

Detail Project

Report On

Biomethanation cum Electric energy generation Plant using segregated 5 TPD Municipal Waste under Rourkela Municipal



Prepared for:

**Rourkela Municipal
Corporation Udit Nagar
Rourkela,
Odisha – 769012**

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Structural Design Proof Checked and
Found Satisfactory

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Feasibility-cum-Project Detailed Report (FDPR)

For

**Biomethanation cum Electric energy generation Plant
using segregated 5 TPD Municipal Waste under
Rourkela Municipal Corporation on Turnkey Basis.**

ROURKELA MUNICIPAL CORPORATION

UDITNAGAR, ROURKELA, ODISHA

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ROURKELA MUNICIPAL CORPORATION

I. INTRODUCTION

2022

Project Site – Kine House, Sector-14, Rourkela,
Odisha

1. INTRODUCTION

An increase in population, rapid urbanization and industrialization has accelerated the rate of municipal solid waste generation. The current disposal of solid waste is a burgeoning issue and it's in immediate need to shift the existing disposal processes to a sustainable manner.

In this context, the effective use of biodegradable and non-biodegradable fraction of solid waste in a closed loop integrated refinery platforms for the recovery of bioenergy resources and for the production of value added products. The biodegradable fraction of solid waste could be treated by advanced biological processes with the simultaneous production of bioenergy such as biohydrogen, biomethane, bioelectricity, etc., and other value added products like butanol, ethanol, methanol etc.

Biodegradable Waste

Biodegradable waste includes any organic matter in waste which can be broken down into carbon dioxide, water, methane or simple organic molecules by micro-organisms and other living things by composting, aerobic digestion, anaerobic digestion or similar processes.

In waste management, it also includes some inorganic materials which can be decomposed by bacteria. Such materials include gypsum and its products such as plasterboard and other simple organic sulfates which can decompose to yield hydrogen sulphide in anaerobic land-fill conditions.

As per specifications of the tender, it is decided to put out unit of capacity nearly **450 m³ biogas per day for available 5 TPD Municipal Waste**. In addition, a biogas genset is used to generate electricity from biogas.

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Vision of the project

The project carries vision to generate biogas for power generation from valuable municipal waste. This project will serve as a model project which should promote more biogas plants across region. This will also highlight the importance and high value of municipal waste.

Idea of the biogas plant was triggered in order to have a proper utilization of municipal waste. The plant looks to utilize the gas into useful fuel for power generation. It will also provide quality manure and fertilizer. The Biogas plant will need approx. 5 MT of Municipal waste on daily basis, which will be collected RMC.

The plant is being set up Rourkela, Odisha. The RMC is progressive and readily adopts latest technology which serves to benefit of the people and benefit the environment.

This DPR highlights the details of the study conducted for assessing the potential for installation of 5 TPD municipal waste based Biomethanation cum electric energy generation plant for converting municipal waste in valuable Biogas and Biofertilizer.

About Place

Rourkela is a planned city located in the northern part of Odisha, India. It is the third-largest Urban Agglomeration in Odisha. It is situated about 328 kilometres (204 mi) west of state capital Bhubaneswar and is surrounded by a range of hills and encircled by the rivers Koel, Sankha, & Brahmani. The city is also popularly known as Ispat Nagar and Steel City of Odisha as well. One of the largest integrated steel plant set up with German collaboration Known as Rourkela Steel Plant, of Steel Authority of India Limited (SAIL). It also has one of the premier national level technical institute known as National Institutes of Technology (NIT Rourkela). Every year, on 3 March Rourkela Day has been celebrated. The city has been selected as smart city in the third phase of the National Smart Cities Mission on 20 September 2016, which is to drive economic growth and improve the quality of life of people by enabling local area development. Rourkela has been declared India's Fastest Moving City (East Zone 2–10 Lakh). Raurkela is third largest city of Odisha state & categorised as a Tier-2 city.

Latitude of Rourkela city : 22° 14' 57" N

Longitude of Rourkela city : 84° 52' 58" E



History

The name Rourkela originates from the local language of Sadri which means "Your Village" (Rour = Your & Kela comes from the word "Kila" which means Village). It comes under Sundergarh district of the Indian state of Odisha.

