BUSINESS MODEL 8

Combined heat and power from agro-industrial waste for on- and off-site use

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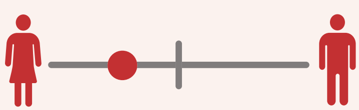
A. Key characteristics

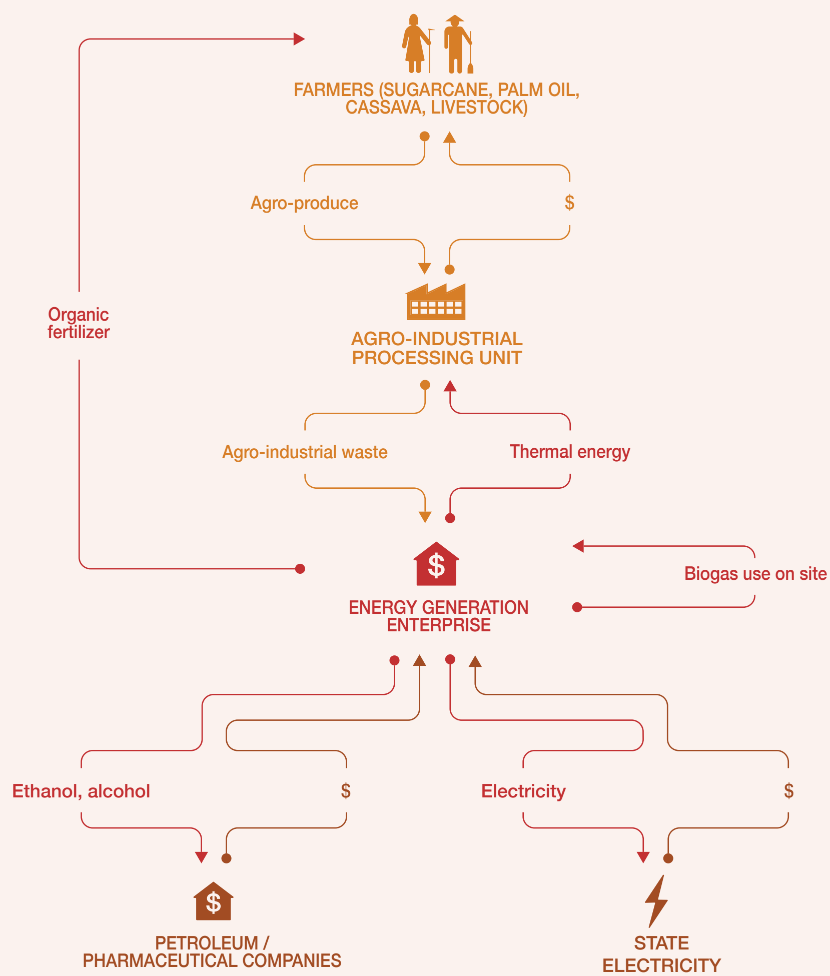
Model name	Combined heat and power from agro-industrial waste for on- and off-site use
Waste stream	Agro-industrial waste – Bagasse from sugar processing factories; Effluent (solid and liquid waste) from agro-industrial units like cassava starch, palm oil and slaughterhouse
Value-added waste product	Electricity, biogas, thermal energy, carbon credit, bio-fertilizer
Geography	Regions with larger agro-industries
Scale of production	Small to large scale 15 KW of power from slaughterhouse waste; 1.4 MW–2.8 MW of electricity annually from effluent from cassava starch and palm oil mills 12 MW–34 MW of electricity from sugar-processing factories
Supporting cases in the book	Mumais district, Kenya; Maharashtra, India; Bangkok, Thailand
Objective of entity	Cost-recovery [X]; For profit [X]; Social enterprise [ ]
Waste removal capacity	About 1.3 million tons of bagasse from crushing 3–4 million tons of sugarcane; 4,000 L/day of wastewater from slaughterhouse; 25,000 m^3/day of wastewater from agro-industrial units
Investment cost range	1.16–1.85 million USD/MW of electricity from sugar-processing factories 2–2.6 million USD/MW of electricity from agro-industrial effluent
Organization type	Private
Socio-economic impact	Reduce environmental pollution by substituting fossil fuel based energy (1.4–34 MW) and by providing better waste management/reducing effluent, reduce fossil fuel dependence, employment generation (5–200 jobs depending on scale)
Gender equity	Access to electricity to local community by replacing kerosene used for lighting resulting in clean working environment for women from clean indoor air 

