Solid Waste Management and Biogas - Introduction

By Alexandre Schinazi , Key Expert in Low Carbon Technologies, November 2017.

Solid waste management (SWM) and biogas are two different but highly correlated sectors, and discussing both simultaneously increases the positive impacts they can mutually have on one other and on the environment. The successful development of the biogas market is a driver for private and public investments in correct waste disposal, while the advancement of urban and rural SWM infrastructure and policy is necessary to fulfil the country's biogas potential.

The SWM sector aims to improve and transform the way society sees and uses waste products, regarding them not as useless items to be discarded, but, rather, as valuable material that can bring multiple benefits. This approach ranges from changes in mentality and daily operations in order to reduce and reuse waste; to implementation of complex municipal infrastructure in order to separate waste and ensure recycling; and recovery and use of the energy embodied in waste through a range of energy-related processes.

Correct disposal and usage of waste through a sound SWM strategy brings clear benefits to society and the environment. Uncontrolled decomposition of garbage allows toxic pollutants to leak into the soil and groundwater, and releases greenhouse gases (GHG) such as methane (CH4) and carbon dioxide (CO2) into the atmosphere. Thus, SWM reduces air, water and ground pollution, decreases health risks to people and animals alike, and prevents carbon emissions.

Waste from different origins – urban landfills, industry, agriculture or livestock – have differing treatment processes, but the main idea should always be to make good use of the material by transforming it into value, such as by generating energy. This can be done through controlled incineration, creating heat that can then be transformed into electricity, in a concept known as Waste-to-Energy (WTE); or by producing biogas through the process of anaerobic digestion, which can be used as heat, electricity or purified into biomethane and used as a substitute for natural gas, for example (Figure 1).

Thus, biogas is a low-carbon means of producing energy, preventing atmospheric GHG emissions from waste decomposition. There is huge untapped potential in Brazil for this energy source, mainly from agriculture or livestock organic waste, although not without its challenges, largely related to the country's continental size, leading farms and pastures to be very scattered. Urban landfills also hold high potential, as only about 15 of the country's 2,000 landfills currently harness and use biogas. Furthermore, Brazilian legislation now allows the biomethane or electricity produced from biogas to be inserted into the gas or power grid as distributed generation, increasing business opportunities while also reducing energy losses that occur due to long transmission lines and ducts.

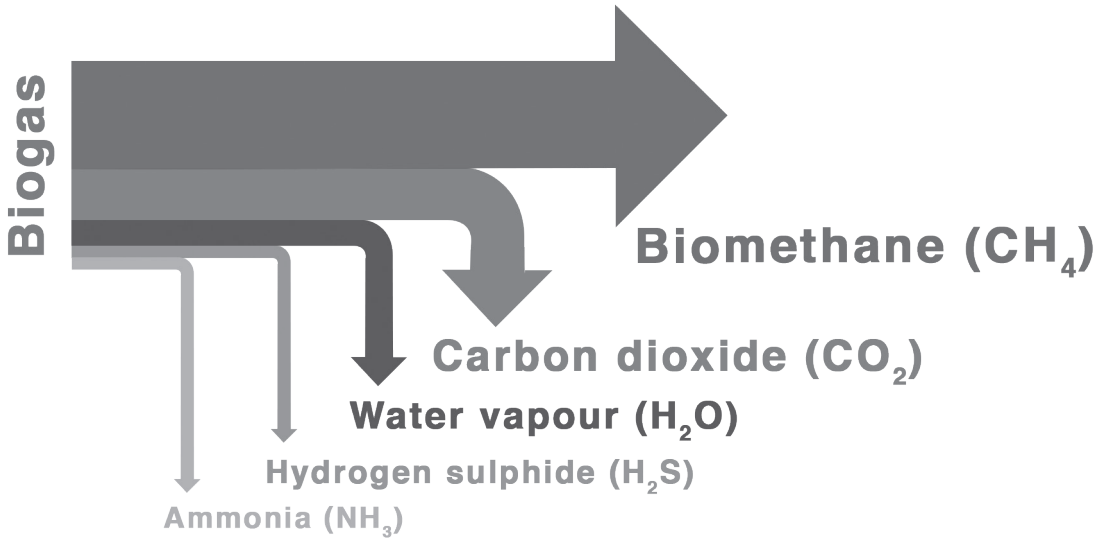

Figure 1. Separation steps for the upgrading of biogas to biomethane. Source: LCBA Sector Mapping Report on Biogas and Biomethane, from Project Virtual Biogas.