The twin towns of Rourkela and Fertilizer Township, as well as their developed periphery, are located in areas that were once covered by dense forests. These forests were once a favourite hunting ground for the kings in the past. According to the census report of 2011, Rourkela has a population of 483,038 (Rourkela Industrial Township is 273,217 and Rourkela Town is 210,412) and the urban metropolitan area population is 536,450. The railway station of Rourkela was within the revenue village of Mahulpali.

India's first public sector steel plant facility was established in Rourkela with the help of German businesses Krupp and Demag. Following India's independence, Pandit Jawaharlal Nehru, the first Prime Minister of India, wanted to make India an industrialized state in Soviet model of social development; giving wings to his dreams, Sri Biju Pattanaik convinced Pandit Nehru to consider the location of Rourkela for setting up a steel plant. The mineral-rich zone of Rourkela intersected by the rivers Brahmani, Koel and Sankha from two sides was aptly chosen for the same.

The preliminary survey for the steel plant at Rourkela was started in 1952 and the Government of Odisha issued a gazette notification on 16 February 1954. In accordance with the notification, the Government of Odisha acquired an area of about 80 square miles around Rourkela for the purpose of Steel Plant. The German private companies Krupp and Demag came forward to provide financial and technical help for the proposed steel plant at Rourkela. Krupp built Rourkela Steel Plant drawing from experience from its own works in Essen, Germany. The technical experts of the company advised the Government of India as well as the Government of Odisha for

acquiring more land. As a result, a further area of 32 square kilometres was acquired out of 31 revenue villages. Almost 13,000 people in 2,424 families lost their dwelling. Later further 11,000 acres (4,500 ha) of land were acquired out of 31 revenue villages for the construction of Mandira Dam, a water embankment. Moreland was requisitioned for the purpose of constructing railway lines to Hatia and Barsuan. The construction of the Bondamunda Railway junction required the further acquisition of land which resulted in 20,000 people's displacement from their habitat. Though there was initial discontentment among the tribals about the land acquisition the authority largely resolved the land dispute, as many of the tribals were provided employment and accommodation. The displaced tribals were relocated to places such as Jalda, Jhirpani, Bisra, and Bondamunda. Their new settlement even extended beyond the river Koel.

Thousands of technical personnel from West Germany came to Rourkela to extend their technical assistance. Some of these Germans came with their family and their small diaspora created the 'Indo-German Club' to socialise. The club exists today with a well-stocked library known as Max Muller library. There are a plethora of local stories of Germans social encounters with tribals (local Adivasis) and people from other parts of India who had relocated themselves to Rourkela for employment. A large part of this population was from coastal and western Odisha who were trained by the German workforce to adapt to the steel plant's technology rigour. The steel plant, which was hugely surrounded by forest, many times witnessed wild animals straying into the plant area. A royal Bengal tiger's lugubrious death in the steel plant's massive blast furnace is a part of the city's folklore. There were also tales about the disappearance of Germans in the nearby Vedvyas cave and the dread whirlpool of river Koel. The river still accounts for human casualty as some day-trippers wade into the water unaware of the maelstrom.

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Geography

Rourkela is located at 84.54E longitude and 22.12N latitude in Sundergarh district of Odisha at an elevation of about 219 m (719 ft) above mean sea level. The area of Rourkela is 200 square kilometres approximately. Being situated on the Howrah-Mumbai rail track, Rourkela had an added advantage of the steel plant being set up there. Red and laterite soils are found here which are quite rich in minerals. The area near Rourkela is rich in iron-ore hence a steel plant is situated in Rourkela. Bolani and Barsuan are the two most prominent mines situated near the town. Rourkela is situated in a hilly region. A small hill range named Durgapur Pahad runs through the heart of the city dividing it into plant area and the steel township. The name "Durgapur" comes from an old village that existed at the foothills long time ago before the plant was set up. The South Koel River and Sankha rivers meet at Vedvyas, Rourkela and flow as a single river called Brahmani.

