

São Paulo, Brazil

Turning pollution into profit: the Bandeirantes Landfill Gas to Energy Project

São Paulo, like many cities around the world, was confronted with a solid waste management issue: the city landfill was releasing methane, a potent greenhouse gas, into the atmosphere. In response, the Bandeirantes Landfill Gas to Energy Project was designed to collect landfill gas to produce biogas that is then used to produce electricity, and began operating in 2004. GHG emissions have since been reduced, and environmental, social, health and economic benefits secured for the local population.

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Abstract

The “Bandeirantes Landfill Gas to Energy Project” (BLFGE) was developed by the City of São Paulo to collect and process biogas from the Bandeirantes Landfill to generate electricity at an on-site power plant. BLFGE was developed in response to a pressing environmental issue that posed a health risk to the local population and needlessly contributed to climate change. It is estimated that the project will prevent the release of more than 7,400,000 tons of CO₂ into the atmosphere between 2004 and 2010, while producing clean energy, generating of additional revenue streams, increasing awareness of climate change and renewable energy in the community, and creating of jobs.

BLFGE is a successful example of climate mitigation in a developing country. It was developed through the Clean Development Mechanism (CDM) in a partnership between the local government of São Paulo and a private company, Biogás Energia Ambiental S/A. The income derived from the CDM credits provides the city with needed funds that are aimed at further sustainable development projects.

The Importance of Solid Waste Management

Solid waste management has never been an easy issue to tackle, and with the significance of climate change, the off gassing of methane (CH₄) from landfill sites is a pressing issue. Methane is produced by the breakdown of organic material in landfills and is a serious greenhouse gas (GHG) 24 times more potent than CO₂. Landfill gas also affects the population living close by, especially in developing countries where land use regulations do not limit residential proximity to landfills. Some of these health hazards include: risk of death and injury in the case of an explosion; poor air quality; and serious illness from chemical and waste exposure, such as cancer. Any attempt to collect or capture landfill gases can reduce health hazards and improve air quality in landfill neighborhoods.

In capturing landfill gas and using it to produce electricity, a former pollutant is turned into a source of energy. In the process, methane is diverted from escaping into the environment, reducing unpleasant odours and mitigating climate change – all while producing a profit, creating employment opportunities, and bringing in financial resources to the city for further environmental projects.



Population

Approx. 11,189,000 (2008)

Land area

1,523 km²

Municipal budget

Approx. R\$25.2 billion (2008)
(€ 9.3 billion)



An ICLEI Initiative

ICLEI supports and strengthens local governments which promote the generation and supply of renewable energy and energy efficiency in the urban environment.

Case Study

The São Paulo Context

The city of São Paulo is the capital of the south-eastern Brazilian State of São Paulo. São Paulo is the wealthiest city in Brazil, with the third highest GDP in Brazil. It is the heart of the country's industrial, financial and commercial activity. São Paulo's population growth has resulted in increased fossil fuel use and increased waste, with tremendous impact on the environment. In 2004, São Paulo emitted approximately 950,000 tons of methane from municipal solid waste and 25,000 tons of methane from wastewater treatment, representing about 1 percent of Brazil's net GHG emissions and averaging approximately 7 kilograms of methane per person per year.

Reaction against such dismal figures, and mobilization for environmental preservation and social assistance initiatives has generated the drive to tackle these issues. São Paulo has shown its commitment to the betterment of the global environment through local action. As an ICLEI member since 1991, it is an engaged partner in many of ICLEI's initiatives. The city was one of the pilot governments in ICLEI's Cities for Climate Protection Campaign™ (CCP), the "Fostering Sustainable Public Procurement in Brazil" Project (CPS-Brazil) from 2007, the Local Action for Biodiversity Initiative (LAB) in Latin America, and participates in ICLEI's Local Renewables Communities Network from 2005. The city has hosted ICLEI's Latin America Secretariat (LACS) Brazil Project Office since 2006, and the Environmental Secretary serves as one of the region's representatives in ICLEI's International Executive Committee.

