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**Greener Business Models: A Journey from Petrochemicals to Biogas**

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# **Greener Business Models: A Journey from Petrochemicals to Biogas**

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## List of Abbreviations

PVC	PolyVinyl Chloride
CE	European Conformity
MSW	Municipal Solid Waste
SWM	Solid Waste Management
CCS	Centre for Consumer Study
IIPA	Indian Institute of Public Administration
MoEF	Ministry of Environment and Forests
CO <sub>2</sub>	Carbon dioxide
CAGR	Compound Annual Growth Rate
CH <sub>4</sub>	Methane
CO	Carbon monoxide
H <sub>2</sub> S	Hydrogen Sulphide
O <sub>2</sub>	Oxygen
NH <sub>3</sub>	Ammonia
LPG	Liquid Petroleum Gas
PPM	Parts Per Million
GHG	Greenhouse Gas
HDT	Heat Deflection Temperature
MPa	Megapascal
PSI	Pound Per Square Inch
MS	Mild Steel
IGST	Integrated Good and Service Tax
IPR	Intellectual Property Right

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## **Executive Summary**

In many developed countries of the world, the rate of research and technology development is speeding up with lots of positive results. Most of the companies even recruit employees for the research purpose, so that, they can diversify their portfolio by commercialising the best research output. However, a productive commercialisation requires an innovative idea and a feasible way to make that plan or idea truly work. This paper presents an overview of a promising technology for anaerobic digestion of organic waste that is, rigid PVC micro biogas digester, for a developing country like; India and also the market potential for biogas digester is identified. The main aim of this project is to put up the workable business plan for the commercialisation of PVC micro biogas digester. To accomplish the given task efficiently by understanding how well our product can respond to the needs of a specific customer segment, target market research, customer and competitor analysis have been done by using different tools such as: SWOT analysis, market segmentation, the business model canvas, Porter's five forces model and IFRS financing model. All these studies were based on literature review. These market reading tools helps to ensure that every external-facing step a company need to take to introduce their newly manufactured product to their customer, are well addressed in the business plan. From the literature review, it is found that a developing country, India, due to the availability of abundant resources of organic waste and the needs of adequate technology for the treatment of those waste in urban setting for single households, is convenient for proposed distinctive PVC micro biogas digester, with high potential.

Key Words: Micro biogas digester, organic waste, biogas

# 1 Company Overview

A large multinational petrochemical company, headquartered in Norway is engaged in developing, manufacturing, and distributing and selling polymer-based construction materials like; synthetic fibres and rubbers, paints, epoxy resins, flooring and insulating materials etc., for industries and households, is now looking for a new and innovative way to achieve the economic benefits of a large-scale production plant while maintaining the benefits of small-scale operations. Through the production of the greener or bio-based product, the company is looking to diversify its product portfolio in new as well as existing markets with significant long-term growth potential by creating a positive impact throughout the world.

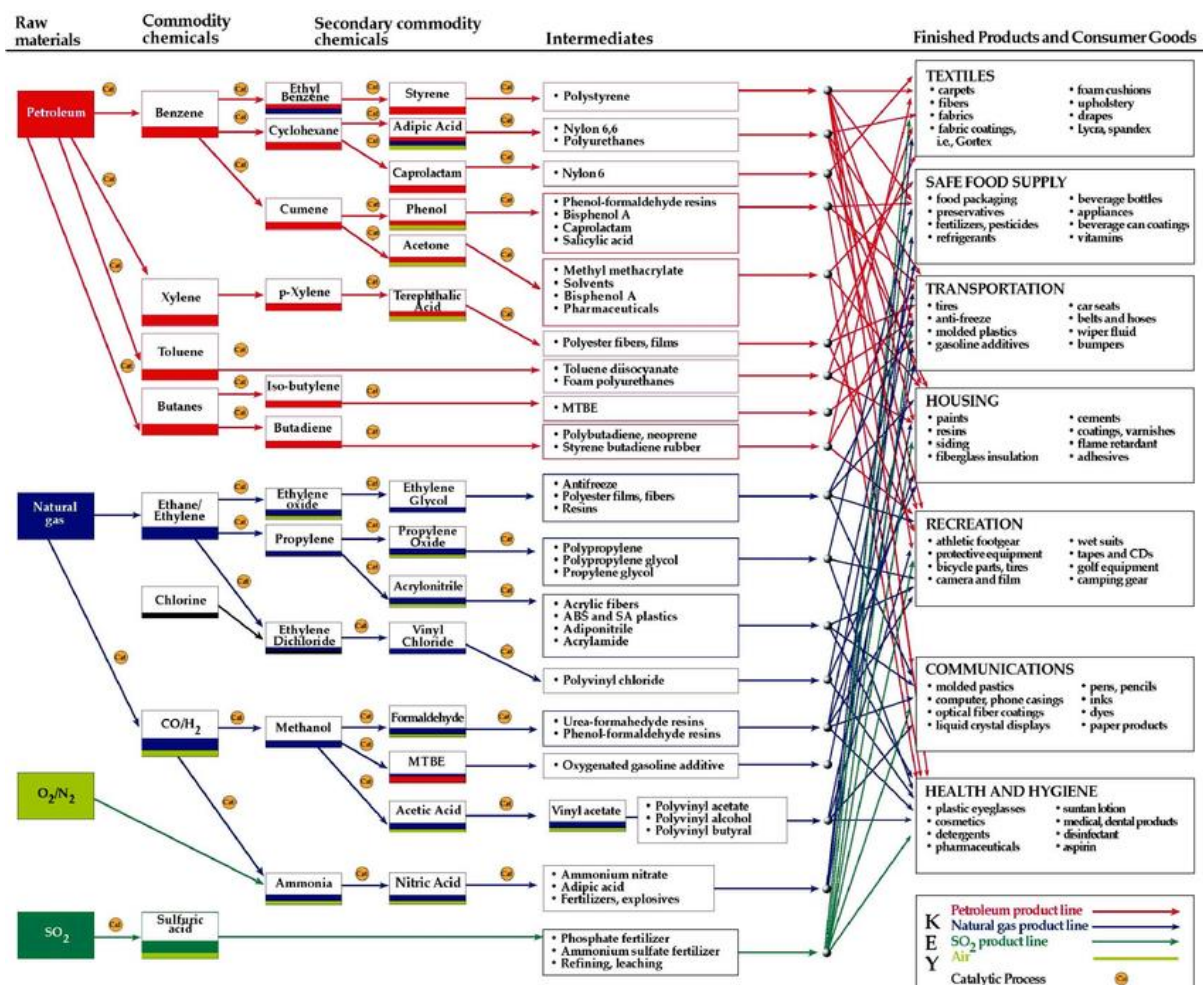


Figure 1: Example of flowchart for the products that a company is producing from Petroleum-based-feedstocks (Werpy et al., 2004).

## **2 Business Overview**

### **2.1 Introduction**

The purpose of this introduction section is to interest the reader to the subject of a business plan and to portray sufficient background information about the problem area.

Despite the development and instalment of different technologies and awareness in the society, there are no signs of declining organic waste management problem in many developing countries due to the lack of affordable, adoptable and adequate technology (Hettiarachchi, Meegoda, & Ryu, 2018). Many developed countries have produced and trying to propose the solution to developing countries in order to extend their market in international level but not all the solutions practiced in and by developed countries fit to the developing country contexts. The local conditions and limitations of the target country must be taken into the account while proposing the option to that country (Lin, Xu, Ge, & Li, 2018). With increasing human population, generation of organic waste is expected to continue increasing, which has become a global issue. If not properly handled, the large volume of organic waste may deteriorate air, water, and soil quality, resulting in significant impacts to food, energy, and water supplies. Thus, reuse and treatment of organic waste play an essential role in our business plan (Gupta, Gautam, Shukla, & Nair, 2019).

Anaerobic digestion is the most cost-effective technology for handling with organic waste at the source, both in economic and environmental terms. Biogas systems which utilize anaerobic digestion, process organic waste into biogas, which can be used for cooking, heating or lighting, as well as bio-slurry as another end product can be used as a green liquid fertilizer instead of chemical fertilizer in the market. Current commercial on-site biogas systems are either basic (made up of plastics) or still traditional, low-capacity systems targeting families and farm (agricultural and livestock) in rural settings or expensive or high-capacity systems oriented towards agricultural and food processing industries. Individual households or homes in urban and semi-urban settings that generate moderate amounts of organic waste are forced to rely on municipal waste collection and therefore pay a significant expense incurred. In this present context, there are no any adequate biogas systems available for urban individual households who donot have agricultural land and enough space outside the house to install the biogas system, when compare to other existing systems (Pandey et al., 2021). PVC micro biogas digester is the solution that will link these problems, in such a way that is beneficial to

both individual households and company by converting their organic food waste into value that is biogas and green fertilizer which are clean and free energy. Currently, looking at many biogas systems and their properties in the market, we still have a space to introduce our unique product in Indian market. Taking PVC micro biogas digester in hand, we will target a completely different category of end users for start-up, higher and middle-class individual households who have or have not a garden outside their houses, residing in urban part of Delhi, India. Our PVC micro biogas digester will present the smallest footprint and shortest installation time in relation to its capacity which is also suitable for indoors, rooftops and backyards, and provides advance features in line with those of biodigesters in market twenty times more expensive. Though the plant is suitable for indoors, it is best not to install inside the house due to the safety hazard should the gas escape. A plan is to introduce a family-sized micro biogas digester. The design of biodigester is taken from the CE certified for safety and health and application proven design, now, will be applied to the urban single households using organic food wastes from kitchens and green garden wastes which is more efficient feedstock chosen than other traditionally used.

The PVC micro biogas digester project is perfectly fall into the line of the flagship scheme “Swachh Bharat Mission”/ “Clean India Mission” which has been launched by Government of India in 2014 to work importantly on the waste generated from different practices and convert it into products that are either useful for humans, animals or for agricultural land (Scarlat, Dallemand, & Fahl, 2018). The National Biogas and Manure Management Programme (NBMMP) lately promotes the instalment of family-sized biodigester for producing biofuel for cooking and organic fertilizer and also to support an initiative for a resource-efficient India and low carbon economy (Scarlat et al., 2018). Together with customer needs, these initiatives taken by government to promote the flagship scheme also help to estimate the result in a high demand for biodigesters. Besides this, it will not be inappropriate that our biodigester itself become pain point for our customers regarding the utilisation of biogas and bio-slurry at the end, because the ultimate goal is to develop a sustainable and commercial micro biogas digester and enables our target customers to have better lives. So, our plan is to facilitate knowledge exchange, build and mobilize the partnership, do the further detail market research and evaluation, and find solution for those households who donot have garden areas outside and donot want to use by-product-fertilizer. Since, our start-up will be small, we will keep it simple. In the beginning, if anyone finds our biodigester’s output, ultra-rich green fertilizer useless, it can also be sold to the farmers bringing vegetables and fruits to the wholesale produce market

at lower cost, nearby our target customers. Because all wards in India have individual wholesale vegetable and fruits market. But if they know the benefits of organic liquid fertilizer they will use it to nourish home crops and gardens (Kumar et al., 2017).

## **2.2 India and household food waste generation**

According to the latest World Bank Study, India is the world's second most populous country with more than 1.27 billion people, and made the record of the world's highest waste-generating nation. Delhi, the capital city of India and largest metropolitan city with proper population 30.7 million has topped the list of Indian cities with maximum waste generation that is; 3.06 million tonnes. Since, population growth is a major contributing factor to increasing MSW, India is facing major environmental challenges associated with waste generation and inadequate waste management (Goswami, 2019). The population density, economic status of population, level of commercial activity, culture and city or region, these are the prime factors of maximum waste generation rate. As our target market is urban Delhi, it is an Indian city experiencing with high population density (Goswami, 2019). And it is not new that Delhi solid waste management is a major challenge in achieving sustainable development within a country. The waste generation in urban Delhi is approximately 0.62 kg per person per day whereas, among average solid waste composition, approximately 41% of total waste is organic generated from the households which is expected to increase by 5% per year with increasing population and changing lifestyles of people (Kumar et al., 2017).