In both the biogas and SWM sectors, there is very high expertise and experience in the EU countries that could aid Brazilian companies and municipalities to create their own infrastructure and enhance production capabilities using local products and services, based upon European technological support.

THE BRAZILIAN BIOGAS AND BIOMETHANE SECTOR

Biogas and Biomethane Potential

The analysis of the biogas sector shows that Brazil offers a very high potential in particular for European SMEs since the European Union (EU) is the world's largest and leading supplier in this market. However, the Brazilian business environment is complex and the biogas sector is in its initial stages of development. European SMEs will thus have the opportunity to offer service and technology alternatives to a growing but still incipient market.

There is still no official consolidated figure on the potential production of biogas in Brazil, but existing estimates are very promising. ABiogás (Brazilian Biogas and Biomethane Association) presents on their website a **biogas** potential of **52 billion m³/year,** enough to produce 24% of the country's power supply or reduce diesel consumption by 44 % (Figure 2). Another important institution, EPE (the Energy Research Company), goes on to estimate a **biomethane** potential of **28.5 billion m³/year** (78 million m³/day). In terms of energy production, this would mean a potential average output of 14 GW, which is more powerful than the Itaipu Hydroelectric Power Plant.

Apart from theoretical potential, actuals forecasts are also encouraging. According to EMBRAPA (Brazilian Agricultural Research Corporation), a biomethane production of 17 million

m^3/day is expected by 2030. ABiogás is even more optimistic and calculates 30 million m^3/day of biomethane in 2030. EPE, responsible for Brazil's official government energy forecasts, anticipates significant growth in the sector, stating that the biogas market will grow by 8.4 billion m^3 up to 2026 in the sugarcane sector alone.

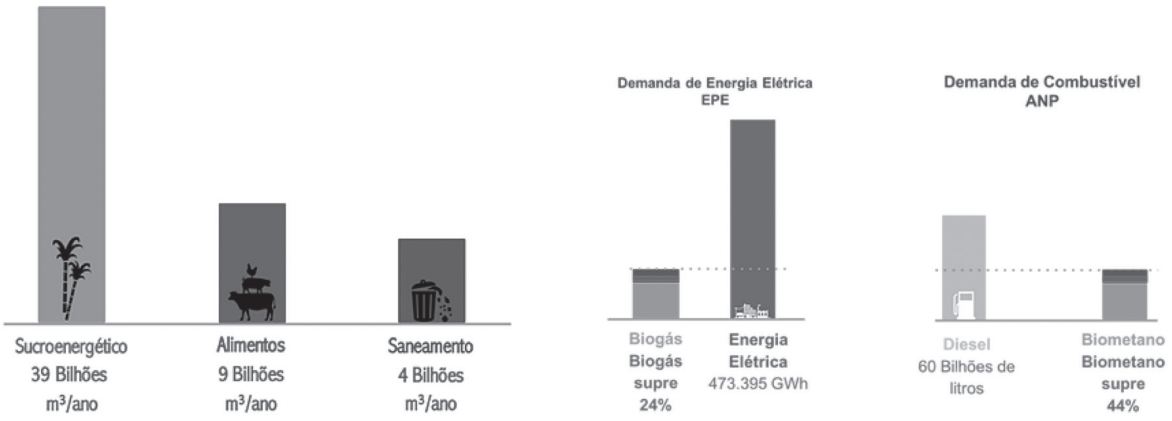

Figure 2. Brazilian biogas potential. In billions of m^3/year: 39 from sugarcane industry, 9 from animal waste for food production, 4 from urban landfills and sewage treatment plants. Biogas potential = 24% of Brazil's electricity demand (EPE). Biomethane potential = 44% of Brazil's diesel fuel demand (ANP). Source: www.abiogas.org.br/setor-no-brasil.

