



HOW MUCH DOES IT COST AND HOW MUCH DOES THE DOMESTIC WASTE GENERATED PER DAY, MONTH AND YEAR IN THE CITY OF GUARULHOS – A SOCIOECONOMIC VIEW OF ITS REMAINS

QUANTO CUSTA E QUANTO RENDE O LIXO DOMÉSTICO GERADO POR DIA, MÊS E ANO NA CIDADE DE GUARULHOS – UM OLHAR SOCIOECONÔMICO DOS SEUS RESTOS

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ABSTRACT

This work shows the functioning and applicability of the VERDES program, using the city of Guarulhos, SP. The generation of domestic solid waste has been increasing greatly in recent decades, the public agencies responsible for the management of this waste have adopted recycling as one of the ways to reuse urban waste, not only as raw material, but also as a generator of employment and income to classes with less educational training. The private sector, together with local governments, are together in projects to implement recycling plants, still insipid and without scale results. The city of Guarulhos has an annual potential of R\$ 613,477,969.00, when reverse logistics is applied, using VERDES, part of these values could return to the public coffers if selective collection was adopted for 100% of its urban waste generation and it was recycled. But, as seen in this article, the city loses 380 million reais per year, by not adopting a waste management policy that takes advantage of the total of its generation. Even so, it still generates 15,865 jobs of a minimum wage per year with the recycling of urban waste already implemented in the city in a formal/informal way.

KEYWORDS: GREEN Program. Recycling. Reverse Logistics. Economy. Environment.

RESUMO

Este trabalho mostra o funcionamento e aplicabilidade do programa VERDES, usando a cidade de Guarulhos, SP. A geração de resíduos sólidos domésticos vem aumentando muito nas últimas décadas, os órgãos públicos responsáveis pela gestão destes resíduos vêm adotando a reciclagem como uma das formas de reutilizar o lixo urbano, não somente como matéria prima, mas também como gerador de emprego e renda a classes com menos formação educacional. A iniciativa privada e os governos locais estão juntos em projetos de implantação de usinas de reciclagem, ainda insipientes e sem resultados de escala. A cidade de Guarulhos tem um potencial anual de R\$ 613.477.969,00, quando se aplica a logística reversa, utilizando o VERDES, parte destes valores poderiam voltar aos cofres públicos, se fosse adotada a coleta seletiva para 100% da sua geração de lixo urbano e ele fosse reciclado. Mas, como é visto neste artigo, a cidade perde 380 milhões de reais por ano, por não adotar uma política de gestão de resíduos que aproveite o total da sua geração,

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mesmo assim, ainda gera 15.865 empregos de um salário-mínimo por ano com a reciclagem dos resíduos urbanos já implantada na cidade de maneira formal/informal.

PALAVRAS-CHAVE: Programa VERDES. Reciclagem. Logística Reversa. Economia. Meio Ambiente

INTRODUCTION

The city of Guarulhos is in the metropolitan region of São Paulo, and has today 1.4 million inhabitants, according to IBGE (2021). It is the second city in the state of São Paulo in population, second only to the capital. It had its budget approved in 2022 in about 5.8 billion reais, which leaves its population with a per capita GDP of approximately 48 thousand reais. Its HDI - Municipal Human Development Index - is 0.763 (IBGE, 2021). All these positive data, if compared to cities of the same size, including developed nations, such as Italy, France, Spain, lead to the conclusion that their leaders are performing a correct destination of domestic solid waste (DSW) generated in the municipality, since the municipal budget and data on economic and social development seem equal to cities with corporate governance management, such as Curitiba-PR, Madrid-Spain, Paris-France. However, this is not what is seen daily in its streets and neighborhoods of the outskirts, with its garbage deposited irregularly and a large volume being taken daily to the city landfill, and worse, spending public money to bury the leftovers of a liquid society that has not yet found its contours (BAUMAN, 2001), neither moral nor much less environmental.

