Biomass Power Generation: Sugar Cane Bagasse and Trash

Brazil
Climate Change
BRA/96/G31
Completed (1997 - April 2003)

GEF Grant US$ 3.750 million
Cofinance US$ 2.770 million
Project Cost US$ 6.520 million

Facts and figures
Although 95% of Brazil's electricity is produced by hydroelectric power, few suitable sites remain for future hydroelectric projects. Where sites with hydroelectric potential do exist – generally in the Amazon region – there are usually economic and environmental considerations preventing their development.

Since Brazil has no indigenous fossil fuel the country has also developed the use of biomass as a fuel for electricity generation to supplement the long term unreliability of hydroelectric power. to a point where nearly 30% of the country's gross domestic primary energy consumption is derived from biomass products. Of this, about half is commercially produced from sustainable yields of short rotation crops from eucalyptus forests and plantations, and is used in industries such as ceramics, steel, pulp and paper. Brazil has also developed and implemented a major programme to replace petroleum with alcohol and many Brazilian automobiles already run on ethanol.

Sugarcane bagasse – the fibrous by-product of sugar extraction from cane stalks – is generally used as a biomass fuel and the trash – the tops and leaves of the sugarcane plant that are typically burned off the field before harvest, or removed at harvest and left on the field to decompose.

Project description
This was the second stage of a three-phase programme on the use of sugarcane biogases and trash in electricity generation. Its specific objectives were to determine the quantity, quality and cost of sugar cane bagasse/trash biomass available for electrical generation; and to resolve engineering, business and economic barriers to the establishment of a commercial electrical generation demonstration plant using biomass-gasifier/gas turbine (BIG/GT) technology and running on sugar cane bagasse and trash.

A pre-feasibility study was conducted in phase 1 and the actual demonstration plant will be constructed in phase 3. Previously, Brazil—the world’s largest producer of sugar — used only part of the sugar waste, or biomass, to drive sugar refinery machines. The new turbines provide twice the available fuel supply, allowing year-round operation and increasing power generation efficiency. In addition, the sugar industry will gain a new commercial opportunity — selling power from its sugar-driven steam turbines.
Considering the size of the global sugarcane industry, it is apparent that there is an enormous potential for the introduction of sugarcane trash for year-round electricity generation at sugarcane mills. Some cane-producing regions (Guatemala, Hawaii, Mauritius, Reunion) have already implemented year-round power generation but in all cases fossil fuels (fuel oil or coal) are used to supplement bagasse. The use of sugar cane trash would avoid the use of fossil fuels and attendant CO2 emissions. Trash utilization has already begun using conventional power plants (boiler-steam turbines), but considerably greater reductions in CO2 emissions will be achieved with the full introduction of BIG/GT technology.

**SELECTED PROJECT RESULTS**

- The project conducted analysis to show that sugarcane trash couple be recovered in suitable quantities, quality and cost for use as a supplemental fuel to bagasse for power generation. This was the first study to provide reliable results on which confident investment decisions could be made, and has already inspired some mill managers to begin using trash for energy production. (Four mills are already using trash (105,000 tons per year) in their conventional boilers as a direct result of the project, and three others are evaluating ways to recover trash on a large-scale basis.)

- Research also showed that biomass-gasifier/gas turbine (BIG/GT) technology, with trash supplementing bagasse, could increase the production of electricity by a sugarcane mill by 500%. Electricity production could be increased from 50 to 60 kWh/ton cane processed (with conventional high pressure steam turbine technology firing only bagasse) to 250 to 300 kWh/ton of cane processed with a BIG/GT system using both bagasse and trash.

- Project analysis suggested that ten 30MW generating units would have to be built before energy production costs fell to levels acceptable to the Brazilian market.

- Considering that existing laws and regulations are forcing the phase out of cane burning and the Brazil’s sugar cane crops amounts to around 315 million tons/year it is estimated the use of BIG/GT technology with sugar cane residues as fuel has the potential to achieve reductions in CO2 emissions in the range of 26 to 40 million tons of CO2 equiv./year, depending on the degree of technology penetration assumed. If the world’s 1 billion-ton sugar cane industry converted its bagasse and field waste into power, use of nearly 250 million tons of oil could be avoided every year.

- The Companhia Paulista de Forca e Luz (CPFL), one of Brazil’s largest private electricity generating companies, has indicated its interest in taking a leading role in phase three of the project which will build a demonstration BIG/GT plant operating on sugarcane residues at a mill in southeast Brazil.
• Since there are some potential benefits to leaving trash on harvested sugarcane fields such as weed control, wind and rain erosion protection, increased soil infiltration of water/reduced soil surface evaporation of water, reduced soil temperatures, and increased soil biological activity, costs and benefits analysis was undertaken and a series of guidelines for trash removal formulated. These guidelines are now being used by some sugarcane owners who have begun collecting trash to use as fuel in existing combustion systems.

• Although co-funding was originally only expected to come from Brazil’s Copersucar, (one of the largest sugar and alcohol producers in the world) other international donors became interested in the project and contributed funding – EU ($575,000) and Sweden’s NUTEK ($340,000)

Legal

• The project’s study of the agricultural and environmental impacts of sugarcane trash recovery has provided information of value to on-going discussions on cane burning regulations

• A Brazilian law passed in 2003, says that after 2006 10% of all new power capacity installed in the country must use renewable energy. Although this cannot be directly attributed to the project it will certainly benefit the project’s future and potential for replication.

Communications

• The project produced and distributed eight newsletters and also made many presentations in international conferences and congresses. As a result there is now a widespread awareness of the potential of sugarcane trash and BIG/GT technology among government agencies, private sector industry, universities and NGOs in Brazil and in sugarcane industries worldwide.

• The project was presented at the 24th ISSCT (International Society of Sugar Cane Technologists) Congress in Australia. As a result Brazil became recognized as a world leader in BIG/GT technology.

• Information and idea exchanges have taken place with similar projects such as the WBP-Brazilian Woodchips Project, a Australian gasification project and with several research projects in different Universities in Brazil and abroad.

Partners, etc

Executing agency was Brazil’s Ministry of Science and Technology

Copersucar, which co-funded the project with approximately US$ 3.6 million and through its Copersucar Technology Centre (CTC) coordinated and developed the majority of the work in the project. Copersucar worked with Termiska-Processer (TPS), a Swedish private company, and
through TPS, strategic and financial collaboration were obtained from the European Commission and the Swedish National Energy Administration (STEM).

Other participants in the project included CENBIO (which assisted in disseminating project information), the University of Campinas (which now has a gasifier laboratory supported by CTC staff), the Centro Tecnico Aero-Espacial and the Instituto Tecnologico de Aeronautica at Sao Jose dos Campos, SP, Brazil (which developed expertise in the design and analysis of cane cleaning processes in the course of the project), ESALQ (which undertook studies of trash availability), Brazilian equipment suppliers such as Dedini and Codistil (which contributed to designing more steam-efficient sugarcane processing plants), and CPFL (which has developed an interest in sugarcane-BIG/GT technology as a commercial opportunity).

**Dedicated project website:**

**Project newsletter:**

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