BUSINESS MODEL 4

Biogas from kitchen waste

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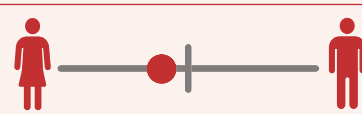
A. Key characteristics

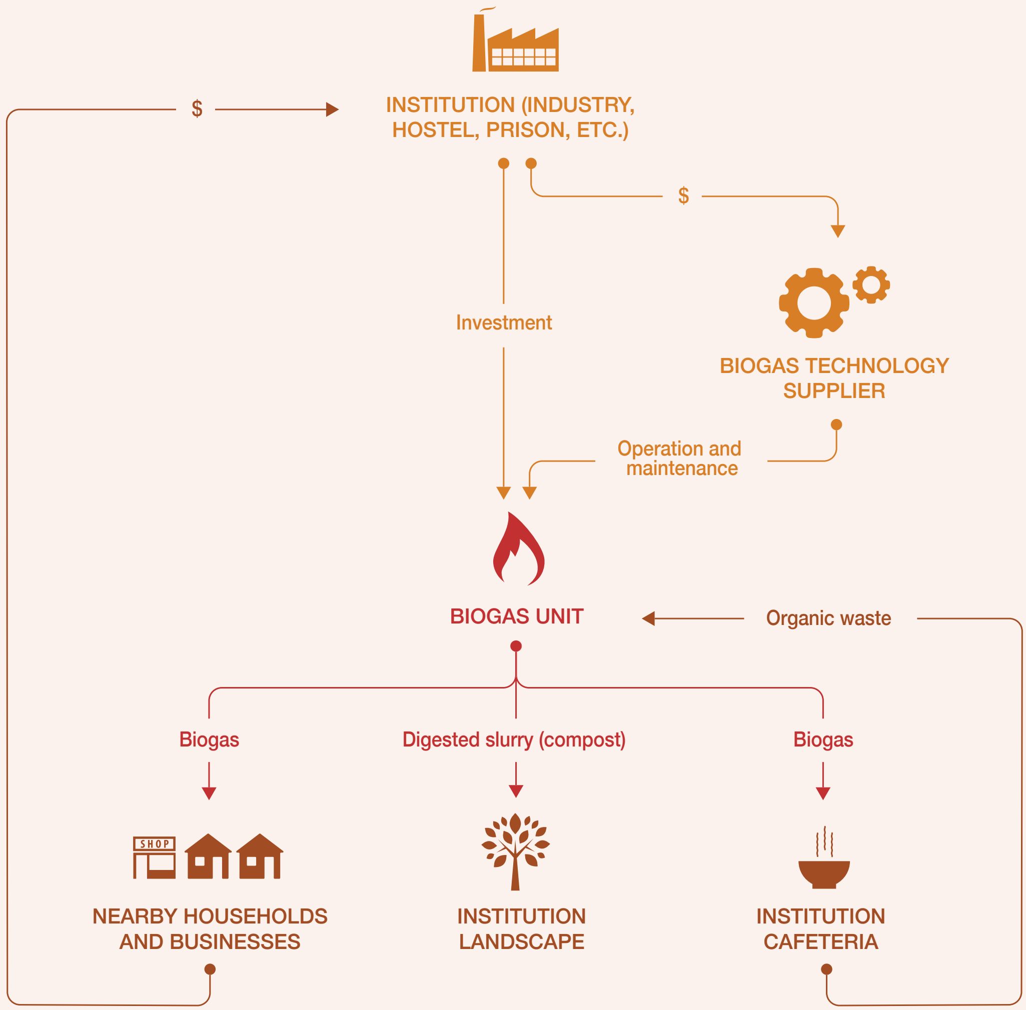
Model name	Biogas from kitchen waste
Waste stream	Kitchen and food waste
Value-added waste product	Biogas as fuel for cooking through anaerobic digestion of kitchen and food waste
Geography	Institutions with large kitchen facility to cook for large number of people
Scale of production	Medium scale; About 100–300 m^3 of biogas per day used to cook food for around 3,000 to 7,000 employees and about 1 to 4 tons/day of sludge as compost
Supporting cases in this book	Bangalore, India
Objective of entity	Cost-recovery [X]; For profit [X]; Social enterprise [ ]
Investment cost range	About USD 75,000 to 125,000
Organization type	Private
Socio-economic impact	Environment-friendly cooking fuel, reduced greenhouse gas emissions; carbon emissions offset from avoided municipal waste landfill and also replacement of LPG/coal/liquid fuel which otherwise would have been used for cooking, improved organic waste management results in reduced pollution of local water bodies and employment generation
Gender equity	Mostly gender neutral; but with benefits through improved indoor air and working environment for women operators/chefs 