As we are proposing the business plan of PVC micro biogas digester to treat organic household wastes and extract value from waste independently that could be energy or nutrients, which can provide a better livelihood to people. With the rising population in urban Delhi, the number of higher income families and the middle-class families is also rising with rapid economic growth along with their living practices and attitudes. According to the survey conducted by CCS, IIPA, New Delhi, it is found that the food waste at higher and middle-class household level is combinedly based on certain specific attitudes and attributes of the households which is upsurging day by day (Mathur, Singhal, & Ojha, 2014). With their high financial capacity, the importance of the food is being undervalued, the consumers are lacking the necessity to use the food efficiently in their daily practices. The foods are discarded unnecessarily due to their preferences (personal taste of food), labelling issues while buying and storing foods, lack of shopping planning and purchasing too much, storage condition (temperature), packaging issues, cooking too much food (in social gatherings, seasonal festivals, religious holidays,

weddings etc.). All these reasons contributing household food waste generation is directly related to the higher and middle-class family due to the urbanisation process and resulting concentration of non-agricultural population. This is why, it is clear that household waste generation in urban areas is quite higher than rural areas with maximum agricultural population (Mathur et al., 2014). Due to the inadequate secondary data and lack of sufficient previous study on household food wastage, actual figure could not be able to consider in this paperwork. But somehow it is found that urban Delhi has seen average monthly per capita expenditure of Indian rupees 3842 out of which 39.22% is spent on food and 60.78% on non-food items (Pandey et al., 2021).

### **2.3 Problems**

The organic waste production in India is enormous, and currently only a small fraction of this waste is being changed into value that is biogas and green fertilizer, which is not enough. Not only urban Delhi, also the city counterparts all over the India is facing major environmental challenges associated with waste generation due to the current failure system in India, to cope with volumes of wastes generated by an increasing urban population (Kumar et al., 2017). The current status of food waste management in Delhi is poor because of inefficient waste management facilities such as; waste collection, transport, treatment and disposal system, and this impacts directly on environment and public health. Though the waste management and handling rules in India were already introduced by the Ministry of Environment and Forests (MoEF), the availability of qualified waste management professionals with enough experience to deliver the improved systems is limited. Due to the lack of accountability in waste management system, the urban households are facing a lot of problems. Municipal authorities who are responsible for managing the wastes, are not provided with sufficient budgets from higher authority to cover the expenses associated with proper waste collection, transport, storage, treatment and disposal, which is why, door-to-door collection by waste pickers is not on time but still households need to pay the expenses incurred for waste collection on monthly basis. The lacking strategic plans, waste collection and a finance regulatory framework by the government are seemed to be current major challenges or problems in urban Delhi in waste management systems and also to retain easily available useful resources within the economy (Kumar et al., 2017).

Being a part of a company, looking for a new market, see an enormous opportunity within this situation in Delhi, India. This critical situation associated with improper waste disposal could

be significantly mitigated by proper material recovery facility, that would be our PVC micro biogas digester. Manufacturing and selling an on-site family size micro biogas digester to Delhi urban individual households would alleviate a social, environmental and economic problems in a very sustainable way by changing waste to valuable energy. The food and wet organic wastes like: food wastes, rotten meats, garden trash, vegetables and fruits peels, rotten fruits and vegetables etc. normally generated by the family in a residence in the course of ordinary day-to-day living contain more than double the energy potential per unit weight as compared to other organic wastes that is used in the production of biogas and green fertilizer. This is the same and massive in volume of waste which is neither disposed in proper manner nor utilize for waste-to-energy development with good records. However, the track record of waste-to-energy in urban Delhi highlighting some of the difficulties regarding ineffective traditional facilities and its failure due to various operational and design problems, seasonal variations in waste composition and properties, inappropriate technology selection, place and maintenance problems etc. (Gupta et al., 2019), build a good opportunity for us to settle our adequate PVC micro biogas digester in Indian market and make it sustainable. To see the record, all over Delhi, there are 294 wards, total waste generation by those wards is 10,500 (MT/D), and only 55% of waste is taken processing but again due to the lack of efficient technology, the productivity is comparatively low (Hettiarachchi et al., 2018).

## **2.4 Solution**

PVC micro biogas digester is a compact renewable energy production technology that will turns the organic wastes generated from the households into cost effective energy and soil nutrients by providing anaerobic condition within it. Through this service, PVC biodigester will provide easy access to enough clean gas to cook three meals a day or at least for three hours continuous cooking and a daily supply of 5-10 litres of free natural fertilizer, while reducing indoor air pollution and environmental problems. PVC biodigester will be the part of the solution to higher and middle-class single households with 4 to 8 family members, by managing their waste locally in their own backyard, also can be located in rooftop. PVC biodigester is a small-size, simple, effective apparatus that can produce a renewable energy through decomposition of organic waste with an anaerobic digestion process. Anaerobic digestion process is a two-part process while each part is performed by a specific group of microorganisms that is; acid forming and methane forming bacteria, in a balanced manner. An acid-forming bacteria breaks down a complex organic waste into simple organic compounds

whereas the breakdown of acids into methane and CO<sub>2</sub> is performed by methane-former bacteria (Abd & Adawi, 2008). As per the Census of India 2011, 94.03% of the total households are using LPG, 1.19% kerosene and 0.84% firewood as a primary source of cooking in Delhi while 99.69% of the total households are dependent on electricity for their lighting needs. Our biodigester will help to cut down this energy costs and fertilizer costs by self-productions with easy feeding. But it is not sure that everyone buying our biodigester will find the output useful, normally called digestate or bio-fertilizer. If they donot have any use of fertilizer, it can be disposed responsibly- as it may get flushed down to the toilet or sell it to the farmers bringing vegetables and fruits to wholesale market nearby in lower cost which will increase their soil productivity and crop yields (Radimin, 2018). The selection of this cost-effective product is done by taking several criteria into an account and lists of the viable products from product concept and selection phase can be found in appendix B.

We will offer the sleek rectangular easy to use and easy-to-assemble biogas plant that takes 2 hours for installation by two people. The size of an unit will be 2.0 cubic meter (48”\*65”\*39.4”) with digester chamber of size 1200 litres and gas storage chamber of 800 litres and weight less than 35 kilograms. A unit can use up 6 litres of food wastes to produce 3 hours cooking biogas and 5-10 litres of bio-slurry, it can just convert 1 kilogram of food waste into about 200 litres (7 cubic feet) of biogas which is more than enough fuel for an hour’s worth of cooking. In addition to the food waste, 1 litre of water need to be added for every litre of waste added. The digester will start to produce biogas in between 2 to 4 weeks after installation and then there will be a continual supply of biogas after the activation period. In comparison to other biogas plants, our PVC micro biogas digester will have 0.44 times more gas output (Gautam & Jha, 2020).



Figure 2: Feed and outputs of planned biodigester. Source: <https://www.rumblerum.com/home-biogas-system/>



The percentage of methane content in biogas produced from kitchen waste from our biodigester will be quite good. Because kitchen waste is the very good source in biogas production while composition of gas produced is approximately CH<sub>4</sub> 65%, CO<sub>2</sub> 35%, O<sub>2</sub> 11.7%, NH<sub>3</sub> 28 ppm, CO 0 ppm and 40 ppm of H<sub>2</sub>S. This high quality biogas can replace 3.064 kg of LPG per month or 36.768 kgs of LPG per year and outlet slurry 12.72 mg/g (Gautam & Jha, 2020).

*Table 1: Typical composition of biogas from organic wastes (Ghiandelli, 2017).*

Components	Concentrations (vol%)
CH <sub>4</sub>	55-70
CO <sub>2</sub>	35-40
H <sub>2</sub> O	2 (20 <sup>0</sup> C) – 7 (40 <sup>0</sup> C)
H <sub>2</sub> S	20 – 20 000 ppm (2%)
N <sub>2</sub>	<2
O <sub>2</sub>	<2
H <sub>2</sub>	<1
NH <sub>3</sub>	<0.05

## 2.5 Value proposition

The value of this business plan falls directly into one and only customer value segment. It has been seen that most of the business plans consider both customer value and social value. Although in the beginning, our proposal is just a small step towards solving organic waste problems in single households in urban, Delhi, we believe that our business plan is the identification of sustainable and replicable strategic plan to prove that our product's model works best and once it is proven, we can begin to play greater role in bigger market by inspiring our customers.

It is very important to highlight that our business plan is not to solve waste management problems in India, we are just grabbing the opportunities from those significant challenges and barriers regarding waste management to settle our business in completely new market. Firstly, to mitigate those problems a method to produce renewable energy and gain value from waste, should be a candidate for government financial assistance. And secondly, it is not 100% sure that our biodigester will be effective in reducing food wastes from households because our product is designed to produce a reliable and clean source of fuel. In future, people using our

biogas system may tends to produce more amount of food wastes instead of reducing, because the more food wastes the system is fed with, the cleaner energy will be generated.

- The PVC biodigester business model is convincing with two qualities that is simple and smart, to raise in completely new market.
- Feasible and a perfect match for urban households, who would like to start a full-cycle waste recovery system in the comfort of their home and get clean cooking gas and manure which can be even used for rooftop farming.
- A relatively affordable, easy transportation and installation, family-sized biogas unit.
- A reliable, health and cost-effective solution, giving people the power over the waste management (Gautam & Jha, 2020).



Figure 3: Advantages of home-biogas-digester. Source:<https://www.tradewheel.com/p/home-biogas-digester-decomposing-food-waste-1194725/>

## 2.6 Uniqueness of the idea: why us?

The unique value of our PVC micro biogas digester is a family-sized do-it-yourself kit, anyone can install it, recycle the waste from kitchen, and also from garden, and produce clean energy and fertilizer effectively, either from their backyard or from rooftop, without going through any biogas system installation application or learning the building process from YouTube (Greco, Comparetti, Orlando, & Mammano, 2022). Another unique and best part is, a kit is made up of economical, versatile PVC in rigid form, anyone can assemble anywhere since it is very easy and simple to put together (Thornton, 2002).

## **2.7 Vision**

Our vision is to be the leading supplier of PVC micro biogas digester in urban counterparts of India and promote sustainability by improving lives, and creating the positive impacts on the environment by mobilizing all the required expertise to supply clean and affordable energy.

## **2.8 Mission**

Our mission is to do good and be profitable being very first choice of residing customers over other alternatives by offering highly convenient, durable, cost-effective and user-friendly family-size biogas units with high quality and convincing design.

## **2.9 Core values**

We believe that our plan for the best approach to the biogas systems, will also offer the very best to our target customers based on our values:

- Affordable and accessible energy
- Quality and reliability
- Human health improvement
- Environmental protection

## **3 Materials and Methods**

In order to end up with the development of a business plan, a quantitative study based on the literature review was done. The literature search was done from different database such as: google scholar, PubMed and other websites of different reliable organisations to our study. Our study had to deal with the limited resources, so that, journals, new reports, internet, magazine etc are also considered as source of the information.

Different tools such as; SWOT analysis, the Business Model Canvas, Market segmentation, Porter's Five forces Model, Gantt chart, assumption chart and improved International Financial Reporting standards have been used to analyse and evaluate the project in this thesis. The SWOT analysis is used to identify and analyse a company's strengths, weaknesses, opportunities and threats, that helps in decision-making process. The Business Model Canvas is used to increase efficiency and effectiveness by identifying every interrelated aspect in business, while Porter's Five Forces Model helps in competitive analysis. The Gantt Chart for

operational planning, Assumption chart and International Financial Reporting Standards for financial projection are used in this thesis project.