Photo: Jefferson Pancieri - SPTuris



The City of São Paulo

The Greenhouse Effect, the Kyoto Protocol and the Clean Development Mechanism

The 'greenhouse effect' is a natural process in which the atmosphere traps some of the sun's energy, warming the earth enough to support life. A layer of gases in the atmosphere acts like an insulating blanket trapping solar energy that would otherwise escape into space. The earth would be frozen, barren and lifeless without these GHGs that include carbon dioxide, nitrous oxide, methane, water vapour, and halocarbons. GHGs are produced by natural processes and/or human activities, for example, carbon dioxide is emitted by burning fossil fuels and deforestation, and methane can be released from rice paddies, livestock and landfill sites.

The burning of fossil fuels and other human activities have increased the concentration of GHGs in the atmosphere. These excess GHGs have resulted in an increase in global temperature, the phenomenon known as 'global warming' or 'global climate change,' and is altering the earth's complex web of systems such as cloud cover, rainfall patterns, wind patterns, ocean currents, and the distribution of plant and animal species. It is calculated that atmospheric levels of CO₂, a gas responsible for over 60 per cent of the enhanced greenhouse effect, will double or triple from pre-industrial levels during the 21st century. Increases thus far have led to a rise in sea level, ocean acidification, glacier retreat, ice sheet shrinkage at the poles, and altered agricultural patterns. Predictions for secondary and regional effects include an increase in extreme weather events, an expansion of tropical diseases, changes in the timing of seasonal ecosystem patterns, species loss, and drastic economic impact.

Burning oil and coal more efficiently may put off the impacts of climate change for a time, but to mitigate the impacts of climate change, serious attention must be paid to switching to renewable sources of energy for heat, cooling, and electrical generation. This tactic must be combined with a serious enhancement in end-use efficiency, including the encouragement of sustainable transport, and the re-tooling of industries for sustainability. Such strategies get at the source of the issue.

The primary international agreement on combating climate change is the Kyoto Protocol, which came into force in 2005. It is an amendment to the United Nations Framework Convention on Climate Change (UNFCCC), with the objective of reducing GHGs in an effort to prevent anthropogenic climate change. Countries that have ratified the Kyoto Protocol have committed to reduce their emissions of carbon dioxide and other GHGs, or engage in emissions trading if they maintain or increase emissions of these gases. A 'mitigation' project involves taking actions to reduce GHG emissions aimed at reducing the extent of global climate change. This is in distinction to 'adaptation', which involves taking action to minimize the effects of global climate change.

Emissions can be traded through the Clean Development Mechanism (CDM), which is defined in Article 12 of the Kyoto Protocol. CDM allows a country with an emission-reduction or emission-limitation commitment under the Protocol to implement an emission-reduction project in a developing country. Certified emission reductions (CERs) are carbon credits issued by the CDM Executive Board in connection with registered CDM project activities that reduce greenhouse gas emissions. Such projects can earn saleable CER credits, each equivalent to one tonne of CO₂ that can be counted towards meeting Kyoto targets. The mechanism stimulates sustainable development and emission reductions. A CDM project must provide emission reductions that are additional to what would otherwise have occurred.

Bandeirantes Landfill Gas to Energy Project (BLFGE)

The Bandeirantes Landfill Gas to Energy Project (BLFGE) aims to provide an environmental, social and financial solution to the release of landfill gas into the environment by utilizing this methane gas produced by the Bandeirantes landfill to



Bandeirantes Landfill Site

generate electricity. Another goal is to sell Certified Emission Reductions (CERs) in accordance with the Kyoto Protocol's Framework in order to provide revenue for the municipality.

The Bandeirantes landfill is located in the metropolitan region of São Paulo. Paulistanos (São Paulo's inhabitants) generate nearly 15,000 tons of waste daily. Half of this waste was disposed in the Bandeirantes landfill, up until 2007 when the landfill became inactive. (Table 01 presents a few of the landfill's characteristics). Built in 1979, the designers dealt with waste gases by collecting them through a passive venting system and occasionally flaring them at the head of

the wells. This process was wasteful and inefficient in destroying methane. In order to deal with the environmental dangers that resulted from methane emissions, Biogás proposed the "Bandeirantes Landfill Gas to Energy Project", which generates renewable energy through 24 engines with a capacity of 20 MW.