Climate

Rourkela has a tropical climate and receives high rainfall during Southwest monsoon (June – September) and retreating Northeast monsoon (December – January). Average annual rainfall ranges between 160 and 200 cm. The minimum and maximum temperatures are in the range of 5 C to 49.7 C with a mean minimum and maximum temperature range of 12.0 C to 31.5 C during coldest and hottest months. Thirty six percent of the geographical area of the district has semi-evergreen or tropical dry deciduous forest.

Demographics

As of 2011 India census Rourkela Metropolitan Area had a population of 536,450. Males constitute 54% of the population and females 46%. Rourkela has an average

literacy rate of 75%, higher than the national average of 59.5% male literacy is 81%, and female literacy is 69%. In Rourkela, 12% of the population is under 6 years of age.

Density of Population – 6,696 per km². approx.

Sex Ratio – 835 Female per 1000 male.

Per capita income – Highest in Odisha.

Population (Census 2011) – 552,970 where as Rourkela Industrial Township (210,412) & Rourkela Town (273,217).

Main Habitations in Rourkela – Civil Township, Koelnagar, Chhend Colony, Uditnagar, Steel Township (Eighteen Sectors), Fertiliser Township, Industrial Estate, Basanti colony, Railway colony, Jhirpani, Jagda, Panposh, Vedavyas, Bondamunda, Bisra and Kalunga.

What Is Biogas

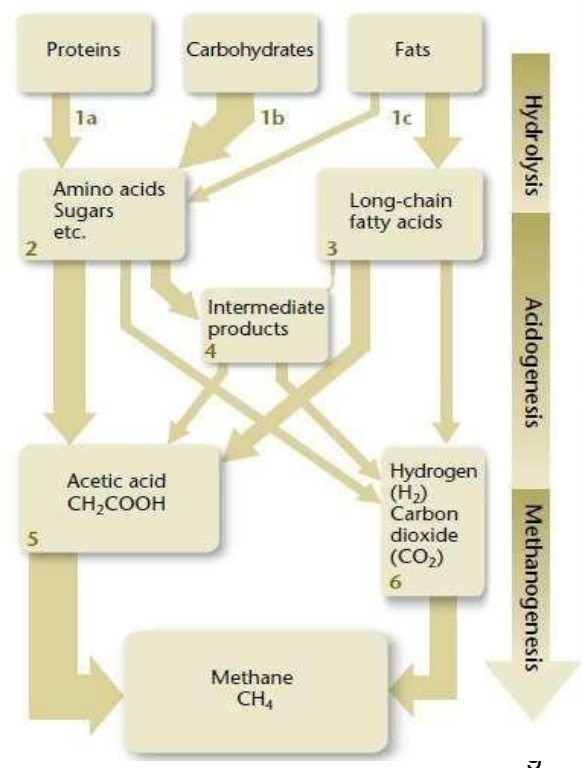
Biogas is a combustible mixture of gasses. It consists mainly of Methane and Carbon dioxide and is formed from anaerobic bacterial decomposition of organic compounds, i.e. without oxygen. The gasses formed are the waste products of the respiration of these decomposer microorganisms and the composition of the gasses depends on the substance that is being decomposed.

Methane makes up the combustible part of biogas. Methane is a colorless and odorless gas with a boiling point of -162°C and it burns with a blue flame.

The complete biological decomposition of organic matter to methane (CH_4) and carbon dioxide (CO_2) under oxygen-depleted conditions – i.e. anaerobic is complicated and is an interaction between a number of different bacteria that are each responsible for their part of the task. What may be a waste product from some bacteria could be a substrate (or food) for others.

The Biogas Process

The biogas process is often divided into three steps: Hydrolysis, acidogenesis and methanogenesis, where different groups of bacteria are each responsible for a step.



Hydrolysis

During hydrolysis long-chain molecules, such as protein carbohydrate and fat polymers, are broken down to monomers (small molecules). Different specialized bacteria produce a number of specific enzymes that catalyze the decomposition, and the process is extracellular – i.e., it takes place outside the bacterial cell in the surrounding liquid. Proteins, simple sugars and starch hydrolyze easily under anaerobic conditions. Other polymeric carbon compounds somewhat more slowly, while lignin, which is an important plant component, cannot be decomposed under anaerobic conditions at all.

