INSTITUTIONAL PLAN

BRAZILIAN ASSOCIATION FOR ENERGY RECOVERY OF WASTE - ABREN

MARCH 2020

SUMÁRIO

1 INTRODUCTION

At some point in its history, countries around the world will have to reassess their policies and practices regarding their waste management.

Much of the developed world has already gone through this phase. The process could be noticed for some time, and in some cases two decades, in the countries with the highest development index, such as members of Europe, United States, Japan, South Korea, and also with great prominence in emerging countries like China. , India, Singapore and Taiwan.

The precocity of these examples was mainly due to the smaller geographic range, less availability of natural resources and the higher concentration of disposable income.

With the end of the second world war, and the increase in optimism about the future, especially in the United States, there was an increase in consumption by the population. More than that, the introduction of the "disposable" concept found a perfect environment for its dissemination. Exacerbated consumerism and the perceived ease in disposable packaging of smaller portions caused an exponential increase in the generation of waste per inhabitant.

It was not long before Europe recovered from the devastation caused by the war, and even less so that this new style of consumption found its way across the Atlantic. This model in European countries had an even more devastating impact, since not only is the population density more accentuated, but the area available for the final destination of Urban Solid Waste (MSW) is smaller, as well as the sludge from the Treatment Station of Effluents (ETE), commercial, industrial and agroforestry waste.

More than that, culturally the average European tends to have greater concerns about the availability of resources, for the reasons already mentioned, and also as a result of difficult times caused by the years of successive wars waged in the old continent.

In this sense, Europe started a movement whose focus was to find better waste disposal solutions. Several solutions have been developed, with greater or lesser efficiency and different resulting by-products.

Currently, in countries such as Austria, Germany, Sweden, Belgium, Denmark, Switzerland, the United Kingdom, Singapore, China, Japan, and several other countries, it is noticed that most of the waste generated is reused. Different technologies today transform what is considered an obstacle in inputs for the generation of clean and renewable energy (in the organic fraction), raw material for production and even in agricultural inputs (biofertilizers and fertilizer).

In Brazil, little has been done for a definitive solution to be applied. Even today, despite passed legislation, few cities have selective collection, and even in cities that have the service, a small part of the population is served.

Even nowadays, it is not uncommon to notice open dumps, landfills outside environmental safety specifications, and even trucks discharging materials in unauthorized or even protected areas. There is no reason why Brazil needs to face all the challenges related to the development of new solutions, as we go through a long process of trial and error.

With these considerations, the opportunity was identified to support the development of sustainable and integrated waste management in Brazil, with the adoption of mechanized recycling, anaerobic biodigestion and thermal treatment with the energy use of waste, providing subsidies and guidance to the Administration bodies It publishes and offers business opportunities for its members, in order to promote the viability of the energy potential of solid waste and the social and environmental benefits that waste energy recovery enterprises have to leave for present and future generations.

The adoption of energy recovery plants, known as Waste-to-Energy (WTE) plants and industrial processes, has been motivated both by the need to minimize the environmental externalities of the landfill, which is a matter of basic sanitation, and by the objective of increasing the participation of clean and renewable energy. Over the past decade, WTE plants have been criticized for causing negative impacts on the environment and public health, but the reality is that WTE and industrial plants require sophisticated Air Pollution Control (APC) systems, or Air Pollution Control, having become one of the cleanest high-temperature industrial processes in existence.

In this sense, a WTE plant has two major attributes, namely, it is non-polluting and has very low intermittency (especially when compared to renewable wind and solar sources) with a capacity factor above 90%, as it is a thermoelectric source that holds the attribute of continuous and uninterrupted generation in its operation, except for maintenance stops that occur sporadically and in a planned manner, which, in this sense, contributes to the desired stability and reliability criteria of the electrical system. In addition, a WTE plant generates energy at competitive prices comparable to conventional thermoelectric plants powered by natural gas (fossil fuel).

Energy recovery plants are a form of energy generation whose environmental impact is positive, because, despite some externalities, such as the production of a small portion of toxic materials, they significantly reduce the environmental externalities that would be caused if they were not implemented , such as the emission of greenhouse gases into the atmosphere (3% of total emissions) and risk of contamination of rivers and groundwater by leachate and leachate resulting from the putrefaction process of landfills.

It is important to note that WTE plants can meet criteria for resilience and mitigation of climate change, and these can be important factors in attracting international investments. For example, compliance with international criteria, such as Green Bonds Principle and / or Climate Bonds Standard & Certification Scheme, can be used by developers and project operators who want to access the debt market to capitalize their projects. A signal of compliance with such criteria, which may granting stamps and certifications of securities and other debt instruments, which are internationally recognized, may attract a larger portfolio of domestic and foreign investors.

Finally, it is noteworthy that criteria for resilience and mitigation of climate change corroborate in the planning of undertakings, in addition to attracting a portfolio of project operators and investors with specific mandates for infrastructures that mitigate climate risks and protect the drinking water available on the planet.

2 WORLD OVERVIEW ABOUT WtE

The current moisture content in Brazilian waste (60%) reduces the calorific value of Urban Solid Waste (MSW), but it does not make it any less attractive for the generation of electricity. The RSU has promising potential for the production of biogas, biomethane, hydrogen, electrical and thermal energy.

In this sense, it is important to emphasize the loss of the opportunity to use the MSW energy for the production of biomethane for use in public transport and in the transport used in the sanitation sector itself. Currently, it is estimated that the main urban centers total about 22,000 garbage trucks (consumption potential of 685,000 m3 / a) and 107,000 urban buses (consumption potential of 4Mm3 / a). Using dual-fuel technology, it would be possible to replace up to 90% of diesel consumption in these vehicles with biomethane produced from MSW.

It is estimated that the potential for biogas production in Brazil is 82 billion Nm3 / year, 41 billion of which are in the sugar-energy sector (sugarcane and its derivatives such as bagasse, straw, filter and vinasse), 37 billion from the agricultural sector (animal protein, animal waste and corn, cassava and soybean crops) and 3 billion from the environmental sanitation sector (sanitary sewage and MSW). This amount is equivalent to 67 million tons of oil equivalent (toe) per year, or 76 billion liters of diesel equivalent. Considering an average presence of 60% of methane in biogas, and being methane 25 times more harmful than equivalent carbon dioxide (CO2eq), Brazil could reach the potential of 1.03 billion tons of CO2eq if it uses it effectively biogas as an energy source.

According to the Italian Biogas Consortium, Italy has 2,000 biogas plants, generating 1,400 MW, 80% of which comes from agriculture, which required EUR 4 billion in investments, 12,000 permanent jobs, 10 TWh of renewable energy - approximately 2, 5 billion m3 of biomethane.

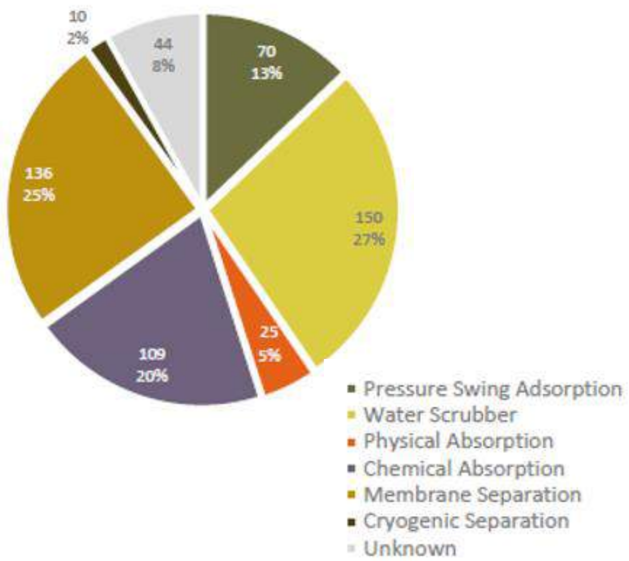
It is estimated that it is possible to produce 122 billion m3 of biomethane (renewable gas) in the European Union by 2050. The graphs below present the current situation in the European Union:[1]

[1] MAGGIONI, Lorenzo. Workshop de Fontes Energéticas no Âmbito do Planejamento de Longo Prazo. Recuperação Energética Waste-to-Energy. Italian Biomethane and biogas scenario. Ministério de Minas e Energia, Brasília, 17 out. 2019. Disponível em: <https://www.abren.org.br/eventos/workshop2019.php>. Acesso em 21 nov. 2019.

Graphs 1 and 2 - Biomethane production in Europe and technologies used

Development of European biomethane production by feedstock type in GWh

Relative use of different upgrading techniques, Europe-wide



EBA 2018. "Statistical Report of the European Biogas Association 2018." Brussels, Belgium, December 2018

For the generation of electricity, it is possible to meet 1.5% of the national demand from the anaerobic biodigestion of MSW, and 5.4% of the national demand from the thermal treatment of MSW (incineration, gasification or pyrolysis), totaling 6,9% of national demand. The following EPE graph[2] presents this data:

Table 1 – Electricity generation potential of MSW

	Electricity	Capacity (MW)	Units
Gás from waste	-	311	-
Incineration	236.520	31.760	106
Accelerated Anaerobic Biodigestion	6.701	868	1.021

Considering only the metropolitan regions, the estimated potential of WTE thermal treatment plants for MSW is 2.4 GW (1.85% of the national matrix), with an annual generation of 14,400 GWh

[2] *Ibid.*

(2.74% of the total generation) , with capacity factor above 90% and with energy being injected close to consumers (distributed generation).[3]

Throughout history, the management of Urban Solid Waste (MSW), commonly known as urban waste, has brought several challenges to humanity. Since the dawn of civilization, we have generated solid waste, which has been deposited in dumps or burned.

Currently, in order to try to solve the problem of garbage, cities have built landfills and incinerators for the disposal of waste, making the management of MSW a problematic issue since the middle of the 20th century, when, in fact, the consumption of goods and their corresponding waste generation grew exponentially[4].

Elements inherent to global change, such as population growth, urbanization and climate change have contributed even more to make the management of MSW a complex issue and, due to the depletion of natural resources, the population has stopped seeing waste as a nuisance, a positive tendency to see garbage as a resource.

Latin America and the Caribbean region has one of the highest rates of urbanization in the world, with an estimated 500 million people living in cities, which translates to about 80% of the population. Among the various problems caused, we highlight those that refer to mobility, safety, health, well-being, sanitation and proper management of MSW. Approximately 354,000 tons are produced daily, through inhabitants with the most diverse consumption habits, cultural characteristics and purchasing power. Of this fraction, it is estimated that 50% (or more) of the MSW generated are food residues and materials of organic origin.[5]

Despite this great potential for recovery through different technological options that currently exist, the portion of organic waste from MSW is discarded and deposited in landfills or dumps, bringing severe impacts to the environment, with the generation of Greenhouse Gases (GHG) due to the emission of methane gas (CH4), which is 25 times more harmful than carbon dioxide (CO2), and today accounts for 3% of total GHG emissions into the atmosphere.[6]

---

[3] RIZZO, Francesco. Workshop de Fontes Energéticas no Âmbito do Planejamento de Longo Prazo. Recuperação Energética Waste-to-Energy. Waste-to-Energy Development: Perspective and Lesson Learned. Ministério de Minas e Energia, Brasília, 17 out. 2019. Disponível em: <https://www.abren.org.br/eventos/workshop2019.php>. Acesso em 21 nov. 2019.

[4] THEMELIS, Nikolas J., BARRIGA, Maria Elena Diaz, ESTEVEZ, Paula, *et al.* Guidebook for the Application of Waste to Energy Technologies in Latin America and The Caribean. 2013. Disponível em: < http://www.seas.columbia.edu/earth/wtert/pressreleases/Guidebook_WTE_v5_July25_2013.pdf>. Acesso em 04 mar. 2019.

[5] ONU. Organic Waste Management in Latin America: Challenges and Advantages of the Main Treatment Options and Trends. 2017. Disponível em: <http://abrelpe.org.br/onu-meio-ambiente-ingles/>. Acesso em 21 fev. 2019.

[6] THEMELIS, Nikolas J., BARRIGA, Maria Elena Diaz, ESTEVEZ, Paula, *Et al.* Guidebook for the Application of Waste to Energy Technologies in Latin America and The Caribean. 2013. Disponível em: < http://www.seas.columbia.edu/earth/wtert/pressreleases/Guidebook_WTE_v5_July25_2013.pdf>. Acesso em 04 mar. 2019; ONU. Waste Management Outlook for Latin America and the Caribbean. 2018. Disponível em: <https://www.unenvironment.org/ietc/publication/waste-management-outlook-latin-america-and-caribbean>. Acesso em 24 mar. 2019.

In addition, there is a risk of contamination of water resources by leachate or leachate, that is, a reduction in drinking water available on the planet, as well as causing damage to human health that can be easily avoided by using available technological processes. According to an ISWA study, Brazil spends an approximate amount of R $ 1.5 billion per year in the treatment of diseases of people who have had inadequate contact with RSU, that is, R $ 10 billion in 10 years. Between 2010 and 2014, the cost of environmental damage caused by MSW was between US $ 1.4 billion and US $ 2.8 billion, with an average of US $ 2.1 billion.[7]

Due to their enormous volume (approximately half of MSW in developing countries), municipal organic waste deserves adequate and specialized management. In addition to minimizing costs and severe environmental impacts, it is possible to produce important by-products such as energy (electrical and thermal), fertilizers (anaerobic composting) and biofuels (biomethane).[8]

According to the Brazilian Association of Public Cleaning and Special Waste Companies (ABRELPE), Brazil produced 79 million tons of MSW in 2018, of which 3.9% were recycled and destined for composting, 59.5% for landfills, and the remainder, 29.5 million tons (or 40.5% of all waste), dumped by 3,001 municipalities in controlled dumps or landfills.[9], not considering that, since August 2014, dumping garbage in a controlled landfill or dump is an environmental crime and is subject to a fine of up to 50 million reais.[10]

With the adoption of energy recovery methods and inputs, it is possible to prevent waste from being deposited in landfills that often do not prevent liquid and gaseous emissions to the environment. Post-recycling MSW is estimated to reach 1.2 billion tonnes per year worldwide, with only 0.2 billion (or 16.6%) being treated using WTE energy recovery technologies. In addition, only 20% of landfilled MSW are disposed of in landfill sites, which have mechanisms to reduce liquid and gaseous emissions to the environment.

In response to such problems, the most advanced countries have developed a variety of methods and technologies to deal with solid waste management, ranging from reduction through product and packaging design, to recycling materials that can be reused by industry and commerce,

---

[7] Estadão. Lixões geram prejuízo anual de US$ 370 mi para sistema de saúde. 29 set. 2015. Disponível em: < https://ciencia.estadao.com.br/noticias/geral,lixoes-geram-custo-anual-de-us-370-milhoes-para-sistema-de-saude,1771302>. Acesso em 22 nov. 2019. ISWAL. The Tragic Case of Dumpsites. 2015. Disponível em: <https://www.iswa.org/fileadmin/galleries/Task_Forces/THE_TRAGIC_CASE_OF_DUMPSITES.pdf>. Acesso em 22 nov. 2019.

[8] THEMELIS, Nikolas J., BARRIGA, Maria Elena Diaz, ESTEVEZ, Paula, *Et al.* Guidebook for the Application of Waste to Energy Technologies in Latin America and The Caribean. 2013. Disponível em: < http://www.seas.columbia.edu/earth/wtert/pressreleases/Guidebook_WTE_v5_July25_2013.pdf>. Acesso em 04 mar. 2019; ONU. Waste Management Outlook for Latin America and the Caribbean. 2018. Disponível em: <https://www.unenvironment.org/ietc/publication/waste-management-outlook-latin-america-and-caribbean>.

[9] Associação Brasileira de Empresas de Limpeza Pública e Resíduos Especiais (ABRELPE). Panorama dos Resíduos Sólidos no Brasil. 2018. Disponível em: <http://abrelpe.org.br/download-panorama-2018/>. Acesso em 21 nov. 2019.

[10] *Vide* art. 56, § 1º, incisos I e II, da Lei nº 9.605/98 (Lei de Crimes Ambientais).

as well as the composting of organic material and combustion with energy use, known as Waste-to-Energy (WTE) plants.

Therefore, we can define WTE as the generation of electric energy from biodigestion or thermal treatment of waste, whether organic or inorganic, through the use of several existing technologies. The implementation of WTE energy recovery plants has been the solution found in several countries, for the final destination of MSW that were not used in the recycling or composting process, that is, the MSW that would be destined to landfills, and these, even the sanitary ones, bring risks of irreversible contamination to the environment.

In this way, international experience indicates that the mass production of these residues, resulting from the rapid growth of the urban world population and the consumption of goods, prevents the deposition of these residues in the dumps of old. European Union member countries, the United States, China, India, among others, included WTE as a priority in the treatment of this waste, which, in addition to obtaining a sustainable destination, contributes to the generation of clean, renewable and steady electricity, attributing greater reliability. and stability to the electrical system.

