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Assessment of Solid Waste Management Practices in Lebanon in 2015

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Abbreviations

CDR	Council for Development and Reconstruction
CEWEP	Confederation of European Waste-to-Energy Plants
CFCs	Chlorofluorocarbons
CO	Carbon Monoxide
CoM	Council of Ministers
EIA	Environmental Impact Assessment
ELV	Emission Limits Values
EMP	Environmental Management Plan
EPR	Extended Producer Responsibility
ESFD	Economic and Social Development Fund
EU	European Union
GBA	Greater Beirut Area
GHGs	Greenhouse Gases
GoL	Government of Lebanon
HBr	Hydrogen Bromide
HCFCs	Hydrochlorofluorocarbons
HF	Hydrogen Fluoride
Hg	Mercury
IMF	Independent Municipal Fund
ISWMP	Integrated Solid Waste Management Plan
LBP	Lebanese Pound
METAP	Mediterranean Environmental Technical Assistance Program
MoE	Ministry of Environment
MoEW	Ministry of Energy & Water
MoF	Ministry of Finance
MoIM	Ministry of Interior and Municipalities
MSW	Municipal Solid Waste
NGO	Non-Governmental Organisation
NOx	Nitrogen Oxides
OMSAR	Office of the Minister of State for Administrative Reform
PCBs	Polychlorinated Biphenyls
RDF	Refuse Derived Fuel
SEA	Strategic Environmental Assessment
SO2	Sulphur Dioxide
StREG	Support to Reform – Environmental Governance
SW	Solid Waste
SWAM	Upgrading Solid Waste Management Capacities in Lebanon
SWEMP	Solid Waste Environmental Management Project
SWM	Solid Waste Management
VOCs	Volatile Organic Compounds
WtE	Waste-to-Energy

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1 INTRODUCTION

1.1 Background

In August 2014, the StREG programme responded to Ministry of Environment's (MoE) request for preparing a Strategic Environmental Assessment (SEA) of the Draft Long-Term Strategy of Solid Waste Management (which will be refered to hereafter as "the SWM Plan").

In Lebanon, the SEA decree has been endorsed and issued by the Lebanese government as decree No. 8213, dated May 24, 2012, and it sets principles and measures necessary to assess the environmental impacts of policies and developments planned for a large area or a whole sector in Lebanon.

As such, a team of experts was called upon to prepare the SEA in line with national regulations; Table 1 below presents the various stages of an SEA along with the requirements of each stage.

However, the timing of this task has coincided with an extensively unclear and changing situation regarding SWM in the country, including the "SWM Plan" which the SEA should consider.

As such, the SEA team has faced several changes in the "the SWM Plan" which needs to be used as a basis for the SEA assessment for 3 consecutive times:

I. In August 2014, at the start of the SEA process, the "SWM Plan" was considered to be the Draft National SWM Plan for Lebanon which was prepared in February 2013 by a Ministerial Committee appointed by the Council of Ministers (CoM);

II. In October 2014, the "SWM Plan" was changed to be substituted by the requirements of the CoM Decision 46 (dated 30/10/2014) related to the solid waste sector;

III. In January 2015, the "SWM Plan" was modified again to reflect the amendments to the CoM Decision 46 (dated 30/10/2014) on SWM, which were issued under the CoM Decision 1 dated 21/01/2015.

Until August 2015, and while the SEA experts were gathering needed data for the assessment of the "SWM Plan" and its alternatives, it was clear that additional CoM decisions were in the making and that any further changes could not be accommodated by the SEA experts given the end of the experts' mission. Moreover, in light of the national debate regarding the socio-economic as well as environmental considerations for SWM planning at that time, it was not possible to conduct a consultative process as called upon by the SEA decree.

As such, the SEA process was interrupted in August 2015, and the experts were requested to reshuffle the available information in the form of a SWM assessment report. Due to lack of time and other emergencies at the level of the concerned experts, the report could only be finalised in December 2016.

Despite the delay in finalising this report, the information provided as part of the SEA exercise can be considered as a baseline which can be further used in the national planning process of solid waste management in Lebanon as well as in the preparation of an SEA for a future "SWM Plan" in Lebanon.

Table 1: Overview of SEA process requirements

No	Stages	Description
1.0	Screening	▪ Determination whether the proposed strategic action (plan or programme) requires SEA
1.1	Scoping	▪ Delineation of the zone of influence of the proposed plan or programme (Geographical coverage, sector of activity and social groups); ▪ Establishment the range of issues and level of detail to be included in the assessment; ▪ Determination of data collection requirements
1.2	Stakeholder engagement	Engagement / involvement of all interested / affected parties in the process; Determination of what trade-offs are acceptable Identification of implementation needs and mechanisms
1.3	SEA	Assessment of environmental impacts of a policy, programme, study, investment, or organisation proposals as a way to combat or at least reducing sources of pollution and degradation of natural resources
1.3.1	Analysis of alternatives	Identification, comparative analysis and evaluation of the different alternatives; Determination of the consistency of the components with pre-set objectives and priorities; Evaluation of the compatibility with current legal, institutional and planning frameworks; Determination of the "most suitable scenario"
1.3.2	Impact assessment and mitigation measures including Environmental Management Plan (EMP)	Identification, assessment of the impacts of the most suitable strategic option selected; Preparation of an EMP for reducing or eliminating negative impacts and enhancing environmental opportunities
1.4	Review and integration of results to the Strategy / Plan / Programme	Ensuring that the assessment has proceeded in a scientific and objective manner; Verification that all significant impacts have been considered; Determination whether the "most suitable strategic option" has been proposed; Determination of the feasibility and suitability of the EMP; Review, amendment or reformulation of the proposed plan or programme
1.5	Decision making	Decision whether to adopt, amend or reject the proposed plan or programme
1.6	Monitoring	Environmental performance evaluation with respect to set environmental objectives; Monitoring implementation with regards to the environmental parameters and assessment of the continued suitability of the EMP

1.2 Structure of the report

As indicated above, this report was initially planned as a Strategic Environmental Assessment of the Draft Long-Term Strategy of Solid Waste Management. However, due to various changes in the SWM decisions in the country since the start of this assessment, it was agreed to revise the report in a way as to report on the information generated under the SEA exercise.

As such, this report was re-structured from its initial form as an SEA report in order to reflect the following elements, which have been gathered as part of the SEA process and includes the following main components:

- A description of the baseline conditions related to SMW in Lebanon in 2015;
- A description of the SWM scenarios identified as part of the SEA process of the "SWM Pan" agreed upon in 2015;
- Recommendations of relevant solid waste management options for Lebanon.

The overall goal of the report is to document the process and information gathered as part of the SEA process in order to use it as a tool in future by the Ministry of Environment (MoE), as well as relevant authorities dealing with the sector, namely the Ministry of Interior and Municipalities (MoIM), the Council for Development and Reconstruction (CDR), the Office of the Minister of State for Administrative Reform (OMSAR) and ultimately the Municipalities and/or the Unions of Municipalities.

1.3 Historical overview of the SWM sector in Lebanon

Various efforts have been deployed by the GoL to organise the SWM system in Lebanon and to improve the treatment and disposal of the waste nationwide. Despite the numerous attempts and efforts in this regards, it is commonly accepted, that up to this date, there is no well-defined national solid waste management policy in the country. All efforts invested have been hindered by the lack of agreement among the key players in Lebanon's SWM system.

Although Lebanon does not enjoy the strict regulatory framework for environmental assessment and protection that has been developed throughout Europe and North America during the last two decades, it is a signatory to a number of international conventions related to environmental protection. Both pre-war and recent legislation make provision for environmental policies to be enforced through appropriate legal and administrative procedures; however, their implementation remains weak.

Indeed, management of solid wastes in the country still does not benefit from a well-defined national SWM policy to define the overall tools or means for achieving goals and for combining forces between the key SWM players in the country.

No national consensus was reached on a specific SWM strategy despite the various attempts and efforts put in place by the various stakeholders to set SWM plans. These SWM plans were variable depending on the stakeholder's view, starting from the plans set to date.

A historical overview of the different attempts to develop a SWM Strategy and Plan for the can be summarised to the following steps and are described in the sections below:

- The 1997 Emergency Plan;
- The 2006 Master Plan for SWM;
- The 2010 Strategy for SWM (according to CoM Decision 55/2010, dated on 01/09/2010);
- The CoM Endorsement of the draft Law on ISWM in Lebanon, dated 10/01/2012;

- The 2013 Draft National Master Plan;
- The CoM Decision 46 dated 30/10/2014 as amended by CoM Decision 1 dated 12/01/2015;
- Other major developments to the sector since September 2015.

1.3.1 The 1997 Emergency Plan

In 1997, in consultation with the MoE, the CDR adopted an Emergency Plan for MSW management in GBA (Decision Nº 58, dated 2/01/97). Originally, the Plan only covered the Greater Beirut Area. However, in 1997 and 1998 the area of MSW collection was extended through several amendments made to the collection contract of Sukleen. By 2015, the Service Area (Extended GBA) covered the District of Beirut (Beirut City) and the Cazas of Kesrouan, Chouf, Metn, Baabda and Aley, except for the caza of Byblos.

When implementing the Emergency Plan, MSW management was contracted to Averda Group companies (Sukkar Engineering) where Sukleen was contracted the provision of MSW collection and public sweeping services, and Sukomi, the operation of the Quarantina and Amroussieh Sorting Facilities, the Coral Composting Plant and the BourjHammoud Warehouse Facility, and the operation of the Naameh Sanitary Landfill and the Bsalim Landfill for Bulky items. The supervision of the MSW collection (Sukleen) was handled by D.G. Jones while the supervision of the processing plants (MSW treatment) and the Naameh Sanitary Landfill (MSW disposal) (Sukomi) was done by LACECO.

1.3.2 The 2006 Master Plan for SWM

In an effort to organise the Municipal SWM system in Lebanon, to improve the treatment and disposal of the waste nationwide, the 2006 SWM Master Plan has been established, prepared by the MoE and the CDR as called for by the Council of Ministers (CoM) (Decision 1/4952 dated August 18th, 2005). The 2006 Master Plan for SWM constitutes an Integrated Municipal Solid Waste Management system that covers all of Lebanon for a period of 10 years. The 2006 Plan was approved by the CoM in Decision Nº 1 dated 28 June 2006 and mainly covered the following:

- Recycling and composting should form a basic practice in the plan, which will reduce the quantity of dumped waste;
- Lebanon is divided into four Service Areas, each constituting of two Governorates: Beirut & Mount Lebanon / North & Akkar / South & Nabatiyeh / Bekaa & Baalbek-Hermel;
- Distribution of recycling, sorting and composting plants on all Cazas with one or more sanitary landfills in each service area. Sorting and composting facilities should be built in each of the 25 Cazas, with only eight disposal sanitary landfill sites being constructed (2 per service area), in addition to Bsalim for inert materials to serve Greater Beirut Areas (GBA) and Mount Lebanon;
- Incentives should be created to encourage municipalities where the plants/landfills will be located. These municipalities will be paid a certain amount per every tonne of solid waste, as proposed in the plan, and according to laws and decrees that will be issued in this respect;
- Each municipality is responsible for sweeping, collection and transporting its generated waste to the plants on its own expense;
- The selected Contractor shall be responsible for financing the relevant study, executing and preparing the sanitary landfills, sorting stations and composting plants. The Contractor is responsible for managing operations in the facility for a period of 10 years and shall be paid for every tonne of waste transported to and treated at the proposed site.

However, this Plan was not implemented, since it did not obtain clearance of the corresponding EIAs by the MoE, as well as due to objection from some communities regarding foreseen site locations.

Following the 2006 Master Plan, few outcomes were witnessed. The Lebanese government did not succeed in building any of the proposed plants and landfills, although some small-scale facilities that complement the master plan were implemented with grant funding.

1.3.3 The 2010 Strategy for SWM (according to Decision 55/2010)

Since the 2006 Master Plan failed in achieving the expected outcomes, the CoM issued Decision N° 55 (dated September 1st, 2010) to amend and complement the 2006 Master Plan.

A new strategy for SWM in all Lebanese districts was accordingly put forth by the ministerial committee mandated by Decision 1 of the council of ministers on 30/03/2010. It is based upon the combination of using incineration and waste-to-energy in large cities and resorting to the strategy of 2006 in the rest of Lebanese districts (as well as studying the possibility of incineration in such areas). This strategy was accepted in its updated form by the CoM in light of the difficulty of finding sites for landfilling in large cities. It mainly consists of the following:

1. Adopt incineration and waste-to-energy technologies in large cities;
2. Adopt the 2006 master plan in the rest of the country;
3. Engage the private sector in the provision of SWM services, and encourage its participation by setting up incentives to promote safe and effective waste management (both fiscal and non-fiscal incentives); e.g., facilitate its roles in SWM so that it can participate through turnkey projects (from collection to treatment) or through various operations (1-collection 2-treatment);
4. Mandate MoE and CDR to reconcile and merge the two plans (2006 and 2010);
5. Mandate Ministry of Energy and Water (MoEW) to draft regulations for waste-to-energy generation by the private sector, i.e., propose a legislation for private sectors for the production and selling of the energy produced from incineration;
6. Incentivise municipalities that will host waste treatment facilities;
7. Mandate CDR, in coordination with MoE, to contract an international consulting firm to select the most appropriate and proven technologies (through due diligence), prepare related tender documents and supervise operations;
8. Mandate MoE to hire an international consulting firm to monitor system performance;
9. Mandate MoE to hire a local consulting firm to promote awareness of waste-to-energy;
10. Vest authority in the Prime Minister to oversee implementation and secure finances.

Based on item 7 of the CoM decision 55 of September 1, 2010, the CDR collaborated with Ramboll, an international engineering consulting company to prepare a feasibility study, pre-qualification documents and tender documents for SWM in Lebanon by integrating WtE through incineration. The study consisted of two phases.

- **Phase 1** included a comprehensive review of WtE concepts and its possible integration in a Lebanese context of SWM, including feasibility from a technical, economical, organisational and financial point of view;
- **Phase 2** consisted of discussion of procurement and prequalification strategies and tendering documents to be handled. Within the scope of the evaluation of integration of WTE technologies in the SWM system in Lebanon, several scenarios with variable degree of implementing WtE were evaluated;

This study showed that all scenarios were based on the fact that no WtE facility should be established in the Bekaa and Baalback-Hermel Service area in light of the following factors: fermentation of low amounts of waste, availability of land and prevalence of agricultural areas. In cases where WtE facilities are found unfeasible for their respective service areas, the original Master Plan of 2006 should prevail. Scenarios with one to three WtE facilities have been proposed and possible suggestions for location and sites were reviewed.

Some of the main conclusions and recommendations of this study are presented here below:

- WtE is found to be a possible option in Lebanon, however a lot of care should be given to the organisation of such facilities;
- Demand for WtE capacity should be evaluated carefully to avoid over-capacity;
- Due to relative low waste generation in Service areas 2 (North & Akkar) and 4 (South Lebanon & Nabatieh) and, combined with limited waste information, it would be beneficial to begin with implementation of one WtE facility in Service area 1 (Beirut & Mount Lebanon), as the marginal treatment cost including smaller plants in Service area 2 and 4 is very high. A treatment capacity of 2 x 40 t/h is proposed for Service area 1;
- The implementation of WtE facilities in Lebanon would be made in two steps:
  - Step one would consist of the establishment of one large plant serving the area with the highest population and waste generation which in this case is Service Area 1 (Beirut and Mount Lebanon). This first WtE facility shall be a large plant with a nominal capacity of 2x40 t/h, which is either built north or south of Beirut.
  - Step two will be the establishment of an additional smaller plant. This WtE facility shall be placed opposite the first facility relative to Beirut. In case step one implies a WtE facility south of Beirut, the second WtE facility shall be placed north of Beirut.

1.3.4 The 2013 Draft National SWM Plan

Based on item 4 of the CoM decision 55 of September 1, 2010, and further to the CoM No. 52 dated January 9th, 2013 pertaining to the assignment of the Ministerial Committee mandated to prepare a national SWM strategy for Lebanon, a proposal was issued on 2 February 2013. The proposal was presented in answer to the urgent need of addressing SWM in Lebanon in terms of effective execution in its various folds, namely technical, financial, institutional, awareness, as well as legal.

The Draft Plan stipulates certain compelling conditions to drive to its success across three areas:

With regards to the collection and sweeping of solid wastes

- Sweeping, collection and transport to treatment plants fall within the responsibility of the municipalities.
- Preparing unified standard terms of reference to be adopted by all municipalities for the contracting of waste sweeping and collection works in all Lebanese regions.

With regards to solid waste treatment

- Financing the treatment of solid waste from the government global budget.
- Adopting the integrated plan mentioned in the report.
- Call for international tenders, contract all works within a single unified terms of reference document and confirm the deadlines set to complete phase 2 of Ramboll's contract set.
- Determining a site to dump all exhausts generating from the incineration plant of the Governorate of South and Nabatiyeh.
- Commissioning of the Ministry of Energy and Water to propose a legislative text guaranteeing the right of the private sector for the production and selling of the power generated from waste decomposing.

- Providing incentives to municipalities that will receive the various constructions of waste management from thermal decomposition plants, to transfer stations, to composting plants and landfills.
- Promulgating the draft law prepared by the Ministry of Environment on solid waste management in Lebanon and the applied decrees thereto with regards to determining the institutional, legal and financial frames of this sector.

With regards to overseeing the monitoring of the implementation of constructions, operations and maintenance

- Requesting the CDR in cooperation with the Ministry of Environment to perform an international call for tenders to enter into contract with an international consultant to carry out the monitoring of the implementation of constructions, operations and maintenance.

The proposed locations and types of waste management facilities in Lebanon as proposed in the Draft Plan of 2013 are in Table 2 below and represented in Figure 1 below. It is to be noted that this proposal was formally submitted by the Vice Prime Minister, in his capacity as President of the 2013 Ministerial Committee, in March 2013. Few weeks later the Prime Minister resigned and accordingly the plan could not be formally endorsed.

Table 2: Summary of the 2013 Draft National SWM Plan

	Service Region	Construction Cost of sorting and composting plants and sanitary landfills (USD Million)	Construction Cost of thermal decomposition plants (USD Million)	Annual Operation cost (USD Million)
1	Akkar	5	---------	4
2	Baalbek Hermel	2	---------	3.5
3	Zahle	1	---------	3.5
4	Central Bekaa, Western Bekaa, Rachaya	6	---------	4.5
5	Governorate of South and Nabatiyeh	17	200	28.5
6	Governorate of North	20	200	17
7	Governorate of Beirut and Mount Lebanon	6	550	53
	TOTAL	57	950	114

Figure 1: Proposed plan for municipal solid waste management (2013)

1.3.5 Decision 46 of 30 October 2014 amended by Decision 1 of 12 January 2015

In February 2014, following more than 11 months of a resigned government, a new Government was formed which considered solid waste as its priority. Accordingly, few weeks laters, a ministerial committee was established headed by the Prime Minister and few months later, on 30 October 2014, the CoM issued Decision 46, which amongst other tasks, called upon CDR to:

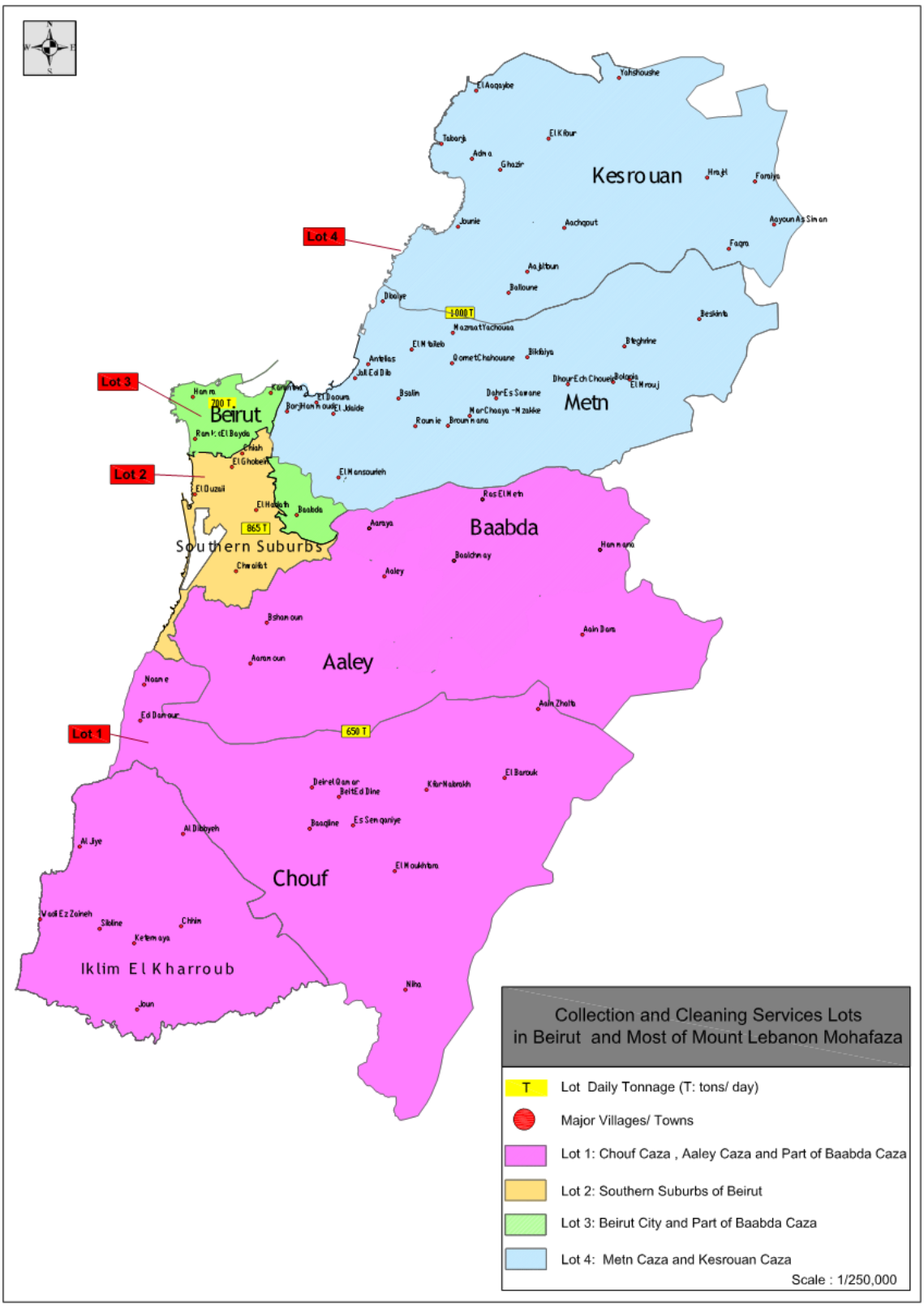
- prepare ToRs for an open tender to take place so that to start the solid waste collection and transportation in Beirut governorate, most of Mount Lebanon governorate and North Lebanon governorate;
- prepare ToR for a tender to take place to start the solid waste management operations, through separation, composting, energy recovery, and landfilling in Beirut governorate, most of Mount Lebanon governorate and North Lebanon governorate.
- request from the International Consultancy Ramboll to continue with the second phase of its contract, which pertains to preparing the documents for thermal disintegration tenders, these documents should be completed within maximum 6 months from the date of this decision.
- continue working temporarily with the current household solid waste plan to secure services for a duration that does not exceed three months extendable for one last and final time for another 3 months.