For the development of business plan for new product, an Intellectual Property Right (IPR) search was also carried out to identify Freedom-to-operate. After identification of product and having key concept of product in mind, the patent search was carried out using the database that is; Google patent search.

Although this thesis project is all about the greener business model, the reason behind the selection of PVC biogas digester as a commercial product is, because there is no significant product alike us that has been developed and ruled the market till the date. The selection criteria for the product are in Appendix A.

## **4 Market Research and Analysis**

The unsolved and inefficient organic waste management facilities and an increasing cost of managing organic waste for households and businesses, are the prime factors driving commercial adoption of small and medium-scale on-site biogas systems in India. Nowadays, the anaerobic digestion system is securing its position in Asian markets also. There are 25 million households worldwide, receiving energy for lighting and cooking from small-scale biodigesters. This figure shows, in Nepal, more than 170,000 households use domestic bio-gas, while 95% of the biodigesters are in daily use. Similarly, more than 35,000 installations have been built so far, in Vietnam where all installations are operational. China has more than 20 million of micro biogas digesters and around 4 million in India mostly in rural areas. The common in these Asian countries is that the installed biogas system are either traditional or balloon type made up of polyethylene (Van Nes & Nhete, 2007). As per World Bank record, the anaerobic digestion market was valued at \$ 7.5 billion in 2018 and is expected to hit or exceed above \$ 15 billion by 2025 with a CAGR of 10.62% over the forecast period. While, the unique strategy and substantial steps in business activities are the key drivers to meet the expectation (Gautam & Jha, 2020).

### **4.1 Target country-India**

A literature review and internet search conducted during this thesis project revealed that, the first biogas plant was built in India in 1859. However, it did not get any popularity within the country until 1973, but almost a century later when oil prices reached a new height, it became

a serious matter of concern. So, in early 1980s, the Indian Ministry of New and Renewable Energy started to look forward for renewable energy technology as an alternative energy source of energy. And started promoting existing household-scale biogas technology in rural areas by providing subsidies and financing to construct and maintain biogas system (Voegeli & Zurbrügg, 2008).

Different biogas units have been implemented throughout the country, to date, focusing rural setting, due to this reason India is considered as the most experienced in anaerobic digestion of kitchen, market or organic household waste, but lack an appropriate technology option. Among different biogas system, it is found that the most commonly used biogas system in India is the fixed dome system which has operational scale varied from household level (1-5 kg/day) to institutional and municipal level (up to 3 tonnes/day) (Voegeli & Zurbrügg, 2008). On the other hand, there is the lack of enough accessible knowledge and information on technical and operational feasibility considering anaerobic digestion as a waste treatment option for urban setting. Though our primary reason for manufacturing, and operating our PVC biodigester in India market is to serve a waste treatment solution, biogas is often an added value by-product in the whole process. Apart from biogas generation, the cost-saving factor for the households incurred by mostly inefficient waste collection schemes in urban areas with high waste collection and transport costs, need to be taken into consideration (Voegeli & Zurbrügg, 2008).

To date, there is no any mandatory rules for households in India to separate their organic waste at home, this could be a possible barrier in an adaptation of biogas system. Thus, while promoting our biodigester, the motivation to invest in and operate our system should not be only related to the factors of waste treatment but rather to the economic benefits of substituting biogas and green soil nutrients for LPG and chemical fertilizer and other energy sources. Evaluating the current costs of fuels and share of fuels in customer's expenditure, and investment cost of our PVC biodigester, the planned cost of our plant can be recovered within few years, depending on benefits of using self-made biogas in their own house.

A significant movement of biogas technology in India, and the vast potential and need of waste management, need of bioenergy has made Indian market an ideal target to sell our newly manufactured PVC micro biogas digester.

## 4.2 Existing biogas technologies in India

In the developing country like India, home biogas production tends to be an alternative source of energy, while its production requires technology and effective mechanism. Different biogas technologies are in operation different parts of India, especially in rural households promoting agriculture. Generally used feedstock in this small-scale biogas production plant are animal waste, human waste, kitchen waste and some crop residues, constituting carbohydrate, protein, fats, cellulose and hemicellulose. And the gas production rate varies with the type of these organic constituents used in the biogas plants that goes through the different processes of biogas production in optimal condition.

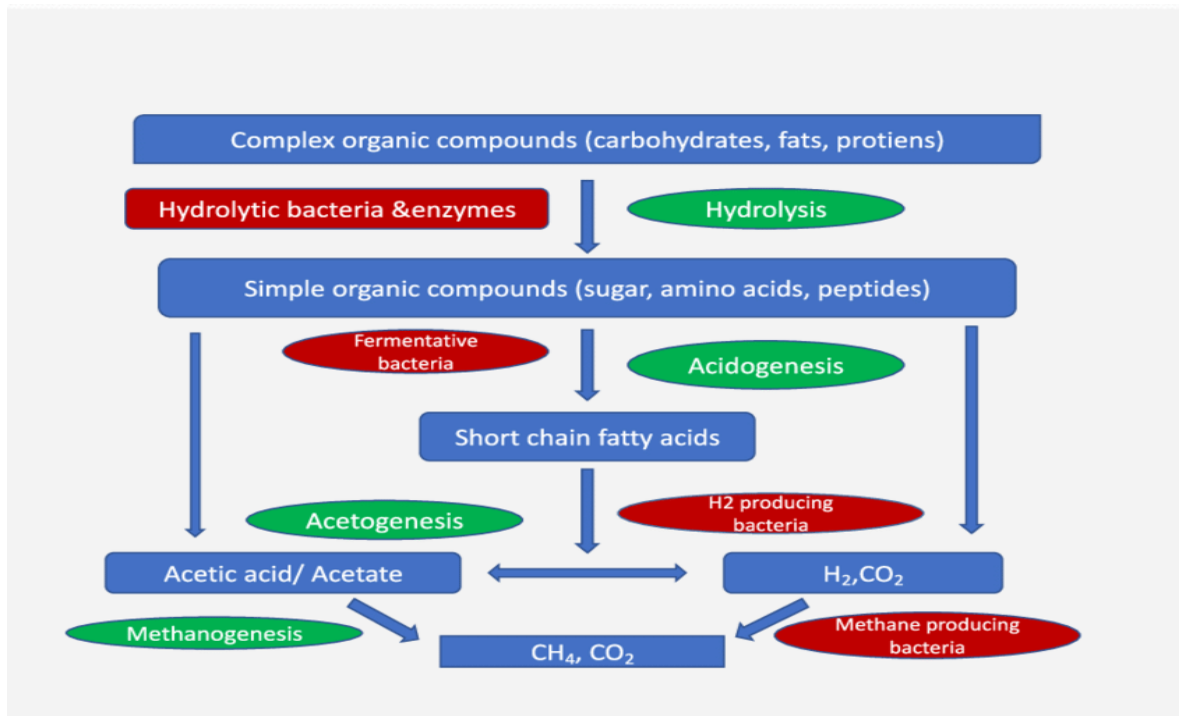


Figure 4: Schematic representative of basic process of anaerobic digestion (Singh, Szamosi, Siménfalvi, & Rosas-Casals, 2020).

Several types of technologies implemented to the date for the biogas production in India are explained below:

**1. Fixed dome digester:** The fixed dome digester is the most popular digester in India. The prototype of this digester is developed in China. It is a closed dome shaped well insulated digester which is constructed under the ground. Since, most part of digester is fixed under the ground, it is suitable for cold climates also. It is a simple, inexpensive mix reactor which is durable, up to 20 years. The digester has fixed gas holder without any other moving parts. But construction

of this digester is difficult (materials used- masonry and cement), labor intensive and high skilled technicians are required. The organic waste like: manure, dung, human excreta etc are fed to the digester for gas production. The digester comes in various types and sizes that is; Chinese fixed dome, Janata model, Deenbandhu and CANARTEC (Balasubramaniyam, Zisengwe, Meriggi, & Buysman, 2008).

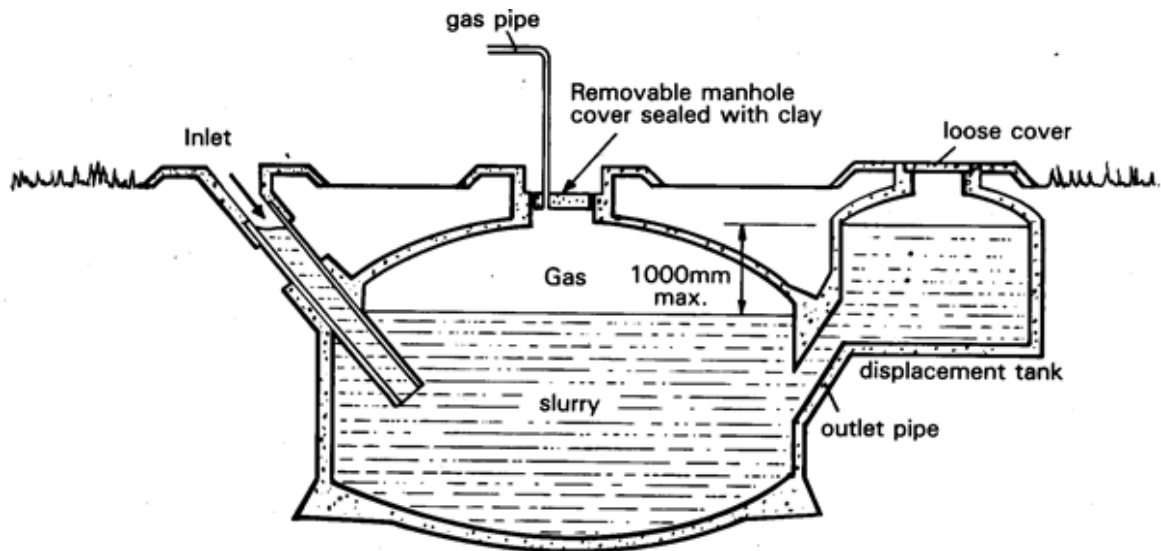


Figure 5: Schematic representation of fixed dome digester (Balasubramaniyam et al., 2008).

## 2. Floating dome digester:

Similar to fixed dome digester, floating dome digesters are also mostly found in India and operation is also almost same. The cylindrical shaped digester is fed with the biomass like, animal manure, human excreta or food/vegetables and produced biogas is collected in a movable gas holder. Actually, the plant has floating gas holder that rises and down according to gas pressure. The weight of gas holder helps to identify whether the gas pressure is constant or not. It is a continuous stirred tank reactor which has operation process easy to understand and operate. But the gas holder is the weakness of this plant, as it is relatively expensive and need regular maintenance because of its possible physical damage. The digester is constructed using brick and concrete and 2-2.5 mm thick steel sheets for gas holder, the life span of digester is up to 15 years. It is easy to construct but installation and operational cost is high for this plant. The floating dome digester is also come in various model notably, KVIC model, Pragati model and Ganesh model, till the date (Balasubramaniyam et al., 2008).