Worldwide, there are approximately 2,430 WTE incineration plants in operation worldwide[11],more than 90% of heat treatment plants use the technology of combustion incineration in mobile grids (mass burning).

There are several factors that can explain the greater or lesser use of energy recovery in different countries. Taking as an assumption that the law may become a precursor to the economic development of certain sectors of a nation[12], it can be said that the adoption of regulatory instruments has been one of the drivers in the development and adoption of energy recovery in several, providing legal certainty and predictability to investors.

According to a study by CEWEP, the European Union foresees that the expansion of the capacity and quantity of WTE plants to meet an additional 40 million ton / year of MSW, in view of the goal of reducing the current destination of 25% of its MSW for landfills up to 10% in 2035. The goal of the circular economy for member countries of the European Union is to bring recycling to 65% levels in 2035, including traditional mechanical recycling and energy recovery. As a result of this policy, the European Union expects that the amount of waste treated in WTE plants, safely destroying pollutants, will generate 18 TWh of energy (heat and electricity) and save 115 million tons of CO2eq, contributing to the reduction of GHG emissions into the atmosphere and for the goals of mitigating the effects of global warming.

---

[11] Ecoprog. Waste-to-Energy 2018/2019. Technologies, plants, projects, players and backgrounds of the global thermal waste treatment business. 11th edition, 2018.

[12] *Vide* GICO JR, Ivo Teixeira. Direito & desenvolvimento: o papel do direito no desenvolvimento econômico. In: Revista Direito e Desenvolvimento, João Pessoa, v. 8, n. 2, p. 110-127, 2017. Disponível em: <https://periodicos.unipe.br/index.php/direitoedesenvolvimento/article/view/370>. Acesso em 18 abr. 2019; SHIRLEY, Mary M. Institutions and Development. Advances in New Institutional Analysis. Massachusetts: Edward Elgar, 2008.

Figure 01 details the WTE heat treatment plants in operation in Europe, not including the incineration of hazardous waste (hospital, radioactive, etc.), in blue the number of plants and in red the amount of thermally treated waste in million tons, representing a total of 522 plants in operation and 263,314 tons / day (tons per day) processed in 2016.

Figure 01 – *Waste-to-energy* in Europe in 2016[13]

In the United States, the WTE industry emerged in the 1960s with the need to find a healthy way to dispose of waste and replace open dumps, having strengthened in 1970 with the need to develop alternative energy resources in the Arab oil era, in a moment when it was thought that energy would be a scarce commodity and prices would continue to rise. However, changes and disinterest in the implementation of new policies and also support in the industry, prevented the development of WTE plants, and efforts were made to build new and large sanitary landfills, in addition to allowing expansion of existing landfills. In other words, there was no strong economic interest to make this noble activity a reality.[14] Originally, state and federal regulations favored WTE plants as a safe, environmentally sound alternative to landfills.

[13] CEWEP. Waste-to-energy: Energising your waste. 2018. Disponível em: <http://www.cewep.eu/wp-content/uploads/2018/07/Interactive-presentation-2018-New-slides.pdf>. Acesso em 03 mar. 2019.
[14] BERENYI, Eileen B. e ROGOFF, Marc J. Is the Waste-to-Energy Industry Dead? Disponível em: < https://foresternetwork.com/weekly/msw-management-weekly/waste/is-the-waste-to-energy-industry-dead/>.

Federal incentives included donations for feasibility studies and pilot projects, tax credits for investments, favorable tax treatment for depreciation of equipment and public financing with reduced interest rates.[15] Currently, there are approximately 87 WTE heat treatment plants in the USA, 26% of which are recycled, 9% for composting processes, 13% for WTE plants and 52% for landfills..[16]

In the mid-1990s, the European Union began to recognize the potential impact of solid waste management on climate change, having introduced targets for diverting MSW from landfills. In the UK this has led to the development of a tax scheduling mechanism on landfill operation and landfill permit trading. Such mechanisms have helped to boost the development of power generation plants from waste plants. [17]

The IPCC's 5th Climate Assessment Report provides relevant information on the problem of methane emission into the atmosphere generated from waste, graphically detailing the waste hierarchy disciplined by the European Commission, which follows the following order of priorities: (i) reuse; (ii) recycling; (iii) energy recovery; (iv) landfill with methane capture, recovery and use; (v) treatment without energy recovery; (vi) landfill with methane flaring; (vii) landfill without methane capture; (vii) non-sanitary landfill [controlled landfill]; and (viii) dumping in landfill.[18]

Acesso em 03 mar. 2019; RAGOFF, Marc. J. e SCREVE, Francois. Waste-to-Energy: Technologies and Project Implementation. 2ª edição. Elsevier: Oxford, 2011, p. 60-65.

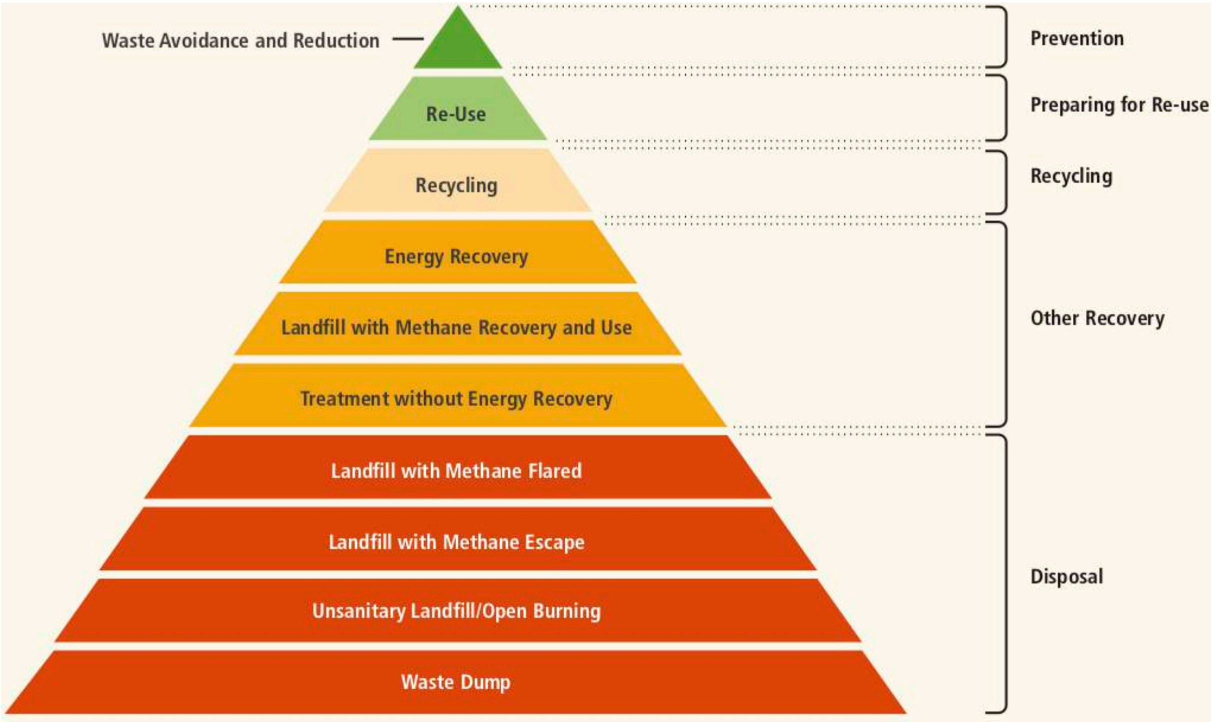
[15] BERENYI, Eileen B. e ROGOFF, Marc J. Is the Waste-to-Energy Industry Dead? Disponível em: < https://foresternetwork.com/weekly/msw-management-weekly/waste/is-the-waste-to-energy-industry-dead/>. Acesso em 03 mar. 2019; RAGOFF, Marc. J. e SCREVE, Francois. Waste-to-Energy: Technologies and Project Implementation. 2ª edição. Elsevier: Oxford, 2011, p. 60-65.

[16] SWANA. From Solid Waste Management to Resource Efficiency and Energy Recovery in The United States. 2018. Disponível em: http://www.foroenres2018.mx/presentaciones/13_10%20de%20oct%20Sara%20Bixby.pdf>. Acesso em 03 mar. 2019.

[17] INGLATERRA. Department for Environment, Food & rural Affairs. Energy from waste: a guide to debate. Disponível em: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/284612/pb14130-energy-waste-201402.pdf>. Acesso em 03 mar. 2019.

[18] IPCC. AR 5 Climate Change 2014. Mitigation of Climate Change. Chapter 10 – Industry. Disponível em: < https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_chapter10.pdf>. Acesso em 04 mar. 2019.

Figure 02 - Hierarchy of garbage according to the Council of the European Union



China today has the largest installed capacity of thermal waste treatment plants in the world, with 7.3 GW of installed capacity, having 339 plants in operation by the end of 2017. Energy recovery grew by 1 GW per year, on average, over the past five years, and now represents the largest form of bioenergy capacity, capable of managing just over 100 million tonnes of MSW per year, which represents almost 40% of national MSW production.[19]

According to Waste Atlas, Australia has only two old WTE plants in operation, in Sydney and Townsville, with landfills predominating [20]. WTE plants are called by Australians as Energy from Waste (EfW) and classified by law as a renewable energy source. However, there are very restrictive regulations that hinder the development of the WTE industry. Generators are required to sample their waste stream to determine the renewable component of their respective stream and, accordingly, the fraction of the waste stream that is an eligible source. It is an expensive and time-consuming process that involves external auditors to sample and audit the waste stream every six months. Such impositions ended up acting as a deterrent for the Australian municipal councils, which

[19] IEA. Will energy from waste become the key form of bioenergy in Asia? Analysis from Renewables 2018. Paris, 2019. Disponível em: < https://www.iea.org/newsroom/news/2019/january/will-energy-from-waste-become-the-key-form-of-bioenergy-in-asia.html>. Acesso em 8 set. 2019.
[20] Waste Atlas. Disponível em: <http://www.atlas.d-waste.com/>. Acesso em 03 mar. 2019.

started to consider the possibility of making the transition from landfill to other forms of alternative waste treatment.[21]

Japan has created a legal system called the Sound Material Cycle Society, so that the consumption of natural resources is conserved and the environmental burden is reduced to the maximum possible. The Basic Law for the Control of Environmental Pollution was created in 1967 and edited in 1993, with the Basic Environmental Plan being created in 1994.

In short, since 1970 Japan has created a range of regulations for the treatment of MSW[22], thus recording a recycling rate of 20.8% of the total MSW produced [23], it has approximately 310 WTE plants in operation, eliminating 114,614 tons / day of MSW, out of a total of 37,822,620 tons / year, which represents 83.38% of all MSW post-recycling.[24]

It is important to highlight that there is no conflict between recycling and waste incineration, as the countries that have the best recycling and composting rates are the ones that incinerate the MSW most, as shown in the following graph.

---

[21] WHARBURTON, Dick, FISHER Brian, VELD, Shirley In't, *Et al*. Renewable Energy Target Scheme. Report of the Expert Panel. 2014. Disponível em: <https://apo.org.au/sites/default/files/resource-files/2014/08/apo-nid41058-1209321.pdf>. Acesso em 20 mar. 2019.

[22] JAPÃO. Ministério do Meio Ambiente. Solid Waste Management and Recycling Technology of Japan. 2012. Disponível em: <https://www.env.go.jp/en/recycle/smcs/attach/swmrt.pdf>. Acesso em 03 mar. 2019.

[23] Waste Atlas. Disponível em: <http://www.atlas.d-waste.com/>. Acesso em 04 mar. 2019.

[24] THEMELIS, N. J. Waste-to-Energy technologies used in Japan. Earth Engineering Center, Columbia University, 2013. Disponível em: < https://pdfs.semanticscholar.org/bfdb/859fb02ede97bdfed221674521369f4bf5e5.pdf?_ga=2.10532989.873479725.1551649619-1810211481.1551649619>. Acesso em 03 mar. 2019.

Figure 03 - Panorama of MSW recycling, composting and heat treatment in the world. [25]

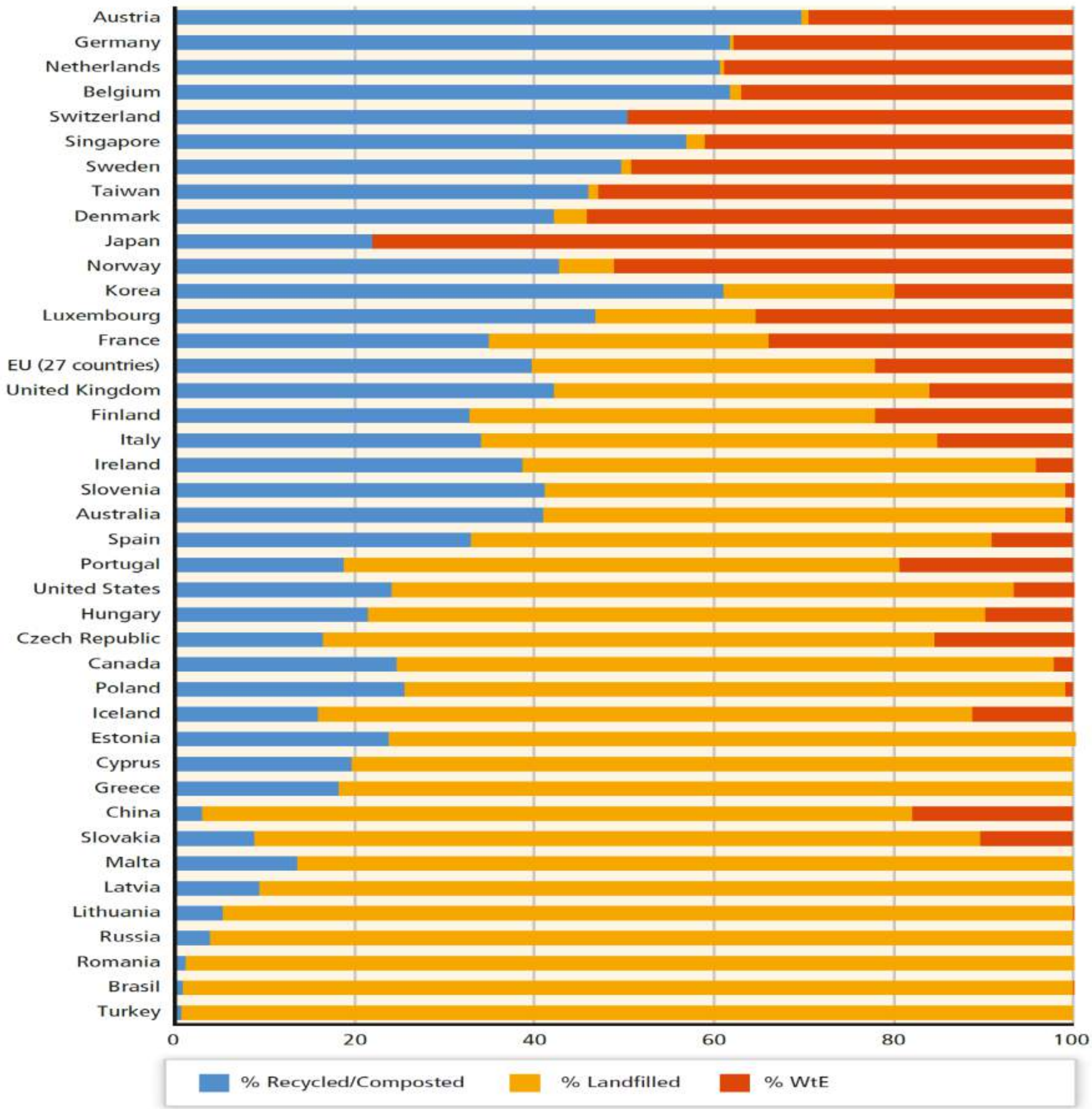


Figure 10.18 | Management practices concerning MSW in several nations (based on World Bank and national statistics, methodology described in Themelis and Bourtsalas (2013).

It is also important to note that Brazil has made international commitments with a view to the correct disposal of solid waste in large cities. In the International Treaty Agenda 21 - the Earth Summit - a document produced at the 1992 United Nations Conference on Environment and Development, known as Eco-92, in Rio de Janeiro / RJ, there is guidance that there is collection and disposal of waste, through (i) the development of appropriate technologies for the disposal of solid

[25] IPCC. AR 5 Climate Change 2014. Mitigation of Climate Change. Chapter 10 – Industry. Disponível em: < https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_chapter10.pdf>. Acesso em 04 mar. 2019.

waste, based on an assessment of its health risks, and through (ii) the development of suitable facilities for the disposal of solid waste in large cities .[26]

Once again, Rio de Janeiro / RJ hosted the United Nations Conference on Sustainable Development, Rio + 20, in 2012. When dealing with sustainable cities and human settlements, the Report indicates the need for integrated planning and management approaches, through sustainable waste management through the application of 3Rs (reduce, reuse and recycle). In the fourth table of discussions, there is the recommendation to promote the use of waste as a source of renewable energy in urban environments.[27]

In 2015, the Agenda 2030 was voted, in a meeting at the United Nations (UN) headquarters in New York, with 17 global Sustainable Development Goals (SDGs) and 169 goals having been outlined. [28].The SDGs and goals are defined in global terms in the form of universal, integrated and indivisible aspirations, but each government must define its own national goals in policy processes and planning strategies, in the economic, social and environmental fields.