B. Business value chain

The business model could be initiated by institutions such as industries, hostels, hospitals, prisons and schools with large cafeteria and kitchen facility that generate large quantities of kitchen waste and food waste. Alternatively, it can be initiated by a technology supplier who provides waste management solution to the institutions. The business concept is to process organic waste from kitchen and cafeteria to generate biogas. Biogas can be used for internal use to cook food in the cafeteria's kitchen or can be sold to nearby households and businesses. Biogas can also be used to generate electricity. The digested slurry (compost) can be used within the institution for landscaping or sold to local farmers (Figure 48).

The key stakeholders in the business value chain are the waste suppliers, institution, technology supplier and end users of the product – the institution itself or household and businesses. The biogas plant can also be fed with other organic waste such as biomass (leaf litter) and sewage sludge generated within the institution premises. The business is eligible for sale of carbon as the thermal energy for cooking is generated from sustainable biomass source instead of using LPG/coal or other liquid fuels

FIGURE 48. VALUE CHAIN OF BIOGAS FROM KITCHEN WASTE



and improved organic waste management as organic waste left in the open releases methane to the atmosphere. Alternatively, this business model can use the biogas to generate electricity especially if the institution is not connected to grid.

In the business model, there is scope for a private technology enterprise, an energy service company, who could get into Build, Own, Operate, Transfer (BOOT) arrangements with the institution. The private entity could bring all investment to set up the biogas technology while the institution provides land and kitchen waste inputs. The private entity designs, constructs and maintains the biogas unit, and sells biogas and digested slurry to the institution. This is done until the BOOT period is expired, after which it transfers ownership of the plant to the institution and assists it to operate the unit on a chargeable basis. The BOOT period can range from three to five years until the investment made by the private technology enterprise is recovered.

C. Business model

The value proposition of the business model varies to some extent with the ownership and the entity driving the business initiative. In the case where the institution is the owner and is driving the initiative, the emphasis is on the management and cost reduction, while it is more on the service provision in the BOOT case. In both cases, the value proposition is to better manage organic waste generated by the institution in an environmentally responsible manner, as well as to generate biogas from food waste for kitchen use. As mentioned above, depending on the connectivity to the grid, the model can offer either electricity or biogas as cooking fuel (Figure 49). Finally, the model also offers the provision of organic compost using the bio-slurry output from the biogas plant that can be used for internally, e.g. for landscaping or sold to local farmers.

If the institution is owner and operator of biogas unit and uses it internally, it incurs substantial savings from avoided fuel purchases for cooking. The business model has scope to sell either entire or excess biogas generated to nearby households and businesses. The model requires the development of a partnership with a biogas technology supplier whose assistance is critical in the initial stages of operation and maintenance until local labor is trained. The key activities include the production of biogas and the key resources are land, equipment, biogas technology and sourcing of the waste.