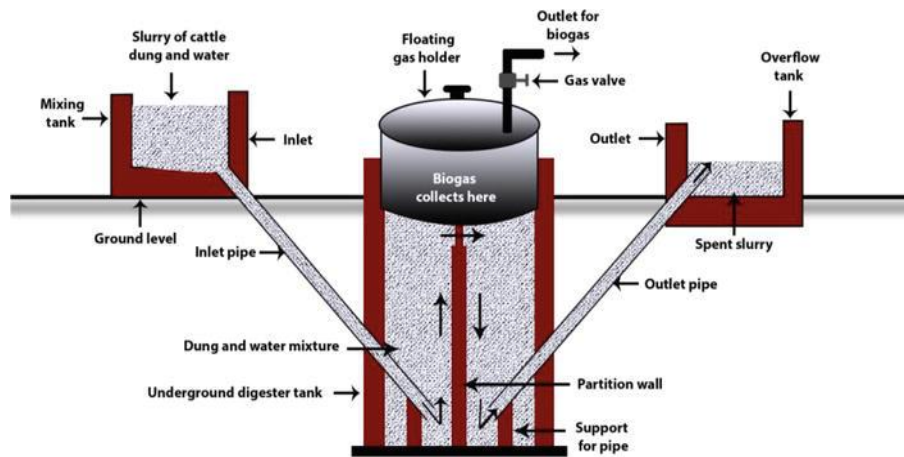


Figure 6: Schematic representation of floating dome digester (Glivin, Vairavan, Manickam, & Santhappan, 2021).

**3. Bag/Balloon type digester:** A bag type digester is a light-weighted semi-buried or ground digester. It is an inexpensive plug-flow reactor and simple technology which is made up of heat sealed plastic or rubber combining the gas holder, digester and inlet and outlet attached directly to the skin of the bag. The gas produced is stored in upper part and digestate in the lower part of a bag while, the pressure build up inside the bag can be enhanced by placing weights on the bag. It has very short life span of 3-5 years (depending on chosen liner) as highly susceptible to the physical damage (puncture) and difficult to repair (Buysman, 2009).

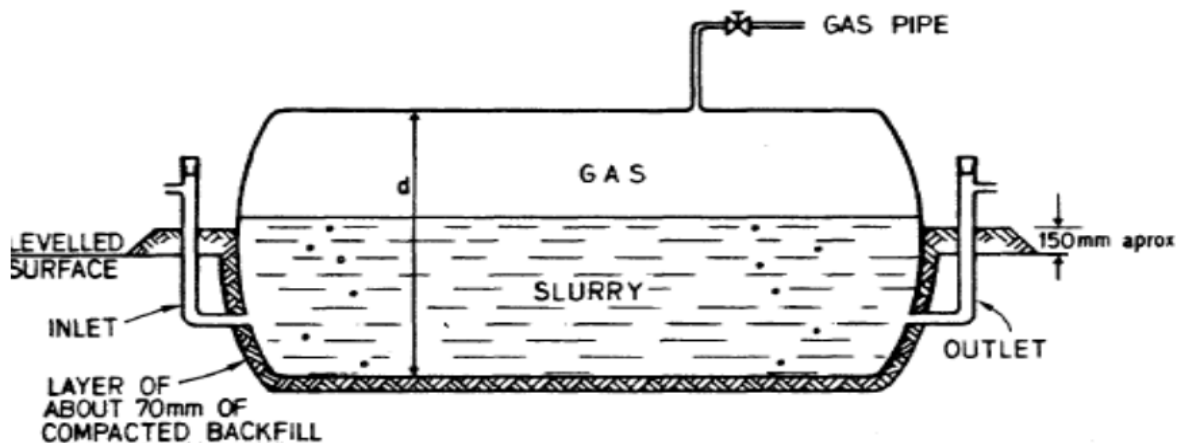


Figure 7: Schematic representation of bag/ balloon digester (Buysman, 2009).

**4. Flexi-type digester:** Flexi-type digester is flexible, above ground, plastic bag made up of PVC tarpaulin. It is commonly install inside green-house tunnel which is very simpler and less costly to build and operate. The tunnel acts like an insulated jacket, absorbing heat and maintaining the temperature in between 25 to 36 degree celsius to increase the gas production.



It is lightweight, simple and easy to operate, quick and inexpensive to install, easy to relocate, facilitate with pressure safety system to prevent structural damage when over-gassed but high cost of good-quality plastic increases the price of liner (Ghiandelli, 2017).

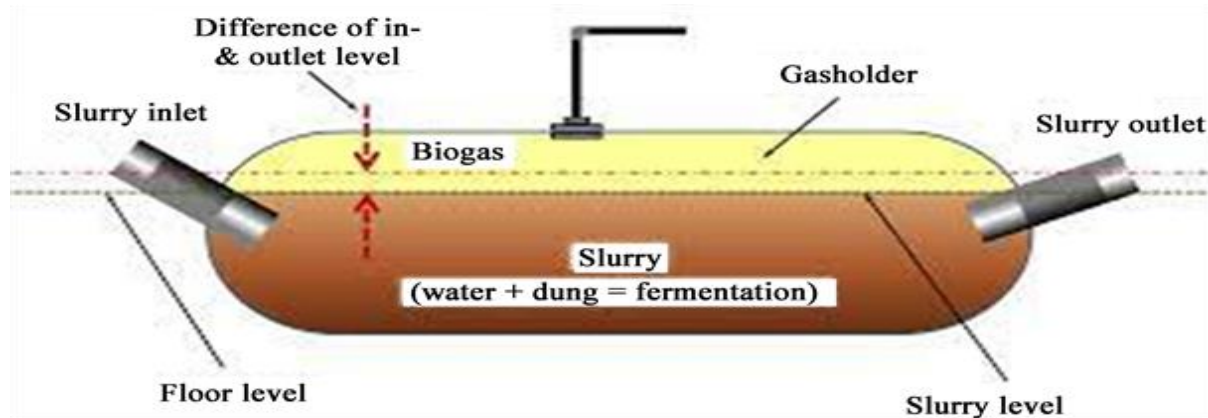


Figure 8: Schematic representation of flexi-type digester (Mungwe, Asoh, & Mbinkar, 2021).

### 4.3 Overall assessment

The overall assessment of existing biodigesters in India and our PVC biodigesters is done in the table with score, based on previously mentioned descriptions above. The following table is built based on the criterias below and are weighed equally.

1. **Availability of materials:** materials required to produce or construct the biodigester.
2. **Structural integrity:** quality of the structure.
3. **Reliability:** a long life span and sound operation.
4. **Constructability:** level of expert know how to build.
5. **Heat emission:** enhancement or optimisation of design to retain heat.
6. **Gas production:** must be able to meet the demand of biogas throughout the year.
7. **Operation and maintenance:** easy operation with low maintenance.
8. **Investment costs:** low costs increase the affordability.

Table 2: Overall assessment of different existing designs of biodigesters and PVC biodigester.

Criteria	Fixed dome	Floating dome	Bag digester	Flexi type digester	PVC digester
Availability of materials	5	5	5	5	5
Structural integrity	5	3	1	3	5
Reliability	5	3	1	3	5
Constructability	3	1	4	4	5
Heat emission	5	2	1	4	5
Operation and maintenance	5	4	5	5	5
Investment cost	3	1	5	2	2
<b>Overall score</b>	<b>31</b>	<b>19</b>	<b>22</b>	<b>26</b>	<b>32</b>

(Score 1 to 5, 1= the worst score, 5= the best score on a criteria)

Table 2 follows that the PVC biodigester scores the best in overall assessment. The detail technical structure of PVC biodigester will be described in other section below.

#### 4.4 Customer segmentation

The customer research and analysis in this proposed plan is just an overview. Regarding customers for PVC biodigesters in Indian market, it has been just identified and submitted which segments would be most likely to purchase our product, knowing the needs of energy and poor waste management system in Delhi, India. To develop the deep understanding of our identified customers, their preferences and behaviours: how they would judge our products, whether they are going to pay for performance and quality or there would be value-based purchasing, a company should hire some market experts who would meet the customers and providing reporting.

Here are some viable customer segments:

Table 3: Customer segmentation – Segment 1

**Segment 1**

<b>Geographic</b>	<b>Demographic</b>	<b>Psychographic</b>	<b>Behavioural</b>
<ul style="list-style-type: none"> <li>• Country: India</li> <li>• City: Delhi</li> <li>• Area: Urban</li> </ul>	<ul style="list-style-type: none"> <li>• Family size: 4 to 5 members</li> <li>• Middle class income</li> <li>• Per month salary: INR 30000 to 40000</li> </ul>	<ul style="list-style-type: none"> <li>• Lives in apartment building</li> <li>• Aware of environmental consequences of waste management</li> </ul>	<ul style="list-style-type: none"> <li>• Use for personal kitchen waste treatment</li> <li>• Ease of use</li> <li>• Value pricing sought</li> <li>• Loyal to product</li> </ul>

Table 4: Customer segmentation – Segment 2

**Segment 2**

<b>Geographic</b>	<b>Demographic</b>	<b>Psychographic</b>	<b>Behavioural</b>
<ul style="list-style-type: none"> <li>• Country: India</li> <li>• City: Delhi</li> <li>• Area: Urban</li> </ul>	<ul style="list-style-type: none"> <li>• Family size: 4 to 5 members</li> <li>• High class income</li> <li>• Per month salary: INR 60000 to 80000</li> </ul>	<ul style="list-style-type: none"> <li>• Lives in apartment building</li> <li>• Aware of environmental consequences of waste management</li> </ul>	<ul style="list-style-type: none"> <li>• Use for personal kitchen waste treatment</li> <li>• Ease of use</li> <li>• Value pricing sought</li> <li>• Loyal to product</li> </ul>

The customer segment 1 and segment 2, is a middle-class and high-class family that lives in an apartment building in urban Delhi. They are conscious about the environmental hazards caused by waste produced in their households. The problem in this segment is the use of outputs (biogas and green fertilizer). A company need to convince the customers, with the solutions.

Table 5: Customer segmentation – Segment 3

**Segment 3**

<b>Geographic</b>	<b>Demographic</b>	<b>Psychographic</b>	<b>Behavioural</b>
<ul style="list-style-type: none"> <li>• Country: India</li> <li>• City: Delhi</li> <li>• Area: Urban</li> </ul>	<ul style="list-style-type: none"> <li>• Family size: 4 to 8 members</li> <li>• High class income</li> <li>• Per month salary: INR 60000 to 80000</li> </ul>	<ul style="list-style-type: none"> <li>• Lives in individual households/homes with backyard or rooftop</li> <li>• Desires sustainable and clean energy through waste management</li> </ul>	<ul style="list-style-type: none"> <li>• Use for household organic wastes.</li> <li>• Cost benefits of energy inspires loyalty</li> <li>• Value pricing sought</li> <li>• Regular users</li> </ul>

This segment with high class income households would base on the central part of Delhi city, where customers are seeking solution to convert their organic household wastes into renewable energy together with waste management, so that, they can gain high value through the cost saving on fuels using homemade clean energy, and be always loyal to us. This segment of customer is the most viable one for selling the PVC biodigester. The main reason to choose higher income households is that, households with higher income waste more than the lower and middle-income households. The number of rich families in Indian society, they have a huge trend of staging extravagant display of foods in any occasion to show off their wealth which is impossible for anyone to taste all those varieties of food and hence large quantity of food is wasted. Also, it usually happens in their day-to-day life, which is the prime factor to choose segment 3 as our target. And another factor is, they can easily afford our product.

The overall business plan would be introducing the newly manufactured PVC micro biogas digester in Indian market for higher income individual households. In this present context, urbanisation process leads to the concentration of higher income population and households where our business plan will be applicable to both existing and upcoming ones. To launch our start-up, we will serve existing households already inhabited with high income families.

#### 4.5 Environmental Analysis/ Competitive position (SWOT analysis)

SWOT analysis is the one of the most useful tools for a company to look at internal and external factors that can affect business, before starting a new business and also to boost the development of a company. This process helps to identify Strengths (S), Weaknesses (W), Opportunities (O) and Threats (T) of a company and overcome challenges and determine what actions need to be taken. SWOT analysis looks at both internal and external environment of a company. Strengths and weaknesses are considered as an internal factor whereas opportunities and threats are external. In addition, it highlights strengths and opportunities as positive while weaknesses and threats as negative.