Legislation and Latest Developments

The biogas sector has undergone very positive changes in Brazil this year and in recent years. On June 29, 2017, ANP (National Agency of Petroleum, Natural Gas and Biofuels) passed Resolution nº 685 / 2017, which allows biomethane to be injected into the gas grid and mixed with natural gas as long as it complies with quality control specifications provided in the resolution. This applies to biomethane from urban landfills and sewage treatment plants, for residential, industrial, commercial or vehicular use. ANP estimates that about 285,000 m^3 of biomethane will be injected into the gas distribution grid per day in the near future as a result.

The first project approved under this resolution is a 10,000 m^3/day biogas power plant in the state of Rio de Janeiro, approved by ANP just recently, on Sept. 21, 2017.

Similar legislation had been passed in January 2015, when ANP's Resolution nº 8 / 2015 set forth quality standards for biomethane originating from agricultural, agroindustrial and livestock (i.e. swine and chicken manure) waste products, thus allowing complying biomethane from these sources to be considered analogous to natural gas in use and value.

In São Paulo State, responsible for over 25% of the country's natural gas consumption, ARSESP (the state's Sanitation and Energy Regulatory Agency) very recently regulated the conditions of biomethane distribution in the state's gas grid on July 26, 2017.

In terms of electricity production, Brazilian legislation (ANEEL Resolution nº 687 / 2015) allows distributed generation (DG) power plants up to 5 MW to inject electricity directly into the national power grid. Allowable sources include cogeneration plants using biogas.

Current Figures

In 2014, there were at least 22 biogas power plants in operation in Brazil, with an installed capacity of 84 MW. Another 8 were under licensing process, comprising an additional capacity of 86 MW (Table 1).

BIOGAS PLANTS IN OPERATION		
Substrate	**No of plants**	**Installed capacity (MW)**
Landfill gas	7	77
Wastewater	3	4
Manure	10	2
Food industry	2	0,9
TOTAL	**22**	**84**

BIOGAS PLANTS IN LICENSING		
Substrate	**No of plants**	**Installed capacity (MW)**
Landfill gas	4	68
Wastewater	1	2,6
Food industry	1	0,04
Sugar cane residues	2	15,8
TOTAL	**8**	**86**

Table 1 – Biogas-based power plants in Brazil in 2014 (Source: Roller et al., 2014)

April 2016 marked the first biogas power plant to be selected in a national energy auction, with an installed capacity of 21 MW. In 2017, according to ANEEL (the National Electrical Energy Agency), biogas now accounts for 127 MW of installed power, still 0.05% of the national power grid, but growing. An additional 300 MW are expected by 2026 in DG plants alone.

In contrast, Europe had, in 2015, according to the EBA (European Biogas Association), 17,240 **biogas** plants in operation with total electric installed capacity of 8,293 MW. Of these, over 60% are located in Germany, followed by Italy, the UK and France. As far as **biomethane** goes, the continent had 367 commissioned plants in 2015, with a total upgrading capacity of over 2.7 billion m3 that year. Germany, Sweden and the UK are continental leaders.

