators t_waste_received
17	Strengthen and enhance the means of implementation and global partnership for sustainable development	17.1 Strengthen domestic resource mobilization, including through international support to developing countries, to improve domestic capacity for tax and other revenue collection 17.3 Mobilize additional financial resources for developing countries from multiple sources	(1) Revenue collection through tipping fee (2) Mobilization of additional financial sources through the NAMA	M12	ENACTED_IPP

Table 48: Waste NAMA MRV parameters reporting on sustainable development

9.2.4 Support/ NAMA Progress

From the perspective both of the International Partners (i.e. Donors), and the government, it is important to receive information on whether the domestic and international allocated funds and the support received are used adequately and whether progress on the supported measures and interventions is achieved. This can in most cases not be measured directly. The successful completion of certain activities like capacity building, the establishment of new entities like the CE and IE, or the implementation of new laws and regulations will convey information about the progress of the NAMA.

NAMA progress can be observed based on the achievement of certain milestones, which will be measured and reported. As an example, once the CE is set up and operational, the milestone is achieved, which also demonstrates that the related international support for setting up the CE was used according to the purpose. According to this logic, monitoring parameters for reporting about NAMA progress have been selected as described in the table below.

Waste NAMA MRV Parameters reporting about support received and NAMA progress			
Para-meter nr.	**MRV parameter description**	**Name of parameter**	**Unit**
M1	The Coordinating Entity is defined, the operation of Coordinating Entity is financed	OP_CE	-
M2	The Implementing Entity is defined, the operation of Implementing Entity is financed	OP_IE	-
M3	Number of capacity building exercises conducted	N_CB held	-
M4	Number of persons trained	N_PE trained	-
M5	The NAMA Finance Facility is defined, the operation of the NAMA Finance Facility is financed	OP_NAMA finance facility	-
M6	International Finance spent on NAMA activities	IntFin_spent	USD
M9	ISWM support has been successful, ISWM law is prepared and presented to the relevant decision makers	DRAFT_ISWM	-
M10	ISWM law (or parts) are enacted	ENACTED_ISWM	-
M11	Level of collected tipping fees in each month	T_collected, month	LBP
M12	Permission for IPPs is available	ENACTED_IPP	-
M13	An offical PPA template is available	DRAFT_PPA	-
M14	Number of LFG collection systems financed and implemented	N_LFGcollection implemented	-
M21	Number of operational reception centres in Lebanon as a result of the NAMA	N_operational reception centres	-
M26	Establishment and operation of one showcase large pre-treatment facility for household and garden waste for the purpose of sorting out recyclables and processing fuel for waste-to-energy.	OP_Showcase pre-treatment facility	-
M29	Feasibility Study for big incinerator is completed	FS_incinerator	-
M30	Site for big waste incinerator is defined	N_site incinerator	-
M35	Feasibility Study for WtE technologies and RDF is completed	FS_WtE	-

Table 49: Waste NAMA MRV Parameters reporting about support received and NAMA progress

9.2.5 Parameters for Transformational Change

The NAMA will be transformative in nature for the entire sector in which it takes place. The newly proposed waste management practices, which are supported by the NAMA, allow for lower levels of pollution (air, soil and water), lower levels of solid waste disposal, increase in renewable energy provision derived from solid waste, and a shift in reuse and recycle of materials compared with the existing situation.

These transformative changes can be measured via parameters which report on changes in the legislation regarding SWM, via the level of collected tipping-fees, as these support the "polluter pays" principle, and via the tonnes of waste, which are treated according to the newly introduced SWM practices. Whether the NAMA leads to the envisaged transformative change in Lebanon's solid waste sector will be reported via the parameters listed in the following table.

Waste NAMA MRV Parameters reporting about transformational change			
Para-meter nr.	**MRV parameter description**	**Name of parameter**	**Unit**
M7	Tranings on source sorting for multipliers (disposal firms, municipalities, etc.) are held	N_CB held, source sorting	-
M8	Information material for public campaigning is developed and prepared	N_material prepared	-
M10	ISWM law (or parts) are enacted	ENACTED_ISWM	-
M14	Number of LFG collection systems financed and implemented	N_LFGcollection implemented	-
M21	Number of operational reception centres in Lebanon as a result of the NAMA	N_operational reception centres	-

M22	Amount of waste received and treated in reception centres	t_waste_received	t/yr
M23	Waste amount composted	t_compost	t/yr
M25	Waste amount treated	t_treated	t/yr
M26	Establishment and operation of one showcase large pre-treatment facility for household and garden waste for the purpose of sorting out recyclables and processing fuel for waste-to-energy.	OP_Showcase pre-treatment facility	-
M27	Calorific Value of the waste	NCV_waste	MJ/kg
M31	Amount of waste incinerated	t_waste_incinerated	t/yr
M34	Amount of waste received and treated in reception centres	t_waste_received	t/yr

Table 50: Waste NAMA MRV parameters reporting on transformational change

9.3 Reporting

The measured data has to be accumulated, processed and reported to the entity heading or coordinating the MRV and the NAMA activities. All measured data need to be reported, unless the data provides only information which is relevant within the same entity or in the case of confidentiality. All measured parameters listed in the previous sections need to be reported, either directly or as cumulative data on a continuous basis.

The operators of landfills, bulk reception centers and WtE facilities will record the relevant measurement data in accordance with the defined parameters.

The IE will be the central authority receiving raw monitoring data from the operators of landfills, waste reception and treatment centers and the WtE plant. The IE will also host and operate the NAMA database and will process and aggregate this data and report accumulated information and data to the CE and the MOE on a regular (presumably monthly) basis in form of Monthly Measurement Reports. Furthermore, the CE will record the completion of Outcomes and Outputs in the form of measures and interventions completed, capacity building completed, and finance received, allocated and utilized. The NFF will need to report about expenditures and revenues from tipping-fees to the MOF and the MOE. Finally, the MOE will report about the progress of the NAMA to the International Partners and the UNFCCC via the CE, which will file reports according to their reporting requirements.

What needs to be reported?

All data according to the parameters listed in the previous sections, which are relevant to assessing the progress and success of the NAMA. This includes qualitative data and quantitative technical data, such as LFG flared, electricity generated or emission reduction achieved.

When shall data be reported?

Reporting is required continuously for all data which can be generated at all times, like the amount of LFG extracted, the amount of waste processed, the amount and composition of waste delivered, etc. Specific achievements like the completion of certain milestones (i.e. implementation of one facility) need to be reported whenever they happen and periodically.

Who shall report?

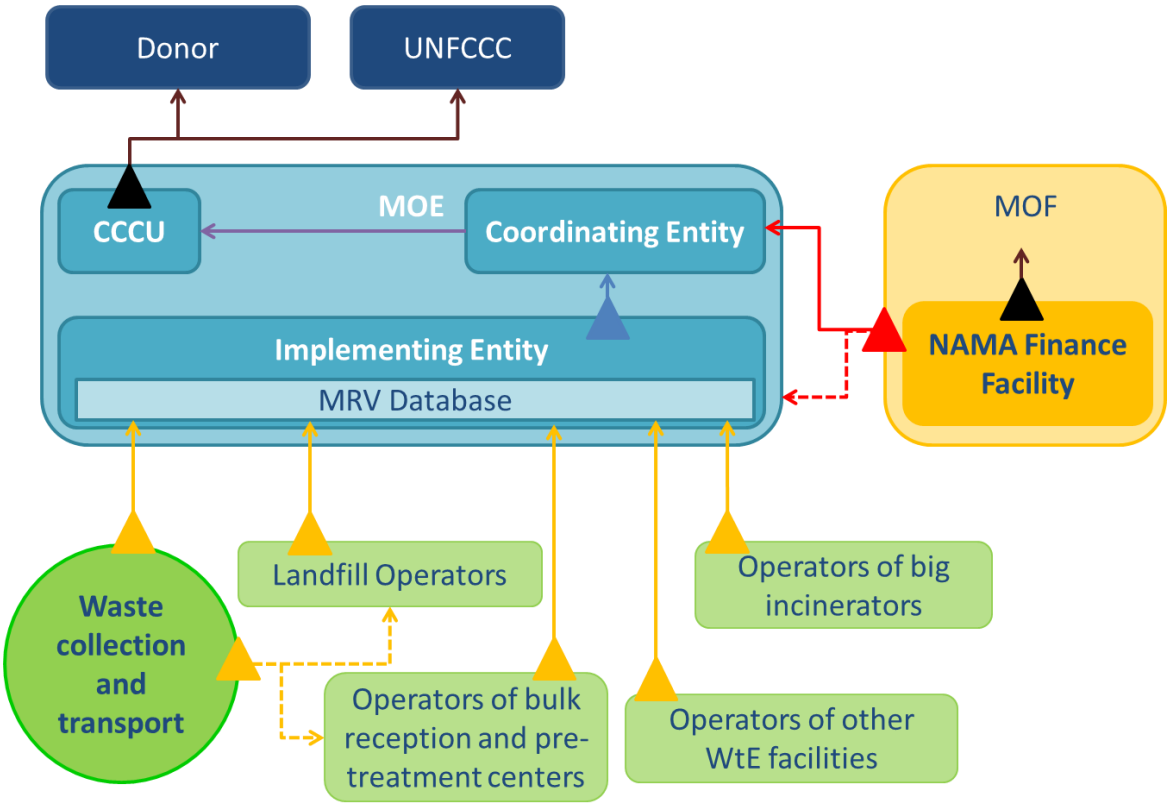
Responsibilities and reporting lines need to be defined at the commencement of the NAMA. A suggestion for the responsibilities can be found in Figure 19 below.

How shall the reporting take place?