According to the VERDES program, used in this work to survey the economic data and the generation of HSW, the city of Guarulhos generates 1.120 thousand tons of domestic solid waste per day, that is, 0.8 kilograms per inhabitant. The partial VERDES report on Guarulhos is included in this article, and although it is a 2007 version, the program is internally updated by the dollar value of the day of the calculation, that is, it is always with the current values in reais and has a margin of error in the final data of around 15%. Such a volume of waste could generate thousands of jobs, income, and an economy of natural resources for Brazil in the millions of reais, but there is no political or cultural will for a circular economy management. As Roseli Salvador said in her paper at the XVII Congresso Metodista de Iniciação Científica about the garbage in the city of Guarulhos (2014):

“Solid waste management is today one of the great challenges of public management. For a long time, solid waste was seen as a by-product of the economic system and as such it needed to be sent away from inhabited areas, however, with the growth of cities and the expansion of outskirts, it started to be configured as a source of environmental and public health problems. Another issue ignored for a long time by the public authorities is related to the added value of solid waste, which can return to the production process as an input, reducing production costs and contributing to the maintenance of natural reserves and preservation of the environment”.

The stakeholders have no interest in changing the direction that the dirty money from garbage has been taking in the last decades in the country. The collection companies and the landfill owners are an oligopsonist group that contributes directly and indirectly to electoral campaigns and to the



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enrichment of many politicians or public agents present in the more than 5,568 municipalities in the country, according to a report by the Public Ministry of São Paulo, cited in licitação.net.

Some cities have taken the initiative to form waste recycling cooperatives to minimize the impact of the management of DSW in landfills, but unfortunately for lack of infrastructure, technological capacity and academic training, they do not recycle even 5% of the waste generated by the municipality and generate on average only 30 direct jobs. Most of them are used for other purposes, only as political propaganda at election time, after all being politically correct today brings free and spontaneous media (MAGERA, 2005).

The proposal of this article is to show the economic and environmental resources that are being wasted daily by the local government and to point out that the recycling of domestic solid waste is economically feasible, not to mention the great contribution to reducing environmental pollution and the reuse of raw materials used in the composition of packaging, which is the great villain of the composition of DSW, thus preserving our riches of the planet's biomass, promoting the reduction of carbon dioxide in the atmosphere and generating jobs and income with this environmentally correct process.

GREEN PROGRAM METHOD

The majority of Brazilian municipalities are unaware of the generation and composition of their DSW, leaving it to private agents, through public bids, to provide the market supply of such public demand, both of the service and of the economic value for the collection and disposal of DSW. Therefore, the need arises to use the VERDES program, which is based on scientific data and makes it possible to calculate the generation potential and how much to invest in infrastructure for the recycling process. For this, the VERDES program uses a mathematical method to illustrate the amounts that are thrown away every day in Guarulhos and in Brazil.

The GREEN program presents in a simple way the results of recycling the five main products that currently make up the DSW of society, such as aluminum cans, steel cans, paper and cardboard, plastic, and glass. These products account for more than 90% of the market value of recycled products in the city of Guarulhos. Thus, the program seeks to indicate to entrepreneurs and governments a result of economic viability of this segment, today so despised by many investors and politicians for not knowing the positive results that these ecologically sustainable actions can generate for society and the entire planet.

VERDES is easy to use and contains all the methodology that shows the results in a macro environmental and marketing way, culminating in a final report that the user can export, save, or print for better use of the results. Thus, the program will give the user all the information regarding the viability of recycling urban solid waste, and it can be printed for future use, or have it saved in the indicated directory. The VERDES program will make available the following macro environmental economic viability data:



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a) Per capita waste generation per day, per month and year; Total waste generation per day, per month and year; Possible annual and monthly savings in raw material, energy, water; Annual and monthly savings lost through non-recycling; Annual and monthly savings gained through formal/informal recycling; Job generation of a minimum wage per month possible; Generation of jobs of a minimum monthly salary obtained; Jobs of a minimum monthly salary lost; Economic and physical data of each product, separately - aluminum can, paper and cardboard, plastic, glass, and steel can; Total result of the economic viability obtained and lost with the application of the recycling process.

b) In the market analysis the program makes available: Results in tons generated from the five products, partially and totally; Average price per ton of the products; Potential economic result to be achieved with the process; Job generation of one minimum wage per month. The methodology used in this program is based on the market mathematics of the natural resources used in the composition of the products under analysis (aluminum can, steel can, plastic, paper and cardboard, and glass), as well as the market prices of the services for the transformation until the final consumer, using, in this context, the prices of public and private services that refer to the collection and recycling process of the solid residues, without neglecting the costs of the production process. Part of the program is based on the model proposed by Thomas Duston in the book *How to measure the gains from recycling* (1993).