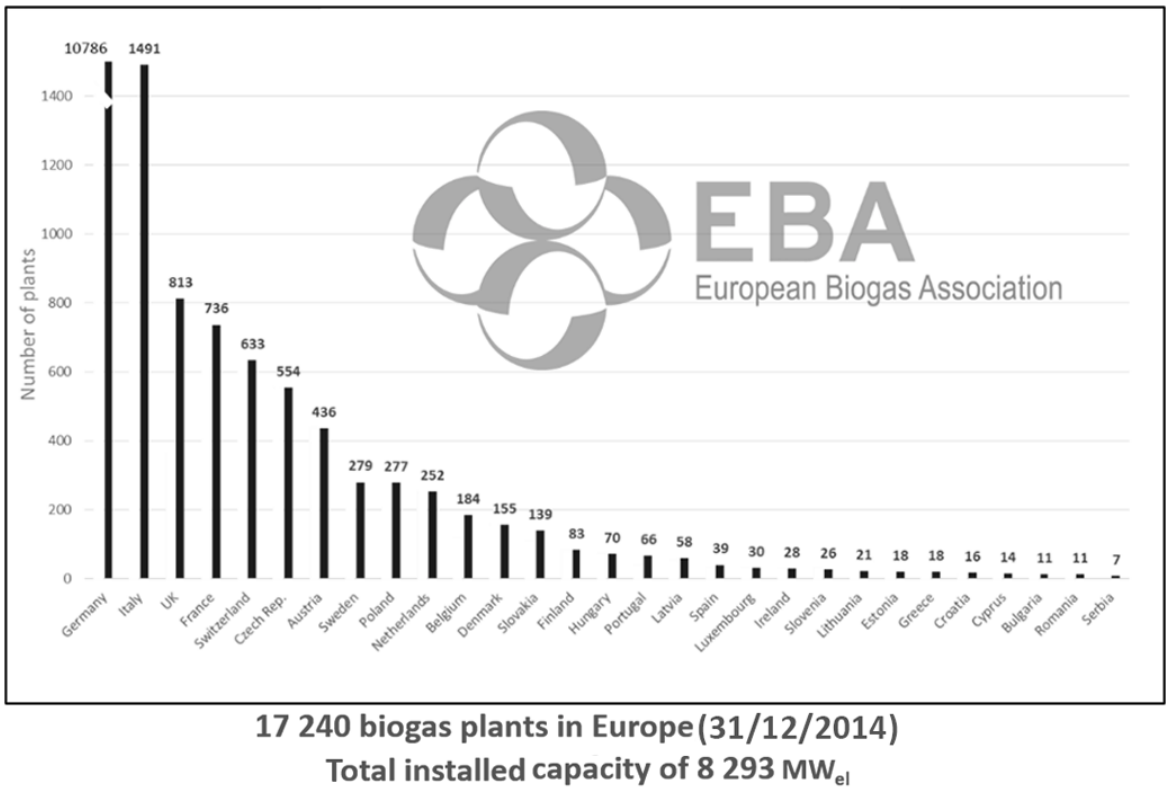

Figure 3. Biogas plants in Europe. Source: EBA Biomethane and Biogas Report 2015.

THE BRAZILIAN SOLID WASTE MANAGEMENT SECTOR

The analysis of the Brazilian SWM market shows high potential for interaction between European SMEs and Brazilian companies in certain areas – particularly with private sector involvement. Since the recent introduction of the National Solid Waste Law (PNRS, from *Política Nacional de Resíduos Sólidos*) in 2010, the sector has become increasingly regulated, structured and dynamic. The PNRS law combines elements of natural resources management with the inclusion of social responsibility in solid waste management. It introduces the integration of different economic and social sectors and brings a definition of waste groups for extended producer responsibility, through a broader concept of shared responsibility, aiming at reverse logistics to be defined through sector agreements.

Thus, Brazilian waste management is on the move to a circular economy, with relatively less consumption of natural resources. The basic instruments are reverse logistics systems (RLS) for particular waste streams, becoming more and more a reality.

According to the PNRS, reverse logistics are of shared responsibility between private and public sectors and the population. In fact, the operation of RLS will always involve manufacturers, importers, distributers or retailers, normally organized in branch associations.

RLS are set up as established in sector agreements or other implementation tools, in consensus between the private sector and federal government. Thus, the private sector becomes directly engaged in the management of specific waste streams. This opens new horizons for SME cooperation in all waste streams, since in the private sector organizational structures tend to be leaner, and financial systems, clearer, than in the public sector. That way, business potential for EU SMEs may encounter a favourable environment in the field of waste management of privately organized and managed reverse logistics systems.

The public Solid Waste Management sector refers mainly to the municipal governments, and there are gaps in almost every stage. Some of them are of structural character with lower business potential, whereas others are more of technical and technological nature, thus offering a higher potential in the given context.

Gaps of structural character are the main difficulties of the public SWM sector, especially the absence of a consistent and transparent refinancing system of the sector, and the total and exclusive competence for SWM on the municipal level, often with weak administrative structures. Moreover, an antiquated mentality on the part of many cities, as well as lack of human and financial resources dedicated to planning the sector, lead many locations to rely on poorly structured landfills; large quantities of recyclables to end up in ordinary landfills; and, worse, waste to end up in open-air "garbage dumps" without any kind of treatment. That is why in many cases, successful recycling is often on the merits of cooperatives and low-income individuals who make a living out of sorting and selling recyclable waste, rather than on public municipal policy and infrastructure.