It is recommended that data arising from the operation of the interventions of the NAMA be reported electronically, whenever possible, and stored in the central database (at the IE). The format of reporting

can vary from automatically generated electronic reports and protocols, to reports issued to the attention of the International Partners.

The different responsibilities of institutions involved in the reporting, the different levels, the direction of the reporting and the periodicity of the reporting are illustrated in the following figure.



Symbol	When	How
	Continuous reporting	Electronic data transfer
	Bi-weekly reporting	Electronic forms
	Monthly reporting	Electronic forms
	Biannual reporting	Internal reports
	Reporting according to requirements	Reports
	according to requirements	External (third party auditor)
	Bi-annually verification	Internal, annually by a third party auditor
	Monthly verification	Internal, when filling forms
	Continuous verification	Automised in database by parameters set

Figure 19: Reporting structure in the Waste NAMA

In terms of reporting frequency, it is suggested that the IE shall be in bi-weekly contact with the operators, who record the measured parameters continuously. The IE also reports to the CE in this interval (every second week). The CE shall report to the CCCU on a biannual basis. The NFF shall also report monthly to the CE. The achievement of measures like capacity building, etc. should be reported on a monthly basis by the IE to the CE. Reporting to the UNFCCC or International Partners will be done by the MOE (CCCU) according to the specific reporting requirements.

The Operators of sites/facilities will report consolidated data (e.g. weekly or monthly reports) either directly into the NAMA database, or in cases where this is not possible, via the IE. The IE would summarize this data for the reports to the CE at ministerial level. The CCCU will issue reports like the BURs and NCs to the UNFCCC and provide reports to the International Partners. The data on emission reductions will help the MOE to improve the quality of these BUR and NC reports.

The specific roles of the stakeholders, including the parameters they need to measure and report are summarized in Table 51. In general, measurement of the overall NAMA coordination and its progress is done by the CE, while the IE will be responsible for the measurement and reporting of all physical interventions and the actual implementation of the NAMA Activities. This will include direct coordination with the operators (including the private sector) of the NAMA interventions. All quantitative and technical parameters will be measured by the operators of the facilities which are commissioned under the NAMA. In addition, the measurement and reporting relating to financial parameters is overseen by the NAMA Finance Facility. Close interaction and coordination among the stakeholders involved in the MRV is essential for successful operation of the NAMA MRV system.

Responsibilities for monitoring parameters					
Para-meter nr.	**MRV parameter description**	**Name of parameter**	**Unit**	**Frequency of reporting**	**Means of measurement**
Responsibility for data recording: CCCU					
M1	The Coordinating Entity is defined, the operation of Coordinating Entity is financed	OP_CE	-	once upon completion	qualitative
M2	The Implementing Entity is defined, the operation of Implementing Entity is financed	OP_IE	-	once upon completion	qualitative
M3	Number of capacity building exercises conducted	N_CB held	-	continuosly	counting
M4	Number of persons trained	N_PE trained	-	continuosly	counting
M5	The NAMA Finance Facility is defined, the operation of the NAMA Finance Facility is financed	OP_NAMA finance facility	-	once upon completion	qualitative
Responsibility for data recording: CE					
M7	Tranings on source sorting for multipliers (disposal firms, municipalities, etc.) are held	N_CB held, source sorting	-	continuosly	qualitative
M8	Information material for public campaigning is developed and prepared	N_material prepared	-	once upon completion	qualitative
M9	ISWM support has been successful, ISWM law is prepared and presented to the relevant decision makers	DRAFT_ISWM	-	once upon completion	qualitative
M10	ISWM law (or parts) are enacted	ENACTED_ISWM	-	once upon completion	qualitative
M12	Permission for IPPs is available	ENACTED_IPP	-	once upon completion	qualitative
M13	An offical PPA template is available	DRAFT_PPA	-	once upon completion	qualitative
Responsibility for data recording: IE					
M14	Number of LFG collection systems financed and implemented	N_LFGcollection implemented	-	continuosly	counting
M21	Number of operational reception centres in Lebanon as a result of the NAMA	N_operational reception centres	-	continuosly	counting
M26	Establishment and operation of one showcase large pre-treatment facility for household and garden waste for the purpose of sorting out recyclables and processing fuel for waste-to-energy.	OP_Showcase pre-treatment facility	-	once upon completion	qualitative
M29	Feasibility Study for large incinerator is completed	FS_incinerator	-	once upon completion	qualitative
M30	Site for large waste incinerator is defined	N_site incinerator	-	once upon completion	counting

M35	Feasibility Study for WtE technologies and RDF is completed	FS_WtE	-	once upon completion	qualitative
Responsibility for data recording: NFF					
M6	International Finance spent on NAMA activities	IntFin_spent	USD	continuosly	qualitative
M11	Level of collected tipping fees	T_collected, month	LBP	monthly	counting
M14	Number of LFG collection systems financed and implemented	N_LFGcollection implemented	-	continuosly	counting
Responsibility for data recording: Landfill Operators					
M15	Amount of methane collected	F_CH4,PJ,y	t CH4/yr	continuosly	flow meter
M16	Amount of methane in the LFG which is destroyed by flaring in year y	F_CH4,flared	t CH4/yr	continuosly	flow meter
M17	Amount of methane in the LFG which is used for electricity generation in year y	F_CH4_electricity	t CH4/yr	continuosly	flow meter
M18	Eectricity consumed by the project activity in year y	EC_PJ,k,y	kWh/yr	continuosly	power meter
M19	Electricity generated	EG_LFG	kWh/yr	continuosly	power meter
Responsibility for data recording: Operators of bulk reception centers					
M22	Amount of waste received and treated in reception centres	t_waste_received	t/yr	continuosly	weighbridge
M23	Waste amount composted	t_compost	t/yr	continuosly	weighbridge
M25	Waste amount treated	t_treated	t/yr	continuosly	weighbridge
M27	Calorific Value of the waste	NCV_waste	MJ/kg	monthly	lab analysis
M28	Average fraction of the waste type in the waste	p	weight % per fraction	continuosly	by sampling
M34	Amount of waste received and treated in reception centres	t_waste_received	t/yr	continuosly	weighbridge
Responsibility for data recording: Operator of big incinerator					
M20	Grid emission factor	GEF	tCO2e/MWh	yearly	calculation
M31	Amount of waste incinerated	t_waste_incinerated	t/yr	continuosly	weighbridge
M32	Project emissions from incineration	PE_inc,y	t CO2e/yr	continuosly	calculation
M33	Amount of power produced	EG_incinerators	kWh/yr	continuosly	power meter

Table 51: Proposed responsibilities with regards to reporting

9.4 Verification & Evaluation

Verification of the reported parameters is necessary to ensure the correctness of the data reported. The goal of verification is to ensure that the NAMA is operating as planned and that the MRV system is being implemented as planned. Verification also ensures that emission reductions and SD benefits are real and measurable. Verification can be done internally, or via an independent third party auditor.

In this NAMA it is suggested that internal quality assurance and quality control (QA/QC) measures be combined with external and independent third party auditors. Third party auditors should be accredited entities. They can be entities accredited under the CDM or under another accreditation system agreed upon by the GOL and International Partners supporting the NAMA. Verification also ensures that emission reductions and SD benefits are real and that the NAMA is effective in reaching its overall targets.

The final verification procedures will be based on the requirements of the CE, the IE and from International Partners supporting the NAMA.

QA/QC procedures will be implemented at the operational level of the NAMA, whereby third party audits will tackle the managerial level of the NAMA, the MRV database and reporting at the levels of IE and CE. Furthermore, the external auditing process should ensure the functioning of QA/QC procedures and may undertake spot-checks of the measured and reported data.

9.4.1 QA/QC Procedures (Internal)

QA/QC procedures are necessary to mitigate risks, to ensure accuracy and correct measurement and reporting and to reduce risks of failure during the verification. In this proposed NAMA, the QA/QC procedures will be applied on each level of the MRV system and governed by the CE. Checks will be undertaken on the level of the operators of the facilities, the IE and the NFF.

QA/QC by operators

The operators of landfills, reception centers, WtE facilities, etc. will be obliged to introduce internal quality checks of the measured data. These checks shall happen periodically. If data are detected as missing, inconsistent or wrong, the reason for the failure needs to be recorded. Operators are responsible for the accuracy of the measured data and need to undertake periodic calibration of the measuring equipment, in accordance with the recommendations of the equipment suppliers.

QA/QC undertaken by the IE

Internal checks on the technical interventions, looking at the performance of the operated equipment and procedures, on the measured and reported data, etc. should be undertaken on a regular basis. Furthermore, the central MRV database operated by the IE should be assessed regularly. Automatic plausibility checks will help ensuring correct data inputs and data processing within the database. A frequency of quarterly checks will ensure that loopholes, mistakes and missing performance can be avoided.

The IE reports discovered problems or significant irregularities to the CE. If necessary, the CE can then intervene.

QA/QC undertaken by the CE

The CE shall ensure the overall performance of the NAMA and should control the reporting procedures of the IE and the NFF. The CE reports discovered problems to the MOE, which will support the CE to fix the issues identified.

9.4.2 Verification procedures (External)

Third party verification is necessary to ensure the credibility of the reported results to the International Partners and other international players. The external verification may take place in coordination with the reporting requirements agreed upon with the International Partners and the reporting requirements of Lebanon to the UNFCCC (BURs, NCs, NDC). The latter is relevant, as reports about domestic emission reduction and achievements towards sustainable development and transformational change are part of these communications. This reporting to the UNFCCCC is mandatory at least on a biennial basis and hence it would make sense to also schedule the third party verification of the NAMA biennially. This verification should be scheduled well in advance to those international reporting requirement, for being able to address necessary corrections pior to the development of such report. This decision is though up to the MOE/CCCU.