Among the objectives of ensuring sustainable production and consumption patterns (SDG 12), there is the goal of achieving the environmentally sound management of all waste by 2020, and by 2030, substantially reducing the generation of waste through prevention, reduction, recycling and reuse[29] [30].

Another energetic potential in incipient exploration is organic waste, which is produced from biodigestion and produced biogas, which is used to generate electricity. In other words, biogas is a gas with a high calorific value produced by the anaerobic biological decomposition of organic waste, which can be burned in motorcycle generators to produce electricity. In addition to generating electricity, after undergoing a purification process, this gas is transformed into biomethane, which has the same destination as natural gas, and can be used in households, industries and automotive vehicles, for example.

A biomethane plant has systemic advantages for generating electricity close to consumption, for being a self-sufficient plant and for encouraging the reuse of organic matter produced in the field, considering the relevance of agribusiness in the composition of the country's economic activity. ZEG

[26] ONU. Conferência das Nações Unidas sobre Meio Ambiente e Desenvolvimento. Capítulo 6. Proteção e promoção das condições da saúde humana. Disponível em: < http://www.mma.gov.br/estruturas/agenda21/_arquivos/cap06.pdf> Acesso em: 03 mar. 2019.

[27] ONU. Report of the United Nations Conference on Sustainable Development. 2012. Disponível em: <http://www.un.org/ga/search/view_doc.asp?symbol=A/CONF.216/16&Lang=E>. Acesso em 23 mar. 2019

[28] A agenda foi resultado da Conferência das Nações Unidas sobre Desenvolvimento Sustentável, Rio + 20, sediada novamente no Rio de Janeiro/RJ, tendo sido elaborado o documento final intitulado "O futuro que queremos", cujo grupo de trabalho resultou nos 17 ODS e 169 metas da Agenda 2030.

[29] ONU. Objetivos de Desenvolvimento Sustentável. Transformando Nosso Mundo: A Agenda 2030 para o Desenvolvimento Sustentável. Disponível em: < https://nacoesunidas.org/wp-content/uploads/2015/10/agenda2030-pt-br.pdf>. Acesso em 24 mar. 2019.

[30] O Brasil criou a Comissão Nacional para os Objetivos de Desenvolvimento Sustentável, por meio do Decreto nº 8.892, de 27 de outubro de 2016.

Biogas, a standard biogas plant is equivalent to 443,886 trees planted, less 1,073,697 km run by garbage trucks per year, 2,828,520 liters of diesel per year or 2,332,800 kg of LPG replaced per year. It is important to highlight that the Energy Research Company (EPE) included, for the first time, biogas in the 10-year Expansion Plan (PDE), providing for a generation of 30 MW per year from the source. In PDE 2027, EPE points out that the greatest potential for biogas production is found in the use of waste from the sugar-energy sector, which can be consumed directly or purified, for the production of biomethane.

According to the adopted premises, PDE 2027 estimates that, in relation to biomass, biogas (both from null CVU) and forest waste, "the total expansion in the ten-year horizon was 2,600 MW, represented in the Southeast / Midwest subsystem".[31] Thus, precisely because of the potential and the modest participation of this source in the regulated energy trading environment, EPE points out that biogas can be "an offer in the basket of projects that are candidates for centralized expansion.".[32]

In Brazil, there is no thermal waste treatment plant in operation, only the CS Bioenergia biodigestion plant in Curitiba, some small R&D plants, and some landfill gas capture plants. However, an WTE plant generates, on average, 600 kWh of electricity per ton of MSW, while landfills with biogas collectors extract an average of 65 kWh per ton, that is, a WTE plant has energy efficiency almost ten times higher, this not to mention that the electricity generated from waste in a landfill environment is slowly extracted over time, while electricity is generated immediately at a WTE plant.[33]

According to EPE, Brazil has the potential to generate up to 5.4% of national demand through MSW thermal treatment plants, with 106 units generating 236,520 GWh / year and a total installed power of 3,176 MW. There is also the potential to generate 1.5% of national demand through accelerated anaerobic biodigestion, with a total installed capacity of 868 MW, generating 6,701 GWh / year. In total, it is estimated that MSW can generate up to 7% of national demand.[34] It is estimated that the country will be able to receive an approximate amount of R $ 28 billion in investments and, thus, result in job and income generation, and by 2031, R $ 11.6 billion / year (approximately US $ 3 billion) in infrastructure investments to guarantee the universality of sustainable solid waste management in Brazil.[35]

---

[31] Empresa de Pesquisa Energética (EPE). Plano Decenal de Expansão de Energia 2027, p. 65. Disponível em: <http://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/Documents/PDE%202027_aprovado_OFICIAL.pdf>. Acesso em: 20 ago. 2019

[32] *Ibidem.* p. 53.

[33] KLINGHOFFER, Naomi B. e CASTALDI, Marco J. Waste to energy conversion technology. Woodhead Publishing: Cambridge, 2013, p. 17.

[34] EPE. Inventário Energético dos Resíduos Sólidos Urbanos. Nota Técnica DEA 18/14. Série Recursos Energéticos. Rio de Janeiro, 2014. Disponível em: <http://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-251/topico-311/DEA%2018%20-%20%20Invent%C3%A1rio%20Energ%C3%A9tico%20de%20Res%C3%ADduos%20S%C3%B3lidos%20Urbanos%5B1%5D.pdf>. Acesso em 22 out. 2019.

[35] Climate Bonds Initiative. Oportunidades de investimento em infraestrutura à Nível Municipal no Brasil. 2018.

Thus, energy recovery from waste translates into (i) strategic benefits, given that it contributes as an alternative source of energy; (ii) environmental benefits, as it contributed to the mitigation of GHG and avoids contamination of water resources, which are so scarce; (iii) socioeconomic benefits, resulting from the development of national technology and employment of skilled and unskilled labor, in the various stages of the energy recovery process from waste, with income generation and local economic increase, giving more visibility to the municipality and helping to attract new investments. Waste, on the other hand, carries a burden for public authorities and citizens.

3 SUSTAINABLE AND INTEGRATED WASTE MANAGEMENT

3.1 Definition of Solid Waste

Any material not used or resulting from any activity qualifies with waste. Commonly called garbage, this resulting from the activities has as main destination landfills.

There are, however, specific classifications for waste resulting from human activities, the origin, state and degree of dangerousness being decisive for this classification.

The Ministry of the Environment, through the National Solid Waste Management Information System (SINIR), presents the following classification of waste:

> I. Regarding the Origin:
>
> a) HOUSEHOLD WASTE: those originating from domestic activities in urban residences;
>
> b) URBAN CLEANING WASTE: those originating from sweeping, cleaning of public places and roads and other urban cleaning services;
>
> c) URBAN SOLID WASTE: those included in points "a" and "b";
>
> d) WASTE FROM COMMERCIAL ESTABLISHMENTS AND SERVICE PROVIDERS: those generated in these activities, except those referred to in points "b", "e", "g", "h" and "j";
>
> e) WASTE FROM PUBLIC BASIC SANITATION SERVICES: those generated in these activities, except those referred to in item "c";
>
> f) INDUSTRIAL WASTE: those generated in the production processes and industrial facilities;
>
> g) HEALTH SERVICES WASTE: those generated in health services, as defined in regulations or rules established by the bodies of Sisnama and SNVS;
>
> h) CIVIL CONSTRUCTION WASTE: those generated in the construction, renovation, repair and demolition of civil construction works, including those resulting from the preparation and excavation of land for civil works;
>
> i) AGROSSILVOPASTORIS WASTE: those generated in agricultural and silvicultural activities, including those related to inputs used in these activities;
>
> j) TRANSPORT SERVICES WASTE: those originating from ports, airports, customs, road and rail terminals and border crossings;

k) MINING WASTE: those generated in the activity of exploration, extraction or processing of ores;

II. Regarding Dangerousness:

a) HAZARDOUS WASTE: those that, due to their characteristics of flammability, corrosivity, reactivity, toxicity, pathogenicity, carcinogenicity, teratogenicity and mutagenicity, present a significant risk to public health or environmental quality, according to the law, regulation or technical standard ;

b) NON-HAZARDOUS WASTE: those not covered by item "a".

This classification follows Law 13,305, of August 2, 2010, which institutes the National Solid Waste Policy (PNRS).

For the development of this work, we will use in particular the waste classified in the items: "c", "d", "f" and "i", in addition to the concept of Organic Solid Waste (RSO).

3.1.1. Municipal Solid Waste (MSW)

SINIR defines urban solid waste on its website as follows:

Law 12,305 in its article 13, item I, subitem i, defines Urban Solid Waste as: those originating from domestic activities in urban residences (household waste) and those originating from sweeping, cleaning of streets and public roads and other urban cleaning services (urban cleaning waste).

Law No. 11,445 / 2007, which establishes national guidelines for basic sanitation, in its Article 6, says that the waste originating from commercial, industrial and service activities whose responsibility for handling is not attributed to the generator may, by decision of the public authority, be considered solid urban waste.

Incluem-se na qualificação de RSU todo e qualquer resíduo produzido e coletado em ambientes urbanos. Deste total, estima-se que aproximadamente 31,9% seja de lixo reciclável, 51,4% de lixo orgânico e 16,7% de outros tipos não classificados.

The MSW qualification includes any and all waste produced and collected in urban environments. Of this total, it is estimated that approximately 31.9% is recyclable waste, 51.4% organic waste and 16.7% from other unclassified types.

However, according to data obtained by the Business Commitment to Recycling (CEMPRE), by September 2014, only 13% of Brazilians had access to selective collection. Taking into account the data from 2010, when the National Solid Waste Policy (PNRS) was approved, the increase in access was 109%.

3.1.2. Waste from commercial establishments and service providers

Conceptually, the qualified wastes within this category do not present great differences in relation to those presented in the previous item (MSW), the main difference in the classification being only its generating activity.

Potentially, the type of activity provided at the generating establishment will have relevant impacts with regard to the composition of the waste generated. We can mention, as an example, commercial establishments with activities aimed at selling non-edible articles, which will present a lower percentage of organic waste.

3.1.3 Industrial Waste

Similar to waste from commercial establishments and service providers, industrial waste will have its composition directly linked to the end activity of the industry. It is worth mentioning here that this classification does not consider non-solid waste, with liquid (industrial effluents) and gaseous waste subject to different standards and classifications.

3.1.4. Agricultural Waste

Composed mostly of biomass, agrosilvopastoral residues have been studied to exhaustion as an energy source. Despite not being used to its fullest, there is already a perception of value in this type of waste, including the emergence of energy solutions that contemplate agricultural production for this specific purpose.

Animal-related waste (excrement in particular) has also been studied as an energy source.

There are also agricultural residues that are considered hazardous, and that, therefore, have their own legislation for their destination.

3.1.5. Organic Solid Waste (OSW)

Compounds of animal or vegetable origin, which contain biological components of this origin, are considered organic solid waste.

Non-organic waste has as main problems the volume they occupy, their time in the environment and the risk of physical damage due to its shape. Organic solid waste, on the other hand, presents even more relevant risks.

When organic matter decomposes, it changes state, generating leaky liquid (slurry) and gases. Leachate, in addition to being a contaminating liquid, has unpleasant and often unhealthy odors.

The gases generated during decomposition, in turn, in addition to having odors and also being unhealthy, also present the risk of explosion and are potential aggravating factors in climate changes caused by man.

Finally, the odors presented by gases and leachate are still known to be responsible for attracting animals and insects that carry high-risk diseases to humans.

3.2. Recycling and Reversal Logistics

As a prerequisite for Circular Economy and sustainable and integrated waste management, there is the need to make efforts to reduce waste production, reuse, recycling and reverse logistics. ABREN encourages, promotes and defends this concept, according to the best international practices.

The main objective of the waste management hierarchy is to reduce waste production, which is also the subject of the so-called Circular Economy. The concept of Circular Economy can be described as one in which the products and materials they contain are highly valued, unlike the traditional linear economic model, which is based on the “take-out, consume and throw-away” pattern. The circular economy is based on two complementary cycles inspired by biological cycles: one for organic materials, which can be decomposed by living organisms, and another for inorganic materials, which cannot be decomposed by living organisms. The objective is to limit the disposal of resources as much as possible. In practice, the circular economy implies reducing waste to a minimum by seeking to keep products that reach the end of their useful life in the economy whenever possible. Such products can be used productively and repeatedly, thus creating more added value. Measures leading to a circular economy include reusing, repairing, refurbishing and recycling existing materials and products. What is considered a worthless resource can be transformed into a valuable resource.

Returning yet to the concept of zero waste and Circular Economy, the priority becomes not only recycling and energy recovery of waste (composting and heat treatment), but also changes in consumption and waste patterns, starting with the modification of the product design , the production and distribution processes, with the ultimate goal of modifying the waste life cycle. Developing sustainable waste management systems becomes the priority, in the form of avoiding, reducing, reusing, redesigning, regenerating, recycling, repairing, remanufacturing, reselling and redistributing waste resources.

Education, behavior change and systemic thinking are long-term strategies, while innovative industrial design, changes in legislation and recycling are short-term strategies.[36]

Recycling consists of the process in which the material, after use, returns to the production cycle, either at the origin or in any other production cycle. Recycling can also be defined as the set of interconnected operations, carried out by several economic agents, with the objective of reintroducing the waste materials generated by human activities in the production process. The reuse of components in the recycling process must be preceded by a separation process, mechanical or manual, and a pre-processing that includes washing, decontamination and packaging of the components. In this way, the recycling production chain begins with the separation of recyclable materials and ends with the effective recycling and the destination of a new product to the market.

[36] *Ibidem.*

Although Brazil recycles less than 2% of MSW in total terms, the recycling of some materials such as aluminum and paper / cardboard is an exception. In 2017, 941 tons / day (ton / day) of aluminum were generated and 821 tons / day of aluminum were recycled, 21,851 tons / day of paper / cardboard were generated and 11,437 tons / day of paper / cardboard were recycled, which represents a percentage. recycling of 87.2% aluminum and 52.3% paper / cardboard. However, plastic recycling in 2017 was only 8.2%, with a generation of 21,153 ton / day and recycling of 1,738 ton / day. Decree No. 7,404 / 2010, which partially regulates the National Solid Waste Policy, created the Interministerial Committee for the National Solid Waste Policy and the Guidance Committee for the Implementation of Reverse Logistics Systems, whose responsibility was attributed to companies and industries, but , in practice, little has been seen regarding the effective action for the reverse collection of such waste, with garbage collectors responsible for the collection of 90% of recyclable materials.[37] ABREN intends to encourage the greater adoption of reverse logistics and promote the certification of companies that are adherent and comply with the goals and objectives that are agreed in the Reverse Logistics Sector Agreements.

3.3. Most used technological routes in the energetic recovery

Energy recovery consists of industrial methods and processes that make it possible to recover part of the energy contained in the MSW. Among the existing methods, the most used ones use combustion process incineration.[38] The composition of the MSW also influences the efficiency of the energy recovery system, depending on the location and how they are generated, especially on the composition (more or less organic waste), calorific value and humidity. Basically, energy recovery can be divided into three groups: (i) mass burning incineration, which operates with excess oxygen, (iii) modern Mechanical Biological Treatment (MBT) techniques, or Mechanical Biological Treatment (TMB) and (ii) gasification or pyrolysis, which operates with oxygen deficit.[39]

It is important to highlight that a waste energy recovery plant is not exactly an energy generation undertaking, but essentially a sanitation agent whose energy input is a by-product. This context is essential to demonstrate to the authorities the nature and essentiality of WTE plants, especially in terms of cost and benefit, when compared to other sources of power generation.

[37] STROH, Paula Yone. Cooperativismo, Tecnologia. Social e Inclusão Produtiva de Catadores de Materiais Recicláveis. *In:* Catadores de Materiais Recicláveis: Um Encontro Nacional. PEREIRA, Bruna Cristina Jaqueto e GOES, Fernanda Lira (Orgs.). IPEA. 2017. Disponível em: <http://www.mncr.org.br/biblioteca/publicacoes/livros-guias-e-manuais/catadores-de-materiais-reciclaveis-um-encontro-nacional/at_download/file>. Acesso em 06 mar. 2019.

