

DETAILED PROJECT REPORT FOR
2.5 MTPD COMPRESSED BIOGAS
(CBG) PROJECT
AT
VILLAGE BHADAULI
GHAZIABAD.
UNDER SATAT SCHEME



PREPARED FOR

M/S ZAK VENTURE PVT LTD

BY

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BIOGAS OUTLOOK

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1. INTRODUCTION

Energy resources are required for the growth and development of the country. Till date, energy resources in the form of fossil fuels such as crude oil have been used all over the world. These fossil fuel resources have been controlled by a cartel in the oil sector or by a few countries. They control the output and price of oil. Countries in the rest of the world are the importer of crude oil and hence are vulnerable to fluctuations in the price of fossil fuels. These countries not only lose valuable foreign exchange but also get terms dictated by countries supplying crude oil. Hence their plans for growth and development have been at stake. Moreover, the usage of fossil fuels has contributed largely to climate change and several problems in the socio-economic sphere. Now, these resources are on the verge of extinction. Hence the world is moving towards the use of renewable energy for energy safety & security.

Biomass is one of such resources that can be used for the production of renewable energy. It is abundant in quantity & available across the globe in every country. Bioenergy can be produced from biomass. Its constituents are municipal waste, industrial use, solid biomass, biogas, and liquid biofuels. Biogas can be produced from different kinds of biomass such as cow dung, poultry litter, energy crops, agricultural residue, industrial waste and wastewater, etc. by means of the microbial process. It can be purified or upgraded to natural gas quality and used as vehicular fuel in place of fossil fuels to cut GHG emissions.

The transport sector forms the backbone of the economy in the country. It accounts for 30% of global energy use & 14% of the total CO₂ emission. At present, it is heavily dependent on oil and so is extremely vulnerable to changes in oil prices. Hence use of biogas as vehicular fuel makes a perfect case for biogas projects to achieve a sustainable future. Waste to biogas projects help us to eradicate the problem of waste on one side and supply clean fuel & organic fertilizer on the other. These projects provide employment opportunities. They help to achieve self-reliance in fuel supply and savings in foreign exchange. These financial resources can now be used for the development of the country. Thus, such projects have the potential to address questions other than energy security. They can provide solutions to matters relating to economic, national, environmental and political security. They offer renewable, low-carbon energy systems, sequestering atmospheric carbon as well as offer numerous environmental and socioeconomic benefits. Moreover, they can support global climate change targets and wider environmental, social, economic, and sustainable targets. Hence various governments in the world are framing policies to develop and use more and more renewable energy resources.

1.1 Biogas projects in the world

Over a period of 16 years from 2000-2016, it has been observed that supply of renewable energy has increased from 54.8 EJ to 80.6 EJ worldwide. It accounts for 14% share in the energy mix (coal, oil, natural gas, nuclear & renewables). Bioenergy constitutes 70% of the renewable energy. In this same period, it has increased from 42.8 EJ to 56.5 EJ. Biogas production has increased from 0.28 EJ in 2000 to 1.31 EJ worldwide in 2016. It constitutes 2% share of the bioenergy energy

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mix. In terms of corresponding volume in m³, its production has increased from 13.2 billion m³ in 2000 to 60.8 billion m³ in 2016. Region wise Europe has 54 % share of the total biogas production while other regions like Asia and Americas have 30% & 14% respectively.

1.2 Europe

Bioenergy is produced from feedstocks such as biomass from agriculture (crop residues, bagasse, animal waste, energy crops, etc.), forestry (logging residues, wood processing by-products, black liquor from the pulp and paper industry, fuelwood, etc.), and other types of biological waste (food waste, food industry waste, the organic fraction of municipal solid waste, etc.). Bioenergy is used for production of heat, generation of electricity and as transport fuels.

Germany, Sweden, Switzerland, UK & US are the largest producers of biogas as vehicular fuel in 2016. Worldwide there are 500 biogas plants that produce 50 PJ (Petajoules) per year upgraded biogas. These countries have promoted biogas through a combination of tax exemptions, investment subsidies, and incentives for biogas injection into natural gas grid.

Germany has a strong biogas industry with 8980 biogas production plants and is the EU leading country in terms of biomethane production. There are 203 biomethane plants connected to the natural gas grid with a total estimated capacity of 1.71 billion m³ of raw biogas processed. It is equivalent to about 940 million m³ of biomethane fed into the German gas grid. This contributes to about 12.3% of the natural gas production or 1% of natural gas consumption in Germany.

One interesting example of promoting biomethane as a transport fuel is in Berlin. Biogas production from 60,000 tons of selectively collected biowaste from households is upgraded into biomethane, which is used to fuel 150 waste collection trucks.

In Sweden 97% of its produced biomethane is used as vehicle fuel. Due to the fact that the gas grid is limited only to the west coast of Sweden, 75% to 80% of the biomethane is transported by trucks from the locations of production to the filling stations.

The biomethane is transported not only in compressed form but also in liquefied form. Natural gas and biomethane are complementary fuels. Almost 70% of the produced biogas is upgraded and used as transport fuel. Swedish natural gas vehicle (NGV) fleet has 54,439 light duty vehicles, 2331 buses (18% of national market), and 821 HD trucks (Including 50 LNG trucks). Sweden is the first country in Europe which has reported to the European Commission about the consumption of biomethane in transport sector.

In Italy biomethane was selected as biofuel for transport. In case of installed capacity of biogas plants it is next to Germany. Italy is at third position in terms biogas production (2.2 bcm/year). Feedstock for biogas production was biomass of agriculture origin, Italy is European leader when it comes to vehicles running on natural gas. It has 1 million CNG vehicles supported by 1250 CNG refuelling stations. And there are 22 LNG stations for powering 1000 heavy vehicles.

In United Kingdom (UK) The government has the strategy '[Road to Zero](#)' wherein the UK Government has indicated a ban on the sale of diesel and petrol cars, with this development biomethane plants have been created in the last five years to produce cleaner fuel for the transport. The government has extensive support policies for these plants such as introduction of attractive Renewable Heat Incentive (RHI) that provided a bonus paid on top of the market value of the gas injected.

In Scotland, the Scottish Government aims to phase out the petrol and diesel vehicles by 2032 and the Irish Government, in their [2019 Climate Action Plan](#) has also indicated the intent to introduce legislation to ban the sale of new fossil fuel cars from 2030. In both these countries biomethane is the solution for the transport fuel in place of polluted fossil fuels.

It has been observed that the potential for development of bio methanation as vehicle fuel. Still European countries like Germany has less than 2% of biogas units (around 203 units) are

biomethane production plants. France has less than 3% (around 30 units) of biogas units for bio methanation, while other EU countries, has between 4% and 12%.

Sweden and Germany can serve as example of effective implementation of biomethane is transport sector. In Germany there is gas grid injection while in Sweden Cascades are used to transport gas to fuel station. In Sweden and Germany, biomethane markets are well established so they can serve as good examples for analysing pros and cons of solutions and models implemented by them. Their experience can be useful for countries starting development of biomethane and use it as vehicular fuel.

1.3 Biomethane In Asia

In Asian countries small and medium size biogas have been installed. These projects aim at using biogas as fuel for cooking or thermal application. Biogas is also used for power generation. But using biogas as a vehicular fuel is new concept. It aims to achieve energy safety and GHG mitigation.

1.4 China

China is developing rapidly. Its GDP has become 13,37 trillion USD. More the development, more and more energy resources are required. Natural gas occupies important position in energy mix. By 2020 its demand will become more than 300 billion m³/year. The gap between natural gas consumption and domestic availability has increased more than 120 billion m³/year. This gap can be met by bio natural gas (BNG). At present its production is 8 billion m³ per year. China has potential to produce 150 billion m³ per year BNG. Plans have been put in place to increase BNG plants from 25 to 197 by 2020. There is subsidy for construction of biogas, digestate fertilizer &

animal manure treatment for promotion of Biogas projects. MOU is signed between German Federal Ministry of Food & Chinese Ministry of Agriculture (MoA) Agriculture (BMEL) for setting up large commercial bio methanation plants in China.

1.5 India

Currently India imports nearly 77% of its crude oil requirements and about 50% of natural gas requirement. We are dependent on other countries for that purpose. Considering volatile international situation, such dependence can endanger energy safety and security. So, the Indian government has set a target of reducing this import by at least 10% by 2022. Further, it has set a target of increasing the contribution of gas in India's energy mix from existing 6.5% (global average is 23.5%) to 15% by 2022.

It has set four pillars of vision of India's energy future – energy access, energy efficiency, energy sustainability and energy security. India is vulnerable to climate change. It is the third largest emitter of GHG after China and USA. It has ratified Paris agreement and pledged to achieve 33-35% reduction in GHG emissions by 2030 compared to 2005 levels. It has focused on transport sector to reduce GHG emissions. Thus, Indian government aims to achieve energy security as well as cut GHG emissions by means of use of renewable energy.

1.5.1 National Biofuel policy

As a step towards usage of renewable energy, Union government of India has released National Policy on Bio-Fuels 2018 vide gazette notification no. 33004/99 dated 08.06.2018. The policy emphasizes on promotion of advanced Bio-fuels including CBG.

1.5.2 Amendment in Central Motor Vehicles Rules, 1989

Ministry of Road Transport and Highways has amended the Central Motor Vehicles Rules, 1989 and included the provisions for usage of biogas, in the form of bio - CNG, in motor vehicles produced from waste.

1.5.3 SATAT scheme

Ministry of Petroleum and natural Gas launched a scheme called SATAT i.e. Sustainable alternative towards affordable transportation, on 2nd October 2018. Under this scheme Government of India is expecting to set up 5000 CBG plants which can produce 15 million tonnes of CBG per annum by 2023, which is about 40% of current CNG consumption of 44 million tonnes per annum in the country. Being the reservoir of biomass of various types, India has potential to produce 62 million tonnes of CBG which can make it energy surplus country. Biogas can be produced by microbial action on this biomass and it can be purified to the grade of automotive fuel. The remaining part of biomass left after microbial action is a very good organic fertilizer which has potential to replace chemical fertilizers is imported at this juncture.

As per projections mentioned in this scheme 350 million tonnes of organic fertilizer can be produced. Its usage can reduce water and soil pollution. One can sell other by-products such as CO₂ produced from purification of biogas. Thus, this is an integrated compressed biogas projects having multiple revenue streams available under one roof. Any entrepreneur can establish such integrated compressed biogas projects based on various organic waste materials and sell purified biogas of automotive fuel grade to Oil Marketing Companies (OMCs) such as IOCL, HPCL and BPCL.

Waste material such as cow dung, poultry waste, press mud, rice straw, organic fraction of MSW etc. can be used as substrate for biogas generation. The scheme is aimed at replacing fossil fuels like diesel, petrol, natural gas with compressed biogas (CBG) which will in turn help to cut on emissions responsible for climate change. Moreover, it is estimated that CBG potential of India is 62MMT with bio manure capacity of 370 MMT. People will go for CBG since it has advantages over fossil fuels. Thus, there is demand for CBG. Government has envisaged policy frame work to set up decentralized CBG projects across India. Raw material for project is easily available, demand for gas is ever rising and Government policy is focused on renewable energy. Thus, there is favourable climate for investment in CBG projects in India. With this, India has entered a new era of biogas in terms of its usage.

1.5.4 Biogas project before SATAT scheme

Earlier biogas projects were established but mostly these projects were set up in industrial sectors namely distillery, paper and pulp, solvent extraction, rice mills, textiles, pharmaceutical industries etc.

Type of waste and % of waste to energy projects:

- ❖ Industrial waste: 65%
- ❖ Urban waste including MSW: 34%
- ❖ Agricultural waste: <1%

The biogas generated was used as fuel in boiler. It was also used in biogas generator to produce electrical power. This power was used to meet own requirement of industry for power. Thus, these projects were aimed at savings in usage of fuel or power. So far 16 CBG projects were installed under WTE programme. Their CBG generation capacity was 0.02 MMT CBG per year. They were embedded with set of problems such as no offtake guarantee from Government, no fixed price of sale of CBG, payment problem, fluctuations in demand, Supply Chain issue etc. This CBG was not used as vehicle fuel. The purity of methane (CH₄) was limited to 80-85% in the biogas.

SATAT scheme is contrast to this scenario. Differential features of this scheme are as given below:

- 1) Off take guarantee from Oil marketing companies / Gas marketing companies.

- 2) The new floor price for CBG is 54 Rs / Kg + 5% GST and it has been linked to the retail selling price of CNG.
- 3) Agreement with Oil marketing companies / Gas marketing companies will be for 10 years. It can be extended further with mutual consent.
- 4) Purified biogas will be used as automotive fuel. Its purity parameters under SATAT scheme are as given below:

Components	Range	Method of test
CH ₄ , percent, Min	>90	IS 15130 (Part 3)
Moisture, mg/m ³ , Max	<16	IS 15641 (Part 2)
H ₂ S, mg/m ³ , Max	< 30.3	ISO 6326-3
CO ₂ +N ₂ +O ₂ , percent, 10 IS 15130 (Part 3) Max (v/v)	<10	IS 15130 (Part 3)
CO ₂ , percent, Max (v/v) 4 IS 15130 (Part 3) (When intended for filling in cylinders)	< 4	IS 15130 (Part 3)
O ₂ , percent, Max (v/v)	< 0.5	IS 15130 (Part 3)

State of the Art plant is required to achieve above mentioned quality parameters on a sustainable basis. The purified biogas will be transported to the fuel station through cascades. Every cascade will carry copy of certificate of on-line monitoring system. If the parameters of purity of biogas are not as per automotive fuel then the whole cascade will get rejected. So, technology selection becomes critical.

5) Multiple revenue streams

- ❖ Compressed biogas
- ❖ Organic fertilizer / Input raw material for Biomass Pellet Plants
- ❖ CO₂

1.5.5 Implementation of SATAT

This scheme has been implemented by Oil marketing companies such as IOCL, HPCL & BPCL as well as GAIL & its associate companies like IGL etc. Till date more than 400 Letter of Intents (LOIs) have been issued for setting up such CBG projects. The entrepreneurs can establish CBG projects across India based on various types of biomass. They can look at either Germany or Sweden for successful installation of bio methanation projects in India for business risk mitigation.

1.5.6 Amendment in Fertilizer control order, 1985

Now solid part and liquid part of the digester output both referred as fermented organic manure has been included in the Fertilizer Control Order, 1985.

1.5.7 Inclusion of CBG projects under Priority Sector Lending

RBI has included CBG projects under Priority Sector Lending. State Bank of India has come up with product package for CBG projects. Under this scheme rate of interest varies from 8.5% to 13%. The tenure of this loan is 12-15 years. The debt: equity ratio is 70:30.

PROJECT IN DETAIL

2. EXECUTIVE SUMMARY

Establishment of **compressed biogas (CBG)** projects in India is need of the hour from the point of view of savings in foreign exchange, protection of environment, energy safety and security, commitment to cut in GHG emissions, employment generation, retaining fertility of the soil and food security. These projects can be established at various locations throughout the country depending on the availability of feedstock such as cow dung, poultry litter, kitchen waste, fruits and vegetable waste, organic fraction of municipal solid waste (OFMSW), industrial waste water (spent wash, starch waste water, dairy waste water etc), rice/paddy straw etc. The outputs of these projects are purified biogas, CO₂ and organic manure/fertilizer. The waste will be utilized to generate energy for vehicles, soil and crop. Thus, these are all waste to energy projects also these are the back bone of **Swachh Bharat Mission (SBM)**.

Ministry of Petroleum and Natural gas has launched a scheme called **SATAT** in which the purified biogas can be used as an **automotive fuel**. Such projects can be established in industries such as sugar, maize etc. In sugar industries waste such as spent wash and press mud can be used for biogas generation.

This project will be established under **SATAT**. Initially the agreement for sale of CBG will be for 10 years. It can be extended further with mutual consent.

The price slabs for CBG are as given below:

1. The Floor Price of CBG is Rs 62 per kg + 5% GST (For Transportation through Cascades) and Rs 56/Kg + 5% GST (For Grid Injection)

ZAK VENTURE PVT LTD, a Company registered under the Companies Act 2013, having its registered office at 2502, 5th Floor, Express Trade tower 2, Sector 132, Noida 2010301.

ZAK VENTURE PVT LTD (ZVPL) is an entity operating in the Renewable Energy field specially in the CBG domain for last 4+ years, and their Board Members have diversified experiences of more than 40 years in the Indian renewable energy sector. ZVPL is a technocrats-led organization which strives to achieve excellence in CBG domain through various international tie-ups to deliver cutting-edge technology and holistic solutions for these projects.

ZVPL has signed letter of intents with Indian Oil Corporation to develop 2 (two) CBG plants of 5 MTPD capacity each. For this project LOI has been signed with Indraprastha Gas Limited under which they can either sell CBG to their outlets or inject in their pipeline. ZVPL is also in the process of signing Tri-partite agreement with GAIL India Limited for the pipeline injection of Compressed Biogas (CBG) under the CBG-CGD synchronization.