The above-mentioned areas were divided as shown in Figure 2 below and included Beirut Governorate and most of Mount Lebanon Governorate, North Lebanon Governorate.

However, a few months later and in order to have a plan which covers all Lebanese territories, another CoM Decision was issued on 12 January 2015 (Decision 1) amending CoM Decision N° 46 dated 30 October 2014.The amended CoM Decision N° 1 of 12 January 2015 mainly differs from the previous one in the following way:

- Defining a revised distribution of the service areas aiming at a more defined global coverage.
- Setting waste recovery targets as follows: recuperating 60% of the waste through separation, recycling and composting as well as energy regeneration in the first three years of the contract; and 75% in the following years until Lebanon reaches the stage of thermal disintegration (including RDF, or incineration or other
- Merging the tenders for all SW services from street sweeping to waste collection, transportation and treatment into one tender, hence giving the Contractor full responsibility for the whole service within his service area.
- Mandating the Contractor (in addition to selecting the sites hosting the treatment facilities from a set list – see bullet below – and provided the selected site meets a set of environmental criteria to be set in the tender documents) to propose the mode / technique adopted for the SW treatment based on a list of approved technologies to be set in the tender documents following best international practice. This approach allows for more flexibility and opens the possibility for the public sector to reach an optimised selection of the most suitable treatment mode in correlation with the local conditions and constraints, and with the acceptable technico-financial and socio-economico-political factors and parameters. This approach would potentially lead to a successful implementation by the private sector where the public initiative was hindered by major reluctance and the Government was not able to impose the sites hosting the treatment facilities.
- Limiting the selection of the landfill sites to those locations that have been identified by the MoE to be in need of rehabilitation, namely quarries, open dumps or other degraded sites and annexed to the CoM Decision 1 of 12 January 2015 – noting that, and as per the CoM Decision 1/2015, the Government would facilitate, as needed, the selected contractors' access to the proposed and approved sites.

Figure 2: Proposed Solid Waste Chatchment areas (Lots) in Beirut and Mount Lebanon as per CoM Decision 46 of 30.10.2014



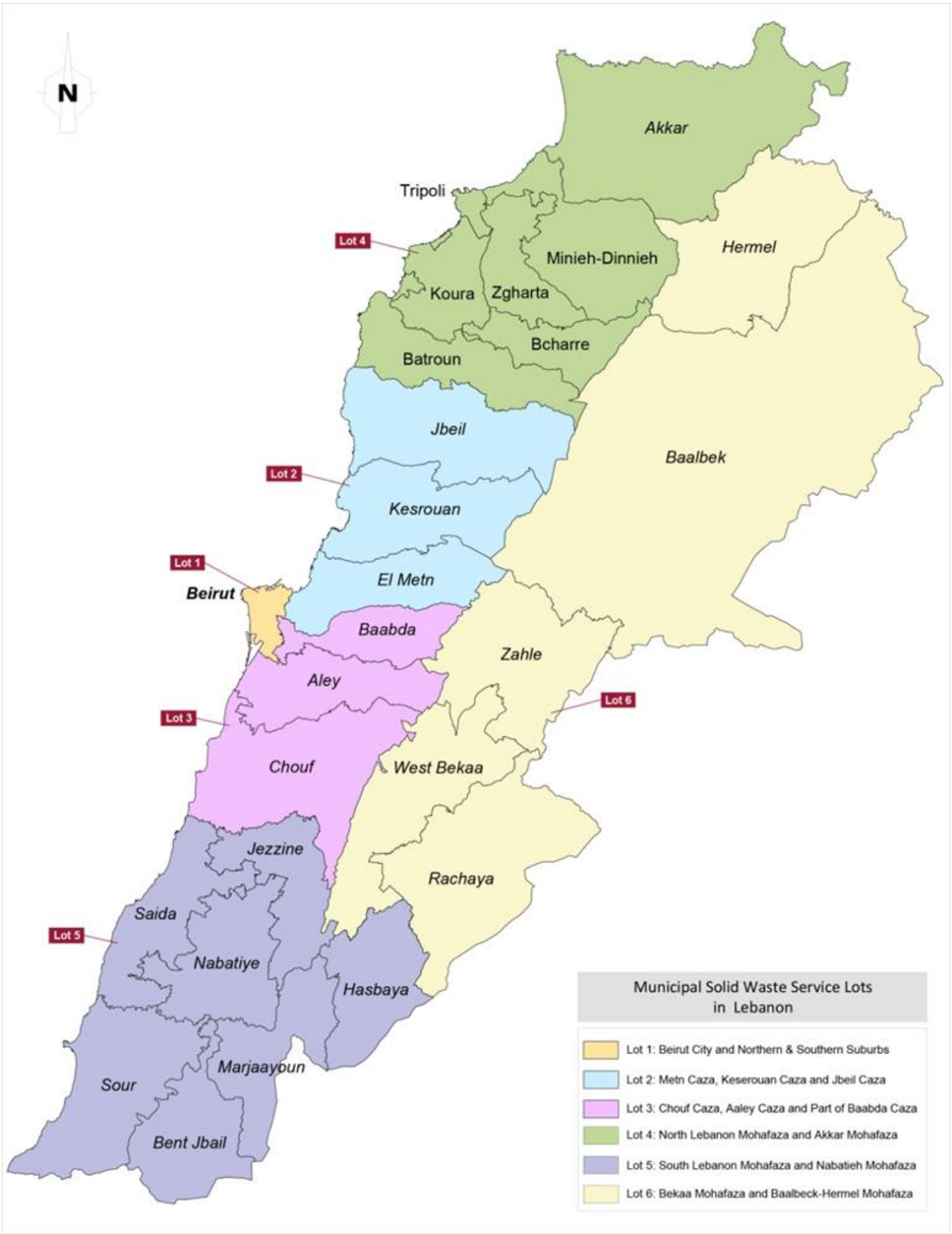
According to this decision, the new geographical Lots that will be the waste catchment areas that each tender will be serving are indicated below and presented in Figure 3 below:

- *Lot 1. District of Beirut and its Suburbs* which comprises the following localities, areas, and neighborhoods: Ghoubeiry, Chiah - Ain Remmaneh, Bourj el Brajneh, Haret Hreik, Furn el Shebbak, El Mraiyje, Hadat, Bourj Hammoud, Sin el Fil and neighborhoods of Hai El Sollom and Amroussieh and Lailaki located in Choueifat Municipality.
- *Lot 2: Byblos Caza and Kesrouan Caza and Metn Caza* (except for the municipalities included in Lot 1(District of Beirut and its Suburbs)).
- *Lot 3: Chouf Caza and Aaley Caza and Baabda Caza* (except for the municipalities and neighborhoods included in Lot 1(District of Beirut and its Suburbs)).
- *Lot 4: North Lebanon Governorate and Aakkar Governorate*
- *Lot 5: South Lebanon Governorate and Nabatieh Governorate*
- *Lot 6: Bekaa Governorate and Baalbeck – Hermel Governorate*

As per the new Decisions, the existing facilities will continue to operate, whereas currently existing but non-operational facilities will need to become operational. The decision entails that the overall treatment schemes per waste catchment area will be determined by the tenderers utilising and taking into account existing or planned facilities.

Following CoM approval, the tenders for waste collection, treatment and final disposal in six service regions were launched and repeated twice for Lots 3, 4, 5 and 6, and 3 times for Lot 1 during the February 2015-July/August 2015. The tenders were evaluated in the July-August 2015 period by a committee headed by the Minister of Environment, and which included representatives of the PCM, MoIM, MoF, OMSAR and CDR, as per CoM Decision 1/2015. The committee was supported by three international consulting firms. The financial bids were opened and accounced on August 24, 2015, resulting in an average price of USD 120 per tonne (including capital costs) for the services of collection, transport, treatment – sorting, composting, and energy recovery – and final disposal. However, the results of these bids were refuted by the CoM one day later in Decision N^{o} 1 dated 25 August 2015.

Figure 3: Proposed Solid Waste Catchment areas (Lots) in Lebanon as per CoM Decision No. 1 of 12 January 2015



1.3.6 Most important SWM planning changes since September 2015

As of September 1st, 2015, and following the CoM's refusal of the bids results on August 25, 2015 while waste had been piling up in the streets of Beirut and the majority of Mount Lebanon since around mid-July 2015 (date of closure of the Naameh sanitary landfill), the Minister of Agriculture (MoA) was mandated to propose a solution to the crisis. Accordingly, the country witnessed an important number of CoM decisions related to SWM, which include the following:

CoM Decision 1 of 9 September 2015

The first decision was issued on 9 September 2015 (Decision 1) based on the findings of a technical committee established by the MoA. This decision called upon the adoption of the principles of decentralisation and giving the municipalities and union of municipalities a role in upholding responsibility of the SWM for a sustainable period and in accordance with implementation mechanisms set for this purpose, as an intrinsic part of the transitional SWM treatment period.

It also requested the adoption of two sanitary landfills to be set up and made operational for an interim period of 1.5 years in accordance with environmental standards in the area of Srar in the Akkar and the Masnaa area in the Anti-Lebanon Mountains. This decision, however, could not be implemented due to the objection of the local communities.

CoM Decision 1 of 21 December 2015

Since the interim solution proposed as part of the CoM Decision 1 of 9 September 2015 could not be implemented, the CoM issued another decision on 21 December 2015 (Decision 1). This decision approved, for an interim period, the commissioning of CDR to outsource the export of municipal wastes resulting from the governorate of Beirut and part of the governorate of Mount Lebanon outside the Lebanese territory and to dispose of them in accordance with the local laws, the international treaties that were concluded and enforced regarding the transport, treatment and disposal of wastes, in accordance with the provisions stipulated in this decision. However, the Decision was not implemented as the export of waste could not take place.

Amongst others, this Decision also called upon the implementation of the decision of the Council of Ministers dated 09/09/2015, for the formation of the centralised technical team, which should support the Ministry of Interior and Municipalities to supervise the best application of the SWM plan.

As such, the following team would work under the direct supervision of the Minister of Interior and Municipalities:
The representative of the Ministry of Interior and Municipalities;
The representative of the Ministry of Environment;
The representative of the Ministry of Finance;
The representative of the Office of the Minister of State for Administrative Reform;
The representative of the Council for Development and Reconstruction.
It also called for this team to cooperate with the following institutions:

A group of experts from UNDP;
A representative of the Lebanese Transparency Association;
A representative of the academic sector selected by the Minister of Interior and Municipalities;
A representative of an environmental NGO selected by the Minister of Interior and Municipalities.

On 27 July 2016, the CoM issued Decision 1 amending Article 5 of the CoM Decision 1 of 21 December 2015 in a way that the centralised technical team, formed to supervise the best application of the domestic solid waste management plan as per Decision 9/9/2015, would work under the direct supervision of the Minister of Agriculture instead of the Minister of Interior and Municipalities.

CoM Decision 1 of 12 March 2016 and its amendments of CoM Decision 1 of 17 March 2016

Given that none of the immediate solutions devised in the former CoM decisions was implemented while waste continued to pile up in most of the Mount Lebanon area, the CoM issued an emergency decision on 12 March 2016 (Decision 1) and introduced some amendments to it one week later (Decision 1 of 17 March 2016). This decision approved the establishment of one temporary sanitary landfill in Bourj Hammoud, Jdeideh – Bouchrieh – El Sed, and another temporary sanitary landfill in Ghadir River estuary, which will be accompanied by handling the removal of the Open Dump in Borj Hammoud and embankments near Ghadir River estuary taking into consideration that the amount landfilled in the centres in Borj Hammoud and Jdeideh – Bouchrieh – El Sed should not exceed the amount produced from sorting 1,200 tonnes/day of solid waste.

The decision also approved a sanitary landfill and treatment centres for the Chouf and Aley districts (exact location to be determined at a later stage). It also stated that the treatment and sorting plants and the sanitary landfills are established and developed in accordance with the scientific and environmental regulations and in coordination with the relevant municipalities especially regarding monitoring filters, amounts of rejects and ensuring the continuous availability of electricity.

The decision approved the distribution of the wastes resulting from Beirut's administrative region over the new sanitary landfills, and in the Saida Treatment Plant.

Among others, it also requested that the the sanitary landfills are established and developed in accordance with the scientific and environmental regulations and in coordination with the relevant municipalities especially regarding monitoring filters, amounts of rejects and ensuring the continuous availability of electricity. The Decision mandated CDR to manage all related bids.

It stated that municipalities or municipal unions or the service-regions are entitled to manage the treatment of their wastes, under their full responsibility if they wish, with the approval of the technical committee established by CoM Decision N^{o} 1 dated 21/12/2015.

The lifetime of the plan devised under this Decision is four years, after which the waste-to-energy facility/ies foreseen under the CoM Decision 55/2010 would become operational. Unlike former plans, this plan was immediately executed, with some delay for the Bourj Hammoud – Jdeideh-Bouchrieh-El Sed site.

2 BASELINE CONDITIONS IN 2015

This section provides the legal, institutional and operational basis in place in 2015 with regards to the SWM sector in Lebanon. Available baseline data was collated from a number of sources and references and is presented in the following sub-sections.

2.1 National legislative framework

There are significant gaps on the Lebanese legislative framework regarding solid waste management. The main existing legislation dedicated to SWM are the following:

The draft Law for Integrated SWM (ISWM) was prepared in 2005 and was approved by the CoM in 2012 (under decree number 8003 dated 23/4/2012) but is still awaiting approval by the Parliament

The MoE of Circular No. 8/1 dated 16/11/2015 related to guidance on integrated management of municipal solid waste as published in issue No. 47 of the Official Gazette dated 19/11/2015.

Other legislation consists of fragmented regulations not specifically related to solid waste but are rather dealing with environmental and/or are relevant to the waste sector and are covered in several sectoral legal frameworks including the following topics: Healthcare Waste; Industrial / Hazardous waste; Energy; ELVs; Compost Ordinance.

Overall, the gaps and challenges of the SWM sector in Lebanon exist at both development and application level:

Development challenges

1. To date, there is no specific legislative framework that deals directly with solid waste management in Lebanon in an integrated approach. A number of laws, decrees, and ministerial decisions govern environmental management in Lebanon including SWM, some dating back to the 1930s;
2. The existing legislation is largely fragmented and does not specifically deal with solid SWM. Generally, regulations are lacking in terms of clarity and precision;
3. Also, the existing laws do not include a clear definition of the solid waste and do not distinguish between waste from domestic sources and waste from non-domestic sources (industrial, healthcare, slaughterhouse, agricultural, etc);
4. The sector also lacks (i) a framework for SWM financing and cost recovery and (ii) a potential role and incentive for private sector participation and investment in the sector.
5. Where national laws are existent, they most often lack the necessary application decrees allowing their effective enacting;

Application challenges

1. At the institutional level, and given the absence of an integrated law, responsibilities are not well-defined, and co-ordination between authorities is not always optimal;
2. Enforcement is practically non–existent due to staffing constraints, lack of proper training, low level of fines, and political interferences, inter alias;
3. Equally important is the lack of awareness of regulations amongst personnel who are supposed to enforce them (i.e. health inspectors, police officers), as well as the general public that is supposed to abide by them. This, in turn, has led to the consequence that the country suffers from a lack of national leadership in the sector, which is hampering the development of an organised SWM scheme in Lebanon.

2.2 Institutional setup

2.2.1 Municipalities and their roles in SWM

Lebanon has more than 1000 municipalities organised according to Decree 118 (dated 30/6/1977). Municipalities are local administrations charged with the day-to-day management of all public works located inside their jurisdiction (municipal boundaries). Specific responsibilities include landscaping and beautification works, maintenance of water and wastewater networks, street lighting, waste disposal, internal roads, recreational facilities, as well as urban planning in coordination with the Directorate General of Urban Planning.

Municipalities are considered as key players and actors in the management of municipal solid waste. The Decree Nº 8735 (dated 23/8/1974) on the maintenance of public cleanliness sets the responsibility of municipalities for the collection and disposal of household wastes, and the Health Council of the Governorate should approve the location of waste disposal sites. Moreover, the Municipal Law Nº 118 of 1977 authorises municipal councils to build solid waste disposal facilities. Municipalities report to the local governor and the Ministry of Interior and Municipalities (MoIM), which manage the allocation and distribution of funds from the IMF, under the control of the Ministry of Finance.

Revenues of Municipalities mainly include municipal taxes and other fees levied by the municipality as well as transfers from the Independent Municipal Fund (IMF). However, the allowances are several years behind so municipalities resort to quick solutions and fixes, including open dumping of waste. In this respect, several international development organisations (European Union, Italian Cooperation, Spanish Agency, USAID, etc.) have stepped in by providing direct technical and financial support to individual municipalities and groups of municipalities. In very rare cases, the municipalities benefited from donor support to build an integrated SWM system, and relied on municipal taxes and gate fees for the operation and maintenance of this facility – see the case of Zahle in section 2.3.

It is to be noted that Decree Nº 9093 (dated 15 November 2002) as well as Decree 1117 of 2008 provides financial incentives to municipalities for hosting SWM facilities or landfills. Law 280 of 30 April 2014 reiterates the same general principle, and also applies it onto thirteen municipalities that surround the Abei and Ein Drafil landfill.

2.2.2 Central government and its role in SWM in Lebanon

Ministry of Environment

According to MoE's new organisational structure (Decree No. 2275, dated 15 June 2009), solid waste issues fall under the Service of Urban Environment (Department of Urban Environmental Pollution Control). Notwithstanding resource availability, the Department should:

1. Prepare draft strategies, plans, programmes, executive projects, activities, and studies that make the urban environment better matched with natural resources, especially through an integrated management of solid, liquid, municipal, industrial, and hazardous waste.
2. Review all studies and tender documents related to solid waste and wastewater treatment plants.
3. Participate in committees for the reception of works linked to SWT facilities and landfills.
4. Prepare and formulate Master plan for the management of MSW.
5. Define environmental limit values for the disposal of non-hazardous solid waste (and liquid waste) in water bodies and on soil.

