Sustainable Development Goals

A PROJECT REPORT

Submitted by

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In Partial fulfilment for the award of the Certificate

Of

Internship

On

Affordable and Clean Energy, Goal – 7,

At

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Jindal School of International Affairs
India's First Global Policy School

Bonafide Certificate

This is to Certify that this project report "Affordable and Clean Energy – Biomass" is the bonafide work of BASANGOUDA PATIL, having "Roll no/University ID. 21030163" who carried out the project report work under my supervision in partial fulfilment for the award of Internship Certificate as an Intern from Earth Revital Foundation affiliated to Jindal School of International Affairs, O. P. Jindal Global University, Sonipat.

Signature:

Ms. Archana Bhanga,

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Abstract:

The term “Biogas” or “Biomass” is familiar to India and the world. This project report tries to put forward India’s road to achieving the Sustainable Development Goals (SDGs), stipulated by United Nations and the International Community through COP-26. This report also takes into India's growing energy needs, and how can the implementation of the “Biogas” project may achieve the energy needs and SDG (Sustainable Development Goals). Along with it, I propose to throw some light on the recent developments on the Technological developments in this field along with providing an account of implemented projects in and around India, and their performances.

Acknowledgement

I would like to thank the 'Revital Earth Foundation,' team and M/s. Archana Bhanga along with other members of the organization for allowing me to Intern with the foundation on the topic of Sustainable Development Goals in India. The exposure and the Knowledge under this research have helped me gain knowledge in the power sector and have given me a unique perspective and view on how addressing one problem in society can address other problems also. By doing this project, I acknowledge that I have helped the organization to address one of the SDGs.

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1.1 Introduction:

India is the second-most populous nation in this world. In the current scenario, India is a developing country and has the prospectus to be a world leader by the mid-21st century. To achieve this the nation must have a strong economy, social security and safeguard its energy sector. This is where the growing energy demand lacks supply. This is evident as yearly demand is growing at a pace of 4.6% yearly and supply lacking (Ramachandra, Vijay, Parchuri, et al. 2006). This comes at a backdrop where the world is experiencing catastrophic climate change taking place. Nation-states pledging to cut their emissions or peak their emissions by 2030 and turn towards carbon neutral to help nature survive. It is to be noted that human beings are not critical for nature to survive, but Nature is for human beings.

Biomass or Biogas is a renewable source of energy. It burns as clean as CNG or LPG. Biogas is odourless and colourless. It burns to produce blue flame and emits minimal to no residues. Biogas is a cheap, clean, renewable, naturally produced, and underutilized energy source (Verstraete, Morgan-Sagastume, Aiyuk, et al. 2005). It weighs 20% less than air and ignites at the temperature range from 650°C to 750°C (Kohler, Hellweg, Recan, et al. 2007). Its caloric value is 20 MJ/m3 (FAO 1997) and usually burns in a conventional biogas stove with 60% efficiency.

As far as India is concerned, to secure its energy sector the nation must look into other sources of Energy. Fossil fuel reserves are fast depleting, and the lack of development in alternate fuel sources will leave India back in the race. This is where Biomass or Biogas comes into the picture. Therefore, the need of the hour is a source of renewable, clean, and sustainable energy sources. Biogas or Biomass can play a crucial role at such a time.

Objective:

This report is based on the Sustainable Development Goals-7, Affordable and Clean Energy Sources. The objective of this study is to provide a detailed report on the production of Biogas

(Biomethane). This report also includes the different types of structures used in the production process. It also gives an insight into India's position in the production of Biomethane. Lastly, I provide a case study of Bowenpally Agricultural Produce Market Committee (APMC) where implementation of the biogas method has helped them reduce the dependence for energy needs on government and address the problem of solid waste management.

1.2 Biogas (Biomethane)

The answer to secure the growing energy needs of India is the use of Biogas or Biomass. Biogas is the production of methane through the digestion of solid waste from kitchens, cattle and human faeces, agricultural waste, etc. Methane, one of the constituents' elements of natural gas in CNG, can be produced. The amount of methane in biogas is around 75% which can substitute the use of natural gas. This can be produced through the anaerobic digestion of organic waste materials. This involves the process of several biological steps, I.e., acidogenesis, acetogenesis, hydrolysis, and methanogenesis through which the organic matter/waste gets converted to methane (CH4) and carbon-di-oxide (CO2).