1.1 KEY PERSON'S BACKGROUND

KASHIF HASAN: Managing Director of ZVPL, is an engineering graduate from *National Dairy research Institute (NDRI), Karnal(Haryana)* and an **MBA** in Marketing from *S P Jain Institute of Management & Research, Mumbai (Maharashtra)*. He has an experience of more than 13 Years in various aspects of Natural Gas business including, but not limited to, pipeline laying, LNG/R-LNG trading, Consulting City Gas Distribution (CGD) companies in India, Commercial Contract management etc. Held key roles in marketing of natural gas for GAIL (India) Limited, a leading Indian integrated energy company, for more than 7 years. Signed various MoUs with Government departments and with PSUs for developing projects in renewable energy sector.

MOHD BABAR: Director, Engineering graduate from *Faculty of Engineering and technology, JMI* with master's in marketing from *Welingkar Institute of Management Development & Research, Mumbai*. He is 38 years old and has over 15 years of experience in handling small to mid-size business with specialization in Business Management, Operation management and execution of Techno-Commercial Operations. Responsible to accrue and expand Company's business by providing solutions on Renewable Energy and Natural Gas sector. Implementation & understanding the need of current industry situation, associated market dynamics & monitoring the policies.

He has worked with many established multinational companies like QUIPPPO ENERGY, CUMMINS, and CLARKE ENERGY in the key role position. Currently associated as Director in ZAK Venture Pvt Ltd with primary responsibility of managing the existing business operations which included day to day business dealing and deliver the upcoming project on time. All the projects are mainly in the waste to energy, Gas based power, Compress Biogas Plants and Natural Gas Pipeline sectors.

ANUBHAV SINGH: Director, A finance graduate from NMIMS. Over the course of his career, he has amassed a comprehensive understanding of financial markets, risk management, investment strategies, and corporate finance. His dedication to precision, strategic thinking, and the pursuit of financial success has enabled us to thrive in dynamic and challenging financial environments. He has implemented Rural Community Bio Gas Projects in several Indian states and is always ready for a challenge. He is also instrumental in manpower management along with Raising Project Finance and implementation.

SUBODH KUMAR: Advisor, Mr. Subodh Kumar, served as Executive Director in India's largest Oil Marketing Company, Indian Oil Corporation Ltd, and has 35 years' experience in the field of Petroleum Marketing, Alternate Energy and Sustainable Development. He was actively involved in increasing the portfolio of IOCL in the areas of Solar, Wind, Nuclear, Bio-fuels, waste to fuel etc. along with planning and monitoring sustainable development and climate change mitigation & adaptation activities. He has been instrumental in IOCL's foray in

alternative fuels like production of ethanol from lignocellulosic Bio-mass sources, production of Bio-CNG from various waste streams. *He played a very significant role in implementing the SATAT scheme.*

ZVPL intends to establish Compressed Biogas (CBG) plant at Khasra no. 946A, village Bhadauli, District Ghaziabad, Uttar Pradesh - **with a capacity of 6250 Nm³ / day raw biogas or 2.5 MTPD Compressed Biogas (CBG).**

1.2 PROJECT DETAILS

ZVPL, will establish a plant of 6250 Nm³ /day raw biogas plant which will produce 6000 Kg/Day or 2.5 MTPD CBG in village Bhulawai, Chandausi, District Sambhal, Uttar Pradesh - 202412. Cow dung (50 MTPD) and other organic waste like Press Mud, Napier grass, Food, and vegetable waste (35 MTPD) will be utilized to produce 6250 Nm³/day raw biogas. There are several food processing industries, dairy farms, Gaushala's, and sugar mills near the identified location for the plant and feedstock tie-up for the plant is under discussion and 2+ Acre of land already in place. The land would be sufficient for the planned biogas capacity, storage of feedstock and organic manure.

1.3 TECHNOLOGY

ZVPL, shall run the plant for 365 days per year, using sophisticated and proven Anaerobic Digestion CSTR technology. Anaerobic digestion is a renewable energy generation process in which micro-organisms break down biodegradable material in the absence of oxygen. Anaerobic digestion technology was developed and commercialized long back in Europe and is technically considered a low-risk, high-output technology.

Four Main Stages of Anaerobic Digestion:

- **Hydrolysis:** Enzymes break down complex organic matter into simpler compounds like sugars, amino acids, and fatty acids.
- **Acidogenesis:** Acidogenic bacteria convert the simpler compounds into volatile fatty acids, alcohols, and other organic acids.
- **Acetogenesis:** Acetogenic bacteria further metabolize the products of acidogenesis, producing acetic acid, hydrogen, and carbon dioxide.
- **Methanogenesis:** Methanogenic archaea convert acetic acid and hydrogen into methane (CH₄) and carbon dioxide (CO₂). This is the stage that generates biogas.

A Continuous Stirred Tank Reactor (CSTR) has been considered for the anaerobic digestion in this project. It is designed to facilitate the continuous mixing of organic feedstock with anaerobic microorganisms to promote the breakdown of organic matter and the production of biogas. Here's an overview of the CSTR and how it functions:

Design and Components:

- A CSTR consists of a cylindrical tank with a motor-driven agitator (stirrer) that continuously mixes the contents inside.
- The tank may be insulated to maintain the desired temperature for optimal microbial activity.
- Inlet and outlet pipes allow for the continuous addition of feedstock and withdrawal of digested material.

Operation:

1. **Continuous Mixing:** The primary characteristic of a CSTR is its continuous mixing. This ensures uniform distribution of feedstock and microorganisms, promoting efficient digestion.
2. **Feedstock Addition:** Organic feedstock, such as agricultural residues, food waste, or animal manure, is continuously added to the reactor. This maintains a consistent level of organic matter for microbial activity.
3. **Microbial Activity:** Anaerobic microorganisms, including bacteria and archaea, thrive in the oxygen-free environment created by continuous mixing. These microorganisms break down the organic matter through a series of biological reactions.
4. **Digestion Process:** The CSTR provides optimal conditions for the different stages of anaerobic digestion: hydrolysis, acidogenesis, acetogenesis, and methanogenesis. This leads to the production of biogas, primarily methane (CH₄) and carbon dioxide (CO₂).
5. **Biogas Collection:** Biogas generated during the methanogenesis stage rises to the top of the reactor due to its lower density. It can be collected and stored for various energy and heat applications.
6. **Digestate Withdrawal:** The digested material at the bottom of the reactor, known as digestate, is continuously withdrawn. Digestate can be used as nutrient-rich organic fertilizer.

Advantages of CSTR:

- Continuous operation allows for stable biogas production and efficient use of reactor space.
- Homogeneous mixing ensures uniform distribution of feedstock and microorganisms, enhancing digestion efficiency.
- Adaptability to varying feedstock compositions and loading rates.

ZVPL shall install the state-of-the-art compressed biogas plant with the latest technology and equipment's. ZVPL will generate the biogas by using the multiple feedstocks like cow dung, press mud and poultry litter as an alternate etc. which are available in abundance in nearby areas of Sambhal.

The generated biogas will be purified, compressed and transported through cascades to retail station. The digestate both solid and liquid will be used as organic fertilizer.

1.4 SUBSIDY ON CBG PLANT

The Ministry of New and Renewable Energy (MNRE) in India has announced a subsidy on Compressed Biogas (CBG) under the Sustainable Alternative Towards Affordable Transportation (SATAT) initiative.

The SATAT initiative aims to promote the use of CBG as an alternative fuel for transportation, which is produced from the biodegradable waste generated by industries, municipalities, and agriculture.

Under the subsidy scheme, the government will provide financial support for the production of CBG by offering incentives for entrepreneurs and businesses who set up CBG plants. The subsidy will be provided based on the production capacity of the plant, and it is expected to promote the adoption of CBG as a sustainable alternative to fossil fuels.

The subsidy on CBG by MNRE is a part of the government's efforts to reduce carbon emissions and promote the use of renewable energy in the country.

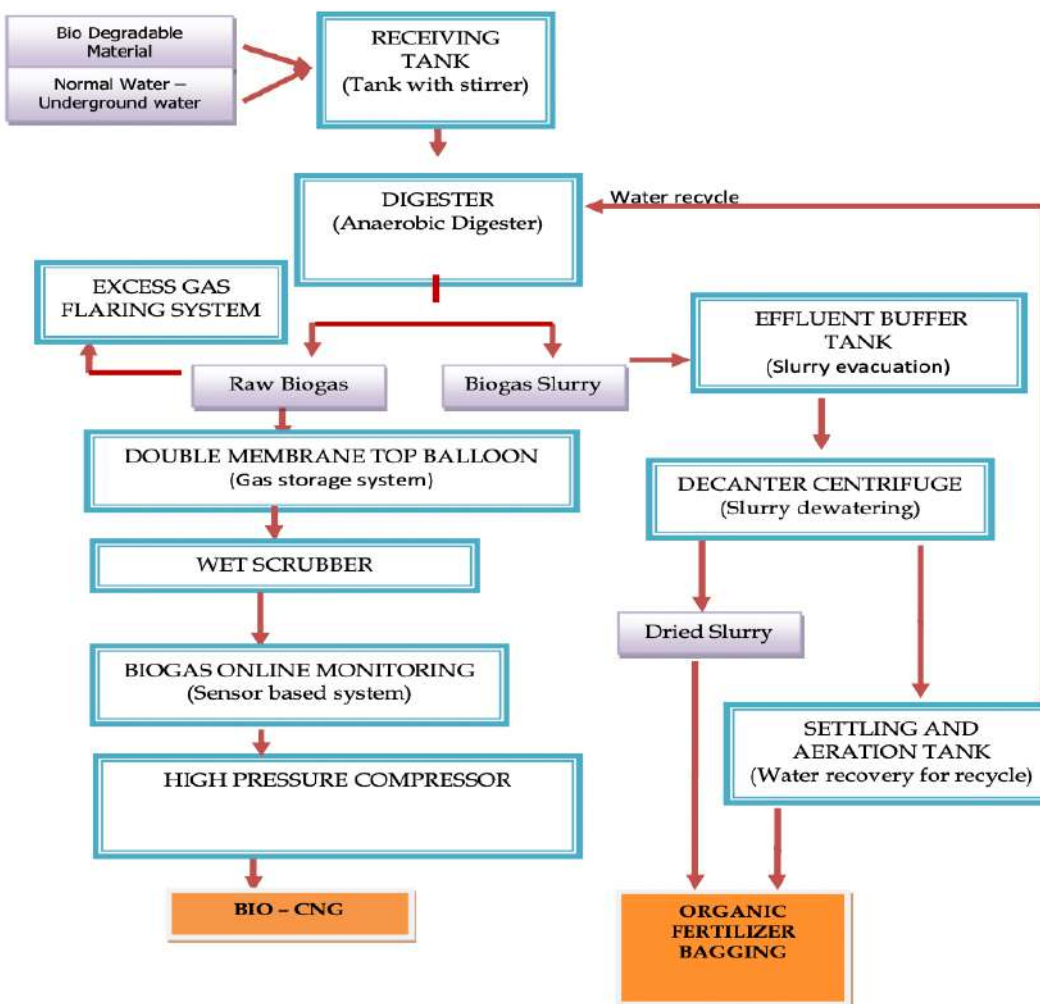
- ***Under this scheme, the Central government provides financial assistance on CBG plants: as follows:***
- ***a) Rs 4.0 Cr per 4800 kg/day (for BioCNG generation from new biogas plant)***
- ***b) Rs 3.0 Cr per 4800 kg/day (for BioCNG generation from existing Biogas plant*)***
- ***(Maximum CFA of Rs. 10.0 Cr/project for both cases.)***

Apart from the MNRE / Central government, the government of UP has also launched the subsidy on CBG project as follows:

- ***Rs 75 lakh / ton to the maximum of Rs 20 Crore on setting up Compressed Biogas (CBG) Production Plant***

Our proposed plant shall be eligible for both central as well as state government subsidy which is 499 Lacs and 450 lacs respectively for 2.5 TPD plant. However, in our financial calculation we have not considered the subsidy amount. If we consider the subsidy, then the overall return on the project will be improved.

1.5 PROJECT SCHEMATIC:



There are 2 revenue streams for this project which are as given below:

1. **Compressed biogas (CBG) 2500 kg/day**
2. **Organic manure (30 MT/day) – Alternatively can be sold as input raw material for Pellet Plants.**

1.6 The salient features of this CBG project:

Sl. No.	DESCRIPTION	2.5 MTPD CBG project at Chandausi
01	Location	Khasra no.422, Village Bhulawai, Chandausi, district Sambhal, Uttar Pradesh - 202412
02	Raw Gas Capacity	6250 Nm ³ / day
03	Compressed Biogas Capacity	2500 kg/day
04	Organic Fertilizer	15 ton/day
05	Power requirement	120 Kwh
06	Land requirement	1.5 Acre
07	Water requirement	120 m ³ / day during commissioning thereafter 20-40 m ³ per day.
08	Completion time	12-14 Months
09	Investment	14.9
10	Project IRR	24%
11	Return on Investment	4 years
12	DSCR	1.81
13	Project Life	25

1.7 STAGES OF THE PROJECT:

A. Civil Work

- Levelling of ground, trenches etc
- Building and shed
- Building the digesters

B. Electro-mechanical equipment and installation

- Electromechanical equipment
- Pressure boosting system
- Biogas cooler
- H₂S scrubber
- Biogas dryer
- CO₂ removal system
- Compressor
- Cascades
- SCADA
- Biogas piping and instrumentation, online monitoring system
- Electrical panels, cables & cable trays, and switchgears

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3. FEEDSTOCK AND ITS PROCUREMENT

Village Bhulawai is situated in the Sambhal district in the state of Uttar Pradesh in India, is situated in an agricultural region. As such, there are several types of feedstocks available in and around Sambhal that could potentially be utilized for compressed biogas production.

1. Crop Residues:

- Crop residues such as rice straw, wheat straw, and sugarcane bagasse are commonly available after harvesting crops like rice, wheat, and sugarcane.

2. Animal Manure:

- The presence of livestock in the region generates significant amounts of animal manure, which can be used for composting, organic fertilizer, and even biogas production. As per the ground level research approximately 400TPD cow manure is available.

3. Agro-Industrial Waste:

- Agro-industrial waste generated from activities like rice milling, sugar production, and food processing can include rice husks, sugarcane residues, and other byproducts.

4. Vegetable Waste:

- Vegetable waste generated from markets or processing units can be a source of organic material for CBG plants. There are few peas processing units which generates more than 50TPD waste.

Feedstock procurement procedures involve the systematic process of acquiring feedstock for CBG production. Typical steps involved in biomass procurement:

a. **Assessment and Planning:** Identify the type of feedstock needed and determine the quantity required and the preferred characteristics of the feedstock, such as moisture content, calorific value, and chemical composition.

b. **Supplier Identification:** Identify potential Feedstock suppliers, which could include local farmers, Aggregators, waste management facilities, and other sources. We have considered factors like proximity to your facility, the sustainability of their practices, and their ability to provide consistent supply.

c. **Supplier Evaluation and Selection:** Evaluate the received proposals or quotations based on factors such as price, quality, reliability, sustainability, and the supplier's ability to meet your requirements. We have selected suppliers that align best with our needs and objectives.

d. **Contract Negotiation:** Negotiate the terms and conditions of the biomass supply contract. Clearly define responsibilities, pricing, payment terms, quality assurance measures, delivery schedules, dispute resolution mechanisms, and any other relevant details.

e. **Quality Assurance and Testing:** Implement quality control measures to ensure that the delivered biomass meets your specified standards. Regularly test samples for factors like moisture content, energy content, and impurities.

f. **Delivery and Logistics:** Coordinate the logistics for the transportation of feedstock from the supplier to your facility. Ensure that transportation arrangements are efficient, timely, and compliant with relevant regulations.

g. **Monitoring and Performance Evaluation:** Monitor the performance of the Feedstock suppliers based on factors like delivery reliability, quality consistency, and adherence to contractual terms. Address any issues promptly and maintain open communication.

h. **Supplier Relationship Management:** Build strong relationships with your Feedstock suppliers. Regularly engage with them to discuss challenges, opportunities, and potential improvements in the procurement process.

i. **Sustainability Considerations:** Consider the sustainability of Feedstock procurement, including factors like the environmental impact of feedstock production, land-use practices, and the potential for regeneration or recycling.

Efficient biomass procurement procedures are essential to ensure a reliable and consistent supply of feedstock for pellet plant.

4. COMPRESS BIOGAS PROJECT

To start the CBG project we need feedstock and for this CBG project we have considered cow dung 50 MTPD and other organic waste like agriculture waste, Napier Grass, food waste, vegetable market waste 35 MTPD as primary feedstock and we shall be using other bio-degradable waste depend upon the availability. The requirement of waste is 85 MT/day. Since the digester will be of multi feed we can use any organic waste. We have selected the trial and tested anaerobic digestion technology (CSTR) from **Germany** for biogas generation. Co-digestion gives stability to the operation of the digester. Also, the liquid digestate will be recirculated back to the digester up to the extent possible.