As per the same Decree, the Department of Integrated Environmental Systems is designated responsible for EIAs and IEEs; and the Department of Environmental Policy is designated

responsible for managing the SEA system for policies, plans, and programmes and the public sector. As per Decrees 8213/2012 and 8633/2012, MoE is the entity designated to review the scoping reports as well as main reports of EIA/SEA, to periodically assess the results and mechanism of SEA, and to monitor EIAs throughout the construction, operation, and dismantling phases. Empirically, MoE has prepared environmental guidelines for the construction and operation of sorting and composting plants, and sanitary landfills, as well as compost guidelines (unpublished). Most importantly, MoE prepared in 2005 a draft law on ISWM (section 2.1) and was involved in the preparation of several plans (section 1.3).

Ministry of Interior and Municipalities

As per section 2.2.1, the legal framework clearly assigns the responsibilities of waste collection, disposal and management operations at the sub-national level to municipalities (according to Law N^{o} 118 of 1977), which are represented by MoIM at the national level. CoM Decision 1 of 17 March 2016 tasked the Minister of Interior and Municipalities to prepare a draft law for the incentives provided to those municipalities that host landfills.

Council for Development and Reconstruction

The CDR is a public authority established in early 1977 by Legislative Decree N^{o} 5, whose role was later amended by several legislative decrees, in partial replacement of the Ministry of Planning, to be the government unit responsible for reconstruction and development. It lends support to the CoM and manages infrastructure projects financed through international loan agreements.

Whereas Law 501 (dated 6 June 1996) charged CDR with the implementation of the WB-funded Solid Waste Environmental Management Program (SWEMP), the programme was terminated and the loan was withdrawn after extensive delays and strong public opposition to proposed landfill sites, except for the case of Zahle (see section 2.3). At present, direct responsibility for MSW management in the Governorate of Beirut and much of the large area of Mount Lebanon, as well as Tripoli lies with the CDR, and to a lesser extent, the MoE and the MoIM (SweepNet, 2014). As earlier mentioned, CDR was involved in the preparation of several plans (see section 1.3).

Office of the Minister of State for Administrative Reform

The Office of the Minister of State for Administrative Reform (OMSAR) is a governmental organisation that seeks to develop the institutional and technical capacities of ministries, other government and public agencies, and municipalities. In 2005, and under the EU-funded programme Assistance to the Rehabilitation of the Lebanese Administration (ARLA), OMSAR launched a municipal SWM programme to improve the provision of solid waste services in rural areas. A new unit was created within OMSAR to manage the implementation of the €14.2 million EU-funded programme (to build and equip the facilities) and related investments worth $15 million from the national treasury (to operate and maintain the facilities) (MoE-UNDP 2010). In addition, OMSAR is assisting municipalities in the Beqaa Valley and Akkar with 3 years of operation of its SWM facilities with the financial support of the government through SWAM I and II programmes, which are the result of grant agreements from the EU, and whose budgets are €14 million and €21 million, respectively (SweepNet 2014).

2.2.3 Non-governmental organisations (NGOs)

CSOs have a major role to play in spreading awareness, building society's capacity and actively participating in WM efforts. These organisations are present throughout the Lebanese territory and are major partners in WM and the cleanliness of their communities. They have also played a watch-dog role by tracking any misconduct of parties involved in WM activities (UN Habitat 2015).

2.3 Status of SWM as of March 2015

2.3.1 Solid Waste Quantities and main characteristics

The *Country Report on the Solid Waste Management in Lebanon* (SWEEP-net, 2014) estimated that, in 2013, Lebanon generated about 2.04 million tonnes of Municipal Solid Waste (MSW).

Moreover, the Report stated that future waste generation is uncertain and no detailed comprehensive data is available on which to base estimates, particularly for the rural areas outside Greater Beirut. Based on waste management data obtained from the MoE as well as various studies undertaken in Lebanon, it could be considered that the MSW generation per capita varies from around 0.8 Kg/p/d in rural areas to around 0.95 to 1.2 Kg/p/d in urban areas. The country-weighted average of MSW generation is estimated to be 1.05 Kg/p/d (assuming a weighted average between urban and rural areas). The high production rate of 1.2 Kg/p/d mainly corresponds to the region of Beirut and part of Mount Lebanon.

Due to the increased migration from rural to urban areas and major cities during the past 20 years, a significant increase in the quantity of waste in Beirut and Mount Lebanon took place over the last years. The estimated quantities of MSW generated within the Greater Beirut Area and Mount Lebanon (excluding Jbeil Caza which is serviced through a private waste collection operator) in year 2013 was estimated to be 2,850 tonnes/day, compared to 2000 tonnes/day back in year 1999. Greater Beirut and Mount Lebanon, alone, generated 51% of the total MSW generated in the country. The estimates of waste generation per Governorate, are summarised in Table 3 below.

It is to be noted that CDR has carried out its own estimations of generated MSW quantities throughout the country.

Table 3: Waste generation per Governorate in 2013 (SWEEPNET, 2014)

Governorate	Daily Tonnage (tns)	Percentage of Country
Beirut	600	11%
Mount Lebanon	2,250	40%
South Lebanon and Nabatiyeh	1,000	18%
North Lebanon	1,000	18%
Bekaa	750	13%
Total	5,600	100%

As per measurements by the contractor carrying out collection, treatment and disposal services indicated that they had received 804,000 t/y of MSW (MSW from public institutions, commercial and industrial enterprises, bulky waste, street sweeping waste etc). Taking into account a population of 2,000,000 in Beirut and Mount Lebanon (excluding Jbeil Caza), the CDR adopted a 1.1 kg/capita/day MSW generation rate in this area.

Outside GBA and Mount Lebanon, there is no estimation of MSW quantities in the other Governorates (beyond contractor's service area). Most Cazas are characterised by rural structures, where much less MSW is usually generated. As such, the CDR adopted the following generation rates:

- 0.9 kg/capita/day for the urban centres of Tripoli and Saida; and

- 0.75 kg/capita/day for the remaining Cazas

The heavy-flow influx of Syrian displaced persons to the Lebanese territories since the Syrian conflict has had its implications on many vital sectors of the country. In terms of generated MSW, the incremental daily quantity of MSW attributed to displaced persons was estimated to be around 889 t/d (approximately 324,485 tonnes per year) in 2014. The incremental annual waste generated by displaced persons is significant and is equivalent to 15.7% of the SW generated by Lebanese citizens prior to the crisis (MoE/EU/UNDP, 2014).

Using these data and based on an estimated yearly increase in the waste generation rate of 1.7%, projected waste generation is given in the Table 4 below and which has been used as part of the SEA process referred to in the Introduction and Section 3 of this report.

Table 4: Projected waste generation in March 2015 for the years 2015, 2020, 2025

	2015	2020	2025
Waste generation (t/y)	2,263,000	2,445,500	2,664,500
Waste generation (t/d)	6,200	6,700	7,300

2.3.2 Existing & planned facilities as of March 2015

Due to the large number of SWM facilities, whether existing or planned, the following section will survey them according to geographic location (BML or outside BML) and to the function of the facility (full-cycle or partial system). It will conclude with a brief overview of those systems, whether full or partial, that had been under planning in March 2015.

2.3.2.1 SWM in the Beirut and Mount Lebanoon Area as of March 2015

In March 2015, the 1997 Emergency plan was still valid. As part of this plan, the following facilities were constructed with financing from the Lebanese Government.

Quarantina Sorting Facility

The Quarantina Sorting Facility is located along the seashore, northwest of Beirut, not far from densely populated residential areas (Mdewar, Rmeil, and BourjHammoud). The Quarantina Sorting Facility is composed of 4 sorting lines. According to the figures of year 2013 provided in the SWEEP-net country report on solid waste management in Lebanon (published in year 2014), the existing Quarantina Plant received in year 2013 incoming daily quantities of approximately 1,700 tonnes of commingled MSW. The initial design capacity of the Quarantina Sorting Facility is 1,100 t / d, as per the Solid Waste Management Emergency Plan (SWEMP) of year 1997.

Amroussieh Sorting Facility

The Amroussieh Sorting Facility is located South-east of Beirut, in an area that is densely populated and expanding. The Amroussieh Sorting Facility consists of two sorting lines. According to the figures of year 2013 provided in the SWEEPNET country report on solid waste management in Lebanon (published in year 2014), the existing Amroussieh Sorting Facility received in year 2013 an incoming daily tonnage of approximately 1,150 tonnes of commingled waste. The initial design capacity of the Amroussieh Sorting Facility was 600 t / d, as per the solid waste management Emergency Plan of 1997. At day, the Amroussieh Sorting Facility is operating beyond its capacity.

Coral Composting Facility

The Coral Composting Facility is located along the seashore, northwest of the city of Beirut, not far from densely populated residential areas (Bourj Hammoud) within the Metn caza. The MSW composting technology that is implemented by this Coral Composting Facility is the Mechanical Agitated Windrow Composting. According to the figures of year 2013 provided in the SWEEPNET (published in year 2014), the existing Coral Composting Plant received in year 2013 incoming daily quantities of approximately 300 tonnes of sorted organic waste from the Quarantina and Amroussieh Sorting Facilities.

Warehouse Storage Facility in BourjHammoud

The Warehouse Storage Facility is located along the seashore, northwest of Beirut, next to the entrance of the old BourjHammoud dumpsite. This Facility was initially conceived for the storage of bulky and recyclable materials. The recyclable materials are further separated into higher and cleaner qualities, baled or shredded and then sent to recycling companies. According to the figures of year 2008 provided in the State and Trends of the Lebanese Environment (MoE/UNDP/ECODIT, 2011), the existing Warehouse Storage Facility in Bourj Hammoud received in year 2008 incoming daily quantities of approximately 60 t/d, divided as: approximately 56 t/d recyclables and approximately 4 t/d bulky items from the operating Quarantina and Amroussieh Sorting Facilities.

Naameh Sanitary Landfill

The Naameh Sanitary Landfill is situated in the southern coastal zone of Lebanon, approximately 15 km South from Beirut. The site was formerly a quarry site located northwest of the deserted Ain Drafil village, about 4 km from the coast, at the junction of two tributaries of the El-Sawmaah perennial stream. According to the figures of year 2013 provided in the SWEEPNET country report on solid waste management in Lebanon (published in 2014), the existing Naameh Landfill in the caza of Chouf, Mount Lebanon Governorate, received in year 2013 incoming daily quantities of approximately 2,500 t/d.

Bsalim Landfill for Bulky Items

The Bsalim Landfill is located on the northern side of the Nahr el Mott valley in the Caza of Metn, about three kilometers from the coast. Materials accepted at the Landfill are restricted to inert material (such as shredded tires, subsoil, topsoil, rock, stone, clay, sand, tiles and slates, brick and concrete, silica, glass, pottery and cement) and wood (timber, shredded furniture and tree branches). The Bsalim Landfill for inert and bulky items received in year 2013, approximately 120 tonnes per day (SWEEPNET, 2014). The Bsalim Landfill for Bulky Items is expected to have a remaining short lifetime.

2.3.2.2 MSW Management outside outside Beirut and Mount Lebanon area as of March 2015

I. Full-cycle systems

I.1 Full-cycle systems – operational in March 2015

World Bank Solid waste environmental management project (SWEMP) – Zahle Sorting Plant and Sanitary Landfill (Zahle city and surrounding areas)

The Solid Waste Environmental Management Project (SWEMP), which was launched in 1996, was designed to provide solid waste management solutions outside Extended GBA. The SWEMP was an International Bank for Reconstruction and Development Project, supporting the Government of Lebanon through a loan agreement. The agreement envisioned the construction of about 15 sanitary landfills, the closure and rehabilitation of existing waste dumps, the construction one incinerator for medical waste etc. In 1998, a Project Coordination Unit was set up at the MoIM to provide technical and administrative assistance to CDR during project implementation.

As mentioned earlier, the only project which materialised under this project was the Zahle Sorting Facility and sanitary landfill in 2001. The sorting facility, which has a treatment capacity of approximately 200 t/d, is a simple manual sorting plant, consisting of a hopper, a sloped conveyor and a horizontal sorting conveyor. Space is allocated for 8 sorters, sorting from delivered commingled MSW. Waste is segregated into recyclables, organics, and non-recyclables. Non-recyclables or refuse is landfilled in an adjacent Sanitary Landfill (SWEEPNET, 2014).

The landfill serves the city of Zahle and around 18 of the 33 surrounding villages, and receives approximately 120 tonnes of sorted waste per day. Generated gas from the Zahle Sanitary Landfill site is flared and the leachate is collected and treated. The implementation of the Sanitary Landfill site in Zahle has been successful through a process that included public awareness, consultation and participation, but also the strong support of the local politicians and authorities.

Operation of the Sorting Facility and Sanitary Landfill is carried out by a private contractor through a management contract with the Municipality of Zahle.

I.2 Full-cycle systems – under construction in March 2015

EU/ESFD Project –
Bar Elias Sorting and Composting Facility and Sanitary Landfill (Zahle caza)

The Economic and Social Fund for Development (ESFD) project is a fund formulated to alleviate poverty and mitigate the social impact of economic transition on marginalised and disadvantaged groups in Lebanon. ESFD was created in year 2000 as an outcome of the Euro-Med partnership represented by the European Commission and the Lebanese Government, through CDR. The Municipal Finance Project, MUFFIN, is an EU-financed project implemented through the ESFD. The Bar Elias Sorting and Composting Facility and Sanitary Landfill in the Caza of Zahle (described below) are part of the ESFD MUFFIN projects.

The Sorting and Composting Facility and Sanitary Landfill currently under construction in the village of Bar Elias were funded by the ESFD. The Sorting and Composting Facility was designed to treat approximately 150 t/d of MSW (sorting capacity). The Sanitary Landfill will be executed with a primary cell of a volumetric capacity of approximately 75,000 m3. Three (3) additional cells of similar volumetric capacities are also planned to be executed in the future. The Sorting and Composting Facility and Sanitary Landfill will be managed and operated by the Municipality of Bar Elias for 2 years and with financial assistance and coverage of operation costs by OMSAR.

II. Partial systems – Operational and/or under construction in March 2015

EU/OMSAR-implemented MSW Treatment Facilities

As of March 2015, a number of small and medium sized sorting and composting MSW plants were been implemented by the OMSAR, through EU grants. Table 5 below presents an overview of the established MSW treatment facilities in Lebanon, out of which the following table have been implemented by OMSAR.

Table 5: EU/OMSAR-implemented MSW Treatment Facilities (SWEEPNET, 2014)

OMSAR-implemented MSW treatment and disposal facility[1]	Treatment / design capacity (t/d)[2]	Status
Hbaline (Byblos) Sorting and Composting Facility	100	Operational (based on management contract)
Khiam (South Leb.) Sorting and Composting Facility	25	
Qabrikha (South Leb.) Sorting and Composting Facility	25	
KherbitSilm (South Leb.) Sorting and Composting Facility	10	
Union of Municipalities of Tyre / Ain Baal (South Leb.) Sorting and Composting Facility	150	
Ansar / Nabatieh (South Leb.) Sorting and Composting Facility	10	
Union of Municipalities of Minieh (Akkar) Sorting and Composting Facility	70	
Michmich (Akkar) Sorting and Composting Facility	10	
Union of Municipalities of Baalbeck-Hermel Sorting and Composting Facility	200	
Tripoli (Union of Municipalities of Al Fayhaa) Sorting Facility	420	Constructed and non-operational (awaiting management contract)
ChoufSwaijani - Kahlouneyye (Chouf) Sorting and Composting Facility	30	
Union of Municipalities of Nabatieh – Chquif (Kfour) Sorting and Composting Facility	250	

EU/ESFD Fnaideq Sorting and Composting Facility (Akkar Governorate)

A Sorting and Composting Facility that is currently undergoing construction in the village of Fnaideq, which is located in the Governorate of Akkar, has been designed to serve the village. It has been studied to replace the ongoing haphazard disposal and open burning of MSW that are taking place at an abandoned quarry site that is located on a geologically and hydro-geologically sensitive area, with an increased possibility of groundwater contamination. The Facility will have a design treatment capacity of approximately 17 t/d of commingled MSW.

USAID Funded Facilities: *Small to medium-sized community-based MSW Facilities*

Eleven small community-based MSW sorting and composting plants were built in selected municipalities throughout Lebanon, particularly in the South. These were funded by the United States Agency for International Development (USAID) through Non-Governmental Organisations (NGOs) like the "Young Men's Christian Association (YMCA)," "Pontifical Mission (PM)," and "Creative Associates International Inc. (CAII),". The execution of the facilities has been undertaken

[1] Composting capacities of the Facilities (Sorting and Composting), mentioned in the above Table and further described in the below sections, are estimated to be approximately 50% of their respective sorting capacities

[2] Capacities for operational facilities indicate the treatment capacities. Capacities for under-construction and constructed – nonoperational facilities indicate the initial design capacity.

by the private sector, contracted through the concerned municipalities. The operation of the majority of the facilities is carried out by the municipalities themselves. Table 6 below presents some of the community-based MSW treatment facilities funded and implemented by NGOs in Lebanon and managed by their respective municipalities, as compiled in the *State and Trends of the Lebanese Environment Report* (MoE/UNDP/ECODIT, 2010).

Table 6: Community-based small scale MSW treatment facilities implemented by NGOs in Lebanon

Locality (Governorate)	MSW Facility	MSW Treatment Capacity (t/d)[3]	Status	Funding Agency
Taibeh (Nabatieh)	Sorting and Composting	10	Operational	YMCA[4]
Qlaiaa (Nabatieh)	Sorting and Composting	5	Operational	PM[5]
Kfarsir (Nabatieh)	Sorting	7.5	Operational	YMCA
Aitaroun (Bint Jbeil)	Sorting and Composting	15	Operational	PM
Chaqra (Bint Jbeil)	Sorting and Composting	5	Operational	PM
Bint Jbeil (Bint Jbeil)	Sorting and Composting	20	Operational	PM

Private sector projects

Saida Facility: Sorting Plant and Anaerobic Digester (Saida city and surrounding areas)

A MSW Sorting Facility and Anaerobic Digestion Plant have been established in Saida by a private company aiming for the treatment of MSW generated by the city of Saidaand its surrounding areas. The SaidaSorting and Anaerobic Digestion Facility hasbeen designed with a treatment capacity of 300 tonnes/day and has been put in operation since year 2013 (SWEEPNET, 2014). The Saida Anaerobic Digestion Plant is composed ofan anaerobic digester and an open area for compost maturation. The Plant is expected to produce compost for use in landscaping and agriculture and it also separate recyclable materials, such as plastics, paper, cardboard, metals etc.The SaidaSorting and Anaerobic Digestion Facility was financed and constructed by a private local contractor based on a Build-Own-Operate (B-O-O) agreement (SWEEPNET, 2014). At present, the Plant is operated by a private contractor based on a management contract signed with the Municipality.

III. Full &/or partial systems – under planning in March 2015

In the framework of establishing a solid waste management infrastructure necessary for coping with the increased MSW generation and the pressures induced by the Syrian displaced persons in the host areas, EU-financed projects will be implemented by the OMSAR under the SWAM I and SWAM II projects: Upgrading Solid Waste Management Capacities in Lebanon as presented in Table 6 below.