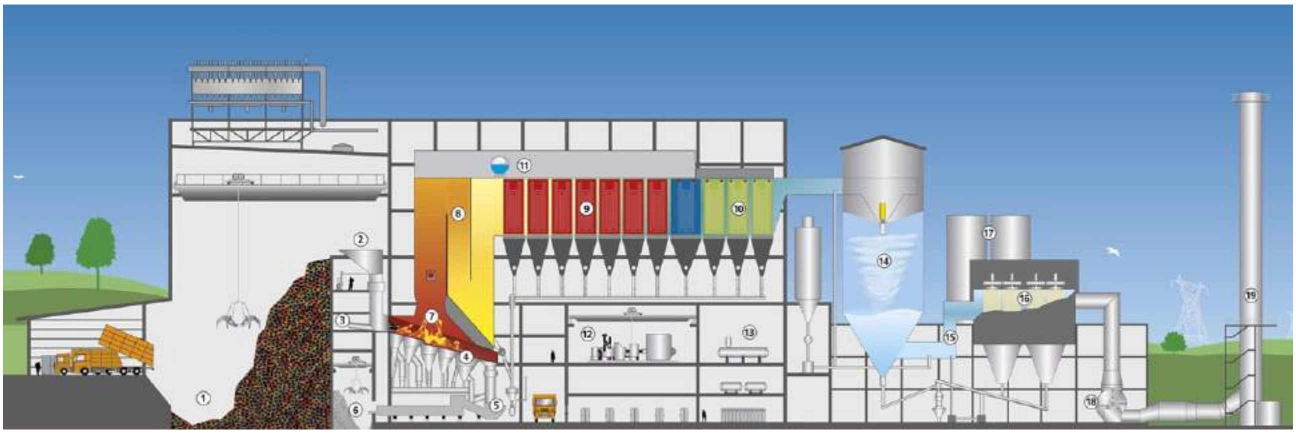
[38] BRANCHINI, Lisa. Waste-to-Energy: Advanced Cycles and New Design Concepts for Efficient Power Plants. Sringer: Bologna, Italy, 2015, p. 19.

[39] ABRELPE e PLASTIVIDA. Caderno Informativo Recuperação Energética de Resíduos Sólidos Urbanos. 2012. Disponível em: <http://abrelpe.org.br/download-caderno/>. Acesso em 01 mar. 2019.

3.2.1. Mass burning

Mass burning incineration is the most widespread and used technological route in the world to treat MSW and thus reuse the inherent energy content, being responsible for more than 90% of MSW heat treatment systems in the world. In this process, MSW are deposited in a storage pit without any need for pre-treatment, that is, separation between the organic and inorganic parcels. Using claws, the MSW are dosed in the boiler or furnace feeding system, to be incinerated with excess oxygen. In this process, hot gases that exchange heat are generated in a boiler, with the walls and tubes producing steam at high pressure and temperature, for thermal use or in sets of turbines and thermoelectric power generators. The most used systems are the Mobile Grids. Before being released into the atmosphere, the gases generated in the combustion process go through a series of environmental control systems to eliminate pollutants, with the emissions required for such plants being the most restrictive among all sources of thermoelectric generation, such as coal, biomass, fuel oil and natural gas.[40]

Figura 04 – Mobing grates WtE mass burning plant [41]



[42]

[40] THEMELIS, Nikolas J., BARRIGA, Maria Elena Diaz, ESTEVEZ, Paula, *Et al.* Guidebook for the Application of Waste to Energy Technologies in Latin America and The Caribean. 2013. Disponível em: < http://www.seas.columbia.edu/earth/wtert/pressreleases/Guidebook_WTE_v5_July25_2013.pdf>. Acesso em 04 mar. 2019; *Vide* RAGOFF, Marc. J. e SCREVE, Francois. Waste-to-Energy: Technologies and Project Implementation. 2ª edição. Elsevier: Oxford, 2011, p. 22-41.

[41] Steinmüller Babcock Environmenta. Energy From Waste. Disponível em: < https://www.steinmueller-babcock.com/_Resources/Persistent/4e379913cef00912c869507f38ae64116c65d569/EfW_english.pdf>. Acesso em 01 mar. 2019.

[42] 1. Depósito de resíduos; 2. Funil de alimentação de resíduos; 3. Alimentador; 4. Grelha móvel para a frente; 5. Extrator de escória; 6. Depósito de escória; 7. Fogo da grelha; 8. Evaporador; 9. Superaquecedor; 10. Economizador; 11. Tambor da caldeira; 12. Turbina; 13. Alimentador do tanque de água; 14. Absorvedor de pulverização; 15. Reator de fluxo; 16. Filtro de tecido; 17. Silos; 18. Ventilador; 19. Chaminé.

3.2.2. *Biological Mechanical Treatment (BMT)*

MSW processing using TMB uses two main technologies. The first is through the Mechanical-biological Pre-treatment (MBP) method, which consists of removing the fraction of Residual Derived Compound (CDR), and then treating the remaining residue , before most of it is grounded. The second form of MBT occurs through Mechanical Biological Stabilization (MBS), or mechanical-biological stabilization, in which, first, the waste is composted for drying before the extraction of a large fraction of CDR, and only a small fraction is grounded. This technology is also called biosecing. In each of the two technologies mentioned, a range of variations is available, depending on the composition of the waste received and the route of the CDR fraction.[43]

3.2.3. *Gasification*

The third group of WTE plants is gasification or pyrolysis, in which MSW undergo a pretreatment, in order to create a more homogeneous and dry mass. Subsequently, they are subjected to heat treatment at high temperatures and a low oxygen environment, a situation in which the gases generated in the combustion process also need environmental control systems to eliminate pollutants. In terms of energy, gasification has less liquid energy. In view of the need to carry out pre-treatment and drying of MSW, the additional operational costs decrease its competitiveness in relation to mass burning incineration.[44]

In the gasification process, the carbon and hydrogen present in the MSW partially react with oxygen, through combustion, generating the synthesis gas (hydrogen gas and carbon monoxide known as syngas), carbon dioxide and ash. Gasification takes place in a first oven by combustion of volatile gases and generation of steam in a second oven, or by the use of syngas in an engine or turbine, in which process equipment called gasifiers are used, which can be configured in different ways. The syngas can be burned in special generators to generate electricity or used as an intermediary for reactions that generate chemicals.[45] The most common types of gasifiers are (i) Fixed Bed, (ii) Fluidized Bed and (iii) Plasma.

3.2.4. *Pyrolysis*

Pyrolysis is the treatment developed entirely without the presence of oxygen. The components of MSW are broken down into hydrocarbons in gaseous and ash forms. The gas fraction can be distilled to obtain different hydrocarbons (gasoline, kerosene and diesel) or burned in boilers or to generate electric energy, or, still partially oxidized to obtain synthesis gas as occurs in

---

[43] CHRISTENSEN, Thomas H., ANDERSEN, Lizzi. Solid Waste Technology & Managemente. Vol. 1 e 2. 2011. Disponível em: <https://www.researchgate.net/publication/235672736_Solid_Waste_Technology_Management_Volume_1_2>. Aceso em 04 mar. 2019.

[44] ABRELPE e PLASTIVIDA. Caderno Informativo Recuperação Energética de Resíduos Sólidos Urbanos. 2012. Disponível em: <http://abrelpe.org.br/download-caderno/>. Acesso em 01 mar. 2019.

[45] *Ibidem.*

gasification.[46] [47] This technology is widely used and efficient for the energy recovery of industrial waste, tires and separate plastics. There is also the pyrolysis of organic waste used for the production of hydrogen (Japanese Technology Blue Tower).[48]

Gasification and pyrolysis technologies require scales starting at 25 ton / day to become viable, while incineration starting at 600 ton / day. Anaerobic biodigestion is possible after 30 ton / day. With this, it is possible to affirm that the current technological stage allows to serve all Brazilian municipalities, or a group of these, from 25 thousand inhabitants, considering the national average production of 1 kg per inhabitant.

3.2.5. Anaerobic Digestion

Anaerobic biodigestion is the process of decomposition of organic matter that occurs in the absence of oxygen, generating biogas and a liquid residue rich in minerals that can be used as a biofertilizer. Biogas is mainly composed of methane and carbon dioxide, both of which are widely used in industry.

The combustion of methane releases thermal energy that can be converted into other forms of energy, which gives biogas the connotation of a Renewable Energy Source. The use of biogas as an energy source has greatly increased its market value and created specific sectors such as biodigesters.

In biodigesters, anaerobic biodigestion occurs in so-called fermenters. The techniques applied in the fermenters are fundamental for increasing the efficiency in the production of biogas and biofertilizers making them the main component of a biodigester, regardless of the model.

At the bacterial level, anaerobic biodigestion takes place in 4 stages: Hydrolysis, Acidogenesis, Acetogenesis and Methanogenesis.

In hydrolysis, complex molecular bonds (polymers) such as carbohydrates, proteins and fats, are broken down by enzymes in a biochemical process and released by a specific group of bacteria, giving rise to simple organic compounds (monomers), such as amino acids, fatty acids and sugars.

Existem diversos tipos de hidrólise, como as que variam em função da matéria orgânica utilizada, como a hidrólise de glicosídeos para a formação de açúcares e de proteínas para aminoácidos.

---

[46] ABRELPE e PLASTIVIDA. Caderno Informativo Recuperação Energética de Resíduos Sólidos Urbanos. 2012. Disponível em: <http://abrelpe.org.br/download-caderno/>. Acesso em 01 mar. 2019.

[47] THEMELIS, Nikolas J., BARRIGA, Maria Elena Diaz, ESTEVEZ, Paula, *Et al.* Guidebook for the Application of Waste to Energy Technologies in Latin America and The Caribean. 2013. Disponível em: < http://www.seas.columbia.edu/earth/wtert/pressreleases/Guidebook_WTE_v5_July25_2013.pdf>. Acesso em 05 mar. 2019.

[48] DOWAKI, Kiyoshi. Energy Paths due to Blue Tower Process. 2011. Disponível em: <https://pdfs.semanticscholar.org/a8fd/86bddd2fb5ae7c7c3ade0b0a29944565562e.pdf?_ga=2.72152979.1052780398.1574454867-719627755.1574454867 >. Acesso em 22 nov. 2019.

Endereço: SHS, Qd. 06, Cj. A, Bl. C, sl. 1.109, Ed. Centro Empresarial Brasil 21, Brasília-DF, CEP 70316-109
Site: www.abren.org.br | E-mail: abren@abren.org.br | Tel.: + 55 (61) 3045-0365

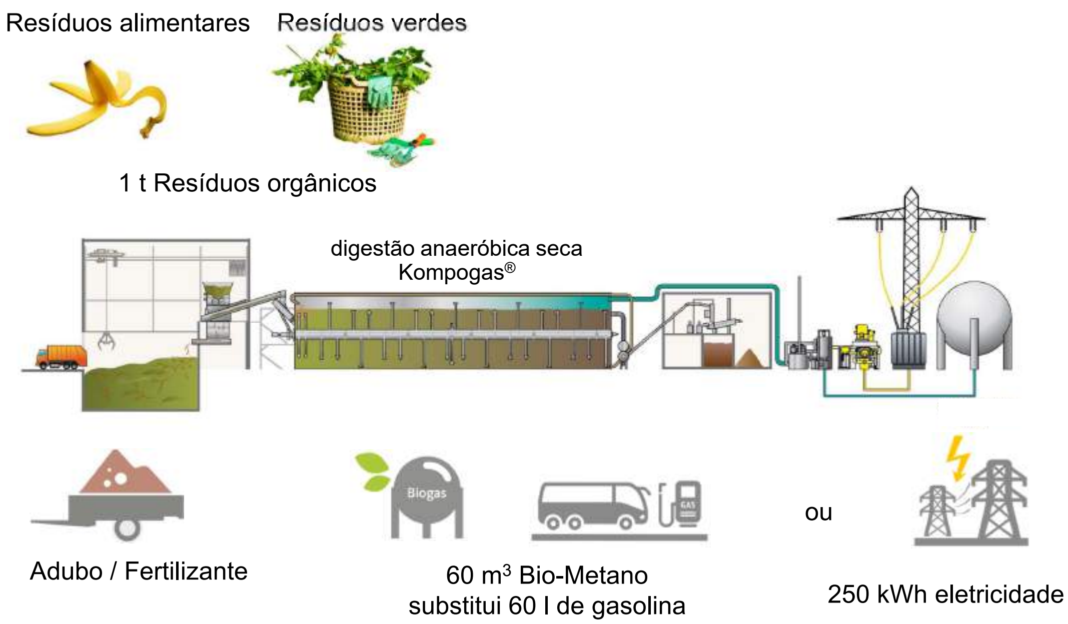
This process is of fundamental importance for the production of biogas, as it is only with the breakdown of the larger polymers that the biodigestion process begins, but, however, this process occurs in the absence or not of oxygen.

In Acidogenesis, the substances resulting from hydrolysis are transformed by fermentative bacteria into propanoic acid, butanoic acid, lactic acid and alcohols, as well as hydrogen and carbon dioxide. The formation of products at this stage also depends on the amount of hydrogen dissolved in the mixture. When the hydrogen concentration is very high, it negatively interferes with the efficiency of acidogenesis, which causes the accumulation of organic acids. As a result, the pH of the mixture is low and the process can be almost completely affected.

In Acetogenesis the material resulting from acidogenesis is transformed into etanoic acid, hydrogen and carbon dioxide by acetogenic bacteria. This is one of the most delicate phases of the process, as it is necessary to maintain the balance so that the amount of hydrogen generated is consumed by the Archeas bacteria responsible for methanogenesis. Methanogenesis occurs by different groups of bacteria, basically through two reactions. In the first reaction, the generation of methane and carbon dioxide derived from acetic acid occurs. In the second, hydrogen and carbon dioxide give rise to methane and water. Methanogenesis bacteria work in the complete absence of oxygen. The lower levels of oxygen concentration can already significantly reduce the action of these bacteria. For this reason, perfect isolation of fermenters is extremely important.

If biogas is used to generate electricity, then we add an electric generator coupled to a combustion engine. In Germany, there are more than 9,200 commercial biodigesters in operation, with full commercial use of this segment. In Brazil, there is great potential to be developed, mainly in the face of livestock and agricultural activities, whose uses in this area are just beginning.

Figura 05 – Planta de Biodigestão anaeróbica Kompogas da Hitachi Zozen Inova



3.2.6. Coprocessing in cement clinker kilns

Since the 1970s, the world cement industry has been developing coprocessing technology, in which the fossil fuel needed in its process is replaced by Fuel Derived from Waste (CDR), or Refused Derived Fuel (RDF). During the last few decades, coprocessing has been highly developed, with factories that operate with more than 90% of their fossil fuel demand replaced by CDR.

The coprocessing process is one of the best environmentally friendly destinations for solid waste. In addition to harnessing its energy potentials, coprocessing does not generate ashes, which are fully incorporated into the process that occurs at 1.4500 C. Every process has emission control, which meets the most complete parameters required by the environmental agencies of the different countries in which coprocessing plants operate.

In several countries, the cement industry has already reached replacement levels above 60%, and in Brazil, in 2018, this level was around 10%, and the ROAD MAP of the Brazilian cement industry regarding CO2 emissions predicts that, in the next three decades, it will reach the level of 55%.

3.2.7. Refuse-derived Fuel

Several technologies have been developed in the world for the production of Fuels derived from Waste (CDR). The technology to be used depends on the characteristics (physical and chemical) of the waste and its origins (urban, industrial, commercial, sludge, agricultural activity, waste tires, etc.).

Several processes can be used in a CDR plant, depending on the characteristics of the waste and the CDR to be produced. Among the processes that can be used, we highlight the following:

a) Crushing;

b) Separation and grading;

c) Separation by density;

d) Metal separators;

e) Optical separators;

f) Drying including biological (activity with bacteria);

g) Mixers;

h) Compactors;

i) Pelletizers.

The characteristics of the CDR to be produced must also conform to its use, with emphasis on the standards required by the cement industry (through co-processing), as well as other industries with thermal energy demand in their process, such as gasification plants for generating steam and electricity.

In the aforementioned Mechanical Biological Treatment (TMB) process, it is possible to prepare CDR using both the non-recyclable organic and inorganic fraction of MSW, using it as a fuel in the cement manufacturing process (co-processing) and in other processes that consume thermal energy. Through these processes with the substitution of fossil fuels for CDR, we have a significant reduction in the emission of greenhouse gases.

3.2.8. Landfill biogás capture

The capture of biogas generated in landfills avoids the emission of its most harmful component in the atmosphere: methane (CH_4). As exposed, this gas pollutes the atmosphere 25 times more than carbon dioxide (CO_2). Producing energy from biogas, instead of fossil fuels, allows a considerable reduction in the amount of CO_2 produced. In addition, it brings benefits such as odor reduction, reduction of fire risk and production of green energy from renewable sources. All landfills to be classified as "sanitary" must have biogas capture, either to burn in the flare (without generating energy), to generate electricity, or even purified to extract biomethane for use in vehicles. This is inefficient, but very necessary in places where landfills already exist.