Each verification should consist of:

- a desk review of documents like monitoring reports and underlying documents/data;
- a site visit/interview of key stakeholders;
- drafting of the verification report;
- provision of feedback on the report by the NAMA CE; and the
- finalization of the verification report.

10 Risk Management

This section describes potential risks for achieving the Outcomes of the NAMA and how the NAMA set-up was designed to mitigate these risks. The risks described do not include risks due to *force majeure* or risks that could affect any large project in the country (i.e. political unrest, refugees, war). The risks described are rather related to regulatory, institutional financial or operational aspects.

The risks will be qualitatively assessed according to their expected seriousness (low, medium, high). Besides outlining proposed and planned Activities and processes within the NAMA that were considered to mitigate the risk, potential opportunities for tracking and mitigating the risks may be described, if appropriate.

The main risks foreseen under the SWM NAMA in Lebanon are summarized in the table below. The potential impact of each risk on the NAMA is briefly described. The three columns in the table identify 1) the specific Outcome/Output of the NAMA that would be affected by the risk, 2) the proposed and planned Activities and risk mitigation measures under the NAMA, and 3) proposed and planned means to assess and track the risk during the NAMA lifetime. The level of expected seriousness (low, medium or high) is qualitatively assessed.

Identified Risks and Risk Mitigation Options

Risk A: [Medium] ISWM law not enacted
The enactment of the ISMW (or parts of it) is a critical step in NAMA Phase 1 as it provides a framework for SWM in Lebanon and is the basis for all sorting, recycling, re-use and energy recovery. The risk is that this law, currently in draft form only, does not receive the necessary parliamentary approval for ratification. Furthermore, delays in (or absence of) enactment of the law would severely hamper any large scale investment in the waste sector and private sector involvement in infrastructure development such as LFG capture and utilization (under NAMA Phase 1 and 2) as well as WtE (under NAMA Phase 2).

Measure & Outcome Impacted	Proposed and Planned Risk Mitigation Measures	Proposed and Planned Means to Track the Risk
Outcome C.: Landfill gas is collected and utilized or flared Outcome D: Solid waste is collected and waste streams are diverted to appropriate disposal sites Outcome E: Waste-to-Energy is applied	Before the start of the NAMA it is recommended that "Policy Needs Assessment" be conducted to assess where and how to best support the process for enacting the ISWM law and establishing the regulatory framework. A key capacity building component of Phase 1 is to provide support to enable the enactment of the ISWM law and reduce barriers for parliamentary acceptance. In Activities B.1.1 to B.1.4, this support will complement the strategic guidance to ensure sufficient policy and institutional capacities to enact the ISWM law and implement domestic financing instruments. In Activity B.2.1, strategic guidance to key decision makers will be provided for master planning, both short and long term, of the SWM sector and the legal basis needed.	1. Progress towards enactment of the ISWM law is tracked through the MRV process 2. The phased NAMA approach will maximize the focus in Phase 1 on ensuring critical foundational milestones are achieved, such as the enactment of the ISWM as a basis for an enabling environment for the interventions under the NAMA.

Risk B: [Medium] Necessary regulation to enable PPP and IPP business models as well as feed-in tariffs is not implemented
Private sector involvement in the waste management and operation activities within the NAMA depends on the availability of public-private mechanisms. In the case of LFG collection and utilization, PPPs and IPP business models as well as a feed-in tariff must be established. If the framework for these models as well as transparent procurement processes under competitive bidding are in place, the GOL would lack the support it needs from the private sector. If the private sector would not be sufficiently incentivized to manage such facilities, the implementation of this Phase 1 (SWDS) and Phase 2 (LFG sites and WtE) milestone would be hindered.

Measure & Outcome Impacted	Proposed and Planned Risk Mitigation Measures	Proposed and Planned Means to Track the Risk
Outcome C: Landfill gas is collected and utilized or flared Outcome E: Waste-to-Energy is applied	Capacity building in Phase 1 will target the key levers to enhance the likelihood of implementing the needed frameworks for public-private mechanisms. In Output A.1, knowledge transfer to the relevant authorities will be conducted to increase acceptance of these models. Furthermore, dialogue and improved communication channels between the GOL and private sector will be facilitated to enable the negotiation of PPPs. Activities under Output A.3 support awareness creation and marketing to increase knowledge and awareness about the technologies applied under the NAMA and the relevance of the NAMA for the solid waste sector.	1. Progress towards enabling of IPP business models as well as ultimate implementation of LFG and WtE facilities will be tracked though the MRV process 2. The technical assessment and stakeholder engagement will be conducted early in Phase 1 to ensure the availability of these models to the private sector

Risk C: [Medium] Financing for large WtE facility in Beirut / Mount Lebanon Service Area not secured
Financing for the WtE infrastructure in Phase 2 is expected to to be provided by both domestic and international project financial sources. The availability of these funds is however crucially dependent on the financial attractiveness of the investment opportunity in Lebanon's waste sector. Without a successful implementation of Phase 1 Activities, demonstrating this attractiveness will prove challenging and ultimately the transformational change sought for the solid waste sector would be hindered.

Measure & Outcome Impacted	Proposed and Planned Risk Mitigation Measures	Proposed and Planned Means to Track the Risk
Outcome E: Waste-to-Energy is applied	Through capacity building, the assessment of required information and the feasibility of the WtE facility, as well as the support for PPP frameworks and establishing the regulatory framework under the NAMA Phase 1, the phased NAMA approach provides the foundation for the implementation and WtE facility, planned under NAMA Phase 2. Site specific assessments of the WtE plant will begin early in Phase 2 to identify feasibility risks. In addition, under Phase 2, further WtE potential in all Lebanon will be assessed.	1. Coordinating efforts to identify potential investors and appropriately target them early in the process will serve to reduce any lag in securing finance

Risk D: [Low] Lack of coordination at the national level to manage stakeholders involved. *Effective implementation of the NAMA relies on careful coordination of both public (various Ministries, Councils and Municipalities) and private sector (various facility operators and waste collection companies) stakeholders. Without a robust structure to manage the integration of these stakeholders in the country's waste management system, the NAMA will not achieve cohesive transformational change.*		
Measure & Outcome Impacted	**Proposed and Planned Risk Mitigation Measures**	**Proposed and Planned Means to Track the Risk**
Outcome A: Institutional framework for waste management is established Outcome B: Regulatory framework for MSW Management is established Outcome C.: Landfill gas is collected and utilized or flared Outcome D: Solid waste is collected and waste streams are diverted to appropriate disposal sites Output E: Waste-to-Energy is applied	Responsibilities will be split between the CE, the IE and the Finance Facility to ensure overall oversight of stakeholder involvement and NAMA implementation. In Outcome A (Output A.1 to A.2), these entities will be set up, staffed and trained to ensure effective coordination and tracking of stakeholder involvement. Stakeholder coordination (including working group meetings and capacity building) is a central element of the NAMA and embedded throughout the NAMA. This will help leverage existing organizational systems and stakeholder interaction/coordination.	1. Progress towards implementation and operation of these institutions as well as ongoing training of the entities will be tracked through the MRV process. 2. Coordination will also be monitored by tracking the implementation of all Activities and engagement of the stakeholders involved at each step.
Risk E: [Low] Waste sector infrastructure not operational as anticipated *An effective waste management system is critically reliant upon the needed infrastructure upgrades planned, i.e. LFG collection, pre-treatment and WtE facilities. Failure to implement or operate these technologies will paralyze any efforts to impact the solid waste sector, reduce GHG emissions and support the achievement of sustainable development co-benefits (mainly SDGs).*		
Measure & Outcome Impacted	**Proposed and Planned Risk Mitigation Measures**	**Proposed and Planned Means to Track the Risk**
Outcome C: Landfill gas is collected and utilized or flared Outcome D: Solid waste is collected and waste streams are diverted to appropriate disposal sites Output E: Waste-to-Energy is applied	The financial risks for the facilities implemented under NAMA Phase 1 (financed mainly by donor funding) are mitigated by the phased NAMA approach applied. Under NAMA Phase 1 emphasis is on crafting an attractive project set-up and business model to leverage donor involvement. For the financial risks of implementing the WtE facility in Phase 2, see Risk C. From an engineering, construction and operations standpoint, detailed feasibility studies and Assessment studies are already recommended as a preparatory step (Step 0) before to the NAMA start and additional activities also incorporated in the NAMA scope (Activities C.2.1, D.1.1, D.2.1 and E.1.2). This will identify the pitfalls and manage expectations in implementing the technical interventions under the NAMA appropriately.	The Activities for feasibility assessment and preparing the technical interventions, as well as the financing, implementation and operation of each technical intervention (LFG collection and utilization, WtE plant, reception centers and pilot waste sorting site) will be tracked through the MRV system of the NAMA.

Table 52: Potential risks of the NAMA and risk mitigation measures

11 Bibliography

Arina, D., Klavenieks, K., & Burlakovs, J. (2014). The Cost-estimation of Mechanical Pre-treatment Lines of Municipal Solid Waste in Latvia. *Proceedings of the Latvian University of Agriculture*, 17-28.

CDR. (2006). *Municipal Solid Waste Management in Lebanon.*

CDR. (2012). *SWM in Lebanon – Phase 1 Report (not for public access).* Prepared by Ramboll for the Council for Development and Reconstruction, Republic of Lebanon.