The production process of Compressed Biogas involves several key steps:

1. Feedstock Collection and Preparation:

- Organic feedstock materials, such as crop residues, food waste, and animal manure, are collected and prepared for the digestion process. The feedstock is typically shredded, chopped, or mixed to increase its surface area and enhance the digestion efficiency.

2. Anaerobic Digestion:

- The prepared feedstock is introduced into an anaerobic digester, a sealed and oxygen-free environment. In this digester, microorganisms break down the organic materials through a series of biological reactions. This process generates biogas, which primarily consists of methane (CH₄) and carbon dioxide (CO₂).

3. Biogas Collection and Purification:

- The biogas produced during anaerobic digestion is collected from the digester. It may contain impurities such as water vapor, hydrogen sulfide (H₂S), and trace contaminants.
- The biogas is then subjected to purification steps to remove impurities. Common purification methods include scrubbing to remove H₂S, moisture removal, and removal of other trace contaminants.

4. Compression:

- The purified biogas is compressed to increase its energy density and make it suitable for storage and transportation. Compression reduces the volume of the gas, making it easier and more economical to transport.

5. Storage and Transportation:

- The compressed biogas is stored in high-pressure containers such as cylinders or tanks. These containers are designed to safely hold the compressed gas.
- The CBG can be transported to various destinations, including fueling stations, industries, and power generation facilities, using specialized transportation vehicles.

6. Utilization:

- Compressed Biogas can be used as a clean and renewable fuel for various applications:
 - **Transportation:** CBG can be used as a fuel for vehicles, especially in compressed natural gas (CNG) or CBG-fueled vehicles.

- **Industrial Applications:** CBG can be utilized as a heat source in industries or as a fuel for industrial boilers.
- **Power Generation:** CBG can be used to generate electricity and heat through combined heat and power (CHP) systems.

7. Emission Reduction:

- One of the primary benefits of CBG is its potential to reduce greenhouse gas emissions. The combustion of biogas produces significantly lower carbon emissions compared to fossil fuels, contributing to environmental sustainability.

While designing biogas purification system, we have made **comparative analysis** of various technologies available and selected the technology that will guarantee production of purified biogas on a sustainable and reliable basis. For this project we have selected equipment manufacturing companies which have hands on experience in biogas plants and have many operational reference projects in European countries. In these projects purified biogas is injected in the natural gas grid. For e.g. Germany. Now these companies have established manufacturing facilities in India. Hence the biogas purification equipment will be sourced from here even though these are companies from Germany.

The system is designed in such a way that **pressure, temperature and flow parameters** of output of one equipment **matches** with pressure, temperature and flow parameters of output of the next connected equipment. That is why we have installed biogas dryer at the input of H₂S scrubber as well as input of the polishing unit.

The **state-of-the-art** plant will be installed for this CBG project which will ensure the quality of pure biogas set by oil marketing companies. It will be **modular** and **scalable**. Its capacity can be increased in future. The purified biogas will have calorific value more than that of natural gas. CBG will be compressed and transported to retail outlet in cascades.

Double membrane balloon (1000m³) will be installed between biogas purification system and compressor. It will give stability to the operation of the compressor and flow rate can be managed so that compressor will run for time interval very much less than 24 hours. The design of the compressor will be such that it will run for **12-16 hours** in a day. Compressor being a reciprocating engine needs service at regular intervals. Availability of spare parts becomes critical while carrying out their maintenance. We have designed compression system by considering **redundancy**. Critical spare parts will be stored at the site.

There will be 2 types of maintenance activities: **Preventive** and **Break down**.

Compressed biogas will be transported to OMC through the cascades to their retail outlet or injected to their pipeline.

SCADA will be installed at the plant which will integrate input from various equipment of the CBG plant. There will instruments for measuring temperature, pressure and flow as well as analysing composition of the biogas. The plant will be monitored and controlled. Every cascade will carry certificate from **on line monitoring system**.

The **deodorizing agent** will be inducted into the stream of purified biogas coming out of CO₂ removal system. The safety system will shut down the CBG plant in case of emergency with safety. Thus, **Ring type fire safety system** will be installed along with **localized fire safety system**.

Since biogas is inflammable, the CBG plant conforms to **CE/ATEX** standards of safety. **Redundancy** Is maintained for mechanical equipment. All the motors will be electric spark proof. They will be with **VFD**. For correction of power factor, **Power factor correction** is devised considering highly inductive load.

Laboratory will be set up at plant for the purpose of testing.

The utilities such as water, compressed air, power etc will be made available at the plant. The plant layout will be made as per **Gas Cylinders Rules 2016**. Flood lights will be installed along the periphery of the plant. This is a **zero-liquid discharge (ZLD)** plant since nothing goes waste. It falls under the category of **Green** projects as per the norms of State pollution control board.

The CBG plant will be run 24x7 throughout the year. The design life period of this project is 25 years.

We will replicate such projects across India. It is said that **waste no more remains waste once we find application for it.**

"Let us do not waste our waste"

i. Biogas Details & Specification

The biogas will be purified to the grade of automotive fuel as prescribed in the SATAT scheme launched by MoPNG. For the purpose of purification of biogas, we have selected equipment manufacturers which have hands on experience in CBG projects in European countries. The produced biogas after the purification will be compressed and transport through cascade for the final use at retail outlet.

The scheme of things of this CBG project is given in the next part of this report.

Quantity of raw biogas: 6250 Nm³ / day

The composition of raw biogas is as given below:

Particulars	Quantity
CH ₄	55-60%
CO ₂	30-35%
H ₂ S	0.5-1%
H ₂ O	2-3%

After purification of biogas, we will get following composition of biogas:

Particulars	Quantity
CH ₄	96-97%
CO ₂	<4%
H ₂ S	20 ppm
H ₂ O	-60 deg C DP

As per IS 16087 : 2016 STANDARD

IS 16087 : 2016 Standard		
S No.	Characteristic	Requirement
1	Methane percentage (CH ₄), minimum	90.0 %
2	Only Carbon Dioxide percentage (CO ₂),, maximum	4%
3	Carbon Dioxide (CO ₂)+ Nitrogen (N ₂)+ Oxygen (O ₂) percentage maximum	10%
4	Oxygen (O ₂) percentage maximum	0.5%
5	Total sulphur (including H ₂ S) mg/m ₃ , maximum	20 mg/m ³
6	Moisture mg/m ₃ , maximum	5 mg/m ³

This pure biogas will be stored in a double membrane gas balloon. Then it is compressed at 250 bar and transported to nearest retailing station or alternatively injected into the grid.

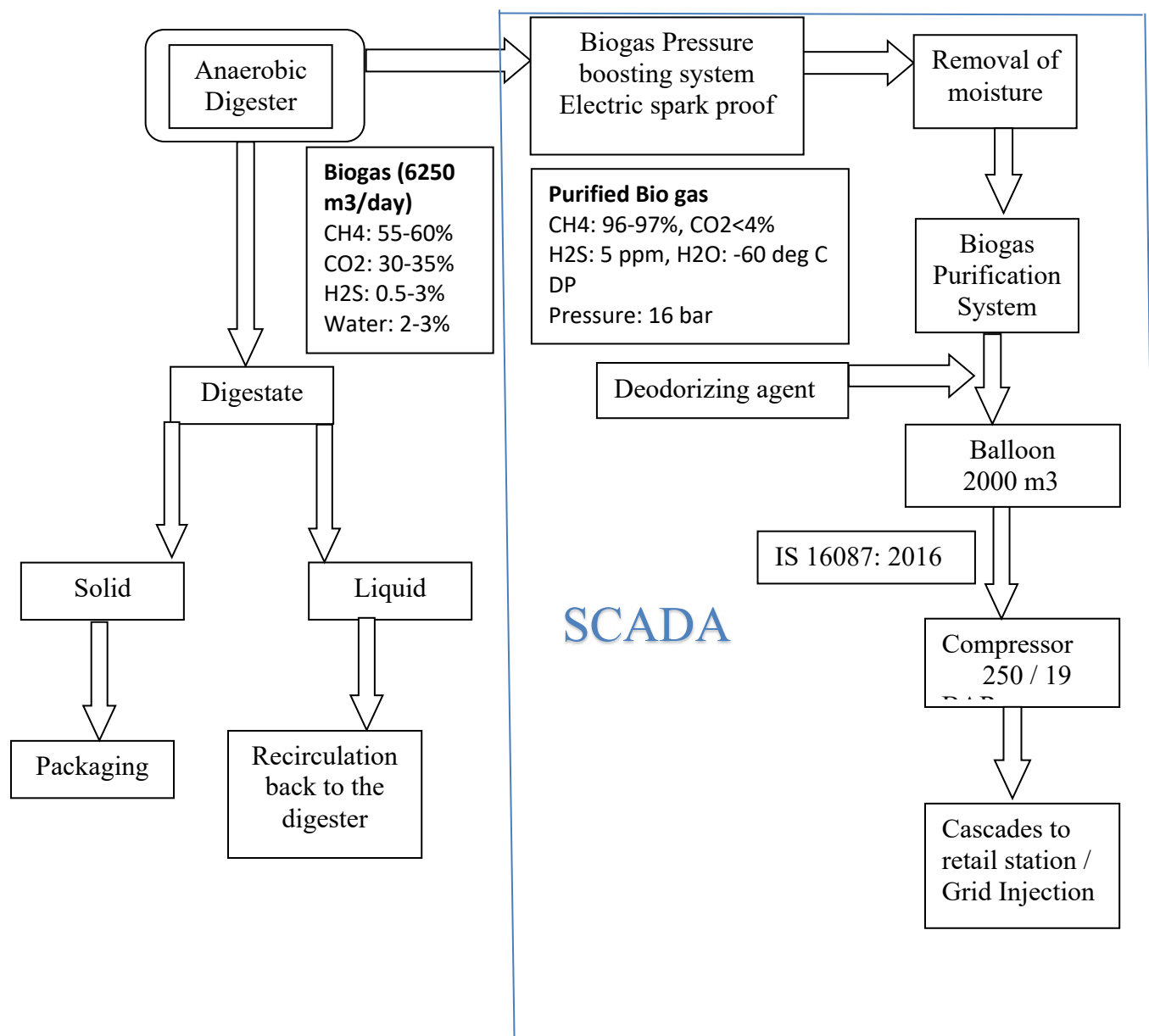
ii. Revenue streams:

Particulars	Quantity	Unit
6250 m3/day Plant		
CH ₄	6,000	kg/day
FOM Quantity	15000	Kg/day

iii. Make list of equipment's:

Digester	GFS	India / China	Rostfrei / Central enamel / equivalent
H ₂ S scrubber	Biochemical scrubber	Netherland	Paques Environmental India Pvt Ltd / Equivalent
CO ₂ removal system	PSA/Amine separation	U.K.	Carbon Clean Solutions Pvt Ltd /Atmos/Airshuddhi/ Equivalent
Compressor	Reciprocating, air cooled	Switzerland	Burckhardt Compression system / Bauer / Equivalent
Cascades	PESO empanel		Everest Kanto / Equivalent
Switchgear			ABB/Siemens/ Equivalent
SCADA			ABB/Siemens/ Equivalent

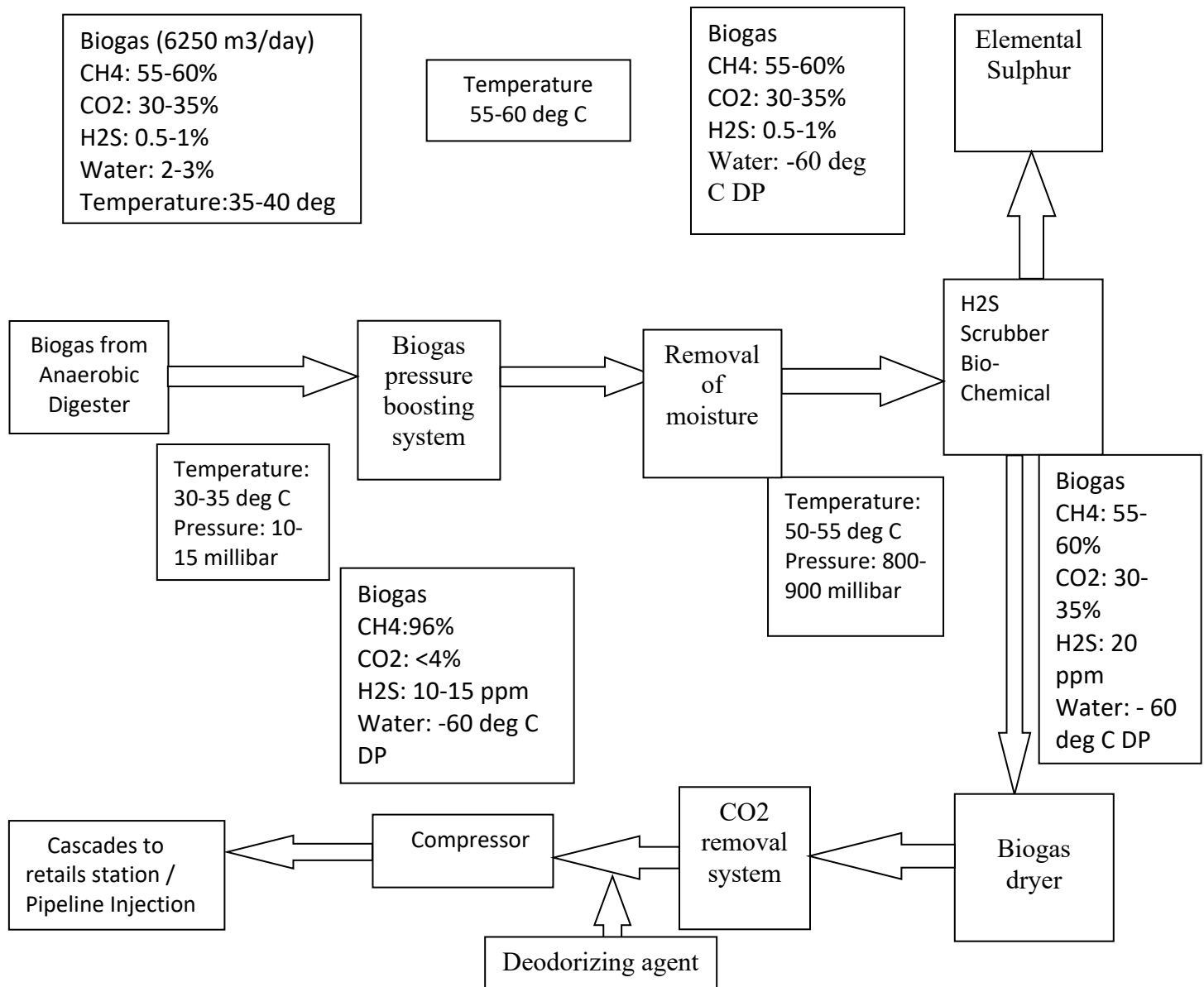
5. PLANT SCHEMATIC



6. BIOGAS PURIFICATION

Biogas purification and compression system

IS 16087: 2016



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Composition and quality of raw Biogas is as given below:

Parameters	Unit	Quantity	Impact on biogas utilization
Lower heating value	MJ/Nm ³	23	
	Kcal/Nm ³	5500	
	KWh/Nm ³	6.5	
	MJ/kg	20	
Density	Kg/Nm ³	1.1	
Relative density		1.014	
Wobbe index, upper	MJ/Nm ³	27	
Methane number		>135	
Composition of biogas			
Methane (CH ₄)	Vol%	55-60	
Carbon dioxide (CO ₂)	Vol%	35-40	Decreasing calorific value, anti-knock properties of engines and corrosion
Hydrogen sulphide(H ₂ S)	Vol%	2.5-3.5	Corrosion, catalytic converter poison, emission and health hazards. SO ₂ , SO ₃ are form
Nitrogen, range	Vol%	0.005	Decreasing calorific value, anti-knock properties of engines and corrosion
Oxygen	Vol%	0.005	Corrosive in nature
Ammonia (NH ₃)	ppm	100	Emission, anti-knock properties of engines and corrosion when dissolved
Water vapor (H ₂ O)	Vol%	2-6	Corrosion in compressors, gas storage tanks and engines due to reaction with H ₂ S, NH ₃ , CO ₂ to form acids
Total chlorine as Cl	Mg/Mm ³	0-5	Corrosion in engines

From the above table, it is seen that biogas consists of methane, CO₂, H₂S, N₂, O₂, water vapor etc. Out of these constituents, only CH₄ contributes to calorific value of biogas while presence of other constituents decreases its calorific value. Hence these impurities are needed to be removed from biogas. When this is done, then its calorific value reaches to that of natural gas or sometimes it exceeds it. Thus, purified biogas can be used in place of natural gas. Natural gas is utilized as for cooking, generating heat & power and as an automotive fuel. Properties of natural gas are as given below:

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Particulars	Unit	Natural gas
Lower calorific value	MJ/Nm ³	39
	kWh/Nm ³	11
	MJ/kg	48
Density	kg/Nm ³	0.82
Relative density	-	0.63
Wobbe index, upper	MJ/Nm ³	55
Methane number		73
Methane	Vol-%	90
Methane, range	Vol-%	85-92
Heavy hydrocarbons	Vol-%	9
Hydrogen	Vol-%	-
Carbon dioxide	Vol-%	0.7
Carbon dioxide, range	Vol-%	0.2-1.5
Nitrogen	Vol-%	0.3
Nitrogen, range	Vol-%	0.3-1.0
Oxygen	Vol-%	-
Oxygen, range	Vol-%	-
Hydrogen sulphide	ppm	3.1
Hydrogen sulphide, range	ppm	1.1-5.9
Ammonia	ppm	-
Total chlorine as Cl-	mg/Nm ³	-

Calorific value of natural gas is double the that of raw biogas gas. More over raw biogas contains impurities that cause severe problems in its utilization. Hence upgradation of biogas becomes essential for utilizing biogas for various applications. When this biogas is purified by removing its impurities, it is called as upgraded biogas (compressed biogas (CBG)/Bio-methane). Its composition is as given below:

Parameters	Unit	Quantity
Lower heating value	MJ/kg	49.55
Density	Kg/Nm ³	0.7
Wobbe index, upper	MJ/Nm ³	27

Methane number		>135
Methane (CH ₄)	Vol%	96-97
Carbon dioxide	Vol%	<4
Hydrogen sulphide	ppm	5-10
Nitrogen, range	Vol%	0.005
Oxygen	Vol%	0.005
Ammonia (NH ₃)	Ppm	100
Water vapor (H ₂ O)	Vol%	-60 deg C DP

It has been observed that calorific value of purified biogas is more than that of natural gas since concentration of methane (CH₄) is more than 96% in biomethane than that in natural gas. Thus, biomethane can replace fossil fuels such as diesel, petrol and natural gas. In Germany the biomethane is being injected into the gas grid.