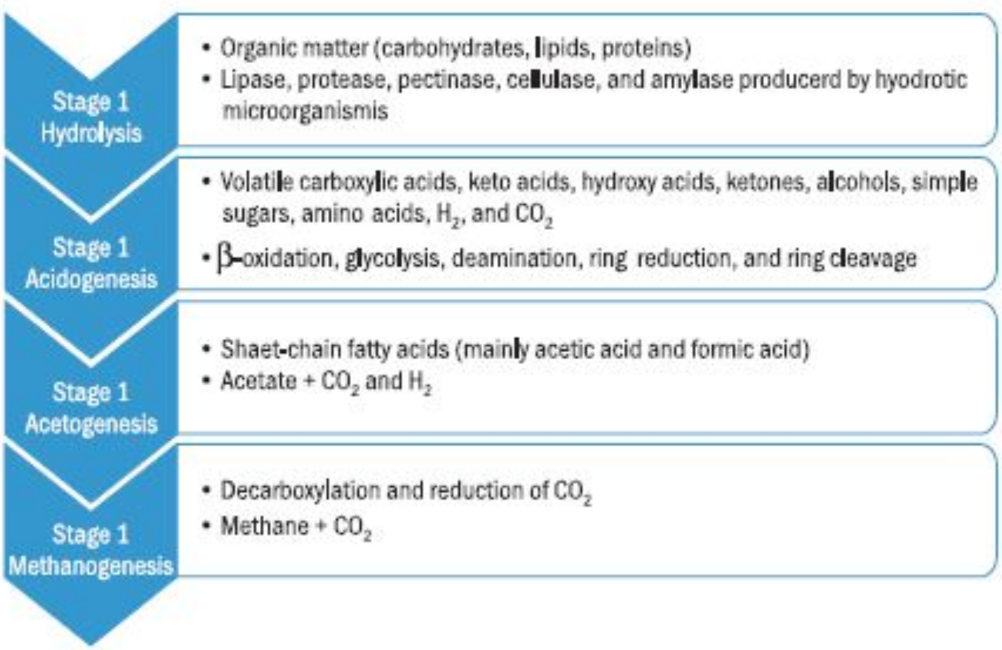


Fig. 1.1 Scheme of anaerobic digestion

Source Angelidaki, Ellegaard, and Ahring (2003), Singh, Sohini & Choudhary, Barbiee & Xavier, Stebin & Roy, Pranita & Bhagat, Neeta & Allen, Tanu. (2019). Biogas Potential in India: Production, Policies, Problems, and Future Prospects. 10.1201/9780429058271-1.

Anaerobic digestion is a multi-stage process because the raw materials used in organic bio-waste which must be broken down.

1.21 Hydrolysis is the first or primary step in anaerobic digestion. This process helps in the facilitation of breaking the complex fats into smaller or minute parts, which aids in the digestion and production of biogas. For instance, biowaste contains proteins, lipids, and carbohydrates, into amino acids, fatty acids, sugars by extracellular amylase, cellulase, lipase, or protease enzymes (Parawira, Murto, Read, et al. 2005).

It is also to be noted that the size of particles matters the most, I.e., the presence of large particles w.r.t reduces surface to volume ratio may hinder or constrain the digestion reaction leading to hydrolysis a rate-limiting step.

1.2.2 Acidogenesis in the secondary process in the production of biogas. Under this process, the substrate from hydrolysis is further broken into acetate, hydrogen, and CO2, which yields higher energy by microorganisms using facultative and obligate anaerobes or anaerobic oxidizers. (Garcia-Heras 2003) This yields into products which contain of approximately 19% H2 / CO2, 51% acetate, 30% intermediate reduced products, such as higher alcohols, lactate, or volatile fatty acids (VFAs) which can be used directly by methanogens.(Angelidaki, Ellegaard, Sorensen, et al. 2002)

1.2.3 Acetogenesis is the process where breakdown of short-chained, alcohols, aromatic fatty acids and higher VFAs to acetate and H2 occurs. The products undergo the last step of biogas production known as methanogenesis. (Singh, Sohini & Choudhary, Barbiee & Xavier, Stebin & Roy, Pranita & Bhagat, Neeta & Allen, Tanu. (2019). Biogas Potential in India: Production, Policies, Problems, and Future Prospects. 10.1201/9780429058271-1.)

1.2.4 Methanogenesis is the last step of anaerobic digestion. Under this, the conversion of the substrate to methane(biomethane) takes place I.e., anaerobic digestion in which methanogenic archaea converts H2 / CO2 and acetate to CO2 and CH4 (Kotsyurbenko 2005).

1.3 Sources/Raw Materials of Biogas Production:

India is one of the largest countries associated with agriculture. In fact, during the pandemic struck period, the agricultural sector has performed better than other sectors with a rate of 3.4% to 3.8% GDP. With such a contribution, agriculture also produces bio-degradable waste which can be used as sources of biogas production. This also includes the food processing industries in India. Several substrates such as peel of corn, soy, wheat and rice, discarded parts of straw or manure from animals or industrial wastes, and even energy crops can be utilized for biogas generation (Ofoefule and Uzodinma 2008; Uzodinma, Ofoefule, Onwuka, et al. 2007).

1.3.1 Food Processing Industrial Wastes

India is a country of diverse religions, ethnicity, and race. The food industry plays a significant role to cater households in India. Food is organic content. Industries involved in the production of dairy products, vegetables, fruits, meat, oil, and sugar produce a lot of waste. This can be both in solid and liquid form. The waste produced can be used as raw material in the production of Biogas.

1.3.2 Sugar Processing Waste

Sugar is a major staple food in the Indian household. The whole Indian nation uses it in several types, from sweets to daily consumption in the form of tea and coffee. India contributes around 17% to world's sugar production as of 2019. The waste sugarcane which is thrown can be used as raw material. This includes pressmud, bagasse, bagasse fly ash, sugar cane trash, sugar beet mud, sugar beet pulp, molasses etc (S. A. Bhat et al., "Management of Sugar Industrial Wastes through Vermitechnology", International Letters of Natural Sciences, Vol. 55, pp. 35-43, 2016) In sugarcane industry, for every 10 tonnes of sugarcane crushed about 3 tonnes of sugarcane peel fiber is generated. For a rough estimate, for every 1 acre of land around 25 tonnes of sugarcane are grown. This produces around 7.5 tonnes of waste is generated.