The results are obtained by analyzing the most profitable products recycled from the urban garbage of Guarulhos, which are: aluminum can, paper and cardboard, plastic, glass and steel can, which represent more than 90% of the market values. Based on the amount produced, recycled and disposed of in landfills, it becomes possible to measure the economy of raw material, energy, water and the reduction of environmental damage, collection, transportation and final disposal of garbage. With the amount of waste disposed of in landfills, added to the figures that have been recycled, one obtains the total produced or consumed of a given product. Both the values in Mwh - Megawatt hours - of electric energy and in cubic meter of water and other raw materials used in the composition of the recycled products were collected in the supplier market of Guarulhos.

In the macro environmental analysis, the values of the recycled products sold were not used for calculation purposes, since when the purchase of these products is considered, the values cancel each other out. For calculation purposes the cost of the recycling process was used, defined as the cost of transportation, storage, baling, shredding, washing, and administrative costs, which enter the formula with a negative sign. The avoided costs with the collection, transportation, and final disposal of the waste are entered as a positive sign since they represent savings with the adopted recycling process. The economic gain with electric power, raw material, and water is computed individually in each spreadsheet of the materials under study, then they are added, generating the result, subtracting the cost of the recycling process.

The main indicators used in this formula to find the economic feasibility of recycling solid waste in the city of Guarulhos were:



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City Population

Production of urban garbage

Urban garbage composition in percentage

Average electricity rate charged for social classes

Weight of the aluminum can

Electrical energy savings obtained in production through the recycling of the aluminum can Recycling index of the aluminum can

Per capita consumption of aluminum cans in Guarulhos

Cost of a ton of bauxite

Composition of one ton of aluminum

Reduction in water pollution by 97%

95% reduction in air pollution

Index of glass recycling

Estimated annual quantity of glass for packaging

Estimated annual quantity of glass recycling

Production from recycling

Energy Consumption

Energy savings from production with cullet

Cost of manufacturing Soda-lime glass from cullet

Reduction in air pollution by 20%.

Reduction in water consumption by 50%

Index of paper and cardboard recycling

Consumption of electric energy in the production of one ton of paper from the raw material Savings of water for each ton of recycled paper

Reduction in water pollution by 35

Reduction in air pollution by 74



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Index of plastic recycling

Electric power consumption from production of ton of plastic

Electric power consumption from recycled material

Price per ton of plastic in Guarulhos, using as base the thermoplastic resins that compose the product

Reduction in air pollution by 80%

Reduction in water pollution by 40%

Index of steel can recycling in Guarulhos

Quantity of steel can consumed per capita

Price per ton of pig iron

Reduction in water consumption with recycling

Value of the cubic meter of water

Electricity savings from recycling

Reduction in water consumption with recycling by 40%

Reduction in air pollution with recycling by 85

Reduction in water pollution through recycling by 76

RESULTS OF THE GREEN PROGRAM FOR THE CITY OF GUARULHOS

The total annual result in Reais obtained by the application of formal/informal recycling of urban DSW in the city of Guarulhos, considering the savings in raw materials, electricity, and water (at market price) of these factors is R\$ 230,747,192.00. However, the total in reais lost due to the non-recycling of these same factors is R\$ 382,730,776.00, millions that were thrown in landfills/landfills in an inadequate way, providing an environmental liability that the next generations will pay for.

If we use as reference the amount that was recycled (formal/informal), the job generation was 15,865 and the loss of job generation by non-recycling was 26,315. The city of Guarulhos has been burying 26 thousand new jobs annually by not using the recycling process of its DSW and allocating 120 million reais per year from the budget to the expenses of sweeping, collection, and disposal of garbage, thus trying to meet the Federal Law 14.026/2020.