7. BIOGAS to CBG PROCESS

a. Biogas Generation

The biogas will be generated from anaerobic digestion using the feed stocks such as Napier Grass / Vegetable waste (Peas waste) and cow dung. Its quantity is as given below:

Cow dung: 50 MT/day

Cow dung: Moisture:80%, TS:20%, VS:80-85%

Vegetable / other organic waste: 35 MT / Day

Napier Grass: Moisture:80%, TS:20%, VS:75%

Type of anaerobic digester: CSTR

Type of fermentation: Wet

Requirement of fresh water: 220 m³

Dimensions of the digester:

No. of digester: 2

Diameter: 32.65 m

Height: 9.025 m

Thickness of the wall: 60 cm

HRT: 35-40 days

Type of digester depending upon temperature: Mesophilic

Biogas generation: 6250 m³/day

Fertilizer Quantity: 15 MT/day

b. Purification Of Biogas

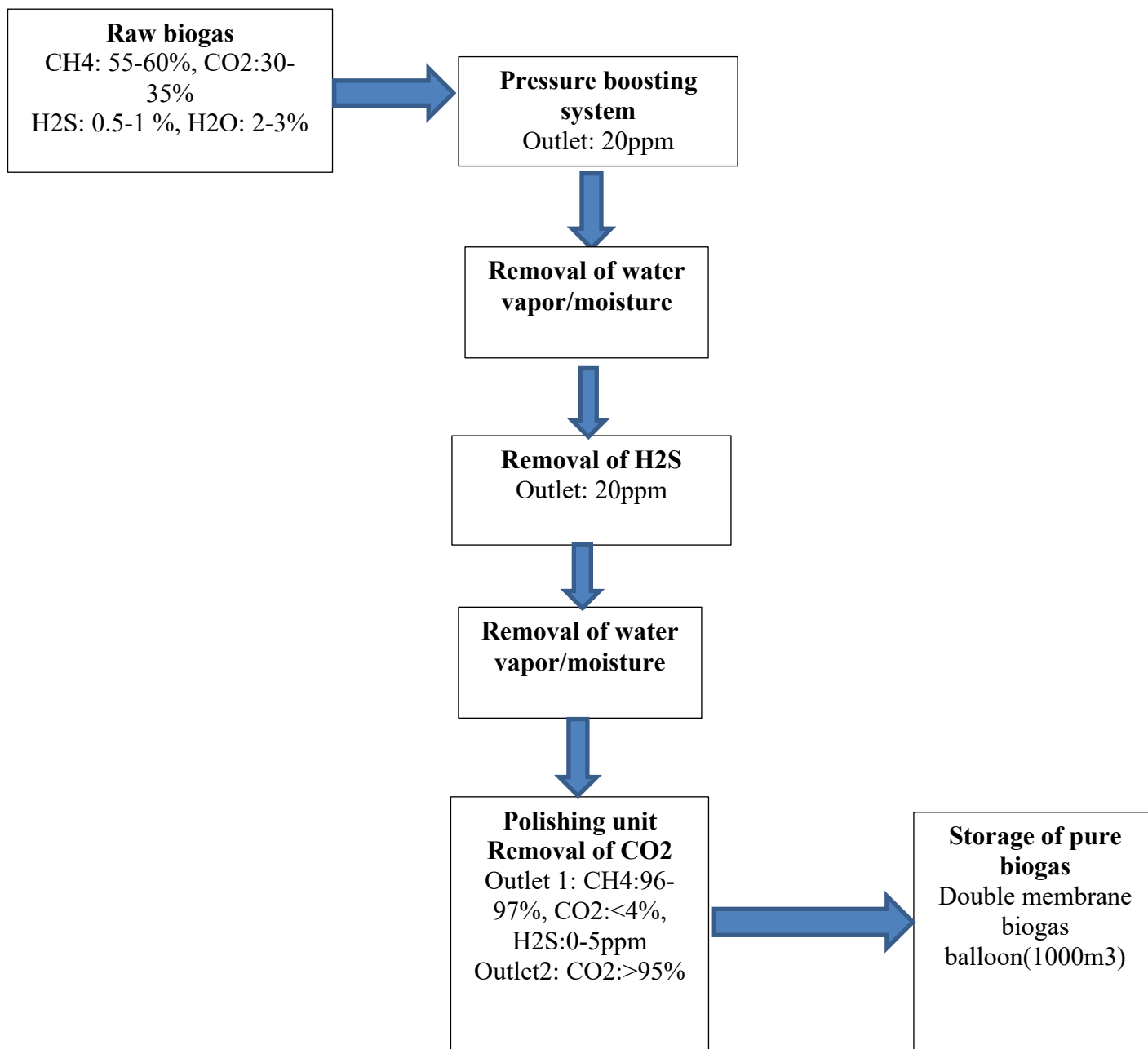
In the biogas purification process, the impurities such as H₂S, CO₂, water vapor, dust etc are needed to be removed from it. The removal of impurities takes place in stages and the sequence for their removal needs to be decided. The pressure of biogas coming out of anaerobic digester is 10-15 millibar and hence it needs to be increased to 900-1000 millibar. It is fed to electric spark proof pressure boosting system. The temperature of biogas at the outlet of pressure boosting system increases to 55-60 deg C. The biogas has 2-3% moisture in it. The biogas needs to be cooled. The water vapor can condense to water. It can cause problems such as corrosion and clogging of pipe line. Also, it reduces calorific value of the biogas and the engine output. The shell and tube chiller type system are used to remove moisture from biogas. The biogas becomes dry and its temperature becomes -60 deg C DP. This dry gas is then fed to H₂S scrubber.

H₂S is removed since it can cause corrosion to metallic parts of the purification system and engine. H₂S is a highly corrosive gas. It can form weak acid with reaction with water. Such acids can cause corrosion to metallic parts of the system. Thus, H₂S poses threat to the safety and performance of the system.

After removing water and H₂S, again the biogas is dried. Then it is passed through polishing unit to reduce H₂S to 0-5ppm. Carbon dioxide is a non-combustible gas. It takes up space when biogas is compressed and stored in cylinder. As it is non-combustible, power used in compressing CO₂ can be considered wastage. In CO₂ removal system, concentration of CO₂ is reduced to less than 4%. Pure biogas with methane (96-97%) is obtained at one of the outlets of CO₂ removal system. At its other outlet CO₂ with more than 95% purity is obtained. This CO₂ can be captured and purified further.

The sequence of removal of impurities is given in the next page.

The sequence of removal of impurities from raw biogas is as given below:



c. Pressure Boosting System

The biogas coming out of digester has a very low pressure. It can be 5-10mbar. We want to feed this biogas to the biogas purification system before it is stored in biogas balloon. For this purpose, biogas compression system is devised which will raise the pressure of biogas to 300 mbar.

Biogas flow rate: 750 cum per hour

Biogas composition:

CH₄: 55-60%

CO₂: 30-35%

H₂S: 0.5-1%

H₂O: 2-3%

Parts of the system:

- Roots blower
- Electric motor
- DOL starter
- Fabricated Channel Iron Base Frame common for Machine & Electric Motor.
- V-Pulley for Machine
- V-Pulley for Electric Motor
- V-Belts
- Non-Return Valve
- Safety Valve
- Attachment for Safety Valve
- Discharge Silencer
- Suction Globe Filter
- Pressure gauges

The Blower is a single stage, roots type, oil free, air cooled, Flame proof , Nickel coated suitable for bio-Gas having following specifications	
Blower Make	TMVTL/KEY
Protection	Nickel coated
Capacity	750 m3/hour
Qty. of Blowers	1W+1S
Suction Pressure	Atmospheric
Discharge Pressure	0.7Barg
R.P.M	1440R.P.M.
Electric motor	25KW,3PHASE,1440R.P.M.,415VOLTS, 50Hz
Rating	Continuous
Temperature of biogas at the outlet	55-60 deg C

Accessories for this pressure boosting system are as given below:

SR.NO.	DESCRIPTION	QTY.
1	Fabricated Channel Iron Base Frame common for Machine & Electric Motor	1 No.
2	V-Pulley for Machine	1 No.
3	V-Pulley for Electric Motor	1 No.
4	V-Belts	1 Set
5	Non-Return Valve	1 No.
6	Safety Valve	1 No.
7	Attachment for Safety Valve	1 No.
8	Discharge Silencer	1 No.
9	Suction Grobe Filter	1 No
10	Pressure gauges	2Nos

Salient features of Pressure Boosting System

- All major castings such as Casing cover, outer cover & other parts made out of C.I. Casting grad FG 300 as per 2010: 2009
- Rotors are made out of SG Iron as per IS 1865 Grade 500/7
- All the bearings are of SKF / FAG Steel cage bearings instead of polymide cage.
- All the rotors are duly dynamically balanced up to 3 grams instead of 5 grams since we are having very precise dynamic balancing machine installed at our plant. Dynamic balancing of rotors ensures the vibration free operation of machine.

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- All the gears are made out of Alloy steel duly hardened and ground and further surface hardness is done by nitriding to increase the life of the gears.
- Suction filters are made specially having 2-stage suction filter. In Ist stage filtering capacity is 25 micron and in 2nd stage filtering capacity is 5 microns.
- All the V – pulleys are made out of CI graded castings and are duly dynamically balanced. These pulleys are machined to close limits. V-pulley for motor is supplied with finished bore & keyway which can be fitted directly on electric motor
- All the V – belts are of high transmission. This are highly resistant to heat, oil, and exposure to weather and has adequate electrical conductivity to ideal with normal static hazards. – belts having much more life than normal V – belts.
- Machine Shaft height is matched with standard I E C motor frame sizes.
- Adjustable machine feet permit both horizontal and vertical flow of medium as required.
- After boosting pressure of biogas, it is fed to the biogas purification system.

After pressure boosting system, the temperature of biogas increases to 55-60 deg c and hence it needs to be cooled to remove moisture from it. Hence biogas is fed to shell and tube type biogas dryer.

d. Biogas Dryer

Shell and Tube type chiller-based biogas dryer.

MoC	
Tube Type	SS 316
Tube length	1900mm
Input Data Specific for Dryer	
Cooling Water Temperature	30°C
Working Data	
Gas Outlet Temperature	10.7°C
Cooling Water Outlet Temperature	2.0°C
Cooling Water Flow	15 m ³ /hr
Glycol Percentage (by weight)	8%
Gas Side Pressure Drop (Exchanger)	1.62 kpa
Gas Side Pressure Drop (Separator)	0.21 kpa
Gas Side Pressure Drop (Total)	1.83
Water Pressure Drop	20.50 kpa
Condensed Moisture	13386 gr/h
Vapour Content at Heat exchanger inlet	40.6 gr/Nm ³
Vapour content at Heat Exchanger Outlet	16.7 gr/Nm ³
Chilling Capacity	32TR

e. Chilling Unit

- 1) 1 Chiller suitable up to 750 M³/hour (min/max) chiller to cool down the Water from 45.0 deg C to 2.0 deg C to meet your requirement as per the flow rate and delta T.
- 2) Scroll type Refrigeration Compressor for better performance, less wear & tear, low Power Consumption and latest technology used in refrigeration/air conditioning nowadays.

Salient Features

- o Hermetically Sealed Scroll compressor from Danfoss.

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- o Latest R407C Refrigerant or gas in the circuit
- o Water Cooled Shell & Tube type Condenser with a PRESSOSTATIC water control valve.
- o Removable Water tank duly insulated. The tank's generous dimensions ensure precise water temperature.
- o Finned Coil Evaporator. The unique design places the evaporator within the tank for steady temperature control.
- o Four in one design i.e. Chiller, tank, pump & bypass, which reduce installation cost.
- o Outlet temperature of water is precise to ± 0.50 C.
- o Galvanized Control Panel based on Programmable Advanced Microprocessor with memory.
- ✓ Digital Display.
- ✓ Main Switch.
- ✓ On-off button & lamp.
- ✓ Alarm siren & lamp.
- ✓ Password protection.
- ✓ Programmable parameter.
- ✓ Hour Counter/ Service alarms.
- ✓ Automatic restart.
- ✓ Volt free general alarm.
- ✓ Remote on-off (optional)
- ✓ Synoptics panel.
- ✓ Status Report (memorizes alarm time & working conditions at time of intervention).
- ✓ Compressor Rotation

Multiple Alarms

Water:

- Pump,
- Low water level,
- Antifreeze, High water temp,
- Low water temp.

Refrigeration:

- High Pressure,
- Low Pressure,
- Compressor fault.

Multiple Gauges

- Water Pressure Gauge,

- Refrigeration LP Gauge,
- Refrigeration HP Gauge.
- Sensor/ Safety for Hydraulic Circuit:
- Water level sensor: Alarm generated if water level reduces (blocks chiller operation).
- Bleed Valve,
- Antifreeze sensor
- Water temperature sensor
- Component made of Stainless steel at water side of Pump.
- Water manometer

Sensor/ Safety for Hydraulic Circuit

- Water level sensor: Alarm generated if water level reduces (blocks chiller operation).
- Bleed Valve
- Antifreeze sensor
- Water temperature sensor
- Component made of Stainless steel at water side of Pump.
- Water manometer.

High tech manufacturing

- Kanban Manufacture (individual component & finished Chiller).
- Helium mass spectrometer test
- Electronic Chiller vacuum.
- Vacuum stability test
- Electronic Refrigerant Charge.
- Water side leak test.
- Sniffer Refrigerant leak test.

Technical specifications

Cooling capacity	kW	31.1
Fridge Compress. Absorb. Power	kW	16.7
Water flow	m3/hr	8.86
Water Pressure Drop	Kpa	30.9
Water inlet temperature	°C	5
Water Outlet temperature	°C	2
Ambient Temperature	°C	45
Min. Ambient Temperature	°C	5
Glycol Percentage(by Weight)	%	8
Condenser Cooling Fluid		Air

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Power Supply	V/ph/HZ	400/3/50
N° Compressor/Circuite		1/1
Sound level	dB(A)	53
Available Water head Press.(nom/min)	mH2O	25/23.1
Max Pressure of Hydraulic Circuit	bar g	6

f. Removal of H₂S

H₂S is present in biogas in varying concentration from 50ppm to 30000 ppm depending upon type of feed stock used for biogas generation. It is primarily produced by sulphate reducing microorganisms which reduce sulphur-containing proteins, under the anaerobic conditions.

It is a gas at room temperature. Its chemical formula is H₂S. It is a colorless chalcogen hydride gas with characteristic smell of rotten eggs. It is very poisonous, corrosive and flammable. It is slightly soluble in water. When it is exposed to air then it slowly oxidizes to elemental Sulphur. It is heavier and denser than air with a density of 1.36 kg/m³.

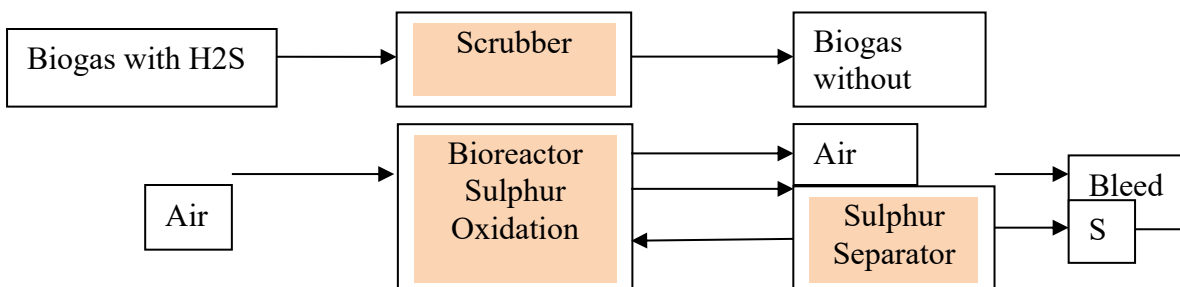
There are various techniques employed for removal H₂S. It can be removed either in the digester, from the crude biogas or in the process of upgradation. Generally, there are 2 methods of H₂S reduction: physical-chemical methods and biotechnological methods. There is third method of H₂S removal which combines physical-chemical methods and biotechnological methods.