[3] Composting capacities of the Facilities (Sorting and Composting), mentioned in the above Table and further described in the below sections, are estimated to be approximately 50% of their respective sorting capacities

[4] Young Men's Christian Association

[5] Pontifical Mission

Table 7: OMSAR planned SWAM I and SWAM II projects (outside GBA and Mount Lebanon) as of March 2015

OMSAR-planned Projects	OMSAR-planned Facility	Initial Design Capacity		
		Landfill (Mm^3)	Sorting (t/d)	Composting (t/d)[1]
SWAM I	Baalbeck Sorting and Composting Facility (including Anaerobic Digester - AD) - Expansion	-	250	125 (inc. 40 t/d AD)
	Hbaline Sorting and Composting Facility - Upgrade	1	-	-
	Jeb Jennine Sorting and Composting Facility - finishing and equipping	-	100	50
	Srar Sanitary Landfill – Construction + Closure of Dump	1	-	-
	Zahle Composting Facility - Construction + Sorting Facility - Expansion	-	250	125
SWAM II	BintJbeil Sorting and Composting Facility + Sanitary Landfill - Construction	0.2	150	75
	Dennieh Sorting and Composting - Construction	-	175	87.5
	Jeb Jennine Sanitary Landfill – Construction	0.2	-	-
	Koura Sorting and Composting - Construction	-	80	40
	Minieh Sorting and Composting Facility - Upgrade from 70 t/d to 100 t/d	-	100	50
	Nabatieh (Kfour) Sanitary Landfill - Construction	1	-	-
	Srar Sorting and Composting - Construction	-	250	125
	Tripoli Composting and RDF Facility - Construction + Sorting Facility - Expansion	-	450	225
	Zgharta Sorting and Composting - Construction	-	120	60
	Union of Municipalities of Tyre (Abassiyeh) Sanitary Landfill - Construction + Rehabilitation of Ras el Ein Dump	0.5	100	-

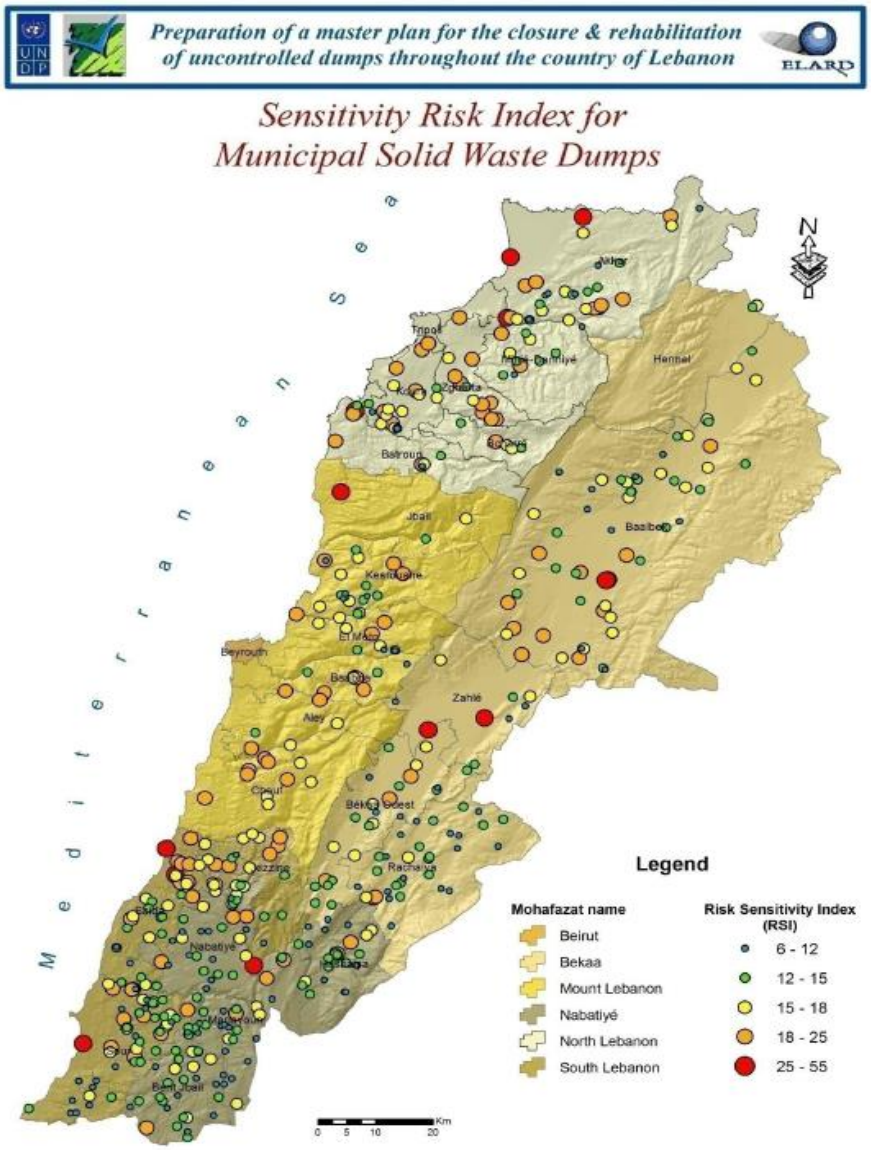
[1]Composting capacities of the Facilities (Sorting and Composting), mentioned in the above Table are estimated to be approximately 50% of their respective sorting capacities

2.3.3 Dumpsites related to SWM

A vast number of dumps prevail in many villages and towns across the Lebanese territory. According to a survey done in MoE in year 2011 for the preparation of a Master Plan for the Closure and Rehabilitation of Uncontrolled Dumps in Lebanon, a total of 670 dumps were identified including 504 for MSW and 166 for Construction and Demolition Waste(CDW) (MoE/UNDP/ELARD, 2011). It should be noted that MoE is currently in the process of updating this survey and the updated results are expected in 2017.

The Master Plan of 2011 has been able to survey the total of 670 dumps over the Lebanese territory, and to conduct a full characterisation of the dumps which was completed and transferred into a GIS based format a Prioritisation Decision Tool (refer to Figure 4 below). It also indicated that the cost estimates for the rehabilitation of all MSW and CDW dumps is around US$ 50 million for all dumps.

Figure 4: Location of Uncontrolled Dumps over the Lebanese Territory (MoE/UNDP/ELARD, 2011)



3 SWM PLAN SCENARIOS FOR THE SEA IN 2015

3.1 Basic assumptions for scenarios' setting

The CoM Decision 46 of 30 October 2014 amended by CoM Decision 1 of 12 January 2015 has consituted "the SWM Plan" which was used as a basis for developing the SEA described in this report and, as such the SEA team has conducted an extensive description of this decision in a way it can be assessed against other SWM alternatives, and to identify possible downsides to the plan and recommend possible improvements.

Waste balances were developed based on data provided by the MoE, figures from literature, assumptions and experts' guess. In this regards, existing and planned SWM facilities were distributed according to the geographical areas (Lots) indicated in CoM Decision 1 of 12 January 2015 as presented in Table 8 below. This allowed identifying the available and missing treatment capacities in terms of first treatment, second treatment, and the difference between demand for landfill and available capacity.

The analysis has allowed the calculation of the waste balances in 2015 and their projection in 2020, as per the requested timelines of CoM Decision 1 of 12/1/2015. These balances represent a top-down approach for the current situation. Top-down means that waste treatment facilities have been grouped into a relatively small number of ISWM technology clusters, not defined by type or capacity. It should be noted that for the needs of this assessment, a more detailed definition of technologies within each cluster could not be made, for the following reasons:

- The assessment is been carried out at a national level; and
- There are no specific technologies, neither prescribed nor presented in the "SWM Plan" put forward as a basis of the SEA.
- The main assumptions used for the identification of the alternative scenarios, are the following:
- Seasonal and regional variations in the waste composition were not taken into account;
- Minor waste streams (e.g. recovery of ferrous metals from the incineration process) not depicted;
- Future trends regarding the composition of waste – change of waste composition over time – was not accounted, since any change is expected to come as a result of the degree of implementation of particular strategies, i.e. awareness and motivation for waste minimisation, separation, recycling and recovery of waste, combined also with the living standards and corresponding GDP.

It has to be noted, that scenarios are "if – then" considerations. Based on defined assumptions ("if") certain observations can be made ("then"). Scenarios should not be confused with projections. One base assumption is, that – independent of the scenarios – efforts are made to keep municipal waste stream separated from other main streams such as hazardous, industrial, waste and construction waste. Currently, this is an issue of great concern since waste streams are getting mixed to some extent (the exact dimension is not known), especially at the stage of final disposal. Mixing of waste of different origins and characteristics is a major obstacle for an environmentally friendly and cost-effective waste management system. The projected period of the scenarios is 2015-2020, which is in line with the target years referred in the CoM decision 1 of 12/1/2015.

As such, three scenarios for SWM in Lebanon were identified and assessed as part of the SEA, these are the following:

- **Do-nothing by 2020 scenario;**
- **NGO inspired by 2020 scenario;**
- **Base scenario Phase I and Phase II, in line with CoM Decision 46 of 30 October 2014 CoM amended by Decision 1 of 12 January 2015.**

Table 8: Existing and planned facilities (as of March 2015)

Lot (as per CoM Decision 1 of 12/01/2015)	SWM facilities which are existing or foreseen (with secured funding)
Lot 1: **Beirut and suburbs: Ghobeiri, Al-Shiah – Ain el Remmaneh, Borj Al-Barajneh, Haret Hreik, Furn el-Shibbak, El-Mreijeh, Hay el Sillum, Amroushieh, Lailaki, el-Hadath, Bourj Hammoud, Sin el Fil**	Amroussieh – sorting facility, currently in operation, current capacity: 600 t/d, however, currently working above capacity at 1100 t/d. Its capacity foreseen to be increased under this Decision, without however extending geographically outside its boundaries. Quarantina – sorting facility, currently in operation, and also serving Metn and Kesrewan cazas. Its current capacity: 1100 t/d, however, currently is working above capacity at 1750 t/d. Its capacity will have to be increased, without however extending geographically outside its boundaries. Coral / Bourj Hammoud – composting facility, currently in operation, and also serving Metn and Kesrewan cazas. Its current capacity: 300 t/d. Its capacity will have be increased under this Decision, without however extending geographically outside its boundaries. Naahmeh – landfill, and also serving Metn and Kesrewan cazas with a capacity of 2000 t/d. It was closed on July 17th, 2015 Bsalim – landfill for bulky items currently in operation, and also serving Metn and Kesrewan cazas. Its current capacity: 50 t/d
Lot 2: **The caza of Keserwan, and the caza of Metn excluding the municipalities within the service areas of Lot1 and the Caza of Byblos**	Coral / Bourj Hammoud – composting facility, currently in operation, and also serving Beirut and part of the caza of Baabda. It has a capacity of 300 t/d that is foreseen to be increased under this Decision, without however extending geographically outside its boundaries; Naahmeh – landfill, currently in operation, and also serving most of Beirut suburbs, Beirut and part of the caza of Baabda. Its current capacity: is 2000 t/d. It was closed on July 17th, 2015; Bsalim – landfill for bulky items, currently in operation, and also serving Beirut and part of the caza of Baabda with a current capacity of 50 t/d; Hbaline - Sorting and composting, currently in operation, with a capacity: 80 t/d. This has secured funding by OMSAR / EU; Hbaline – Extension of sorting and composting with a capacity of 150 t/d. It is planned under SWAM 2- Funded by OMSAR / EU. It is also foreseen to include sorting and composting; Hbaline – Landfill and rehabilitation of the old dump. Its capacity is not defined. It was initially planned by the Union of Municipalities of Byblos. May be added to this tender further to assessing its currrent situation / status.
Lot 3: **Aley Caza and the Cazas of Shouf and Baabda excluding the municipalities in Lot1**	Chouf Swayjani / Khaldounieh – sorting and composting with a capacity of 26 t/d. It currently exists but is not operational. This was funded by OMSAR – EU; Naahmeh – landfill, no longer in operation, it served most of Beirut suburbs, Beirut, part of the caza of Baabda, and the cazas of Metn and Kesrewan. Its operational capacity was 2000 t/d. It was closed on July 17th, 2015.

Lot (as per CoM Decision 1 of 12/01/2015)	SWM facilities which are existing or foreseen (with secured funding)
Lot 4: **Governorates of Southern Lebanon and Nabatieh**	Khiam – sorting and composting with a capacity: 15 t/d, currently in operation and funded by OMSAR / EU. Kabrikha – sorting and composting with a capacity of 15 t/d. The facility is currently in operation and it was funded by OMSAR / EU. Kfar Kila – sorting and composting Capacity: 20 t/d. This is currently under construction. Its funding is coming by AECID (Spanish Cooperation for International Development) through IMG (International Management Group). Blat - Majeyoun - sorting and composting, with a capacity of 60 t/d. This project is not specified in SWAM1 or SWAM2 programmes and its funding was not clear at time of this report preparation. Bint Byblos – sorting and composting with a capacity of 50 t/d. The facility is currently in operation; Aytaroun – sorting and composting with a capacity of 15 t/d. The facility is currently in operation; Kherbet Selem – sorting and composting with a capacity of 15 t/d. The facility is currently in operation; Ain Ebel – sorting and composting with a capacity of 5 to 10 t/d. The facility is currently in operation; Bint Byblos – facilitywith a capacity of 150 t/d. Planned under SWAM 2 – Funded by OMSAR / EU; Ain Baal – sorting and composting with a capacity of 150 t/d. The facility is currently in operation. Funding source is OMSAR / EU; Ain Baal – Extension with a capacity of 250 t/d. This facility is planned but currently lacks funding; Abasseyeh and Ras el Ein – Landfill with a capacity of 250 t/d. This project is planned under SWAM 2 programme; Kfour Nabatiyeh – sorting and composting with a capacity of 200 t/d. The facility exists but currently not in operation which is to be awarded. Its fundingis orginated from OMSAR / EU; Ansar – sorting and composting with a capacity of 10 t/d. the facility is in operation and it has been funded by OMSAR / EU; Kfour Nabatiyeh – Landfill with a capacity of 200 t/d. The facility is planned under SWAM 2 programme and its funding issecured by OMSAR / EU; Jezzine – sorting and composting with a capacity of 150 t/d. This project is not specified in SWAM1 or SWAM2 programmes and its funding was not clear at time of this report preparation; Saida – sorting and composting (digestor) with a capacity of 300 t/d. This is currently operational. Both construction and operation activities are handled by a private company; Al Zahrani – sorting and composting with a capacity of 100 t/d. This facility is planned under SWAM 2 programme. Its funding is planned under OMSAR / EU.
Lot 5: **Governorates of Northern Lebanon and Akkar**	Zgharta – sorting and compostingwith a capacity of 120 t/d. This is planned under SWAM2 programme; Minieh – Deneyeh – sorting and composting with a capacity of 60 t/d. This facility is in place but currently not ioperational. The operation contract is yet to be awarded. It has been funded by OMSAR / EU; Minieh – Deneyeh – sorting and composting with a capacity of 175 t/d. This is planned under SWAM2 programme;

Lot (as per CoM Decision 1 of 12/01/2015)	SWM facilities which are existing or foreseen (with secured funding)
	Koura – sorting and composting with a capacity of 80 t/d. This is planned under SWAM2 programme; Batroun – sorting and composting (as foreseen in Decision 46 of 10 October 2014). This is foreseen to have a capacity of 100 t/d. This project is not specified in SWAM1 or SWAM2 programmes and its funding was not clear at time of this report preparation; Bcharreh – sorting and composting (as foreseen in Decision 46 of 10 October 2014). This is foreseen to have a capacity of 50 t/d. This project is not specified in SWAM1 or SWAM2 programmes and its funding was not clear at time of this report preparation; Tripoli – RDF facility with a capacity of 420 t/d. This facility is planned under SWAM2 programme; Mechmech – sorting and composting with a capacity of 10 t/d. It is currently in operation and it has been funded by OMSAR / EU; Srar – sorting, composting and landfilling with a capacity of 200 t/d. This is planned under SWAM2 programme; ISWM – facility with a total capacity of 800 t/d. This is planned under SWAM2 programme.
Lot 6: Governorates of the Bekaa	Hermel – sorting and composting (as foreseen in Decision 46 of 10 October 2014) with a capacity of 100 t/d. This project is not specified in SWAM1 or SWAM2 programmes and its funding was not clear at time of this report preparation; Baalbeck – sorting and composting with a capacity of150 t/d. This has been constructed through OMSAR funds but is is not operational; Baalbeck – Extension - sorting and composting with a capacity of225 t/d. This has been under SWAM 1 programme to receive funding by OMSAR / EU; Baalbeck – Landfillwith a capacity of 150 t/d. This is planned under SWAM 1 programme to be funded by OMSAR / EU (after withdrawal of the Italian Agency that was initially in charge of funding); Zahle – sorting with a capacity: 200 t/d. This facility is currently in operation; Zahle – Extension - sorting and composting | Capacity: 200 t/d Planned under SWAM 1 programme destined to be funded by OMSAR / EU; Zahle – landfill with a capacity of 180 t/d. This facility is currently in operation; Barr Elias – sorting, composting and landfill with a capacity of 150 t/d. It is planned and currently in its tendering stage (ESFD). Funded by ESFD / EU; Jeb Jenin – sorting, composting and landfill with a capacity of 100 t/d Planned under SWAM 1 – Funded by OMSAR / EU; Al Mhaydtheh – sorting and compostingwith a capacity of 60 t/d. This project is not specified in SWAM1 or SWAM2 programmes and its funding was not clear at time of this report preparation; Hasbaya – sorting and composting with a capacity of 60 t/d. This project is not specified in SWAM 1 or SWAM 2 programmes and its funding was not clear at time of this report preparation.

3.2 The "Do-nothing scenario by 2020"

3.2.1 Brief description

In the "Do-nothing scenario by 2020", existing facilities will continue to operate (with the exception of Naahmeh landfill that will be ultimately closed), whereas facilities that are currently under construction and those for which funds have already been secured (i.e. EU funded programmes like SWAM 1 and 2) will be constructed and operated. The name of the scenario ("do nothing by 2020") shall not be interpreted in a way, that no action is required – on the contrary, it foresees the construction of a variety of waste treatment facilities with a total capacity of approximately 3,200 t/d. Thus it will change the waste management practices compared with the current status.

However, under this scenario it is assumed that no Strategy will be implemented, i.e. the CoM Decisions 46/2014 as amended by CoM Decision 1/2015, will not become effective.

This Scenario is based on the following assumptions:

Informal sector (scavengers) continue its current activities

Separation plants with a total capacity of about 4,600 t/d are in operation

Composting plants are in operation with a total capacity of about 1,100 t/d

Landfill capacity is 1,500 t/d

In the Do-nothing scenario by 2020, as shown in Table 9 below, the total SW generation rate reached about 7,200 t/d or about 2,44 mio t/a (amounts of recyclables collected by the informal sector excluded), however, the capacity of the first treatment step (separation) is only 4,600 t/d. This leaves a gap of about 2,100 t/d, which – in the absence of sanitary landfills – will most likely find its way towards the uncontrolled dumpsites. Since there is a gap in the composting capacities of approximately 700 t/d, further pressure is put on dumpsites. Under this scenario, 30% of the output of composting plants is sold on the market and 8.7% of the output of the first treatment step is recycled. Figure 5 and Table 9 below present the mass balance flowchart of the Do-nothing by 2020 Scenario.

3.2.2 Assessment

In the "Do-Nothing scenario by 2020" and compared to the current state, the efficiency of the whole waste management system is expected to worsen:

- Approximately 78% of municipal solid waste will be ultimately disposed in landfills or dumpsites, (4% higher than current rates);
- Due to closure of Naahmeh landfill there will be a general increase in waste disposed of at dumpsites (57% compared to a current share of 33%).

Due to higher capacities of the separation plants and under the assumption that the rate of recyclables will remain unchanged (8.7%), absolute figures of separated recyclables will increase. The same is assumed in case of sellable compost. However, due to the increase of generated waste, overall recycling rates are expected to slightly decrease. There are no measures regarding waste prevention foreseen in this scenario – neither the total waste generation nor the waste composition will be affected. It is expected that the adverse environmental effects will increase due to increased emissions of pollutants into all media (e.g. groundwater contamination by leachate, surfacewater contamination by leachate and sweep-off from the surface of open dumps, non-compliance with air quality standards by emissions from open burning and open dumps, odour emissions, emissions of greenhouse gases, overall hygiene in the surrounding environment, health & safety issues, fire and accidents expectations, etc). Since there will be a significant increase in new treatment capacities, both Institutional Capacities (in terms of cooperation and co-ordination of involved authorities and institutions) and Technical capacities (in terms of staff, time, equipment, education and skills) have to be increased as well. It is currently not determined how this will be achieved, therefore it is considered as a drawback.

