Multimodal Platform for the Enhancement of Post-Industrial and Post-Consumer Waste

Deliverable 3:

NAMA

Prepared by
Transcarbon Africa Middle East S.A.R.L.

for
UNEP DTU Partnership

Date: June 2017

TRANSCARBON AFRICA MIDDLE EAST
Architects of Sustainability®

Written by:

Hiba Rizk	**Senior Project Manager** *Transcarbon Africa Middle East*
Widad Hassy	**Process Engineer** *Transcarbon Africa Middle East*

Reviewed by:

Zineb Lahlou	**Project Manager** *Transcarbon Africa Middle East*
Mohamed Alaoui	**General Manager** *Transcarbon Africa Middle East*

Content

List of Tables

List of Figures

List of Acronyms

BHET	bis(2-hydroxyethyl)terephthalate
CAPEX	CAPital EXpenditure
CSR	Corporate Social Responsibility
DPLs	Development Policy Loans
DTU	Danmarks Tekniske Universitet (Technical University of Denmark)
EIA	Environmental Impact Assessments
GHG	Greenhouse Gas
IRR	Internal Rate of Return
LCTs	Low Carbon Technologies
MEMEE	Ministry of Energy, Mines, Water and Environment
MSW	Municipal Solid Waste
NAMA	Nationally Appropriate Mitigation Action
NAP	National Adaptation Plan
NPV	Net Present Value
NSP	National Sanitation Plan
OPEX	OPerating EXpenditure
PNDM	National Household Waste Program
RC	Reclamation Chain
ROI	Return On Investment
UNEP	United Nations Environment Programme
UNOPS	United Nations Office for Project Services
WRM	Waste Reclamation Model

1 Introduction

The "Multimodal Platform for the Enhancement of Post-Industrial and Post-Consumer Waste" is a project that aims to create a self-sustaining market for investments in waste management and reclamation projects. This project was initiated in March 2016 and includes a comprehensive waste market study, a technical analysis of the waste recycling and valorization processes, an integrated system analysis tool that evaluates cost benefits, environmental impact, investment risk, and socioeconomic impacts of the solid waste treatment technologies, and a detailed business plan for a multimodal platform replicable concept. In addition, one of the most important aspects of the project is to communicate with different stakeholders including waste recycling industrials, local communes, the Ministry of Energy, Mines, Water and the Environment, financial institutions and different associations in Morocco.

The first phase of the project was essential in understanding the waste sector in Morocco, outlining the regulatory framework that is in place and identifying the barriers to waste recycling and valorization projects.

2 Context: Morocco's commitment to climate change

Since the ratification of the United Nations Framework Convention on Climate Change (UNFCCC) in 1995 and the Kyoto Protocol in 2002, Morocco has made a firm commitment to the fight against climate change by implementing a proactive and ambitious climate policy.

In order to participate in the global effort to mitigate greenhouse gas (GHG) emissions and to consolidate and strengthen its national sustainable development policy, Morocco invested early in the Clean Development Mechanism (CDM) By registering a portfolio of projects considered to be the 4th largest CDM project portfolio in Africa (17 projects registered with a total emission reduction potential of about 2.4 $MtCO_2eq$ / year).

To follow the new international trends under development in the framework of the UNFCCC, Morocco also invested in the development of new GHG mitigation instruments, notably through the development of various appropriate mitigation measures at the national level (NAMA) in the most relevant economic sectors. By adopting a bottom-up approach, these NAMAs ultimately constitute the basis for the development of the Low-Emission Development Strategy (LEDS), one of the important results to be achieved within the Low Emission Capacity Building (LECB) project.

Thus, Morocco wishes both to contribute to the international effort and, on the other hand, to put in place the necessary mechanisms to benefit from technology transfer, financing and capacity building under the new post-2012 climate regime.

3 Waste sector in Morocco

The market study on the waste sector is covered in detail in *Deliverable 2: Market Study and Technical Analysis*. It provides the context and quantified information for the waste management sector in Morocco, identifies existing initiatives, summarizes the different waste collection methods in Morocco, and includes the processes identified to treat each type of waste as well as the market prices for the waste and secondary raw materials.