FIGURE 49. BUSINESS MODEL CANVAS – BIOGAS FROM KITCHEN WASTE

KEY PARTNERS
- Equipment suppliers
- Carbon trading partners

KEY ACTIVITIES
- Kitchen and organic waste collection and segregation
- Biogas generation and use in kitchen
- Maintenance of biogas plant
- Managing VER process
- Compost production
- Landscaping using digested slurry

KEY RESOURCES
- Consumables (MSW and peat)
- Human resource
- Capital and land
- Certification by regulator
- Equipment

VALUE PROPOSITIONS
- Improved management of kitchen and organic waste generated by the institution in environmentally responsible manner
- Environment friendly fuel for cooking
- Low-cost organic compost from bio-slurry by-product from biogas digester

CUSTOMER RELATIONSHIPS
- Direct interaction

CHANNELS
- Direct sales
- Carbon market agents

CUSTOMER SEGMENTS
- Institution, households and businesses
- Institution and potential for households with gardens/ local farmers
- Carbon market

COST STRUCTURE

- Investment costs – land, building and Equipment and gas distribution lines
- O&M costs – training, utilities, labor (can be intensive and skilled labor)
- Costs incurred for VER registration and carbon sale
- Savings – cooking fuel, compost costs and cost of disposal of kitchen and cafeteria waste

REVENUE STREAMS

- Sale of surplus biogas
- Sale of carbon credit
- Sale of surplus digested slurry (compost)

SOCIAL & ENVIRONMENTAL COSTS

- Potential leakage of gas
- Potential occupational health risks from handling machinery and equipment for workers at production facility
- Potential environmental risk if the organic waste is not treated and disposed properly, particularly possible exposure to pathogens

SOCIAL & ENVIRONMENTAL BENEFITS

- Creation of jobs for low-income workers
- Reduction of pollution of water bodies and natural habitats
- Reduction of human exposure to untreated waste
- Climate change mitigation and reduction in GHG emissions
- Improved waste management and treatment at the source contributes to reduced MSW management for the government

The business model primary revenue is from sale of biogas to nearby household and business; however, as mentioned above, when biogas is internally used, it offers operational costs savings for the institutions from avoided fuel purchase for cooking. In addition to energy, a key output from biogas plant is digested slurry (compost), which is rich in nutrients and can be processed to make organic compost that can be used for landscaping within the institution premises. Thus, there is additional savings for the institution from avoided purchase of fertilizer. The biogas model is eligible for carbon offsets. If the biogas plant size is too small to be viable to apply for Clean Development Mechanism (CDM) projects due to associated transaction costs, another preferred route would be to apply for carbon offset on the Voluntary Emission Reductions (VERs) market, or bundle with other similar projects for combined registration as CDM project.

D. Potential risks and mitigation

Market risks: The market risk does not exists if the business is initiated by the institution and the biogas and compost are used internally within the institution. However, in the case of private biogas supplier initiating the business, there is potential risk of the institutions' willingness to participate for a BOOT arrangement. Based on the economics the institution is likely to incur savings and there are no high risks associated except if the biogas plant is not treating the organic waste properly and is causing environmental pollution. If the business has high dependence on sale of carbon credit for its viability, the volatility of carbon credit market puts the sustainability of this reuse business under risk. In such scenarios, the business has to diversify its revenue streams by using biogas and compost productively so as not to entirely depend on the sales of carbon credits.

Competition risks: The business risk for the output is present if the competing fuel source provides higher economic benefits. However, in this business model, there is the cost incurred by the institution to purchase cooking fuel is reduced significantly with biogas plant installed. With short payback periods of three to five years, before the life cycle of the biogas plant, investment cost of the plant and its operation cost is completely recovered.

Technology performance risks: The technology process used is anaerobic digestion, which is well established and mature. However, the type of digester required could potentially be sophisticated and might not be available in developing countries, and in addition the technology requires skilled labor. It is ideal for the business to transfer the technology from a market where it is widely implemented and have their staff trained in repair and maintenance of the technology to mitigate the performance risks.

Political and regulatory risks: In most developing countries, price of cooking fuels such as kerosene and Liquefied Petroleum Gas (LPG) are subsidized for domestic consumption. If the government has similar policies for commercial entities and institutions, it can diminish the economic advantage offered by the biogas plant and hence making this business model less viable. Lately, governments are encouraging green initiatives by providing incentives such as concessional loans and accelerated depreciation benefits. Policies supporting green initiatives make this business model highly attractive.