Sugar is manufactured through crushing of sugarcane and sugarcane beet. This produces molasses and after desugarization, is known as desugarized molasses (DM). ((Satyawali and Balakrishnan 2007; Olbrich 1963).)

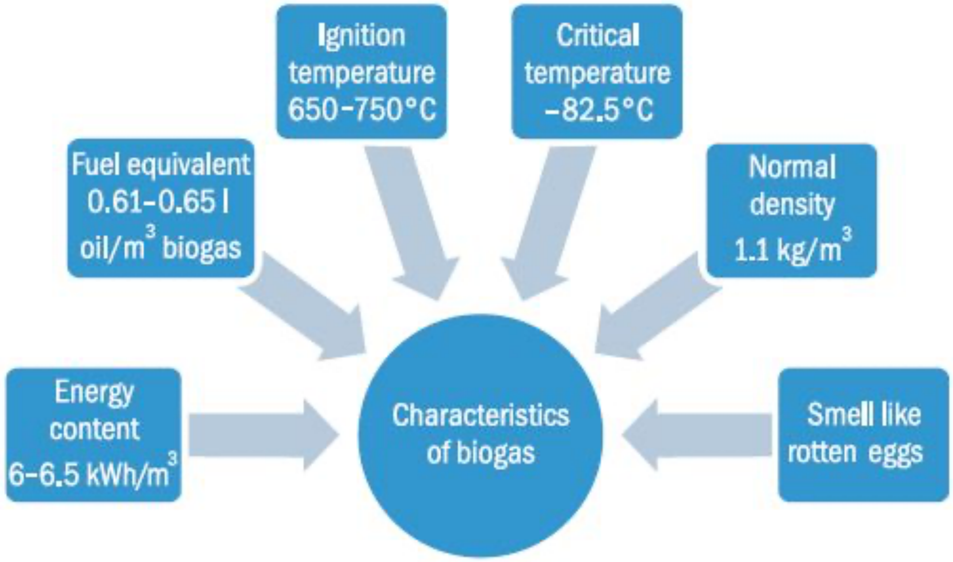


Fig. 1.2 Characteristics of biogas

Source Angelidaki, Ellegaard, and Ahring (2003)

1.3.3 Potato Starch Processing Waste

Another staple food in India is Potato. India contributes around one-third of potato production in the world. States Such as Gujarat, Uttar-Pradesh, West Bengal, Bihar, and Punjab are major contributors. Potato starch, the substitute of potato, contains 20% water and 80% potato starch. While processing, this produces 0.73 tonne of potato pulp and 6.6 sqm. Of potato juice, which are its by-products. This can be used as a raw material.

1.3.4 Paper Waste

Paper waste is easily found in India and other parts of the world. Many places, like offices, schools, factories, printing press use paper, and sometimes due to discrepancies or mistakes are discarded. Around 18 lakh tonnes of paper are produced each year. This account of production can facilitate the functioning of biogas plant, for a full year.

1.3.5 Poultry Waste

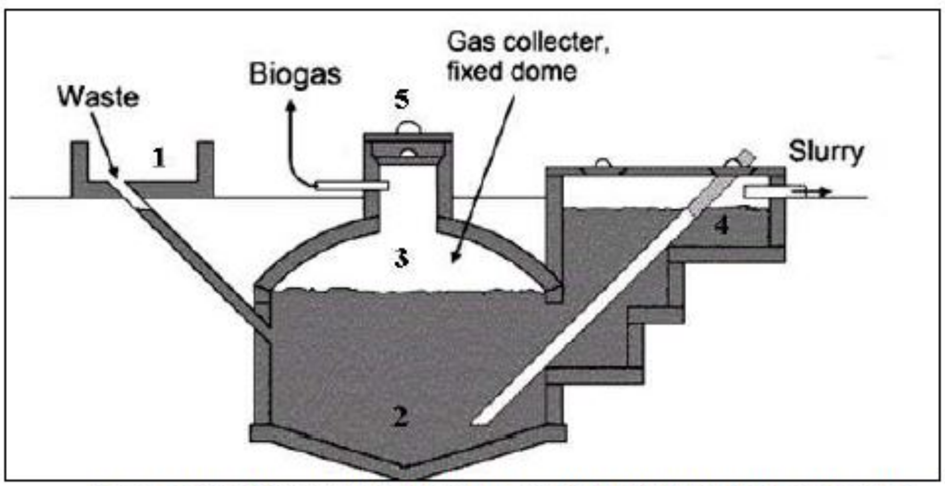
Poultry is one of the key Industries worldwide. Chicken meat is used as a substitute for many occasions. In India, poultry industry is estimated at 1.71 billion US dollars. With such a huge industry, the waste produced can be used a source to produce biogas. This comes with some conditions, I.e., the quality of poultry litter, the climatic conditions, and the time.

1.4 TYPES OF BIOGAS DIGESTERS:

One of the main components in the production of Biogas is the digester, which helps in the decomposition of the solid waste and the systematic accumulation of Biomethane. All the digestors use Anaerobic process of Bio methanation. The following section will give a rough outline of the digesters used in the production.