Figure 5: Mass balance flowchart for the Do-Nothing Scenario by 2020

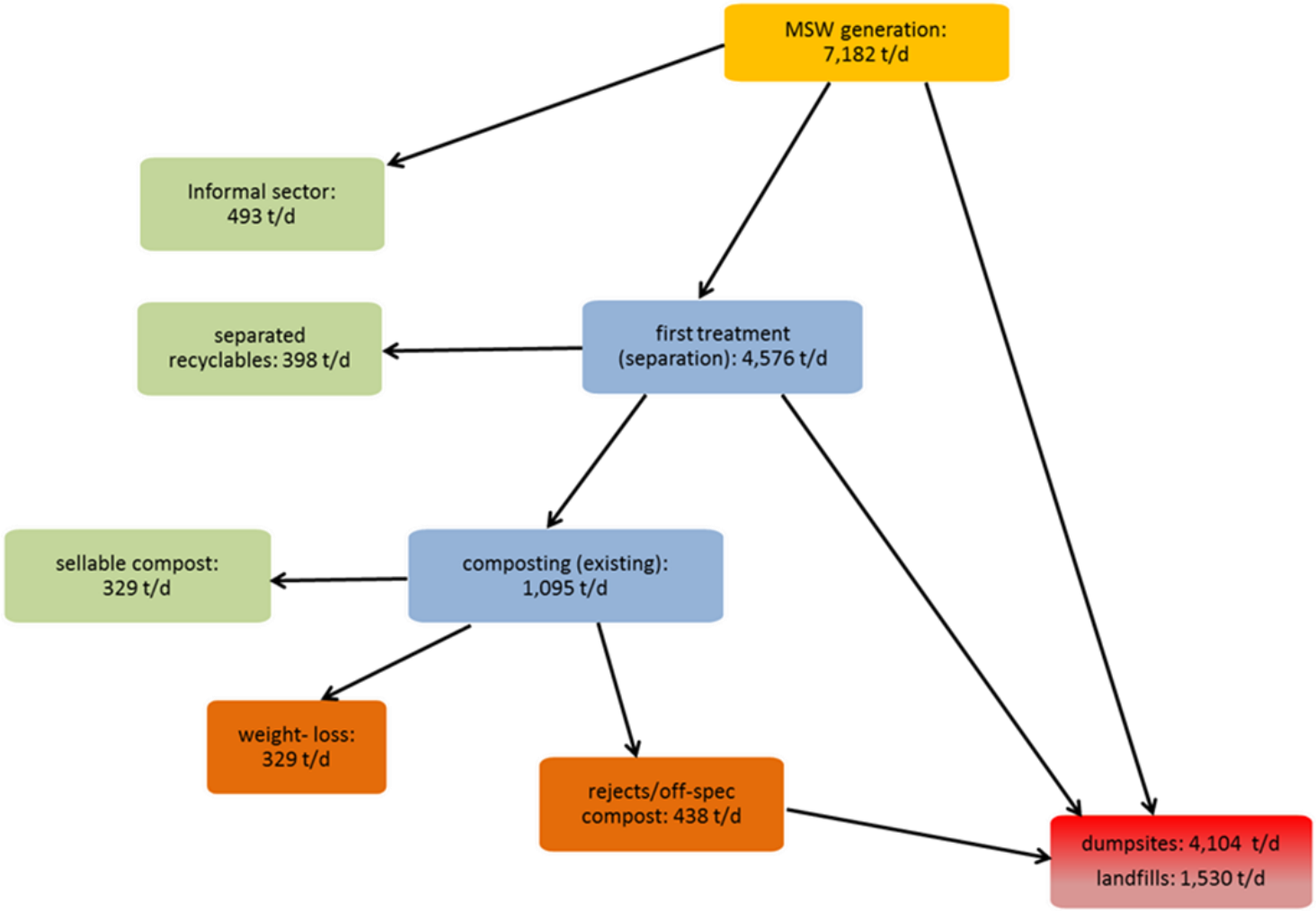


Table 9: Mass balance of Do-nothing Scenario by 2020

Scenario	Do nothing by 2020		
Waste generation	Without informal sector:	6,700 t/d	2,441,800 t/y
	Informal sector included:	7,200 t/d	2,621,400 t/y
First treatment step	Separation:	4,600 t/d	1,670,200 t/y
Output of first treatment step	Separation of recyclables:	400 t/d (8.7%)	145,300 t/y
	Output to composting plant:	1,100 t/d[7]	399,700 t/y
	Output to final disposal:	3,100 t/d	1,125,300 t/y
Input into composting plants (pre-treated MSW)		1,100 t/d [8]	399,700 t/y
Output of composting plants	Sellable compost:	300 t/d (30%)	120,100 t/y
	Weight losses:	300 t/d (30%)	120,100 t/y
	Off-specification compost and rejects:	400 t/d (40%)	159,900 t/y
Final disposal	Output from first treatment step:	3,100 t/d	1,125,300 t/y
	Off-specification compost and rejects:	400 t/d	159,900 t/y
	Difference between waste generation and first treatment step:	2,100 t/d	771,200 t/y
	Total:	5,600 t/d	2,056,400 t/y
	Landfills:	1,500 t/d	558,500 t/y
	Dumpsites:	4,100 t/d	1,498,000 t/y

[7] (available capacity of composting plants);

[8](available capacity of composting plants)

3.3 Alternative scenario 1: "NGO inspired scenario by 2020"

3.3.1 Brief description

The "NGO-inspired by 2020 scenario" was developed on the basis of information provided by NGOs as "Ecomovement's Sustainability Plan for Solid Waste Management"; the NGO approach can be illustrated as per Figure 6 below.

Figure 6: Trash to cash approach

(source: Ecomovement's presentation held in spring 2014 at the Horizon 2020 workshop)

During the preparation process of the SEA, the NGO approach was interpreted as follows:

- Use of RDF
- Maximum recycling, also by introducing separate collection at source
- Maximum composting, also by introducing separate collection at source
- High calorific waste streams treated as RDF in cement plants
- None or very low amounts of waste disposed at landfills
- No waste incineration

Based on experience of EU Member States it can be concluded, that some components of the NGO approach can not be implemented within the time-frame proposed by the NGOs due to the complex legal, institutional and technical background required for their implementation. However, some elements have been considered useful and thus have been included in the so-called "NGO inspired by 2020" scenario.

Calculations in the "NGO inspired by 2020 scenario" were based on the estimated waste accumulation in the year 2020 – which is about 7,200 t/d or 2.62 mio t/a (informal sector included).

Thus, the "NGO-inspired by 2020 scenario" is based on the following assumptions:

- Separate collection of glass, metals, plastics and paper is introduced; the informal collection of recyclables has been "formalised"
- Separate collection of organic waste is introduced followed by composting

- Separation of a high-calorific fraction of waste allows RDF production
- Landfilling of pre-treated waste is provided
- Based on those assumptions, and as shown in Table 10 and Figure 7 below, the NGO inspired by 2020 scenario can be further described hereby:
- A separate collection system is in place, the following collection targets are achieved: paper: 30%, metals: 80%, glass: 70% and plastics: 30% (% related to the content in the waste). Overall, approximately 1,600 t/d are separated at source and thus diverted from mixed municial waste. There is a market for collected recyclables, however, a certain fraction (about 125 t/d) does not meet market criteria and has to be disposed of at landfills.
- The share of separately collected organic waste is 50% (related to the organic content in the waste), about 1,700 t/d are separeted at source and further treated in composting plants. This treatment results in about 800 t/d of sellable compost (45% of the input), a weight-loss of 50% and 5% (about 86 t/d) of rejects, which have to be disposed of at landfills.
- RDF is produced in designated RDF-production plants. In a first step, a high-calorific fraction is separated from MSW. This fraction is further processed into high-quality RDF (high quality in terms of meeting pre-defined criteria regarding calorific value, chlor-organic compounds, heavy metals and unwanted substances), which is used in cement kilns. The input of high-quality RDF in cement kilns is about 300 t/d. This figure has been calculated by assuming 10%[9] substitution of petcoke by RDF (calculated based on the energy content; a calorific value of RDF of 20 GJ/t; and a loss of efficiency for clinker production of 15%). To obtain this amount of high-quality RDF an input of about 1,100 t/d into the RDF production plant is required, which in turn leads to an output of separated recyclables (about 82 t/d; 7.3%), output material to the subsequent composting plant (approximately 400 t/d, or 39% of the input, respectively) and off-spec material (about 300 t/d), which is sent to landfill.
- Separation/composting plants are in operation with a total separation capacity of 2,700 t/d. The required capacity is calculated as the difference between waste accumulation and the amount of recyclables/organic waste separated at source plus input into the RDF producing plants. Output materials will be recyclables (glass, metals, paper, plastics; about 200 t/d or 7.3%, respectively), input to composting plant (39% of input into separation; about 1,100 t/d) and off-spec material to landfill (about 1,500 t/d). Total capacity of composting plants is about 1,500 t/d; output materials are sellable compost (about 400 t/d; 30%), losses (about 400 t/d; 30%) and off-specification compost and rejects (about 600 t/d; 40%).
- Landfilling is still required in this scenario: an overall capacity of approximately 2,600 t/d has to be provided for the final disposal of off-specification compost/ rejects from composting plants (about 600 t/d), off-spec material from RDF production (300 t/d), off-spec material from separation (about 1,500 t/d), off-spec compost from composting of separately collected organic waste (about 86 t/d) and rejects from separately collected recyclables (about 100 t/d).

3.3.2 Assessment

The “NGO inspired by 2020 scenario” can be described as a highly integrated waste management system with a strict control of waste streams from primary waste generation to recovery/recycling and final disposal of stabilised residues based on the following:

- The share of separately collected waste is high and on a level of advanced EU Member States of 21% (reaching 45% if separate collected organic fraction is included);

[9] Limitations occur due to technical constraints for feeding RDF into the kilns (operators need some time and experience to adjust the whole system accordingly and to ensure that clinker is produced with the same quality) and due to availability of RDF meeting pre-defined criteria; 10% is an ambitious number, but may be achieved, if the overall framework conditions (legally, technically, economically, management and control) allowed for it.

- High recovery rates means return of valuable materials and substitution of raw-materials.
- Use of RDF in cement production reduces consumption of petcoke and heavy fuel oil (HFO).
- Compost with high quality should be used in agriculture.
- The share of municipal solid waste, which is disposed of at landfills, is 36% and only pre-treated waste is diverted to landfills.

There interpretation of this scenario considered that are no measures regarding waste prevention are foreseen in this scenario – neither for the total waste generation nor for the waste composition will be affected.

However, there are serious obstacles for the implementation of the "NGO inspired by 2020 scenario": Major constraints identified are the following:

- Time;
- Awareness;
- Education;
- Legal,
- Administrative;
- Technical capacities; as well as
- Logistics.

To implement an effective and sustainable separate collection system, the whole system of waste delivery/waste collection, transport, (intermediate) storage, processing and sale has to be based on a sound legal and administrative system across Lebanon. The citizens have to be educated by series of long lasting awareness campaigns to secure their commitment to separate recyclables/organic waste at source and to reduce misthrows. Experiences in EU Member States have shown that such a process would take from minimum 5 to 15 years depending on the country. In essence to translate the "NGO inspired by 2020 scenario" into a fully operational integrated waste management scheme, realistically more than 10 – 15 years would be needed.

Regarding RDF production it should be noted that it is a technically complex process and in addition requires an already organised and an operating market. RDF must have a high and constant calorific value and a low variability of main constituents (composition). Hazardous substances, PVC or other material containing halogenated substances have to be removed. This means that a certain percentage of rejects/off-specification material will have to be treated/disposed of otherwise (e.g. landfill or incineration together with mixed municipal waste).

Moreover, RDF is still considered as waste by legal definition and as such cement kilns using RDF as fuel are considered as waste co-incineration plants. Thus, they have to undergo an environmental impact assessment (EIA) in order to be able to receive it and furthermore have to adjust their whole environmental performance to much stricter requirements (including waste delivery, storage, pre-treatment, waste feeding and flue gas cleaning) in order to ensure sound environmental performance. Waste co-incineration plants have to be controlled by experienced in the sector authorities in order to be capable to supervise and monitor environmental parameters and consequently their performance.

It is expected that the environmental impacts (e.g. ground- and surfacewater contamination, non-compliance with air quality standards, littering) will be less compared with the current status, mostly due to the fact that waste disposal in open dumps and open burning of waste will not occur anymore.

Other critical issues are the control of quality criteria for compost and how off-spec materials from composting plants are managed.

Figure 7: Flowchart of NGO Inspired by 2020 scenario

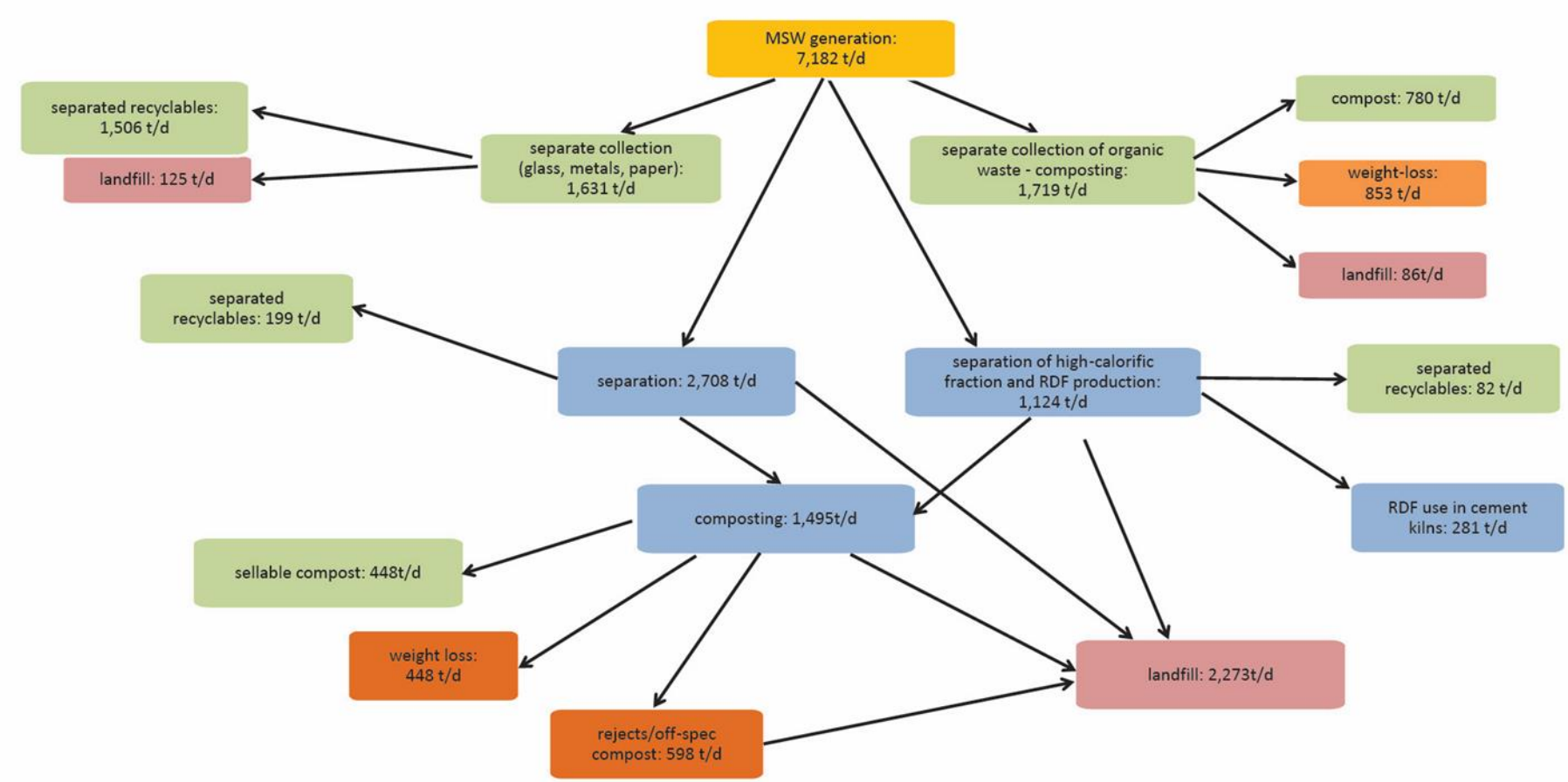


Table 10: Mass balance of NGO inspired Scenario

Scenario	NGO inspired scenario		
Waste generation		7,200 t/d	2,621,400 t/y
Separate collection of glas, metals, plastics and paper, scavengers' activities have been "formalised"	Including (% related to content in the waste): Paper: 30% Metals: 80% Glas: 70% Plastics: 30%	1,600 t/d	595,300 t/y
Rejects from separate collection	Including (% related to recovered materials): Glas, metals, paper: 5%, Respectively plastics: 20%	100 t/d	45.600 t/y
Separate collection of organic waste + composting	50% of the organic content in the total waste	1,700 t/d	627,400 t/y
Output from composting of separately collected organic waste	Losses:	900 t/d (50%)	313,900 t/y
	Sellable compost:	800 t/d (45%)	282,500 t/y
	Off-spec compost to landfill:	86 t/d (5%)	31,400 t/y
Input into separation of high-calorific fraction and RDF-production		1,100 t/d[10]	410,300 t/y
RDF produced and used in cement clins		300 t/d	102,600 t/y
Output from RDF production	Separated recyclables:	82 t/d (7.3%)	29,900 t/y
	Output to composting plant:	400 t/d (39% of input)	159,900 t/y
	Off-spec material to landfill:	300 t/d (residuum)	117,500 t/y
Input into "regular" separation step (plants for mixed MSW)	Difference between total MSW accumulation and the amount of recyclables & organic waste separated at source and input into the RDF producing plants	2,700 t/d	988,400 t/y
Output from "regular" separation step (plants for mixed MSW)	Recyclables (glas, metals, paper, plastics):	200 t/d (7.3%)	72,600 t/y
	Input to composting plant (39% of input into separation):	1,100 t/d	385,400 t/y
	Off-spec material to landfill:	1,500 t/d (residuum)	530,300 t/y
Input into composting plants for pre-treated MSW	39% of input into separation step	1,500 t/d	545,700 t/y
Output of composting plants for pre-treated MSW	Sellable compost:	400 t/d (30%)	163,500 t/y
	Weight loss:	400 t/d (30%)	163,500 t/y
	Off-specification compost and rejects:	600 t/d (40%)	218,300 t/y
Input to landfills	Total:	2,600 t/d	943,200 t/y
	Off-spec, compost rejects from composting plant of pre-treated MSW:	600 t/d	218,300 t/y
	Off-spec material from RDF production:	300 t/d	117,500 t/y
	Off-spec material from separation:	1,500 t/d	530,300 t/y
	Rejects from composting of source-separated organic waste	86 t/d	31,400 t/y
	Off-spec material from source separated recyclables:	100 t/d	45,600 t/y

[10]Four (4) times the output of RDF

3.4 Alternative scenario 2: CoM Decision 46/2014 as amended by CoM Decision 1/2015

In this scenario, 2 phases are considered as per the recovery rate set in the COM Decision 1/2015:

- Phase I: for the first 3 contractual years, with an overall recovery rate of 60%
- Phase II: for the next 4 contractual years, with an overall recovery rate of 75%

3.4.1 Brief description of Phase I

CoM Decision 46/2014 as amended by CoM Decision 1/2015 stipulates that during the first 3 contractual years of operation a share of 40% of the municipal solid waste is disposed of at landfills. Thus, calculations were based on the waste accumulation in the year 2016 – which comes to 6,800 t/d or 2.47 mio t/a (recyclables collected by the informal sector included) as per Table 11 and Figure 8 below.

In this scenario, existing facilities will be further operated (with the exemption of Naahmeh landfill), facilities under construction and facilities, where funds have already been secured (i.e. SWAM 1 and 2), are assumed to have been built and have been put into operation. Separate collection at source may be considered. This Scenario is based on the following assumptions:

a) Informal sector continues its activities;

b) Separation plants with a total capacity of about 4,600 t/d are in operation;

c) Composting plants are in operation with a total capacity of about 1,800 t/d;

d) Operation of one or several “Integrated Solid Waste Management Facility (ISWM-Facility)";

e) Overall landfill capacity is about 2,700 t/d (equivalent to 40%).

Based on those assumptions, the Phase I of the Base scenario can be further described hereby:

a) Informal sector will continue as usual (about 500 t/d), since there is no specific measure foreseen which could change the status and the activity level of the “informal sector”.

b) As in the “do-nothing scenario 2020” total capacity of separation plants is about 4,600 t/d (which means that large capacities have to be planned, permitted, built and put into operation within a short period). Output streams are separated recyclables (400 t/d; 8.7% of the input), input to composting plants (about 1,800 t/d; 39% of the input), the remaining output is further treated in an ‘Integrated Solid Waste Management Facility (ISWM-Facility)’.

c) Required capacity of composting plants is 700 t/d higher than the capacity of the existing ones. The additional composting facilities are referred to as “composting new”. It is assumed that 30% of the input will be sold as compost (about 500 t/d), 30% are weight-loss and the remaining 40% (about 700 t/d) have to be sent to landfills.

d) In addition to the new composting plant(s) referred to above, additional treatment facilities have to be put into operation; these additional treatment facilities are referred to as “Integrated Solid Waste Management Facility (ISWM-Facility)”. From a technical point of view, any technology suitable for the treatment of untreated or pretreated municipal solid waste could be chosen, namely: incineration with or without energy recovery, chemical-physical treatment, mechanical-biological treatment, sorting, aerobic and anaerobic treatment, etc. The demand for ISWM capacity is determined by the overall target value for landfilling, which is 40% of total generated MSW for Phase I. Another crucial factor is the applied technology for ISWM and their related input-output balances (in principle lower capacities are required, when the amount of weight loss and/or recyclables is high). Based on these framework conditions, the required capacity for the ISWM-Facility will be in the range of approximately 2,700 – 4,100 t/d depending on the technology and can be explained as follows:

- Lower range (approximately 2,700 t/d): output of separation plants: about 2,400 t/d plus about 300 t/d, the latter figure represents waste which has to be pre-treated in order to reach the overall target value for landfilled waste of 40%. Please note: the gap between waste accumulation, capacity of first treatment step and waste collected by scavengers is 1,689 t/d. This amount of waste could in principle be reduced by extended separate collection of waste. However, the effect has not been quantified in this scenario.
- Higher range (about 4,100 t/d): output of separation plants: about 2,400 t/d plus about 1,700 t/d (gap between waste accumulation, capacity of first treatment step and waste collected by scavengers).