This section summarizes the findings of the report that are directly linked to Moroccan government initiatives in regulation, program development and support the transformation of the waste sector in Morocco. The government has put in place a policy to structure the sector through specific regulation, an integrated development program (PNDM) and a Nationally Appropriate Mitigation Actions (NAMAs).

3.1 Regulation

The Constitution in Morocco provides the framework for environmental regulation and policy in the country. The general legal framework for waste management in Morocco comprises essentially the following laws, decrees, and executive orders:

- Law No. 28-00 on solid waste management, adopted in November 2006, serves the purpose of preventing and protecting human health, the fauna, the flora, the waters, the air, the soil, the ecosystems, the sites and landscapes, and the environment in general from the harmful effects of waste. Thus, it aims at:
    - → Preventing the harmful impacts of waste and reducing its generation;
    - → Organizing the collection, transportation, storage and treatment of waste and disposing of it in an ecologically rational manner;
    - → National, regional and local planning in terms of waste management and disposal;
    - → Informing the public about the harmful effects of waste on public health and the environment;
    - → Establishing a system of control and penalties for breaches of the law in this domain.

This law was accompanied by the publication of a number of implementation decrees as well as orders and joint orders, such as:

- Decree No. 2-09-139 on the management of medical and pharmaceutical waste;
- Decree No. 2-07-253 for waste classification and determining the list of hazardous waste;
- Decree on administrative procedures and technical requirements for landfills;

- Decree No. 2-03-538 fixing the terms for preparing the national master plan of hazardous waste;
- Decree on the terms for drafting the provincial or prefectural master plan for the management of household and similar waste (adopted by the Government Council on March 2010);
- Draft Order concerning the criteria for drafting the provincial or prefectural master plan on the management of household and similar waste;
- Draft Decree on the incineration of waste;
- Draft Decree on the management of hazardous waste;
- Draft Order on the technical requirements for the storage, recovery, treatment and disposal of hazardous waste;
- Draft Decree on the management of used oils.

Other laws relating to waste management in Morocco are the following:

- Municipal Charter No. 78-00 of October 2002, amended in 2009 to improve the performance and management of public services, the aim being to improve the quality of services offered to citizens.
- Law N°77-15 on the prohibition of the use of plastic bag came into effect on July 1. 2016. It aims at prohibiting the use, production, importation, and sale as well as the free distribution of plastic bags.
  - Other types of plastic bags are still authorized, but their use is defined by specific rules. The plastic bags that are allowed are: Bags for industrial and agricultural use, isothermal bags, freezing bags and bags for waste collection.
  - Fines in case of breaches of the law are as follows:
    → Production (200 000 to 1 000 000 Moroccan dirhams (MAD))
    → Distribution / sales (10 000 to 500 000 MAD)
    → Use (20 000 to 100 000 MAD)

In addition to the laws linked directly to waste and reclamation, there are other laws protecting the environment. Although they do not affect waste collection, they need to be taken into account during the design phase of a reclamation plant.

3.2 National Program for Domestic Wastes (PNDM)

The National Program for Household Waste focuses on enhancing solid waste services in urban areas, while improving working conditions and incomes for traditional jobs associated with solid waste collection ('waste pickers' from the informal sector), as well as developing new businesses and jobs based on recycling.

The main points of the program are the following:

- Program framework:
  - → Program period: 2007 – 2021
  - → Cost: 5 Billion USD
- Responsible parties:
  - → Ministry of the Interior,
  - → Ministry of Finance,
  - → Ministry of Energy, Mines, and the Environment
- Support:
  - → The World Bank provides both financial and technical support for the program under its Development Policy Loans (DPLs)

- Main objectives:
  - → 90% of waste collection rate achieved by 2021;
  - → 100% cities with sanitary (controlled) landfills by 2021;
  - → Develop solid waste sorting, recycling, and recovery chain to reach a recycling rate of 20% by 2020;
  - → Train and raise awareness among all stakeholders.

Currently, and with the support of the PNDM, collection rate of urban waste is more than 80% in most of zones served by delegated companies. This rate will reach 90% by 2020.