The above values of the recycling gain came out of the cost of recycling which was R\$ 84,221,690.00, less the cost avoided with the collection of R\$ 20,213,205.00, more the gain of electric energy of R\$ 77,639,709.00, more the gain of raw material of R\$ 189,355. 558.00, plus the gain of



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water of R\$ 27,760,409.00, totaling a gain with the formal / informal recycling of the city of R\$ 230,747,192.00 and an annual revenue loss of R\$ 382,730,776.00 by not adopting the selective collection and recycling of DSW generated annually by the city. Because it is a macroeconomic gain, it is difficult for the public agent to see the economic and environmental gain for his municipality in isolation from the union, so the vision is myopic when it comes to actions aimed at sustainable environment directed at the country and the planet. Unfortunately, people forget that they live in the municipality, and it is there that the actions for a socio-environmental balance must start.

The positive macro-environmental impacts caused by recycling can be measured by the savings in natural products that are no longer extracted. In one year of recycling, the city of Guarulhos saved the equivalent to 943,488 trees that were no longer cut down. It is also worth mentioning the process of reusing raw materials that used to go to landfills and that in this recycling process end up having a second life in the paper and cardboard market. Through the recycling carried out in this process there was an economy of 5,601 tons of bauxite, the raw material of aluminum cans. Electric energy worth R\$ 5,869,733.00 was also saved, as well as millions of cubic meters of water. Even so, the citizens of Guarulhos threw more than 58 tons of aluminum cans into landfills and dumpsites in the region.

As for plastic, the city recycled 9,031 tons, saving 677 barrels of oil, and saving R\$ 112,896,000.00 macroeconomically for the country. However, it threw into the landfill R\$ 271,436,981.00, money that could be used for infrastructure, health, education, and the quality of life of the Brazilian people, not to mention the indirect expenses caused by the sanitary problems to which the environment and living beings are exposed. We are describing the result for one municipality in the country, imagine if this calculation were for all of Brazil! How many billions are being thrown away by the published authorities? But the establishment has no intention of changing the course of things. The Brazilian state is an end in itself! The political, economic and social elite protects itself, is a great parasite, a host that has been grinding the Brazilian people for centuries (OSTROWIECKI, 2021).

The generation by type of waste, according to the VERDES program: urban solid waste generated per year is 403,200 tons, which is equivalent to a per capita/year generation of 288 kilos. If the organic part of this waste, which is a total of 197,000 tons per year, were used to generate energy, we would have a total of almost 4,000 megawatts, that is, thousands of low-income houses could have energy subsidized by their own garbage. But, as discussed here, there is no political will for this.

The GREEN program also points out the value of dry or inorganic residues sold in the recycling market, hypothetically, and the value is close to 150 million reais per year, which could generate 123 thousand jobs of one minimum wage for the city of Guarulhos, in case all this generation was made available to the solid residues market. Therefore, the recycling of DSW is economically feasible, the problem is the logistics and political will of such an enterprise.

In the rainy season, from January to April, the city of Guarulhos is punished with floods and inundations, according to specialists connected to the City Hall, aggravated by the great volume of



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garbage and debris that end up clogging the gutters and hindering the water drainage. According to the GREEN program, the city's population generates 403,200 tons per year, which is 468 kilos per inhabitant per year, but according to the City Hall, it receives only 60,000 tons in the Ecopontos, which is equivalent to only 15%, that is, more than 85% is disposed of in inappropriate places or sold as garbage to companies in the industry.

Partial result of the VERDES program

Table 1

Viabilidade Econômica da Reciclagem de Resíduos Sólidos (Urbano) - Macro Ambiental	
<ul style="list-style-type: none"> Lixo gerado por habitante (orgânico e inorgânico) Lixo gerado por dia em kilos: <input type="text" value="0,8"/> Kg Lixo gerado por mês em kilos: <input type="text" value="24"/> Kg Lixo gerado por ano em kilos: <input type="text" value="288"/> Kg 	<ul style="list-style-type: none"> Total de lixo gerado (orgânico e inorgânico) Lixo gerado por dia em toneladas: <input type="text" value="1.120"/> Ton. Lixo gerado por mês em toneladas: <input type="text" value="33.600"/> Ton. Lixo gerado por ano em toneladas: <input type="text" value="403.200"/> Ton.
<ul style="list-style-type: none"> Economia obtida com a reciclagem (dos 5 resíduos) Economia possível por mês: <input type="text" value="R\$ 51.123.164,00"/> Economia obtida por mês: <input type="text" value="R\$ 19.228.932,00"/> Economia possível por ano: <input type="text" value="R\$ 613.477.969,00"/> Economia obtida por ano: <input type="text" value="R\$ 230.747.192,00"/> 	
<ul style="list-style-type: none"> Economia perdida pela não-reciclagem (dos 5 resíduos) Economia perdida por mês: <input type="text" value="R\$ 31.894.231,00"/> Economia perdida por ano: <input type="text" value="R\$ 382.730.776,00"/> 	