  Depending on the technology applied in the ISWM`s, output from ISWM`s and achieved weight-loss/extent of size reduction would greatly vary. Weight losses/size reduction would be highest in case of a combination of RDF production with subsequent use of RDF in cement plants, waste incineration and recycling of bottom ash (maximum ratio assumed in this scenario: 77% of input into ISWM). Lower range could be explained by moderate RDF production and separation of recyclables.

e) Overall landfill capacity in this scenario is 2,700 t/a (capacity required to reach the target value of 40%). Whereas a daily capacity of 1,500 t/d is provided by existing landfills, new landfill capacity of 1,200 t/d have to be built. Landfills will receive waste from composting plants (off-spec compost; 700 t/d), waste that is sent directly to landfills (0 - 1,400 t/d) and landfill fractions from the ISWM-Facility.

3.4.2 Assessment of phase I

This scenario is based on the capacities of treatment plants, which are currently in operation. Facilities under construction and those for which funds have already been secured (i.e. SWAM 1 and 2; see scenario “Do nothing”) are also assumed to have been built and are operational. No further explanation regarding the type and capacities of new treatment technologies is given in the Plan. The starting date for achieving the target value of 40% of accumulated waste to be disposed of in landfills is set for 2016, prescribed to last three (3) years, while the remaining 60% of waste have to be treated otherwise.

Rate and absolute amount of recyclables is expected to increase: On the one hand this is the result of higher capacities of the separation plants (compared to current status) and under the assumption that the rate of recyclables retrieved in separation plants will remain unchanged (8.7%). On the other hand recyclables will come from the Integrated Solid Waste Management Facilities (ISWM), and depending on the chosen technology other material can be recovered (RDF, bottom ash). Also, sellable compost will be generated at higher rates.

There are no measures regarding waste prevention foreseen in this scenario – neither the total waste generation nor the waste composition will be affected.

It is expected that the environmental impacts (e.g. ground – and surface water contamination, non-compliance with air quality standards, littering) will be less compared with the current status, mostly due to the fact that waste disposal in open dumps and open burning of waste is reduced remarkably.

Critical issues are the control of quality criteria for compost and how off-spec material from composting plants are managed. Since there will be a significant increase in new treatment capacities, both Institutional Capacities (in terms of cooperation and co-ordination of involved authorities and institutions) and Technical capacities (in terms of staff, time, equipment, education and skills) have to be increased as well.

Without further definition of treatment technologies and capacities the presented figures can be regarded as rough estimates only, and uncertainties will remain high. Whereas it can be assumed that treatment facilities currently under construction will be operational within one year (by 2016), one year would be much too short to plan, built, permit and put into operation large and complex

treatment facilities. This is in particular true for waste incineration plants, where experience has shown that the planning and permitting phase (in EU Member States, such plants have to undergo an EIA and an integrated permitting process) usually takes between 2 and 5 years and the subsequent construction phase another 1.5 to 2 years. In addition plant operators usually need a certain period of time (0.5 to 1 year), until the waste incineration plant is optimised and stable operation conditions are achieved.

Although it would be beneficial from an environmental point of view, it seems unlikely to achieve the 40% target value within the foreseen implementation period for Phase I (the current share of waste disposed of in landfills or dumpsites is approximately 74%[11]). For this reason a number of suitable recommendations are provided within the present report that could support the effort to meet the targets set forth in the “SWM Plan” used as a basis of the SEA.

[11] This figure is based on the database established during the Strategic Environmental Assessment exercise based on figures collected in 2014.

Figure 8: Flowchart for CoM Decision 46/2014 as amended by CoM Decision 1/2015 (Phase I)

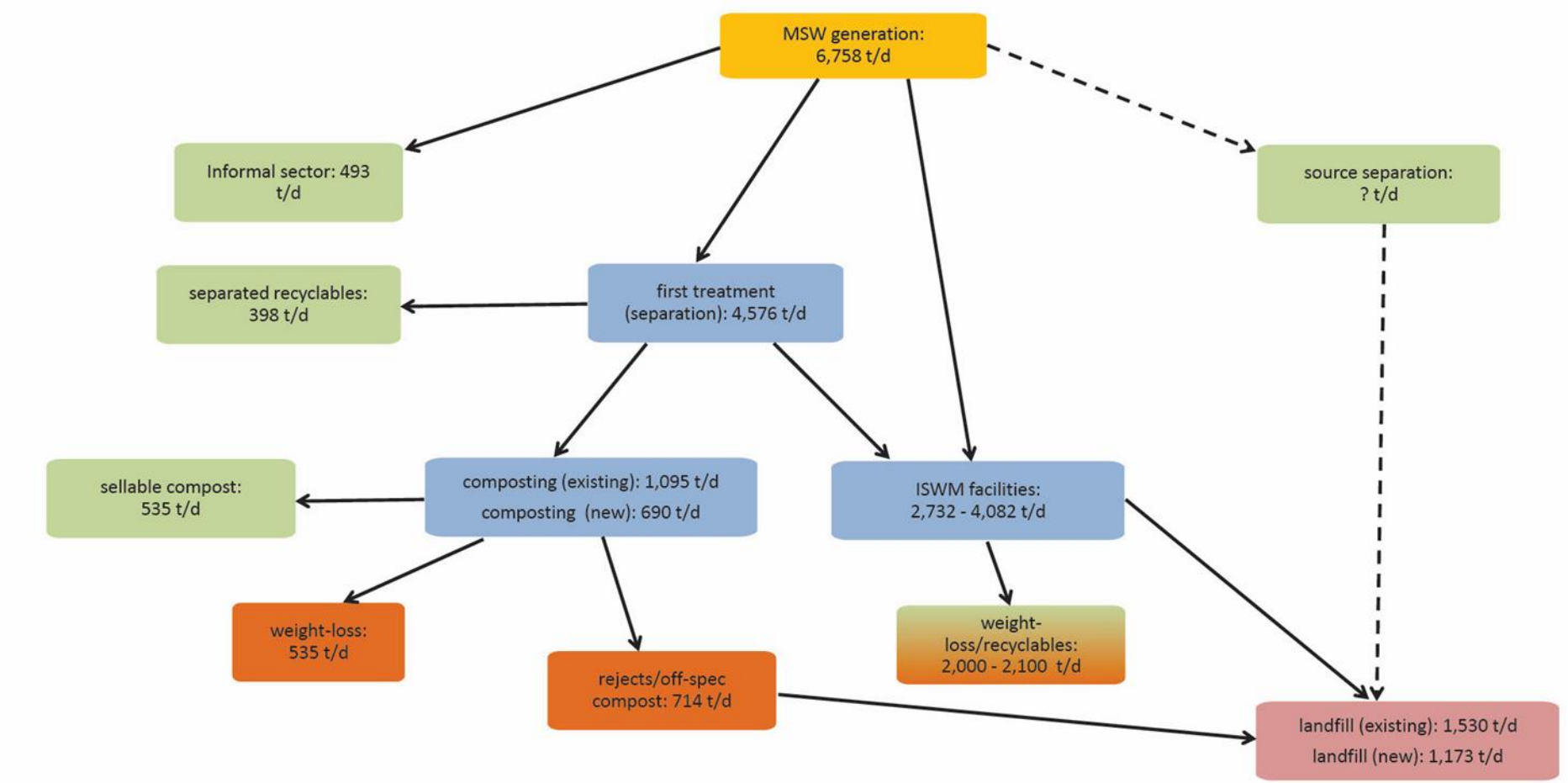


Table 11: Mass balance of CoM Decision 46/2014 as amended by CoM Decision 1/2015 scenario (Phase I)

Scenario	Decision 46, amended by Decision 1/2015 scenario (Phase I)		
Waste generation	Without informal sector:	6,300 t/d	2,287,000 t/y
	Scavengers included:	6,800 t/d	2,467,000 t/y
Input into first treatment step (separation of mixed MSW)	Existing capacity - separation:	4,600 t/d	1,670,000 t/y
Output of first treatment step	Recyclables (glass, metals, paper, plastics):	400 t/d (8.7%)	145,300 t/y
	Input to composting plant (39% of input into separation):	1,800 t/d	652,000 t/y
	output to ISWM:	2,400 t/d	873, 500 t/y
Input into composting plants	39% of input into separation step	1,800 t/d	651,500 t/y
	Thereof existing composting plants:	1,100 t/d	399,700 t/y
	There of new composting plants:	690 t/d	251,900 t/y
Output of composting plants	Sellable compost:	500 t/d (30%)	195,300 t/y
	Weight-losss:	500 t/d (30%)	195,300 t/y
	Off-specification compost and rejects:	700 t/d (40%)	260,600 t/y
Input into ISWM	Minimum:	2,700 t/d	997,200 t/y
	Output of separation plant plus waste, which has to be pretreated to reach the landfill target of 40%)	2,400 t/d + 300 t/d = 2,700 t/d	873,500 t/y + 123,700 t/y = 997,200 t/y
	Maximum[12]:	4,100 t/d	1,489,900 t/y
Output from ISWM - weight loss/recyclables	Rough estimate, depending on technology[13]	2,000 - 2,100 t/d	730,000 – 766,500 t/y
Input to landfills	40% target value is equivalent to	2,700 t/d	986,600 t/y
	Existing landfill:	1,500 t/d	558,500 t/y
	New landfill:	1,200 t/d	428,200 t/y
	Landfill fractions include Off-spec compost Waste which is send directly to landfills and Landfill fractions from ISWM-Facilities	 700 t/d 0 - 1,400 t/d 700 - 2,000 t/d	 259,200 t/y 0 – 492,800 t/y 237,300 – 730,000 t/y

[12] gap between waste generation, informal sector and capacity of first treatment step plus output of separation plant.

[13] lower range could be based on the assumption of RDF production and separation of recyclables; higher range could be based on the assumption of RDF production, waste incineration and bottom ash recycling.

3.4.3 Brief description of Phase II

CoM Decision 1/2015 stipulates that in the second phase (2019) only 25% of the generated municipal solid waste is disposed of at landfills. Thus, calculations were based on the estimated waste accumulation in the year 2019 – which is 7,100 t/d or 2.58 mio t/a (informal sector included).

In this scenario existing facilities will be further operated (with the exemption of Naahmeh landfill), facilities under construction and facilities, where funds have already been secured (i.e. SWAM 1 and 2), are assumed to have been built and have been put into operation. This scenario is a continuation of the first phase without changes to the capacities of separation and composting plants. However, to achieve the target of 25% of waste disposed of at landfills, there is no waste stream, which is directly landfilled and even rejects/off-specification compost from the composting plants will be treated in the ISWM-Facilities.

This Scenario is based on the following assumptions:

a) Informal sector continues its activities;

b) Separation plants with a total capacity of about 4,600 t/d are in operation;

c) Composting plants are in operation with a total capacity of about 1,800 t/d;

d) Operation of one or several „Integrated Solid Waste Management Facility (ISWM-Facility)“;

e) Overall landfill capacity is about 1,800 t/d (equivalent to a 25% ratio);

f) Separate collection of recyclables: could also be an option, but it is not quantified.

Based on those assumptions, the Phase II of the Base scenario can be further described hereby (refer to Table 12 and Figure 9 below):

a) The informal sector will continue as usual (about 500 t/d), since there is no specific measure foreseen which could change the status and the activity level of the “informal sector“.

b) As in the “do-nothing scenario 2020“ total capacity of separation plants is about 4,600 t/d (which means that large capacities have to be planned, permitted, built and put into operation within a short period of 3 year). Output streams are separated recyclables (about 400 t/d; 8.7%), input to composting plants (about 1,800 t/d; 39% of the input), the rest is further treated in one or several “Integrated Solid Waste Management Facility (ISWM-Facility)”.

c) Required capacity of composting plants is about 700 t/d higher than the capacity of the existing ones (in total 1,785 t/d). The additional composting facilities are referred to as “composting new”. It is assumed that 30% of the input will be sold as compost (about 500 t/d), 30% are losses and the remaining 40% (about 700 t/d) have to be treated in one or several ISWM-Facilities.

d) In addition to the new composting plant(s) referred to above, additional treatment facilities have to be put into operation; these additional treatement facilities are referred to as “Integrated Solid Waste Management Facility (ISWM-Facility)”. From a technical point of view, any technology suitable for the treatment of untreated or pretreated municipal solid waste could be chosen, namely: incineration with or without energy recovery, chemical-physical treatment, mechanical-biological treatment, sorting, aerobic and anaerobic treatment, etc. Input into the ISWM-Facility will be in the range of approximately 3,100 to 5,100 t/d and can be explained as follows:

   - Lower range (approximately 3,100 t/d): output of separation plants: about 2,400 t/d plus 700 t/d off-spec material from composting plants. The lower range can only be achieved, if appr. 2,000 t/d of municipal solid waste are separately collected.

- Higher range (about 5,100 t/d): output of separation plant (about 2,400 t/d) plus off-spec material from composting plant (about 700 t/d) plus any additional waste generated (about 2,000 t/d).

  Depending on the used technologies output (or recyclables) and losses would greatly vary. The given range has been calculated based on the input into ISWM-Facility and the available capacity for landfills, which is determined by the 25% target. Technically, the lower range (about 1,500 t/d) could be based on the assumption of RDF production and separation of recyclables; the higher range (about 3,400 t/d) could be based on the assumption of RDF production, waste incineration and bottom ash recycling.

e) Overall landfill capacity in this scenario is approximately 1,800 t/a (capacity required to reach the target value of 25%). Whereas around 1,500 t/d are existing landfills, new landfill capacity of about 200 t/d have to be constructed.

3.4.4 Assessment of Phase II

Phase II of this scenario is based on the capacities of treatment plants which are currently in operation. As per definition, also facilities under construction and facilities, where funds have already been secured (i.e. SWAM 1 and 2), are assumed to have been built and have been put into operation. No further explanation regarding type and capacities of new treatment technologies is given. Deadline for achieving the target value of 25% - i.e. 25% of accumulated waste may be disposed of in landfills, the remaining 75% have to be treated otherwise – is 2019.

Rate and absolute amount of recyclables is expected to increase. On the one hand this is the result of higher capacities of the separation plants (compared to current status) and under the assumption that the rate of recyclables retrieved in separation plants will remain unchanged (8.7%). Moreover, recyclables will be expected from the Integrated Solid Waste Management Facilities (ISWM and depending on the chosen technology also other material can be recovered (RDF, bottom ash)). Also, sellable compost will be expected to be generated at higher rates.

There are no measures regarding waste prevention foreseen in this scenario – neither the total waste generation nor the waste composition will be affected.

It is expected that the environmental impacts (e.g. ground- and surfacewater contamination, non-compliance with air quality standards, littering) will be much less compared with the current status, mostly due to the fact that waste disposal in open dumps and open burning of waste will not occur anymore.

Critical issues are the control of quality criteria for compost and how off-spec materials from composting plants are managed.

No further specification of type and capacities of treatment technologies are given in the Plan, the description and assessment is based on several assumptions. It can be assumed that treatment facilities currently under construction or less complex treatment facilities will be operational within the next few years. However, this will not be the case for large and complex treatment plants, which are at the moment not even in the planning phase. This is in particular true for waste incineration plants, where experience has shown that the planning and permitting phase (in EU Member States, such plants have to undergo an EIA and an integrated permitting process) usually takes between 2 and 5 years and the subsequent construction phase another 1.5 to 2 years. In addition plant operators usually need a certain period of time (0.5 to 1 year), until the waste incineration plant is optimised and stable operation conditions are achieved.

Since there will be a significant increase in new treatment capacities, both Institutional Capacities (in terms of cooperation and co-ordination of involved authorities and institutions)

and Technical capacities (in terms of staff, time, equipment, education and skills) have to be increased as well. The major constraints are time, awareness, education, legal, administrative and technical capacities as well as logistics.

To implement an effective and sustainable separate collection system, the whole system of waste delivery/waste collection, transport, (intermediate) storage, processing and sale has to be based on a sound legal and administrative system across Lebanon. The citizens have to be educated by awareness campaigns to achieve co-operation and avoid impurities. Experiences in EU Member States have shown that such a process would take much longer than 5 years.

It should be noted here, that the 25% target value for landfilling of municipal waste, including residues from pre-treatment is a very ambitious one: For example, in Austria it took 15 years (from 1989 to 2004) to reduce the share of municipal waste disposed of at landfills from 74.8% to 23.8%. Waste that is currently landfilled in Austria includes pre-treated waste, fly ash and bottom ash from waste incineration and inert rejects from separate collection.

Although it would be beneficial from an environmental point of view, it is unlikely to achieve the 25% target value within the tight implementation period foreseen in the Decision. For this reason a number of suitable recommendations are provided within the present report that could support the effort to meet the targets set forth in the “SWM Plan” considered in the SEA.

Figure 9: Flowchart for CoM Decision 46/2014 as amended by CoM Decision 1/2015 (Phase II)

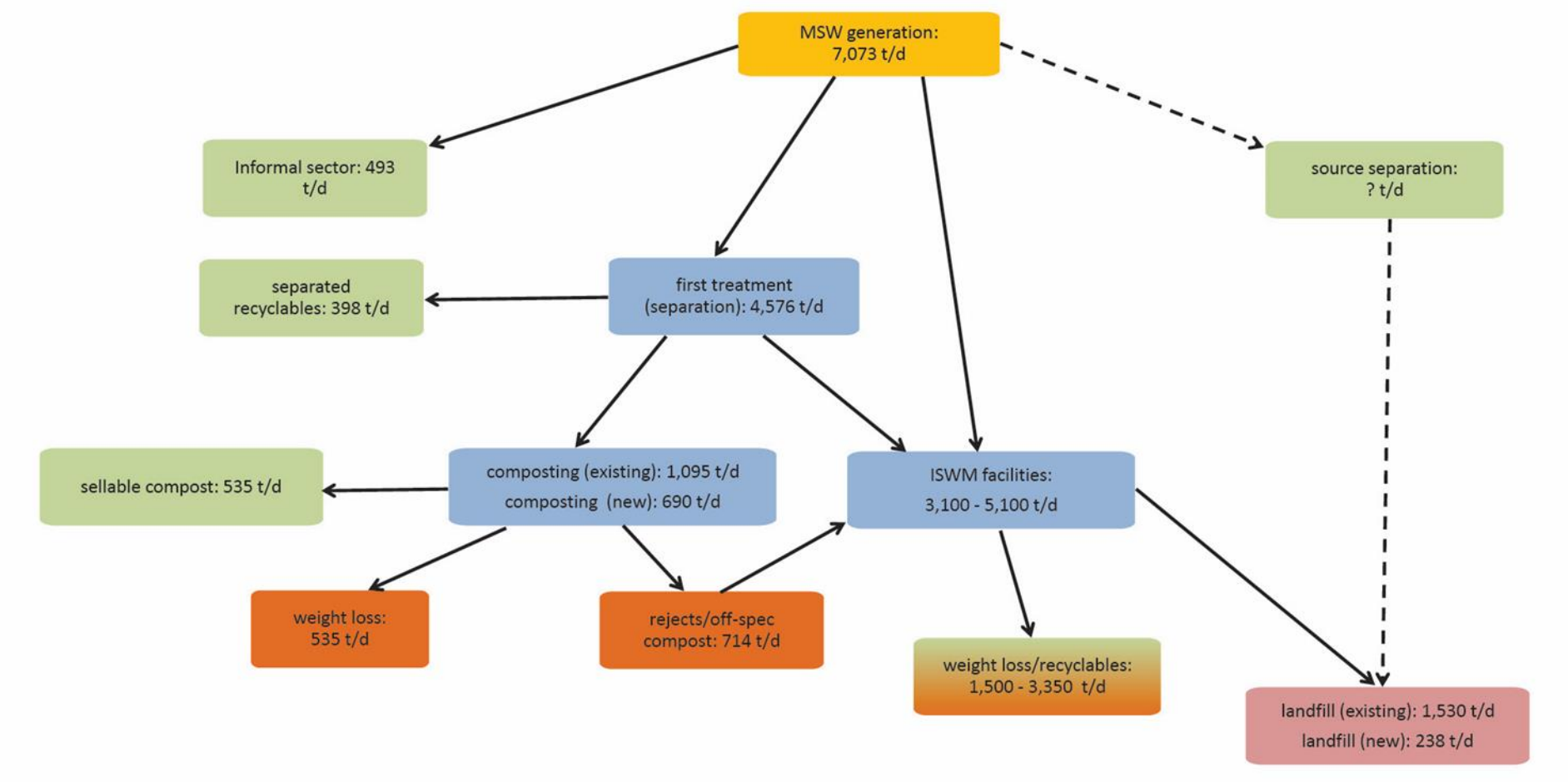


Table 12: Mass balance of CoM Decision 46/2014 as amended by CoM Decision 1/2015 scenario (Phase II)

Scenario	Decision 46, amended by Decision 1/2015 scenario (Phase II)		
Waste generation	Without informal sector:	6,600 t/d	2,401,700 t/y
	Informal sector included:	7,100 t/d	2,581,700 t/y
Input into first treatment step (separation)	Existing capacity - separation:	4,600 t/d	1,670,200 t/y
Output of first treatment step	Recyclables (glas, metals, paper, plastics):	400 t/d (8.7%)	145,300 t/y
	input to composting plant (39% of input into separation):	1,800 t/d	651,500 t/y
	input to ISWM:	2,400 t/d	873,500 t/y
Input into composting plants	39% of of input into separation step:	1,800 t/d	651,500 t/y
	thereorfexisting composting plants:	1,100 t/d	399,700 t/y
	new composting plants:	700 t/d	251,900 t/y
Output of composting plants	sellable compost:	500 t/d (30%)	195,300 t/y
	Weight-loss:	535 t/d (30%)	195,275 t/y
	off-specification compost and rejects:	700 t/d (40%)	260,600 t/y
Input into ISWM	Minimum:	3,100 t/d	1,131,500 t/y
	output of separation plant plus off-spec material from composting plant [14]	2,400 t/d + 700 t/d = 3,100 t/d	873,500 t/y + 260,600 t/y = 1,134,100 t/y
	Maximum[15]:	5,100 t/d	1,861,500 t/y
Output from ISWM - weight loss/recyclables		1,500 - 3,400 t/d[16]	547,500 –1,222,800 t/y
Input to landfills	25% target value is equivalent to	1,800 t/d	645,300 t/y
	existing landfill:	1,500 t/d	558,500 t/y
	new landfill:	200 t/d	86,900 t/y
	landfill fractions include landfill fractions from ISWM-Facilities	1,600 - 1,800 t/d	572,300 – 645,300 t/y
	landfill fractions from separately collected waste	0 - 200 t/d	– 73,000 t/y

[14] based on the assumption that appr. 2,000 t/d are separately collected

[15] output of separation plant plus off-spec material from composting plant plus any additional waste generated

[16] (rough estimatedepending on technology); range is determined by input into ISWM-Facility and the available capacity for landfills,which are fixed by the 25% target lower range could be based on the assumption of RDF production and separation of recyclables;
higher range could be based on the assumption of RDF production, waste incineration and bottom ash recycling

4 RECOMMENDED SWM OPTIONS IN LEBANON

In this chapter, the main SWM options are being presented, accompanied by specific recommendations that could enhance their environmental performance and consequently paving the path for a sustainable Long Term Solid Waste Strategy in Lebanon.

