Waste to Energy in Brazil

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Abstract This chapter discusses the current status of waste treatment in Brazil, initially presenting the projects for mitigating greenhouse gas emissions in landfills already approved by the Ministry of Science and Technology. It addresses the issue of consumerism and the "extraction-production-consumption-post wasteful consumption" that makes a more modern technical solution unfeasible. It also discusses the regulatory framework and issue of conservation and energy supply. The laws of the National Climate Change and National Solid Waste policies signed in 2009 and 2010, respectively, are also discussed. It finally stresses the importance of these laws and not just waste disposal in landfills, but does not make them a problem for future generations, always alert to the possibilities of waste recycling and energy use, which will certainly be significant for future societies, considering the increasing production of waste worldwide and the problems caused by different forms of energy production, such as nuclear power, evidenced recently in Japan.

1 Introduction

Although energy potential in Brazil is significant, only a few cases of energy generated from urban solid waste are in operation; namely, two landfills in the São Paulo capital generating the equivalent of 44 MW electric power, the Horizonte Asja 6 MW plant in Minas Gerais, the recently inaugurated Minas de Leão plant of

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Table 1 Projects to mitigate gas emissions responsible for the greenhouse effect in landfills in Brazil (MCT [13])

Landfill	Year of approval	Landfill	Year of approval
Nova Gerar	2004	Itapevi	2006
Vega Bahia		Quitaúna	
MARCA		Pedreira	2007
Lara	2005	SANTECH	
Tremembé		PROBIOGÁS-JP	
ESTRE		Tijuquinha	
Caieiras		URBAM	
Bandeirantes		Irani	
Anaconda		Vila Velha	
São João		Feira de Santana	
Canabrava	2006	Gramacho	2008
Aurá		TECIPAR	2009
Bragança		CTRS	
SIL		Natal	
Manaus		Corpus/Araúna	2010
Alto Tietê		Manaus	
Terrestre Ambiental		Itaoca	

6.5 MW in Rio Grande do Sul, and Gramacho landfill in Rio de Janeiro about to provide treated biogas for the Duque de Caxias Refinery.

Table 1 shows which landfills in Brazil have submitted MDL projects to the Ministry of Science and Technology.

In general, waste consists of food leftovers, electro-electronic material, packaging, clothes, animal remains, paper, cardboard, leather, contaminant construction and inert material. Its disposal in landfills produces gas emissions responsible for the greenhouse effect, producing leachate, loss of area for other activities and a tendency to real estate devaluation in the region. When the disposal is in refuse dumps, the damage is even worse in terms of real estate and traffic in the region, in addition to much environmental damage to the soil, surface and ground water in the vicinity and the air, in addition to a variety of social and health hazards, by occupying surrounding regions and sometimes in the actual waste disposal site.

Questions regarding waste production can lead to a discussion on consumerism, very often justified by planned obsolescence—a strategy adopted by the global production sector to reduce costs of goods and make them accessible to most of the population so that it can maintain the growing demand and therefore keep jobs and "turnover" of the economy. But this capitalist strategy has failed to specify the importance of recycling waste and demonstrate its unfeasibility. Inertia seems to be mostly responsible for continuing with the current "extravagant extractivism-production-consumption-post-consumption" pattern than any technical unfeasibility. In fact, it is possible to substitute some of the inputs from extractivism by waste from the process, preventing depletion of natural resources and damages from the end disposal of still useful materials.

2 The Regulatory Framework

European regulations provided disposal restrictions on food leftovers in landfills from 2014 on in order to prevent emissions. Since this is a costly procedure, although being a good practice for society as a whole, it is to be expected to be required as a minimum parameter against environmental dumping in international negotiations. In Germany, this procedure has been adopted since 2005 with excellent results and has been increasingly adopting procedures of waste treatment for energy use.

Brazil's National Climate Change Policy [11] is committed to a goal to reduce the emissions of various sectors, including waste by 2020. However, since the disposal of a large part of Brazilian waste is in refuse dumps and controlled landfill, the sanitary solution provided by the National Solid Waste Policy [12]—which considers the sanitary landfill as its minimum standard -, tends to increase emissions [3]. It will, therefore, be necessary to have more feasible alternatives to this method, including compliance with the prerogative of this legal instrument, which only permits refuse disposal in sanitary landfills, the concept of which is "waste without economic, environmental and technical feasibility" for reuse.