B. Business value chain

This business model can be initiated by industrial factories in order to create additional value and revenue by generating energy from their organic waste by-products. By-products include agro-industrial waste such as bagasse and molasses from sugar-processing factories, and wastewater from cassava, palm oil and slaughter-house industrial factories. The technologies applied and the resulting energy products vary depending on the type of waste processed. These include 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. Production technologies such as combustion and covered lagoon bio-reactor are suitable for processing bagasse and wastewater to produce biogas. Figure 103 depicts the value chain for on-site energy generation from an agro-industrial waste business model. The electricity produced by the co-generation unit or by the covered lagoon bio-reactor is sold to the state utility on a long-term power purchase agreement. The alcohol/ethanol produced from the distillery unit of sugar-processing factories is sold to petroleum and pharmaceutical companies, while the energy produced by the biogas unit is used on-site as input fuel to the co-generation unit. The discharge from the biogas unit, which is high in organic matter, can be distributed to farmers to be used as bio-fertilizer.

The ownership and operation of the energy-producing units take different forms. The energy-production technologies are either designed, constructed, owned and operated by the factory or are installed by an external private enterprise on a BOOT model. In the latter case, the enterprise brings investment to

FIGURE 103. GENERIC VALUE CHAIN FOR COMBINED HEAT AND POWER FROM AGRO-INDUSTRIAL WASTE FOR ON- AND OFF-SITE USE MODEL



set up the energy production technology while the concessionaries i.e. the factories provide land and inputs. The enterprise designs, constructs, trains and maintains the energy production unit until the BOOT period expires, after which it assists the host company in operating the unit.

C. Business model

This business model involves processing of waste by-products from an agro-industrial factory in order to generate and sell electricity to the national grid through a long-term power purchase agreement (Figure 104). By-products are heat which can be fed back into the industrial process, resulting in energy savings, and ethanol which can be sold to petroleum and pharmaceutical companies. Additional revenue can be generated from registering the model as a CDM project and earning money from selling certified carbon emission reductions.

D. Potential risks and mitigation

Market risks: The outputs, electricity and alcohol (ethanol), are sold to different markets and hence face different market risks. The electricity is mainly sold to state electricity grid on a long-term power purchase agreement, while ethanol is sold to petroleum or pharmaceutical companies. The growing demand for electricity in developing countries reduces the market risks in terms of ensuring sales.

FIGURE 104. BUSINESS MODEL CANVAS – COMBINED HEAT AND POWER FROM AGRO-INDUSTRIAL WASTE FOR ON- AND OFF-SITE USE

KEY PARTNERS
- Out-growers
- State government
- Concessionaries
- Technology developers

KEY ACTIVITIES
- Build, operate, own and maintain energy producing unit
- Sales of electricity and ethanol
- Managing CDM process and obtain emission reduction credit

KEY RESOURCES
- Equipment
- Agro-industrial waste
- Technical and operational competencies
- Capital
- Power purchase agreement
- Improved farmers' productivity

VALUE PROPOSITIONS
- State utility obtain competitively-priced renewable electricity
- Petroleum, alcohol and pharmaceutical companies obtain alcohol and ethanol for blending
- Farmers obtain fertilizer rich in organic matter
- Tradable carbon credits to meet carbon emission reduction commitments

CUSTOMER RELATIONSHIPS
- Long-term contract
- Long-term contract
- Personal
- Dedicated web interface for registering CDM project online (Semi-automated)

CHANNELS
- Connection to state electricity grid
- Alcohol/ethanol purchase agreement
- Direct
- Carbon credit trading platform

CUSTOMER SEGMENTS
- State electricity grid
- Petroleum, alcohol and pharmaceutical companies
- Farmers
- Annex 1 countries

COST STRUCTURE

- Capital investment (co-generation unit, distillery and biogas unit)
- Input cost
- Interest on borrowed fund
- O&M
- Marketing for alcohol/ethanol sales
- Reduced operational costs from using own electricity and thermal energy
- CDM administration-related costs

REVENUE STREAMS

- Sale of electricity
- Sale of alcohol/ethanol
- Sale of compost
- Sales of carbon credit

SOCIAL & ENVIRONMENTAL COSTS

- Possible flue gas emissions and fly ash from boilers
- Significant water requirement
- Possible contamination of water source
- Possible human health hazard from direct contact to pathogens that may still exist from the organic fertilizer
- Laborers' health risk due to contact with agro-industrial waste
- Environmental risks from biogas leakage to the atmosphere

SOCIAL & ENVIRONMENTAL BENEFITS

- Climate change mitigation through use of non-fossil fuels
- Livelihood, advice and support to out-grower farmer members
- Creation of jobs
- Expanding access to electricity to local communities
- Reduced environmental pollution from waste effluents