1.4.1 Fixed Dome Biogas:

This type of digester is a fixed, underground dome digester. This is used eventually as it is fixed. This type of Digester helps in the production of Biomethane, whole-year-round and takes up less space on the surface. The digester and the gas holder are integrated as a single unit. This type of digester can be implemented in urban areas and near cowsheds.



Source: http://fastonline.org/CD3WD_40/BIOGSHTM/EN/APPLDEV/DESIGN/DIGESTYPES.HTML

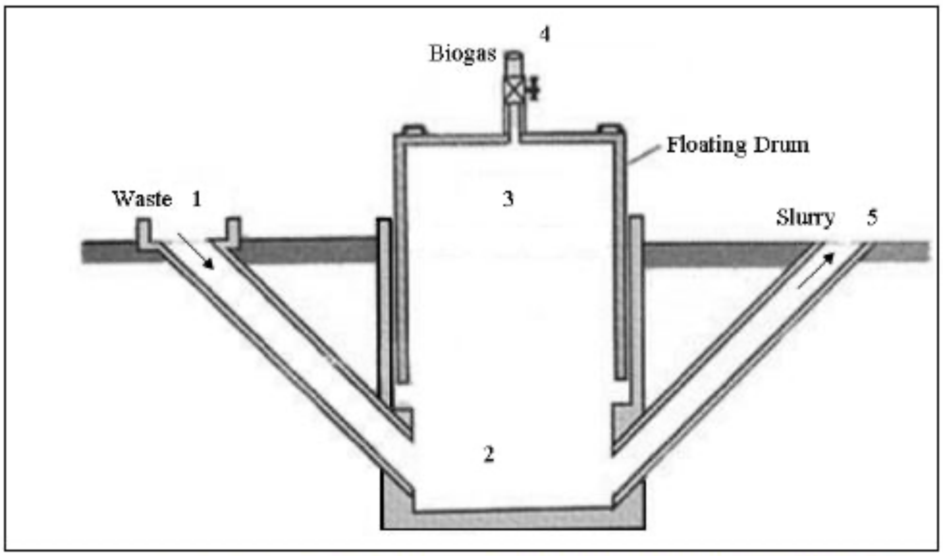
Figure 1: Fixed Dome Biogas Digester

Here, the waste goes into the digester from point 1, or is the opening. There upon, the waste Is collected in the digester, 2 and 3, where 2 represents the solid waste and 3 represents the accumulation of Biomethane. Thereafter the decomposed material is moved to point 4, where the waste (manure) is collected.

This type of digestor is convenient to construct. The cost involved is considerably less equivalent to its period of function. This type is a long-term project. As far as maintenance is concerned, it is a minimal maintenance system. The only problem is the cleaning of the tank.

1.4.2 Floating Drum Biogas:

This type of digester is the same as the fixed dome type. But one of the main differences is gas collector floats when the gas is collected. Its placement is same as fixed dome, but the gas collector partially on the surface. This type of digester is used mainly in India.



Source: http://fastonline.org/CD3WD_40/BIOGSHTM/EN/APPLDEV/DESIGN/DIGESTYPES.HTML

Figure 2: Floating Drum Biogas Digester

As the name suggests, Floating Drum, I.e., 3 is the gas collector where the drum is placed. As when the gas collection takes place it floats or expands. The process is same as that of fixed dome digestor.

This type of digestor is a costly system and moreover the maintenance of this system is crucial. The floating dome is made up of steel or metals of similar type and there is a possibility of rust and damage. Maintenance also includes the system to be cleaned regularly.

1.5 ISSUES AND CONCERNS FOR THE BIOGAS

PRODUCTION PROCESS

Production of Biogas is dependent on the temperature and the quality of the feedstock/raw material available. It's effects maybe of different types, for instance too much water in the feedstock may act as an inhibitor and too dry feedstock may hinder the process of anaerobic digestion. The absence of nutrients also plays a significant role in the anaerobic digestion process. The appropriate conditions are mentioned below.

1.5.1 Temperature

Temperature plays a key role in facilitating the anaerobic digestion process. The advantage is, the increased inorganic solubility, complex compounds break down easily, facilitate – Biological and Chemical reactions, and help in breaking of long-chain fatty acids and VFA's. The following are the appropriate temperature for biogas generation.

"(i) Mesophilic range: Microbes are called mesophilic when they can function around the temperature range 30–38°C or 20–45°C.

(ii) Thermophilic range: Thermophilic bacteria act around temperature range of 49–57°C or up to 70°C (Kangle, Kore. and Kulkarni 2012)." (Singh, Sohini & Choudhary, Barbiee & Xavier, Stebin & Roy, Pranita & Bhagat, Neeta & Allen, Tanu. (2019). Biogas Potential in India: Production, Policies, Problems, and Future Prospects. 10.1201/9780429058271-1**.**)

1.5.2 pH and Buffering Capacity (Alkalinity)

As the feedstock is mainly animal waste or some form of organic compound. There are micro-organisms present in it, which help facilitate the breakdown of insoluble compounds like long-chain fatty acids and VFA's into minute articles. These in turn decompose to produce biogas, so. If the feedstock is more alkaline in nature, it affects the fermentation or digestion process, and if it is less alkaline, this may also affect the production of biogas. An optimum um ph. range of 6.6 to 7.8 is to be maintained and is considered ideal.