4 Waste NAMA

The National Household Waste Program in Morocco aims to regulate the landfills and collect waste through formal methods. The household waste NAMA is designed to 1) reduce the amount of waste that is sent to the landfills through recycling, valorization and incineration; and 2) limit the methane that is released into the atmosphere at the landfills. This NAMA is divided into four (4) components as shown in figure 1 below.

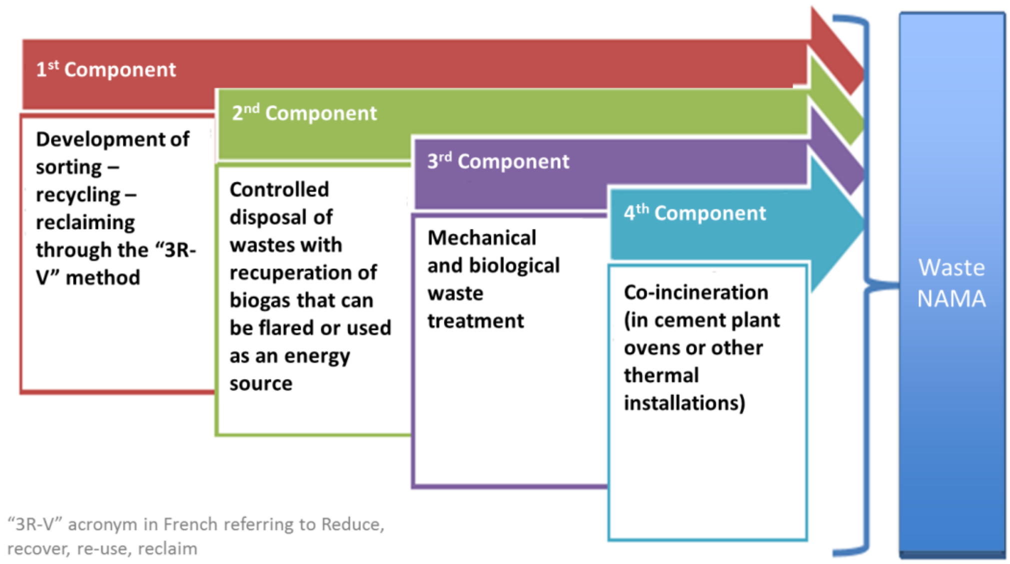

Figure 1. NAMA components

4.1 NAMA components

Component 1: Applying the "3R-V" principles

This first component's aim is to act on the waste before it is collected to be sent to landfills. The 3R-V is a term coined in the French language and it refers to **R**educing waste at the source, **R**e-use, **R**ecycling and **V**alorization. In this context waste is not seen as the end of life of a material, but rather as a new beginning and the 3R-V is described as follows. Reduction at the source means finding ways to avoid or at least reduce the waste produced during the manufacturing, distribution and use of a product in order to preserve natural resources. An example would be to buy local products to avoid unnecessary emissions due to packaging and transportation of the product. Re-use, as the name suggests, is using again in different way or after reclaiming and processing. This can be done through simple habits of using re-usable bags for groceries or glass containers instead of plastic ones. Recycling refers to any act of transformation of the waste into a product that can be used as a raw material in different industries. This term is used in reference to paper and cardboards, metals, glass, and plastics. Finally, valorization refers to the transformation of waste into new different products or energy. Ideally, valorization would be the last resort if reducing, re-using, and/or recycling cannot be done. A common example for this would be for used tires that are used as alternative combustibles.

Component 2: Biogas, flaring and alternative sources of energy

Biogas is the product of an anaerobic fermentation process of organic matter. Biogas consists mainly of methane (CH_4) and carbon dioxide (CO_2). For municipal waste, this fermentation can take place in storage centers, methanation centers and sewage treatment plants.

Biogas capture is carried out on the storage site by a network of horizontal drains, distributed over all the bins of the storage facility and connected to vertical wells. The better the waterproofing of the traps, the better the capture of biogas and the lower the leaks; they generally vary between 20 and 50%.