Social-equity-related risks: The model does not have social equity risks. The model is mostly gender neutral and the benefits are accrued by the institution generating waste with limited or no employment creation.

Safety, environmental and health risks: Safety and health risks to humans arise when processing any type of waste. Laborers in such enterprises should be provided with appropriate gloves, masks and other appropriate tools to handle the waste to ensure their safety. The risk of environment pollution is high if leachate from kitchen waste seeps into groundwater or other natural water bodies. The waste processing technologies are not without problems and pose a number of environmental and health risks if appropriate measures are not taken. The environmental risks associated with the anaerobic digestion units include possible leakage of gas and these emissions should be controlled. Organic waste when left in open begins to decay and releases methane, which is more damaging to the environment than carbon dioxide. There is a very limited chance that the compost made from digested slurry potentially could have risks of pathogens (Table 16).

TABLE 16. POTENTIAL HEALTH AND ENVIRONMENTAL RISK AND SUGGESTED MITIGATION MEASURES FOR BUSINESS MODEL 4

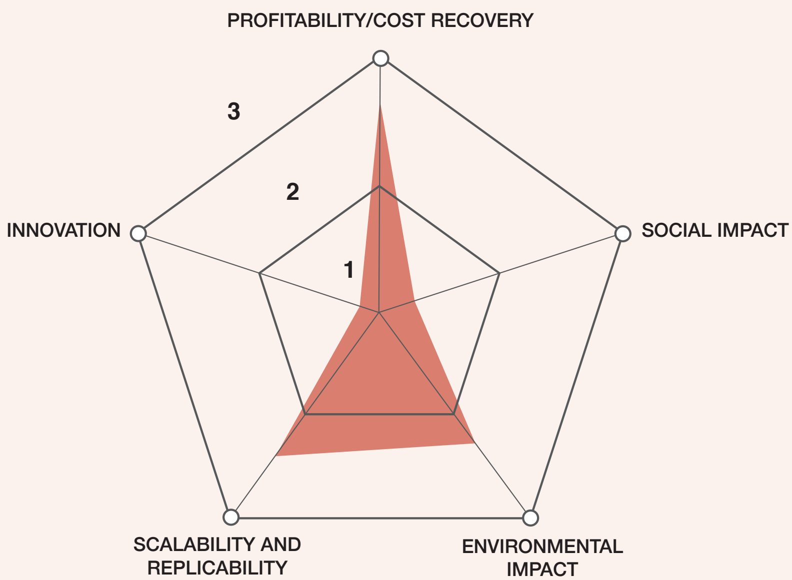
Risk group	Exposure					Remarks
	Direct contact	Air	Insects	Water/Soil	Food	
Worker						Risk to workers through direct contact with waste and compost can be mitigated using protective equipment and gear.
Farmer/user						
Community						
Consumer						
Mitigation Measures						

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

E. Business Performance

This business model is rated high on cost-recovery and positive environment impact followed by replicability (Figure 50). The business model doesn't have a strong revenue source. However, it is based on cost recovery through savings incurred from avoided fuel expense. In addition, due to it environment friendly aspects, it offers scope for revenue from sale of carbon. The business model has a high potential for replication in developing countries with no limiting factors except for the technology. However, on scalability it scores low.

FIGURE 50. RANKING RESULTS FOR BIOGAS FROM KITCHEN WASTE BUSINESS MODEL



The environmental impact scores high because of high replication potential that the business model offers that could result in safe management of organic waste and reduced burden on the government machinery to manage solid waste. In addition, it offers reduced greenhouse gas emissions. The business model scores low on innovation and social impact. The technology and financing required is fairly straightforward. The social impact scores low due to low job creation and on a comparative basis with other business models managing solid waste, net impact on social development indicators is low.

