CGIAR | RESEARCH PROGRAM ON Water, Land and Ecosystems | LED BY: IWMI International Water Management Institute

# Generating On-site Combined Heat and Power from Agro-waste

## Business characteristics

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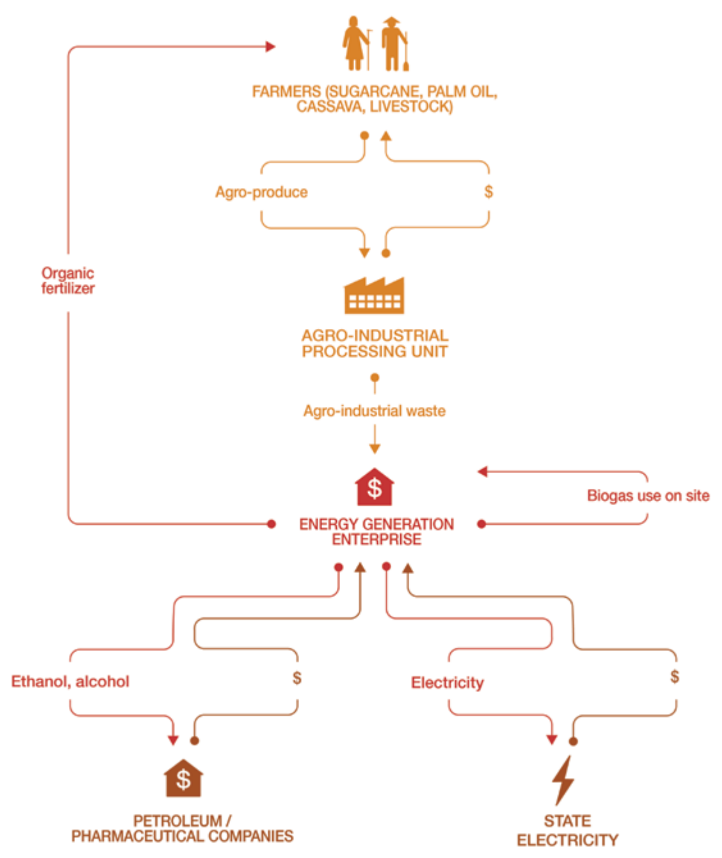
|---|---|
| Geography | Regions with large agro-industries |
| Scale of production | 15 KW of power from slaughterhouse waste; 1.4 MW - 2.8 MW of electricity from wastewater produced from cassava starch and palm oil mills; 12 MW - 34 MW of electricity from sugar processing factories |
| Type of organization | Agro-industrial factory and/or private technology enterprise |
| Investment cost range | USD 1.16-1.85 million/MW of electricity from sugar processing factories; USD 2-2.6 million/MW of electricity from agro-industrial effluent |
| Key costs | Capital investment (co-generation unit, distillery and biogas unit), input costs, interest on borrowed funds, operation and maintenance costs, and marketing costs for alcohol/ethanol sales |
| Revenue stream | Sale of electricity, and potential sale of carbon credits and compost |

## Business model

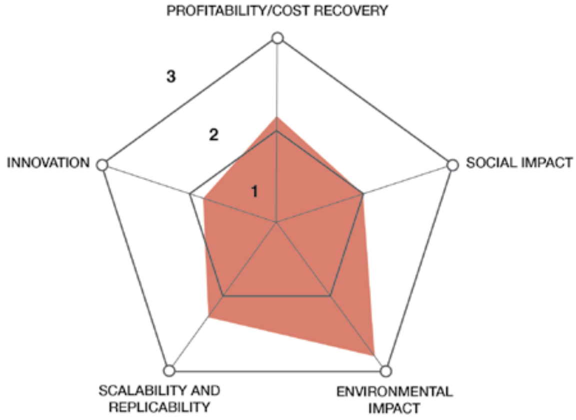
**The business model processes organic waste by-products of agro-industrial factories (e.g., sugar, palm oil, cassava processing) to generate energy.** Depending on the type of waste, various technologies can be installed, including co-generation units to produce electricity and thermal energy, distillery units to produce ethanol/alcohol, and biogas units to produce electricity and thermal energy/heat. The electricity generated is then sold to the national grid and the ethanol/alcohol is sold to petroleum and pharmaceutical companies.