The capture of biogas is generally followed by four types of process: 1) flaring in order to destroy the biogas before it is emitted into the atmosphere; 2) thermal process where the biogas undergoes boiler combustion in order to produce heat in the form of steam or hot water; 3) production of electricity through generator, gas turbine, or boiler with vapor turbine; and 4) the production of biofuel.

Component 3: Mechanical and biological processes

This component describes the mechanical and biological processes that can be used in waste management. The mechanical processes are the mainly used during the waste sorting enabling the identification of the waste that can be recycled therefore reducing the quantity of waste that will end up in the landfill. The biological processes covered by this component aerobic drying transforming the isolated fermentable fraction into calorific waste or "stabilized" products that can be buried in landfills. This includes creating compost, biogas, digest and other products described in more detail in *Deliverable 2*.

Component 4: Co-incineration

This component focuses on transforming waste that has a high calorific value into alternative combustibles known as residual derived fuels (RDF). On the one hand, the production of RDF limits the tonnage of waste at the storage stations and at the same time produces fuels having the same characteristics as the usual fuels. This solution is key for the treatment of waste and is a means of recycling waste but also of preserving raw resources. The main users of RDF are cement plant kilns and thermal power plants. In Morocco, the main users are the cement plants.

4.2 Baseline

The baseline of the NAMA is the scenario where the national program of household waste is fully achieved, especially in terms of the percentage of waste that will be recycled. The values that were used to calculate the baseline are as follows:

Table 1. NAMA baseline for waste recycling, landfilling and valorization

		Rate / year				
Type of treatment		**2014**	**2016**	**2020**	**2024**	**2030**
Recycling	Paper & Cardboard	20%	25%	50%	70%	70%
	Plastics	18%	30%	55%	70%	70%
	Glass	70%	75%	80%	85%	85%
	Ferrous metals	62%	70%	78%	85%	85%
	Aluminum	50%	60%	70%	80%	80%
	Textile	1%	1.5%	2%	4%	4%
	Household organic waste	0%	2%	4%	4%	4%
	Other organic waste	0%	0%	0%	5%	5%
Uncontrolled landfills		62%	40%	30%	10%	5%
Controlled landfills (without biogas capture)		30%	50%	59%	78%	80%
Controlled landfills (with biogas capture)		8%	10%	11%	12%	15%
Biological stabilization + landfilled		0%	0%	0%	0%	0%
Mechanical/biological treatment + secondary treatment + landfilled		0%	0%	0%	0%	0%
Stabilization (mechanical/biological/physical) + co-incineration in cement plant kilns		0%	0%	0%	0%	0%
Incineration		0%	0%	0%	0%	0%
Treatment Technologies						
Landfilled	Biogas collection efficiency	0%	20%	20%	20%	20%
Collected biogas treatment	Flaring	0%	0%	0%	0%	0%
	Electricity production	0%	0%	0%	0%	0%
Incineration plant	Electrical	0%	0%	0%	0%	0%
	Thermal	0%	0%	0%	0%	0%

4.3 NAMA description

The objectives of the NAMA are summarized in the table below. The changes between the baseline and the NAMA include the use of RDF in the cement plant kilns starting at 5% in 2016 and increasing by 10% for each year of calculated scenarios (2020, 2024 and 2030). The second is the increase in collecting biogas directly from the landfills. The baseline was for 20% starting 2016 and with the NAMA implementation it is expected to be at 30% starting 2024. The last objective is to treat the collected biogas starting with 60% through flaring and 40% for electricity production from 2014 to 2024, then from 2024 to 2030 a 50/50 split between both methods and finally from 2030 onward converting 60% of collected biogas into electricity and 40% torching.