SWOT analysis of PVC biodigester business, based on data about current state, the effectiveness, high efficiency and the functioning, is summarized below:

Table 6: SWOT Analysis

<b>Internal</b>			
<b>Positive</b>	<b>Strengths</b>	<b>Weaknesses</b>	<b>Negative</b>
	<b>Opportunities</b>	<b>Threats</b>	
<b>External</b>			

##### 4.5.1 Strengths

- A company already have abundant resources that is; a company itself is a producer of PVC in a very large quantity.
- A company will serve a developed technology, rigid PVC biodigester.
- A company will be contributing to the more flexible operation of biogas technology.
- PVC biodigester will serves it exact purpose of clean energy and biofertilizer alternative.
- A product will solve waste disposal problems.
- It will help in the reduction of GHG emission and useful for closing carbon cycle.
- There is a flexibility for small, medium and large biogas plant.

- It will be like one time investment due to the long-life span of biodigester and its resistance.
- It is very easy to relocate the biogas unit.
- There will be proper utilization of waste in densely populated city.
- The proper storage of waste will decrease risks of health hazards.
- Large number of potential customers in the city.
- Decrease in energy and chemical fertilizer cost among the individual households.
- Sustainable energy source creates long term benefits to customers which will keep them loyal to the product and a company.
- Competitors are not clearly identified in our target market (individual households in urban Delhi, who will use our biogas plant for treating organic wastes from kitchen and garden wastes).

#### **4.5.2 Weaknesses**

- High investment cost for PVC biodigester.
- A movable biodigester in backyard can be stolen and damaged easily.
- Handling of digestate could be a problem.
- Unclear policy support in target market.
- Proper customer awareness towards sustainable practices is needed regard to this product.
- However, the need of maintenance will be very low because of quality of product and materials used in it, if needed maintenance costs will be high.

#### **4.5.3 Opportunities**

- A positive word of mouth can create high potential for market expansion.
- Loyal customer base created in the urban area can bring more opportunities.
- Growing interest in flexible (demand-driven) energy production technology.
- A replacement of 50 to 100% of LPG used in households.
- A PVC biodigester covering peak energy consumption can build up more opportunities in market.
- Biodigester can keep the households and surroundings clean and green.
- Larger projects due to the effectiveness of biodigester in creating renewable energy.

- Consumption pattern of households, waste generated from their kitchen and behavioural patterns can be identified in details to integrate additional function in the product or to come up with new version of a product in future.
- Customer needs, demands and suggestions lead to the improvement and upgradation of biodigester.
- Public logistic support.

#### **4.5.4 Threats**

- Low level of understanding of environmental problem and its solution among citizen.
- General changes in renewable energy sectors like; market legislation, structure etc. may influence usefulness of PVC biodigester (even in small scale).
- High ignorance due to lack of knowledge to operate and maintain biodigester system.
- Limited practical experience in both producers and consumers.
- Discontinuous use of biogas plant may reduce the level of biogas production and may have trust issues between the customers and company.
- Negative word of mouth may cause the product value to go down.
- Public subsidies for fossil-based energy.

It is very clear from the above-mentioned SWOT analysis that our PVC biodigester business has more strengths and opportunities in an Indian market, in comparison to weaknesses and threats. These identified weaknesses and threats can be easily overcome through different operational strategies.

## **5 Business Model Canvas**

Business model canvas helps to identify what, how and for whom a company creates and delivers the values. A good business model is a key to success for a company. If any start-up company trying to identify the opportunities in their internal and external environment and wants a clarity about what they are actually doing, they need to develop a business model first. Customer segments, value proposition, channels, customer relationships, revenue streams, key resources, key activities, key partners and cost structure, are nine different building blocks that describes a business model.

In case of our PVC biodigester business model, it is simple and smart to boost the development in Indian market by developing the competitive advantage and sustainable value creation in biogas production technology. The business model canvas for our biodigester is shown in the table 7.

Table 7: Business model canvas for PVC biogas digester.

Key partners	Key activities	Value proposition	Customer relationship	Customer segments
<ul style="list-style-type: none"> <li>• Local households and educational partners like; universities</li> <li>• Agrotech companies or wholesalers who is selling agricultural equipment</li> <li>• Farmers</li> <li>• Technological companies</li> <li>• Micro finance</li> <li>• Municipalities</li> <li>• Green associations</li> <li>• E- commerce partners</li> </ul>	<ul style="list-style-type: none"> <li>• Research and development</li> <li>• Design specifications</li> <li>• Prototyping</li> <li>• Subsidiary establishment</li> <li>• Supply chain development</li> <li>• Mass production</li> <li>• Packaging and supply</li> <li>• Assembly</li> <li>• Distribution channel development</li> <li>• Launch the product</li> </ul>	<ul style="list-style-type: none"> <li>• Improved management of kitchen and organic waste generated from individual households</li> <li>• Environment friendly clean energy for cooking</li> <li>• Free organic and nutritious liquid fertilizer</li> </ul>	<ul style="list-style-type: none"> <li>• Direct interaction or personal assistance through phones, email or face-to-face communication for preferences and feedbacks</li> <li>• Assigning a customer’s representative which provides familiarity and build trust.</li> </ul>	<ul style="list-style-type: none"> <li>• High class income individual households with or without gardens</li> <li>• Potential for middle- and high-class families living in apartment building</li> </ul>
	<p><b>Key resources</b></p> <ul style="list-style-type: none"> <li>• Materials (PVC)</li> <li>• Investment capital</li> <li>• Time</li> <li>• Subsidies</li> </ul>		<p><b>Channels</b></p> <ul style="list-style-type: none"> <li>• Direct selling (direct sales representative)</li> <li>• Selling through intermediaries (wholesalers and retailers)</li> </ul>	



	<ul style="list-style-type: none"> <li>• Human resources</li> <li>• Technical and commercial knowledge</li> <li>• Certification by regulatory authorities</li> </ul>		<ul style="list-style-type: none"> <li>• E-commerce (e-mail, website and social media)</li> </ul>	
<b>Cost structure</b> <ul style="list-style-type: none"> <li>• Product manufacturing</li> <li>• Infrastructure building</li> <li>• Hiring new employees</li> <li>• Research and development</li> <li>• Operational cost</li> <li>• Company registration</li> <li>• Promotion cost</li> <li>• Distribution cost</li> <li>• Salaries and administration costs</li> </ul>		<b>Revenue stream</b> <ul style="list-style-type: none"> <li>• Sales biogas units (Customer's payment)</li> </ul>		

## 6 Product features and pricing

As per our concept, our product is a new class of family-sized anaerobic biodigester to convert organic waste into clean energy which is designed and manufactured specially for urban individual households with or without garden areas. To come up with start-up by making the biodigesters available in Indian households, we need to be clear about how customers are going to judge our product and what values they are seeking in our products, before they pay for it. These are also the important factors that need to be considered when pricing our biodigester and service. Therefore, we need to have a detail study on our customers through direct interaction.

Though our family-sized biodigester does not have any direct competitors in the market, the other simpler and cheaper biogas technology available in rural settings may pose a challenge

only due to their drastically lower price, they could divert our customer set of minds regarding the price of biodigester.

Here are some features that our target customers may seek in our products and services:

- User friendly and low maintenance.
- Gives any of the family members the capability of utilising their unused resources and creating their own energy.
- Simple to assemble in shorter period of time, so that, they donot need to pay extra for technician.
- Safety features like: no harmful pathogens in fertilizer, no gas leakage from gas tank, eliminates exposure to indoor air pollution.
- No need to compress and fill the produce biogas in separate cylinder for kitchen use, automatic control and gas release valve to the kitchen from biodigester on a very safe pressure condition.
- Durable and high-quality materials.
- Reduce waste disposal costs incurred by municipalities.
- Free cooking gas from kitchen wastes and easy disposal.
- They can relocate easily as per their wish.
- They may want good after-sells service with periodic follow up by company's side to share their either good or bad experience with our products.

Since, our product and services have all these features mentioned above, and evaluating materials and production costs, the high cost of PVC (material used to produce biogas plant), our plan is to sell single biogas unit at a price of about \$2000 through direct selling with 10% sales commission and \$1550 through indirect intermediaries without sales commission. The cost-plus pricing strategy will be used in the case of PVC biodigester because it will be easy to communicate the high price to the costumers at the market entry stage. In a long run, the pricing model can be changed to pay-per-use model, as the customer base become stronger. Every household who buys our biodigesters, will pay a monthly fee for the use of the system. This pricing model will be cost-effective for our target customers, since the monthly payment will be significantly lower than their usual expenses for their waste disposal, LPG and chemical fertilizer. Together with customer preferences, considering manufacturing costs, energy-related benefits, fertilizer-related benefits, health-related benefits, environmental-related

benefits and economic related benefits, while building costs for our product, is a key to success and product acceptance with value (Balasubramaniyam et al., 2008).

### 6.1 Technical design of the proposed digester

A rigid PVC micro biogas digester is a proposed household biogas system which is flexible to convert food wastes and green garden wastes into clean gas that can be used for cooking, heating and lighting, and into nutritious liquid fertilizer for the garden. It is made up of rigid form of polyvinyl chloride, the most widely produced and used thermoplastic polymer in everyday applications like; construction, electrical, transport, packaging and health care application providing a light weight, excellent hardness and durable material to use (Thornton, 2002). The properties of PVC are shown in table below:

*Table 8: Properties of rigid PVC (Zahran, Hegazy, & Eldin, 1985).*

Property	Value
Technical name	Polyvinyl Chloride
Chemical formula	$(C_2H_3C)_n$
Melting temperature	212 - 500 <sup>0</sup> F
Tensile strength	34 – 62 MPa (4930 – 9000 PSI)
HDT	92 <sup>0</sup> C (198 <sup>0</sup> F)
Specific gravity	1.35 – 1.45

Many biogas systems production companies have also used the high quality PVC material in their biodigesters, especially to build fertilizer and biogas outlets and also connection between pipes (Gautam & Jha, 2020) but not the whole biogas system that we are planning to do except mild steel frame for excellent support. Apart from the market situation and high-quality construction materials, other facts that support this product selection are:

- Abundant resources – a company itself is a manufacturer of PVC materials.
- Existing large-scale production plants.
- Findings on existing implementation of similar product design in Israel.

The proposed design of family-sized, compact biogas digester is shown in the figure below:



Figure 9: Schematic representation of inner parts of proposed PVC biogas digester. Source: <https://techxplore.com/news/2015-12-energy-home-homebiogas-bio-digester.html>

It is an easy to assemble kit that will be served as a personal digester in a box. In addition to these parts shown in figure above, the unit is featured with a built-in grinder, a tap, a sink and a manual mixer, a bio-filter and a chlorine filter while,

- a built-in grinder - grinds the food wastes fed into the digester.
- a tap - rinses off the plates
- a sink and a manual mixer - to mix the food wastes and water
- a bio-filter - reduces odours
- a chlorine filter - eliminates pathogens in green fertilizer produced as by-product.

More detail of the digester is described in *Section 2.4*.

