"Programme for Supporting Up-scaled Mitigation Action in Peru´s Solid Waste Sector"

- Programme Solid Waste NAMA – Peru -

EXECUTIVE SUMMARY

BAU Scenario 2010 to 2030 for municipal solid waste

Lima, 14th July 2014

Programme Solid Waste NAMA – Peru

BAU Scenario 2010 to 2030
for Municipal Solid Waste

Note: *The preparation of the BAU scenario was an exercise that was based on several assumptions, which were not validated by the competent authority. They served to raise awareness and educate different stakeholders in the development of the NAMA proposal.*

ACRONYMS AND ABBREVIATIONS

AFOLU	Agriculture, Forestry and Other Land Use
BAU	Business-As-Usual
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DOC	Degradable Organic Carbon
DOCf	Fraction of Degradable Organic Carbon which Decomposes
DIGESA	*Dirección General de Salud Ambiental* (Dirección General de Salud Ambiental (Directorate for Environmental Health)
EPA	Environmental Protection Agency
ECRS	*Estudios de Caracterización de Residuos Sólidos* (Solid Waste Characterization Studies)
EPS-RS	*Empresas Prestadoras de Servicios de Residuos Sólidos* (Solid Waste Service Provider Companies)
F	Fraction of Methane in Generated Gas
FOD	First Order Decay
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIRS	*Gestion Integral de Residuos Sólidos* (Solid Waste Integrated Management)
GPC	Generation per Capita (waste)
Gg	Gigagram (= 1000 MT)
HSW	Household Solid Waste
IPCC	Intergovernmental Panel on Climate Change
IDB	Inter-American Development Bank
INEI	Instituto Nacional de Estadística e Informática (National Statistics Institute)
JICA	Japan International Cooperation Agency
K	Methane Generation Rate
KfW	Kreditanstalt für Wiederaufbau
MAP	Mean Annual Precipitation
MAT	Mean Annual Temperature
MCF	Methane Correction Factor
MINAM	*Ministerio del Ambiente* (Ministry of Environment)

MSW	Municipal Solid Waste
MEF	Ministry of Economy and Finances
NAMA	Nationally Appropiate Mitigation Actions
NEFCO	Nordic Environment Finance Corporation
NHSW	Non-Household Solid Waste
NMVOCs	Non-methane Volatile Organic Compounds
NOAK	Nordic Working Group for Global Climate Negotiations
Nox	Nitrogen Oxides
N_2O	Nitrous Oxide
OX	Oxidation Factor
PIGARS	*Plan Integral de Gestión Ambiental de Residuos Sólidos* (Integrated Plan of Solid Waste Environmental Management)
PET	Potential Evapotranspiration
PLANCC	Planning for Climate Change Project
PUCP	Pontíficia Universidad Católica del Perú
R	Methane Recovery Factor
SEDS	Solid Waste Disposal Sites
SENAMHI	*Servicio Nacional de Meteorología e Hidrología del Perú* (Peru´s National Meteorology and Hydrology Service)
SIGERSOL	*Sistema de Información para la Gestión de Residuos Sólidos* (Solid Waste Management Information Service)
SLCP	Short-lived Climate Pollutants
SNINGEI	*Sistema Nacional de Inventarios de GEI* (National GHG Inventory System)
SWDS	Solid Waste Disposal Site
TIER	Level
UNFCCC	United Nations Framework Convention on Climate Change
USD	US Dollars

EXECUTIVE SUMMARY AND MAIN CONCLUSIONS

Supported by the Nordic Environment Finance Corporation (NEFCO) and the Nordic working group for global climate negotiations (NOAK), the Peruvian Ministry of Environment (MINAM) is executing the Programme"Solid Waste NAMA-Peru", assisted during the period from 2013 to 2015 by the consortium composed of NIRAS (Denmark), Perspectives (Germany), ECO Consultorías e Ingeniería (Peru), Miranda & Amado Abogados (Peru) and the Pontificia Universidad Católica del Perú - PUCP (Peru).

This report, along with the Excel model "Modelo para Calcular Emisiones de GEI provenientes de los MSW en Perú", represents the BAU scenario (Business As Usual scenario) of GHG emissions from Peru´s municipal solid waste (MSW) sector for the years 2010 to 2030, and it is the deliverable "D-2.1.1 - Reporte del BAU scenario" (BAU scenario report) of the Programme, while the model is the deliverable "D-2.1.2 - Sistema basado en Excel para los cálculos de los escenarios BAU" (Excel-based system for BAU scenarios calculations).