However, in environments where 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 medium. In such situations, the feed-in tariff policy announced by the government will protect the interest of the renewable-energy-based power producers. Ethanol/alcohol is sold to various industries and with the introduction of government requirements for ethanol blending of fuel, ethanol will have various buyers and less market risks. However, in countries where ethanol blending is not mandatory, the business will face competition from other fossil-based substitute products. In sharp contrast to the ensured sales of electricity to state utility, the carbon credit market is considered to be volatile and this puts the sustainability of the whole reuse business under risk if carbon credit sale is the major revenue stream. In such scenarios, the business has to diversify its revenue streams so as not to entirely depend on the sale of carbon credits.

Competition risks: The risk associated with output market is low. The electricity is sold to state utility on a long-term contract, and hence has a ready buyer. With the introduction of government requirement for ethanol blending, ethanol has various buyers and less competition risk. Competition risks exist in the input market. In the case of sugar-processing factory, the cogeneration units are designed to process only a specific kind of input, i.e. the by-product from processing sugarcane and its operations depend heavily on the continuous supply of sugarcane from its suppliers. In scenarios where the inputs are sourced from the sugarcane growers, the competition in the sugar commodity market will affect the decision of sugarcane growers. For instance, fluctuating sugar prices might force farmers to shift to other crops, and this will affect the operations of the cogeneration and distillery units of the sugar-processing factory. This risk can be mitigated by forming a cooperative sugar factory which is vertically integrated and owns the raw materials and agro-waste.

Technology performance risks: The technologies applied for processing agro-industrial waste from sugar-processing factories as well as for processing wastewater are well-established, robust and mature with high flexibility to changing wastewater volumes and quality. However, the technologies require skilled labor for construction as well as O&M of the plant.

Political and regulatory risks: With the projected electricity demand set to grow, governments are encouraging green power initiatives by putting in place various incentive mechanisms such as concessional loans, feed-in tariff mechanisms and through long-term power purchase agreements. Thus, the risk is fairly low.

Social-equity-related risks: The model is considered to have more advantages to women if excess electricity generated by these agro-industries is supplied either for rural electrification or fed to the grid. Since access to electricity to local community will help replace kerosene used for lighting resulting in clean working environment for women from clean indoor air. Modern energy access will also benefit the community from increased productivity. If the energy generated is used for agro-industries internal use, then the model is gender neutral. The social-equity risks from the model are limited; however, the agro-industry could consider under their corporate social responsibility to improve energy reliability in neighbouring community.

Safety, environmental and health risks: The environmental risks associated with co-generation units include possible leakage of gas and emission of flue gas and fly ash. These emissions should be controlled within acceptable limits by putting in place suitable equipment. The safety and health risks to human arise when processing waste from agro-industry, especially meat production. Proper mitigation measures should be put in place to protect laborers, farmers, consumers and surrounding communities (Table 29). Another issue is with respect to the water requirement for the energy-producing units. The water requirement can be high, and thus competes with uses for other purposes such as irrigation. This has important implications in terms of evaluating trade-offs for competing uses.

TABLE 29. POTENTIAL HEALTH AND ENVIRONMENTAL RISKS AND SUGGESTED MITIGATION MEASURES FOR BUSINESS MODEL 8

RISK GROUP	EXPOSURE ROUTES					REMARKS
	DIRECT CONTACT	AIR	INSECTS	WATER/ SOIL	FOOD	
Worker	Low risk	Low risk	Medium risk			Risks apply to the use of slaughterhouse waste, and its management, including fly control
Farmer/User	Low risk					
Community			Low risk	Low risk		
Consumer					Low risk	
Mitigation measures						

Key: NOT APPLICABLE; LOW RISK; MEDIUM RISK; HIGH RISK

E. Business performance

The business model scores high on environmental impact as it avoids environmental pollution from large agro-industrial factories and generates renewable energy on a large scale, substituting fossil-fuel-based energy sources, and thus resulting in reduced GHG emissions (Figure 105). This business model is scalable and replicable in countries where there are large agro-industrial factories and where there is government support such as provision of concessional loans and feed-in tariff mechanisms for renewable energy initiatives and government's directive on blending of ethanol with petrol/gasoline as transportation fuel. The ranking of other factors scores significantly low in comparison to environmental impact.

FIGURE 105. RANKING RESULTS FOR ON-SITE COMBINED HEAT AND POWER FROM AGRO-WASTE BUSINESS MODEL