3.3. Choice of technological route

The proper treatment of the treatment to be given to the waste generated in a locality or region requires several information, some of which are fundamental. Examples of this information are: (i) amount of waste produced in each location, production per capita; (ii) waste composition (and what this represents in terms of development); (iii) where and how the waste is disposed of and the availability of new areas; (iv) what are the environmental and social impacts that waste causes; (v) what are the opportunities that the (re) use of waste can make possible.

With these elements raised, it is possible to elaborate a Master Plan for waste management in order to make them an input for new technological processes. The Association is able to bring its associates closer to teaching and research institutions and city halls to jointly identify potentials for the exploitation of MSW in the production of biomethane or electric energy from anaerobic biodigestion of agricultural and urban (organic) waste, as well as thermal treatment of MSW (incineration, pyrolysis or gasification of waste that would go to landfills), with the objective of providing socioeconomic benefits to the population and the municipality.

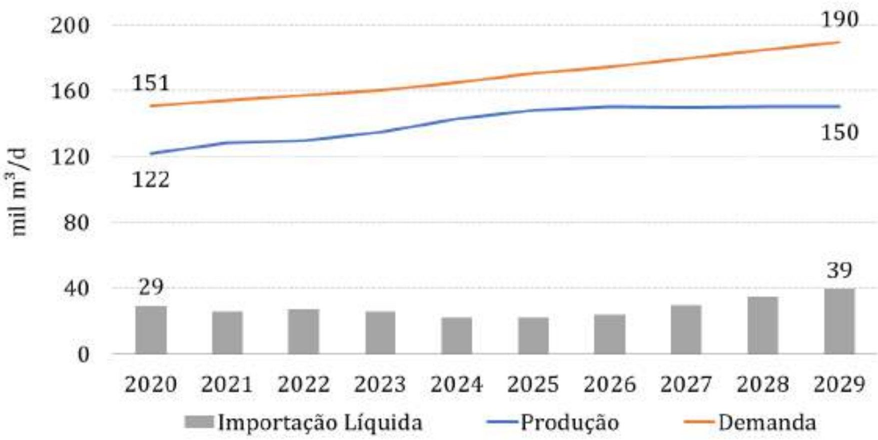
The main destination of MSW has been landfills, many of which are classified as "dumps". In the vast majority of situations, liquid and gaseous effluents are generated that are not treated and contaminate the air, soil, groundwater and rivers.

In cases where urban sanitation exists, it requires specific treatments and for periods greater than three times the operating time for receiving the MSW, a situation that demands the construction of new landfills and only transfers the problem for years to come without facing it.

The methane gas produced in the dumps, as shown, is 25 times more harmful than carbon dioxide in terms of GHG emissions, and its simple conversion and burning in the form of biogas represents an environmental benefit. In addition, the biological anaerobic biodigestion process used in the production of biogas (or biomethane) promotes a drastic reduction in the area used for landfills, with greater energy use and eliminating the risk of contamination of water resources and GHG emissions in the atmosphere. As for waste, which is post-recycling waste and is no longer subject to separation for anaerobic biodigestion processes, it must go to heat treatment plants, where there is 10x more energy efficiency when compared to the process of capturing landfill biogas for electricity generation or biomethane production.

In addition, the energy use of biodigestion also avoids the emission resulting from the burning of fossil fuel (diesel) used in the public transport and basic sanitation fleets, a fact that would represent a significant saving of financial resources, not only for the municipalities but also in the balance of payments. of the country, considering that Brazil will continue to import diesel oil throughout the ten-year horizon as mentioned in PDE 2029 (graph 1 below), despite the prospect of increasing the percentage of biodiesel blending.

Gráfico 3 - Balanço nacional de óleo diesel



3.4. Environmental Governance as an instrument of integrated and sustainable waste management

One of the main problems in the management of MSW is the deficiency in aspects of environmental governance and, consequently, in the Integrated Sustainable Waste Management (GSIR), which is an important tool for the investor to be successful in his project.

Governance aspects generally explain how a society participates and performs complex tasks in order to achieve a common objective, as occurs in the MSW management process, which includes multiple stakeholders and is closely connected to the daily life of the population. The strengthening of the governance aspects of waste management has been shown to be crucial, as its urban populations are extremely high and continue to grow, whose inadequate waste management has caused environmental and health problems. Observing the management of urban waste, from a governance perspective, provides transparency and solutions to solve problems about who is involved and who is responsible.[49]

Sustainable waste management is an integral part of a country's sustainable development and has become increasingly important in the formulation of a sustainable urban development agenda, with emphasis on the nations of Latin America and the Caribbean. Although notable efforts have been made to increase recycling rates, that is, in the recovery of materials from MSW, international experience shows that, after economically possible recycling, there remains a large fraction of waste that can be heat treated , that is, liable to recover its energy content, because, otherwise, there will be waste in terms of the energy-economic value of such residues and they will inevitably be sent to landfills..[50]

One of the instruments for the effectiveness of sustainable development is environmental governance, which includes the participation of the whole of society in decision-making when the topic involves the environment, which can occur through the State or civil society, in order to obtain broad and unrestricted adhesion to a project whose scope is the integrity of the environment on the planet. Governance has been the greatest challenge for the international community on environmental issues, which occurs only if nations cooperate jointly with the establishment of rules and institutions aimed at the common good, all with the primary objective of preventing the catastrophe of the planet. , through a coordinated and long-term effort, involving alliances of bold, innovative and flexible actors, at state and non-state levels, willing to obtain resources, knowledge and engage the active participation of all citizens.[51]

In this context of global governance, environmental sustainability and civil society participation, Integrated Sustainable Waste Management (GSIR), or Integrated Sustainable Waste Management (ISWM), emerges. It is a dynamic tool that includes several variable aspects inherent to the creation of public policies and institutional development, including also the technical design of integrated solutions for the handling and disposal of MSW. In this process, the participation of interested parties (stakeholders) is sought, encompassing the prevention of waste generation and the recovery of resources, which includes the interaction with other systems and promotes the integration of different spaces, such as the city, neighborhood and residence. In addition to the technical aspects, GSIR also recognizes political and social facts as having equal importance in the MSW management process.[52] GSIR examines (i) physical components, such as energy collection, disposal, recycling and recovery, as well as (ii) governance aspects, such as the inclusion of users and

[49] HETTIARACHCHI, Hiroshan, RYU, Sohyeon, *et. al.* Municipal Solid Waste Management in Latin America and the Caribbean: Issues and Potential Solutions from the Governance Perspective. Disponível em: http://collections.unu.edu/eserv/UNU:6506/recycling-03-00019-1.pdf>. 2018. Acesso em 21 fev. 2019.
[50] *Ibidem.*
[51] ESTY, Daniel C. IVANOVA, Maria H (Orgs.). Governança Ambiental Global. Opções & Oportunidades. Nota e prefácio. Tradução Assef Nagib Kfouri. São Paulo: Editora Senac, 2005, p. 7-17.
[52] *Cf.* THEMELIS, Nikolas J., BARRIGA, Maria Elena Diaz, ESTEVEZ, Paula, *Et al.* Guidebook for the Application of Waste to Energy Technologies in Latin America and The Caribean. 2013. Disponível em: < http://www.seas.columbia.edu/earth/wtert/pressreleases/Guidebook_WTE_v5_July25_2013.pdf>. Acesso em 04 mar. 2019.

service providers, financial sustainability, consistent and solid institutions supported by public policies proactive.[53]

4.1. STRATEGIES FOR THE DEVELOPMENT OF THE WASTE INDUSTRY IN BRAZIL

4.2. Brazilian overview of the technological routes of the WtE plants

The Waste-to-Energy (WTE) market is at its best in the country, given that the current government has put aside the ideologies and prejudices of previous governments and is actively working for Brazil to follow the best international practices of urban solid waste management (MSW). Brazil today produces 80 million tons / year of MSW, with only 2% being recycled and the rest deposited in landfills.

Brazil has several biogas capture plants in landfills for electricity or biomethane generation, but it does not have any large WTE mass burning plants in operation, which are the plants used on more than 90% of the occasions to treat mixed MSW, which in Brazil are classified as waste and go to landfills.

In the world, there are 2,450 WTE plants in operation, 1,072 in Japan (many small), 522 in the European Union, 339 in China, 20 in India, among other countries. They are considered sources of clean energy generation, cleaner than coal, biomass or fossils due to the modern filters with water, activated carbon and films that are installed.

In addition, WTE mass burning plants generate 650 kW to 1,000 kW per ton of MSW, while landfills with biogas capture generate only 65 kW per ton of MSW. Therefore, WTE plants are 10 to 13 times more efficient, which reduces the need for fossil thermoelectric generation.

FOX HAZTECH is the company that has been a pioneer in this segment when designing the Barueri plant, with 20 MW of installed power and the potential to treat up to 825 ton / day of MSW, using Chinese technology. It already holds all licenses, tariffs, energy sold on the market and financing, and is expected to start construction in March 2020.

The company Ciclus treats approximately 9,000 ton / day of MSW at the Seropédica landfill, Rio de Janeiro-RJ, and intends to build a WTE mass burning plant with 30 MW of installed power, to treat 1,200 ton / day of MSW, and may also build plants bigger and so many units. Ciclus already holds the Preliminary Environmental License and is about to obtain the Installation License in order to start the works.

---

[53] RODIC, Ljiljana, VELIS, Costas A. e WILSON, David C. Integrated Sustainable Waste Managemente in Developing Countries. 2012. Disponível em: <http://eprints.whiterose.ac.uk/78792/13/Wilson%20et%20al.1.pdf> Acesso em 04 mar. 2019.

The company Grupo Lara, which operates landfills and treats 20,000 ton / day of MSW, has a project to implement an 80 MW plant of installed capacity, to treat 4,000 ton / day of MSW, in the city of Mauá, São Paulo, for 45 km from the Capital of the State of São Paulo, and the project is on the verge of obtaining a prior environmental license. It will be a project with German technology and one of the largest plants in the world.

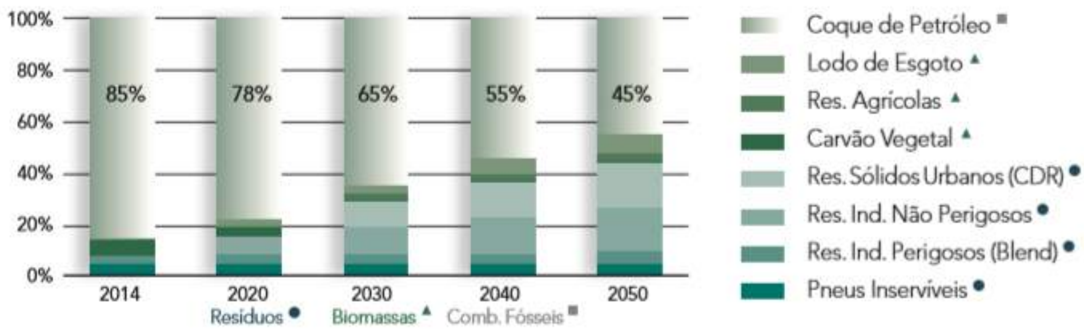
Brasília is also conducting studies to bid PPPs for 2 WTE mass burning plants of 30 MW of installed power each, and 2 other anaerobic biodigestion plants of 500 ton / day each, with a project that will make it a model city in Brazil in waste management and with the highest selective collection.

Brazil has several co-processing plants in operation that use Compound Derived from Waste (CDR), owned by the companies Votorantim Cimentos and Intercement, for example. According to 2017 data, Brazil has 38 co-processing plants in operation, which represents 70% of Brazil's production capacity.

According to the Road Map of the Cement Industry in Brazil, referring to GHG emissions, coprocessing is one of the most important tools and expects to reach, in 2035, the percentage of 35%, and in 2050, 55%. The cement industry would go from the current 1,000,000 ton / year CDR to another 4,000,000 ton / year in 2035, and around 7,500,000 ton / year in 2050. Most of this increase comes from important growth in the Biomass, CDRs of MSW and Class II Waste

.

Graphic 4 - Evolution of the use of alternative fuels in the “Scenario 2º C”[54]



For the treatment of separate organic MSW at the source and sewage sludge, we highlight the company CS Bio, located in Curitiba, Paraná, which has an anaerobic biodigestion plant that treats 200 ton / day of MSW and sewage sludge, generating 2.8 MW of installed power. The plant is in the final stages of entering into commercial operation and is already operating at 50% of its capacity.

[54] ROADMAP tecnológico do cimento: potencial de redução das emissões de carbono da indústria do cimento brasileira até 2050. Coordenado por Gonzalo Visedo e Marcelo Pecchio. Rio de Janeiro: SNIC, 2019.

Figura 06 – Anaerobic digestion plant of CS Bio, Curitiba-PR.

Brazil has approximately 10 smaller WTE plants, from 1 to 5 MW of installed capacity, with national and imported gasification and pyrolysis technologies to treat MSW and hazardous industrial waste, including national technologies being developed by WEG (gasifier) and ZEG (pyrolysis) for treating MSW and other waste.

Figure 07 – WEG gasification powe plant, 2.5 MW capacity. Mafra-SC.

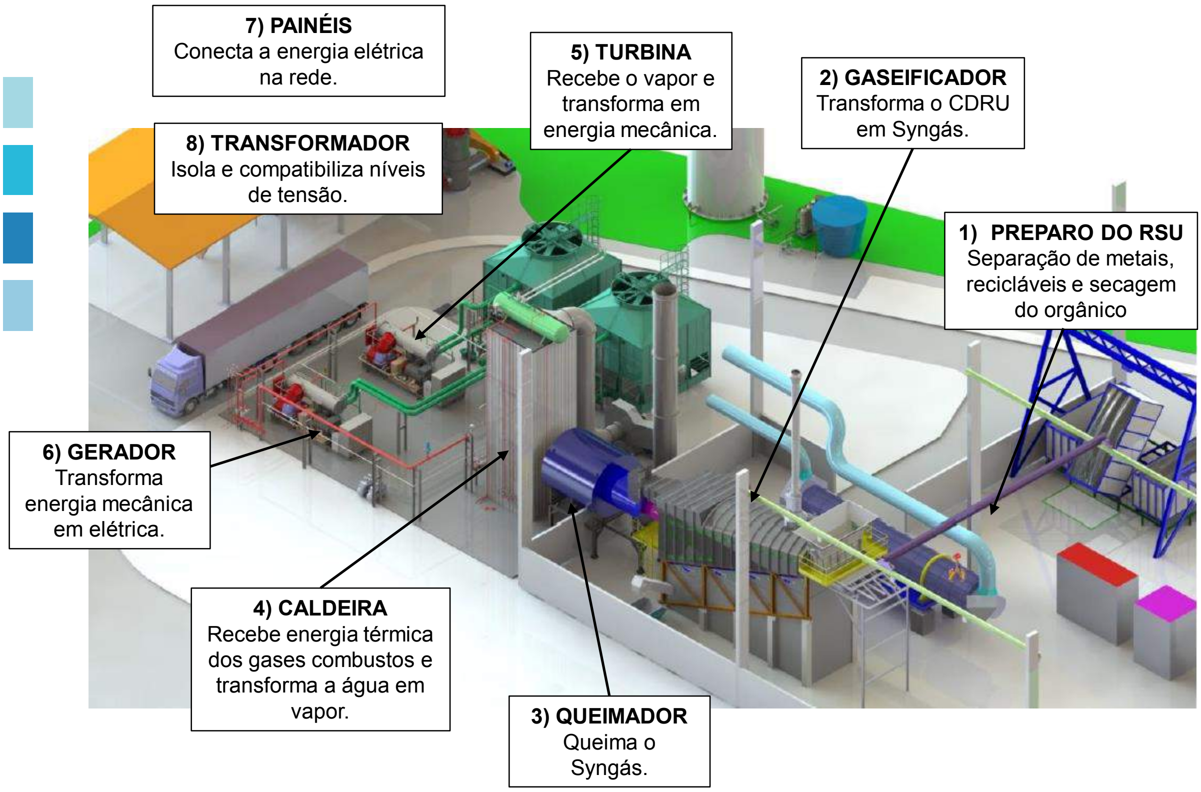


Figura 08 – Pyrolysis power plant (*flash dissociation*) of ZEG – Chile.

The country also has some pyrolysis to treat separate tires and plastic, with some projects having low profitability due to the poorly developed projects. However, there are thousands of tire and plastic pyrolysis plants in operation abroad, which have a very high profitability, with paybacks of 3 to 5 years, such as those developed by Pirólisis Latonoamérica and other renowned global brands.

Figure 09 - Pyrolysis 8 ton/d for fuels and *carbon black*. Pirólisis Lationoamérica.

In Brazil, there is also a compact industrial pyrolysis unit in operation since February 2015, where dozens of types of waste have already been tested: solid urban waste (MSW), health care waste (RSS), various industrial waste (RSI), sewage treatment plant sludge (ETE sludge), industrial sludge, biomass in general (coconut husk and fiber, wood chips, organics, leather scraps), scrap tires, electronic waste, among others.