Thus there are various techniques employed for removal H₂S. We have selected biochemical scrubber for removal of H₂S from biogas. Its information is as given below:

Input biogas qualities

Parameter	Unit	Value
Gas flow	Nm ³ /h	750
Gas Temperature	°C	35
Pressure	mbarg	20
CH ₄	%	55-65
CO ₂	%	40-45
H ₂ S in	ppm	5000-15000
H ₂ S out	ppm	50

Biochemical scrubber



This scrubber has 3 sections: Absorber section, Reactor section & Sulphur recovery section. Biogas enters absorber section from bottom. The caustic wash is given from the top. H_2S gets absorbed in the alkaline solution and separates it out from biogas. A demister section prevents carry over of fluid into the treated gas. The scrubbed biogas leaves the scrubber at the top.

The spent scrubber liquid is collected at the bottom of the scrubber and directed to the bioreactor. In the reactor, air is dispersed at the bottom in order to enable the biomass to convert the dissolved sulfide into elemental sulfur, thereby regenerating caustic soda. The sulfur is separated as a solid and the Sulphur slurry can be pumped into Sulphur recovery unit. The slurry can be dewatered and discharged as a cake for further use. The liquor is returned to the reactor,

The bioreactor effluent is recycled to the scrubber for renewed removal of H₂S. From the system a small bleed stream is taken in order to prevent any built up of formed salts.

Biochemical scrubber can handle H₂S in the biogas from less than 100 ppm to more than 30000-35000 ppm. The caustic solution (45%) is used as medium for removal H₂S. H₂S concentration in the product gas is 15-20 ppm. Thus, this system removes 99.9% of the total H₂S from biogas. The system is designed on the basis of Sulphur recovered from the scrubbing process. It is given by following formula:

$$\text{Sulphur recovery (kg/day)} = \text{Biogas flow rate} * \text{H}_2\text{S \%} * 1.42$$

Thus, H₂S in the biogas can be captured in the form of Sulphur.

Process Chemistry:

The process is combination of a caustic scrubber and a bioreactor in which the spent caustic solution is regenerated.

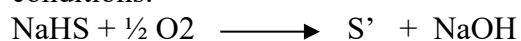
When biogas is fed to the scrubber, hydrogen sulfide gets absorbed under alkaline conditions, i.e. at pH 8 - 9. The absorption of H₂S proceeds according to the following equation:



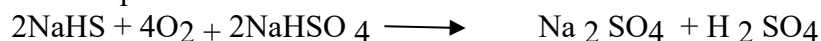
From this equation it follows that alkalinity is consumed.

High H₂S removal efficiency is feasible, because the H₂S concentration in the washing liquid entering the scrubber will be virtually zero.

In the process, the alkalinity consumption due to the absorption of H₂S is compensated by the oxidation of hydrogen sulfide to elemental sulfur which proceeds under oxygen-controlled conditions:



The THIOPAQ[®] process uses bacteria of the genera Thiobacillus to oxidize the hydrogen sulfide. These bacteria grow very fast and are known to be highly resistant to varying process conditions. A small part of the dissolved sulfide will be oxidized to sulfate according to:



As a result of this side reaction, caustic soda is required to neutralize the sulfuric acid formed. A small bleed stream is withdrawn from the system to ensure that the build-up of sodium sulfate and other salts is prevented. The bleed stream (containing sodium salts and some sulfur particles) is harmless and can generally be discharged without problems.

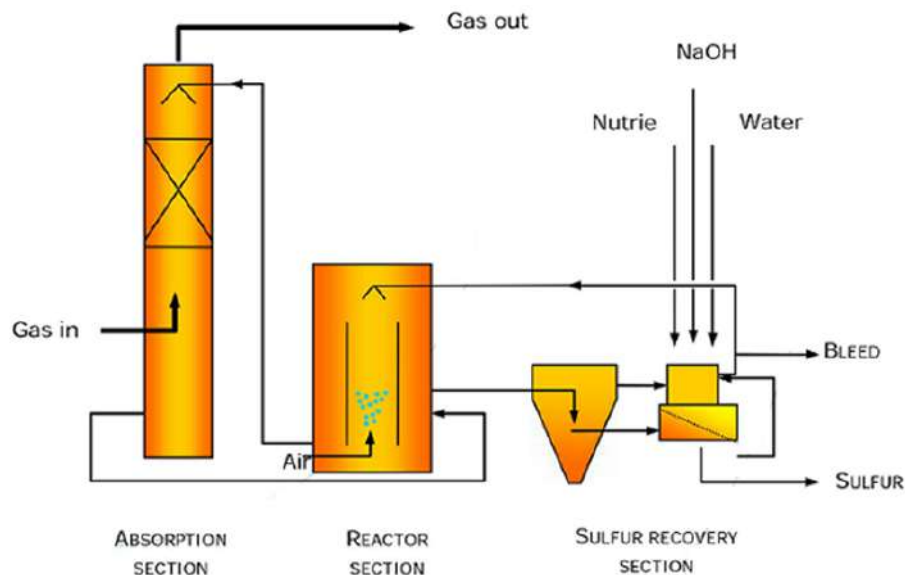
In case the gas stream to be treated contains oxygen, part of the H₂S may be converted into sulfur in the scrubber instead of in the bioreactor. In this case, a thin layer of bacteria will grow on the scrubber packing material. Since the formed hydrophilic sulfur immediately reacts with absorbed H₂S to form soluble polysulfides, clogging of the scrubber is not a risk.

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Process Configuration:

The process of removing H₂S from gas consists of three sections. These include an absorber, an aerobic (biological) reactor and a sulfur separation step. A schematic overview of the system is given below.



Absorption Section

Hydrogen sulfide is absorbed in a packed absorption tower. In the scrubber gas is brought in contact with the washing liquid in a counter current mode. The washing liquid from the aerobic reactor is sprayed downwards from the top by means of nozzles. From the bottom, the spent washing liquid is directed to the aerobic reactor where the sulfides are oxidized into solid elemental sulfur. It is important to note that the sulfur is produced in the reactor and not in the scrubber. Due to this feature, clogging problems that generally occur in conventional caustic or liquid iron-based scrubbing systems, are prevented in THIOPAQ[®] scrubbers. Overall, the biological produced sulfur increases the operational reliability of the system and enhances the H₂S absorption.

Reaction Section, Aerobic Reactor

The aerobic reactor contains the microorganisms that oxidize the absorbed sulfides into elemental sulfur. Reactor internals are used to ensure complete mixing. The volume of the aerobic reactor is designed in accordance with the optimal activity of the bio-organisms. The exhaust air from the reactor can normally be emitted without further treatment. The reactor effluent is recycled to the absorber column.

The air supply to the reactor must be controlled accurately in order to minimize the formation of sulfate. The dosing of air is therefore automated and controlled by a PLC that serves the complete system.

The conversion of H₂S into elemental Sulphur is a biological process and therefore nutrients are required for good operation of the scrubber. The biomass requires certain salts for their growth and maintenance. Extensive laboratory and field research have led to the optimization of the nutrient formula and dosing rate for this process.

Sulfur Recovery Section:

The produced sulfur is separated from the liquid by means of a settling unit. Part of the reactor contents is recycled over the settler to maintain the desired dry solid content in the system. The sulfur slurry may optionally be dewatered by means of a decanter centrifuge also to obtain a dry-solid concentration of about 60%. The sulfur will have a purity of about 90-95% on dry basis. The remainder is biomass.

Operation and maintenance

Operation and maintenance cost are towards the consumption of Caustic solution (45%) & Nutrients.

Their requirement is as given below:

- ❖ Caustic solution: 0.88 liters/Kg S recovered/day
- ❖ Nutrients: 0.03 liters/kg S recovered/day

Power required: 0.05 kwh/kg S recovered

Space required for installation: 250-300 sq m

This desulphurization plant essentially comprises of the following:

- ❖ Scrubber unit-1 No.
- ❖ Circulation pump-2 Nos.
- ❖ Bio reactor blower with motor-2 Nos.

- ❖ Caustic dosing unit-1 Set
- ❖ Nutrients dosing unit-1 Set
- ❖ Centrifuge System & its accessories-1 No.
- ❖ Centrifuge Feed Pump-2 Nos.
- ❖ Centrate Transfer Pump-2 Nos.
- ❖ Interconnecting pipes and fittings within the battery limit
- ❖ Instruments
- ❖ Electrical and control installation including:
 - ✓ Supply and adjustment of instrumentation
 - ✓ Supply and programming Siemens PLC
 - ✓ Supply and assembly electrical installation

Utilities:

- ❖ Main power supply cable
- ❖ Softened water connection
- ❖ Interconnecting piping inlet and outlet biogas
- ❖ Caustic connection
- ❖ Sulphur bleed outlet connection

Civil tanks:

- ❖ Bio-reactor tank
- ❖ Sulphur settler
- ❖ Sludge Holding Tank
- ❖ Foundation for all mechanical equipment, Scrubber etc.

Consumables required:

- ❖ Caustic solution (45%): 0.90 liters/kg S removed/day
- ❖ Nutrients: 0.03 liters/kg S removed/day

Power required: 0.10 kwh/kg S

Advantages:

- ❖ Deep removal (99.9%) of H₂S on continuous and sustainable basis
- ❖ Ability to withstand thermal shocks
- ❖ H₂S is recovered in the form of elemental Sulphur
- ❖ It can handle very high concentration of H₂S such as 2.5 to 3% in the raw biogas

Disadvantages:

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- ❖ Operation and maintenance cost towards caustic solution and nutrients

g. Polishing unit



The dry biogas will be fed to polishing unit which will reduce the concentration of H_2S in biogas to 0 ppm. For this purpose, an activated carbon filter will be installed in the gas feed line to Biogas upgradation system. If any excess level of H_2S level found in the biogas will be physically entrapped in the charcoal bed to always insure that biogas free from corrosive H_2S contaminants.

H ₂ S Input	20 ppm
H ₂ S Output	0 ppm
Quantity of carbon	500 kg
Volume of tower	1 m ³ tower
MoC	SS 304

h. CO₂ REMOVAL SYSTEM (Optional for expansion)

Carbon dioxide is a colourless gas. Its formula is CO₂. It consists of carbon atom covalently bonded to 2 oxygen atoms. It exists in solid, liquid and gas phase atmospheric temperature and pressure. Its density is 1.977 kg/m³ (gas at 1 ATM and 0 °C), 1101 kg/m³ (liquid at saturation –37 °C) and 1562 kg/m³ (solid at 1 ATM and –78.5 °C). Its solubility is 1.45 g/L at 25 °C (77 °F), 100 kPa.

It occurs naturally in Earth's atmosphere as trace gas. Its current concentration is about 0.04% (412 ppm) which has increased from its pre industrial levels of 280ppm. It occurs in natural resources such as volcanoes, hot springs and geysers. Since it is soluble in water, it is found in ground water, rivers and lakes, ice caps, glaciers and sea water. It is also found in deposits of petroleum and natural gas. It is odourless at normal concentration but it has a sharp and acidic odour at higher concentration. Atmospheric carbon dioxide is the primary carbon source for life on the earth. Its concentration is regulated by photosynthetic organisms and geological phenomena. Plants, algae and cyanobacteria use light energy to produce carbohydrate from carbon dioxide and water. Oxygen is released to atmosphere in this process. This process is called as photosynthesis.

It is produced by all aerobic organisms when they metabolize carbohydrates and lipids to produce energy by respiration. It is produced in the processes such as decay of organic materials and fermentation of sugars in bread, beer and wine making. It is produced by combustion of wood and other organic materials and fossil fuels such as coal, peat, petroleum and natural gases.

It is a versatile industrial material. It is used as inert gas in welding and fire extinguishers, as a pressurizing gas in air guns and oil recovery, as a chemical feed stock and as a super critical fluid solvent in decaffeination of coffee and supercritical drying. It is added to drinking water and carbonated beverages including beer and sparkling wine to add effervescence. The frozen solid form of CO₂ known as dry ice is used as a refrigerant and as an abrasive in dry ice blasting. It is a feedstock for synthesis of fuels and chemicals.

Presence of CO₂ in biogas poses following problems:

- i) It takes up space when biogas is compressed and stored in cylinder
- ii) As it is non-combustible, power used in compressing CO₂ can be considered wastage.
- iii) Its presence in biogas may lower power output from engine operation.
- iv) It can cause freezing problems at valves and metering points where the compressed gas undergoes expansion during engine running. Removal of CO₂ from biogas enriches biogas in terms of its methane content. Methane burns faster hence yields a higher specific output and thermal efficiency compared to raw biogas when used as fuel.

Uses of CO₂:

Carbon dioxide is used as a refrigerant, in fire extinguishers, for inflating life rafts and life jackets, blasting coal, foaming rubber and plastics, promoting the growth of plants in greenhouses, immobilizing animals before slaughter, and in carbonated beverages.

For removing CO₂ from biogas we have selected CO₂ removal system based on amine separation. Container – High Cube 20ft Containers will be divided into two parts. One will be fitted with Membranes along with heat exchanger and filtration system. Other two will be fitted with 16 bar Biogas compressors.

Quantity - 1 nos Biogas Compressor - Biogas compressor with all safety features along with efficient oil filtration system

Working Pressure - 16bar Type – Screw Compressors Compressor Gas conditioning unit – Shell tube heat exchanger for heating the biogas along with refrigerating water chilling equipment as a part of compressor unit.

Filtration system

Particulate filter before the compressor.

Coalescing filter for elimination of water vapours, Oil absorber and Activated carbon filter for the elimination of oil vapour and particulate filter for the micron dust removal from the biogas

Hollow fibre Gas Separation Membrane –

Evonik Membrane module for the Processing stage -2. Membranes will have operational life of 8-10 years.

The offered method is based on the different permeability of gases in polymers. Our membrane upgrading process with SEPURAN® Green delivers a constant high Bio methane grade up to 99.4% purity. In addition to the SEPURAN® Green membranes, SLPP RENEW has also developed a biogas upgrading process that makes optimum use of the membranes separation properties: Through skilful connection of SEPURAN® Green membranes it is possible to obtain methane with a purity level of up to 99.4% from the Raw Bio gas.

This separation process creates a high-pressure methane-rich product stream (referred as non-permeate or retentate) and a low pressure carbon dioxide-enriched stream (referred to as permeate). The driving force for the separation is the difference between the partial pressure of each gas on the inside of the hollow fibre and that on the outside.

The pre-filtered and de-sulphurised biogas is compressed to 16 bar pressure for the separation process. The, throughput passes thru the cooling process, the resulting free condensate is separated from the raw gas, oil filters and coalescing filters for clean gas. The Bio gas stream of the biogas plant passes through a 2-stage constructed membrane-gas processing plant and with CH₄ separated to more than 97%.

Biogas Measurement and Analysis

1. Gas analysis –

Biogas analyser is used for process monitoring of individual stages and to measure the concentration of the following components in the gas. It is online Analyzer with 3 location

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measurement connected to Raw biogas, after scrubber and after upgradation system. - Methane CH₄ - Carbon dioxide CO₂ - Hydrogen sulphide H₂S - Oxygen O₂

Ultrasonic Biogas Flow Meter – After Biogas polishing system

Approval: ATEX II2G Ex ia Output; Input: 4-20mA HART

Display; Operation: SD02 4-line; push buttons + data backup function

Housing: GT20 Dual compartment, alum, coated

Electrical Connection: Thread NPT1/2 Sensor version: Volume flow + Biogas analysis

Process Connection: Cl.150, A105, lap joint flange ASME B16.5

Max Flow rate: 1000 cum/hour

CNG Mass Flow meter – After upgradation system

Select medium - Gas

Select gas type - Methane CH₄

Mass flow unit - kg/min

Volume flow unit - l/min

Density unit - kg/l

Temperature unit - °C

Corrected volume flow unit - Nm³/min

Reference density unit - kg/Nl BM

Approval - ATEX II2G + IECEx Ex ia, ATEX II2D + IECEx Z21 Ex

Power Supply: 24VDC

Output; Input: Modbus RS485 Display;

Operation: W/o; via communication

Housing: Compact, alu, coated

Electrical Connection: Thread NPT1/2 Meas.

Tube Mat.: Stainless steel

Process Connection: G1/2" female thread

Calibration Flow: 2-point, 25/100%

CODES AND DESIGN BASIS

1. HDPE Gas Pipe - Manufactured as per IS-4984
2. Structural Steel – As per IS 800-2007
3. Cabling – IS 1554
4. Compressed Bio Gas (CBG) – As per IS 16087:2016 specifications of BIS (detailed below).
5. All Motors – Flame proof.
6. Instruments on Gas line - ATEX II2G
7. SS Gas pipe for pressurized gas – SS304.
8. Automation - Non-Redundant PLC with HMI.
9. Output to central SCADA – Modbus communication.