Cellulose – a polymer composed of several glucose molecules – and hemicellulose composed of a number of other sugars – are complex polysaccharides that, are easily hydrolyzed by specialized bacteria. In plant tissue both cellulose and hemicellulose are tightly packed in lignin and are therefore difficult for bacteria to get at. Therefore, only approx. 40% of the cellulose and hemicellulose in pig slurry is decomposed in the biogas process. Normally the decomposition of organic matter to methane and carbon dioxide is not absolute and is frequently only about 30-60% for animal manure and other substrates that have a high concentration of complex molecules.

Fermentation – Acidogenesis

In a balanced bacterial process approximately 50% of the monomers (glucose, xylose, amino acids) and long-chain fatty acids (LCFA) are broken down to acetic acid (CH_3COOH).

Twenty percent is converted to carbon dioxide (CO_2) and hydrogen (H_2), while the remaining 30% is broken down into short-chain volatile fatty acids (VFA). Fatty acids are monocarboxylic acids that are found in fats. Most naturally occurring fatty acids contain an even number of carbon atoms. VFAs have fewer than six carbon

atoms. LCFAs have more than six carbon atoms.

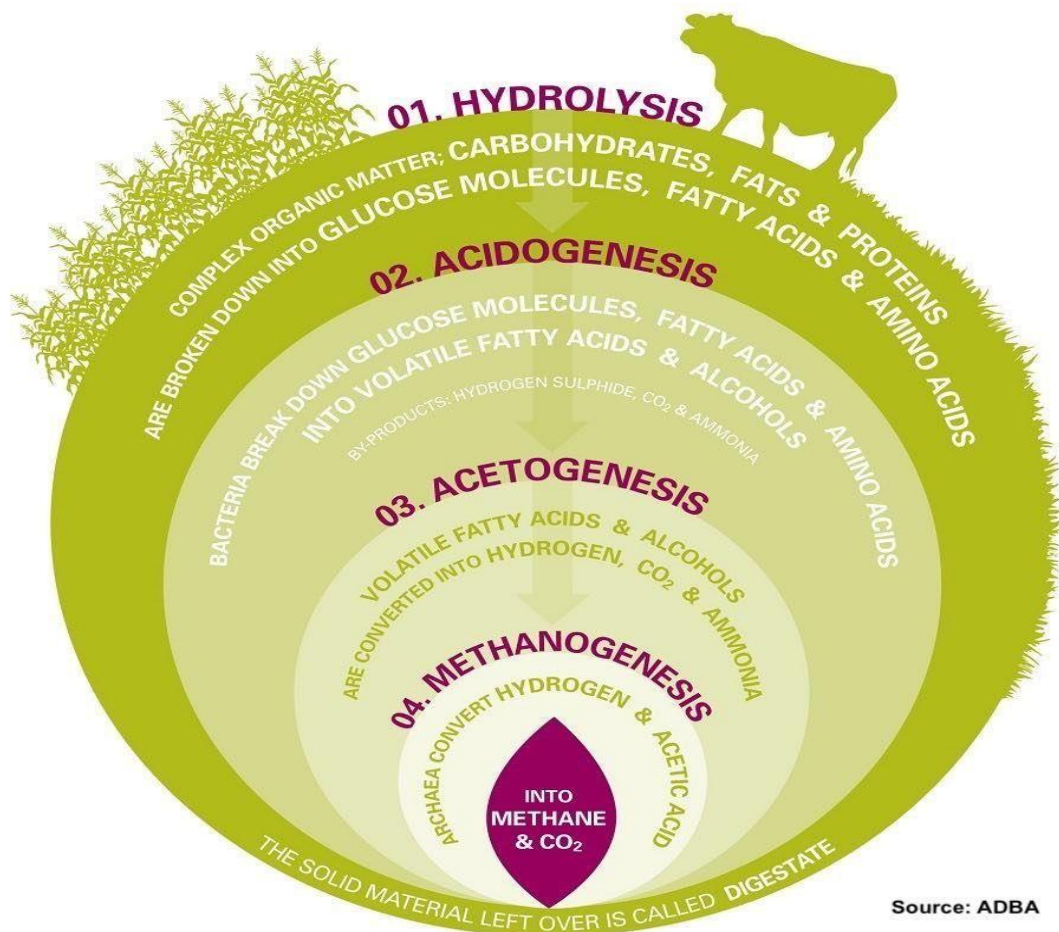
If there is an imbalance, the relative level of VFAs will increase with the risk of accumulation and the process “turning sour” because the VFA- degrading bacteria have a slow growth rate and cannot keep up. A steady degradation of VFAs is therefore crucial and often a limiting factor for the biogas process. Hydrolysis of simple fats results in 1 mol glycerol and 3 mol LCFA. Larger amounts of fat in the substrate will thus result in large amounts of long-chain fatty acids, while large amounts of protein – that contain nitrogen in amino groups ($-NH_2$) – will produce large amounts of ammonium/ammonia (NH_4^+/NH_3). In both cases this can lead to inhibition of the subsequent decomposition phase, particularly if the composition of the biomass feedstock varies.