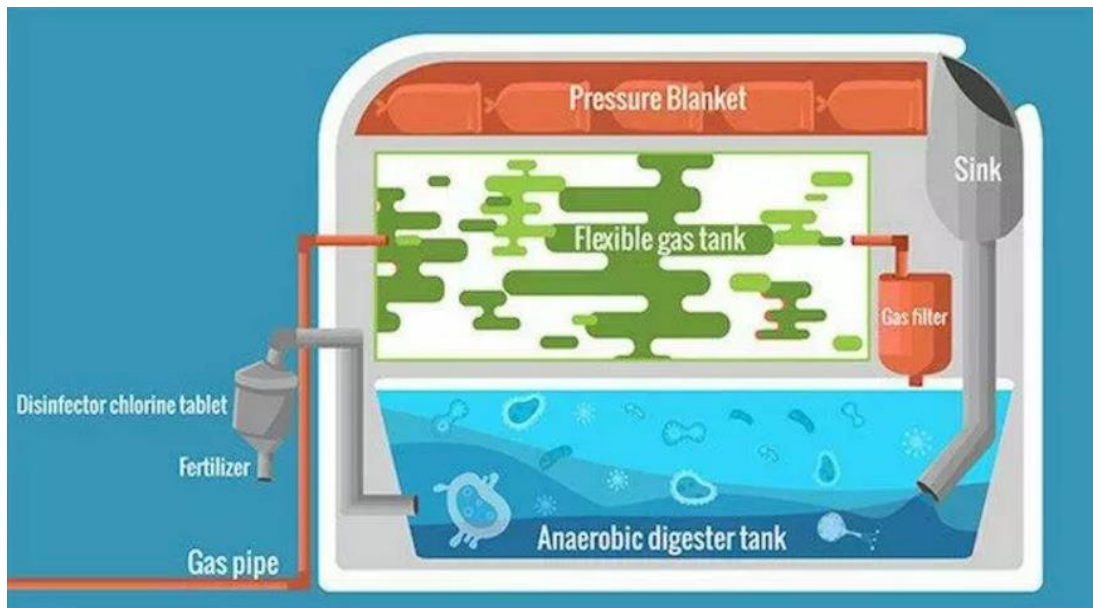


Figure 10: Schematic representation of Inner working mechanism of proposed biodigester. Source: <https://techxplore.com/news/2015-12-energy-home-homebiogas-bio-digester.html>

## 6.2 Comparable design of biogas digester in market



Figure 11: Schematic diagram of comparable image in market. Source: <https://www.rumblorum.com/home-biogas-system/>

According to the HomeBiogas company's updated report published by FROST and SULLIVAN, Independent Equity Research in August 29, 2021:

- This the first family-size biogas plant designed by HomeBiogas company, Israel whose initial prototype was piloted in 2014 and commercially available in 2016.
- The materials used to build this system are 100% recyclable with lifespan of 15+ years.

- The system size is portable with 23 kg to 32 kg.
- It is an Israeli certified technology built with a patented mechanical pressure generation mechanism.
- It is currently highly available in Israel and the Palestinian areas where people donot have access to the energy.
- The buyers are often private citizens from 25 different countries, notably Israel, Mexico, Australia and South Africa.
- The company has extended its market in the United State and Australia with quite good records and now planning to make it more international for long run.
- The company right now is selling their biodigester at a price of about \$2500 separately and they are working actively in E-commerce also.
- A unique advantage of making use of hot weather and sunlight to decompose organic scraps-both meat and vegetables and animal manure, itself is the one and only limitation noticed till the date. It is because the unit could give accurate result only if the average day-night temperature stays at or higher than 17 degrees Celsius all the year, it could not operate properly in cold climates. This biodigester is specially designed to works best in tropical and sub-tropical areas.
- Currently, the company is upgrading their biogas system from domestic to commercial and industrial level, hotels, restaurants and food processing company.

### **6.3 Prototype**

It takes many years to set-up a new business in a commercial market. To make it happened, an outstanding planning and good investment are the key factors. Since, PVC biodigester is a new product for a company, of course they want to find out the likeability and feasibility of the product before launching to a wider market, and development of a product prototype is the best way to do that. Developing a minimal viable product and start testing on small scale helps us to understand the market very closely and fix the experienced problems regarding the market, customers and biodigester itself.

Prototyping is an important phase in production development that shouldn't be overlooked. To make the transition from design to final product (for mass production and distribution) much easier, faster and smoother, a company should involve manufacturer in early prototyping and evaluate where improvements are necessary. Hence, to make the things easier for us to describe our product more effectively among customers and investors, prototyping is the best step.

Since, the urban households in Delhi, India have not been a part of any family-size biogas system until now, we will highlight them and develop good customer relationship, and put our prototype in front of them trying to get their feedback. Also, to see if it passes certain requirements. While presenting product prototype for testing, it will work much better, if we approach the customer directly with positive word of mouth for the growth based on success rate.

## 7 Industrial assessment

### 7.1 Porter's five forces analysis

Porter's five forces is a structured framework that identifies and analyses competitive industry's structure impacting an industry's profit potential. For those companies looking forward to enter a new market, a five forces analysis can help to determine whether the profit opportunities exist in that particular market or not by identifying the weaknesses and strengths of an industry. Identifying the potential profitability within the industry helps in obtaining a sustainable and long-term competitive advantage over others, by taking advantage of strengths and improving identified weaknesses.

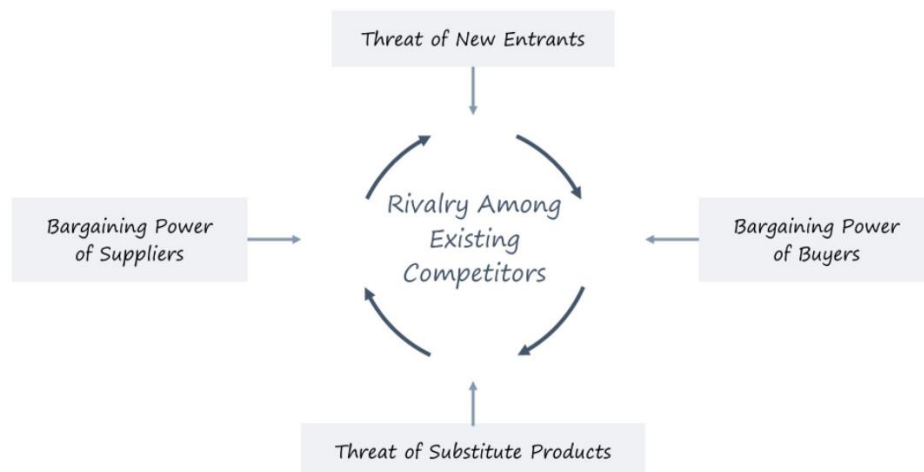


Figure 12: Graphical representation of porter's five force model. Source: <https://www.wallstreetprep.com/knowledge/porters-five-forces-model/>

#### Rivalry among existing competitors: Low

It is found that there are no other micro biogas digesters appropriate for urban settings, in small-scale, in Delhi and all over India. As our plan is to serve individual upper-class households,

while no any other system highlights this segment as a target customer. In comparison to urban environments, rural environments have numerous competitors like; Sistema Biobolsa, Flexi Biogas, including conventional biogas systems and bag type digesters made up of polythene.

Strong competition from biogas produced in industrial scale also affecting the settlement of small-scale waste treatment technologies in many countries but in case of urban India it is just opposite. The central government of India has not issued legal standards or guidelines for injection in natural gas grid. For the biogas production in large scale, it is very important for everything to be in placed on time such as; proper technologies and strategies for waste segregation, collection and transportation, tipping fee for waste collecting and handling, long-term financing, capital grants etc., but the absence of government policies to support these acts, driving biogas production projects economically and technically less viable at large-scale. This is the reason that there are no well-established and commercialized biogas production technologies functioning active at industrial scale (Mittal, Ahlgren, & Shukla, 2018). Hence, competitive rivalry will be low.

#### **Threat of New Entrants: Moderate**

New entrants in the market can change the whole business environment of existing company that could significantly impact the profit-making pattern, so that, an existing company may have to experience high levels of threats. There exist many barriers in a new market that can stop new company to enter that market. For instance; controlled market, government regulations, high capital requirements, getting access to the customers, lack of awareness about the product and its benefits in a new market, high IGST rate.

Although the demand for PVC biodigesters is expected to rise considerably, the high price may limit their adoption in target market. Additionally, for Indian market entry, integrated goods and service tax also need to be considered when determining the final pricing of biodigester. And India has been applying 13.8% of IGS tax for new entrants. And it is found that they are applying this rate for imported finished goods (Sehrawat & Dhanda, 2015). Taking all these barriers in consideration, we have institutional, operational and product competitive advantage which proves that we have ability to cross those barriers such as:

- Low capital requirements, because we already have plenty of resources and processing PVCs and other polymers, through existing large scale production plant.
- We are multi-national company with high level of well-recognised brand.



- The plan is to supply the PVC biodigesters parts from Norway to warehouse (assembly plant) in India, in order to reduce the IGST rate applied.
- Differentiated products: Our PVC biodigester is highly differentiated product with unique new feature in order to compete.

Analysing all these elements of market entry and ability of a company to cross the barriers, it can be concluded that a company is quite attractive. Only because of our biodigester's price, we cannot ignore that new entrant may pose moderate threat to our company. But can overcome the threats by making people aware about the brands. Because a high level of brand loyalty can be our bigger strength.

### **Threat of substitute products: Low**

To commercialize PVC biodigester, a unique value proposition, in a completely new market, a company need to identify other products or services that can perform same function as our product do, in a target market. Moreover, if we know the needs they are solving currently, we can improve our weaknesses to overcome the challenges pose by those substitutes. In case of anaerobic digestion technologies, most of the time a company has to experience competition from other various waste treatment technologies and services like;

- Door-to-door waste collection service
- Composting and vermi-composting
- Waste to pellets
- LPG
- Package fertilizer

But in our case, a door-to-door waste collection service is not in place in Delhi due to the absence of government policies for long-term financing for enough tipping fee for waste collection and handling, and other waste treatment activities, which results in low collection efficiency.

Though composting, vermi-composting and waste to pellets are the low-cost waste treatment methods, the processing requires more space, terrible odour from mix organic trashes, long time to complete the process, unsuitability of feedstocks for processing like; meat waste etc., are the problems that people have to face adopting these methods. And these waste treatment methods donot fit for our customer segments that is; individual households in urban setting with or without gardens (Mittal et al., 2018).

LPG and package chemical fertilizer may pose threats to our biodigester but making people aware of benefits that our PVC biodigester offers can easily displace these fossil fuels from our target market. Always rising cost of LPG and its impacts on environment can be easily covered by our convenient PVC biodigester. As the main value of our biodigester is to produce clean energy for cooking, lighting and heating, and save money on purchase of LPG while, green fertilizer is just a by-product with value, there is very low chance that chemical fertilizer will replace our biodigester for urban setting. Hence, the threat of substitution is low in our market.

### **Bargaining power of buyers: Moderate**

As it has been already mentioned in section 6.1.1 that, there are no other competitors for urban domestic biogas system identified so far. Still, we cannot overlook the consumer's behaviours and powers that may pull down our business. Customers have the power to drive the price of our biodigester up or down. The bargaining powers of customers give them chance to compare our set price across the websites. The biggest challenge that our new technology has to overcome is trust. First to build the trust among the buyers, promotional activities like demonstration events, personal interaction with word-of-mouth in the region where we are going to operate will be the best choice, that support to raise awareness about our product and its value and also set up good customer relationship.

Price sensitivity is high among the customers in India that could be a problem for us to sell our high-cost PVC biodigester. Though our target customer is upper-class households, the higher living costs in Urban Delhi in comparison to other states, is challenging for them also because of their show-off attitudes and preferences. And in this situation, our PVC digester is a huge investment for them. As making investment in PVC biodigester will be a major financial and lifestyle alteration for the families in the beginning, who already have high expenditure in basic requirements like health and education. And this is also the reason the people are price sensitive either they represent upper class or lower class. And being a customer, it is certain that they want to have a product with lower price but with high quality and more features. But donot have such kind of option in market, so that, bargaining power is medium in this case.