The technology is 100% national and developed by RTB Holding Energia in a technical and commercial partnership with INDDRA Energia e Residuos. It involves slow pyrolysis in a rotating, humid and catalyzed drum, where 90% of synthesis gas is produced for the generation of electricity and / or steam and 10% biochar (biochar), intended for agriculture or the recovery of degraded soils.

In Figures 10 to 12 we can see images of the UTR2 reactor model, capable of treating 2 ton / day of waste.

Figure 10 – Overview of UTR2

Figure 11 –Side view of the reactor .

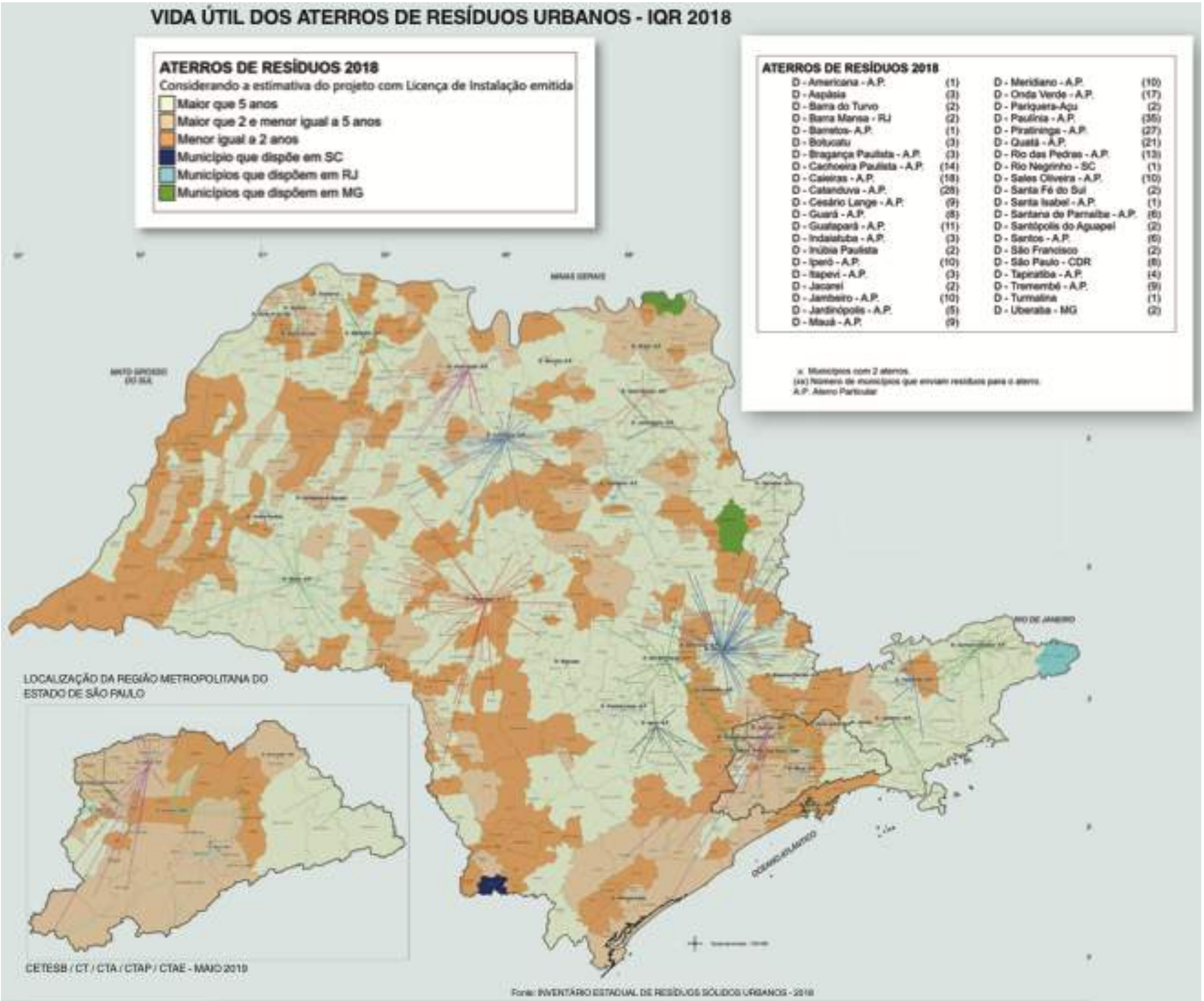
Figura 12 – Side view of the filtration system

As stated, Brazil has the potential to meet 1.5% of national demand from anaerobic biodigestion of MSW, and 5.4% of national demand from mass burning plants (106 units, 3.1 GW of installed power) and 236,520 GWh), totaling 6.9% of national demand or 3.9 GW of installed power. The following EPE graph [1] presents such data:

It is estimated that in 3 to 5 years the majority of landfills in the states of Rio de Janeiro and São Paulo will be depleted and these states will start to have high expenses to transport the garbage for great distances due to the lack of space to build new landfills, especially considering that the Federal

Supreme Court recently banned the construction of landfills in areas of environmental preservation.[55]

Figure 13 – Life range of MSW landfills in the State of São Paulo (2018)



4.2. Difficulties developing WtE power plants

A relevant issue to be debated also refers to the untruths that are propagated in the media regarding incineration, even reaching pyrolysis and gasification. Uninformed people, often manipulated by vested ideological interests, have spread lies to hinder the environmental licensing of WTE plants in Brazil for decades. Due to the lack of regulation of thermal treatment plants - which only happened in 2019, through Interministerial Ordinance No. 274/2019 - malicious groups and social movements made it difficult to implement projects in Brazil, influencing the Public Ministry,

[55] STF. ADI 4903. Rel. Min. Luiz Fux. Julgado em 28/02/2018. Disponível em: <http://portal.stf.jus.br/processos/detalhe.asp?incidente=4355144>. Acesso em 17 dez. 2019.

the Judiciary, Brazilian Bar Association, among other public and private institutions. They are groups that understand that incinerators pollute the environment, are financially unviable and will end the environment.

All of these issues are refuted with vast literature in the book by ABREN's Executive President, Yuri Schmitke, “Waste-to-Energy: Energy Recovery as an Environmentally Appropriate Way to Dispose of Solid Urban Waste”, especially with regard to the works published on the Movement's website National Waste Pickers (MNCR), drawing on vast literature researched in more than 40 countries and empirical assumptions.

In short, WTE plants are considered clean energy sources, being the most effective way to reduce greenhouse gases caused by MSW methane emissions, and to protect water resources by leachate and leachate contamination, which guarantees more water. drinking water available on the planet. There is also no conflict between recycling and incineration, since the separation of recycled materials is previously accomplished in homes and in transshipment plants (with the work of waste pickers' cooperatives), and the MSW that go to incineration are those that otherwise. would be destined for landfills. There is also no economic unfeasibility or problems regarding the calorific value, since there are now 2,430 WTE plants in operation, with China, whose MSW has the same calorific value as the Brazilian, due to the presence of 50% organic, today incinerating 40% of its MSW, generating 7.3 GW of electricity, enough to meet 7.5% of Brazilian electricity demand.

Currently, there is a very favorable scenario, due to (i) the current Government being fully favorable to the heat treatment of MSW, (ii) the union and social movements that lost strength due to the financial resources being scarce (extinction of the mandatory union contribution), and (iii) there are projects at an advanced stage that have already obtained environmental licensing, such as the FOXX Consortium (URE Barueri), which already has an installation license and overcame all social, environmental and legal barriers to make the mass burning incineration project feasible.

4.3. Strategical proposals to implement WtE plants

There are several challenges for Brazil to achieve high levels of sustainability in the management of MSW. The biggest of these is related to the sale of the energy that will be generated, as it is the largest revenue of this enterprise. ABREN has been working with proposals so that investors in WTE plants can obtain long-term power sale contracts (Power Purchase Agreement - PPA), either in the free, regulated market, or through Public Calls to be promoted by electricity concessionaires. electricity distribution, with the goal of allowing the use of Project Finance to make it possible to obtain resources in advance for the construction of the plant.

Another relevant issue is the remuneration for the environmentally adequate destination service of MSW, which occurs through a fee or tipping fee, necessary to complement the revenue of a WTE plant. ABREN defends the extinction of the Public Cleaning Fee (TLP), currently charged together with the IPTU, with the creation of a tariff (public price), charged on the water bill. This defense is legitimate and has a legal provision in art. 29, of Law No. 11,445 / 2007. ABREN made a contribution to the new legal framework for Sanitation (Bill No. 3,261 / 2019), having submitted this proposal to Deputy Rapporteur Geninho Zulliani. The project was approved in December 2019, with the possibility of funding the public service for treating MSW in the consumption account (water or electricity). With this tariff structure, it is possible to offer guarantees to financial agents to obtain funds for financing WTE plants.

Another relevant issue is that the Federal Government portfolios can establish inter-ministerial working groups. Recently, energy recovery was qualified by the Investment Partnership Program (PPI), through Decree No. 10,117, of 11/19/2019. This Decree provides for the creation of an Interministerial Committee, with two representatives from the Civil House (PPI), two from the Ministry of the Environment (Secretariat of Environmental Quality) and two from the Ministry of Regional Development (National Secretariat of Sanitation). However, the main portfolio, in our view, is the Ministry of Mines and Energy, and this was not covered by express participation and the right to vote. ABREN is working to include the MME representation to vote on decisions that will qualify WTE plants in the PPI, and thus improve the discussion of the participation of energy from WTE technologies in the country's energy matrix.

At the request of the Subnational Infrastructure Planning Secretariat, of the Ministry of Economy, and in partnership with the UN / UNDP, FGV, BNDES, MDR, MME, among other portfolios, ABREN is carrying out a joint work to present, among other issues, the modeling economic and financial analysis of the various technologies of WTE plants, with the objective of assisting the Ministry in planning subnational infrastructure and several other entities in planning the management of MSW.

ABREN also argues that the Ministry of Agriculture, Livestock and Supply (MAPA) can create incentives for ranchers to implement biodigesters. Some pig farmers even get up to 40% of their revenue from the biodigestion of swine waste, and the southern region of Brazil has enormous potential. The UN / UNIDO, verifying this scenario, has developed an excellent program with resources from GEF and other development institutions, entitled “Applications of Biogas in Brazilian Agroindustry (GEF Biogas Project)”. With the new gas market that has been projected with the pre-salt natural gas and the construction of gas pipelines, biomethane will be able to be sold at very competitive prices and make many enterprises of poultry, pork and cattle producers (intensive farming) viable.

Efforts are also needed so that the population can become aware of the importance of the reduction, reuse, recycling, composting and energy recovery of solid waste, aiming to show the population that waste has a high added economic value. It is also relevant to promote more courses, publications and courses at universities, in view of the lack of academic knowledge about WTE in Brazil. ABREN has made efforts so that the MEC can create a theoretical and practical program of environmental education focused on sustainable practices in waste management for elementary and high school, as well as developing academic training and qualification for theoretical and practical content, this with partnerships and agreements for the development of Research and Development (R&D) projects.

From the analysis of the world panorama (12 countries and the European Union) and Brazil, under the statistical, conceptual, technical, regulatory, political and environmental aspects, and using the Regulatory Impact Analysis (AIR) - a modern tool that analyzes and assesses the assumptions for the normative-regulatory construction -, and the model of environmental governance called Integrated Sustainable Waste Management (GSIR), the author made the comparison between a landfill and a WTE (mass burning) plant, using analysis of quantitative and qualitative cost and benefit, with the result that a WTE plant has more than 50% of economic and environmental attributes than a landfill.

As a result of the empirical analysis carried out, Yuri Schmitke developed proposals for adjustments to the National Solid Waste Policy (PNRS), as well as several other regulatory solutions for the development of the WTE industry in Brazil, evaluating the regulatory frameworks of the waste, electricity and biofuels, with a view to presenting some designs that can be followed for the public policy maker, at all levels.

4.4. Strategies for recycling and reversal logistics

One of the greatest difficulties in increasing recycling rates is found in the absence of the use of industrial machinery, processing and commercialization centers, absence of subsidies and tax exemptions and charges. ABREN intends to encourage the use of mechanical separation equipment, using sorts with optical sensors, pneumatic, mechanical, gravimetric instruments and magnets to separate the types of recycled materials, by size, type and color. It also intends to foster the creation of recycling and processing centers for recyclables, so that they can reach market values and be sold more easily. The combination of recycling and biodigestion has been one of the most successful strategies abroad, through Biological Mechanical Treatment (TMB) plants. To achieve these goals, efforts will be made to create legislation and regulations that can institute subsidies and exemption from taxes and charges.

With regard to reverse logistics, ABREN intends to work with the certification of companies that are adhering to the Reverse Logistics Sector Agreements, as well as encouraging the adoption of interactive technologies that encourage citizens to contribute to the return of waste to their respective manufacturers. A successful example is the use of totems or machines that receive waste in exchange for some benefit, which can be financial or even through a chocolate. They are reward mechanisms that have high added value in them to raise awareness and create a habit among the population about the need for proper disposal of certain wastes, such as batteries, pet bottles, disposables, etc.

ABREN understands that recycling and reverse logistics are in the same context as energy recovery from waste, given that returning such waste to the production chain saves a significant amount of energy that would otherwise be necessary to produce such products, not to mention with the environmental benefits inherent in the economy of inputs that would be necessary for its production. Keeping recyclable products in the production chain is adhering to the concept of circular economy, being an irreversible global trend that has great potential in strengthening the corporate image through sustainability.

As for the socio-environmental issues of recycling, ABREN believes that specific programs should be created for the reintegration of waste pickers into other productive activities, and as an alternative, the incentive for the co-participation of waste pickers' cooperatives in undertakings of Biological Mechanical Treatment (TMB), through agreements or municipal partnerships, but always in a sustainable way to guarantee the economic and financial viability of such enterprises.

5. THE CONTEXT AND UNDERSTANDING OF THE ASSOCIATION

5.1. Identifying partners and potential associates

In view of the wide scope of the Solid Waste theme and its energy recovery, there is the potential involvement of agents who work in various sectors of the economy, both in terms of public services granted, as well as industries producing consumer goods and services, as well as for companies and enterprises of basic sanitation, electric energy and of treatment and final destination of wastes of various kinds.

Therefore, potential associates will be divided into the following categories:

1) Basic sanitation companies focused on the treatment of water, sewage and solid urban waste in general;
2) Companies providing public and private services for the collection and final destination of solid waste;
3) Cement industry that uses coprocessing technology;
4) Agricultural and livestock production companies and cooperatives;
5) Contractors and suppliers of engineering and assembly services (EPC);
6) Manufacturers and suppliers of equipment and components for solid waste treatment systems;
7) Banks and Investment Funds specialized in financing infrastructure projects, mainly energy and sanitation;
8) Electricity Generation and Distribution Concessionaires;
9) Electricity trading companies;
10) Large consumers of electrical and thermal energy;
11) Waste generating industries in the area of food and consumer goods production;
12) Process industries (chemical, petrochemical, steel, mining, paper, cellulose, etc.);
13) Engineering, consulting, project and business development companies;
14) Recycling and reverse logistics companies;

5.2. Macroenvironment

The macroenvironment is considered to be variables external to the Association, but which can directly influence its functioning and performance. For a better understanding of each of the variables, they are divided into the following sub-chapters.

5.2.1. Demographic environment

The demographic environment takes into account the population structure (age, population variation, etc.), in addition to migratory movements. Population evolution tends to follow the same metric, directly linked to the country's level of development. As the country develops, the population improves its per capita income and its level of education, which tends to lead to reduced growth and the aging of its structural pyramid.

One of the biggest problems of the aging population is related to social security, since a greater number of pensioners has an income guaranteed by the economically active population. The problem begins to arise when the economically active portion is no longer able to afford these costs and maintain their consumption pattern, bringing negative impacts to the economy.

In Brazil, despite the fact that we are beginning to face this problem, the availability of mass credit guaranteed not only maintenance but also an increase in purchasing power (increased consumption), but this model is heading towards exhaustion. Despite the signs of exhaustion, the perceived decrease is in the growth of consumption, and not in consumption itself. In other words, consumption grows less, but it still grows. Most likely, consumption has managed to maintain its growth thanks to the population migration from the countryside to the cities, which despite having decreased, is still present in Brazil.

Thus, with regard to the demographic environment, not only do we have the confirmation of excessive demand, but it is also correct to say that in the coming years it will continue to grow, demanding more and more the production of solid waste in cities and fields.

5.2.2. Economical Environment

The economic environment brings the impacts of consumer income availability, which in turn directly affects the generation of waste and the demand for MSW transshipment services, since Brazil is in need of transformation technologies, thus having a market virtually untapped with cutting edge technologies.