This is slowly changing, however, as there is an increasing momentum for establishing well-structured landfills capable of efficiently sorting waste, sending recyclables to the reverse logistics streams, and reaping the benefits of waste decomposition, such as with the production of biogas, electricity and fertilizers, for example. This represents a business opportunity for Brazilian and EU companies.

In Brazil, there are very limited sector-specific refinancing systems, such as waste-specific charging, in place. However, there are efforts to overcome the lack of charging for waste collection and treatment services, and reverse logistics systems with private financing may improve this situation, thus creating a more favourable panorama for business potential.

In addition, there is a trend for inter-municipal waste management associations. Many consortia have been created in recent years, since the PNRS has been enacted, which privileges access to federal resources for such models. Public consortia offer higher administrative stability, better possibilities for training of the municipal administrations and of the different operators of the SWM system, and provide a framework for definition of Public-Private Partnership (PPP) models, enhancing business potential for the private sector.

KEY BUSINESS OPPORTUNITIES AND CHALLENGES

The Sector Mapping Reports on Biogas and Solid Waste Management published by the Low Carbon Business Action in Brazil (http://lowcarbonbrazil.com/audiovisuals#publications) present a number of sector gaps, challenges and business opportunities, some of which are highlighted below.

Biogas: The reports identify technology gaps in almost all stages of biogas production, preparation and use in Brazil, with noteworthy innovation needs in the following areas:

Biogas upgrading, removal of particle droplets, siloxanes, and other trace components, desulphurisation, separation of CO2 and H2O, final conditioning, dew-point control, adjustment of heat value, etc.;
Biogas use, heat generation, power generation;
Biomethane use, power and heat generation, vehicle fuel, injection of biomethane in the natural gas grid;
Monitoring, metering, control equipment;
Transportation conversion kits – from diesel to gas (biomethane) for trucks, gas trucks.

Solid Waste Management: Business opportunities in SWM associated with sector gaps in Brazil and identified with a low carbon footprint in the reports are the following:

Recycling of plastics, metals, glass and cellulose materials, from collection logistics to the transformation industry with input from processed secondary raw materials;
Aerobic composting of organic waste;
Recycling of specific waste streams, such as residues from electrical and electronic equipment and from the construction & demolition industry;
Heavy-duty shredders and crushers, mechanized or automated revolving equipment (aerobic composting), as there is no national production;
Sensors and automation in sorting plants;
Automatized receiving and separation equipment for collection centers in supermarkets;
Small-scale technology suitable for small municipalities.

Challenges

In both sectors, it is clear that there are many potential SMEs in the EU willing to offer their products and services in the country, especially since the EU has several nations that are global leaders in the biogas segment. EU SMEs willing to participate in the Brazilian market will need to overcome a few barriers by, for example:

- Working together with financial institutions able to offer applicable special financing conditions (for example, export credit agencies in the EU);

- Developing associations and/or joint-ventures in Brazil with local companies to increase the capacity to carry out some local research and adapt/tropicalize equipment/services;
- Support local initiatives by supplying local capacity building in the private (technical and financial) and public sectors.

Opportunity subsectors

The subsectors that have been identified as those that can benefit the most from partnerships between Brazilian and European companies are listed below:

Solid Waste Management: Consulting, planning, logistics, monitoring and information and communication tools (ICT)
Solid Waste Management: Collection and transportation
Solid Waste Management: Technology or equipment for sorting/separation
Solid Waste Management: Processing and upgrading of recyclable solid waste as input materials for production processes
Reverse Logistics: Planning, consulting, operationalization
Organic Waste Management: Composting
Biogas production: Engineering and project implementation
Biogas production: Manufacture or supply of biodigestors or other equipment
Biogas production: Upgrading or compression
Biogas use: Operations and maintenance for heat generation
Biogas use: Operations and maintenance for power generation
Biogas: Monitoring, metering or control systems and equipment
Waste-to-energy from agricultural waste (biomass)
Waste-to-energy from animal waste (livestock)
Waste-to-energy from urban and construction waste

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