GIZ/SWEEP-Net. (2014, April). *Country profile on the solid waste management situation in Lebanon.* Retrieved July 1, 2015, from http://www.sweep-net.org/sites/default/files/LEBANON%20PROFIL.pdf

Government of Lebanon, Council of Ministers. (1997, 1 2). *COM Decision No.58.* Retrieved from http://www.pcm.gov.lb/arabic/landing.aspx?pageid=9

Government of Lebanon, Council of Ministers. (2005, 8 18). *COM Decision No.1/4952.* Retrieved from Decisions and Decrees are only available in Arabic but the Ministry of Environment often will provide an unofficial English translation of the most important environmental regulations, which can be requested from the Ministry directly. : http://www.pcm.gov.lb/arabic/landing.aspx?pageid=9

Government of Lebanon, Council of Ministers. (2010, 9 1). *COM Decision No.55.* Retrieved from Decisions and Decrees are only available in Arabic but the Ministry of Environment often will provide an unofficial English translation of the most important environmental regulations, which can be requested from the Ministry directly.: http://www.pcm.gov.lb/arabic/landing.aspx?pageid=9

Government of Lebanon, Council of Ministers. (2014, 10 30). *COM Decision No.46.* Retrieved from Decisions and Decrees are only available in Arabic but the Ministry of Environment often will provide an unofficial English translation of the most important environmental regulations, which can be requested from the Ministry directly.: http://www.pcm.gov.lb/arabic/landing.aspx?pageid=9

Government of Lebanon, Council of Ministers. (2015, 01 12). *Amendment of the Council of Ministers' decision No. 1 dated 12/01/2015.* Retrieved from Decisions and Decrees are only available in Arabic but the Ministry of Environment often will provide an unofficial English translation of the most important environmental regulations, which can be requested from the Ministry directly.: http://www.pcm.gov.lb/arabic/landing.aspx?pageid=9

Government of Lebanon, Council of Ministers. (2015, 9 9). *COM Decision No.9.* Retrieved from Decisions and Decrees are only available in Arabic but the Ministry of Environment often will provide an unofficial English translation of the most important environmental regulations, which can be requested from the Ministry directly.: http://www.pcm.gov.lb/arabic/landing.aspx?pageid=9

IPCC. (2006). *Guidelines for National Greenhouse Gas Inventories.* Intergovernmental Panel on Climate Change, www.ipcc-nggip.iges.or.jp/public/2006gl/.

McKinsey & Company. (2010). *Impact of the financial crisis on carbon economics.* Retrieved 11 5, 2015, from http://www.mckinsey.com/client_service/sustainability/latest_thinking/greenhouse_gas_abatement_cost_curves

MOE. (2004). *Evaluation Report (draft): Rural Material Recovery and Composting Facilities in Lebanon.* Beirut.

MOE. (2005). Draft Law – Integrated Solid Waste Management. Prepared under EU-funded project Regional Solid Waste Management Project in Maghreb and Mashreq Countries.

MOE. (2015). *Lebanon's First Biennial Update Report to the UN Framework Convention on Climate Change.* http://climatechange.moe.gov.lb/Library/Files/Uploaded%20Files/Lebanon%20First%20Biennial%20Update%20Report%20%28BUR%29.pdf.

MOE, UNDP, ELARD. (2011). *Provision of consultancy services for the Preparation of a Master plan for the Closure and Rehabilitation of Uncontrolled Dumps throughout the country of Lebanon.* http://www.moe.gov.lb/The-Ministry/Reports/Master-plan-for-the-closure-and-rehabilitation-of.aspx.

MOE/ CDR. (2006). Municipal Solid Waste Master Plan. Ministry of Environment/ Council for Development and Reconstruciton.

MOE/GEF/UNDP. (2011). *Lebanon's Second National Communication to the UNFCCC.* Beirut: http://www.lb.undp.org/content/lebanon/en/home/library/environment_energy/lebanon_s-second-national-communication-to-the-unfccc.html.

MOE/GEF/UNDP. (2015). *National Greenhouse Gas Inventory Report and Mitigation Analysis for the Waste Sector in Lebanon.* Beirut: http://climatechange.moe.gov.lb/viewfile.aspx?id=222.

MOE/UNDP/ECODIT. (2011). *State and Trends of the Lebanese Environment 2010.* http://www.moe.gov.lb/The-Ministry/Reports/State-Of-the-Environment-Report-2010.aspx?lang=en-us.

MORES. (2009). *Landfill Gas Capture and Flaring and/or Reuse.* Beirut: UNDP.

Republic of Lebanon. (2015). Lebanon's Intended Nationally Determined Contribution. MoE.

UNDP. (2014). *Finance Structure and its Management for a Rural Electrification NAMA.* Retrieved 12 17, 2015, from Untied Nations Development Programme: http://www.undp.org/content/undp/en/home/librarypage/environment-energy/mdg-carbon/finance-structure-and-its-management-for-a-rural-electrification.html

UNEP. (2015). *UNEP DTU CDM/JI Pipeline Analysis and Database*. Retrieved December 17, 2015, from UNEP DTU Partnership: http://www.cdmpipeline.org/

UNFCCC. (2011). *Methodological Tool "Project and leakage emissions from composting".* UNFCCC, EB 65 Annex09.

UNFCCC. (2014). *ACM0022 - Large Scale Consolidated Methodology - Alternative Waste Treatment Processes Version 2.0*. Retrieved 2015, from https://cdm.unfccc.int/filestorage/6/J/B/6JB3U5TZDWEOP9NLQRAHV4MIC1X07F/EB81_repan13_ACM0022_ver02.0_281114_clean.pdf?t=Z2F8bng5aDN6fDDBtClBlWsiTrAVTh9O6_RO

UNFCCC. (2015a). *CDM Methodology Booklet.* UNFCCC.

UNFCCC. (2015b). *Methodological tool 04 - Emissions from solid waste disposal sites, Version 7.0*. Retrieved 2015, from https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v7.pdf

Annex 1: NAMA Measures and Interventions and their Outputs, Activities and Inputs

Step 0: Preparatory steps/assessments (prior to the NAMA start)				
Activities	0.1	Identification and feasibility study of priority landfill and dump sites	To be undertaken before the NAMA starts	
	0.2	Assessment study on waste streams and waste compositions		
	0.3	Environmental and Social Impact Assessment of the NAMA interventions		
	0.4	Policy Needs Assessment (incl. recommendation to the Lebanese Government)		
NAMA measures & interventions and their Outputs, Activities, and Inputs			**Measure/ intervention (M/I)**	**Inputs**
Outcome A. Institutional framework for waste management is established				
Output A.1 - A Coordinating Entity (CE) and Implementing Entity (IE) are implemented and operating			M	
Activities	A.1.1	CE is defined, staffed and is operating		Finance
	A.1.2	CE is trained on relevant issues related to their role and responsibility under in the NAMA		Capacity Building
	A.1.3	Support to develop mandates and regulation for PPP and IPP business models		Capacity Building
	A.1.4	IE is defined, staffed and is operating		Finance
	A.1.5	IE is trained on relevant issues related to their role and responsibility under the NAMA		Capacity Building
Output A.2 - NAMA Finance Facility is implemented and operating			M	
Activities	A.2.1	Agreement with the Financial Trustee (FT) is established		Capacity Building
	A.2.2	The Grant Subsidy Scheme is established and operational under the FT		Finance
Output A.3 - Awareness creation and related activities			M	
Activities	A.3.1	Support on development of material for trainings and public campaigning		Capacity Building
	A.3.2	Marketing of waste management improvements is undertaken as a pilot, information campaign is launched		Finance
	A.3.3	Marketing of the source sorting initiative is undertaken, information campaign is launched in SA 1-6		Capacity Building
	A.3.4	A country-wide campaign for source sorting is being undertaken		Capacity Building

B. Regulatory framework for Municipal Solid Waste (MSW) Management is established				
Output B.1 - Relevant laws tackling Integrated Solid Waste Management (ISWM) are enacted, including Measuring, Reporting and Verification (MRV) and raising of domestic finance			M	
Activities	B.1.1	Strategy support for short and long term master planning under the ISWM law and for harmonization of policies, regulations and laws		Capacity Building
	B.1.2	Policy and institutional support to enact the (or parts of) ISWM law		Capacity Building
	B.1.3	Support to develop the mandates and regulation for the national level finance needed to implement interventions under the NAMA and other ISWM actions		Capacity Building
	B.1.4	The law is drafted and presented to the Parliament and the COM		Capacity Building
Output B.2 - Regulatory framework for Landfill Gas (LFG) collection and utilization is enacted			M	
Activities	B.2.1	The relevant authorities are approached to lead to a regulation permitting LFG collection, IPPs, negotiation of PPAs and setting of feed in tariffs		Capacity Building
Outcome C. Landfill Gas is collected and utilized or flared				
Output C.1 - Gas collection at landfills and open dumps is installed at 4 identified sites, gas is flared or power produced			I	
	C.1.1	Engineering of the LFG collection system is undertaken at 4 identified sites, implementation of the LFG collection system has happened		Finance, Technology, Capacity Building
	C.1.2	LFG collection systems including flares or genset are operating at the 4 identified sites		Finance
Output C.2 - Gas collection at landfills and open dumps is prepared and installed at 4 additional sites, gas is flared or power produced			I	
	C.2.1	Technical feasibility studies and EIA on landfills and big open dumps are undertaken for 4 second most attractive LFs/dumps		Capacity Building
	C.2.2	Engineering of the LFG collection system is undertaken at 4 additional sites, implementation of the LFG collection system has happened		Finance, Technology, Capacity Building
	C.2.3	LFG collection systems including flares or genset are operating at the 4 identified sites		Finance
Outcome D. Solid waste is collected and waste streams are diverted to appropriate disposal sites				
Output D.1 - Waste is collected in Service Area 1, transported to reception centers and pre-treated			I	
	D.1.1	Location, design and function of reception centers in SA 1 are identified, based on existing		Capacity Building

