

## **Evaluation of the mitigation potential of greenhouse gases (GHG) as a result of recycling of solid waste plastic, glass, paper and cardboard**

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August 2018

### **Introduction**

This document presents the summarized results of the consultancy "Evaluation of the mitigation potential of greenhouse gases (GHG) as a result of the recycling of solid waste plastic, glass, paper and cardboard." It covers the diagnosis of the waste cycle and mass balances of recyclable waste to the estimated GHG reduction potential and the proposal of measures to reduce barriers and establish enabling conditions for a growing formal recycling sector.

The study is based upon collected data and analysis of 16 departments (Tumbes, Piura, Lambayeque, La Libertad, Tacna, Ica, Ancash, Arequipa, Junín, Huánuco, Cusco, Puno, San Martín and Lima). In the case of the province of Lima, 13 districts were considered representative for the sectors of Lima East (San Juan de Lurigancho, Ate, El Agustino), Lima Norte (Comas, Los Olivos, San Martín de Porres), Lima Centro (La Victoria, Lima, Rímac), South Lima (Villa El Salvador, San Juan de Miraflores) and Callao (Callao and Ventanilla).

### **Diagnosis of the waste cycle and recycling sector**

A high level of informality was identifiable regarding the collection centers dedicated to the commercialization of usable solid waste. In the area of Lima and Callao, it was identified that of the total number of collection centers interviewed, the informal collection centers represent the higher percentage with 83% compared to 17% of formal ones. In other provinces, the situation is quite similar. Therefore, most municipalities do not have updated or profound information on these collection centers and the quantities of waste processed.

One important characteristic of the collection centers is that in Lima and Callao more than 50% of these centers operate in premises with areas of less than 100 m<sup>2</sup>, while in the area of the selected provinces; the majority (44%) of collection centers occupy areas of 100 - 500 m<sup>2</sup>.

As a result of this study it can be determined that approximately 20,500 tons of metal, cardboard, paper, plastic, glass and textile waste are commercialized on a monthly basis in Peru, certainly with regional differences correspondent with the population density. The largest amount of commercialized waste is metal and cardboard, with approximately 6,000 tons commercialized per month for each of these residues. The largest amount of metal waste (5,416 t) originates from the departments, while in the case of cardboard it is inversely proportional, since the largest amount of cardboard (5,042 t) is commercialized in Lima and Callao. This can be explained by the low sale prices of cardboard and because its recycling is done in the city of Lima, implying higher transportation costs.

In percentages, it turns out that at the national level, metal waste accounts for 30% of the traded waste, followed by cardboard with 29%, paper with 23% and plastic with 17%, while just 1% corresponds to waste glass and textiles, as shown in the following chart.



Figure 1. Percentage of waste commercialized, Source: Consultant team. Field work, February 2018.

About 90% of recyclable waste in the collection centers of Lima and Callao is supplied by local waste pickers. Usually small collection centers sell their waste to a medium or intermediate collection center. Those pass it on to a wholesale collection center, which markets it to industries according to the type of waste. In the majority of collection centers (96% in Lima and Callao), a lack of appropriate equipment for waste processing has been identified. Only 80% perform waste segregation and just 3% press and chop it. In the provinces, the percentage of pressing and chopping is 12%.

Waste types with the highest sales value by far is copper (S/ 15,825 per ton), the least valuable waste types are cardboard (S/ 339 per ton) and textiles (S/ 175 per ton). In the case of a wholesale collection center, it was reported that the cost of operation for a ton of waste is around S/ 160 soles. The amount of waste paper, cardboard, plastics and glass that are currently recycled and sold in Peru cover in sum only 66% of the demand for waste of companies and industries. The most obvious case is that of glass, whose estimated demand is 2 436 t/month, but only 11% (280 t) of it are covered.

In conclusion, a high level of informality is perceived in the recycling sector, which needs to be regulated and organized, since there is a high potential for waste that can be put in value. This potential is not realized because the segregation programs at the places of origin are still implemented only in pilot areas and are optional. Likewise, the recycling industry remains concentrated mainly in the city of Lima. It is necessary to develop that industry in other main cities in order to reduce the costs of waste transportation.