The BAU scenario reflects the development of GHG emissions in the absence of the NAMA. The main objectives of the BAU scenario are to perform well-sustained projections of important future developments such as economic factors and waste policies, show waste trends in MSW disposal and GHG emissions in the sector up to year 2030, determine the emission levels in the base line against which impacts of future mitigation actions can be quantified, and present a model for the BAU scenario calculation and its emissions, allowing the establishment of a dynamic base line. **This report uses the latest global warming potential of 25 for conversion of Methane into CO_2 equivalent.**

Methodology:

The applied methodology for the BAU scenario is consistent with the one for GHG inventory for the MSW sector, developed under the framework on this Programme. The BAU scenario is limited to direct GHG emissions, i.e. to methane gas emitted by the decomposition of MSW disposed at dumpsites or sanitary landfills, and the emissions from MSW biological treatment. Other emissions such as waste incineration are considered not significant in the Peruvian reality of the sector. Its scope encompasses the municipal solid waste generated by the country´s urban population where waste collection service exists, because disperse waste disposal occurring in rural areas does not generate significant methane emissions. The BAU scenario shows the emissions for the years from 2010 to 2030.

The most recent norms, i.e. "2006 IPCC Guidelines for national inventories", are applied in order to ensure the environmental integrity of its calculations. For emissions from disposal, the First Order Decay (FOD) model is applied and Tier 2, complemented by some default values from IPCC 2006. For the emissions from biological treatment, Tier 1 is applied.

In order to define the sources of emission with a spatial resolution, ten groups of municipalities have been differentiated, based on their population (no. of inhabitants) and their type of waste management, grouping the cities in municipalities of less than 10,000, between 10,000 and 50,000, and more than 50,000 inhabitants, in each of the climatic zones of the country (Coast - costa, Highlands - sierra, Jungle - selva). Furthermore, the metropolitan area of Lima-Callao was defined as its own group.

The model for BAU scenario calculation is an extension of the model elaborated for inventory calculations; it is based on Excel, and it enables the calculation of emissions up to year 2030 and the consideration of biological treatment emissions. Furthermore, it allows presenting and evaluating alternative scenarios and strategies for GHG mitigation in the sector.

The input data has been derived from a large number of waste characterization studies at municipal level, information of the Solid Waste Management Information System (SIGERSOL), field studies and surveys performed by the consultants team, evaluating the sector´s current infrastructure projects and programmes, numerous interviews and other sources, as well as from a broad analysis, statistical processing and compilation of all this information, which is reflected in the Report "Diagnosis of Solid Waste in Peru", issued by the consultant team in December of 2013.

The following data and key parameters to be considered for the development of the BAU scenario have been identified, and they were determined for each of the 10 municipality groups:

- Gross Domestic Product (GDP), total and per capita; growth of certain economic sub-sectors with particular impact in MSW generation and composition; changes in consumption patterns.
- Peru´s projected population, including migratory movements and urbanization trends.
- MSW generation per capita, total and by waste type; MSW composition.
- Fraction of MSW disposed in different types of disposal sites (sanitary landfills, dumpsites), increasing share of sanitary landfills and possible landfill gas capture measures.
- Share of MSW processed by biological treatments and share of recycling.

In order to project these parameters towards the future up to the year 2030, econometric methods have been applied to the data of population, economic development (GDP and GDP per capita, sectors), consumption patterns, and generation of MSW types. Furthermore, the future characteristics of the MSW management system, including biological treatment and recycling, and of the disposal sites were projected, considering the development of legal framework and implementation of the sector´s programmes and projects.

Emission trends, economic developments and population trends

The MSW sector´s historical GHG emissions have risen from around 857 Gg CO_2e in 1980 to their current level of 2,648 Gg CO_2e in 2012 (total growth of 208% or 2.1% p.a. in average), mainly due to the population and economic development.

The following illustration 1 shows the population development (total and urban) until 2030, forecasting a total population 35.9 million, of which 29.7 million are urban population (82.6% urbanization).