### **Bargaining power of suppliers: Low**

As our parent company in Norway is a huge petrochemical company, manufacturing PVC in a very large scale. Hence, a company itself is rich in resources (PVC) and needn't purchase components and materials to build PVC biodigester from any other suppliers, except mild steel frame to give support to biodigester. As per our plan, a conception, design, and parts of PVC

biodigester (rigid PVC sheets which is very easy to weld) manufacturing will be done in main company in Norway and supply to the warehouse (assembling plant) in India where those rigid PVC sheets will be welded properly giving a shape to different parts digester and come out with ultimate product with perfect quality. Therefore, there is almost no bargaining power of resources suppliers in Norway.

In case of mild steel frames used in biodigester, there is high availability of steel in low-cost in local Indian market. So, suppliers can be changed at any given time with minimal hassle by contacting other local suppliers to extend partnerships. Thus, the power of company to choose or change suppliers results in low bargaining power of suppliers.

The analysis of all five forces from porter's model determines the highly competitive intensity and therefore, the attractiveness of a company in terms of profitability in target market, Delhi, India.

## **8 Competitive strategy and operational planning**

### **8.1 Value chain of PVC biodigester**

The manufacturing processes of biodigester, its quality assurance, outbound logistics, sales and marketing of biodigester and services to customers creates values to the whole process from inputs to end products and builds a good value chain for PVC biodigester.

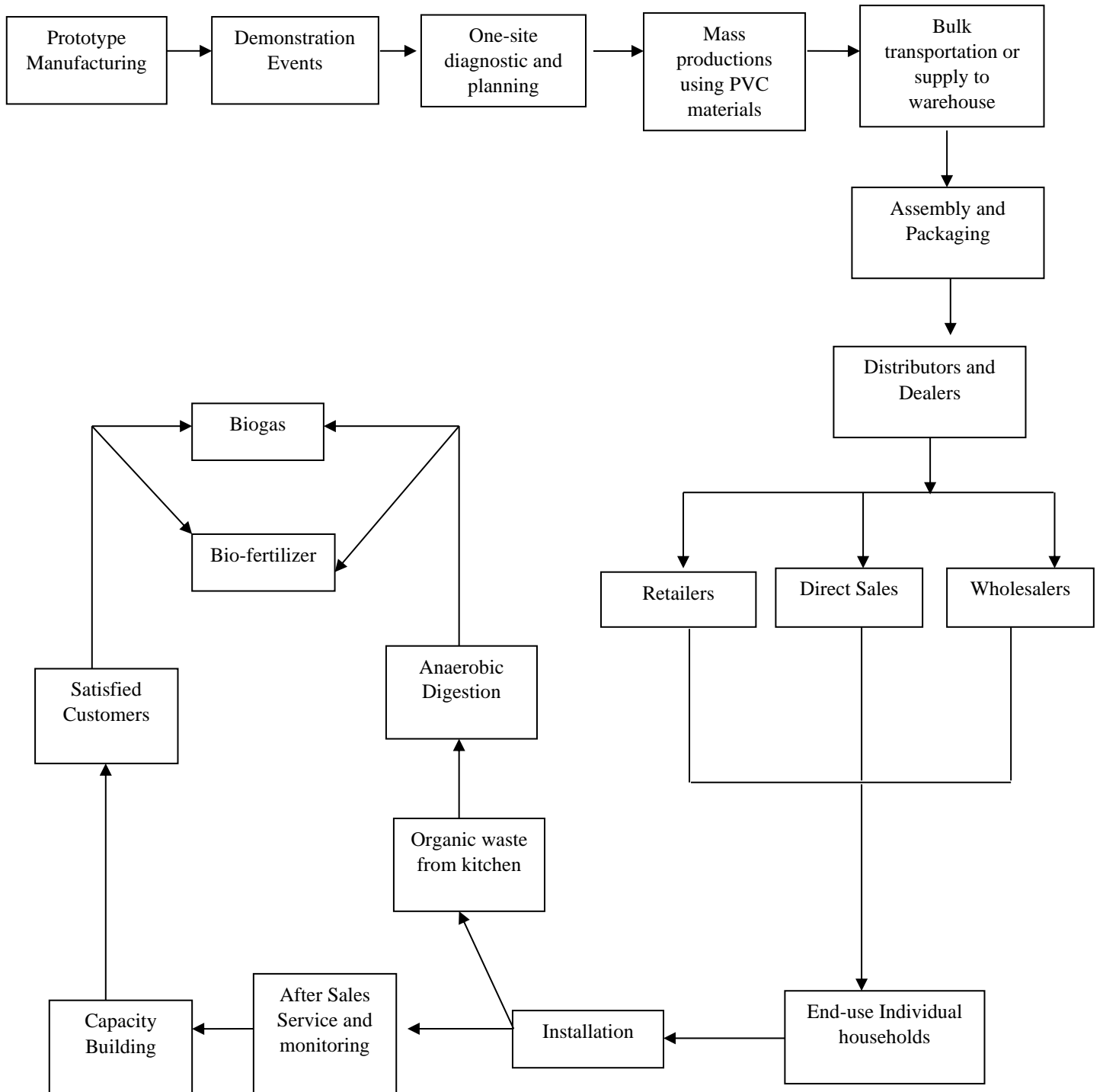
**Manufacturing and operations:** Our company is a huge petrochemical company, manufacturing PVC products. Hence, a company itself is rich in resources and needn't purchase components and materials to build PVC biodigester from any other suppliers.

Conception, design, and parts of PVC biodigester (PVC sheets) manufacturing will be done in main manufacturing company in Norway.

**Outbound logistics:** PVC parts for biodigester is then packed properly and supplied, so that, undamaged parts will be received to warehouse (assembling plant) in India where those PVC sheets will be welded properly and come out with ultimate products with perfect quality. Our suppliers will be well established freight company in Norway.

**Warehouse assembly and storage:** All the parts such as heat capturing solar cover on top, gas storage compartment, suspended digester tank, gas pipe, gas filter and gas pressure mechanism

come together to form the final product, PVC bio digester. The products are assembled in India to save high IGST rate incurred during export.



Flow chart 1: Value chain of PVC micro-biogas digester.

All those finished product will then be stored in a warehouse in India. From there, PVC biodigesters are supplied directly to customers through different distribution channels such as wholesalers, retail stores, advertising, online channels and through direct sales. Online channels will include retail websites like Flipkart or Amazon that are popular in India and official social media pages of the brand.

**Marketing and sales:** Firstly, branch office must be set up in India for the marketing and sales management of PVC biodigester. One consequence of this fragmented supply of the biodigester is that a company needs to employ more than people that a company needs to supply the finished product directly from Norway (for assembling, for marketing and sales).

Secondly, collaboration with public, private and educational partners to create sustainable business and also for the identification and development of the urban high class-communities as a part of CSR. CSR has a wide-ranging effect across the globe especially in emerging markets like India (Paul V & Devi N, 2016). This increases the sales as well as the brand value in the long run by building a diversely growing product portfolio.

The strategic partnership with local small subsidy agencies in India helps to bring high-quality PVC biodigester technology and biogas program to the targeted communities from our distribution and demonstration events. Partnership with local organisations or companies helps with an access to the local customers and know their interests and needs better. These local enterprises in collaboration with our company could also sell our product with their own at some interest. They can be a strong link between customers and the company for selling PVC biodigester.

Moreover, our company can partner with Agrotech company manufacturing and selling different agricultural tools, for the marketing of PVC biodigesters and expansion of market in future. This company can also help us with technical aspects of the PVC biodigester. Repair and maintenance could be outsourced to the technicians of this Private Limited, if needed. The agro-tech company manufacturing spray pump to fertilize the plant can add the value to our biodigester business.

Local agro-store in the areas will also act as a partner and retailer for reference to their client base and connection if there is requirement of PVC biodigesters. In case of successful sales through their connection reference commission will be provided to them. Similarly, close

relationship with micro-finance or other financial institutions will help in distribution of PVC biodigester in subsidized price.

**Services:** The value that will be delivered to our customers is affordable and clean energy technology. Apart from selling a biogas technology, customers will be facilitated with our after-sell services like; capacity building of customers and continuous monitoring in specific time gap while, establishing strong strategic local partnerships can ease after sales service to customers. In addition to this, at the end of product's life, customers can send products back to the nearest stores or dedicated recycling facilities, so that our customer will be always with us and also contribute to our value chain.

## **8.2 Operational planning**

An operational planning is creating a roadmap for planned project and outlining what activities a company need to focus on and complete over the time, by assigning roles and responsibilities to each team member of project based on their skills. To implement our planned PVC biodigester project, we need to go through distinct steps. And it is very important to carry out those steps in critical order for the overall growth and success of our business model. Each milestone to reach the end goal within estimated timeframe is illustrated in Gantt Chart in Appendix C.

### **8.2.1 Structure of organisation and its management**

Our main operating company, headquartered in Norway, already have required workforces to accomplish the tasks assign to them, because it is already a well-established and leading multinational petrochemical company achieving grand success in their business, till the date. The product development and manufacturing task will be completed in Norway within estimated time. The first batch of 5000 units will be manufactured to start our business. Then after the completion of paper works like; contractual agreement, company registration in India, regulatory submissions, and supply chain development, the unfinished biogas units will be exported to India that will arrive in warehouse. Since, our main company in Norway is a large-scale manufacturer of PVC materials, proposed micro biogas digester is completely new for the existing team. Thus, they need to recruit a product designer and some others.

As we plan to launch our PVC micro biogas digester in urban setting of Delhi, India, first a branch office will be opened in India to undertake all the activities that need to be performed

to provide value to customers through PVC biodigester. We make sure that our product is completely new with unique concept that differentiate it from other existing biogas technologies in all over India, which makes sure that we create the right supporting structure for the growth of a company in a new market. A company will grow and benefit from having diverse group of employees on every team, so that, we ensure we recruit experienced, well-trained, qualified, loyal and sincere, trustworthy and customer-centered personalities, right for our company to make a profitable business.

Here is the list of the roles that we planned to employ in responsible hands, in order to set our business in India.

- Country Operating Head
- Warehouse supervisor
- Assembly manager
- India sales and marketing manager
- Information technologist
- Financial associate/accountant
- Customer service manager

#### **8.2.1.1 Job roles and responsibilities**

- **Country Operating Head**
  - Responsible for administrative activities for the India branch office.
  - Responsible for identifying commercial requirements and convert it into operational plans by building and managing the team to match the plans.
  - Establish, communicate and execute the scope, goals and timeline for the overall project.
  - Project designing and budget estimation for efficient operation, with the commercial team who were agree on goals and estimated timelines.
  - Identification of new partners and new project opportunities and communicate the overall strategy of the organisation with the team members for prioritising and reaching them.
  - Track the project progress, delays and bottlenecks on a daily basis and discuss with commercial team to solve them and strive for higher customer satisfaction.

- **Warehouse supervisor**

- Responsible for establishing, monitoring and managing the warehouse operations goals.
- Responsible for ensuring efficient warehouse operations by supervising, organising, directing and training warehouse employees.
- Financial estimation for all the key activities for warehouse and logistic operations.

- **Assembly manager**

- Responsible for verifying product specification by measuring the completed level of product components.
- Responsible for supervising, managing and inspecting kit assembly and packaging for the products with better quality.
- Responsible for conducting quality control check.
- Documentation on completed product assembly and quality forms, and submit report to the warehouse supervisor or operation head.