		facilities		
	D.1.2	Transport to these reception centers is ensured		Finance
	D.1.3	Waste is pre-treated, fractions recycled if applicable and rest is transported to disposal sites or the WtE plant		Finance
Output D.2 - Waste is collected in Service Area 2-6, transported to reception centers and pre-treated			I	
	D.2.1	Locations of reception centers in SA 2-6 are identified		Capacity Building
	D.2.2	Reception centers are erected at the identified sites and operating		Finance
	D.2.3	Transport to these reception centers is ensured		Capacity Building
	D.2.4	Establishment and operation of one showcase large pre-treatment facility for household and garden waste to sort recyclables and process fuel for WtE		Finance, Technology
	D.2.5	Waste is pre-treated, fractions are recycled if applicable and rest is transported to disposal sites		Finance
Outcome E. Waste-to-Energy is applied				
Output E.1 - Waste-to-Energy (WtE) potential is assessed in Service Area 1			I	
	E.1.1	Waste amounts and composition are monitored at existing reception centers		Finance, Capacity Building
	E.1.2	Feasibility study for one WtE plant (incinerator) is undertaken and site and size of the plant are clear		Capacity Building
Output E.2 - Waste-to-Energy (WtE) plant (incinerator) in Service Area 1 is erected, operational and feeds power into the grid			I	
	E.2.1	A site is identified and legal requirements fulfilled		Capacity Building
	E.2.2	The incinerator is engineered financed and erected		Finance
	E.2.3	The incinerator is operational and produces power		Finance
Output E.3 - Further Waste-to-Energy (WtE) potential is assessed in all Lebanon			I	
	E.3.1	Waste amounts and composition are monitored at reception centers		Finance, Capacity Building
	E.3.2	Feasibility studies of different WtE technologies are undertaken (RDF, big incinerators)		Capacity Building

Annex 2: Stakeholder Consultations during the Design Phase

List of relevant stakeholder consultations		
Dates and consultation topic	Relevant stakeholders attending	Brief summary of consultation and outcomes.
10-11/06/2014 Kickoff	- Nikolaus Wohlgemuth – Senior Advisor First Climate Consulting - Ramy Marei – TUV-NORD - Marwan Rizkallah – LEPAP Project Manager – UNDP/Ministry of Environment (MoE) - Manal Moussalem – MoE Institutional Support Project Manager - UNDP/MoE - Nicolas Gharib – Rehabilitation of the Saida Dumpsite Project Manager – UNDP/MoE - Bassam Sabbagh – Head of Department of Urban Environment Pollution – MoE - Vahakn Kabakian – Climate Change Projects Project Manager - UNDP/MoE - Youssef Doughan - Advisor to the Minister of Environment - MoE - Mary Awad – Climate Change Projects Administrative and Financial Assistant - UNDP/MoE	Objectives of the Meeting As part of the NAMA preparation phase, the mission to Lebanon had the following objectives: - Determine the key agency, its goals and responsibilities; - Discuss the status and NAMA selection process; - Analyze the NAMA decision making process in Lebanon; - Discuss the MRV baseline and projections; - Assess the policies to incite governmental involvement; - Discuss the available means of financial support for the NAMA.
10-11/02/2015 Inception Workshop	- First Climate (Nikolaus Wohlgemuth, Dominik Englert), - ECODIT (Karim El-Jisr, Lama Abdul Samad, Capricia Chabarekh), - Lamia Mansour (MOE, StREG policy	During this inception meeting, the NAMA team gave three presentations: - Background and NAMA methodology, by Nikolaus Wohlgemuth - Overview of solid waste sector in Lebanon, by Dominik Englert

	expert), - Constantinos Nicolopoulos (LDK), George Tsivilis (LDK), - Vahakn Kabakian (CCCU), - Bassam Sabbagh (MOE), - Mohamed Baraki (OMSAR) - Marwan Rizkallah (LEPAP), - Jihan Seoud (UNDP country office),	- Preliminary mitigation actions in solid waste sector, by Lama Abdul Samad The presentations were followed by a discussion about possible mitigation actions in the waste sector. One major finding of the discussion was that the tendering process for each service area according to the COM decision has a major impact on the decision of what mitigation actions to include under the Waste NAMA. The meeting concluded with the following findings: Mitigation actions can currently only be proposed in line with the national strategy, as the sector is highly fluid and the choices made by the chosen contractors in each service area need to be observed first. Any concrete measure like waste collection, WtE, sorting and composting, recycling, landfilling will be in the hands of the contractor of each service area. Whether measures proposed by the contractors can be included or complemented by GHG mitigation actions under the framework of a NAMA can only be discussed once the proposals of the contractors are available. NAMA funding is likely to be in the range of EUR 15 million, which should be a small component of the total costs. A detailed analysis of the costs of implementation of the NAMA and a discussion on donor contribution will be held during the course of the NAMA development.
23-24/11/2015 Validation Workshop	Climate Change Coordination Unit (UNDP-CCCU) - Mr. Vahakn Kabakian - Ms. Lea Kai Abou Jaoude - Ms. Sarah El Rayes Ministry of Environment (MOE) - Mr. Bassam Sabbagh Council for Development and Reconstruction (CDR) - Mr. Yousef Aziz StREG (EU-funded programme) - Ms. Noura Nasser Lebanon Pollution Abatement Program (LEPAP) - Marwan Rizkallah Ministry of Finance (MOF) - Farah (missing) LACECO (Solid Waste Consultant) Ramboll	The workshop objective was to present the draft final NAMA Design Document (DD) and validate the overall proposal and solicit feedback from relevant stakeholders, in support of the Final DD. The NAMA DD: Outcome D (Waste is Sorted at the Source) should be phased- in earlier, perhaps under Phase 1. It should also be considered as an Activity (display vertically extending in Phase 1 and 2) rather than an *Outcome*. The NAMA team will reconsider how best to package Outcome D. The MOE conducted a survey (under StREG) on recycling facilities which showed that the quantities of recyclables received by these facilities have increased over the years. The EIA for the rehabilitation of Tripoli dumpsite shows exactly the quality of waste dumped in Tripoli; ECODIT will request a copy from the MOE-StREG Team. The Team should consider the Ras Al Ain (Tyre) dumpsite in Outcome A in Phase 1, subject to the result of the GHG reduction calculations. Ms. Lama Abdulsamad pointed out that the inclusion of Ras El Ain dumpsite in the list of priority sites should be matched with a full rehabilitation plan considering the hydrogeological sensitivity of the site and its proximity to the Tyre Coastal Nature Reserve (note: The Open Dump Sites Rehabilitation Plan for Lebanon had classified the Ras el Ain site closure as "excavate and transfer" and not "grade, cap, manage gas and leachate"). Bekaa was excluded from the Ramboll WtE feasibility study for several reasons: unreliable data on total waste quantities and composition, and the potential availability of lands for future

- Ms. Arwa El Zein

ECODIT (local Consultant)

- Mr. Karim El Jisr (Team Leader)
- Ms. Lama Abdul Samad (Waste Expert)
- Mr. Naji Tannous (Energy / GHG Expert)

Ms. Capricia Chabarekh (Coordinator)

First Climate (international Consultant)

- Mr. Nikolaus Wohlgemuth
- Mr. Jonathan Schwieger

landfills. The same could be argued of south Lebanon.

SWOT Analysis (open discussion and brainstorming)

At the end of the presentation, the workshop facilitator asked the participants to brainstorm on the strengths and weaknesses of the draft NAMA DD in the waste sector. Those were:

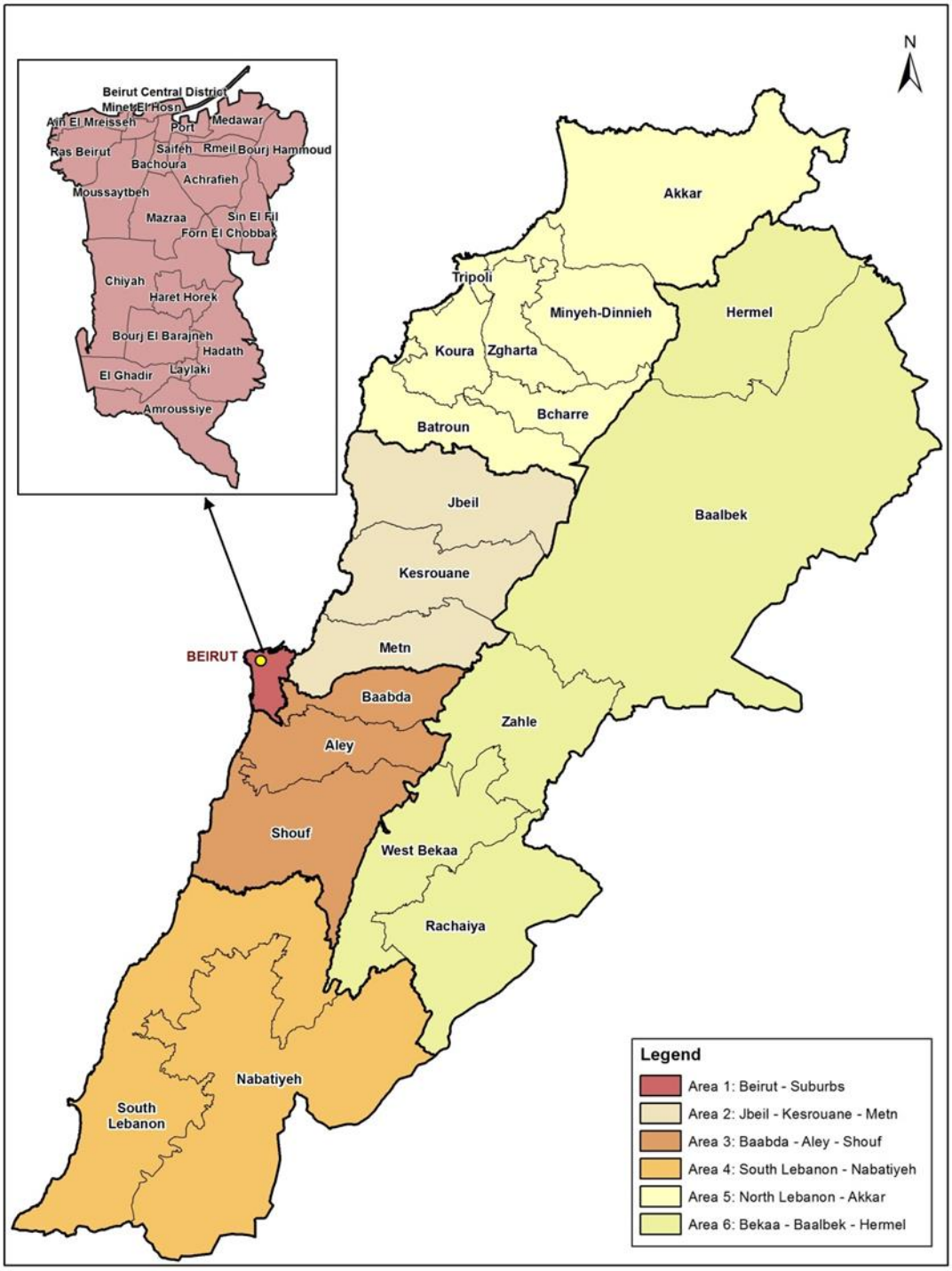
Strengths	***Weaknesses***
Expected GHG emission reductions seem solid The expected marginal abatement cost for the Waste NAMA is low (compared to the international abatement cost of USD100/t $CO_{2\text{-eq}}$) There is an electricity production in Phase 2 which can offset the electricity gap in the country	Weakness of the NAMA proposal so long as the policy and institutional framework for the solid waste sector are not clarified. Outcome D: sorting at source appears to be weak. Lack of technical feasibility of Output A. The transition between Phase 1 and Phase 2 is not clear.
Opportunities	***Threats***
The baseline situation in the waste sector is very bad. Therefore, any small initiative is considered an improvement The NAMA is potentially considered the basis for a future policy document	No strategy for integrated solid waste management is under development, nor is a decision on the waste problems expected to being taken soon. The NAMA is not going to finance rehabilitation of the dumpsites which could become a disincentive to complete open dump site rehabilitation plans.

Other considerations during guided discussion:

Review the draft ISWM law to include references on GHG reduction

The NAMA may help guide national discussions on WtE technologies, including pros and cons, and therefore enhance awareness (and dispel erroneous interpretations and statements that are often reported in the media).

Annex 3: Representation of the six Service Areas in Lebanon



Annex 4: MRV Parameters

Waste NAMA MRV Parameters						Relevant for				
Para-meter nr.	MRV parameter description	Name of parameter	Unit	Proposed frequency of reporting (e.g. continuously, monthly, annualy)	Means of measure-ment	ER	SD	NAMA progress	T-change	Responsibility for data recording
Outcome A. Institutional framework for waste management is established										
Output A.1 - A Coordinating Entity (CE) and Implementing Entity (IE) are implemented and operating								.		
M1	The Coordinating Entity is defined, the operation of Coordinating Entity is financed	OP_CE	-	once upon completion	qualitative			X		CCCU
M2	The Implementing Entity is defined, the operation of Implementing Entity is financed	OP_IE	-	once upon completion	qualitative			X		CCCU
M3	Number of capacity building conducted	N_CB held	-	continuosly	counting			X		CCCU
M4	Number of persons trained	N_PE trained	-	continuosly	counting			X		CCCU
Output A.2 - NAMA Finance Facility is implemented and operating								.		
M5	The NAMA Finance Facility is defined, the operation of the NAMA Finance Facility is financed	OP_NAMA finance facility	-	once upon completion	qualitative			X		CCCU
M6	International Finance spent on NAMA activities	IntFin_spent	USD	continuosly	qualitative			X		CE
Output A.3 - Awareness creation and related activities								.		
M7	Tranings on source sorting for multipliers (disposal firms, municipalities, etc.) are held	N_CB held, source sorting	-	continuosly	qualitative		X		X	CE
M8	Information material for public campaigning is developed and prepared	N_material prepared	-	once upon completion	qualitative				X	CE
Outcome B. Regulatory framework for Municipal Solid Waste (MSW) Management is established										
Output B.1 - Relevant laws tackling Integrated Solid Waste Management (ISWM) Law are enacted, including MRV and raise of domestic finance								.		
M9	ISWM support has been successful, ISWM law is prepared and presented to the relevant decision makers	DRAFT_ISWM	-	once upon completion	qualitative		X	X		CE
M10	ISWM law (or it's parts) are enacted	ENACTED_ISWM	-	once upon completion	qualitative		X	X	X	CE
M11	Level of collected tipping fees in each month	T_collected, month	LBP	monthly	counting		X	X		NFF
Output B.2 - Regulatory framework for Landfill Gas (LFG) collection and utilization is enacted								.		
M12	Permission for IPPs is available	ENACTED_IPP	-	once upon completion	qualitative		X	X		CE
M13	An offical PPA template is available	DRAFT_PPA	-	once upon completion	qualitative			X		CE
Outcome C. Landfill Gas is collected and utilized or flared*										
M14	Number of LFG collection systems financed and implemented	N_LFGcollection implemented	-	continuosly	counting		X	X	X	IE
M15	Amount of methane collected	F_CH4,PJ,y	t CH4/yr	continuosly	flow meter	X	X			LF Operators
M16	Amount of methane in the LFG which is destroyed by flaring in year y	F_CH4,flared	t CH4/yr	continuosly	flow meter	X	X			LF Operators
M17	Amount of methane in the LFG which is used for electricity generation in year y	F_CH4_electricity	t CH4/yr	continuosly	flow meter	X	X			LF Operators
M18	Eectricity consumed by the project activity in year y	EC_PJ,k,y	kWh/yr	continuosly	power meter	X	X			LF Operators
M19	Electricity generated	EG_LFG	kWh/yr	continuosly	power meter	X	X			LF Operators
M20	Grid emission factor	GEF	tCO2e/MWh	yearly	calculation	X	X			Operator of big incinerator/IE
Output C.1 - Gas collection at landfills and open dumps is installed at 4 identified sites, gas is flared or power produced								.		
Output C.2 - Gas collection at landfills and open dumps is prepared and installed at 4 additional sites, gas is flared or power produced								.		

Outcome D. Solid waste is collected and waste streams are diverted to appropriate disposal sites*										
M21	Number of operational reception centres in Lebanon as a result of the NAMA	N_operational reception centres	-	continuosly	counting	X	X	X	X	IE
M22	Amount of waste received and treated in reception centres	t_waste_received	t/yr	continuosly	weighbridge	X	X		X	Operators of reception centers
M23	Waste amount composted	t_compost	t/yr	continuosly	weighbridge	X	X		X	Operators of reception centers
M24	Project emissions from composting	PE_comp,y	t CO2e/yr	continuosly	calculation	X	X			
M25	Waste amount treated	t_treated	t/yr	continuosly	weighbridge	X	X		X	Operators of reception centers
Output D.1 - Waste is collected in Service Area 1, transported to reception centers and pre-treated								.		
Output D.2 - Waste is collected in Service Area 2-6, transported to reception centers and pre-treated								.		
M26	Establishment and operation of one showcase large pre-treatment facility for household and garden waste for the purpose of sorting out recyclables and processing fuel for waste-to-energy.	OP_Showcase pre-treatment facility	-	once upon completion	qualitative		X	X	X	IE
Outcome E. Waste-to-Energy is applied										
M27	Calorific Value of the waste**	NCV_waste	MJ/kg	monthly	lab analysis	X	X		X	Operators of reception centers/IE
Output E.1 - Waste-to-energy (WtE) potential is assessed in Service Area 1								.		
M28	Average fraction of the waste type in the waste	p	weight % per fraction	continuosly	by sampling	X				Operators of reception centers
M29	FS for big incinerator is completed	FS_incinerator	-	once upon completion	qualitative			X		IE
Output E.2 - Waste-to-energy (WtE) plant (incinerator) in Service Area 1 is erected, operational and feeds power into the grid								.		
M30	Site for big waste incinerator is defined	N_site incinerator	-	once upon completion	counting			X		IE
M31	Amount of waste incinerated	t_waste_incinerated	t/yr	continuosly	weighbridge	X	X		X	Operator of big incinerator
M20	Grid emission factor	GEF	tCO2e/MWh	yearly	calculation	X	X			Operator of big incinerator/IE
M32	Project emissions from incineration	PE_inc,y	t CO2e/yr	continuosly	calculation	X	X			Operator of big incinerator/IE
M33	Amount of power produced	EG_incinerators	kWh/yr	continuosly	power meter	X	X			Operator of big incinerator
Output E.3 - Further Waste-to-energy (WtE) potential is assessed in all Lebanon								.		
M34	Amount of waste received and treated in reception centres	t_waste_received	t/yr	continuosly	weighbridge	X	X		X	Operators of reception centers
M35	FS for WtE technologies and RDF is completed	FS_WtE	-	once upon completion	qualitative			X		IE

Annex 5: Cost Estimates for Landfill Gas Collection and Utilization

The implementation of flaring and power generation from landfill gas at dump and landfill sites in Lebanon is a key intervention of the waste sector NAMA. Financial estimates of capital expenditure and the operation and maintenance costs of the facilities to be implemented in Lebanon are derived from existing data on registered landfill gas projects under CDM (available from the CDM Pipeline Analysis and Database (UNEP, 2015)). To ensure the selection of high quality data applicable to the Lebanon context, projects located outside of South America were filtered out. The sample analyzed included 36 projects ranging in values of emission reduction from 10 to 800 tCO_2/year.