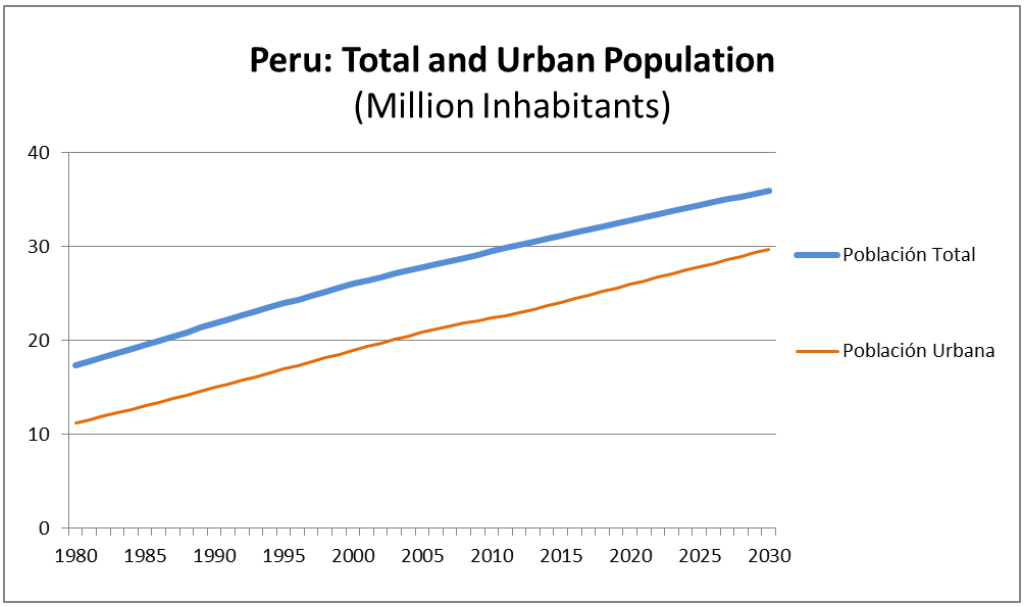

Illustration 1: Total Population and Urban Population, years 1980 to 2030

The GDP forecast foresees an average growth of 5.1% p.a. for the BAU scenario over the 2013 to 2030 period. This growth rate is consistent with a slightly more moderate economic development, in comparison to the growth velocity of the past decade, and in line with a generally slower global growth.

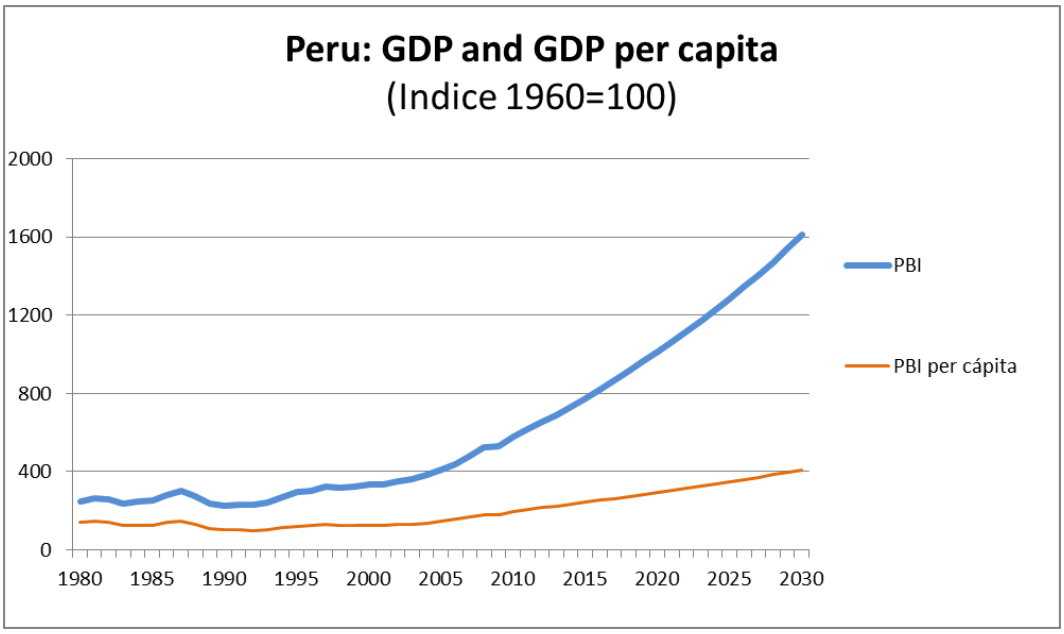

Illustration 2: GDP and GDP per capita, years 1980 to 2030

Legal-strategic framework of the sector

The policies, plans, strategies and national regulation of the general environmental sector, solid waste sector and climate change sector, as well as the relevant authorities in these fields and the future new solid waste law have been analyzed in detail.