- **Sales and marketing manager**

- Responsible for setting goals, making the overall strategy for sales and marketing, sales projections and timeframe for the achievements.
- Recruiting, managing, training and co-ordinating the sales team and sales coordinator to drive sales in target customer's segment.
- Follow-up and manage day to day sales and keep records.
- Identify and sign-up new distributors, partners and a network of stakeholders to develop a strong sales network.
- Responsible for the promotion of biogas technology and value awareness by conducting different regular promotion programs.

- **Information technologist**

- Responsible for designing, implementing and managing the website of the company.
- Ensures that company has efficient and up-to-date technology to facilitate ecommerce service to our customers.
- Manages all the digital records and information about the customers to the company.



- **Financial associate/accountant**

- Responsible for supporting the overall accounting functions in our branch office in India. for example; invoicing and cash receipts, records all the payment and bank transactions, cash flow updating, calculating GST and other taxes, annual audits etc.
- Responsible for preparing the financial report for a company.
- Prepares overall financial structures and policies implementation and management to mitigate the possible risks.

- **Customer service manager**

- Responsible for managing after-sales services focusing on customer needs and satisfaction and ensuring services meet the business need.
- Responsible for maintaining good customer relationship.
- Developing service improvement plan by solving the encountered service issues and considering customer's complaints independently.
- Recruiting and training service employees to achieve highest record of customer satisfaction, with their communication skills.

## **9 Promotion plan**

After the completion of warehousing and assembling tasks, different promotional activities and demonstration events will be done under the supervision of sales and marketing manager to promote our biogas technology, create awareness and increase visibility about our products in target markets.

- **Advertising**

Advertisement will be created imparting the benefits and usage of PVC biodigester focusing our target specific customers through below the line advertising media such as; social media, company website, Direct mails and cold calling.

- **Awareness programmes**

To create awareness among the customers, we plan to activate 100 sales and market representatives on-site to organize the awareness programmes through the numbers of events and promotional activities.

- Demonstration events
- Events with dealers and distributors
- Static visibility campaigns in nearest marketplace
- Exhibitions and fairs
- Distributing leaflets to the households to door-to-door steps

- **Public relation**

- Public Relation is a versatile communication tool to build and maintain a positive image about product and services. This tool aims to inform target audiences about positive associations with our product, service and organization through communication skills. In terms of public relation endeavors, it is the best tool to maintain good relationships with influencers who can strongly influence the decision-making process of target customers by shaping their opinions.
- Through strategic alliances with various local level government agencies, retailers and suppliers, a network will be built through which the benefits and long-term positive implications of PVC biodigester will be conveyed.
- Public relation is effective in building high-value backlinks from media websites, boosting referral, organic and direct traffic to the website over time.

- **Personal/direct selling**

- Sales representatives hired will use interpersonal skills to convince or persuade the customers to install the biodigester in their homes. This is the most effective form of promotion in India till date for individual households (Cheng et al., 2014).
- The salesperson can also promote our product in between the potential customers that he/she meets.

- **Sales promotion**

- In order to raise the number of sales, we need to capture the high customer's attention. To make it happened, we plan to provide home kitchen biogas stove together with the biodigester without any cost which may attract potential customers to buy the product also for the benefits being offered, by promoting partnership with Agrotech companies.

## 10 Financial projection

The production of micro biogas digester utilizing the plentiful of high-quality resources that a manufacturing company already has, and producing the clean energy and biofertilizer through our micro biogas digester by utilizing a raw material of low cost, our business model is profitable for both, a company and a target customer's segment. Being optimistic and analyzing competitive landscape, our company is expected to secure strong financial position in Indian market in an initial duration of three years and be ready to grow further. The forecasted financial statement is prepared on the basis of principle of accounting using "International Financial Reporting Standards" format that brings transparency, accountability and efficiency to financial markets (see Appendix E). Our financial statement is based on assumptions table (see Appendix D), which is prepared with fair assumptions and judgement of the target market.

The sales of PVC biodigester in first three years will be carried out by different distribution channels like; direct sales representative, wholesalers and retailers. The units' sales and expected revenue in an initial duration of three years, through these channels on the basis of assumed number of representatives, sales meeting per representative per month, sales conversion rate and costs of biodigester is calculated in the financial statement including selling expenses.

*Table 9: Sales revenue per month for three years.*

Years	Sales Revenue through different channels (\$ per month)		
	Direct sales representative	Wholesalers	Retailers
1	22000	24800	84000
2	22000	24800	84000
3	22000	24800	84000

The sales revenue is expected to be 28.5 % for coming three years. The financial situation is good for start-up, and net value of sales revenue per month is expected to be stable for 36 months. In above table, income through retailers is highlighted, it is because the sales conversion rate through the retailers is expected to be low, just because it is uncertain that each visit of customers to retail shop will be to buy our biodigester. The continuous promotional endeavors and strategic partnerships are expected to raise the sales number and contribute to net income. Because I believe there will always be a room for improvements at optimum level.

## 11 Conclusion

The scenario of different biogas technologies and its dissemination in all over India for the production of alternative source of energy has been studied in this project, through different literature reviews. It is found that, due to inadequacy of these available biogas plants related to their designs, construction issues, inappropriate financing, operational problems, low production of biogas, toxic fertilizer and also problem associated with manufacturing company itself, creates a room for our company to develop and manufacture a new class of anaerobic biogas digester, in order to diversify its product portfolio in completely new market, India.

Therefore, I have proposed a unique and adequate biogas system with high operational efficiency replacing with superior light weighted, excellent tensile strength and durable rigid PVC material on the place of low-grade plastics and concrete in micro biogas digester. By understanding the benefits of PVC material and various data analysis regarding customers, biogas production system and present state of biogas production in urban setting, we can conclude that there is huge potential for our proposed biogas plant treating segregated organic household waste in urban Delhi, India. By upholding this presented business plan and model of PVC micro biogas digester for identified customer base, a company can result in successful business. As per projected financial reported, the income will be average in starting and for few upcoming years, but the expansion of business activities like; increase in sustainable value creation will be effective for a company. It is sure that our biogas system is feasible for our target market, but this business plan is not meant to be a complete review of every aspect of the business model because the data available are limited. Thus, future research on performance of biogas plants, condition of biogas production market in India, as well as their customers will help to obtain more accurate information on economic possibility and feasibility, taking PVC micro biogas digester for urban setting in India. Moreover, while doing the financial projection for a company, I have not considered all the transaction costs of all activities done for the implementation of proposed plan, so that, I am taking the final calculated value in financial report as a real value for now.

## Appendix

### Appendix A: Product Identification

#### Criteria need to be considered for product selection

Scoring criterions from 1 to 5, 1 – very low to 5 – high

Products	Criteria								
	Feedstocks	Availability of feedstocks	Level of investment required	Technical feasibility	Profit viability	Associated risk level	Government support	Market potentiality	Competition
<b>Bioplastics (PHAs)</b>	Renewable oils and fats	5	4	3	5	3	5	5	4
<b>Natural rubber</b>	Guayule plants	3	4	4	4	3	5	4	5
<b>Bio lubricants</b>	Renewable oils and fats	5	3	5	5	2	5	5	4
<b>Lignin Bio-Oil</b>	Plant fibers	5	4	4	4	4	5	5	4
<b>Bacterial biosurfactants</b>	Polyelectrolyte/ glycerol	4	5	3	3	4	5	4	3
<b>Polycarbonates</b>	Limonene from citrus fruits or plants	4	3	4	5	3	5	5	2
<b>Third generation chitosan</b>	Polyelectrolyte/ algae and fungi	4	5	4	5	4	5	5	3
<b>Lignin carbon fibers</b>	Plant fibers	5	3	4	5	3	5	5	4
<b>Resin Prepreg</b>	Plant fibers (bagasse)	5	4	4	5	4	5	4	2
<b>Bioplastics (PHAs)</b>	Municipal solid wastes	5	4	5	5	3	5	5	4
<b>Micro Biogas digester</b>	Organic wastes	5	2	5	5	2	5	5	2

- ❖ Micro biogas digester is selected as convenient product for the report, from overall assessment.

## Appendix B: Product selection

Overall assessment of different existing designs of micro biogas digester and PVC micro biogas digester.

(Score 1 to 5, 1= the worst score, 5= the best score on a criteria)

Criteria	Fixed dome	Floating dome	Bag digester	Flexi type digester	PVC digester
Availability of materials	5	5	5	5	5
Structural integrity	5	3	1	3	5
Reliability	5	3	1	3	5
Constructability	3	1	4	4	5
Heat emission	5	2	1	4	5
Operation and maintenance	5	4	5	5	5
Investment cost	3	1	5	2	2
Overall score	<b>31</b>	<b>19</b>	<b>22</b>	<b>26</b>	<b>32</b>

❖ The PVC biodigester scores the best in overall assessment.

## Appendix C: Gantt Chart

[https://docs.google.com/spreadsheets/d/1iWsYrmO4hDph3qcwRaE1EGPNg5mHWY8\\_Iv0eMyDqT88/edit?usp=sharing](https://docs.google.com/spreadsheets/d/1iWsYrmO4hDph3qcwRaE1EGPNg5mHWY8_Iv0eMyDqT88/edit?usp=sharing)

## Appendix D: Assumption Table

<https://docs.google.com/spreadsheets/d/1qiBMqY8-B7NmjPMjlluis-llgBAEot8wRt7hmkMEos/edit?usp=sharing>

The assumed data are highlighted yellow in the assumption table.

## Appendix E: Financial Projection

<https://docs.google.com/spreadsheets/d/1dfdDBYgxK35M0Lo-MdbTIVAIUvN-3A2HHBKwnoSqM-Y/edit?usp=sharing>

## Appendix F: An overview of Proposed product; PVC micro biogas digester.

<b>Product description</b>	A rigid PVC micro biogas digester is a proposed household biogas system which is flexible to convert food wastes and green garden wastes into clean gas that can be used for cooking, heating and lighting, and into nutritious liquid fertilizer for the garden.
<b>Target country</b>	India- Urban setting in Delhi.
<b>Target customer</b>	Single households attached with/without garden areas.
<b>Suggested retail price for start-up</b>	\$1550 to \$ 2000
<b>Manufacturing method</b>	Mass production
<b>Competitive landscape</b>	<ul style="list-style-type: none"><li>• Almost no competitors in urban areas.</li><li>• If our target market will be rural areas, then there are many competitors like: Sistema Biobolsa, Flexi Biogas, including conventional biogas systems and bag type digesters made up of polythene.</li></ul>
<b>Goal</b>	Affordable clean energy and quality life to customers.
<b>Outputs</b>	Biogas and green fertilizer.
<b>Feedstock</b>	Organic food waste from households.
<b>Feedstock requirements (kg per day)</b>	6 litres of organic food wastes.

<b>Additional input requirements</b>	1 litres of water for every litre of waste added into the biodigester.
<b>Average production of biogas (daily)</b>	Produce 3 hours cooking biogas.
<b>Production of bio-slurry (daily)</b>	5-10 litres of bio-slurry.
<b>Design specification</b>	<ul style="list-style-type: none"> <li>• Sleek rectangular easy to use and easy-to-assemble biogas plant.</li> <li>• The size of an unit is 2.0 cubic meter (48”*65”*39.4”) with digester chamber of size 1200 litres and gas storage chamber of 800 litres and weight less than 35 kilograms.</li> </ul>
<b>Installation time</b>	2 hours of installation by two people.
<b>Activation time</b>	Start to produce biogas in between 2 to 4 weeks after installation.
<b>Performance target</b>	Composition of gas produced is CH <sub>4</sub> 65%, CO <sub>2</sub> 35%, O <sub>2</sub> 11.7%, NH <sub>3</sub> 28 ppm, CO 0 ppm and 40 ppm of H <sub>2</sub> S.



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