Methanogenesis

The last step in the production of methane is undertaken by the so-called methanogenic bacteria or methanogens. The methanogens belong to a kingdom called Archaea, part of a taxonomic system that also comprises eukaryotes and bacteria at this level. A kingdom is the highest taxonomic level and Archaea are therefore at the same level as the other kingdoms – plants, animals, bacteria (Eubacteria), protozoa and fungi. Methanogens are believed to have been some of the first living organisms on Earth.

Two different groups of bacteria are responsible for the methane production. One group degrades acetic acid to methane and the other produces methane from carbon dioxide and hydrogen. Under stable conditions, around 70% of the methane production comes from the degradation of acetic acid, while the remaining 30% comes from carbon dioxide and hydrogen. The two processes are finely balanced and inhibition of one will also lead to inhibition of the other. The methanogens have the slowest growth rate of the bacteria involved in the process, they also become the limiting factor for how quickly the process can proceed and how much material can be digested. The growth rate of the methanogens is only around one fifth of the

acid-forming bacteria. As previously mentioned, the methanogens do not release much energy in the process. But due to the anoxic conditions, the competition from other bacteria is limited, which is why they manage to survive.



Source	Process	Energy yield kJ/mol methane
Hydrogen	$4\text{H}_2 + \text{CO}_2 \rightarrow \text{CH}_4 + 2\text{H}_2\text{O}$	131
Formic acid	$4\text{HCOOH} \rightarrow \text{CH}_4 + 3\text{CO}_2 + 2\text{H}_2\text{O}$	145
Methanol	$4\text{CH}_3\text{OH} \rightarrow 3\text{CH}_4 + \text{CO}_2 + \text{H}_2\text{O}$	105
Acetic acid	$\text{CH}_3\text{COOH} \rightarrow \text{CH}_4 + \text{CO}_2$	36

ROURKELA MUNICIPAL CORPORATION

II. GENERAL INFORMATIO N

2022

**Project Site – Kine House, Sector-14, Rourkela,
Odisha**

2. GENERAL INFORMATION ABOUT PROJECT

Project Background

Rourkela Municipal Corporation (RMC) intends to set up a Biogas Based Captive Power Plant (BCPP) at Rourkela, Odisha. The proposed Biogas based Captive Power Plant is expected to be set up with a 5 TPD (Tonnes per Day) feed capacity including the components of Biogas Digester and Auxiliaries. The generated Biogas is planned to be converted into electric power and evacuated into the public power grid. The BCPP is to be set up at Sector-14, Rourkela or Balughat, Rourkela.

Project Mission

To undertake the green energy project through optimal utilization of locally available resources.

Project Objectives

The prime objective of the project is to achieve clean and green Rourkela under Swatch Bharat Mission and to provide decentralized, in situ waste handling solutions for handling Municipal solid waste (MSW). The project comprises of setting up a 450 m³ capacity biogas plant for power production.

- **Power Component:** On daily basis plant could produce around 400 kWh power and produced electricity will be supplied to grid.
- **Agriculture Component:** Unit will also convert the raw waste in to highly nutrient rich organic fertilizer. Plant will produce around 800 kg bio-manure per day.