It was concluded that the current legislation of the solid waste sector, particularly the current Solid Waste Act, is not focused GHG mitigation. E.g., currently active capture and burning of landfill gas is not legally required. The legal framework does not provide mechanisms to encourage GHG mitigation, and even creates certain barriers or disincentives for respective measures. Some established incentives, e.g. a mechanism to purchase electricity generated from biomass, fail to sufficiently promote GHG mitigation because of deficiencies in their implementation[1]. The revenues from the current tariff system cannot cover adequately the costs of an improved solid waste management. Major deficiencies in compliance with existing regulations are due to, among others, inadequate supervision by the authorities, which do not have sufficient institutional and economic capacities for this task. The draft of a new solid waste law does not explicitly consider GHG mitigation.

However, due to the availability of (national and internationally supported) funds, and a gradual improvement in public administration and supervision, a trend toward better implementation of sector policies can be observed, which is reflected in the coming infrastructure projects and programmes.

Current programs and future development of the sector of municipal solid waste

Presently, there are many projects and programs, especially for the construction of sanitary landfills outside Lima-Callao, in their sum representing the MSW generated by around 6 million people. Several projects are already in the stage of investment and / or have financing (JICA, IDB, KfW, Swiss cooperation, private companies). Therefore, it is assumed for the BAU scenario that most of them will be implemented over the coming years.

Replacing dumpsites by sanitary landfills and thus establishing an anaerobic environment, in principle increases in the generation of methane. None of the envisaged projects foresees active capture and centralized burning of landfill gas, all of them contemplate just passive venting. Some projects consider the semi-aerated concept, but its effectiveness is not guaranteed. Most initiatives contemplate preventive GHG mitigation strategies such as composting and recycling, although only for smaller waste streams.

The reduction of GHG emissions by two landfill gas capture and burning projects in sanitary landfills in Lima-Callao (Huyacoloro and Modelo Callao) is considered in the BAU scenario.

Solid waste management data and emission factors

The per capita generation and composition of MSW has been forecasted by considering the developments of economy and urban population, applying an econometric model that relates the per capita waste generation of waste types with the GDP per capita. The resulting data were verified by a comparative study on international level on the relationship between per

[1] The promotion of landfill gas capture and utilization relied on CDM for many years, with low participation of Peruvian landfills. Finally the new law for renewable energy which in principle would allow electricity generation from landfill gas did not incentive adequate return on equity to attract the investors for this kind of projects in a moment of significant growth of the economy.

capita GDP and per capita waste generation. The results are summarized in the following figure and table below:

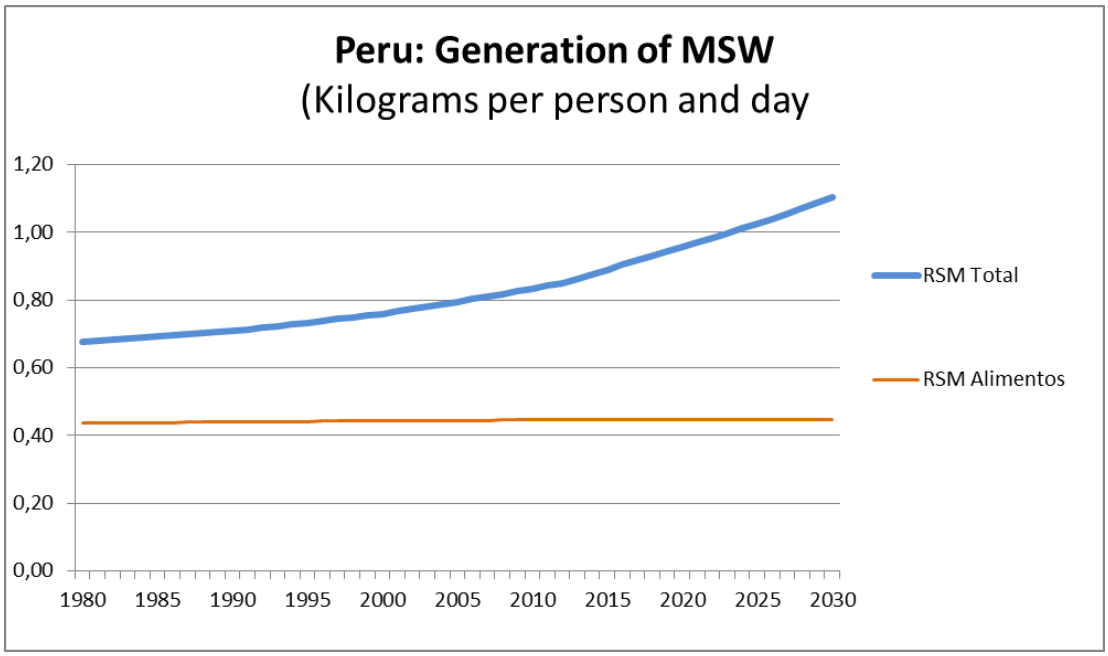

Illustration 3: MSW Generation per capita (urban population), years 1980 to 2030

Table 1: MSW Composition, generated by urban population - years 2010 to 2030

Component	2010	2012	2020	2030
Organic Waste (food)	53,5%	52,6%	46,7%	40,6%
Inerts and others, including plastic, glass and metals	33,1%	33,3%	38,4%	43,9%
Paper and cardboard	6,9%	6,7%	6,3%	5,2%
Diapers	3,7%	4,5%	5,9%	7,6%
Gardens and parks	1,4%	1,4%	1,4%	1,2%
Textiles	1,3%	1,3%	1,3%	1,4%
Wood	0,1%	0,1%	0,1%	0,1%
Total	**100,0%**	**100,0%**	**100,0%**	**100,0%**

The growth of the fractions "disposable diapers" and "inert and others, including plastics, glass and metals" should be emphasized. On the other hand, for "organic waste (food)" it is supposed that the amount of organic food consumed per capita, and therefore of organic waste per capita, remains constant, leading to a lower percentage within the overall growing quantity of MSW. Furthermore, the following factors have been projected until 2030:

- the quantities of MSW disposed of at sanitary landfills respectively dumpsites, assuming a collection service coverage growing to 100% in urban areas by 2030,
- the future characteristics of the disposal sites, and the foreseen GHG mitigation measures,

- the share of biological treatment (composting and mechanical-biological treatment), increasing to 1% of MSW in 2030, and
- An increase in the overall recycling rate (recycling by municipalities and informal sector) to 6% of MSW in 2030.

Results of the BAU scenario and conclusions:

The main result of this report is the BAU scenario of GHG emissions coming from municipal solid waste in Peru for the years 2010 to 2030, as shown in the following graph for selected years. All graphs and numbers in this section are based the application of factor 25 for methane GHG potential.