1.5.3 Nutrients

Another factor that helps in the anaerobic digestion process is the nutrients. Nitrogen, Phosphorous, Carbon, Sulphur, Potassium, Nickel, Iron, Cobalt, and Zinc are some of the necessary nutrients. These help in the microbial cell growth process.

1.5.4 Volatile Fatty Acids

CO_2 and CH_4 are the intermediate products of the digestion or fermentation process. The anaerobic process requires a certain amount of VFA's to produce CO_2 and CH_4. Therefore, as suggested by Björnsson (2000) and Boe (2007), VFA is recommended as a marker during the anaerobic digestion process.

1.5.5 Organic Loading Rate

This is the most crucial step of the process. The organic loading rate is defined as the amount of feedstock feed into the digester. The biological matter flows into the digester uniformly at a steady rate, so that the time taken for fermentation or digestion is optimum. The recommended rate at which OLR is done is 0.5 and 3 kg VSS/ (m^3 day). Another cause of concern is, overloading and underloading. As most of the industrial waste produces CH4, the higher the CH4, the higher is the VFA's (for overloading), and if lower the CH4, the lower is the VFA's (for underloading). This imbalance accounts for higher or lower VFA's causing more noxious for methanogens and reducing the ph. which results in an end to anaerobic digestion.

1.6 Stakeholders Management:

Stakeholders are the foremost entities in an organization. Any project either small scale or large scale depends on the stakeholders in the region to be implemented. A stakeholder is defined as those elements without which an organization or a project would cease to exist or take a form. So, it becomes important to understand and identify the stakeholders. Further to add, stakeholders is divided into power, legitimacy, and urgency. All the actors outside of this field are considered as non-stakeholders.

Dominant Stakeholders – Capital Intensive Companies (Reliance, TATA Energy, L&T Energy, International organizations involved in addressing key concerns- WHO, WTO etc) - Corporates board of Directors.

Discretionary Stakeholders – NGO's, which receive funds and grants from organizations and Government (Revital Earth Foundation).

Dependent Stakeholders – Dependent on Dominant stakeholders for action on issues (People affected due to climate change/End customers to receive electricity).

Definitive Stakeholders – Play a leading role in the implementation of the project (Government of a nation/state/locality)

As for the above project to be implemented, the stakeholders are important. Under the above-classified ones:

Dominant Stakeholder – International Energy Agency (IEA) - Capital Investment.

Discretionary stakeholder – Revital Earth foundation – Implementation of the project and nodal point of contact in collaboration with International Energy Agency (IEA) - Human Resources, Groundwork, and research.

Dependent Stakeholders – Civil society.

Definitive Stakeholder – Government of India/state and local bodies.

1.7 Problems Encountered

Most of the population in India resides in rural areas. Biogas was a common source of energy earlier, but due to its inefficient production, it was slowly phased out. This also comes at the backdrop when India, under the current Prime Minister announced LPG cylinders for each household. The other factor for its unpopularity is the availability of raw material and its technical usage. This is discussed below:

Technical:

With limited clarity on the functions of the biogas plant, most of the systems were left unoperated. These are in different ways, plants left Un operational, parts being damaged due to rust and carelessness. Lack of technical knowledge to common people adds to the issues. The following are some of the listed issues:

- Input problems.

- Assessing techno-economic feasibility.
- Technical parameters for target setting.

Political/Bureaucratic:

Civil Authorities play an important in social projects. The same is with this. This is facilitated by the non-recognition of the main target population to address. Many times, biogas plants are installed at Urban or Semi-Urban locations, where raw material is not accessible. To address this, a bureaucratic process is necessary. Panchayat level bodies fail to analyze the situation in rural areas, where most of the poverty lies.

Human Resources:

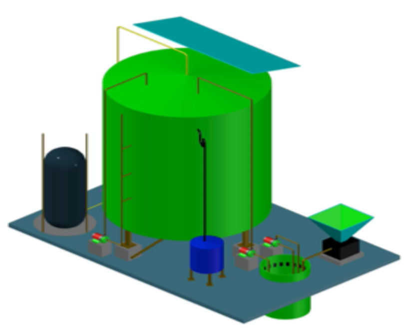
Though governments push for implementation of Biogas projects in India included incentive led schemes by NABARD or Ministry of New and Renewable energy, the programs fail to take off. The lack of staff to train, overlook report and head the programme are some of the causes.

1.7 Case Study: Bowenpally Vegetable Market

Bowenpally is an urban locality in Hyderabad where an Agriculture Produce Marketing Committee (APMC) is located. The Agricultural Produce Market Committee (APMC) administration in collaboration with Council for Scientific & Industrial Research - Indian Institute for Chemical Technology (CSIR - IICT) has developed a highly efficient Anaerobic Gas Lift Reactor to treat the solid waste problem in the market yard.

Objective of the Project – To address the sloid waste at the Bowenpally market Yard.

<u>Technology:</u>



The technology used in the high-rate bio methanation process is different from the conventional process. As in conventional biodigester, the organic slurry would be digested to produce methane here the organic slurry is digested twice in the reactor/digestor. Through the process of pressure change, I.e., when the methane is produced the slurry, due to pressure change moves up the digestor to the opening to pass out. The undigested or partially digested matter comes back into the digestor to react and completely yield biomethane. Here this system is centered on liquid and gaseous hydrodynamics through pressure management across the system. This essentially means that the digestion process is in two stages and three settlers at the middle and bottom of the reactor/digestor, a baffler settler at the middle of the reactor/digestor, a liquid outlet at the top, a gas riser, and a path for the liquid to come down.