Since world technologies are, by their very existence, technically feasible and also environmentally feasible based on the granting of environmental licences, there is still the need to demonstrate economic feasibility, since disposal charges currently paid by local governments in Brazil are around half or less than the European charges. It is worth recalling that, unfortunately in developing countries, even when in comfortable economic phases, the view of waste costs is in the short term, and very often long term monitoring costs, environmental damage, traffic losses, damaged public thoroughfares, the health of the neighbouring population, real estate devaluation, and so on are not considered, and which will be paid by future societies.

Accordingly, the question to be asked from this viewpoint is how this issue should be addressed: socially or privately? Socially, it would be sufficient for the project to prove that it is more profitable than the country's discount practice, but this would require investment and operating the system by public authorities and would, therefore, require technical specialization, also involving risk, so it is better if there is interest in using private enterprise.

And this has been the trend in Brazil since around the 1970s in São Paulo and since the 1990s in the rest of the country and large towns with a population of over a million. More recently, there have been attempts to create the figure of multi-municipal consortia in order to share the implementation and operating costs and create more solid opportunities for selling carbon credits and for power generation. It should be noted that, in the case of private enterprise, feasibility depends, of course, on profitability competing with the other applications and existing return rates—including consideration of the risks, in the last case, of innovation and payment of part of the revenue by the public authorities. This, then, is one of the challenges of this generation: to make waste utilization feasible in Brazil.

Table 2 Conservation of energy from recycling, according to various references

Material	Brazil	Canada	USA	Australia
Reference:	[5]	[14]	[7]	[22]
Paper and cardboard	3.51	1.75	2.95	1.37
Plastic (including PET)	5.06	5.55	15.39	5.91
Glass	0.64	0.08	0.62	1.25
Metals (aluminium, steel)	5.3	3.25	5.85	2.67

It is also worth mentioning that the first spark of the many environmental accidents since the 1960s is caused by inadequate waste disposal on hillsides, associated in the sequence with the presence of unsuitable waste disposable in valleys, close to rivers, creeks and culverts. If these costs are added up, certainly proper solutions for waste would be considered important and costs would not be addressed just as short-term factors.

One of the potential aids for the waste issue involves the fact that packaging and a number of electro-electronic items can be recycled by processes that prevent extractivism of natural resources, while at the same time, increase their working life and that of the existing sanitary landfills.

3 Energy Conservation

One potential aid is the fact that packaging can be recycled; a process against extractivism of natural resources, which at the same time increases the working life of natural resources and sanitary landfills.

One of the benefits of waste recycling is saving energy. Although there are bibliographic references on the topic, which suggests considerable values, as shown in Table 2, there is very little international exploitation.

In Brazil, considering the production of 60 Mt/a (IBGE [8]) and composition of the waste [10], as shown in Table 3, it is possible to estimate potential energy conservation from the [14].

Accordingly, the potential of 87.5 TWh electricity equivalent, or 22 Mtep, is achieved, enough to attend the consumption of the national residential sector (BEN) and similar to all electric power generated from waste in the 2,000 or so thermopower plants in the world (CEWEP [6]).

This is, in fact, a greater quantity of energy since the Brazilian energy matrix consists first and foremost of hydropower plants on sites appropriate for using this source, and the majority are far from consumer centres, which requires transmission over 2,000 km. This activity incurs losses, today in the 15% range of the generation (ANEEL [1]). This is why recycling prevents not only electricity consumption but also loss in transmission. It is worth mentioning that this supply is

Table 3 Composition of Brazilian waste and potential energy conservation

Material	Composition (%)	Conservation factor (MWh/t)	Potential Conservation (MWh/a)
Paper and cardboard	12	3.51	54.6
Plastic (including PET)	18	5.06	25.3
Glass	3	0.64	1.15
Metals (aluminium, steel)	2	5.3	6.36

equivalent to that of the Itaipu hydropower plant and more than the entire nuclear complex in existence and planned [2], [20].