Table 2. NAMA projected outcome

		Rate / year				
Type of treatment		**2014**	**2016**	**2020**	**2024**	**2030**
Recycling	Paper & Cardboard	20%	25%	50%	70%	70%
	Plastics	18%	30%	55%	70%	70%
	Glass	70%	75%	80%	85%	85%
	Ferrous metals	62%	70%	78%	85%	85%
	Aluminum	50%	60%	70%	80%	80%
	Textile	1%	1.5%	2%	4%	4%
	Household organic waste	0%	2%	4%	4%	4%
	Other organic waste	0%	0%	0%	5%	5%
Uncontrolled landfills		62%	40%	30%	10%	5%
Controlled landfills (without biogas capture)		30%	50%	59%	78%	80%
Controlled landfills (with biogas capture)		8%	10%	11%	12%	15%
Biological stabilization + landfilled		0%	0%	0%	0%	0%
Mechanical/biological treatment + secondary treatment + landfilled		0%	0%	0%	0%	0%
Stabilization (mechanical/biological/physical) + co-incineration in cement plant kilns		0%	5%	15%	25%	30%
Incineration		0%	0%	0%	0%	0%
Treatment Technologies						
Landfilled	Biogas collection efficiency	**30%**	**30%**	**30%**	**30%**	**30%**
Collected biogas treatment	Flaring	**60%**	**60%**	**60%**	**50%**	**40%**
	Electricity production	40%	40%	40%	50%	60%
Incineration plant	Electrical	0%	0%	0%	0%	0%
	Thermal	0%	0%	0%	0%	0%

4.4 Projected GHG emission reduction with the NAMA

The GHG emissions are estimated to be reduced by 4.05 million tons of equivalent CO_2 by 2030, corresponding to a 54% reduction of the baseline CO_2 emissions.

In addition to avoided emissions, the NAMA implementation will also affect (positively) the social, environmental and economic aspects of waste management in Morocco.

4.5 NAMA implementation

Component 1: Applying the "3R-V" principles

According to the official report on the NAMA, in order to reach the 3R-V objectives set by the PNDM and the NAMA, funding should be available to assist in the implementation of these objectives with the introduction of an Eco tax in 2017. Also, a pilot sorting program is being put in place in the city of Casablanca with the aim to sort 1 million tons of recyclable products per year.

Component 2: Biogas, flaring and alternative sources of energy

The implementation of this component of the NAMA is already ongoing through the controlled landfills of Fes and Oujda. Any other initiatives by local municipalities will contribute to surpass the NAMA objectives.

Component 3: Mechanical and biological processes

This component, as described in the previous section, is the sorting at the landfill where additional recyclable materials are collected and the organic waste is dried and stabilized. The objective is to reduce the amount of waste that is landfilled and to prepare the waste for other uses.

Component 4: Co-incineration

The implementation of the last component is underway with the support of the Professional Association of Cement plants (APC). The use of alternative energy from RDF has reduced the energy costs for cement plants and reduced the quantities of waste that are sent to the landfill.

5 Waste Reclamation Model use for NAMA

The Waste Reclamation Model (WRM) developed by Transcarbon AME, is a tool used to generate financial, environmental, and social indicators for different waste recycling and valorization processes. The model is based on the results of the market and technical study presented in *Deliverable 2* of this project. (The detailed description of the model is presented in *Deliverable 4*). The Waste Reclamation Model will enable municipalities and potential investors to make informed decisions on the best investment opportunity in waste valorization plants. This decision making tool uses an integrated system analysis to assess economic, environmental, and social impacts of waste treatment technologies. The model offers 35 different waste streams to choose from with data contained in a database used by the model to generate automatic business plans. The intended user of WRM is any investor in the waste valorization sector that needs to decide on best area of implementation of a platform, most lucrative process to transform a specific waste, or to try different options of investment in order to choose the best one. This user can be a private investor, a financial institution, a regional investment center or a local commune.

In light of the proposed NAMA, the model can be used to assist the government initiatives in the development of NAMA Support Projects (NSP) during the design and implementation phases.

5.1 NAMA support during the design phase

This phase can be regarded as pre-feasibility assessment of the NAMA where the solid waste technologies are selected and their economic and environmental impacts are assessed. Therefore, an integrated system analysis tool is needed in order to evaluate cost benefits, environmental impact, investment risk, and socioeconomic impacts of the solid waste treatment technologies during the design phase of the NAMA.

WRM tool can offer the needed technical assistance for NAMA development. During the design phase, WRM can be used to:

- determine the perimeter of the NAMA support projects. The waste available per region is embedded into the WRM. Each region has a predefined total yearly value for each type of waste. WRM database can be used to define the waste per region and the relevant technologies for waste reclamation. Table 3 presents an example of the waste generated by type and by region.