According to the International Monetary Fund (IMF) World Economic Outlook (WEO), database of April 2019, Brazil is today the 9th largest economy in the world in Gross Domestic Product (GDP), with U $ 1.7 trillion in 2019, considering all countries, and the third largest economy in GDP among developing countries.[56] Brazil is the world's second largest corn exporter (25%), the world's

[56] MGM Research. Workd GDP Ranking 2019. Disponível em: >https://mgmresearch.com/world-gdp-ranking-2019/>. Aesso em 22 dez. 2019.

second largest soy producer, and the world's largest exporter (56%), and the world's third largest agricultural exporter.[57] Brazil has the largest cattle herd in the world, the second largest chicken producer and the third largest pig producer in the world [58], which represents a great potential for the production of biofuels from agricultural and animal waste.

Despite also showing a decrease in growth, consumption has still increased in Brazil, and only in 2015 did it actually show a stagnation. The projections for the coming years are optimistic and analyzed in per capita parameters, which tend to remain stable with a great tendency for growth. In addition, Brazil is supported and fulfills all conditions to join as an OECD member country, which will represent greater security for investments due to the adoption of the various governance and compliance requirements required, many of which have already been implemented.

Especially due to the reasons presented above, the economic environment does not present great risks to ABREN, especially because, since the worst scenario is consolidated, and we really face the stagnation of consumption, the volume of existing waste already justifies the entry into the market. cutting-edge technologies.

5.2.3. Sociocultural environment

Developed countries have a tendency to raise population awareness regarding the need for better management of non-renewable resources, and the capacity of the environment to absorb the volume of waste generated. However, developing countries have had the opportunity to consume a variety of products previously unavailable. Economic groups such as the BRICS (Brazil, Russia, India, China and South Africa) today represent one of the greatest opportunities for market growth.

For these reasons, the same awareness of these populations is not expected in the same way that is presented by more developed countries. The consumer must then remain in growth around the globe, but concentrated especially in emerging economies, such as Brazil.

5.2.4. Technological environment

New technologies have appeared more frequently than before in the form of new solutions to everyday problems. The growing concern with the environment, and the actions that try to promote this concept, have directed a large volume of investment capital to several sectors, including waste management. As a consequence, we see not only the development of more and more efficient solutions, but also a greater capacity for acceptance of the new by society. There are still occasional resistances to new technologies and new paradigms in the way companies operate, but these resistances have not presented great risks.

[57] MAPA. Relatórios 2019. Disponível em: <http://www.agricultura.gov.br/ouvidoria/relatorios>. Acesso em 22 dez. 2019.

[58] Abiec, Brazilian Beef e Apex Brasil. Perfil de Pecuária no Brasil. Relatório Anual 2018. Disponível em: < http://www.abiec.com.br/Sumario2019.aspx>. Acesso em 22 dez. 2019.

It is noted, however, that the risks of increased costs and decreased revenue generation in large economies, assuming a technological risk aspect. This situation is false, but it has been shown as a desperate attempt to “maintain the business model”. The positive side of this situation is that investments directed to studies and research have brought down each of these attempts, further guaranteeing their acceptance.

In this sense, ABREN's role is to foster all technologies, seeking for each project to align the best it has in the market for the use of solid waste energy. In the face of this evolving scenario, the support and management of R&D resources is also part of ABREN's business, further encouraging the emergence of new technologies and new businesses.

5.2.5. Political regularoty environment

Brazil is a democratic country by law, with a separation between the Legislative, Executive and Judiciary branches, and an independent Public Prosecutor's Office, which is responsible, among other prerogatives, for authoring public criminal actions and defending the environment. Brazil has solid institutions that work in harmony, with legitimate courts and that operate reasonably, ensuring compliance with laws and contracts.

Brazil has all the requirements to be a good place for investments: it has independent regulatory agencies; Bankruptcy and Judicial Recovery Law (Law No. 11,101 / 2005); Antitrust Law (Law 8,137 / 1990, amended by Law 12,529 / 2011), which includes an independent Antitrust Administrative Council that acts on issues of abuse of market power; Fiscal Responsibility Law that obliges the Union of States, States and Municipalities (Complementary Law No. 101/2000); and a Stock Exchange - B3 - stable and with good solidity and corporate governance ratios, being considered the fifth largest in the world.

Brazil has development banks, such as the BNDES, considered one of the largest development banks in the world and which has special lines of credit for sanitation and waste projects, and a market for the issuance of encouraged debentures (Law No. 12,431 / 2011) for infrastructure without incidence of Income Tax.

The Federal Court of Accounts (TCU) also stands out, an independent Court of Accounts that exercises, among other powers, monitoring the country's budgetary and financial execution and exercising the accounting, financial, budgetary, operational and patrimonial inspection of the bodies and entities public authorities in terms of legality, legitimacy and economy, including vis-à-vis regulatory agencies.

Brazil has faced a political and economic crisis since 2015, which has caused the loss of confidence in the Federal Government and the investment grade. Corruption cases have been reported almost weekly in recent years. However, another analysis shows that the country was able to undertake the largest anti-corruption operation in world history, Operation Lava Jato, with 201 arrest warrants issued, R $ 2.4 billion of goods blocked or seized, R $ 745 million. returnees and R $ 12.5 billion of amounts analyzed in investigated financial transactions. The operation also has the mark of 2,252 years in sentences for 159 defendants, which represents 11% of its 426 defendants, having also kept former President of the Republic Luiz Inácio Lula da Silva imprisoned for 580 days. This demonstrates that the control bodies work, which has the potential to rule out new crimes of corruption in Brazil according to the perception of non-impunity.

The waste disposal sector has been used around the world as the main source of income for criminal organizations, especially in the United States and Italy. In Brazil, there are some cases like these, which increases the risk variables for the development of MSW-related projects. However, it is clear that Brazil has advanced a lot in the fight against corruption, and it is relevant to highlight that ABREN maintains its philosophy of transparency, compliance, unblemished ethical conduct, seeking to join efforts to reduce this image in Brazil.

5.3. Microenvironment

Making a counterpoint to the previous chapter, the microenvironment takes into account the internal and inherent variables of the association. They are the agents that are close to the association, and that very commonly impact their competitive and growth capacity. Despite being recent, ABREN has already established itself as a unique association in the defense of its competences, especially with regard to the energy recovery of solid waste, especially considering that some of the associations that today defend the thermal treatment of waste did not have a prominent role in the past in that sense. The proposals that ABREN offers have been exclusive to this market segment that intends to attract many investments in the coming years.

6. BUSINESS CONCEPTION

6.1. Association's Definition

The Brazilian Association of Energetic Waste Recovery (ABREN) was created in 2019 with the aim of promoting mechanized recycling, reverse logistics and Waste-to-Energy (WTE) or Solid Waste Energy Recovery technologies in Brazil. WTE technologies can simultaneously solve two major problems in Brazil and in the world: the destination of solid waste and the generation of clean energy.

With WTE technologies, the problem of Urban Solid Waste produced in increasingly monumental quantities would have a clean and self-sustainable solution. With the WTE technologies implemented in Brazil - as has been done for more than half a century in the rest of the developed and emerging world - damage to the environment, biodiversity and public health would have a solution: that of Energy Recovery from of that waste.

For WTE technologies, resources deemed useless are in fact valuable and can be used to produce clean and renewable energy. WTE technologies should be applied only after selecting recyclable and usable waste in the Circular Economy.

6.2. Organization's purpose

Encourage the development of projects and implementation of projects that seek to maximize the reuse of solid urban, industrial, hospital and agricultural waste, focusing on the generation of electric, thermal, biogas, biomethane, composed of waste derivatives, hydrogen, biofertilizers, pyrolysis fuels, among other inputs, minimizing the environmental impact caused by landfills, sanitary landfills, industries, hospitals and ranchers. To this end, ABREN will be acting, directly, indirectly, or jointly, with public and private entities to study and present solutions with effective and assertive public policies.

6.3. Goals

For a good representation of the association's objectives, 7 strategic objectives were mapped:

6.3.1. Represent associated companies

Representing associated companies that are authorized to carry out energy recovery of waste, recycling companies, composting, reverse logistics, equipment manufacturers, according to their individual or collective demands regarding contact with national and international organizations, bodies and public authorities, autarchies, public companies, mixed-capital companies, agencies or the like, federal, state and municipal, directly or indirectly affected by the waste energy recovery sector.

6.3.2. Monitoring the Processing of Proposals

Monitor the processing of proposals, bills and provisional measures of interest to members in the National Congress, state legislative assemblies, Legislative Chamber of the Federal District, and municipal legislative chambers.

6.3.3. Promoting and closing partnerships

Promote and sign partnerships, consortia, cooperatives, intergovernmental working groups, covenants, contracts and receive donations from the most diverse types of companies, organizations and institutions, both public and private that are in line with the purposes and values of ABREN and its associates.

6.3.4. Certificating Companies correctly

Recognize and certify companies and undertakings that perform energy recovery from waste, composting, recycling, reverse logistics, electric energy distribution concessionaires and permissionaires who purchase electricity from waste energy generation, industry, commerce and public agencies that allocate waste to energy recovery, recycling and composting projects, among others. Certification will be a differential for such associated companies, as the corporate image will be aligned with the purposes of the Circular Economy, energy recovery from waste, protection of the environment and sustainable development.

6.3.5. Proposing Legal and Regulatory Solutions

Propose legal and regulatory solutions to technically and financially enable projects of interest to the waste energy recovery sector, in line with the values of the association, through contributions, proposals, defenses, oral arguments, participation in public consultations, public hearings and events in general whose purpose is to discuss public policies related to the competences of the Association.

6.3.6. Promoting training courses

Promote training and disseminate knowledge about energy recovery from waste, through the most diverse means of communication and periodic events, such as workshops, seminars and conferences that bring visibility, as well as partnerships with educational institutions and organizations. ABREN understands that convincing society is essential for the implementation of good practices in waste management, being a priority for ABREN to have good communication and press advisory to achieve these objectives.

6.3.7. Promoting, executing and managing studies and projects

Promote, carry out and manage Research & Development (R&D) studies and projects for waste energy recovery, recycling, reverse logistics, composting, hybrid generation, automation and other disruptive technologies within the scope of ANEEL, MCTIC, University, and other research institutions. research, as well as promoting the dissemination of technical and scientific knowledge in the academic, political and community spheres.

6.4. Vision

Based on the strategic objectives, the Association intends to be recognized nationally and internationally as a reference in the defense, induction and catalytic tool for the process of implementing Waste-to-Energy energy recovery technologies in Brazil, acting strongly in the defense of its members. and effective participation in public sector policies.

6.5. Mission

Our mission is to promote synergy between the public and private sectors, whether regulatory or technical, through agreements, events, participation in public hearings and consultations, construction of regulations, seeking income generation, jobs and sustainability for Brazil with clean and renewable energy generation.

6.6. Values

ABREN's values are to develop its activities with ethics, respect, responsibility and integrity, through strategic joint action with its associates, always seeking a working environment conducive to the development and professional training with excellence.

7. OPERATIONS DIMENSIONING

7.1. Physical Structure

ABREN is headquartered in Brasilia, capital of the Republic and center of the country's decisions. Currently it is located in one of the most prominent and important commercial centers in Brasilia, the Centro Empresarial Brasil 21 Building, next to the TV Tower, located less than 04 km, in a straight line, from the symbolic Praça dos Três Poderes. In this office, all the administrative activities of the Association are concentrated, being the Presidency, Boards and support team. Other provisional support units may be created throughout the national territory, depending on the demand for work and strategic projects.

By the end of 2020, a new space is being considered for ABREN and its associates: commercial room, of the type of institutional representation office, containing spaces for the Association's routine, including meeting room and image projection (TV), and private room for members to use when in Brasilia.

7.2. Organizational Structure

Here are defined the organization charts of the association, from its initial phase, going through a growth stage and reaching its point of full operation.

The highest instance of the association is the Deliberative Council, which results from the nomination and voting of the associates or initially indicated and appointed by the Executive Board. The Deliberative Council is a body of elected members that jointly oversees the activities of the Association, deliberating and voting on the main issues of the Association.

The responsibilities and powers of the Deliberative Council are detailed in the Association's Bylaws, which define the number of members, as well as the way in which they must be chosen, and the duration of their mandates.

7.2.1. Deliberative Council

ABREN will be composed of a Deliberative Council composed of 11 Directors, one of whom will be the Chairman of the Board. Initially, the Directors will be chosen by the Executive Board, to serve a term of 02 (two years), reelection being permitted, according to the transitional rule of the Bylaws. In a second step, the Counselors will be voted by the members in a General Meeting called for this purpose.

7.2.2. Executive Board

The Board of Directors will be elected by the board, at an Ordinary Meeting convened for this purpose, to hold office for a period of 02 (two years), and may be reappointed for an equal period, subject to a limited number of reappointments, provided that the Director's essentiality is duly justified. for the purposes of the association.

The Director's role is much more external to the association. It must always be turned to the outside world, following the performance of the Association and the business of its members in the market. Obviously, some directors will be more focused on what happens in the external environment all the time, but everyone must be following the trends in their area, points of risk and also opportunities.

To carry out his work, the director can and must have a support area, since his time is almost all directed to activities that demand his physical presence.

The importance and the volume of work in each area described here justify the presence of a Director for it. These Directors will have the entire team below them as support, but strategic and even tactical decisions are under their tutelage. The powers of the Director are limited to the powers of the ABREN Statute, and according to the goals and objectives outlined in the Strategic Planning of the Association and to the directives and guidelines issued by the Executive President, who relies on the summaries and analyzes of each area as information for taking decision.

7.2.3. President

Directly below the Deliberative Council, the Executive President is responsible for the conduct and the administrative, economic and financial performance of the Association, in accordance with the established goals and guidelines.

It is the main executive function of the Association. Its responsibilities include resolving and making strategic decisions, managing resources and general operations and acting as the central point of communication between the Board and the Deliberative Council.

It is responsible for determining the strategic direction of the Association and ensuring that the objectives are implemented through functional steps. In addition, its mission is to take the lead in creating the organizational culture.

The president has the final say in all decisions, in accordance with the general guidelines of the Deliberative Council, and acts as an aggregator among all boards.

7.2.3.1. Vice-Presidente

The Executive Vice President has the responsibility to support the Executive President in his duties, complementing his activities according to the demands of the work, as well as replacing him at external national and international events to represent the Association and defend the interests of members.

7.2.3.2. Institutional Director

The Institutional Director is responsible for creating and supporting projects that strengthen the institutional image, verify and guarantee the ethical performance of the Association, and monitor with the Federal, State and Municipal bodies the handling of matters of interest to the Association. Monitor the provision of information to government agencies. Coordinate the Strategic Planning activities of the Association and Government Relations with the National Congress, state legislative assemblies, the Federal District and city councils.

The Institutional Director is also responsible for the Association's internal and external communication, information management, institutional image and the Association's communication strategy. It is who organizes and monitors ABREN's participation in events, congresses and seminars, both internal and external, and promotes relations with external individuals, coordinating the Association's dissemination activities. Responsible for the relationship with advertising agencies and the press (television, radio, internet and newspaper), thus implementing actions in the areas of advertising, events, sponsorships, public relations and the press with regard to the topics of interest to the company. Association.

ABREN understands that the communication has great relevance for the development of the waste energy recovery market, in the sense of clarifying society about the benefits of WTE plants, clarifying misconceptions, with the objective of obtaining social and governmental support for the projects of the associated.

7.2.3.3. Technical Director

The Technical Director is responsible for conducting matters related to scientific and technological issues. He is ultimately responsible for technology policy and related matters, such as Research and Development (R&D). It must develop and put into practice the objectives of the Association in the technological area. The technical director must have the vision of the Association and the knowledge of the goals to align the technology with its objectives.

7.2.3.4. Support Team

ABREN will have a support team for the Executive Board, aiming that it can carry out its activities, and the positions may be cumulated, created or extinguished according to the financial possibilities and needs of the Association.

As an advisor to the board, he will have the competence to provide administrative and management support to the Executive President, in addition to complementing and developing his work, which guarantees his direct or indirect participation in the decision-making made at the Association, as well as in the administrative management of the Office and other Association activities.

The position of executive secretary will be responsible for controlling the following activities: the Association's agenda, travel planning, shipping and conference documents, organizing files, receiving customers, supporting event planning, supporting member services, monitoring and preparation of meetings and external services.

8. ECONOMICAL – FINANCIAL FEASIBILITY ANALYSIS

The Economic Financial Viability analysis is the mathematical demonstration that all the resources and efforts invested in it will result in financial resources of a greater order. For the Association to be financially viable, its income generation must then be sufficient to compensate its direct operating costs, expenses and direct and indirect expenses, maintaining a financial balance between revenues and expenses.

The Association's viability is also achieved only when its investment need is within the capacity of the members' contribution, added to its credit capacity. The business model, especially the analysis of economic and financial feasibility, here takes on yet another responsibility, to prove to external associates its ability to pay.