In the Brazilian case, where there is a fund for mandatory investment in activities with this profile—the Energy Efficiency Programme (PEE), controlled by the regulatory national electricity agency (ANEEL [1]) and adopted by the distribution and generation concessionaires –, of R$ 400 million a year (2010), and must benefit less favoured classes with 60% of the total, it is possible to establish a public policy for recycling.

Moreover, one of these international references on conservation from recycling founded the UN-approved AMS-III.AJ methodology on reducing greenhouse gas emissions based on recycling plastics (IPCC [9]), corroborating the proposal made by Pimenteira et al. [19].

The allocation of resources available in the PEE to encourage recycling can, therefore, be used to drastically reduce the need for private investment in waste utilization projects, which increases their profitability and directly their feasibility, in response to the legal precept and against burying the recyclable material.

4 Energy Supply

Consequently, the food leftovers to be segregated may undergo anaerobic composting to generate electricity or sell the resulting gas, since the investment will have been reduced and it will then also be feasible—although the amount of available electricity is below 40% of the conserved. Lastly, in the case of selling electricity, the exhaust heat should be used to dry the organic compost and consume it in a boiler to generate a little more electricity, reducing the disposal of material in a landfill by around 10%.

As a result, the waste is now supported by the energy sector as a feasible proposition and, in counterpart, helps it to postpone building new plants, optimising financial, human and natural resources of society.

Thus, the energy potential of urban solid waste is now a function of the minimum scale of feasibility of the projects, which was based on international experiences in which biodigestors that treat 150 t/d (OWS [18]) of organic waste,

successfully supply a thermopower plant of 850 kW. Making this restriction compatible with the available waste per Brazilian citizen, there are around 300 cities that can provide plants to treat their own waste, which totals around 60% of all waste produced in the country. This achieves the power of 460 MW—or the equivalent in use of the gas now made available, including for vehicles as a substitute for diesel fuel (BOSCH [4])—in approximately 550 plants, as stated by [15]. Possibly these values are higher when implementing multi-municipal consortia, but this requires assessments regarding transport, energy balance, emissions and finance still to be undertaken. It should be noted that Brazil is a country with more than 5,500 towns, many of them in densely populated regions, where joint solutions for solid waste would certainly be extremely welcome.

If the segregation of recyclables or consumer market of this packaging is not enough to absorb them only by recycling, it is possible that incineration technologies take over some of the space—even if a larger scale of materials is required, it represents fewer plants and greater supply of electricity.

In any case, it is a good opportunity for different technologies in energy use from landfill waste, since the Brazilian market proves able to increase by more than half the number of plants currently in operation in the world market.

5 Incentives and Sanctions

In this case, the National Solid Waste Policy itself, by its regulatory decree, provides economic incentives for feasible projects in this sector, such as lower interest rates, financeable portion and longer terms, plus lower taxation on products and incentive for its procurement by public authorities.

On the other hand, failure to meet the requirements incurs fines between R$ 50 and R$ 500 per relapse (which may be charged on a daily rate), to discourage non-action.

Since this alternative also attends the National Climate Change Policy, it is desirable to use the concept of mitigating cost to hierarchise the alternatives and choose the cheapest. In this sense [17] show that energy utilisation of urban solid waste is cheaper than alternative wind energy, which has been given incentives based on this environmental criterion.

And, lastly, because of the transversality of the topic, which also covers the social and strategic issue—especially to prevent public health hazards and help increase energy security as the supply is being decentralised -, it is suitable to apply the concept of sustainability to this source, so that the characteristics of the economic, environmental, operating, social and strategic dimensions can be analysed jointly, which was done by Oliveira et al. [16] and Rovere et al. [21].

Solid waste solutions that enable financial gain for a large part of the population are welcome and must be considered in the future. The sanitary landfill, however good its disposal, is a solution that in essence benefits the owners or the companies operating the landfills. There is room in Brazil to implement processes that

consists of more recycling, composting, anaerobic fermentation and incineration with energy use, which are processes that will involve many more new companies and jobs, and which will certainly be implemented in our country in the next few years.

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