This technology is designed keeping in mind the conditions of biogas production, I.e., Temperature, ph and buffering capacity, Volatile fatty acids, nutrients, and Organic Loading Rate (OLR).

- <u>The Specifications of the system are as follows:</u>

Patent Number: 307102 (India), Abroad: filed, under scrutiny; PT-609/0207NF2012

Title of Product / Technology	Anaerobic Gas lift Reactor (AGR): A High rate bio methanation technology to treat organic solid waste for the generation of biogas and bio manure
i. Capacity of plant	i) 10 Tons per day
ii. Operating Days Process	ii) It is a continuous process
iii. Feed stock used	iii) Market vegetable waste
iv. End product/By product	iv) Biogas and Bio manure
v. Yield cum/d	v) 350 m^3/day
vi. Capital cost (Initial/ yearly)	vi) Capital cost: INR 250 lakhs (Initially)
vii. Operating Cost/yearly	vii) Operating Cost: INR 30 lakhs per annum
viii. Biogas production yearly (cum/d)	viii) 1,15,500 m^3/ year (by considering 330 working days per year)
ix. Fuel replacement/ Power replacement/	ix) 120 m^3 per day of Biogas is used for replacing 52 kg LPG for cooking 230 m^3 per day of biogas is used for generating 175 units of power.
x. Biofertilizer (TS) TPD – Specification	x) Liquid Biofertilizer: 5000 kg/day
xi. Area required	xi) 1200 m^2

(Inputs from Dr. A. Gangagani Rao, Chief Scientist, CSIR - IICT)

The above plant is scalable up to 25 tons, provided the available biowaste and the requirement of the customer.

- <u>Economics of Biogas Plant:</u>

	Biogas plant at vegetable marker waste	Unit
Quantity of feed stock (Market vegetable waste)	10,000	Kgs/day
	10	Tons/day
Biogas generation from vegetable waste per day	350	m^3/day
Capital cost of the plant	2,50,00,000	Rupees

Operation and maintenance cost per annum	30,00,000	Rupees
Total working days of the plant in a year	330	days
Total Biogas generation per annum	1,15,500	m^3
Calorific value of biogas having 60% methane	5,138	Kilo Calories
Calorific value of LPG	11,900	Kilo Calories
Amount Biogas used for LPG replacement per day	120	m^3
LPG equivalence of Biogas per day	52	kg
Cost of 1 Kg commercial cylinder	91	Rupees
Total revenue from cooking fuel per annum	15,55,907	Rupees
Biogas used for power generation per day	230	m^3/day
Power generated per day	175	units/day
Total Power generated per annum	57,750	units
Cost of one unit of power	11	Rupees
Total revenue from sale of power per annum	6,35,250	Rupees
Total liquid Bio manure generation per day	5,000	kg/day
Total liquid Bio manure generation for annum	16,50,000	kg
Cost of one Kg Bio manure	50	Paisa
Total revenue from bio manure sale per annum	8,25,000	Rupees
Total Revenue from the plant	30,16,157	Rupees
Cost of O&M per annum	30,00,000	Rupees
Net Profit	16,157	Rupees
Waste disposal cost	1,000	Rs/day/ton
Total disposal cost per annum	33,00,000	Rupees
Total Profit	33,16,157	Rupees
Payback period	8	years

(Inputs from Dr. A. Gangagani Rao, Chief Scientist, CSIR – IICT, Patent Number: 307102 (India), Abroad: filed, under scrutiny; PT-609/0207NF2012)

- <u>The impact on Societal, Environmental and Other Benefits:</u>

So far, the governing body at the Agriculture Produce and Marketing Committee (APMC) has saved around 100,000 INR in electricity bills and 52 kgs of LPG for cooking. In turn, addressed the solid waste problem in the compound vicinity and produces high-quality, nutrient-rich bio-manure for sale to farmers.