The main SWM options are grouped into the following categories:

Separate collection of recyclables & organic waste;

Separation and composting / biological treatment of mixed MSW;

Incineration and Co-incineration with Energy recovery;

Landfilling- Sanitary Landfills.

4.1 Separate collection of recyclables & organic waste

4.1.1 Introduction

Separate collection of recyclables and organic waste is an indispensable part of a modern waste management system.

Recyclables

In Lebanon, when mixed or sorted waste is collected from street bins, most formal sector service providers use truck compacters, which are efficient, but reduce the quality (due to contamination) and quantity (due to comingling) of both recyclable and compostable material. For example, 20-30% of otherwise recyclable cardboard/paper turns into rejects due to contamination during handling.

Recyclable materials are collected at the source by NGOs, companies, industries, unregulated scavengers, licensed scavengers and service providers.

Recyclables mostly consist of metal, glass, plastic and paper wastes. The objective of separate collection of recyclables is to accumulate them at source instead of separating them at a later stage from mixed municipal waste. Whilst it is technically achievable to separate metal waste and to some extent plastics and glass from mixed MSW, the quality of waste paper deteriorates significantly if not already separated at source.

By separate collection of recyclables the amount of mixed municipal waste to be handled in pre-treatment plants (separation plants) or in final treatment plants (waste incineration) can be reduced significantly. Furthermore, considerable revenues may be generated, depending on the market prices of recyclables.

For the separate collection of paper, public containers placed outdoors for the separate collection have disadvantages. When waste paper gets wet or moist, as to be expected after rainfalls, its quality deteriorates.

In principle, private persons / individuals could be obliged by law to hand over recyclables to separate collection points. However, in practice there is little chance to enforce such provisions. In some countries, financial incentives for delivering recyclables to collection points helped to increase collection rates. In case that citizens have to pay for the collection of municipal solid waste on a unit base, a cost reduction by keeping recyclables separated from the mixed waste might be an incentive.

Awareness raising with regard to environmental protection in general, and how individuals can contribute to protecting the environment, has proven to be an effective instrument.

Key environmental issues related to the separate collection of recyclables at source are:

- To increase recycling rates by minimising the misthrows in the separate collection;
- To minimise the required transport capacity by optimizing pick-up intervals from collection points;
- To minimise energy and water consumption when preparing the material for recycling;
- To secure adequate treatment/disposal of rejects or off-specification materials;
- To secure a market for the recyclables to avoid the need to dispose of the collected material.

Separate collection of organic waste

Municipal organic waste consists mainly of food and kitchen wastes from households, restaurants, caterers and retail premises, green waste from market places and to a certain degree biodegradable waste from garden and parks. In Lebanon, around 52.5% of solid municipal waste is organic.

The objective of the collection of organic waste is primarily to keep it separated from mixed municipal waste. By this, the content of biodegradables in the MSW is reduced and consequently the emission of greenhouse gases from landfills. Furthermore, volume and water content of MSW are much lower when organic waste is collected separately. Correspondingly, the calorific value of the residual MSW will increase. The separately collected organics can be treated in composting plants to produce a compost of very good quality which can be used in agriculture for improving the soil quality and to substitute inorganic fertilisers. To some extent, the organic fractions could also be treated by anaerobic digestion with energy recovery of the produced biogas.

Separating organic waste at a later stage from mixed municipal waste can be technically achieved. Compost from mixed municipal waste usually has a lower quality than waste from separately collected organic fractions, with regard to the content of inorganic matter and plastics. There is a risk of contamination with heavy metals or other contaminants from batteries, small electrical appliances or other hazardous constituents of the MSW (“hazardous household wastes”). Therefore, a plan of action to promote separation of those stream fractions outside the municipal stream is also highly recommended (MoE/EU, 2016).

When deciding on the way how to organise the separate collection of organic waste, factors like population density, the availability of suitable public space for placing containers and other local or regional aspects have to be taken into account. It cannot be expected that households keep a sort of intermediate in-house storage of organic matter.

In cities, negative experiences have been had with public containers for the separate collection of organic matter. During the warm seasons, sanitary problems caused by biological degradation can be expected to occur frequently. Bad odour will have a negative impact on the public acceptance. Misthrows may lead to a significant deterioration of the produced compost. These problems may be overcome by adjusting the system of separate collection of organics to specific local or regional conditions. For example, in densely populated inner city areas the separate collection of organic waste could be restricted to the collection of kitchen and food waste only from restaurants, canteens and caterers.

In principle, private persons / individuals could be obliged by law to hand over organic waste to separate collection; however, in practice there is little chance to enforce such provisions. In case citizens have to pay for the collection of municipal solid waste on a unit base, a cost reduction by keeping organics separated from the mixed waste might be an incentive.

Awareness raising with regard to environmental protection in general, and how individuals can contribute to protecting the environment, has proven to be an effective instrument.

Key environmental issues related to separate collection of organics at source are:

- To avoid sanitary problems caused by extended and long time intervals for the pick-up of organic waste from separate collection points.
- To avoid contamination of the compost by minimising misthrows in the separate collection of organic waste.
- To secure adequate treatment/disposal of rejects or off-specification materials
- To avoid uncontrolled biodegradation which may occur during extended intermediate storage
- To avoid long storage times of the collected organic waste prior to composting in order to avoid or reduce uncontrolled biodegradation which may occur during extended intermediate storage of the collected organic waste.

European Laws

Relevant EU Law requires that separate collection systems of waste are set up where technically, environmentally and economically practicable and appropriate to meet the necessary quality standards for the relevant recycling sectors. At least, separate collection shall be set up for **paper**, **metal**, **plastic** and **glass**. Recycling targets have been set such that by 2020, preparing for re-use and recycling at least for paper, metal, plastic and glass from households would be increased to a minimum of overall 50 % by weight.

Targets with regard to recycling/recovery have also been laid down for **packaging waste**, **waste from electrical and electronic equipment**, **batteries** and **end-of-life vehicles**.

EU Laws also require that the separate collection and proper treatment of **bio-waste** is facilitated in order to produce environmentally safe compost. By that the amount of greenhouse gas emissions originating from waste disposal on landfills is reduced (Waste Framework Directive 2008/98/EC).

Furthermore, European Laws require that a strategy be developed to reduce the amount of biodegradable waste going to landfill. The target for European Member States was a reduction of biodegradable municipal waste going to landfills by 35 % of the total amount (by weight) of biodegradable municipal waste within 15 years (Landfill Directive 1999/31/EC).

4.1.2 Recommendations regarding the implementation of separate waste collection of recyclables & organic waste in Lebanon

It is recommended to introduce separate collection systems at source for paper & cardboard, metals, glass and plastics so that the material is gradually diverted (at least partially or from selected sources) from mixed MSW. To start the system, the separate collection should be installed at large point sources (e.g. trade centres, small enterprises, shopping centres, office buildings) first and then be continuously expanded. In a short-term view (i.e. until 2020), up to 15% of the overall paper content, 5% of the plastic content and 20% of the metal and glass content constitute realistic percentages that can be diverted from the mixed municipal waste by separate collection.

These figures have to be considered in addition to the activities of the informal sector, which will continue its activity unless the latter is integrated into the formal separate collection system. The latter would also assist in the overall efforts of a sound SWM system and is therefore recommended as a plan of action.

Without prejudice to the existing legal and institutional arrangements in Lebanon the following points are highlighted:

- Separate collection of recyclables and organic waste has implications on local, regional and national waste management and on the transport logistics;

- Depending on the quality requirements for secondary raw material, a further pre-treatment of the recyclables may be necessary. Rejects and off-specification material will have to be disposed of;
- A market for recyclables has to be in place. Without a market, accumulated recyclables will have to be stored and ultimately disposed of;
- Recommendations for the implementation of separate collection systems:
- It is recommended to introduce a formalised system of separate collection of recyclables at source;
- It is necessary to introduce adequate legislation for the implementation of separate collection of recyclables;
- It is recommended to secure sites for the interim storage of collected recyclables, which will be needed to accumulate the material to marketable amounts. These storage sites will have to be permitted and inspected by the competent authority on a regular basis;
- It is recommended to integrate the informal sector into the future scheme of separate collection of recyclables in order to avoid possible adverse effects;
- It should be examined whether the separate collection of recyclables should be implemented step-wise, starting at points of high accumulation, e.g. separate collection of paper at offices;
- It is recommended to introduce a separate collection of organic waste from households only in rural or less densely populated areas where there is ample public space for collection points. Collection points should not be located in the immediate vicinity of residential areas. It is not recommended to introduce a separate collection of organic waste at a large scale in Beirut/Mount Lebanon, although local initiatives even in city areas should not be discouraged;
- It should be examined whether a collection of kitchen waste from restaurants, canteens and caterers should be introduced in densely populated inner city areas, e.g. in Beirut;
- It is recommended to introduce analysis of the composition of municipal waste (mixed MSW and separately collected fraction) on a regular basis, determining the main constituents of mixed MSW and the contamination of separately collected fraction caused by misthrows. By this, the efficiency of separate collection and of recycling can be monitored and measures for improvements can be implemented;
- It is recommended to initiate the process of promoting the separation of different waste stream fractions from the municipal waste, by introducing legislative measures but also incentives (“pay as you throw”, “deposit refund systems”, etc.);
- Awareness raising campaigns should be conducted to promote separate collection and avoid misthrows.

4.2 Separation and composting / biological treatment of mixed MSW

4.2.1 Introduction

Currently, there are several medium to relatively large sized facilities for separation (sorting) and composting/biological treatment in operation in different areas in Lebanon. There are also other solid waste (sorting and composting/biological treatment) projects which have secured funding (mostly under SWAM 1 & 2 Programmes).

Thus, separation and composting/biological treatment of MSW is considered to be a core element of the future MSW management system in Lebanon. Due to the predicted increase of the volume of MSW, it is most likely that large capacities for separation of mixed municipal solid waste have to be installed in addition to the already existing ones. The capacity which will be required for the

subsequent biological treatment step is about 2/3 of the installed separation capacity. This means that additional capacities for the biological treatment have to be installed as well.

Taking into account the weight loss as a result of the biological treatment, roughly 30% of the mixed MSW) will remain as biologically stabilised material. Its quality is predominantly grade C or grade D compost. As such, it can be utilised in landscaping, re-cultivation of abandoned quarries, soil for green space along traffic roads (grade C compost) or as recultivation material on controlled landfills (grade D compost). Use in agriculture is rarely feasible, as previous experience has shown. As there is only a limited market for such a material, landfilling might also be considered as an option.

Between 30% and 40% of the mixed MSW will remain as non-compostable material which can not be recycled. It has a considerably higher calorific value than mixed MSW. This fraction must be landfilled unless the quantity is reduced by recovery of energy.

As MSW generation can be expected to increase in the years to come, additional pressure on treatment capacities can be foreseen. This pressure will be alleviated if separate collection of recyclables and organics is implemented successfully, as the amount of mixed MSW will be reduced by diverting recyclables/organics from the mixed waste stream.

Separation of a high-calorific fraction from mixed MSW has benefits, if capacities for energy recovery are available. In principal, there is a wide range of possible uses:

- High-calorific fraction can be processed into high-quality RDF for co-incineration in industrial plants, e.g. cement plants. High-quality RDF must have a high and constant heating value and a low variability of main constituents (composition). Hazardous substances, PVC or other material containing halogenated substances have to be removed. This means that a certain percentage of rejects/off-specification fraction will remain which either goes to landfill or is incinerated together with mixed municipal waste.
- In case there is capacity for incineration of mixed municipal waste, a part of the high calorific fraction can be incinerated together with mixed MSW to increase its heating value. The input of high-calorific fraction into MSW-incineration plants is limited technically by its heating value, which is significantly higher than the heating values of mixed MSW. The most widely applied technology for incineration of mixed MSW is the grate firing which is a very robust technology.
- The high-calorific fraction can also be further processed through incineration in fluidised-bed incinerators for energy recovery. This incineration technology allows a higher heating value of the fuel but has higher demands on quality of the input material. The technology is less robust than grate firing.

Among the key environmental issues that are related to the separation and composting/biological treatment of Municipal Solid Waste are:

- Dust emissions are the most relevant emissions into air during mechanical treatment/separation;
- During composting/biological treatment odour and emissions of N_2O, NH_3 and CH_4 have to be minimised by adequate operation conditions in the treatment plant;
- Adequate treatment/disposal of rejects;
- Capacity for environmentally safe utilisation for biologically stabilised material and landfill capacity for off-specification compost has to be made available;
- A market for good quality compost is to be secured to avoid the need to dispose of it.

4.2.2 Recommendations regarding the implementation of separation / biological treatment of MSWM

Without prejudice to the existing legal and institutional arrangements in Lebanon the following recommendations for the implementation of separation/biological treatment are highlighted:

- It is necessary to introduce adequate legislation for the limitation of emissions from separation, biological treatment and composting plants;
- It is recommended to open a market for the environmentally sound utilisation of biologically stabilised material and introduction of quality control and monitoring system;
- It is recommended to promote energy recovery as treatment scheme;
- It is necessary to introduce adequate legislation for the implementation of separate collection of recyclables;
- It is recommended to secure sites for the interim storage of compost / biologically stabilised material prior to utilisation of the material in an environmentally safe way. These storage sites will have to be permitted and inspected by the competent authority on a regular basis.

4.3 Incineration and Co-incineration with Energy Recovery

4.3.1 Introduction

Incineration with energy recovery is used as a treatment for a very wide range of wastes, including MSW. Incineration itself is commonly only one part of a complex waste treatment system that in combination with source separation and mechanical biological treatment provides for the overall management of the broad range of wastes that arise in a certain society or community.

Incineration of MSW with energy recovery could be gradually introduced in Lebanon alongside with RDF production and use in cement plants. In order to minimise transport efforts, it is recommended to secure sites in the vicinity of densely populated areas.

Due to the high content of organics, the calorific value of the mixed MSW will be at a low level (appr. 7.5 GJ/tonne have been reported).

It is recommended not to fully deploy / implement the separate collection of organic waste in densely populated areas (for reasons of odour emission, sanitary problems and which could increase the calorific value of the remaining waste).

Instead, other measures could be taken, such as separate collection of kitchen and food waste from restaurants, canteens and caterers or garden waste from cultivation of parks, etc.

Also, mixing MSW with high-calorific fractions of waste or adjusting the design of the waste incineration plant to waste with low calorific value could be considered. As an example, to achieve a calorific value of approx. 9 GJ/tonne, the input material into the waste incineration plant should consist of approx. 80% mixed MSW and 20% high-calorific fraction.

Fly ash and flue gas cleaning residues from the incineration process (approximately 3% of the incoming waste) have to be disposed of at a specific landfill. Bottom ash (approximately constitutes 25% of the incoming waste by weight) may be recycled if it meets defined criteria, or it has to be deposited of in designated sites (e.g. backfilling after stabilisation) or landfilled.

Concerning further energy recovery of high-calorific fraction from mixed MSW, it is recommended to initiate co-incineration of RDF in cement plants. By further processing of the high-calorific fraction, a high-quality RDF can be produced with a calorific value of approx. 20 GJ/tonne (20MJ/kg). Co-incineration of RDF in cement plants will substitute petcoke, which is currently used as fuel.

4.3.2 Technical Aspects of Waste Incineration

The objective of waste incineration is to treat wastes so as to reduce their volume and hazards, whilst capturing (and thus concentrating) or destroying potentially harmful substances that are released during incineration. Incineration processes can also provide a means to enable recovery of the energy, mineral and/or chemical content from waste.

Basically, modern waste incineration is the full oxidation of the combustible materials contained in the waste. The organic fuel substances in the waste will burn when they have reached the necessary ignition temperature and come into contact with oxygen. The actual combustion process takes place in the gas phase at flue-gas temperatures generally between 800 and 1,450°C in fractions of seconds and simultaneously releases energy where the calorific value of the waste and oxygen supply is sufficient, this can lead to a thermal chain reaction and self-supporting combustion, i.e. there is no need for the addition of other fuels. Grate firing systems are predominantly used for incineration of MSW.

Flue gas contains among water vapour, carbon dioxide and oxygen, also air pollutants, such as CO, HCl, HF, HBr, HI, NOx, SO_2, VOCs, PCDD/F, PCBs, Hg and other (heavy) metal compounds.

Depending on the combustion temperatures during the main stages of incineration, volatile heavy metals and inorganic compounds (e.g. salts) are totally or partly evaporated. These substances are transferred from the input waste to both the flue-gas and the fly ash it contains. A mineral residue fly ash (dust) and heavier solid ash (bottom ash) are created.

In municipal waste incinerators, bottom ash is approximately 10% by volume and approximately 20 to 30% by weight of the solid waste input. Fly ash quantities are much lower, generally only a few per cent of input. The proportions of solid residue vary greatly according to the waste type and detailed process design. Fly ash is usually disposed of in landfills (sometimes after pre-treatment), bottom ash is either landfilled or treated for recycling. Overall volume reduction by waste incineration is about 90%.

Due to the nature of municipal wastes and the pollutant load of flue gases, extensive cleaning of emitted gases is required, which is achieved by dry, semi-dry or wet systems (scrubbers). Generally they are applicable independent from the upstream combustion system and can be combined in every suitable manner. Wet systems generate wastewater, which has to be treated accordingly.

In many cases, waste incinerators may have only limited control over the precise content of the wastes they receive. This then results in the need for some installations to be designed so that they are sufficiently flexible to cope with the wide range of waste inputs they could receive. This applies to both the combustion stage and the subsequent flue-gas cleaning stages.