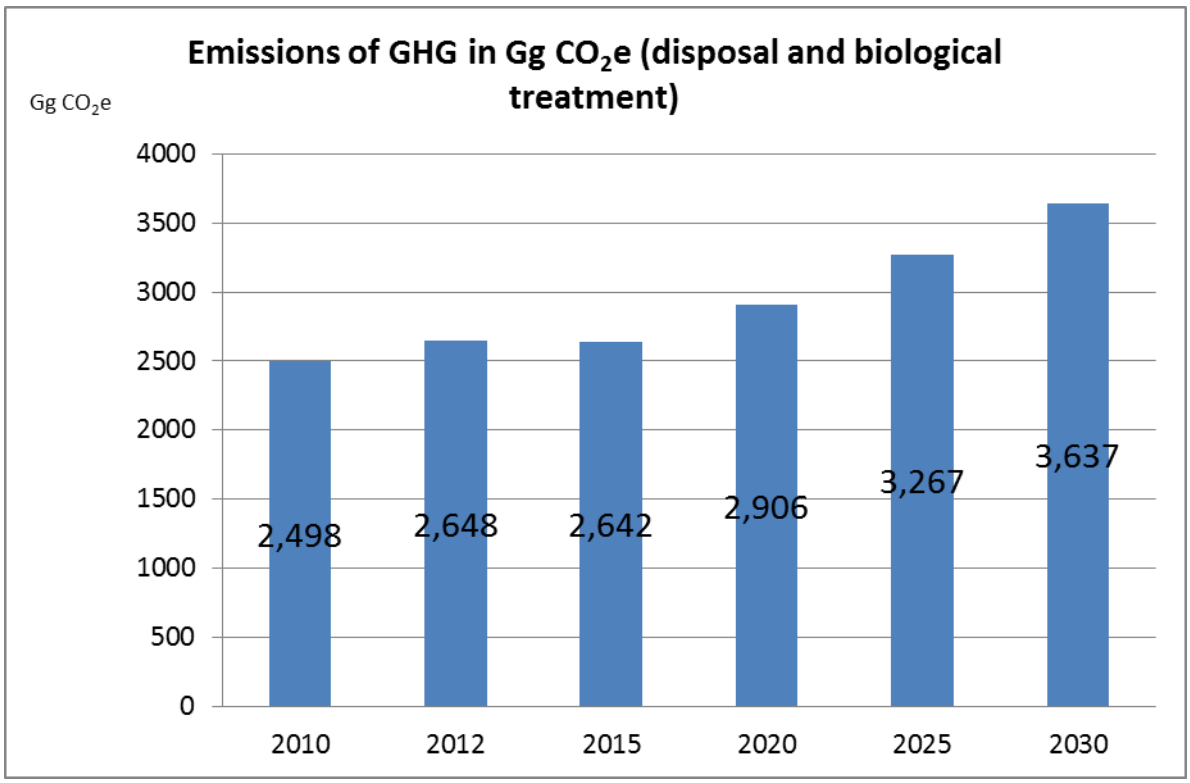

Illustration 4: GHG emissions from municipal solid waste in Peru -BAU scenario, years 2010 to 2030

In the chart below the total emission trends from 1980 to 2030 and the historical and future emissions for each of the groups of municipalities are shown. The graph illustrates that most of the emissions will arise in Lima-Callao and shows the effect of landfill gas capture and destruction at two landfill sites in Lima-Callao, resulting in an overall reduction of GHG emissions, especially from 2007 and 2013.

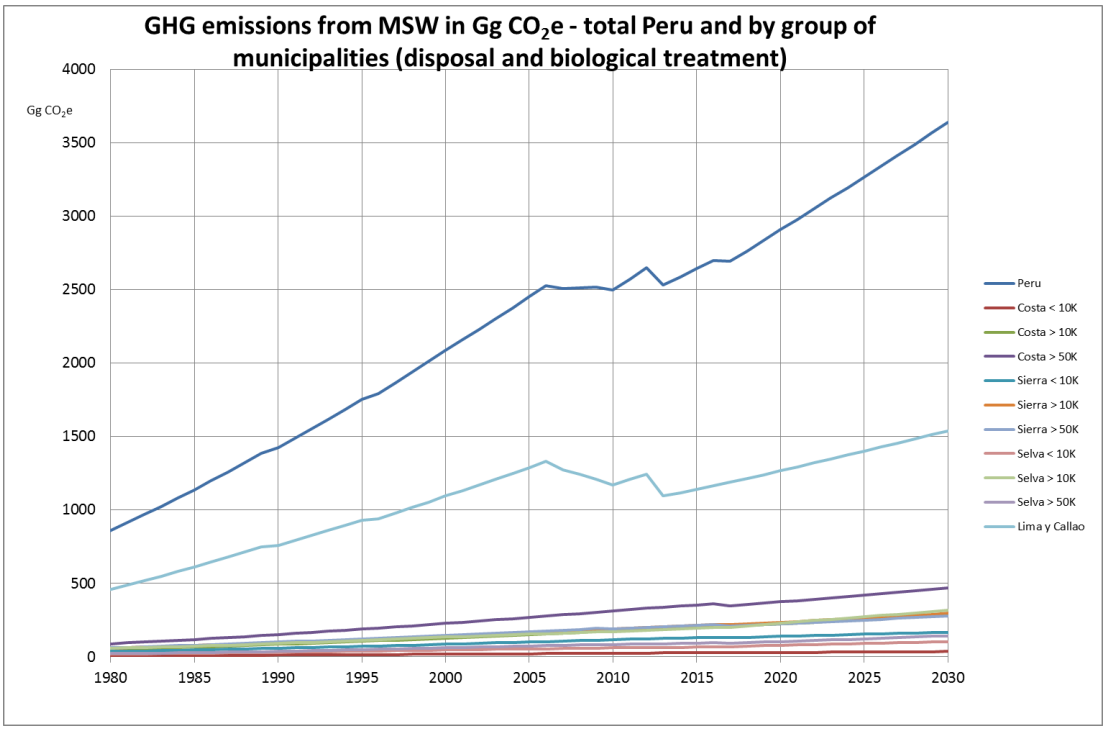

Illustration 5: GHG emissions from municipal solid waste in Peru – historical emissions and BAU scenario, total and per municipality group, years 1980 to 2030