The business model can be set up by an agro-industrial factory or by an external private enterprise on a Build, Own, Operate, Transfer (BOOT) basis. In the second case, the enterprise designs, constructs, operates and maintains the energy production unit until the BOOT period expires, after which it transfers ownership to the factory and assists with operation when needed. As well as generating revenue from electricity and ethanol/alcohol sales, the factory can also make savings by using the biogas produced on-site for internal use and distributing bio-fertilizer (secondary product of biogas production) to its farmers. It can also sell carbon credits for additional revenue.

### BUSINESS MODEL VALUE CHAIN



## Business performance




The business model scores particularly high on environmental impact, with reduced pollution from large agro-industrial factories and generation of renewable energy on a large scale, substituting fossil fuel-based energy leading to reduced greenhouse gas (GHG) emissions.

## Main risks

**Market risks:** If the electricity sector is regulated and the state utility is the sole buyer, the bargaining power of the business producing and selling electricity will be low. Also, if ethanol blending is not mandatory in the country, the business will face competition from other fossil-based substitute products.

**Competition risks:** Fluctuating sugar prices could force farmers to shift to other crops and affect the operations of the co-generation and distillery units of the sugar processing factories.

**Technological risks:** Although the technology used is well established and mature, it requires skilled labor for construction, and operation and maintenance.

**Safety, environmental and health risks:** The environmental risks associated with the co-generation units include the possible leakage of gas and emission of flue gas. Proper mitigation measures need to be put in place to protect laborers, farmers, consumers and surrounding communities.

## Case study: Thailand (Southeast Asia)

Founded in 2003, the Thai Biogas Energy Company (TBEC) develops, designs, finances and operates biogas projects on a Build, Own, Operate, Transfer (BOOT) basis for various agro-industries in Southeast Asia. The company has built and operates a number of biogas plants for treating wastewater for electricity generation.

TBEC provides investment for the project and the host industry provides land and inputs. TBEC runs the project until the BOOT term expires (usually 15-17 years), when it transfers the biogas plant operation to the industry. The company recovers its investment costs by generating electricity from the biogas produced and selling it to the national grid through provincial electricity authorities. It has also gained additional revenue from carbon credits for some projects. The business has so far operated projects in Thailand and Lao PDR, and is developing new ones in Myanmar, Cambodia and Vietnam, covering industries such as palm oil mills and cassava processing plants.

The company's model results in local employment and additional electricity supply for the host area, as well as reduced pollution and GHG emissions.

## Key performance indicators (as of 2013)

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| Capital investment: | Highly project specific depending on scale, location, labor and benefit-sharing arrangements with concessionaries |
| Labor: | 116 full-time employees (including operation and management of multiple plants) |
| Output: | 25,000 m3 of treated wastewater/day<br>Across multiple projects, 6,200,000 $m^3$ of processed wastewater/year are converted into 38,360,000 $m^3$ of biogas/year, generating 26,500,000 kWh of electricity/year, and 250,000 tons of $CO_2$ equivalent/year of carbon credits |
| Social and environmental impact: | Reduced dependence on imported fossil fuels for power generation; $CO_2$ emission reduction; local jobs in construction of plant; skilled jobs in operation and maintenance; and reduced water pollution |

For more information on the business model and related cases, see Chapter 5 of **Otoo, M.; Drechsel, P. (Eds.). 2017. *Resource recovery from waste: Business models for energy, nutrient and water reuse in low- and middle-income countries.* London: Earthscan/Routledge. In press.** The book has been produced by the Resource Recovery and Reuse subprogram of the International Water Management Institute (IWMI), under the CGIAR Research Program on Water, Land and Ecosystems (WLE) and its Rural-Urban Linkages Research Theme. The support of the Swiss Agency for Development and Cooperation (SDC), the International Fund for Agricultural Development (IFAD), and CGIAR Fund Donors (www.cgiar.org/about-us/our-funders/) is gratefully acknowledged.