Table 2

Viabilidade da Reciclagem de Resíduos Sólidos (Urbano) - Mercado	
<ul style="list-style-type: none"> Resultado Anual Latas de Alumínio: <input type="text" value="R\$ 10.614.240,00"/> Vidro: <input type="text" value="R\$ 7.257.600,00"/> Papel e Papelão: <input type="text" value="R\$ 78.624.000,00"/> Plástico: <input type="text" value="R\$ 49.392.000,00"/> Latas de Aço: <input type="text" value="R\$ 4.200.000,00"/> 	<ul style="list-style-type: none"> Resultado em Toneladas Latas de Alumínio: <input type="text" value="1.179"/> Ton. Vidro: <input type="text" value="16.128"/> Ton. Papel e Papelão: <input type="text" value="104.832"/> Ton. Plástico: <input type="text" value="28.224"/> Ton. Latas de Aço: <input type="text" value="5.600"/> Ton. Total geral de toneladas por mês: <input type="text" value="12.996"/> Ton. Total geral de toneladas por ano: <input type="text" value="155.963"/> Ton.
<ul style="list-style-type: none"> Preço médio (de mercado) de Venda por tonelada dos resíduos: <input type="text" value="R\$ 962,00"/> Resultado econômico total potencial a ser conseguido com a reciclagem dos 5 principais resíduos por ano: <input type="text" value="R\$ 150.087.840,00"/> 	<ul style="list-style-type: none"> Empregos potenciais a serem gerados de 1 S.M. por mês: <input type="text" value="10.319"/> Resultado econômico total potencial a ser conseguido com a reciclagem dos 5 principais resíduos por mês: <input type="text" value="R\$ 12.507.320,00"/>



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Table 3

Software VERDES versão 1.5 ano 2007

Resultados

- Análise Macro-Ambiental
- Análise Mercadológica
- Resultados Finais
- Balanco Ambiental

Por Categoria

- Latas de Alumínio
- Vidro
- Papel e Papelão
- Latas de Aço
- Plástico
- Orgânico / Água / Óleo
- Entulho

Ações

- Alterar dados do cálculo
- Imprimir resultados
- Exportar resultados
- Fazer análise da viabilidade da cooperativa
- Voltar ao menu principal

Resultados Finais

Economia obtida anualmente pela reciclagem		Economia perdida anualmente pela não-reciclagem	
Custo da reciclagem	R\$ 84.221.690,00	Custo da reciclagem	R\$ 110.732.510,00
Custo evitado com a coleta	R\$ 20.213.205,00	Custo evitado com a coleta	R\$ 26.575.802,00
Ganho de energia elétrica	R\$ 77.639.709,00	Ganho de energia elétrica	R\$ 100.962.643,00
Ganho de matéria-prima	R\$ 189.355.558,00	Ganho de matéria-prima	R\$ 332.015.362,00
Ganho de água	R\$ 27.760.409,00	Ganho de água	R\$ 33.909.478,00
Total	R\$ 230.747.192,00	Total	R\$ 382.730.776,00

Nota:
A economia obtida de energia elétrica, matéria-prima e água corresponde aos seguintes recursos naturais: bauxita, madeira, ferro gusa, areia e petróleo.