Table 01 – Main characteristics of Bandeirantes Landfill

Location	Perus Neighborhood, Northern Zone
Area	1,400,000 m ²
Active disposal operation	1979 - 2007
Disposed residues (tones/day)	7,000
Accumulated tCO ₂ e (2004-2010)	7,494,404

Source: Adapted from Biogás Energia Ambiental S/A, 2005

The landfill is operated by Biogás, a private company concessioned by the municipality of São Paulo through a bidding process. Biogás is a Dutch-Brazilian collaborative venture.

The Bandeirantes project is the largest landfill gas recuperation plant in the world with an annual generation of 170,000 MWh. Since the landfill stopped accepting waste in April 2007 the site has been remediated, covered over and planted with grass. The site owners estimate that the landfill received approximately 35 million tonnes of material between 1979 and 2007.

The current strategy is to extract methane gas until 2018, after which insufficient gas will be produced from the organic waste in the site. This prediction is based on the yield of gas, which is continuously monitored to evaluate future flow rates. The collected biogas is sold as fuel to the Bandeirantes Thermoelectric power

plant, a clean energy power plant that began its operations in 2003. The electricity generated through the project's biogas provides enough energy to supply 400,000 inhabitants.

Upon receiving CDM approval in the municipal, state, national and international level processes, Biogás started to generate electricity at the site in January 2004. Its operations at Bandeirantes have created more than 30 local jobs. Biogás directs 50% of the received carbon credits to the municipality of São Paulo. The city aims to use these funds in social and environmental projects that benefit the population surrounding the landfill, according to the concession contract.

The emission reductions estimate for the project's first stage is shown in Table 02. Based on the figures presented, it is estimated that BLFGE will account for an emission reduction of 7.5 million tCO₂e in the first crediting period (2004–2010).

On September 26, 2007, the Brazilian Mercantile & Futures Exchange (BM&F) held a public auction to sell the Certified Emissions Reductions (CERs) held by the municipal government of São Paulo, pursuant to current Brazilian legislation and applicable international rules governing the CDM, created in accordance with article 12 of Kyoto Protocol. It was the first public auction of CER in the world and has been considered a great success. The Dutch bank, Fortis Bank NV/SA bought the credit unit for €16,20.

As a result, São Paulo received €13,096,890 in 2007. These funds have been targeted at environmental improvements in the communities surrounding the landfill. São Paulo has designed a number of these restoration and reurbanization projects through its Secretariat of Green Areas and Environment, and with the sub-municipalities of Perus and Pirituba. These projects include linear parks (parks designed to restore the vegetation and control floods), bicycle lanes, new squares, recycling and environmental education programs, and a park with an arboretum, veterinary hospital and carpentry school. Some of these projects are now in progress.



Credit: Biogas Ambiental

Gas collection at Bandeirantes Landfill

Table 02 - Estimated reduction in emissions over the crediting period

Year	Annual estimated reduction of emission in tonnes of CO ₂ e
2004	748,624
2005	1,086,919
2006	1,364,960
2007	1,236,153
2008	1,120,186
2009	1,015,780
2010	921,782
Total estimated reductions (tonnes of CO ₂ e)	7,494,404
Total number of crediting years	7
Estimated average annual reduction over the crediting period (in tonnes of CO ₂ e)	1,070,629

Source: Adapted from Biogás Energia Ambiental S/A, 2005

Results and Impacts of the Project in the Community

The BLFGE project has contributed to the sustainable development of São Paulo, through addressing the environmental, social and economic issues listed below:

- This project has taken a pollutant and harvested it in the form of biogas, generating a useful by-product (electricity) while bringing in much needed money, investment, and jobs to the city.
- Emissions of methane, a potent GHG have been reduced. The electricity generated from biogas substitutes for fossil fuels, which offsets the air and water pollution, climate change and other environmental and health hazards associated with the use of fossil fuels. The project enables the city to mitigate climate change and minimize explosion risk at the landfill site by capturing an amount of methane gas equivalent to 7.5 million tonnes of CO₂ that would otherwise be released into the atmosphere.
- The city of São Paulo can now invest in measures to improve the community surrounding the landfill, for example, by improving rubbish dumps, and in financing recycling and waste management awareness projects, among others.
- A large number of employment opportunities have been created during the implementation of the project both directly and indirectly, with 26 jobs created for the project's operation.
- The operators were trained in how to use new technology. This training was then disseminated to the community. The capacity building element of the BLFGE project existed throughout the implementation and operation stage of the project.
- Public awareness in the community has been raised, mainly through educational activities in waste management, recycling and renewable energy in schools. Visits from the general public to the landfill biogas extraction and treatment facilities and power plant, are another integral component in raising public awareness of these issues and showing practical solutions that visitors and students can be a part of.

Credit: Wanderlei Celestino - SPTuris



São Paulo City Scape

Lessons Learned

A win-win scenario was achieved when the private and public actors established a partnership to transform landfill gas emissions into a cleaner source of energy.

The partnership between the two sectors was especially important to São Paulo as Biogás took responsibility for the project's costs and risks as well as the legal procedures that involved the CDM approval, a long 4-year process. Biogás was also in charge of finding financing for the project, a difficult task since the contract was approved in 2000, when the CDM issue was still incipient and the Kyoto Protocol had not been ratified yet.

The positive results from this partnership is also due to the well-elaborated bidding process that was planned and implemented by the Brazilian government, that both ensured the municipality's interests and was attractive to the private sector. Moreover the project has decidedly confirmed that GHG emission reductions not only bring social and environmental benefits, but also open doors to economic advantages in the international finance market.

The BLFGE project is a result of a fruitful co-operation between the public and the private sectors at the local level. The project has demonstrated how joint action from specialized and engaged agents from different sectors can create inventive initiatives to tackle the challenges that face cities.

Research prior to the project would have been effective in improving partner relations. At times, the negotiations between the Municipality and Biogás on the distribution of the profits from the carbon credits sale were very intense. In 2004 an agreement was made by both parties for the even distribution of project the profits – 50% for São Paulo and 50% for Biogás. Although this agreement seems fair, in retrospect it is recognized that it would have been wise to have invested in a research study to determine the economic gains from the investments.

The city should have involved all stakeholders in their decision-making processes for a greater public acceptance of the project. When determining how the profits of the carbon credits would be spent, the city of São Paulo and the sub-municipalities of Perus and Pirituba decided together that all of the funds would be allocated to environmental projects. This decision was taken before the auction took place without the involvement of other stakeholders such as the communities that live in the areas surrounding the landfill. It was discovered at a later time that the community felt disengaged and deprived because they thought their health, education, housing and public transportation needs were not considered or met with the funds. Support for the projects implemented by the city would have been higher if they had been consulted. The community should have been involved in the decision making process since the beginning of the project in order to achieve more satisfactory results.

Replication

The BLFGE project is the first landfill gas to energy project implemented in Brazil. Its replication potential is tremendous in the country and abroad, mainly due to the common problem that waste disposal presents, and waste's often high organic content. An extremely positive impact brought by the initiative is the development and spread of technology for landfill gas capture and destruction through flaring and electricity generation.

Besides the BLFGE, Biogás participates in two other projects with the same aims - CERs and energy generation. One of the projects started in June 2007 at the Biogás São João Ambiental, located at the São João Landfill in the Eastern Zone of São Paulo, which also captures gas and generates electricity. The other project is located in the state of Rio de Janeiro, at the Gramacho Landfill. Along with Biogás, the consortium Novo Gramacho manages the landfill and operates the waste disposal, gas extraction and leachate treatment - leachate is the liquid from landfill decomposition that drains or 'leaches' from a landfill.

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Finances

Biogás invested R\$12 million in the installation of the gas capture system during six months in 2003, and R\$45 million was invested in the construction of the power plant in the same year by Unibanco, a Brazilian private bank. In addition, São Paulo received €13,096,890 through the selling of CERs in 2007.

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