The investment costs of both Landfill flaring and Landfill power projects in this sample were compared on the basis of their annual reductions in CO_2 emissions. Due to the high costs of gas generators needed for landfill power projects, the investment costs of such facilities are two to five times higher than for landfill flaring (see Figure 20).

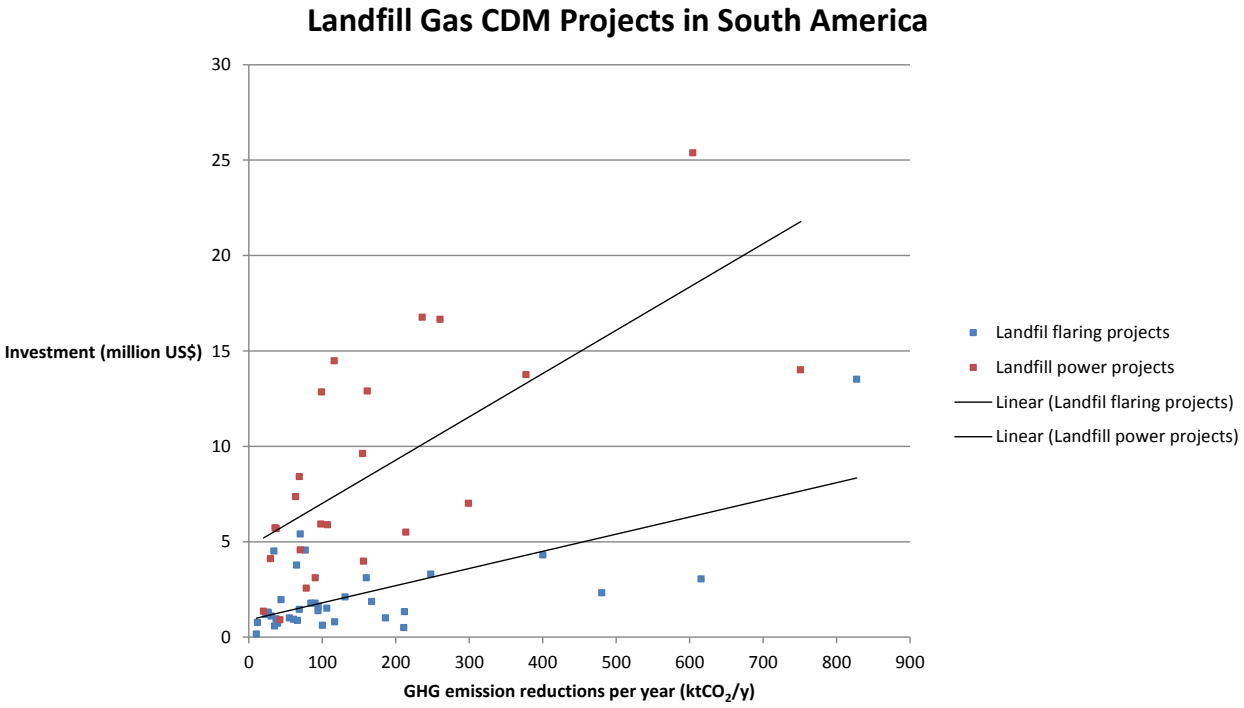


Figure 20: Comparison of investment costs for Landfill flaring and Landfill power CDM projects on the basis of their emission reduction potential. Data taken from (UNEP, 2015)

On average for this sample, investment costs per annual emission reduction potential are presented in Table 53. These values are then applied to the calculated emission reductions anticipated for the 4 sites pre-selected for development in Phase 1 (Tripoli, Zahle, Hbaline and Srar). These four sites demonstrated the largest potential for emission reduction in the pre-NAMA technical assessments conducted. In the case of Phase 2, the 4 sites considered (Aayta Ech Chaab, Adweh, Ghaziye, Qraiyet Saida) represent second tier sites in terms of emission reduction potential and are shown for indicative purposes only.

Landfill flaring	Landfill power
15.31 USD/(tCO_2/y)	49.94 USD/(tCO_2/y)

Table 53: Unit investment costs of landfill collection and utilization projects

In terms of operation and maintenance costs, values were selected for the 5 most recent landfill flaring and landfill power projects where data were available among the sample of registered CDM projects in South America. The average annual O&M expenses determined for this subset are presented in Table 54 as a percentage of investment costs. The higher burden of operating the gas engine in comparison with gas flaring is clear in the higher operating costs.

Landfill flaring	Landfill power
12.49%	16.27%

Table 54: Operation and maintenance costs of landfill collection and utilization projects as a percentage of capital expenditure

Based on the values inferred from existing CDM projects, the investment and O&M costs were estimated for the 8 sites targeted in Lebanon and the results are reproduced in Table 55 below. It should be noted that anticipated costs for some gas flaring sites were adjusted upwards to reflect a more realistic scenario than those predicted by using emission reduction potential, which are rather low.

Site	Type	Average Annual ER (tCO_2/a)	Estimated Investment cost (USD)	Estimated O&M costs (USD/a)
Phase 1				
Tripoli	Landfill power	47,016	2,400,000	390,000
Zahle	Landfill power	28,353	1,400,000	230,000
Hbaline	Landfill flaring	15,093	500,000	60,000
Srar	Landfill flaring	75,363	1,100,000	140,000
Phase 2				
Aayta Ech Chaab	Landfill flairing	2,450	250,000	31,000
Adweh	Landfill power	10,889	550,000	90,000
Ghaziye	Landfill flaring	8,428	250,000	31,000
Qraiyet Saida	Landfill flaring	1,361	250,000	31,000

Table 55: Estimated investment and O&M costs for landfill and dump sites in Lebanon for Phase 1 and Phase 2

Annex 6: Overview of Public Private Partnership models

The general concept of financing the interventions under a PPP business models consists of National Government Support (see Section 7.2.1), International Finance Support (see Section 7.2.2), Private Sector Support (see Section 7.2.3), and municipal or national government in-kind contribution.

The municipal or national government in-kind contribution under the proposed PPP business models consists of the community providing two types of in-kind contribution during the development phase and one type of contribution during the operational phase; information about the in-kind contributions can be seen below.

1) The first of the in-kind contributions is the existence of a municipal or national representative who will work for the community and with external consultants during the development phase of the interventions. The representative will establish community buy in, analyze technical and financial feasibility, and facilitate agreements between the prvate sector and the government and communities (with expertise provided by the CE and IE).

2) The second in-kind contribution is for the municipal or national government to provide the land for the interventions, rights-of-way for required systems, and land for any additional facilities directly or indirectly supported under the interventions, to include allowance for future expansion.

Key components of the PPP business model are described below (derived from (UNDP, 2014))

- PPP Agreement: The government enters into a long term PPP agreement (of at least 10 years for LFG systems and 20 years for the waste-to-energy plant to ensure long term financial stability) with a private partner. The PPP agreement grants the private partner the previous outlined concessions and incentives, and requires the obligation to operate the facilities. The private partner also holds the responsibility for measurment and reporting and regulatory compliance. The eligibility criteria for the private partner will be determined in a national context during the implementation phase of the NAMA, by the CE, IE, and Financial Trustee.

- Fees and Feed-in-Tariff (FiT): The PPP agreement will include a Fees and FiT setting mechanism which allows for a viable internal rate of return (IRR) or return on equity (ROE) for the private partner, this should also include a mechanism for expansion and extension, and higher returns for any capital investments made by the private partner.

- Performance: Reasonable penalties should be placed on the private partner for non-performance and incentives should be introduced to encourage growth and good performance. Performance standards for the private partner will be determined in a national context during the implementation phase of the NAMA, by the CE and IE. The main incentive to encourage growth would be the additional profits made from increased treatment and sales of electricity.

- Revenues: Tipping fees, management fees, and electricity sales revenues go directly to the private partner.

- Cost Reduction Measures: The private partner should also benefit from the National Finance Cost Reduction Measures (e.g. tax incentives) and any rural development subsidies.

- Selection Process: The private partner should be selected through a tender process to ensure competitive costs and technical ability, as well as transparency of selection. It is suggested that the landfill gas collection and utilization be tendered out in lots, under one tender, to reduce administrative costs and to make it financial attractive for private partners, through economies of scale.

- The PPP business model has several advantages, most notably:

- Know- How Retention: There is a higher likelihood that a private partner, compared with a state owned company, will garner and retain the required technical skills and capacity to perform at a better level of quality in relation to management, operation, and maintenance.

- Economies of Scale: If several interventions are operated by the same private partner then economies of scale can be gained under operation, likely leading to timely availability of services and possible reduced costs.

- Brain Drain: Limits the risk of "brain drain" commonly found in rural communities, where persons are trained in new skills and later move to the city where higher wages and opportunities are available.

- Access to Finance: The private partner may have better ability than municipalities to access finance for investing in new connections and expansion.