5. BUSINESS MODELS FOR SUSTAINABLE AND RENEWABLE POWER GENERATION

Introduction

Over 1.2 billion people do not have access to electricity, a majority of them living in countries in Africa and Asia. SDG 7 thus calls to ensure access to affordable, reliable, sustainable and modern energy for all, and to increase substantially the share of renewable energy in the global energy mix by 2030, including energy derived from waste, biogas and biofuels (SDG 7.2). In developing countries, governments are promoting power generation from various agro-industrial waste and municipal solid waste (MSW) streams to improve access to energy and ensure long-term security of power supply. The recent high energy prices, coupled with environmental and financial incentives such as carbon financing and modern biomass energy options such as biomass-based energy generation, are becoming economically attractive in low-income countries. Depending on the waste source and end use of the power generated along with the ownership structure of the entity generating power, the business model can take various forms:

- **Business model 5: Power from manure** – Livestock management and the related industry are important components to the growth of the economy and an important source of livelihood in developing countries. Livestock industry results in large quantities of livestock manure, which if not managed properly pollutes waterways and generates greenhouse gas emissions. However, it also presents an opportunity to harness energy in the form of biogas or electricity on a commercial scale. Business Model 5 demonstrates that through sustainable market mechanisms, successful commercial biogas systems could be implemented.
- **Business models 6 and 7: Power from agro-waste and power from MSW –** In this business model, a social enterprise or private entity which is not a public utility generates power and sells electricity either to utilities or directly to households or businesses. The models are typically focused in regions with communities that do not have access to reliable energy and is one of the key modes to achieve SDG 7 indicators. The business cases discussed take different ownership structure and are initiated by a standalone private enterprise or are set up as social enterprise or as public-private partnerships. While there is increasing need for waste-to-energy plants, high variations in the calorific value of unsorted wet MSW make the business highly dependent on subsidies, which are justified given the large waste volume reduction. However, in this energy section, the focus is on organic waste valorization and not waste in general, thus we did not include waste incineration cases in our selection.
- **Business model 8: Combined heat and power from agro-industrial waste for on- and off-site use –** Majority of large-scale agro-industries such as sugar processing factories, cassava, palm oil and slaughterhouse industrial units in developing countries are diversifying into usage of agro-industrial waste produced during the process into a value-added by-product through co-generation. Energy generation from own agro-industrial waste also referred to as on-site energy generation model is driven by the need for agro-processing units to reduce their energy costs. In addition, these units explore new revenue streams from selling excess energy. The power generation technologies are either designed, constructed, owned and operated by the agro-industrial processing factory or are installed by an external private entity on a Build, Own, Operate, Transfer (BOOT) model. The business model offers a multi-value proposition as it not only allows agro-industries to be self-sufficient in energy while disposing of their waste sustainably, but also secures additional revenue streams by exporting excess renewable electricity to the national grid along with trading of carbon credits.

These business models have been successfully implemented in Latin American, African and Asian countries with cases presented from Brazil, Peru, Mexico, India, Kenya and Thailand. Policies, regulations and institutions play crucial roles in the successful implementation of these business models through appropriate national policies, programs and fiscal incentives. For example, a number of policy reforms in the Kenyan power sector have liberalized the energy-generation sector thereby paving the way for independent power producers (IPPs) such as Mumias Sugar Company (MSC) to participate in power generation. A number of domestic and international programs to support bagasse-based cogeneration in India were launched which promoted the advancement of co-generation plants in India. These support programs include extension of loans for cogeneration by the Asian Development Bank (ADB) through the Indian Renewable Energy Development Agency (IREDA), capital and interest subsidies, research and development support, accelerated depreciation of equipment, a five-year income tax holiday and excise and sales tax exemptions by the Ministry of Non-Conventional Energy Sources (MNES).

The cases on livestock industry will for instance, demonstrate the role of industry such as the meat or dairy industry in promoting sustainable development in the livestock sector through the implementation of innovative financing schemes to set up biogas systems in the livestock farms to be energy self-sufficient while earning additional revenue through carbon credit market (Sadia case in Brazil). The cases will also highlight effective partnership amongst a range of stakeholders and community-led strategies coupled with market mechanisms to lead to the successful implementation of a rural electrification program.

Thus, depending on local conditions in the respective countries on renewable energy policy, institutional set-up and power purchase agreements, the cases provide a broad range of innovative partnership structure, value chain, market and pricing mechanisms.