Economia Possível (ou Potencial) de ser conseguida anualmente com a reciclagem:
R\$ 613.477.969,00

Table 4

Software VERDES versão 1.5 ano 2007

Resultados

- Análise Macro-Ambiental
- Análise Mercadológica
- Resultados Finais
- Balanco Ambiental

Por Categoria

- Latas de Alumínio
- Vidro
- Papel e Papelão
- Latas de Aço
- Plástico
- Orgânico / Água / Óleo
- Entulho

Ações

- Alterar dados do cálculo
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Orgânico / Água / Óleo

Lixo orgânico total gerado por dia	548 Ton.	Total de energia potencial a ser gerada por dia	10 Megawatts
Lixo orgânico total gerado por mês	16.464 Ton.	Total de energia potencial a ser gerada por mês	329 Megawatts
Lixo orgânico total gerado por ano	197.568 Ton.	Total de energia potencial a ser gerada por ano	3.951 Megawatts

Água consumida por dia pelos habitantes	210.000.000 Litros	Óleo consumido por mês pelos habitantes	1.050.000 Litros
Água consumida por mês pelos habitantes	6.300.000.000 Litros	Óleo consumido por ano pelos habitantes	12.600.000 Litros
Água consumida por ano pelos habitantes	75.600.000.000 Litros		

Nota: Caso queira alterar os valores indicados acima de litros para metro cúbico, basta dividir o valor por 1.000



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Table 5

Software VERDES versão 1.5 ano 2007

Balança Ambiental	
Ganhos ambientais com a reciclagem	Perdas ambientais com a não-reciclagem
Economia de bauxita (alumínio) 5.601 Ton.	Perda de bauxita (alumínio) 294 Ton.
Economia de areia, barrilha, calcário e feldspato (vidro) 8.902 Ton.	Perda de areia, barrilha, calcário e feldspato (vidro) 10.450 Ton.
Média de árvores poupadas (papel e papelão) 943.488 Árvores	Média de árvores perdidas (papel e papelão) 1.153.152 Árvores
Economia de minério de ferro (aço) 3.000 Ton.	Perda de minério de ferro (aço) 3.383 Ton.
Economia de petróleo (plástico) 677 Barris	Perda de petróleo (plástico) 1.439 Barris

Nota: os valores acima são apenas ilustrativos sem valor científico.

Nota: caso queira decompor o valor em toneladas da matéria-prima utilizada na fabricação do vidro, use a seguinte composição:
Areia: 58%
Barrilha: 19%
Calcário: 17%
Feldspato: 6%

Table 6

Software VERDES versão 1.5 ano 2007

Entulho	
Entulho gerado por habitante	Total de entulho gerado
Entulho gerado por dia em kilos 1,3 Kg	Total de entulho gerado por dia em toneladas 1.120 Ton.
Entulho gerado por mês em kilos 39 Kg	Total de entulho gerado por mês em toneladas 33.600 Ton.
Entulho gerado por ano em kilos 468 Kg	Total de entulho gerado por ano em toneladas 403.200 Ton.



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Márcio Magera Conceição, Joelma Telesi Pacheco Conceição, Noêmia Lazzareschi, Marcelo Dourado Sales, Fabrício Bau Dalmas

FINAL CONSIDERATIONS

Analyzing the economic and environmental results projected in this study and justified by the GREEN program, it is scientifically proven that recycling of municipal solid waste is economically feasible. So why is it not fully adopted in our country? Or in the cities? The answer is not simple. Brazil is one of the largest exporters of commodities in the world, including iron ore, bauxite, and wood, and if these products have accessible market prices, that is, low prices for their abundant supply, the cost of recycling is not worth it, as seen from the point of view of the entrepreneur and the public agent. The country has a continental extension, and the logistics of this process makes its execution unfeasible in the short term. But, if the focus of the analysis is the environment and the gain for future generations, such process becomes feasible considering the raw materials reused in the process.

Although Brazil has a National Solid Waste Policy, which was signed on August 2, 2010 (Law 12,305), the country recycles only 2.1% of the total waste collected, according to data from the SNIS (National Information System on Sanitation). The most recent information is from the 2019 Urban Solid Waste Management Diagnosis. Recycling has difficulties to advance in Brazil because it has not yet resolved primary issues for the area. An example of this is that only 41.4% of the population has access to selective collection, 47.6% does not have basic sanitation, 35 million Brazilians do not have access to treated water and 46% of the sewage collected in the country is treated. Therefore, we cannot paint the house without having built it! (One thing depend on the other). This is the great question of our political leaders. What priority will be given in public policies? The speech is always the same, that there is no budget in the federal budget for such a demand, thus, more than 90% of federal resources are to feed a bloated, corrupt state, full of privileges for an establishment that is the host of this sad nation of miserable people.

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