ABREN is a non-profit association, but, however, it must provide sufficient cash flow to honor its commitments, both with Directors, employees, outsourced consultants, as necessary for the sustainability of its coordinated projects.

Bearing in mind that ABREN will have as its main revenue resources from the association fee, paid by its members, a financial model was developed to prove its viability, in which revenues from each class of members are simulated. The table of values of members was set up based on the collection of fees charged by other associations or institutions with similar or converging purposes.

Considering that the objective of the association is non-profit, and that the income of its members must be sufficient for the fulfillment of obligations, a financial study was therefore started for the basic expenses of the association and, subsequently, a mix simulation of associates for the faithful fulfillment of obligations.

As pointed out, the analyzes presented in the previous chapter are carried out within the so-called "Competence Regime", that is, it analyzes the economic performance of an institution only from the operational aspect. In order to be sure of the company's financial viability, an analysis known as "Cash Regime" must be carried out.

This analysis considers the movement of financial resources within the institution, as well as the financial flow between the institution and its associates. The association's Free Cash Flow was also developed and projected, ie, the cross between its financial need and its potential to generate revenue.

The association's capital structure has a great impact on this analysis, since this structure will point out the Association's options regarding the availability of the necessary monetary resources to finance its operations.

In this specific case, the revenues from the businesses are practically related to the monthly fees of the associates and a small portion coming from consultancy and management of R&D projects, which are not considered at first due to the uncertainties involved at this time.

ABREN's Institutional Plan considers analyzes for the next 5 years, starting from its foundation in 2019, that is, the period from 2019 to 2024, according to the premises, expenses, investments and considerations established in the following spreadsheets:

Premissas	2.019	2.020	2.021	2.022	2.023	2.024
Inflação IPCA (Boletim Focus)	3,30%	3,60%	3,75%	3,50%	3,50%	3,50%
Câmbio (R$/US$ - final ano)	4,00	4,00	4,00	4,00	4,00	4,00
Juros (Taxa Selic-Bacen)	4,50%	4,25%	6,00%	6,00%	6,00%	6,00%
Encargos sobre folha de pagamento	110,00%	110,00%	110,00%	110,00%	110,00%	110,00%

Premissas de Receitas						
Crescimentos de Associados (por classe)*	Base	100,00%	20,00%	20,00%	20,00%	20,00%
Premissas de Despesas						
Crescimento das Desp. Pessoal = (Inflação IPCA+15%)	3,80%	4,14%	4,31%	4,03%	4,03%	4,03%
Crescimento das Outras Desp. Operacionais = (Inflação IPCA)	3,30%	3,60%	3,75%	3,50%	3,50%	3,50%

* quando o numero for decimal, arredonda-se para o valor interiro imediatamente acima

Investimentos Iniciais			
Descrição	**Qtdd/mês**	**Custo Unitário**	**Custo Total**
Mesa reunião	1	R$ 2.200,00	R$ 2.200,00
mesa de trabalho	6	R$ 900,00	R$ 5.400,00
Cadeiras reunião	10	R$ 600,00	R$ 6.000,00
Cadeira Executiva	6	R$ 900,00	R$ 5.400,00
Armarios escritorio	3	R$ 800,00	R$ 2.400,00
Material de Escritorio	1	R$ 500,00	R$ 500,00
TV 60	1	R$ 3.000,00	R$ 3.000,00
Painel TV	1	R$ 800,00	R$ 800,00
Projetos	1	R$ 5.000,00	R$ 5.000,00
TOTAL			**R$ 30.700,00**

Custos Fixos			
Descrição	**Qtdd/mês**	**Custo Unitário**	**Custo Total**
Aluguel	1	R$ 3.400,00	R$ 3.400,00
Condominio	1	R$ 1.600,00	R$ 1.600,00
Energia	1	R$ 200,00	R$ 200,00
IPTU	1	R$ 800,00	R$ 800,00
Telefone/internet	1	R$ 200,00	R$ 200,00
Passagens Aereas	1	R$ 5.000,00	R$ 5.000,00
Diarias e hospedagens	1	R$ 800,00	R$ 800,00
Material de Consumo	1	R$ 200,00	R$ 200,00
Serviços de Terceiros	1	R$ 1.000,00	R$ 1.000,00
Despesas bancarias	1	R$ 70,00	R$ 70,00
Manutenção	1	R$ 500,00	R$ 500,00
Seguros	1	R$ 100,00	R$ 100,00
Contabilidade	1	R$ 500,00	R$ 500,00
Marketing / Propaganda	1	R$ 2.500,00	R$ 2.500,00
outros	1	R$ 500,00	R$ 500,00
TOTAL MENSAL			**R$ 17.370,00**
TOTAL ANUAL			**R$ 208.440,00**

Folha de Pagamento				
Função	Qtdd	Salário Bruto	Encargos	Custo Total
Conselheiros*	11	R$ -	R$ -	R$ -
Presidente Executivo*	1	R$ 22.000,00		R$ 22.000,00
Vice Presidente Executivo*	1	R$ 11.000,00		R$ 11.000,00
Diretor Institucional*	1	R$ 11.000,00		R$ 11.000,00
Diretor de Comunicação*	1	R$ 11.000,00		R$ 11.000,00
Diretor Técnico*	1	R$ 11.000,00		R$ 11.000,00
Secretaria Executiva*	1	R$ 5.000,00		R$ 5.000,00
Secretaria Administrativa	1	R$ 2.000,00	R$ 2.200,00	R$ 4.200,00
TOTAL MENSAL		**R$ 73.000,00**	**R$ 2.200,00**	**R$ 75.200,00**
TOTAL ANUAL		**R$ 876.000,00**	**R$ 26.400,00**	**R$ 902.400,00**
*Contratados como PJ				

Adding the values of fixed expenses with payroll costs, we conclude that according to the proposed salary standards and estimated fixed costs, we have the following configuration of expenses:

CUSTOS TOTAIS	MENSAL	ANUAL
FOLHA DE PAGAMENTO	**R$ 73.000,00**	**R$ 902.400,00**
CUSTOS FIXOS	**R$ 17.370,00**	**R$ 208.440,00**
TOTAL DESPESAS	**R$ 90.370,00**	**R$ 1.110.840,00**

With respect to revenue, the following condition is estimated, based on the stipulated assumptions, mainly with regard to the number of contributing members (see Spreadsheet for Revenue Assumptions above):

RECEITAS												
CLASSE	2.019		2.020		2.021		2.022		2.023		2.024	
	Qtde	Total/mês	Qtde	Total/mês	Qtde	Total/mês	Qtde	Total/mês	Qtde	Total/mês	Qtde	Total/mês
Consultor	2	R$ 400,00	3	R$ 600,00	4	R$ 800,00	5	R$ 1.000,00	6	R$ 1.200,00	8	R$ 1.600,00
A1	2	R$ 1.000,00	3	R$ 1.500,00	4	R$ 2.000,00	5	R$ 2.500,00	6	R$ 3.000,00	8	R$ 4.000,00
A2	2	R$ 2.000,00	3	R$ 3.000,00	4	R$ 4.000,00	5	R$ 5.000,00	6	R$ 6.000,00	8	R$ 8.000,00
A3	1	R$ 2.000,00	2	R$ 4.000,00	2	R$ 4.000,00	3	R$ 6.000,00	4	R$ 8.000,00	5	R$ 10.000,00
A4	3	R$ 13.500,00	4	R$ 18.000,00	3	R$ 13.500,00	4	R$ 18.000,00	5	R$ 22.500,00	6	R$ 27.000,00
A5	0	R$ -	2	R$ 11.000,00	3	R$ 16.500,00	4	R$ 22.000,00	4	R$ 22.000,00	4	R$ 22.000,00
A6	0	R$ -	2	R$ 20.000,00	3	R$ 30.000,00	4	R$ 40.000,00	4	R$ 40.000,00	4	R$ 40.000,00
A7	0	R$ -	1	R$ 20.000,00	2	R$ 40.000,00	3	R$ 60.000,00	3	R$ 60.000,00	3	R$ 60.000,00
MENSAL	10	R$ 18.900,00	20	R$ 78.100,00	25	R$ 110.800,00	33	R$ 154.500,00	38	R$ 162.700,00	46	R$ 172.600,00
ANUAL		R$ 56.700,00		R$ 937.200,00		R$ 1.329.600,00		R$ 1.854.000,00		R$ 1.952.400,00		R$ 2.071.200,00

The Income Statement for the Year (DRE) below considers that ABREN, as a non-profit organization, is framed in Law No. 9,532, of 12/10/1997, which allows the exemption of taxes according to the conditions therein stipulated, which should be the object of attention by the Directors, in order to fit the Association within the limits of the law, avoiding deviations that may cause unforeseen costs.

ANO	2.019	2.020	2.021	2.022	2.023	2.024
RECEITAS	**R$ 56.700,00**	**R$ 937.200,00**	**R$ 1.377.465,60**	**R$ 1.920.744,00**	**R$ 2.022.686,40**	**R$ 2.145.763,20**
INVESTIMENTOS		**R$ 30.700,00**				
FOLHA DE PAGAMENTO		**R$ 902.400,00**	**R$ 939.759,36**	**R$ 980.262,99**	**R$ 1.019.767,59**	**R$ 1.060.864,22**
CUSTOS FIXOS		**R$ 208.440,00**	**R$ 215.943,84**	**R$ 224.041,73**	**R$ 231.883,19**	**R$ 239.999,11**
RECEITA LIQUIDA	**R$ 56.700,00**	**-R$ 204.340,00**	**R$ 221.762,40**	**R$ 716.439,28**	**R$ 771.035,62**	**R$ 844.899,87**

Considering that in the first year of full operation (2020), there will not be enough resources to cover all expected expenses, payments should be staggered in order to remunerate professionals strictly according to their involvement in the Association. There will be cases where the work will be partially remunerated depending on the availability of initial resources. Thus, the payment priority will be for employees hired via CLT, followed by the Executive President, who is the Director most involved in the activities of the Association at this time. Payment to the other Officers will be made according to the premises described above.

With the end of 2020, and the increase in the number of members, the situation of the Association improves a lot, and the remunerations can be regularized and new plans can be initiated to expand the Association's participation in national and international events, in addition to the promotion events of interest to members, with a view to expanding the use of WTE technology in Brazil.

9. ASSOCIATION OFFER

9.1. What ABREN offers its associates

There are several advantages that will be offered to associated companies (legal entities) and associated consultants (individuals), such as:

1) National visibility in view of ABREN's performance, especially due to the communication plan and strategic plan;

2) Disclosure of new associates with a personalized impact phrase on Facebook, LinkedIn and Instagram, as well as the insertion of the logo on the ABREN website with a link to the website of the associated company or the consultant's curriculum;

3) Discounts and preference for members to sponsor events organized directly or indirectly by ABREN;

4) Possibility of inviting members to present their projects and businesses at events organized directly and indirectly by ABREN;

5) Unlimited access to an exclusive Virtual Library that has over 2GB of texts, books, newsletters, legislation, reports, projects, portfolios, articles and academic theses from different countries on all subjects that, directly or indirectly, are related to ABREN objects;

6) Networking through the indication of companies, consultants and institutions that can contribute to the members' projects;

7) Granting discounts and preference for participation in international travel packages organized by ABREN to participate in events, fairs, seminars and technical visits to plants and institutions;

With regard to institutional activities, ABREN intends to contribute and defend the implementation of energy recovery in Brazil, and activities related to waste treatment, and its efforts will be concentrated (but not limited) in the following aspects:

1) Present public policy proposals for public and private institutions, with a focus on proving the electrical, energetic, climatic, socioeconomic and environmental benefits of the energy use of residues from recycling, reverse logistics, biodigestion of organic residues (animals, vegetables, urban areas), thermal treatment of MSW, for the production of biomethane, thermal energy and electricity, production of compost derived from waste, hydrogen or other inputs, all with the objective of guaranteeing legal and institutional security, thus seeking to attract investments for investors in energy recovery of waste;

2) Clarify to public agents and other institutions that the WTE projects have the potential to meet 1.5% of the national electricity demand from MSW anaerobic biodigestion, and 5.4% of the national electricity demand from the thermal treatment of MSW (incineration, gasification or pyrolysis), totaling 6.9% of national demand;

3) Present public policies for the adoption of anaerobic biodigestion for the production of biomethane, especially regarding the possibility of replacing up to 90% of diesel consumption in urban buses, trucks for the transportation of garbage, a fact that would represent a significant reduction in greenhouse gases and economy in transport costs;

4) Participate in the Energy, Sanitation and Environment sectors in order to promote the energy recovery of waste, according to the benefits inherent to the reduction of dumps and sanitary landfills and, consequently, the reduction of liquid and gaseous effluents that contaminate the air, the soil, groundwater and rivers, as well as a reduction of up to 8x in greenhouse gas emissions resulting from the implementation of WTE plants with thermal treatment, considering that methane is 25 times more harmful than carbon dioxide. carbon according to global warming mitigation goals;

5) Support the development of investment potential of up to R $ 145 billion in the next 12 years in the solid waste sector, through studies, agreements, contracts and cooperation, in partnership with public and private institutions, to seek funding (funding, project finance) for making projects feasible, promoting the certification of WTE companies and plants, developing a green bond market and promoting studies with economic-financial modeling of the various technological routes, aiming to guarantee the development of a free and competitive market;

6) Promote the approximation of teaching and research institutions to identify potentials for the exploitation of energy recovery from waste in Brazil, promoting research and development studies and projects;

7) Invest in communication with the objective of disseminating the energy, socioeconomic and environmental benefits of energy recovery from waste to the population and municipalities, through the internet, press, films and advertisements, as well as in the organization of events, courses and training

9.2. Associate’s Duties and Obligationss

The Rights and Obligations of associates are found in articles 8 and 9 of ABREN's Bylaws, as defined below:

Art. 8 Members are entitled to:

a) attend general meetings and vote;

b) propose the admission of new Associates; and

c) request the exclusion of any Associate for a just and reasoned reason.

Art. 9 The duties of Associates are:

a) respect and comply with statutory and regimental provisions;

b) to contribute punctually to the maintenance and development of the Association with financial resources;

c) to keep permanently updated before the Association all its registration data, including its representatives;

d) appoint their representatives to the Association;

e) to care for the good name, interests and assets of the Association.

In particular, it is important to highlight that the members will have the right to participate in the General Meetings and vote to choose the Directors, and the vote will be proportional to their contribution, as follows: (i) Consultant and Associate A1 will be entitled to one vote, (ii) Member A2 will be entitled to 2 votes, Member A3 will be entitled to 3 votes, and so on.

9.3. How to Become an associate of ABREN

To join ABREN, interested parties must submit a portfolio or curriculum for prior analysis by ABREN's Board and Board. Once approved by the Deliberative Council, interested parties must complete the association form and send the logo in source format (eps, ai, cdr or vectorized pdf). For companies, the balance sheet of the previous year must still be sent for the purpose of assessing the category of associate that the interested party falls under. Interested parties should also answer the following question in one to two lines: "How can ABREN help your business and the environment?" The answer will be used in a digital art to promote the entry of the new member on social networks.

Members must pay an annual contribution, which can be divided into 12 (twelve) monthly installments, the amount of which will be due according to the company's annual billing, according to the following spreadsheet and notes:

Tabela exercício 2020

Classes	Revenues (R$)	Montly Contribution (R$)	Annual contribution (R$)
Consultant**	–	200,00	2.400,00
A1	Up until 5 milion	500,00	6.000,00
A2	From 5 to 7 milion	1.000,00	12.000,00
A3	From 7 to 10 milion	2.000,00	24.000,00
A4	From to 10 milion	4.500,00	54.000,00
A5*	From 10 to 50 milion	5.500,00	66.000,00
A6*	From 50 to 100 milion	7.500,00	90.000,00
A7*	Above 100 milion	10.000,00	120.000,00

Explanatory notes:

* Classes A5, A6 and A7 are intended for associated companies that have authorization to generate electric, thermal, biofuels or other inputs from solid waste, except landfill gas, and are in commercial operation. .

** The Consultant class is intended for individuals who are not partners or top managers of an energy company with revenues above R $ 5 million.

*** Marketing, project development and consulting companies, manufacturers and suppliers of inputs will be classified up to Class A3.

Billing is the gross annual revenue for the previous year's financial year.

ABREN wants to **revolutionize** waste management in Brazil.

Join us and be part of this **story**!

Get connected to ABREN social networks!

Website: www.abren.org.br

Facebook: https://www.facebook.com/abrenbr/

LinkedIn: https://www.linkedin.com/company/associa%C3%A7%C3%A3o-brasileira-de-recupera%C3%A7%C3%A3o-energ%C3%A9tica-de-res%C3%ADduos-abren/?viewAsMember=true

Instagram: https://www.instagram.com/abren_brasil/

YouTube: https://www.youtube.com/channel/UCzHs5zeQOWwYcLgibX6h__Q