**Mass balance for the generation of usable waste of plastic, glass, paper and cardboard.**

To identify mass balances for the different types of waste additional primary data has been collected from waste producers and distributors and the Adex Data Trade system has been used to obtain information about import and export flows.

For plastic waste, it has been estimated that approx. more than 161,000 tons are produced per year, of which only 25% are valued and only 1% are exported as plastic waste, therefore it can be assumed that almost 74% are disposed of in landfills etc.

In the case of paper and cardboard, it has been estimated that recyclable goods which are available for national consumption add up to more than 1,319,000 tons per year, of which it has been

estimated that only 10% are valued and around 16,000 tons (1%) are being exported as waste paper and cardboard, consequently it can be assumed that almost 89% of this waste is disposed in landfills, dumps, etc.

Regarding the mass balance of glass, discarded recyclable glass products add up to around 11,000 tons per year, of which only 28% are valued (more than 3,3000 tons) and none exported. Almost 72% of these residues are disposed in landfills and dump sites.

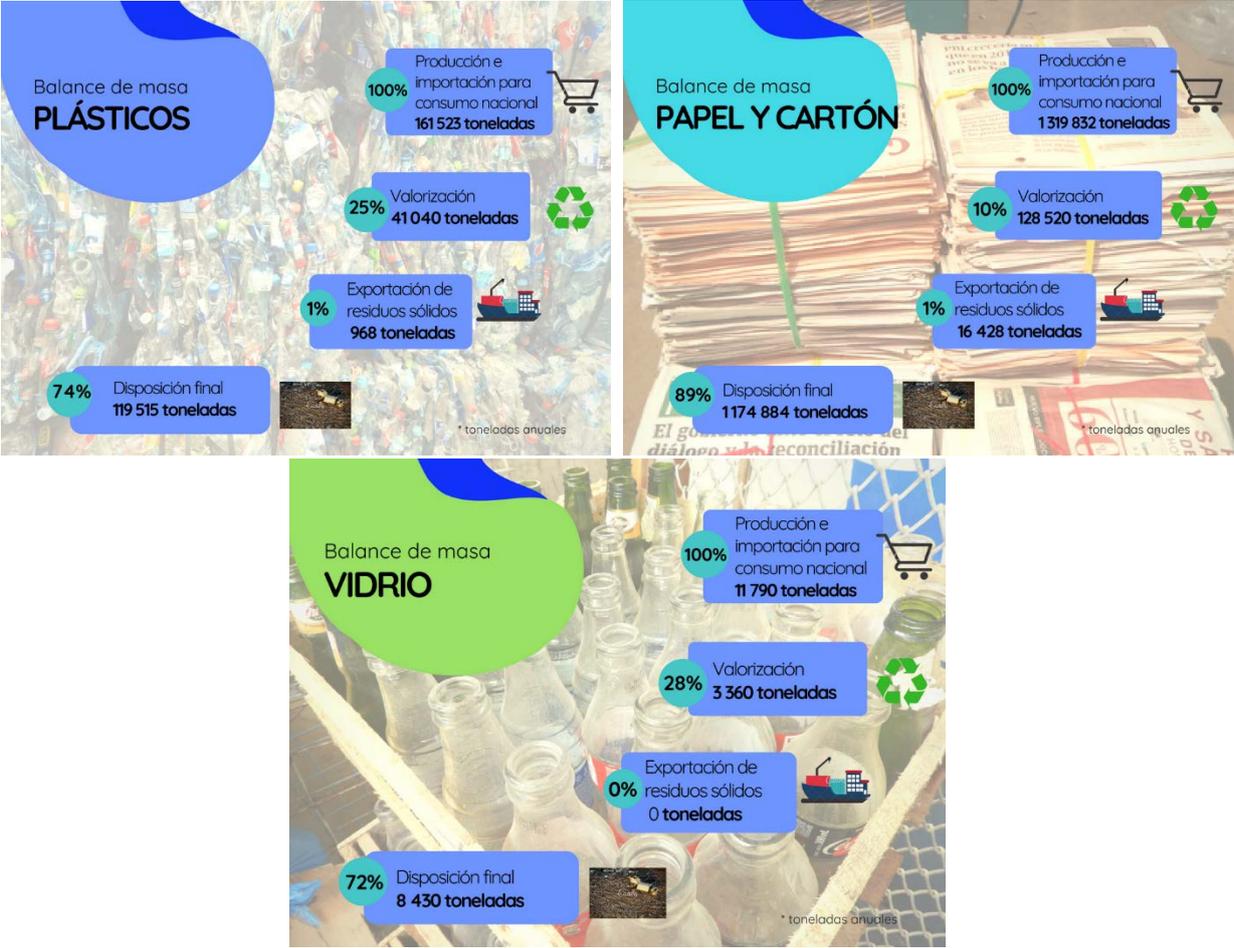


Figure 2. Mass balances.

In the last five years a total of 242,813 tons of waste was imported, where the amount of paper and cardboard waste represents the highest percentage (79%), followed by glass waste (11%) and finally, plastic waste (9%).