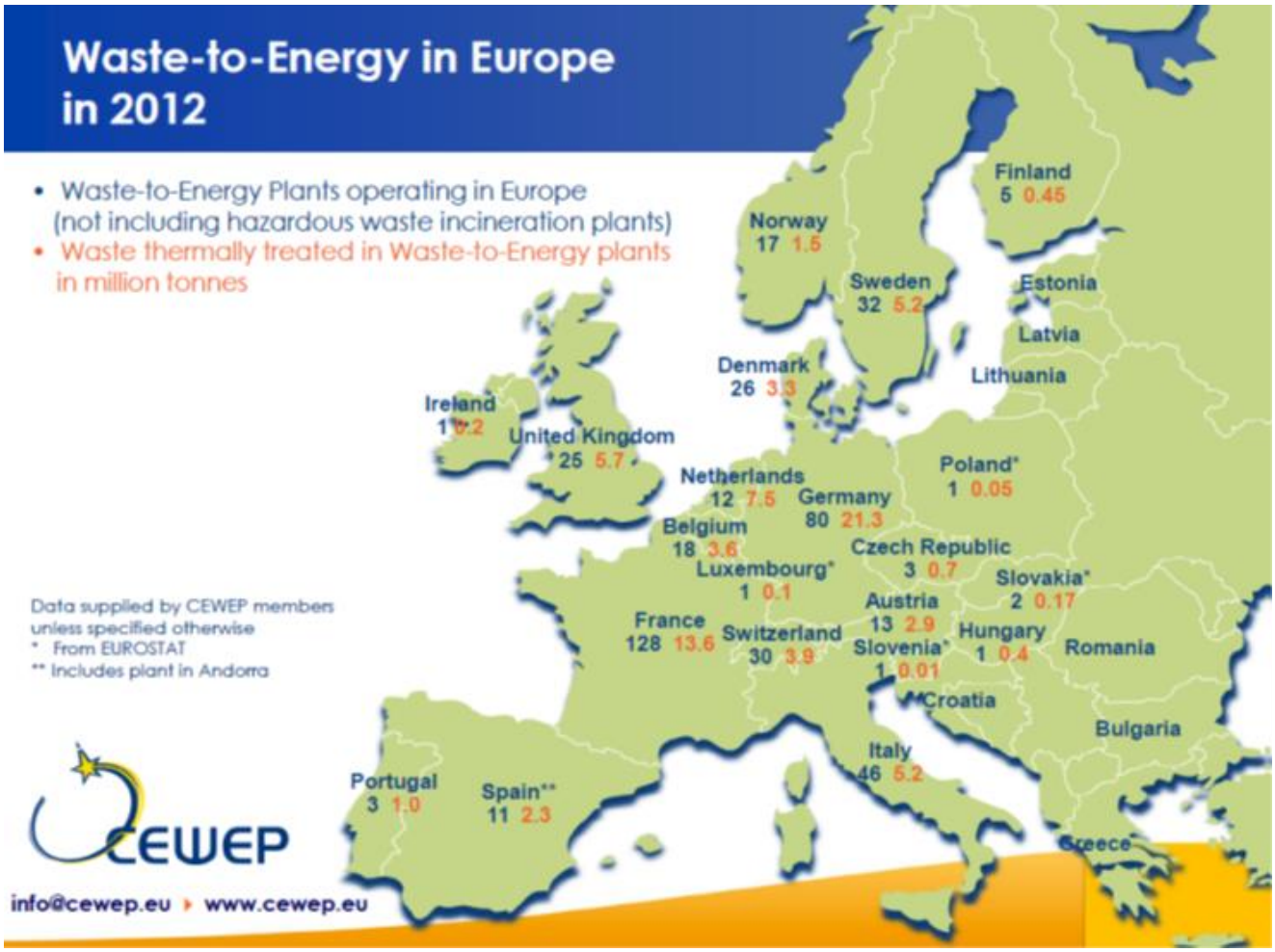
The main types of waste to which incineration is applied as a treatment include municipal wastes (residual wastes - not pre-treated), pre-treated municipal wastes (e.g. selected fractions or RDF), non-hazardous industrial wastes and packaging, hazardous wastes, sewage sludge and clinical wastes.

According to the Confederation of European Waste-to-Energy Plants as presented in Figure 10 below, more than 430 waste incineration plants are operated in European Member States. Key environmental issues related to energy recovery of waste (waste incineration, RDF co-incineration) are:

- Emissions to air (including odour)
- Emissions to water (in case wet systems for flue gas treatment are used)
- Generation of bottom, boiler ash, fly ash and sludges from wastewater treatment (in case of wet systems for flue gas treatment)
- Residues from flue gas treatment
- Emissions of noise and vibration
- Energy consumption and production
- Raw material (reagent) consumption

- Water consumption (steam cycle, cooling system)
- Fugitive emissions – mainly from waste storage
- Transport of incoming waste and outgoing residues

Figure 10: Waste-to-Energy Plants and Capacities in Europe



4.3.3 Recommendations regarding waste incineration & co-incineration in Lebanon

Without prejudice to the existing legal and institutional arrangements in Lebanon the following issues are relevant with regard to waste incineration and waste co-incineration[17] of waste:

- Incineration and Co-Incineration of waste (such as the use of High-Quality RDF in cement plants) has implications on local, regional and national waste management, on the energy system and on the transport logistics. These processes can only be implemented as part of an overall waste management system, which includes separation at source, separation of different waste streams (i.e. MSW, hazardous waste, industrial waste, clinical waste, construction waste, others), different waste treatment techniques and a gradually limitation of landfilling of untreated municipal solid waste (either by prohibition or by economic instruments). The implementation of the overall waste management system must be properly controlled.
- Waste incineration and waste co-incineration are widely applied in Europe with more than 430 incineration plants currently in operation (Confederation of European Waste to Enegry Plants).
- The process of waste incineration and waste co-incineration causes emissions of pollutants into air and water, noice and odour emissions and generates solid waste (bottom ash, boiler ash and fly ash) and waste/residues from flue gas treatment. Also water consumption for the energy recovery system (water-steam cycle) and - where applicable - for the flue gas treatment system is an environmental issue. Transport of waste is related with air emissions and noice.
- Current practice in EU member states is to use the concept of integrated prevention and control of pollution arising from industrial activities. This concept is based on prevention or, where prevention cannot be achieved, reduction of emissions into air, water and land and the prevention of the generation of waste shall be umplemented, in order to achieve a high level of protection of the environment taken as a whole.
- This concept is implemented by a permitting system based on best available techniques[18] and a risk based inspection system for large industrial activities.
- The concept of best available techniques focuses on emissions. However, to protect the health of human beings, the vegetation and ecosystems, it is essential to take the environmental situation into consideration and to ensure that environmental quality standards are met. If by application of best available techniques those standards are not complied with, additional measures shall be implemented.

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[17] The EU Industrial Emissions Directive defines in Art 3 waste incineration and waste co-incineration plants: "waste incineration plant“ means any stationary or mobiletechnical unit and equipment dedicated to the thermal treatment of waste, with or without recovery of the combustionheat generated, through the incineration by oxidation ofwaste as well as other thermal treatment processes, such aspyrolysis, gasification or plasma process, if the substancesresulting from the treatment are subsequently incinerated; on the other hand, ‘waste co-incineration plant’ means any stationary or mobiletechnical unit whose main purpose is the generation ofenergy or production of material products and which useswaste as a regular or additional fuel or in which waste isthermally treated for the purpose of disposal through theincineration by oxidation of waste as well as other thermaltreatment processes, such as pyrolysis, gasification or plasmaprocess, if the substances resulting from the treatment aresubsequently incinerated.

[18] “Best available techniques” means the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole:

- “techniques” includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;
- “available techniques” means those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator;
- “best” means most effective in achieving a high general level of protection of the environment as a whole;

- The operator of a waste incineration or co-incineration plant has to prove to the satisfaction of the authorities involved, that the plant is designed, built, maintained, operated and decommissioned in a way, so that emissions are prevented or reduced. This is done by submitting application documents, which in the case of waste incineration plants can be very comprehensive.
- The authorities have to check the application documents for an incinerator or co-incineration plant in terms of plausibilty, completeness and accuracy and ask for further information if required. It has been proven best practice to designate a “leading authority” (or “competent authority”), which is responsible for co-ordinating the process of permitting and inspection. This authority should make sure that all environmental issues are properly adressed in the permitting-inspection cycle, so that a high level of protection of the environment taken as a whole.
- It is beneficial to nominate contact persons on both the authorities and the operator’s side and to implement an efficient document handling system.
- Relevant Laws shall describe in a clear way roles and responsibilities and the procedure of the permitting process, including co-ordination and communication amongst authorities. These laws shall cover all environmental issues related with waste incineration and waste co-incineration. They shall include precise conditions related to monitoring and reporting and shall give clear guidance on how compliance is assessed and on measures to be taken in case of non-compliance.
- Permit conditions shall be set so that they provide for a high level of protection of the environment as a whole and that they are clear, unambigous and enforceable.
- Permits shall give the authority the power to enter the waste incineration/waste co-incineration plant at any time and that they can collect evidence and take samples.
- On a technical level, detailed knowledge on the technical process of waste incineration/waste co-incineration, emissions into all media, emission control systems, impact of emissions, dispersion modelling and monitoring as well as on compliance control is required both on the operators and the authorities side. This requires a high standard of available ressources in terms of staff, equipment and time, including education and training.
- It has been proven best practice to introduce a system of self-monitoring by the operator complemented by external monitoring by either accredited laboratories or by the authorities themselves.
- Monitoring must always be based on approved standards, highly recommended is the use of CEN standards or international standards, which ensure the provision of data of an equivalent scientific quality.
- Results of monitoring shall be processed, recorded and reported to enable the authority to check compliance with ELVs and other permit conditions. Online reporting is a very efficient and well-proven approach.
- Emission monitoring should always be complemented by monitoring the environmental state, in particular monitoring ambient air quality and the quality of surface-water and groundwater.
- It is best practice to introduce an inspection system, which includes regular site visits and checking whether the waste (co-) incineration plant is operated as described in the application documents and whether the permit conditions are met. Usually, on site inspections are performed by a team of environmental inspectors, each of them covering different technical and environmental aspects. Again, on site inspections need efficient coordination of concerned authorities. On site inspections are usually documented in an inspection report.

Best practice is the active information of the public about the waste incineration/waste co-incineration process and the related emissions. This could be done by providing monitoring data via public screens or the web. Information campaigns (including the possibility for the public to visit the plant, e.g. once a year) organised by the operator has been proven best practice to involve the public.

4.4 Landfilling- Sanitary Landfills

4.4.1 Introduction

A Sanitary Landfill refers to an engineered facility for the disposal of the remaining rejected inert portion of treated municipal solid waste, namely after sorting and composting activities have been carried. Sanitary landfills are designed and operated to minimise public health and environmental impacts.

The principal elements that must be considered in the planning, design and operation of sanitary landfills consist of: 1) landfill layout and design which takes into account a liner system, top cover and daily cover, 2) leachate collection and treatment, 3) landfill gas management, and 4) landfill closure and post-closure.

4.4.2 Recommendations related to Landfilling Methods

There are three principal methods used for the landfilling of municipal solid waste. These methods are: 1) excavated cell/trench, 2) area and 3) canyon/depression. It is to be noted that the canyon/depression method is found to be the most suitable landfilling method for quarry sites.

The main aspects which should be taken into consideration as part of planning, operating and closure of a sanitary landfill are the following:

Landfill Basal Liner System(s). Landfill liners are materials (both natural and manufactured) that are used to line the bottom area and below-grade sides of a landfill. The objective of landfill liners is to prevent the infiltration of leachate into the subsurface soils below the landfill, thus eliminating the potential for groundwater contamination. Figure XXX below is an illustration of a typical landfill basal liner system.

Waste Placement and Daily Cover / Intermediate Layer. Once a landfill site has been prepared, the next step in the process involves the actual placement of waste material.

Intermediate Drainage Layers of Sanitary Landfills*. I*nstallation of an intermediate drainage layer is recommended after one or two lifts have been completed. This intermediate drainage layer is necessary to speed up the leachate collection process. The number of intermediate drainage layers and their placement within the landfill depends upon the final height of the landfill and will therefore be determined in the detailed design phase of the sanitary landfill.

Landfill Top Cover. When the landfill reaches its full capacity it will be closed. This is typically carried out by capping off the landfill with a final layer or cover of top soil.

Leachate and Liquid Waste Management in Landfills*.* Leachate is generated in sanitary landfills from the compacted wastes. Leachate can also be defined as the water (percolating rainfall) that comes into contact with waste and is potentially contaminated by nutrients, metals, salts and other constituents. Leachate has the potential to cause serious pollution to groundwater and surface water if not properly managed.

Landfill Gas Management. The degradation of putrescible waste in a landfill generates gases such as methane, carbon dioxide and other trace gases that pose potential hazards to site safety, human health and the environment. Generation of landfill gas can continue for years after placement of the waste. Methane is explosive if it present in the range of 5% and 15% by volume in air. Both methane and carbon dioxide do not only asphyxiate if present in excessive concentrations, they are also greenhouse gases.

Closure plan. When a sanitary landfill reaches its full capacity, it will be closed and can therefore no longer receive any municipal solid waste. However, the facility must continue to function by adhering to all relevant environmental control and management requirements.

Post-Closure plan. The end use of a former landfill is dictated by the needs of the local community, the regional land planning, and the availability of funds for the reclamation project. Parks with limited facilities and wildlife habitats, for example, would require less expenditure than multi-recreational areas.

Post-closure maintenance. Post-closure maintenance shall be carried out at the sanitary landfill facility. This will be conducted for at least 30 years following closure of the sanitary landfills. The Post-Closure Maintenance consists of routine inspections, infrastructure maintenance and environmental monitoring.

5 MAIN CONCLUSIONS

The SEA process has allowed gathering extensive data regarding SWM practices in 2015. The data has been organised in a way that can serve future assessments of the SWM sector in Lebanon, especially with regards to developing future strategies and plans at national as well as regional levels.

Despite the fact that the SEA process was not completed due to changes in the "SWM Plan" which is used as a basis of the SEA, several important issues can be concluded from the SEA process.

5.1 Consequences of the "Do-nothing scenario by 2020"

The "Do nothing by 2020" is not interpreted as no action is made, but rather that the action continues similarly to the way it occurred with the closure of the Naameh landfill in July 2015, which has been replaced by the Bourj-Hammoud-Jdeideh and Ghadir River (Costa Brava) landfills in March 2016. Lebanon has witnessed this scenario between July 2015 when the Naameh landfill was closed and March 2016 pior to the opening of the 2 landfills in Borj Hammoud and Costa Brava. Such a scenario would also be envisaged to reoccur if no alternative to the Borj Hammoud and Costa Brava landfills is adopted by 2020 when these 2 landfills are expected to close.

Under the "Do-nothing scenario by 2020", it was estimated that existing facilities will continue to operate with the exception of Naahmeh landfill (which has been effectively closed in July 2015), it was also assumend that facilities that are currently under construction and those for which funds have already been secured (i.e. EU funded programmes like SWAM 1 and 2) will be constructed and operated. Accordingly, if no measures are taken to avoid the "Do-nothing scenario by 2020", the total SW generation rate is expected to reach about 6,700 t/d (reaching 7,200 t/d if the fraction taken by the informal sector is included), while the following situation would prevail:

- Informal sector (scavengers) continues its current activities
- Separation plants with a total capacity of about 4,600 t/d are in operation
- Composting plants are in operation with a total capacity of about 1,100 t/d
- Landfill capacity is 1,500 t/d

This means that a gap of about 2,100 t/d will remain and that this quantity will most likely find its way to uncontrolled dumpsites in the absence of sanitary landfills or other solutions. Moreover, the gap in the composting capacities of about 700 t/d will also be channelled to dumpsites.

As such, if Lebanon does not reverse the "Do-nothing Scenario by 2020", the overall waste management system is expected to worsen by 2020 and will be as follows:

- Approximately 57% of the waste will be disposed of at dumpsites (compared to a current share of 33%).
- Due to higher capacities of the separation plants, it expected that the rate of recyclables will remain unchanged (8.7% compared to 2015).

It is also expected that the adverse environmental effects will increase due to increased emissions of pollutants into all media (e.g. groundwater contamination by leachate, surfacewater contamination by leachate and sweep-off from the surface of open dumps, non-compliance with air quality standards by emissions from open burning and open dumps, odour emissions, emissions of greenhouse gases, overall hygiene in the surrounding environment, health & safety issues, fire and accidents expectations, etc).

5.2 Limitations of the "NGO inspired scenario by 2020"

This report has described the "NGO inspired scenario by 2020" as a highly integrated waste management system with a strict control of waste streams from primary waste generation to recovery/recycling and final disposal of stabilised residues.

According to this scenario, the share of separately collected waste is high and on a level of advanced EU Member States at 21% (reaching 45% if separate collected organic fraction is included).

However, in order to implement an effective and sustainable separate collection system, the whole system of waste delivery/waste collection, transport, (intermediate) storage, processing and sale has to be based on a sound legal and administrative system across Lebanon. The citizens have to be educated by series of long lasting awareness campaigns to secure their commitment to separate recyclables/organic waste at source and to reduce misthrows. Experience in EU Member States have shown that such a process would take between 5 to 15 years depending on the country.

In essence to translate the "NGO inspired scenario by 2020" into a fully operational integrated waste management scheme, realistically more than 10 – 15 years would be needed.

Regarding RDF production sought under the "NGO inspired by 2020 scenario", the report noted that this is a technically complex process which requires an already organised and an operating market. RDF must have a high and constant calorific value and a low variability of main constituents (composition). Hazardous substances, PVC or other material containing halogenated substances have to be removed. This means that a certain percentage of rejects/off-specification material will have to be treated/disposed of otherwise (e.g. landfill or incineration together with mixed municipal waste).

5.3 Limitations of the CoM Decision 46/2014 as amended by CoM Decision 1/2015

The CoM Decision 46 of 2014 as amended by CoM Decision 1 of 2015 stipulates that during the first 3 contractual years of operation, a share of not more than 40% of the municipal solid waste is to be disposed of at landfills. Thus, calculations made in this report indicated that this will have to account for waste generation rates of 6,800 t/d in the year 2016.

According to the SEA assessment, it seems unlikely to achieve the 40% target value within the foreseen implementation period for Phase I (the share of waste disposed of in landfills or dumpsites is approximately 74% in 2015).

This CoM Decision also stipulates that in the second phase (starting 2019) only 25% of the generated municipal solid waste is disposed of at landfills. The estimations made in this assessement have estimated waste generation rates at around 7,100 t/d in the year 2019. The assessment has indicated that such a scenario would require an additional ISWM-Facilities in the range of approximately 3,100 to 5,100 t/d.

As such, one or several "ISWM-Facility" have to be put into can include the following:

- Lower range ISWM Facilities (approximately 3,100 t/d): output of separation plants: about 2,400 t/d plus 700 t/d off-spec material from composting plants. The lower range can only be achieved, if appr. 2,000 t/d of municipal solid waste are separately collected.
- Higher range (about 5,100 t/d): output of separation plant (about 2,400 t/d) plus off-spec material from composting plant (about 700 t/d) plus any additional waste generated (about 2,000 t/d).

Technically, the lower range (about 1,500 t/d) could be based on the assumption of RDF production and separation of recyclables; the higher range (about 3,400 t/d) could be based on the assumption of RDF production, waste incineration and bottom ash recycling.

As no specification of the type and capacities of treatment technologies are given in the Decision 1/2015, it could be assumed that treatment facilities currently under construction or less complex treatment facilities could be operational within the next few years.

However, this will not be the case for large and complex treatment plants, which are at the moment not even in the planning phase. This is in particular true for waste incineration plants, where experience has shown that the planning and permitting phase (in EU Member States, such plants have to undergo an EIA and an integrated permitting process) usually takes between 2 and 5 years and the subsequent construction phase another 1.5 to 2 years. In addition, plant operators usually need a certain period of time (0.5 to 1 year), until the waste incineration plant is optimised and stable operation conditions are achieved.

Moreover, the report has indicated that the 25% target value for landfilling of municipal waste, including residues from pre-treatment is a very ambitious one. For example, in Austria it took 15 years (from 1989 to 2004) to reduce the share of municipal waste disposed of at landfills from 74.8% to 23.8%. Waste that is currently landfilled in Austria includes pre-treated waste, fly ash and bottom ash from waste incineration and inert rejects from separate collection.

5.4 Prerequisite for an Integrated SWM system in Lebanon

The report has highlighted the legal, institutional as well as technical challenges facing Lebanon for establishing and integrated SWM system in Lebanon and which need to be considered in a comprehensive and strategic approach in order to put in place an integrated SWM Plan.

In addition to planning a technically feasible systems, the report has indicated that in order to implement an effective and sustainable separate collection system, the whole system of waste delivery/waste collection, transport, (intermediate) storage, processing and sale has to be based on a sound legal and administrative system across Lebanon.

Moreover, the citizens have to be educated through awareness campaigns in order to ensure their co-operation and engage them in proper separation systems which avoid impurities. Experiences in EU Member States have shown that such a process would require 5-15 years and as such efforts should be made into such a direction as soon as possible in Lebanon.

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