Table 3. Waste production by region and by type

Region	Total waste (t/y)	Organic (t/y)	Paper and Cardboard (t/y)	Plastics (t/y)	Glass (t/y)	Metals (t/y)	Other (t/y)
Tangier-Tetouan-Al Hoceima	740 486	487 980	66 644	83 675	7 405	7 405	87 377
Oriental	502 691	368 623	40 215	61 228	9 953	2 765	19 907
Fez-Meknes	886 178	626 528	53 171	65 577	25 699	12 406	102 797
Rabat-Sale-Kenitra	1 028 251	668 363	113 108	133 673	15 424	25 706	71 978
Beni Mellal-Khenifra	480 050	361 477	42 532	45 413	5 425	6 721	18 482

Grand Casablanca-Settat	1 583 772	1 037 370	194 804	205 890	33 259	25 340	87 107
Marrakech-Safi	814 258	569 981	116 439	57 812	12 214	8 143	49 670
Drâa-Tafilalet	271 438	192 721	24 429	29 858	4 343	3 800	16 286
Souss-Massa	541 102	416 649	32 466	54 110	8 117	8 117	21 644
Guelmim-Oued Noun	93 615	66 467	8 425	10 298	1 498	1 311	5 617
Laayoune-Sakia El Hamra	96 789	68 720	8 711	10 647	1 548	1 355	5 807
Eddakhla-Oued Eddahab	33 150	23 537	2 984	3 647	530	464	1 989
TOTAL (Morocco)	**7 071 780**	**4 888 417**	**703 928**	**761 827**	**125 415**	**103 532**	**488 661**
Total (%)	**100%**	**69.13%**	**9.95%**	**10.77%**	**1.77%**	**1.46%**	**6.91%**

- choose optimized technologies: The complexity of NAMA solid waste management arises from selecting technologies and assessing their economic and environmental impacts. WRM can help in the choice of the right technologies. Table 4 shows an example of technologies covered by WRM model.

Table 4. Process technologies

Category	Plastics	Organic Waste	Metals	Paper & Cardboard	Glass
Types	PET, PVC, PEHD, PELD, PS, PP	Domestic, Agribusiness, Manure, Sludge, Special	Aluminum, Iron/Steel, Copper	Paper, Cardboard	Clear, Green, Brown
Process Types	Mechanical, Chemical, Thermal, Liquefaction, Gasification	Composting, Co-Composting, Methanation	Mechanical, Thermal, Chemical	Mechanical, Chemical	Mechanical, Thermal

- analyze the business model: WRM can provide a basis for the technological choices, economic success and sustainability of the NSP, and the viability of the financing mechanism under current market conditions, and simulate the economic and environmental impacts under any market distortion, as well as the cost of NSP alternatives.

- Asses the risks: WRM can be used to assess the risks associated with the development of the NAMA projects. Those risks include: technical risks, sourcing risks, sales risks, safety risks, and other external risks.

5.2 NAMA support during implementation phase

One of the challenges reported by the ministry for the implementation of the NAMA is the lack of a system of reporting and evaluation. This system should cover two levels:

- The NSP level managed by the communes or the private sector (ex: cement factories);
- The NAMA level managed by the delivery organizations.

A synthesis of the overall reporting for the NAMA waste in Morocco is shown in Figure 2