In the case of paper and cardboard waste that was imported, the cumulative amount is 192,424 tons. Paper and cardboard waste was obtained mainly in the form of chemical pulp and has been imported in the greatest quantity with 54%, followed by paper waste/kraft cardboard or paper/corrugated cardboard with 44%.

In the case of plastics waste, the cumulative amount is 22,802 tons, where the item "waste of other plastics" (PET, PP, others) registers almost all imports with 90%, followed by ethylene (PEHD, PELD) polymer waste with 7%.

In the case of glass waste, this reaches the cumulative amount of 27,588 tons according to Peruvian Customs.

Regarding the origins of imported waste, we find that 48% originates from the United States, 20% from the Dominican Republic and 11% from Costa Rica. In contrast to that, about 87,000 tons of waste has been exported during the same period. Paper and cardboard waste represent the highest percentage with 94%, followed by plastic waste with 6%. No export of glass waste has been registered. 80% of the solid waste goes to South American countries, mainly Chile with 32 121 tons (37%), followed by Colombia with 20,117 tons (23%) and Ecuador with 17,700 tons (20%). Main ports of export are Arequipa, Callao and Tacna, while 98% of cardboard and paper waste was shipped from Callao and plastic waste was exclusively exported in Callao and Tacna.

In conclusion, comparing the accumulated flows of imported and exported waste in the last five years, we find that in the case of paper and cardboard waste only 43% (82,142 tons) of the total waste that has been imported (192,424 tons) has been exported and in the case of plastic waste the cumulative amount of waste exported is almost 20% (4,839 tons) of the total waste that has been imported (22,802 tons).