Note: For membrane-based CO2 removal system, **consumables/chemicals** are **not** required.

i. Storage of pure biogas



Standalone Double Membrane Biogas Holder

Membrane: 1100 GSM

Over pressure vacuum relief valves for Biogas

Over pressure relief valves for Air

Air Blowers for Outer membrane

Gas holder will be securely mounted on the top of the platform with SS Anchor fasteners.

Automated Level indicator control for Inner membrane, pressure Regulator for outer membrane

Sight Glass for outer membrane mounted with HDPE Flanges

Specification

Capacity: 1000 Cum

Membrane Pressure: 25 mmwc (Max)

Air Blowers: 0.5 HP, 150 cum/hour (Flame Proof)

Membrane: 1100 GSM, Climate UV Rain +++, Fire Retardant +++, B1- Certificate, Methane Permeability FR

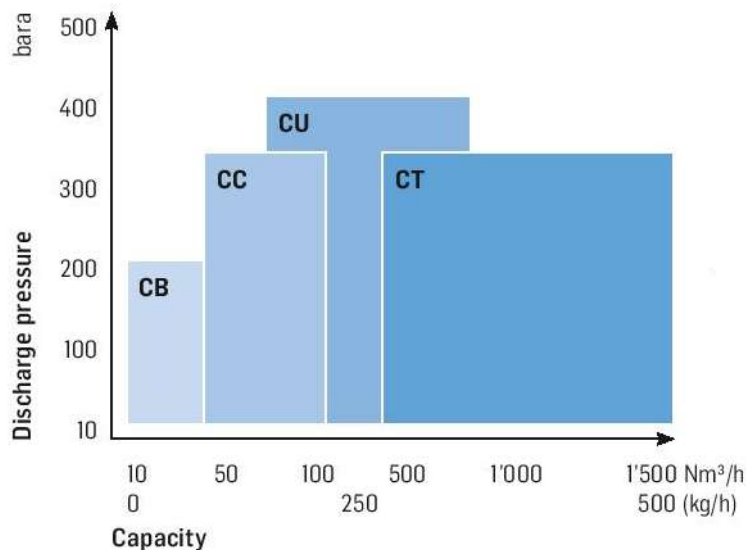
j. COMPRESSION AND DISPATCH

Compressor

The purified biogas coming out of the biogas purification system will be stored in a balloon. From there it will be supplied to compressor. It has low energy density. To supply the biogas through cascade we need to compress it to 250 bar pressure. For that purpose, reciprocating air-cooled compressors are used. We have selected Burckhardt compressors for this project. This company is from Switzerland.

Burckhardt Compression is one of the worldwide market leaders in the field of reciprocating compressors and the only manufacturer that covers a complete range of reciprocating compressor technologies. Its customized compressor systems are used in the upstream oil & gas, gas transport and storage, refinery, chemical, petrochemical and industrial gas sectors. Burckhardt Compression's leading technology, high-quality compressor components and the full range of services help customers to minimize life cycle costs of their reciprocating compressor systems around the world. Since 1844 its highly skilled workforce has crafted superior solutions and set the benchmark in the gas compression industry.

Performance range



**KEY COMPRESSOR COMPONENTS –
FOR BEST PERFORMANCE AND LONGEST LIFETIME**

PISTON RINGS

- Specially designed for high pressure
- Metallic for optimum cylinder lubrication and to limit the oil content in discharge gas
- Non metallic for special cases

CONCENTRIC VALVES

- Combined suction and discharge
- Compact in size
- Easy to assemble and dismantle
- Metallic/non metallic internals

SMALL END BEARINGS

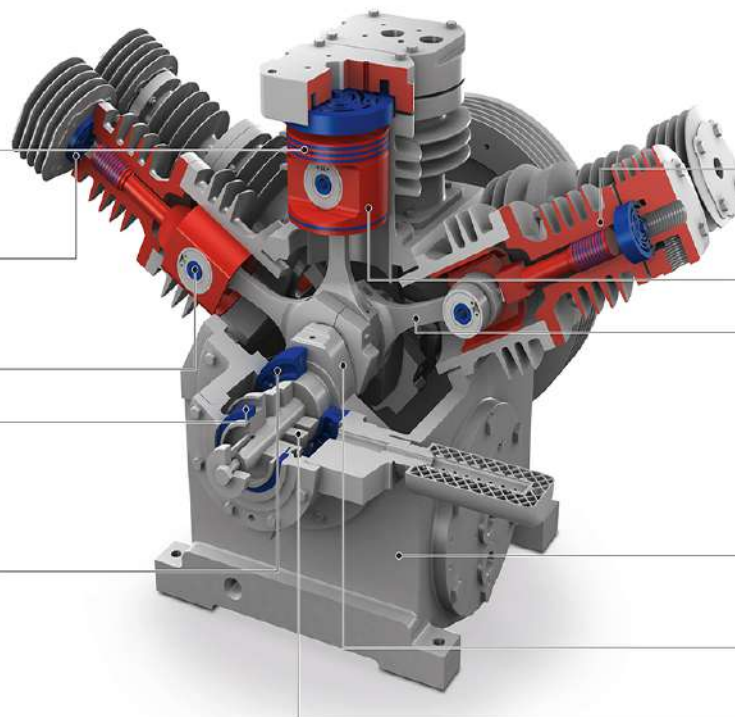
- Cylindrical roller bearings/sleeve bearings with high reliability

SEALS

- Pressure-tight and pressure-relieved
- Oil seal for low suction pressure application
- Mechanical seal for high suction pressure application
- Available in two versions
- No gas loss

MAIN BEARINGS

- Specially designed journal type for H₂ application with high suction pressure
- Angular contact double roller bearings for other applications



**IN-HOUSE DESIGNED AND
MANUFACTURED MAIN PARTS –
FOR HIGHEST RELIABILITY**

CYLINDER

- Single acting
- Specially coated for longer ring life
- No liner required
- Air cooled or water cooled

PISTON

- Wide range of sizes

CONNECTING ROD

- High strength material

**RUGGED DESIGN –
FOR HIGHEST DURABILITY**

CRANKCASE

- Robust and compact design
- Suitable for elevated suction pressure

CRANKSHAFT

- Dynamically balanced

LUBRICATION PUMP

- Highly reliable
- Lobe type
- Crankshaft-driven

Components of the compressor

No gas loss for safe operation

No gas loss to the atmosphere, gas tight even for very light gases

Higher efficiency

Low pressure ratio per stage

Compression up to six stages for high pressure

Certifications

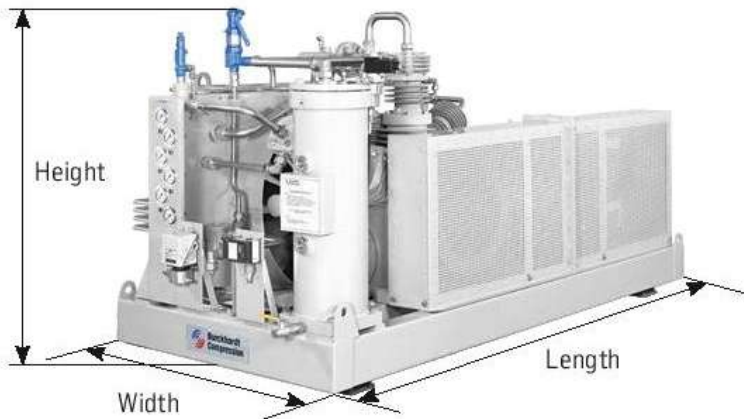
Standard High-Pressure Compressors can be supplied with the following certifications:

- MD, PED, ATEX and CE
- KHK for Japanese market
- Gost and RTN Marine standard (DNV/GL, LR or equivalent)

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Compressor package



Remark: Plug and play type of installation

The compressors are supplied as skid mounted; factory assembled packages. The compressor can be started just by connecting it to the inlet connection, outlet connection and power supply through a control panel.

Scope of Supply

Motion Work

- Crankcase with Mechanical seal
- Crankshaft
- Main Bearing (Spherical Roller type)
- Connecting rod bearing big end and small end
- Main Oil Pump mounted on the crankshaft
- Oil filter and oil strainer
- Oil level sight glasses

Compression Chambers

- Oil Lubricated Air-cooled cylinders fins on surface
- Piston with piston rings
- 1 no. combined suction and discharge valve per cylinder

Gas Stream

- Interconnecting Gas piping from first stage to outlet separator last stage
- Inter stage and aftercooler combined in one radiator block (induced type air cooled)
- Separator after each cooler
- Condensate draining system consisting of:
 - Condensate bottle with level sight glass
 - Diaphragm valve on each separator

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- Manual condensate drain valve on condensate bottle
- Pressure gauge after each stage, gauge-board mounted on skid
- Relief valve after each stage Closed type , mounted on separators
- Flexible hose on discharge with non-return valve and compression fittings
- Suction hose at compressor inlet.

Compressor package

- Skid (common base frame for compressor and motor) mounted on 4 vibration dampening elements
- Gauge panel integrated with fan shroud mounted on compressor skid
- Flywheel with guard
- Motor pulley and V-belts for standard speeds

Area Classification for Electrical and instrumentations

- Area classification considered for electricals:
- Hazardous Zone-2, Gas group IIA/ IIB

Instruments:

- Instrumentation area considered - Hazardous Zone-2, Gas group IIA/IIB
- Instruments mounted on compressor are NOT wired with control panel.
- Instrumentation voltage: 24 V DC,
- Incoming supply 415 volts 50Hz, Three phase
- 3-way solenoid valve for condensate drain control
- Low / high suction pressure transmitter at compressor inlet
- Low lube oil differential pressure Transmitter for trip
- Temperature Transmitter for trip at high discharge temp at final stage discharge of compressor.
- Pressure Switch for trip at high discharge pressure at final stage discharge of compressor.

Control Panel:

- Flame proof (Weatherproof) PLC based control panel with
- Star-Delta starter for 90 kW motor, suitable for Safe Area
- Local Push Button Station in hazardous area (Zone-2, IIA/IIB), for compressor On/Off
- PLC by (SIEMENS / ABB / Equivalent) in with Weather proof enclosure with power supply redundancy and back up memory on EPROM
- _ RS485 serial communication port.
- _ HMI (Human machine interface) , 4 line , 16 character for indication as below
- Running status of compressor
- Active trips
- Input / Output status
- _ 230 Volts AC power supply for panel mounted instruments
- Hour Meter

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- Hooter
- CFL light inside the control panel
- _ 24 Volts DC power supply for following
- HMI
- CPU
- PLC input and output cards

Additional Scope of Supply (Included):

- Activated Carbon Filter downstream of the compressor to reduce the oil content in the discharge gas to less than 5 ppm
- Main motor according to specifications
- Pressure Maintaining Valve (PMV) at discharge (loose supply)
- Blow down vessel for 1200 liter with spool and piping

Selection of compressor:

Raw biogas flow: 8000 m³/day

Pure biogas stored in a balloon of 2000m³.

Discharge pressure: 5-40 bar (Will be selected depending upon the dispatch set up)

Suction capacity: 250 m³/hour

No of compressors: 3 nos.

Note: Redundancy is taken into consideration. Hence 1 compressor will remain in standby mode.

Compressor package



CT compressor package

The compressors are supplied as skid mounted; factory assembled packages. The compressor can be started just by connecting it to the inlet connection, outlet connection and power supply through a control panel.

Cascades

In case of CBG supplied to retail station Cascades will be used to store compressed purified biogas and transport it to the nearest fuel station of OMC. The purified biogas will be stored in cascades at pressure of 250 bar. The cascade will get connected to the cascade at fuel station. It will remain there till it gets empty.



k. Online continuous biogas purity monitoring system for biogas flow rate of 750 m³/hour

One biogas analyser will analyse biogas composition (CH₄, CO₂, H₂S, O₂ & N₂) at 3 testing points given below:

1. Raw biogas composition
2. Product gas outlet of CO₂ removal system
3. Exhaust of CO₂ removal system

The composition of raw biogas is as given below:

Particulars	Quantity
CH ₄	65-70%
CO ₂	25-30%
H ₂ S	0.5-1%
H ₂ O	2-3%

After purification of biogas we will get following composition of biogas:

Particulars	Quantity
CH ₄	96-97%
CO ₂	<4%
H ₂ S	20 ppm
H ₂ O	-60 deg C DP

Pressure: 0.3-0.4 kg/cm²

At the vent of CO₂ removal system

CH₄: 1-2%

CO₂: 98-99%

H₂S: <5 ppm

Pressure: 0.3-0.4 kg/cm²

Microprocessor based Continuous Biogas Analyzer shall consist of:

a) Gas Analyzer

b) Sampling System

Parameter	Sensor	Range(Nom/Max)	Resolution
CH ₄	TCD/IR	0-100% V/V	0.1 %
CO ₂	TCD/IR	0-50% V/V	0.1 %
H ₂ S	EC	0-10000 PPM	1 PPM
O ₂	EC	0- 25% V/V	0.1 %
N ₂	EC	0- 100% V/V	0.1 %

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a) The model with digital display

Measuring principle: Infrared absorption (NDIR)

Accuracy: +/-2% for H₂S, CH₄, CO₂, 0.5% for O₂, N₂

Operating Temperature: 0 to 50 deg Cel.

Display: Alpha-Numeric LCD

Alarms: 2 level alarms

Signal response time: t₉₀ < 2sec (At 1 LPM) 90

t₉₀ < 1sec (At 3 LPM) 90

Warm up time: < 3 min

Base line noise: +/- 0.5% of the range

Repeatability: +/-0.5% of the range

Power Supply: 220V AC, 50 Hz

Output: 24V DC, 4-20 mA

Enclosure: Aluminium casing

Digital interface: RS 485/232

Protection: IP 65-67

Data logging system

Data acquisition software for acquiring data as per CPCB guidelines

Data to be logged for a month

RE 485/RS 232 port connectivity for SCADA

Self-diagnostic check

Battery backup for RAM

System retains set mode in case of power failure

b) Sampling System

Housed in a MS Weather proof stand-alone panel, systems consisting of required filter moisture separator, flow meter, solenoid valve for purging the air

Installation and commissioning of the system

Location of installation:

At the inlet for raw biogas

I. Continuous monitoring of Dew Point

The analyzer uses a highly accurate capacitive integrated thin film water vapor sensor, and is an economic alternative to the chilled-mirror dew point type meters. It utilizes micro-controller based circuits to give a direct read out in dew point or other units and the units corresponding to sensor output based on psychometric equations.

SPECIAL FEATURES

- Alphanumeric LCD or LED digital display
- Fully temperature compensated
- Remote or integral sensor
- Capacitive thin film water vapor sensor
- Samples pressures up to 12 Kg/cm
- RS-232 computer interface
- data logging facility

SPECIFICATIONS

Type	Field wall mounted
Features	Capacitive sensor technology, compatible with most gases, vapours, moisture measurement in PPM, high sensitivity, Zero-span - calibration, instant reading, range available from -80°C to -30°C & -60°C to 30°C,
Detectable gases / parameters	Moisture in air or gas, dew point, temperature, RH
Electronics / processor	Micro-controller
Power supply	230 V AC
Display	Graphic LCD
Alarm	Hi for wet & Low for dry P/F Contact
Output	4-20mA, RS 485, Data logging
Sensor technology	IC Capacitive
Range resolution	Dew Point : -80°C to -30°C & -60°C to 30°C / 0-100 % RH Temp : 0-100 °C
Accuracy	± 2%
Response time	Less than 60 sec
Operating temperature	0 - 55 °C
Sampling / input	Direct plug-in
Housing / case	Plastic
Included accessories	Datalogging, RS 485, 3m cable for sensor, sensor holder

Other accessories: Sampling system(MS plate)with flow meter, explosion proof

OTHER SPECIFICATIONS

Probe	Capacitive Thin film water vapor sensor
Max sample temperature	80 °C
Max pressure	12 kg/cm ³
Response time	10 sec for 63 % step change
Housing	High impact plastic
Output relay	5AMP, 220 volts rating
Dimensions	254 x 180 x 90 mm
Remote sensor	Direct Insertion 1/2 inch BSP(M) (R) (extensions cable 2 m long)
Integral sensor holder connection	Suitable for 6 mm OD Tubing (I)

Installation:

At the outlet of VPSA for purified biogas

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m. AUTOMATION AND ON-LINE MONITORING SYSTEM

SCADA Systems

A SCADA (supervisory control and data acquisition) is an automation control system that is used in industries such as energy, oil and gas, water, power, and many more. The system has a centralized system that monitors and controls entire sites, ranging from an industrial plant to a complex of plants across the country. A SCADA system works by operating with signals that communicate via channels to provide the user with remote controls of any equipment in a given system. It also implements a distributed database, or tag database, that contains tags or points throughout the plant. These points represent a single input or output value that is monitored or controlled by the SCADA system in the centralized control room. The points are stored in the distributed database as value-timestamp pairs. It's very common to set up the SCADA systems to also acquire metadata, such as programmable logic controller (PLC) register paths and alarm statistics.