- <u>Potential Stakeholders Partners in the current project:</u>

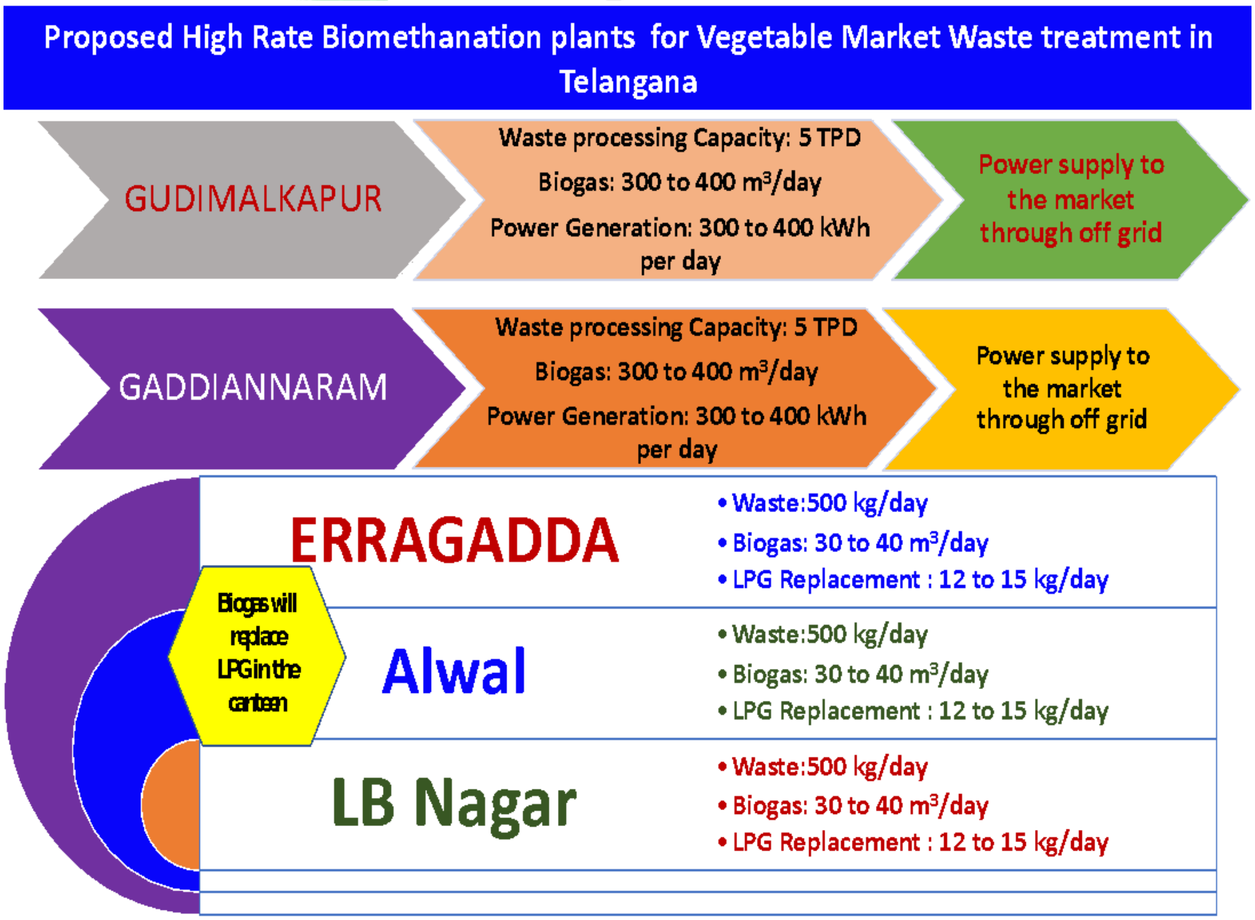
1. Department of Biotechnology (DBT), GoI
2. Department of Science and Technology (DST), GoI
3. Ministry of New and Renewable Energy (MNRE). GoI
4. Ministry of Housing and Urban Development (MHUD), GoI
5. Department of Agriculture and Marketing, GoT
6. Department of Agriculture and Marketing, GoAP
7. M/s Ahuja Engineering Services, Secunderabad,
8. Greater Hyderabad Municipal Corporation (GHMC)
9. M/s Hyderabad integrated MSW Limited,
10. M/s Nyrmalya Bio Engineering Solutions (NYBES), Hyderabad
11. M/s KHAR Energy Optimizers
12. M/s GESPL, Hyderabad

Plant Image:

- <u>Salient Features of the Plant:</u>

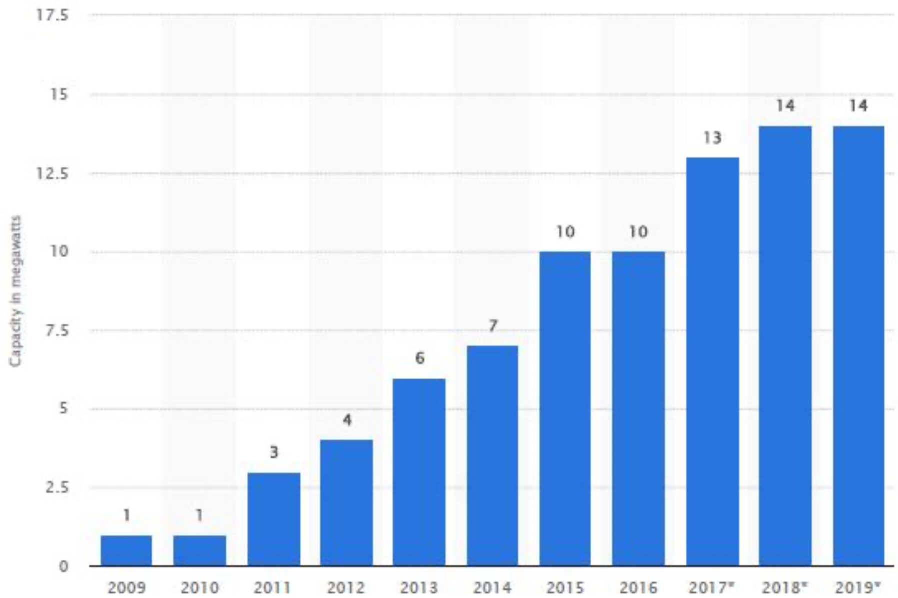
1. Low Hydraulic Residence Time (HRT).
2. High Volatile Solids Loading Rate (VSLR).