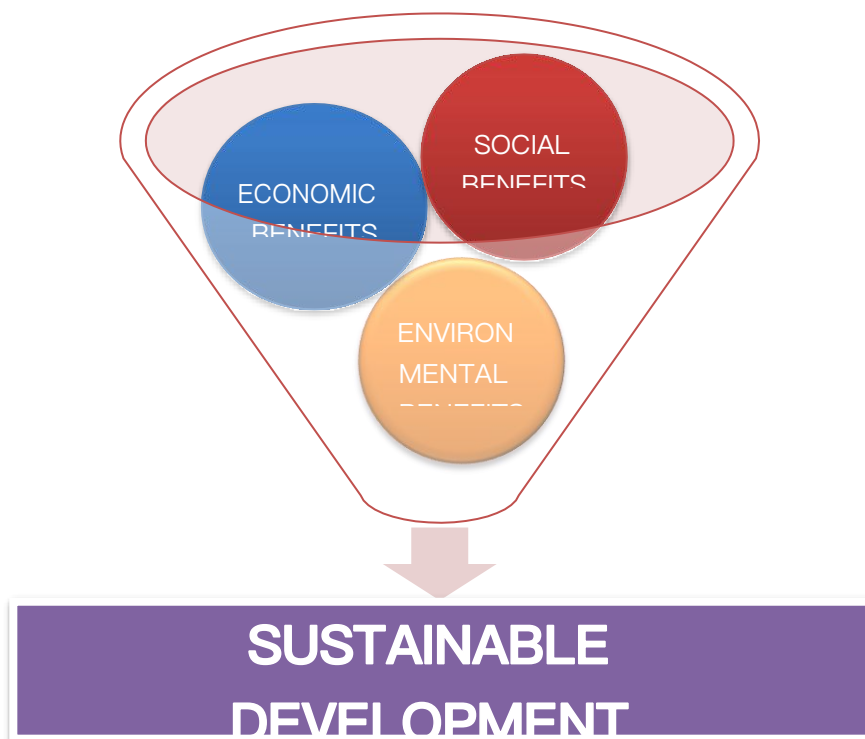
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Key favorable Factors of the project

- Replacement of fossil fuels & their migration of GHG emissions & Environmental Pollution.
- Market is created for presently unused / wasted commercially viable municipal waste.
- By-product from the biogas plants can be used as bio-manure.
- Creation of local employment.
- Reduce load on the landfill site and produce electricity.

Socio Economic Benefits



Some of the other advantages of a biogas plant are listed below:

- **Sanitation:** with proper management of urban wastes, city will be clean leading to better health and hygiene in city areas.
- **Energy security:** conversion of organic waste into methane and its use as fuel will lead to energy security because the fossil fuel is not going to last forever.

- **Pollution control:** normally aerobic decay of organic waste leads to emission of greenhouse gases like carbon dioxide or carbon monoxide. The process of biomethanation reduces greenhouse gas emission and helps in arresting depletion of the ozone layer. This is likely to earn carbon credits.
- **Employment generation:** Such plants can be easily set up and operated at local level. Since the product has a captive market the plant is bound to be economically viable and generate employment opportunity for a large number of people.
- **Organic Farming:** Outlet slurry of biogas plant contains reach amount of nutrients such as Nitrogen, Phosphorus and Potassium (NPK) along with micro nutrients which helps to enhance the crop production and promote the organic farming.

Benefits to the stakeholders

The establishment of biogas plant has been beneficial to all the involved stakeholders. The key stakeholders and the positive impacts of the Biogas Plant on them are discussed below:

- **Clean Fuel for Power Generation:** Produced biogas will be used as fuel for 100% biogas genset. Generated power will be supply to the grid.
- **Hygiene:** Cleanliness and hygiene city as produced waste will be used as a feed material for biogas plant.
- **Farming Community – Bio-Manure:** Local farmers will get large quantity of fertilizer which can be applied to fields which would save each villager cost of spending on DAP and Urea. Satibheti village being a farming zone with no means of occupation other than farming, will benefit the farmers and the farming with organic production of food.