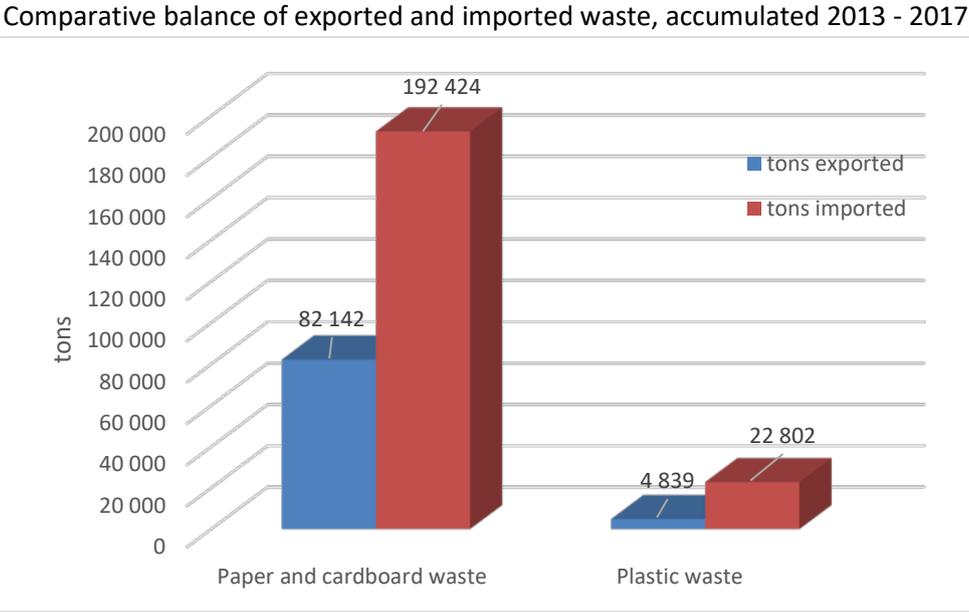


Figure 3. Balance of exported and imported waste.

**Estimation of the potential reduction of GHG emissions, as a result of the valorization of reused solid waste**

The CDM methodology has been selected to estimate the following data of potential emission reduction by recycling: AMS II.AJ "Recovery and recycling of solid waste materials" (version 6). In addition, to identify the emission sources in the processes of each product, PAS 2050 methodology<sup>1</sup> was applied, which includes the life cycle analysis (LCA). The different processes are identified by type of material included in the analysis. The processes in the recycling usually consider: pick up of the materials, cleaning and selection, grinding (plastic, glass and metals), storage and distribution.

The potential emission reduction, for the period 2016-2030 has been estimated at an annual average of 258,467 tCO<sub>2</sub>e/year. The reductions are directly proportional to the amount of recycled material. The high informality in the recycling sector affects the quantity and quality of information, since there are no formal sources of information on energy consumption and fossil fuels. The information necessary for the calculation of emissions and GHG reductions was collected in surveys. The largest

<sup>1</sup> PAS (Publicly Available Specification) 2050 is a specification for assessing product life cycle Greenhouse Gas (GHG) emissions.

amount of emission reduction would be in the province of Lima, followed by Lambayeque and Arequipa.

*Table 1. Emission reductions in various provinces.*

Department	Reduction of GHG Emissions 2016-2030 [tCO <sub>2</sub> e]
Ancash	102,536.00
Arequipa	270,878.69
Cusco	24,159.61
Huanuco	21,398.45
Ica	84,572.63
Junin	44,099.48
La Libertad	7,787.21
Lambayeque	412,421.08
Lima	2,236,602.16
Loreto	97,793.11
Piura	204,287.92
Puno	41,046.64
San Martin	52,973.06
Tacna	1,879.34
Tumbes	74,027.81
Ucayali	200,542.33
<b>Total</b>	<b>3,877,005.55</b>

One of the most important conclusions is that the amount of reduction is directly proportional to the amount of recycled material. Finally, the recycled products that provide the greatest amount of GHG emission reduction are paper and steel, as shown in the following table.

Table 2. Emission reductions from various materials.

Year	Recycling - GHG Emissions [tCO <sub>2</sub> e]					
	Plastic	Glass	Aluminum	Steel	Paper	Total
2016	7,222.86	584.87	7,407.25	56,098.69	138,999.86	<b>210,313.53</b>
2017	7,436.89	601.75	7,621.04	57,718.44	143,011.69	<b>216,389.80</b>
2018	7,651.53	619.12	7,697.04	59,384.01	147,139.30	<b>222,491.00</b>
2019	7,872.37	636.99	7,919.19	61,097.95	151,386.04	<b>228,912.55</b>
2020	8,099.58	655.37	8,147.76	62,861.37	155,755.36	<b>235,519.44</b>
2021	8,333.36	674.29	8,382.92	64,675.68	160,250.78	<b>242,317.02</b>
2022	8,573.87	693.75	8,624.87	66,542.35	164,875.95	<b>249,310.79</b>
2023	8,821.33	713.77	8,873.80	68,462.90	169,634.61	<b>256,506.41</b>
2024	9,075.94	734.37	9,129.92	70,438.88	174,530.61	<b>263,909.72</b>
2025	9,337.89	755.57	9,393.42	72,471.89	179,567.93	<b>271,526.70</b>
2026	9,607.40	777.37	9,664.54	74,563.58	184,750.63	<b>279,363.52</b>
2027	9,884.69	799.81	9,943.48	76,715.64	190,082.91	<b>287,426.53</b>
2028	10,169.98	822.89	10,230.47	78,929.81	195,569.10	<b>295,722.25</b>
2029	10,463.50	846.64	10,525.74	81,207.89	201,213.63	<b>304,257.41</b>
2030	10,765.50	871.08	10,829.53	83,551.72	207,021.07	<b>313,038.90</b>
<b>Total</b>	133,316.69	10,787.63	134,390.95	1,034,720.81	2,563,789.46	<b>3,877,005.55</b>
<b>Average</b>	8,887.78	719.18	8,959.40	68,981.39	170,919.30	<b>258,467.04</b>
<b>Percentage</b>	3.44%	0.28%	3.47%	26.69%	66.13%	<b>100.00%</b>