While these systems simplify a given infrastructure, their components are quite complex. There are five essential composing parts of a SCADA system:

Human Machine Interface (HMI)

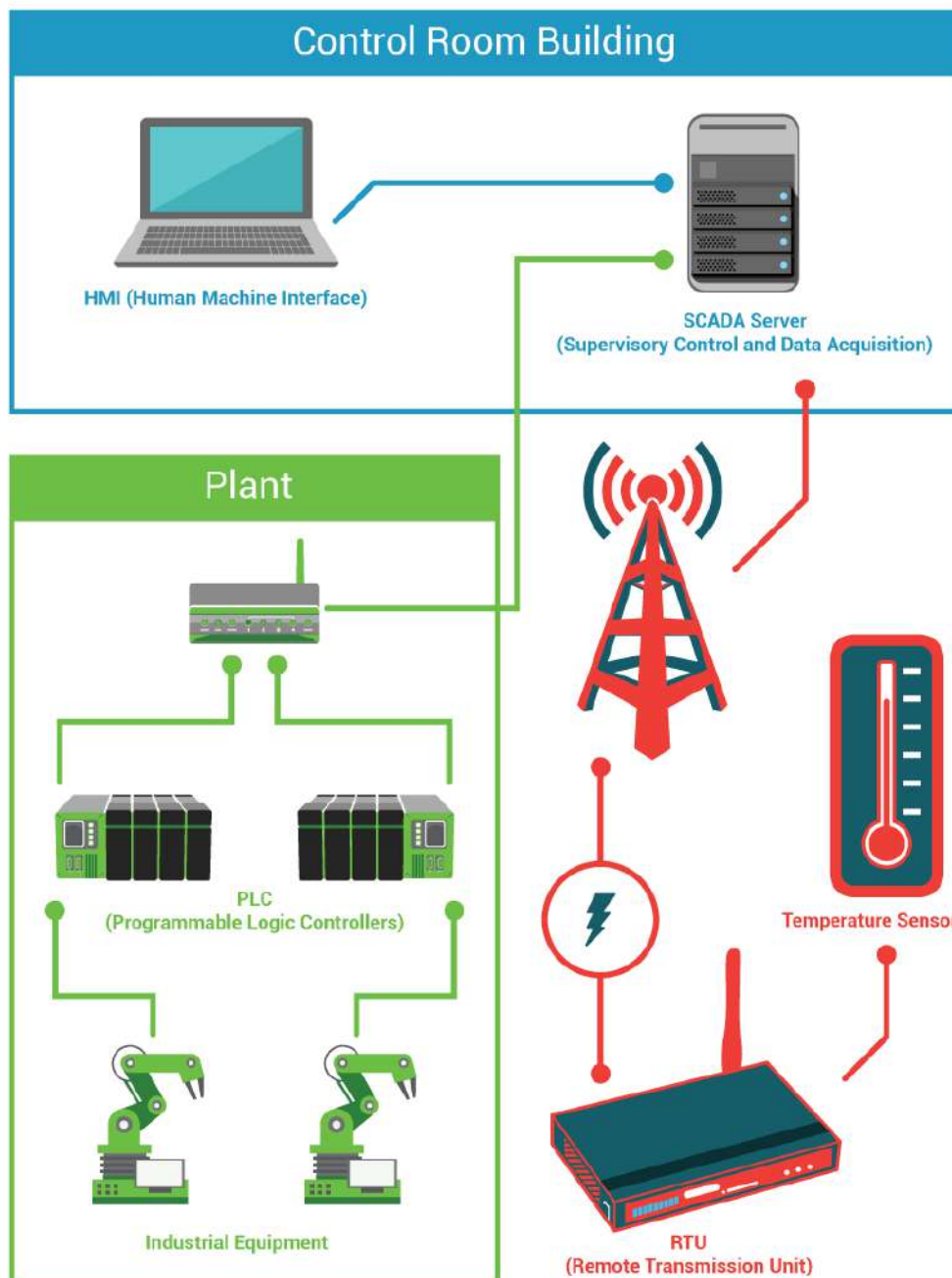
supervisory system

Remote Terminal Units (RTUs)

Programmable Logic Controllers (PLCs)

communication infrastructures

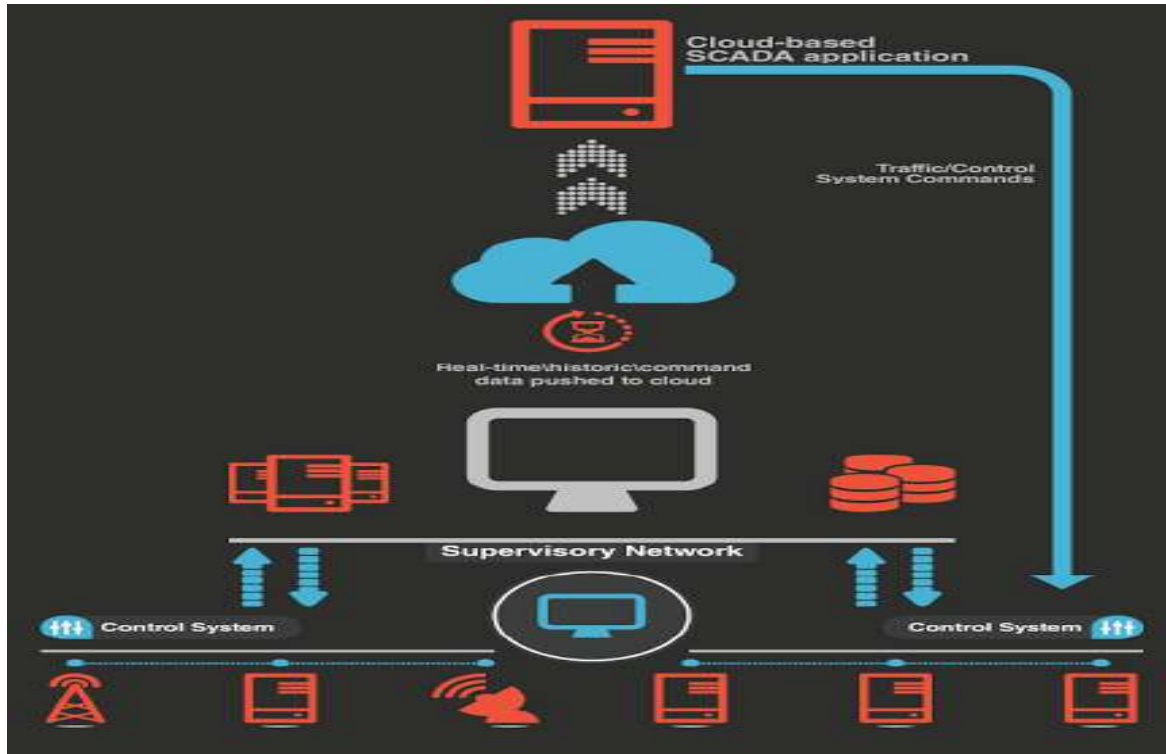
The HMI processes data from each tag and sends it to a human operator, where he or she then can monitor or control the system. The supervisory system gathers the data sent from each tag and sends commands or operations to the process. The RTUs connect sensors and convert their signals to digital data and send it to the supervisory system, where it can be stored in a distributed database. PLCs are used as field devices because they are much more versatile and economical than process-specific RTUs. Finally, the communication infrastructure delivers connectivity to the supervisory system and then to the RTUs and PLCs for the user to command. The communication infrastructure is necessary to relay data from remote RTU/PLCs, which run along electric grids, water supplies, and pipelines. Communication is the absolute most essential link for a SCADA system to operate properly; however, how well the system manages communication from HMI to RTUs and PLCs fundamentally determines how successful a SCADA system can be. Below is a figure of what a basic SCADA system might look like for a given infrastructure.



Optimizing Performance

SCADA systems just process and store data in a distributed database, but there's much more complexity to the system itself. The system provides numerous benefits over manual labor such as redundancy adjustments, stable backups of time stamped data, and a secure alarm system. Instead of using humans to check for errors throughout the plant, grid, or pipeline, SCADA uses scripts that detect problems in the

system, and quickly adjusts the system from creating an outage. If an outage were to occur that slipped past, a SCADA system's distributed database would help workers instantly identify the location of failure. Also, the automation system significantly increases the time of power restoration that comes with an outage; from the control room, at the press of a button, a worker can enable switches and help reroute power to unaffected sections.



SCADA systems now have the available power of cloud computing; these systems can report close to real-time accuracy and use cloud environments to implement more complex algorithms. These algorithms otherwise would not be implementable on traditional PLCs or RTUs. Without even being at the plant, workers can access computing resources such as networks, storage, servers, and equipment controls. Cloud computing can be supported by two ways: The SCADA system is running on-site, connected to the communication infrastructure directly, and delivering information to the cloud or the SCADA system is running completely in the cloud network and remotely connected to the communication infrastructure.

Scope of Supply of system

i. Automation

1. Supply of design, engineering & supply Honeywell non redundant control system with Experion SCADA software.
2. The system has been considered with one no. Engineering cum operating station.

3. One no. Computer for engineering/operating station have been considered of 22" Size TFT monitor, 2GB RAM, 250GB HDD, optical mouse & K/B.
4. One no. CRCA powder coated control system cabinet with power supply, relay boards, fan, filter, wiring, termination & testing has been considered of Rittal make.
5. One no. report printer has been considered.
6. Approximately 250 Analog signals & 150 Digital signals have considered.
7. Communication cable, switches, converter required for internal communication has been considered in the scope. This includes communication cable between computers & PLC.
8. Supply & Installation supervision of erection hardware including cable, tray, glands, lugs, ferules tie has considered
9. Application logic development, PLC programming 8r
10. Cabinet & other equipment shall be provided with earthing bolt
11. Makes of all items shall be as per make list in the offer.
12. One set of Documentation

ii. BOM

- 1.Honeywell PLC control system consisting – controller, power supply modules, suitable no. of Analog/Digital IO modules, communication modules, IO racks, interfacing module etc.-1 lot
- 2.MS fabricated control cabinet with relays for DO, Power supply, terminations, TBs, wiring, testing. --
- Make - Rittal-1 no
- 3.Computer for engineering/operating station have been considered of 22" Size TFT monitor , 2GB RAM, 250GB HDD, optical mouse & K/B-1 no
- 4.PLC programming software-1 no
- 5.A4 size Printer-1 no
- 6.SCADA software license for Engineering station cum Operating station-1 no
- 7.SCADA software development, Logic development etc.-1 job
- 8.Factory acceptance test-1 job
- 9.Cable, cable tray, Lugs, ferrules, ties, etc.-1 lot
- 10.Documentation-1 set

The Design engineering activities considered are as below:

- The Instrument index sheets
- The cable schedule
- The cable layout plan
- Signal & control cable schedule & the BOM, routing plan
- The instrument installation drawings/ loop drawings
- Instrumentation erection hardware requirement BOM i.e. cables, trays, conduits, glands.
- All the instrumentation documentation shall be done as per ISA formats.

OTHER INFORMATION

1.Project requirement:

Raw Biogas (Quantity: 6250 Nm³/day)

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E mail: infoalmatin@gmail.com; Tel No: 9654953201

Pressure at which pure biogas would be compressed: 250 bar

2.Safety precaution:

De-odorizing agent to be added to the pure biogas

Deodorizing agent is added to purified biogas so that leakage of biogas can be detected. It is done from the point of view of safety.

Some of the deodorizing agents are as given below:

Tetrahydrothiophene (THT)

2-Propanethiol, commonly known as isopropyl mercaptan (IPM)

Fencing and flood lights

2.1.Fire Protection System

- Fire protection system generally shall be designed based on Loss Prevention Association (LPA) guidelines and NFPA standards.
- The fire protection system shall be designed on the following basis:
- Control and extinguishing of only one fire at a time occurring through the whole Power plant area.
- Fire spreading is assumed not to exceed the fire area limits it arises from.
- Design water demand shall generally not exceed the greatest amount of water required for each fire scenario.
- For the purpose of system design, the entire Power Plant is considered as ORDINARY HAZARD risk as per the classification of TAC.
- The various types of fire prevention/protection systems considered for fighting the fires in different plant areas/buildings are :
Fire Hydrant System
Fire detection
Portable Fire Extinguishers
Fire detection and alarm system

3.Standards for CBG project:

Biogas purification and compression: CE/ATEX

Pure biogas: Automotive fuel grade

CODES AND DESIGN BASIS

1. HDPE Gas Pipe - Manufactured as per IS-4984
2. Structural Steel – As per IS 800-2007
3. Cabling – IS 1554
4. Compressed Bio Gas (CBG) – As per IS 16087:2016 specifications of BIS (detailed below).
5. All Motors – Flame proof.

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6. Instruments on Gas line - ATEX II2G
7. SS Gas pipe for pressurized gas – SS304.
8. Automation - Non-Redundant PLC with HMI.
9. Output to central SCADA – Modbus communication

4.LABORATORY EQUIPMENTS

n. PH METER DIGITAL

Type	Electro Type
Quantity	1 No
Make	Elico

b. GAS ANALYZER

Type	SR2-DO Multi gas measuring device with Built in pump, measurement storage and Data interface, with in 3 sensors for monitoring 4 gases. CH4/CO2/O2/H2S
Rating	AC/DC adapter, 100-240V/12.5 V=700 mA
Serial No	046 03 000142
Quantity	1 No
Make	Sewerin GMBH

c. HEATING OVEN

Type	Electric
Temperature range	5 oC to 250oC
Size	600 x 600 x 450 mm
Quantity	2 Nos
Make	Technico

d. MUFFLE OVEN

Type	Muffle Furnace
Size	150 x 150 x 350 mm
Rating	1200oC Max, 4 KW
Quantity	1 No
Make	Technico

e. BOD INCUBATOR

Type	Bacteriological
Rating	2 KW
Model	YSI-438
Serial No	04022476
Power Supply	230V, 50 Hz
Temperature	27oC
Quantity	1 No
Make	Yorco Scientific Instruments Pvt Ltd

f. HOT PLATE

Type	Wiswo
Size	400 x 600 mm
Rating	3000 Watts
Quantity	1 No
Make	Widscien

g. HEATING MANTLE

Type	
Size	8" Dia
Rating	1.2 KW
Temperature	120oC Max
Quantity	1 No
Make	Widscien

h. WATER DISTILLATION PLANT

Type	Condencer Type
Capacity	4 ltr / hr
Rating	3 KW
Quantity	1 No
Make	Technico

i. KJEDAHN DIGESTION ASSEMBLY

Type	Kjedahl
Serial No	KD-6
Quantity	1 No
Make	Widscien

k. SPECTRO PHOTO METER

Type	UV-VIS
------	--------

Model No.	SL-150
Serial No	118/0559
Quantity	1 No
Make	Elico

I. ELECTRONIC BALANCE

Type	Electronic Type
Model	2000
Power Supply	220-240 V, 50 Hz
Quantity	1 No
Make	Dhona

m. GLASS WARES

Type	Laboratory Use
Quantity	1 Lot
Make	Borosil

n. CHEMICALS

Type	Laboratory Use
Quantity	1 Lot
Make	JV

Makes of equipment:

H2S removal system: Paques Environmental India Pvt Ltd
CO2 removal system: Carbotech GMBH, Germany
Compressors: Burckhardt Compression Systems
Cascades: Everest Kanto/Maruti/Rama cylinders

Other makes:

SCADA: Honeywell/Siemens
Switchgear: Polycab/ABB
Biogas analyser: Endee/Binder GMBH
Biogas flowmeter: Endruss/Binder GMBH

8. PROJECT IMPLEMENTATION:

TIMELINE

ACTIVITIES	MONTHS													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Approvals from government departments and institutions (PESO, PSB etc.)														
Application to MNRE for CFA and further process (Submission of progress report etc.)														
Test reports for substrate, soil, and water														
Agreements for raw material and land														
Arrangements for sale of CBG, organic manure, CO2 etc.														
Approval of Design of the system														
Preparation of the project report														
Floating of EOI and award of contracts														
Placement of order along with advance for equipment														
Arrangement of utilities such as power, water etc. at the site														

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Arrangement of equipment (crane etc.) for installation and commissioning														
Civil work at the site (levelling of site, construction of digester etc.)														
Ordering of Equipment & Delivery of equipment at the site, payment against proforma Invoice before dispatch														
Started feeding to the digester														
Biogas generation														
Commissioning of equipment														
Arrangement of service support and storage of critical spares														

a. Execution and Management Plan:

Project Initiation:

- Define the project's objectives, scope, and goals.
- Identify key stakeholders and establish their roles and responsibilities.
- Conduct a feasibility study to assess the technical, financial, and environmental viability of the project.

Project Design and Engineering:

- Develop detailed engineering plans and design specifications for the CBG plant, including feedstock handling, anaerobic digestion process, purification, compression, storage, and distribution.
- Procure necessary equipment, materials, and technology based on the chosen design.