Annex 7: Detailed NAMA Cost Assessment

			Total	Domestic	International
Step 0: Preparatory steps/assessments (prior to the NAMA start)					
Activities	0.1	Identification and feasibility study of priority landfill and dump sites	500,000	500,000	-
	0.2	Assessment study on waste streams and waste compositions	100,000	100,000	-
	0.3	Environmental and Social Impact Assessment (ESIA) of the NAMA interventions	80,000	80,000	-
	0.4	Policy Needs Assessment (incl. recommendation to the Lebanese Government)	50,000	50,000	-
TOTAL - Cash Flow Preparatory steps/assessments			**730,000**	**730,000**	**-**
Outcome A		**Institutional framework for waste management is established**			
Output A.1		**A Coordinating Entity (CE) and Implementing Entity (IE) are implemented and operating**			
Activities	A.1.1	CE is defined, staffed and is operating	3,015,000	3,015,000	-
	A.1.2	CE is trained on relevant issues related to their role and responsibility under in the NAMA	76,000	-	76,000
	A.1.3	Support to develop mandates and regulation for PPP and IPP business models	103,000	-	103,000
	A.1.4	IE is defined, staffed and is operating	3,015,000	3,015,000	-
	A.1.5	IE is trained on relevant issues related to their role and responsibility under the NAMA	76,000	-	76,000
Output A.2		**NAMA Finance Facility is implemented and operating**			
Activities	A.2.1	Agreement with the Financial Trustee (FT) is established	70,000	-	70,000
	A.2.2	The Grant Subsidy Scheme is established and operational under the FT	90,000	90,000	-
Output A.3		**Awareness creation and related activities**			
Activities	A.3.1	Support on development of material for trainings and public campaigning	120,000	-	120,000
	A.3.2	Marketing of waste management improvements is undertaken as a pilot, information campaign is launched	230,000	230,000	-
	A.3.3	Marketing of the source sorting initiative is undertaken, information campaign is launched in SA 1-6	75,000	-	75,000
	A.3.4	A country-wide campaign for source sorting is being undertaken	1,344,000	-	1,344,000
TOTAL - Cash Flow: Outcome A			**8,214,000**	**6,350,000**	**1,864,000**
Outcome B		**Regulatory framework for Municipal Solid Waste (MSW) Management is established**			
Output B.1		**Relevant laws tackling Integrated Solid Waste Management (ISWM) Law are enacted, including Measuring, Reporting and Verification (MRV) and raise of domestic finance**			
Activities	B.1.1	Strategy support for short and long term master planning under the ISWM law and for harmonization of policies, regulations and laws	206,000	-	206,000
	B.1.2	Policy and institutional support to enact the (or parts of) ISWM law	116,000	-	116,000
	B.1.3	Support to develop the mandates and regulation for the national level finance needed to implement interventions under the NAMA and other ISWM actions	166,000	-	166,000
	B.1.4	The law is drafted and presented to the Parliament and the COM	51,000	-	51,000
Output B.2		**Regulatory framework for Landfill Gas (LFG) collection and utilization is enacted**			
Activities	B.2.1	The relevant authorities are approached to lead to a regulation permitting LFG collection, IPPs, negotiation of PPAs and setting of feed in tariffs	103,000	-	103,000
TOTAL - Cash Flow: Outcome B			**642,000**	**-**	**642,000**
Outcome C		**Landfill Gas is collected and utilized or flared**			
Output C.1		**Gas collection at landfills and open dumps is installed at 4 identified sites, gas is flared or power produced**			
	C.1.1	Engineering of the LFG collection system is undertaken at 4 identified sites, implementation of the LFG collection system has happened	5,412,000	-	5,412,000
	C.1.2	LFG collection systems including flares or genset are operating at the 4 identified sites	9,840,000	9,840,000	-
Output C.2		**Gas collection at landfills and open dumps is prepared and installed at 4 additional sites, gas is flared or power produced**			
Activities	C.2.1	Technical feasibility studies and EIA on landfills and big open dumps are undertaken for 4 second most attractive LFs/dumps	360,000	-	360,000
	C.2.2	Engineering of the LFG collection system is undertaken at 4 additional sites, implementation of the LFG collection system has happened	1,312,000	-	1,312,000
	C.2.3	LFG collection systems including flares or genset are operating at the 4 identified sites	1,281,000	1,281,000	-
TOTAL - Cash Flow: Outcome C			**18,205,000**	**11,121,000**	**7,084,000**
Outcome D		**Solid waste is collected and waste streams are diverted to appropriate disposal sites**			
Output D.1		**Waste is collected in Service Area 1, transported to reception centers and pre-treated**			
Activities	D.1.1	Location, design and function of reception centers in SA 1 are identified, based on existing facilities	58,000	-	58,000
	D.1.2	Transport to these reception centers is ensured	40,000	40,000	-
	D.1.3	Waste is pre-treated, fractions recycled if applicable and rest is transported to disposal sites or WtE plant	15,000	15,000	-
Output D.2		**Waste is collected in Service Area 2-6, transported to reception centers and pre-treated**			
	D.2.1	Location, of reception centers in SA 2-6 are identified	121,000	-	121,000
	D.2.2	Reception centers are erected at the identified sites and operating	5,400,000	1,400,000	4,000,000
	D.2.3	Transport to these reception centers is ensured	40,000	-	40,000
	D.2.4	Establishment and operation of one showcase pre-treatment facility for household and garden waste to sort recyclables and process fuel for WtE	13,600,000	9,600,000	4,000,000
	D.2.5	Waste is pre-treated, fractions are recycled if applicable and rest is transported to disposal sites	15,000	15,000	-
TOTAL - Cash Flow: Outcome D			**19,289,000**	**11,070,000**	**8,219,000**
Outcome E		**Waste-to-Energy is applied**			
Output E.1		**Waste-to-energy (WtE) potential is assessed in Service Area 1**			
Activities	E.1.1	Waste amounts and composition are monitored at existing reception centers	263,500	82,500	181,000
	E.1.2	Feasibility study for one WtE plant (incinerator) is undertaken and site and size of the plant are clear	472,000	-	472,000
Output E.2		**Waste-to-energy (WtE) plant (incinerator) in Service Area 1 is erected, operational and feeds power into the grid**			
Activities	E.2.1	A site is identified and legal requirements fulfilled	203,000	-	203,000
	E.2.2	The incinerator is engineered financed and erected	150,000,000	140,000,000	10,000,000
	E.2.3	The incinerator is operational and produces power	282,000,000	282,000,000	-
Output E.3		**Further Waste-to-energy (WtE) potential is assessed in all Lebanon**			
Activities	E 3.1	Waste amounts and composition are monitored at reception centers	593,000	240,000	353,000
	E 3.2	Feasibility studies of different WtE technologies are undertaken (RDF, big incinerators)	334,000	-	334,000
TOTAL - Cash Flow: Outcome E			**433,865,500**	**422,322,500**	**11,543,000**
TOTAL - Cash Flow: ALL NAMA (excluding preparatory phase)			**480,215,500**	**450,863,500**	**29,352,000**

Annex 8: Characteristics of the Selected SWDS for Phase I and of the WtE for Phase II

FOD Parameter			Units	Tripoli	Zahle	Hbaline	Srar	GBA
Project commissioning year			Year	1998	2003	1986	1998	2025
Waste deposited/burned			t/yr	146,000	61,200	29,200	54,750	590,000
Load			h/yr	-	-	-	-	7300
Deposition trend			-	constant	constant	constant	constant	-
Landfill closure			Year	operational	operational	operational	operational	-
Waste conditions				wet	wet	wet	wet	wet
Waste fraction	Wood/wood products	j	% wt.	2	2	2	4	1.0
	Pulp/paper/cardboard	j	% wt.	17	17	17	15	15.6
	Food/food waste/ beverages/tobacco	j	% wt.	50	50	50	55	51.4
	Textiles	j	% wt.	3	3	3	3	3.0
	Garden/yard/park waste	j	% wt.	0	0	0	0%	0
	Glass/plastic/metal/other inert	-	% wt.	28	28	28	23	29.1
Regional climatic conditions				tropical	temperate	tropical	tropical	temperate
Regional precipitation conditions				dry	dry	dry	dry	Dry
Decay rate	Wood/wood products	k_j	1/yr	0.025	0.02	0.025	0.025	0.02
	Pulp/paper/cardboard	k_j	1/yr	0.045	0.04	0.045	0.045	0.04
	Food/food waste/ beverages/tobacco	k_j	1/yr	0.085	0.06	0.085	0.085	0.06
	Textiles	k_j	1/yr	0.045	0.04	0.045	0.045	0.04
	Garden/yard/park waste	k_j	1/yr	0.065	0.05	0.065	0.065	0.05
	Glass/plastic/metal/other inert	k_j	1/yr	0	0	0	0	0
DOC content	Wood/wood products	DOC_j	% wt.	43	43	43	43	43
	Pulp/paper/cardboard	DOC_j	% wt.	40	40	40	40	40
	Food/food waste/ beverages/tobacco	DOC_j	% wt.	15	15	15	15	15
	Textiles	DOC_j	% wt.	24	24	24	24	24
	Garden/yard/park waste	DOC_j	% wt.	20	20	20	20	20
	Glass/plastic/metal/other inert	DOC_j	% wt.	0	0	0	0	0
Degradable DOC fraction which degrades actually		DOC_f	-	0.77	0.77	0.77	0.77	0.77
Methane correction factor		MCF	-	1.0	1.0	0.8	0.8	1.0
Fraction of methane in LFG		f_{LFG}	-	0.5	0.5	0.5	0.5	0.5

Oxidation factor	*OX*	-	0.1	0.1	0.0	0.0	0.0
Fraction of methane captured in the baseline	$f_{CH4,BL}$	-	0.0	0.0	0.0	0.0	0.0
Model correction parameter for uncertainties	*Phi*	-	0.9	0.9	0.9	0.9	0.9
Fraction of methane captured in the baseline	$f_{CH4,BL}$	-	0.0	0.0	0.0	0.0	0.0
Global warming potential	GWP_{CH4}	t CO_2e/ t CH_4	25	25	25	25	25