### Identification of barriers and proposal of enabling conditions for the valorization of recyclable waste

Based on the analysis developed to obtain the mass balance for the generation of waste and interviews with key stakeholders in the sector, the following barriers were identified:

#### *Regulation of district and provincial governments*

The current Solid Waste Management Law and its regulations suggest a wide range of possibilities for the location of waste collection centers, under the premise of not being located in residential areas. A greater regulation of locational restrictions is recommended, specifying that the location of a collection center should only be in industrial and commercial zones. In addition, since there are no parameters on the direct relation between the area and the volume of solid waste in a collection center, it is necessary to analyze and establish indicators that establish solid waste operation limits, by day or month, according to the area of the land. Likewise, it is necessary to regulate with greater precision the design and operation of collection centers for municipal solid waste. For this purpose, the introduction of a Peruvian Technical Standard is being proposed. Furthermore possible lands, areas or sectors need to be identified where a temporary collection center could be installed.

#### *General conditions of credits to PYMES and MYPES and their conditions of applicability for operators of solid waste*

In the case of small and medium-sized enterprises (PYMES, for its acronym in Spanish) and micro and small enterprises (MYPES), their conditions as legal entity and their tax obligations before the National Superintendence of Customs and Tax Administration (SUNAT) make them subject to financial credits more easily, so this analysis focuses on the access of the Associations of Recyclers.

For the Associations of Recyclers it is quite difficult to access a credit program, due to the high informality in which they find themselves. Some initiatives, which have boosted access to credit, stem from Caja Nuestra Gente, Scotiabank and MiBanco. This shows that in the case of the main banks in the country, these do not see the associations of recyclers as an attractive market.

From the analysis of the information gathered it could be concluded that before the regulation of the legislation for recyclers, greater access to credits was possible for them thanks to the projects and

initiatives of the Healthy City NGO. However since 2010, the year the Credit Program and Guarantee Fund for recyclers was created, the National Environmental Fund - FONAM has not been able to promote this program, citing the informality problem of the sector, despite being indicated as responsible for it according to the Regulation of the Recycler Law (D.S. 05-2010-MINAM).

*Formalization of solid waste operators by the local governments.*

In our country, thousands of families have found an opportunity to generate economic income in the recycling activity. Belonging to the informal sector means existing outside of taxes and legal norms, but it also implies not benefiting from the protection and services the state can offer. It is necessary that the state, through its local and provincial governments, promotes the urgent formalization of this sector that has uncontrollably grown and does not allow records of updated information, with tax regulations and incentives.

**Proposal of enabling conditions for the valorization of recyclable waste**

In conclusion, the proposal of enabling conditions mainly considers the following: a greater regulation of collection centers for municipal waste, updating the Peruvian Technical Standard - Colour Code, evaluation of territorial opinions for the location of the collection centers, promotion of investments, protection of the local market, the opportunity of use and the impulse for the formalization of the market. Only through these methods and through understanding that each of these aspects is important and must be reached, a positive and significant impact will be possible in the recycling sector.