Permitting and Regulatory Compliance:

- Obtain required permits and approvals from relevant authorities for environmental, health, safety, and energy regulations.
- Ensure compliance with local, regional, and national regulations pertaining to waste management, energy production, and emissions.

Construction Phase:

- Develop a construction schedule and timeline.
- Hire contractors, suppliers, and subcontractors for various project components.
- Oversee construction activities, quality control, safety measures, and adherence to engineering designs.

Testing and Commissioning:

- Conduct thorough testing of equipment, systems, and processes to ensure proper functioning.
- Address any issues or deviations that arise during testing.
- Obtain necessary certifications for safety and performance standards.

Operations and Management:

- Recruit and train a skilled workforce for plant operation, maintenance, and safety.
- Implement standard operating procedures (SOPs) for each aspect of the CBG production process.
- Establish a monitoring and control system to track feedstock, biogas production, purification, compression, and distribution.

Feedstock Management:

- Develop a feedstock sourcing and supply chain strategy.

- Ensure reliable and consistent feedstock supply to maintain optimal plant performance.

Biogas Purification and Compression:

- Implement purification technologies to remove impurities, moisture, and contaminants from the biogas.
- Employ efficient compression techniques to achieve the desired pressure for storage and transportation.

Storage and Distribution:

- Design and construct appropriate storage facilities for compressed biogas.
- Develop a distribution network for supplying CBG to end-users, such as vehicles, industries, and households.

Health, Safety, and Environmental Measures:

- Implement safety protocols for plant personnel and nearby communities.
- Address environmental concerns, waste management, and odor control.

Monitoring and Reporting:

- Set up a monitoring system to track biogas production, quality, and distribution.
- Regularly report operational and financial performance to stakeholders.

Maintenance and Upkeep:

- Develop a maintenance schedule and conduct routine inspections to ensure equipment functionality.
- Plan for preventive and corrective maintenance to minimize downtime.

Financial Management:

- Create a financial management plan to monitor costs, revenues, and budget.
- Evaluate the financial performance of the project and identify opportunities for improvement.

b. Engineering & Construction Plan:

An Engineering, Procurement, and Construction (EPC) plan for a CBG plant outlines the step-by-step approach for designing, procuring equipment, and constructing the plant. It ensures that the project is executed efficiently, on time, and within budget. Here's a breakdown of the EPC plan for a biomass pellet plant:

Preliminary Phase:

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- **Project Feasibility Study:** Assess the project's technical and financial viability, including feedstock availability, market demand, and regulatory requirements.
- **Site Selection:** Identify a suitable location for the plant considering logistical factors, access to feedstock, utilities, and transportation.

Engineering Phase:

- **Detailed Engineering:** Develop detailed engineering plans, layouts, and process flow diagrams for the entire plant.
- **Equipment Specifications:** Define the technical specifications for all major equipment, machinery, and systems required for pellet production.
- **Permitting and Approvals:** Obtain necessary permits and approvals from regulatory authorities.

Procurement Phase:

- **Vendor Selection:** Identify and select suppliers based on their expertise, reputation, and equipment quality.
- **Request for Proposals (RFPs):** Issue RFPs to potential vendors, detailing equipment requirements, specifications, and evaluation criteria.
- **Vendor Contracts:** Negotiate and finalize contracts with selected vendors, specifying terms, delivery schedules, and warranty agreements.

Construction Phase:

- **Site Preparation:** Clear the site, lay foundations, and establish infrastructure such as utilities, roads, and buildings.
- **Equipment Installation:** Install purchased equipment following manufacturer's guidelines and engineering plans.
- **Construction Management:** Supervise contractors, manage schedules, and ensure compliance with safety and quality standards.
- **Commissioning and Testing:** Test and commission each equipment and system to ensure proper functioning and integration.

9. OPERATION AND MAINTENANCE

Setting up an effective operation and maintenance (O&M) setup for a CBG plant is crucial to ensure smooth, efficient, and safe plant operations while maximizing the plant's lifespan. O&M setup for your biomass pellet plant:

8.1. Operations Setup:

- **Staffing:** Hire skilled operators, technicians, supervisors, and administrative personnel based on the plant's size and complexity.
- **Training:** Provide thorough training to all employees, covering safety protocols, equipment operation, troubleshooting, and emergency response.
- **Shift Scheduling:** Establish a rotating shift schedule to ensure round-the-clock plant operations.
- **Standard Operating Procedures (SOPs):** Develop detailed SOPs for each process, outlining step-by-step guidelines for safe and efficient operations.
- **Process Control and Automation:** Implement advanced process control systems, such as PLCs and HMIs, to monitor and regulate various plant processes.

8.2. Maintenance Setup:

- **Maintenance Team:** Employ a skilled maintenance team comprising mechanical, electrical, and instrumentation technicians.
- **Preventive Maintenance:** Develop a preventive maintenance plan that includes regular inspections, lubrication, and replacement of critical components like die, roller etc.
- **Predictive Maintenance:** Utilize condition monitoring techniques (vibration analysis, thermography, oil analysis, etc.) to predict equipment failures and schedule maintenance accordingly.
- **Spare Parts Inventory:** Maintain an inventory of critical spare parts to minimize downtime during equipment breakdowns.
- **Emergency Maintenance:** Establish an emergency response team capable of addressing urgent maintenance issues promptly.
- **Maintenance Records:** Keep comprehensive records of maintenance activities, repairs, and replacements for each piece of equipment.

Setting up a robust operation and maintenance setup requires meticulous planning, training, and a commitment to continuous improvement. By ensuring the safety of personnel, optimizing plant processes, and prolonging equipment lifespan through effective maintenance, you can achieve efficient and successful biomass pellet plant operations.

10. MANPOWER REQUIREMENT

The manpower requirement for a CBG plant can vary based on factors such as the scale of the plant, production capacity, degree of automation, and specific processes involved. Here's a general overview of the key roles and positions typically required for our proposed biomass pellet plant:

9.1. Management and Administration:

Plant Manager:

- Develop and implement operational plans and strategies to meet production targets and business objectives.
- Monitor and manage production processes to ensure efficient and high-quality biogas production.
- Manage plant resources, including human resources, equipment, materials, and utilities.
- Ensure compliance with environmental regulations and oversee emissions monitoring and control.
- Implement preventive and predictive maintenance programs.
- Address equipment breakdowns promptly and coordinate repairs to minimize production disruptions.
- Implement quality control processes to meet customer specifications and industry requirements.
- Recruit, train, and supervise plant staff, including operators, technicians, and support personnel.
- Develop and manage the plant's budget, monitor expenses, and identify cost-saving opportunities.
- Prepare regular reports on production, safety, quality, and plant performance for upper management.
- Address and resolve operational challenges, emergencies, and unexpected issues that may arise in the plant.
- Represent the plant in interactions with local communities, regulatory agencies, and industry associations.
- Stay updated on industry trends and technological advancements to identify opportunities for innovation and efficiency improvements.

The Plant Manager plays a pivotal role in ensuring the CBG plant operates smoothly, safely, and efficiently. Their leadership, strategic thinking, and ability to manage resources effectively contribute to the plant's overall success and growth.

9.2. Operations Department:

03 Nos. Supervisors

04 No. Plant Operators (for various process stages like Purification, Upgradation, Compression and control & Instrumentation)

02 No. Technicians (for equipment maintenance and repairs)

06 No. Material Handlers (for feedstock loading and unloading)

03 No. Security Guards for plant safety and security.

Keep in mind that these are general roles, and the specific titles and responsibilities may vary depending on the plant's setup and processes. Additionally, as automation and technology continue to advance, some positions may require more technical and specialized skills.

11. ENVIRONMENTAL IMPACT OF CBG PLANT

Compressed Biogas (CBG) plants have several potential environmental benefits, particularly when compared to traditional fossil fuel-based energy sources.

Positive Environmental Impacts:

1. **Reduced Greenhouse Gas Emissions:** CBG is primarily composed of methane, a potent greenhouse gas. By capturing and utilizing methane from organic waste through anaerobic digestion, CBG plants prevent methane emissions into the atmosphere. This significantly reduces the greenhouse gas impact and contributes to mitigating climate change.
2. **Waste Management:** CBG plants effectively manage organic waste, including agricultural residues, food waste, and animal manure. Proper waste management reduces the likelihood of improper disposal, pollution, and the release of harmful substances into the environment.
3. **Air Quality Improvement:** The combustion of CBG produces fewer air pollutants compared to conventional fossil fuels, resulting in improved local air quality and reduced health risks for nearby communities.
4. **Renewable Energy Source:** CBG is a renewable energy source, as the feedstock used in its production is replenished naturally. This contrasts with fossil fuels, which are finite and contribute to resource depletion.
5. **Resource Efficiency:** By utilizing organic waste streams as feedstock, CBG plants reduce the need for virgin resources to produce energy, contributing to resource conservation.

Government Regulation / Clearance Required

1. NOC from the village Pradhan
2. NOC from the pollution control Board
3. Electricity Connection required
4. Water Connection Required
5. PESO License – CTE & CTO

12. SOCIO-ECONOMIC IMPACT OF CBG PLANT

The establishment and operation of a Compressed Biogas (CBG) plant can have several positive socio-economic impacts on local communities, the environment, and the economy. Here are some potential socio-economic benefits of a CBG plant:

Rural Employment Generation:

- CBG plants require a workforce for various tasks such as feedstock collection, plant operation, maintenance, and distribution. This can lead to increased employment opportunities in rural areas where the plants are located.

Income Generation for Farmers:

- Farmers can earn additional income by supplying agricultural residues, organic waste, and other feedstocks to the CBG plant. This diversification of income sources can improve their financial stability.

Waste Management and Pollution Reduction:

- CBG plants help manage organic waste such as crop residues, animal manure, and food waste, which might otherwise contribute to pollution or improper disposal. This promotes cleaner and healthier environments.

Energy Access and Security:

- CBG can provide an affordable and reliable energy source, particularly in rural areas with limited access to conventional energy. This can improve energy security and reduce dependence on traditional fuels.

Reduced Greenhouse Gas Emissions:

- The use of CBG as a clean energy source helps reduce greenhouse gas emissions compared to fossil fuels, contributing to climate change mitigation and environmental sustainability.

Agricultural Productivity Enhancement:

- The digestate (residue) generated during the biogas production process is a nutrient-rich organic fertilizer. Its application to agricultural fields can improve soil fertility, crop yields, and overall agricultural productivity.

Regional Economic Growth:

- CBG plants can stimulate economic growth by promoting local business activities related to feedstock supply, transportation, maintenance services, and distribution of CBG.

Skill Development:

- The operation and maintenance of CBG plants require skilled technicians and operators. Training and skill development programs can enhance the employability of local residents.

Energy Independence and Reduced Imports:

- CBG production reduces the need for importing fossil fuels, thus contributing to energy independence and a more balanced trade profile.

Public Health Benefits:

- The use of CBG as a cooking fuel can reduce indoor air pollution, leading to improved respiratory health for households.

Community Development:

- CBG projects often involve community engagement and collaboration. This can foster a sense of ownership and cooperation within the local community.

Government Revenue Generation:

- Governments can generate revenue through taxes, fees, and royalties associated with CBG production, distribution, and utilization.

Overall, the socio-economic impact of a Compressed Biogas plant goes beyond energy production. It contributes to rural development, waste reduction, enhanced agricultural practices, and improved quality of life for communities while supporting broader sustainability and environmental goals.

13. FINANCIAL ANALYSIS

Capex and Funding assumptions in crores	
Digester for generating 12500 M3/Day	1.5
Biogas upgrading Unit (PSA) 2 Towers	0.8
Scrubber, Polishing Unit, Balloon & other ancillaries	2.4
Compressor & pipeline for GRID Injection	3.98
Preoperative & Preliminary expense including DPR extra	0
IDC	0.0
SCADA & Electricals	1.19
Land Cost	5
Existing Loan Take Over	0
Total	14.9
Working capital	0
Grand Total	14.9
Particulars	Rs Crs
Promoter's equity	6.5
Term loan from bank-	8.4
Investment	14.9

Operational assumptions		
Revenue assumptions		
Raw Biogas Production	6250	SCM/Day
FOM production	15	MT/Day
No of days	350	
Qty. of Bio-CNG	2500	Kg/Day
Price of Bio-CNG	70	Rs/Kg
Price of fertilizer (Incl. MDA of 1.5)	2	Rs/Kg
Cost of power	8.5	Rs/unit
Revenue from Bio-CNG	61,250,000.00	Rs/year
Revenue from fertilizer	10,500,000.00	Rs/year

RM - Cost assumptions

Raw material required (Cow Dung)	50	tons/day
Other organic Raw material required – Press Mud, Napier Grass, Food & Vegetable Waste etc.	350	tons/day
Average Cost of raw material	841	Rs/ton
Annual Expenditure on Raw Material	25,025,000.00	Rs/year

Power - Cost assumptions

Auxiliary Power Consumption - Hourly Consumption		
Digester (Agitators)	120	Units
Blower for Pressure	10	Units
H2S Scrubber	15	Units
PSA	55	Units
Compressor/Gas Engine	75	Units
S/L separator	10	Units
Borewell	5	Units
Mixing(Mixers)	30	Units
Cooling tower	15	Units
Packaging	00	Units
Miscellaneous	5	Units
Total connected Load	340	Units
Expenditure/day @ running load of 208KW	24480	INR
Expenditure/year	8,935,200	INR
Inflation Rate	3%	Per year

Rated capacity of equipment's may be higher. However, since the equipment's will run only for a limited time period during the day, the total day's consumption has been averaged out on hourly basis for 24-hour working format.

Employee costs			
Particulars	Nos	Salary	Total
Plant Manager	1	150000	150000
Supervisors	2	75000	150000
Operators	4	30000	120000
Labours	4	15000	60000
Security	3	15000	45000
Total	14		525000
Expenditure for a year			6,300,000

Annual Repair & Maintenance	
Particulars	Rs Crs
Electro-Mechanical Equipment's*	0.075
Compressor & Cascades**	0.19905
Digester & Others***	0.197
Total	0.47

Investment required: INR Cr

Particulars	Amount (INR Cr)
Equity	6.5
Debt	8.4
Total	14.9

Profit & Loss Statement (in Cr.)

Year	I	II	III	IV	V	VI	VII	VIII	IX	X
FY	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
Capacity	90%	95%	95%	95%	95%	95%	95%	95%	95%	95%
Income										
Renenue from Sale of										
Bio-CNG	5.5	5.8	6.0	6.2	6.4	6.5	6.7	6.9	7.2	7.4
Organic Manure	0.9	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.3
CFA/Subsidy		4								
Total Income	6.5	11	7	7	7	8	8	8	8	9
Expenditure										
Purchase of Raw material	2.3	2.4	2.4	2.5	2.6	2.7	2.8	2.8	2.9	3.0
Power	0.8	0.8	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.1
Maintenance	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6
Labour & salaries	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8
Interest on Bank Loan	0.9	0.9	0.8	0.7	0.5	0.4	0.3	0.1		
Depreciation	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Miscellaneous	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3
Total Expenditure	6.8	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.1	7.2
EBIDTA (in Crs)	-0.32	3.7	0.1	0.3	0.5	0.7	0.9	1.1	1.3	1.4
Net Profit (Pre-tax)	-0.32	3.7	0.1	0.3	0.5	0.7	0.9	1.1	1.3	1.4
Profit After Tax	-0.32	3.7	0.1	0.3	0.5	0.5	0.6	0.8	1.0	1.0

Projected Cash Flow Statement (in Rs Cr.)

Year	I	II	III	IV	V	VI	VII	VIII	IX	X
FY	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
Inflows										
Net profit	-0.3	3.7	0.1	0.3	0.5	0.5	0.6	0.8	1.0	1.0
Depreciation	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Inflow from Equity	6.5									
Inflow from Debt	8.4									
Total Inflows	16.1	5.1	1.5	1.8	2.0	2.0	2.1	2.3	2.4	2.5
Outflows										
Construction of building, Plant and machinery	14.9									
Repayment of term loan	0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0	0
Total outflows	14.9	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0	0
Opening Balance	0.0	1.2	5.1	5.5	6.0	6.8	7.6	8.5	9.6	12.0
Surplus/Deficit	1.2	3.9	0.3	0.6	0.8	0.8	0.9	1.1	2.4	2.5
Closing Balance	1.2	5.1	5.5	6.0	6.8	7.6	8.5	9.6	12.0	14.5

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Term Loan repayment schedule

Principal			8.4	
Rate of Interest			11%	
Sr No	Principal	Interest	Total	Balance Principal amount
1	0	0.92	0.92	8.40
2	1.20	0.92	2.12	7.20
3	1.20	0.79	1.99	6.00
4	1.20	0.66	1.86	4.80
5	1.20	0.53	1.73	3.60
6	1.20	0.40	1.60	2.40
7	1.20	0.26	1.46	1.20
8	1.20	0.13	1.33	0.00
	8.40	4.62	13.02	

14. CONCLUSION

Executive Dashboard		
Investment	14.9	INR Cr
Avg. DSCR	1.81	
IRR	24.0%	
NPV	13	INR Cr
Payback Period	4.17	Years