The main conclusions from the calculation of the BAU scenario and its analysis are:

- The BAU scenario for the Peruvian MSW projects a significant increase in GHG emissions from 2,648 GgCO2e in 2010 to 3,637 GgCO2e in 2030, equivalent to an increase of 37.3% or almost by a factor of 1.4, within the 20 years horizon of the BAU scenario.
- This significant increase in emissions will occur - according to the concept of this BAU scenario - if no additional GHG mitigation measures will be taken
- This increase will materialize despite of the current GHG mitigation measures in the existing disposal sites (which are expected to be continued), and despite of the expected GHG mitigation measures on the proposed new landfills.
- Between 2007 and 2013, a significant reduction of emissions can be observed, due to the start of operation of active capture and destruction of landfill gas in 2 of the 3 largest disposal sites of the country (sanitary landfills Huyacoloro and Modelo Callao). From the year 2013, the total emissions continue its growth trend again. It should be noted that these two projects are operated without legal obligation. In one case the incentive is revenue from selling the generated electricity, while in the other case it is corporate responsibility of the landfill operator. The BAU scenario assumes that the projects continue to operate, however the company may decide to terminate operation.
- Due to the anticipated start of operation of several new landfills, some of which include measures to reduce methane emissions, around 2017 a further, slight reduction of emissions can be expected.

- In 2030, around 42.3% of total sector emissions are generated in the Lima-Callao metropolitan area, while it was 47.0% in 2012.
- The cities with a population of over 50,000 inhabitants in the coastal zone remain the second largest group in terms of emissions, with 12.9% of the total emissions in 2030 (in 2010 it was 12.5%), while the lowest emissions will be generated in jungle cities with fewer than 10,000 inhabitants: 2.8% of the total (in 2010 it was 2.4%).
- The emissions continue to arise almost exclusively from MSW disposal in landfills and dumpsites. The share of emissions from biological treatment will rise slowly, but will reach only 0.7% of total sector emissions in 2030.
- Among other economic factors impacting future waste quantities and composition, also tourism is an uncertain factor. Its expected growth might significantly affect MSW generation, especially in urban conglomerates outside Lima.
- The emission growth is concerning, because it consists almost entirely of methane. Methane gas is one of the short-lived climate pollutants (SLCP), with a very critical impact on shorter time horizons. It was determined that, due to its half-life of 12 years, methane is a 70 times stronger GHG than CO_2, calculated over a period of 20 years GHGs. This period represents a critical time horizon to avoid several potentially irreversible impacts of global warming (see more details in the GHG inventory report).

The main causes of the increase in GHG emissions are:

- increasing MSW generation per capita, due to economic development and changing consume patterns,
- population growth,
- expansion of urban areas,
- increasing coverage of waste collection, and
- The trend towards disposal in sanitary landfills instead of dumpsites, but without sufficient consideration of GHG mitigation.

Based on projected emissions and their identified causes, it can be concluded that the following factors may be the most critical for the success of a future MSW sector GHG mitigation strategy:

- Whether or not the active capture and destruction of methane gas in the two large landfills in Lima-Callao will continue, and with the same efficiency.
- The quantities of MSW disposed at these two disposal sites, i.e. their share of the total MSW stream.
- Mitigation measures to be taken at the other disposal sites in Lima-Callao.
- Mitigation measures to be taken at future sanitary landfills in the conglomerates outside Lima-Callao.
- Flows and quantities of organic waste and recyclables, directed towards biological treatment or recycling processes, respectively; thus avoiding their disposal in sanitary landfills and dumpsites in- and outside of Lima-Callao metropolitan area.
- Further development of composting in municipalities, taking advantage of the MSW´s high organic content.

- The future role and extent of recycling of dry materials, especially packaging, paper and cardboard, plastics, glass or metal.
- Incentives and / or legal and operating pressure for increased use of landfill gas for electricity generation.
- Incentives to use certain fractions of MSW as a fuel, e.g. in cement plants or boilers.
- In general terms, adaptation of legislation and national strategies to include transversely (*mainstreaming*) the aspect of mitigation, particularly in the draft of the new waste law, and to establish respective incentives and financing mechanisms.
- Strengthening institutional capacity to adequately supervise compliance with current standards.