3. High Methane Yield.
4. Addresses Solid Waste management, end to end.
5. Scalable plant, from 100 kgs to 10 tons.
6. Incorporates pre and post processing mechanisms.
7. Advanced Digester: high methanation, nutrient rich fertilizer, Minimum space, Semi-automatic plant operation.



1.8 India's Share in the Biogas Energy Capacity:

As of the fiscal year 2020, India had a peak power requirement of 192 thousand megawatts. And as per statistics, electricity generation through biogas accounted for 14 megawatts in 2020. To safeguard its energy needs, India must push for alternate sources of energy keeping in mind the environmental concerns.



To facilitate the production of electricity through the biogas Ministry of New and Renewable Energy, the Government of India has issued incentive-linked schemes for North-Eastern regions and Non-North-Eastern Regions. The following are the tables. (E-File no. 253/17/2017)

Pattern of Central Financial Assistance (CFA) & rates applicable under the Biogas Power Generation (Off-grid) and Thermal application Programme (BPGTP) w.e.f. 26-11-2018 and up to 2019-20 (31.03.2020) for SCs, STs, and all Category Beneficiaries of NER States, including other charges are given as below-

Power generating capacity (kW)	**Biogas plant capacity (cubic metre)**	**Require-ment of DPR**	**CFA/subsidy limited to the following ceiling or 40% of the Project cost whichever is less.**		**Administrative Charges to Program Implementing Agencies, State Nodal Departments /Agencies/ BDTCs for providing technical supervision, submission of project completion and commissioning reports of Project and monitoring of the projects.**	
			Power Generation	**Thermal applications**	**Power Generation**	**Thermal applications**
3-20kW	30 M^3 to 200 M^3	DPR required above 10 kW (above 100 m^3 biogas plant size)	Rs.40,000/- (Rupees forty thousand only) per kWeq	Rs.20,000/- (Rupees Twenty thousand only) per kWeq thermal/ cooling	10% of the CFA	5% of the CFA
>20kW up to 100kW	Biogas plants of above 200 cu. metre size or any combination of above size plants or approved alternate matching capacity/design	DPR required	Rs.35,000/ - (Rupees Thirty five thousand only) per kW	Rs.17,500/- (Rupees Seventeen thousand five hundred only) per kWeq thermal/ cooling	Rs. 2,00,000/- (fixed)	Rs. 1,00,000/ - (fixed)
>100 kW up to 250 kW	1000 cubic metre biogas plant of single digester or any combination of above sizes approved plants capacity/ design	DPR required	Rs.30,000/ - (Rupees Thirty thousand only) per kW	Rs.15,000/- (Rupees Fifteen thousand only) per kWeq/ cooling	Rs. 3,00,000/- (fixed)	Rs.1,50,000/- (fixed)

Pattern of Central Financial Assistance (CFA) & rates applicable under the Biogas Power Generation (Off-grid) and Thermal application Programme (BPGTP) w.e.f. 26-11-2018 to 2019-20 (31.03.2020) for All Other States (except SC/ST category beneficiaries of all States/ UTs & NER States) including other charges are given as below-

Power generating capacity (kW)	Biogas plant capacity (in cubic metre)	Requirement of DPR.	CFA/subsidy limited to the following ceiling or 35% of the Project cost whichever is less.		Administrative Charges to Program Implementing Agencies, State Nodal Departments / Agencies/BDTCs for providing technical supervision, submission of project completion and commissioning reports of project and monitoring of the Project performance.	
			Power Generation	Thermal applications	Power Generation	Thermal Applications
3-20 kW	30 M^3 to 200 M^3	DPR required above 10 kW (100 m^3 biogas plant size)	Rs.35,000/- (Rupees Thirty five thousand only)per kW	Rs.17,500/- (Rupees Seventeen thousand five hundred only) per kWeq thermal/ cooling	10% of the CFA	5% of the CFA
>20kW up to 100kW	Biogas plants of above 200 cu. metre size or any combination of above plants or approved alternate matching capacity/design	DPR required	Rs.30,000/- (Rupees Thirty thousand only) per kW	Rs.15,000/- (Rupees Fifteen thousand only) per kWeq thermal/ cooling	Rs 2,00,000/- (fixed)	Rs. 1,00,000/- (fixed)
>100kW up to 250 kW	1000 cu. metre biogas plant of single digester or combination of above plants or approved alternate matching capacity/design	DPR required	Rs.25,000/- (Rupees Twenty five thousand only) per kW	Rs.12,500/- (Rupees twelve thousand five hundred only) per kWeq thermal/ cooling	Rs.3,00,000/- (fixed)	Rs.1,50,000/- (fixed)

1.9 Conclusion:

Biogas is an untapped potential in India and around the world. Around one-third of the food produced is wasted around the world. The United States of America alone wastes 108 billion pounds of solid food, and the U.S.A (United States of America) is analysing ways to address its solid waste disposal problem. Considering the entire world, Biogas has the potential to address Solid Waste issues, Affordable and Clean energy for cooking, heating, and electricity. India can realize its climate change goal of being carbon-neutral at a much earlier period. Biogas also generates employment for the youths in villages, organic fertilizer for farming, and can act as an economic center at village levels. The Anaerobic Gas Reactor developed by CSIR – IICR is a breakthrough in Biogas production. The techno-economic feasibility of the plant has proven to be effective. The recent addition of Asia's biggest Bio-CNG plant is an appropriate case to study.

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