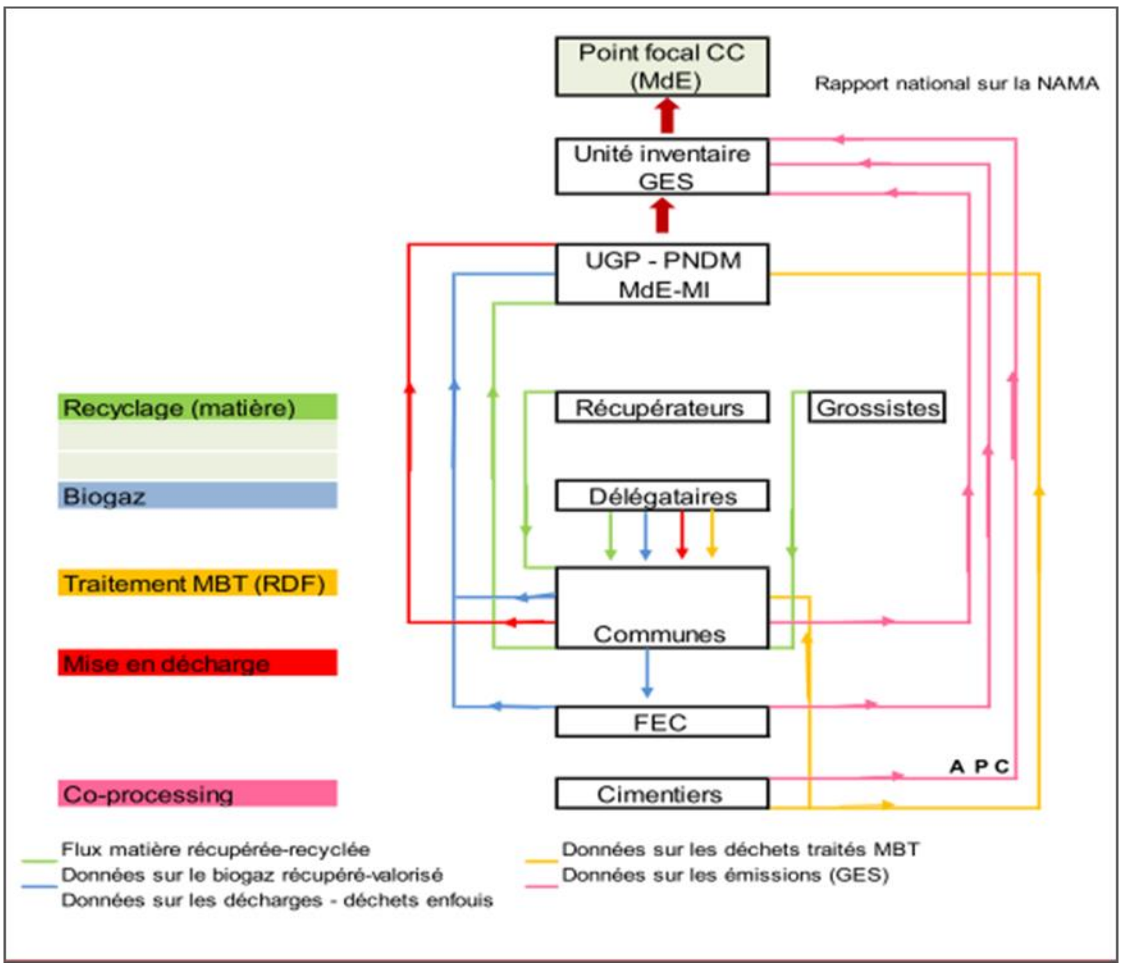

Figure 2. NAMA reporting ***(source: Ministry of the Environment)***

A discussion between Transcarbon and the ministry of the environment was held in order to use WRM to monitor and report key NAMA required indicators.

WRM can be used to:

- Calculate GHG emissions reductions ;
- Evaluate the social impact by estimating the number of people directly benefiting from NAMA Support Projects ;
- Evaluate the potential for scaling up, replication and transformation ; and
- Estimate the volume of public and private finance mobilized for low-carbon investment and development.

5.3 Adapting WRM for sorting

WRM is aimed at the transformation of waste into re-usable products or energy. It can be improved to include the collection and sorting stages of the waste reclamation process. This will require extra work and could provide a comprehensive waste reclamation solution. With the addition of the collection and sorting detailed processes, the model could become an integrated tool for investment decisions for the NAMA as a whole. It could also include the processes used to capture CH_4 at the landfill level.

6 Conclusion

The Waste Reclamation Model is very useful as an integrated system in order to evaluate cost benefits, environmental impact, investment risk, and socioeconomic impacts of the solid waste treatment technologies during the design phase of the NAMA and as a monitoring and reporting tool during the implementation phase. Furthermore, WRM can be upgraded to include collection and sorting methods in order to take into account the entire waste management chain.