- **Disposal of Solid Waste:** Solid waste management is serious issues for the municipal corporations now a days. Dumping yards height is increasing day by day. It emits the odorous gases, causing a nuisance for the surrounding neighborhood.
- **City - Employment generation:** The plant would require lot of people to run the project from gas generation, operations, feeding to slurry handling. The source of people will be local citizens hence benefiting the city community. Thus, the biogas plant will provide employment for the citizens.
- **Environment:** Use of clean fuel, proper waste disposal system for municipal waste and organic manure are the main benefits to the environment from the plant.

Project Location

Kine House, Sector-14, Rourkela Municipal Corporation, Rourkela.

22°15'56.8"N 84°50'14.0"E

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II. General Information

Name of the Project Proponent	Rourkela Municipal Corporation
Type of concern	Government of Odisha
Location / Address (Office)	Rourkela Municipal Corporation, Udit Nagar, Rourkela Dist.- Sundargarh (Odisha) Pin-769012
Location / Address (Plant)	Kine House, Sector-14, Rourkela, Odisha
Promoter	Rourkela Municipal Corporation

Installed Capacity	Unit	Values	Basis
Capacity Of Gas plant	m ³ /day	450	INPUT From SURVEY
Electricity Generation	kWh/day	400	
Biofertilizer Production	Kg/day	800	

Production from Project	Unit	Values	Basis
Capacity Of Gas plant		450	INPUT From SURVEY
	m ³		CHECK CELL
Total waste Required	Kg	5000	
Capacity (waste per day into the digester)	MTs / day	5	
No of working days of the Operation	Day	330	
Hours of Operation	sHr	10	
Total Capacity	MTs / annum	1650	
Life of the Plant assumed	Years	20	Assumed Minimum PlantLife
Annual Production		Quantity	
Raw Methane (m ³)		81675	
Electricity Production(kWh)		132000	
Bio-fertilizer Production(kg)		264000	
CO ₂ Generation (m ³)		52800	

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2.2 Project Promoter	
Type of Organization and Structure	Municipal Corporation
Registration Number	
Place Of Registration	
Date of Registration	

2.3 Accessibility to proposed Location	
Village	Sector-19
Taluk	Rourkela
District	Sundargarh
State	Odisha
Telephone	
Fax	
Email	

2.4 Accessibility to Project	
Nearest Tehsil/Block	Rourkela
Road Head	
Nearest Railway	Rourkela Junction
Nearest Airport	Birsa Munda Airport, Ranchi, Jharkhand
Nearest Grid	

2.5 Special Category	
Not Applicable	

2.6 Detail of Project Land	
Own Land	0.3 Acres

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**III.
TECHNICAL
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2022

**Project Site – Kine House, Sector-14, Rourkela,
Odisha**

3. TECHNICAL INFORMATION

Biogas and Bio-Manure Unit:

Biomethanation is the process of conversion of organic matter in the substrate to Biomethane (commonly referred to as biogas) and effluent (good Quality manure) by microbial action in the absence of air, known as "anaerobic digestion". Biogas is a high quality fuel, can be used for cooking, lighting and fired in special biogas engine - alternator set that produce electricity. Similarly, the slurry can be used as fertilizer, feeding fish and animals, mushroom cultivation, earthworm cultivation and so on. Thus the advantages of biogas are good quality fuel and fertilizer, environmental pollution control, environmental sanitation.

Components of the Biogas Plant:

The plant comprises 6 main operating units, viz:

Operating unit 1: Waste Reception / Storage & Segregation Unit

Operating unit 2: Feed Preparation Unit

Operating unit 3: Biomethanation Operating Unit

Operating unit 4: Biogas Storage Operating Unit

Operating unit 5: Biogas Cleaning Unit

Operating unit 6: Biogas Genset Unit

Operating unit 7: Digested Organic Manure Unit

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Operating unit 1: Waste Reception / Storage & Segregation Unit

The materials required for the fermentation process are received in operating stage 1 are waste and water (largely recycled).

The portion of each individual component is entered into the feeding program will be measured, controlled and recorded.

Waste -RMC will collect the wet waste from city & will bring it to the storage shed at plant. Further wet waste will be cross checked segregate and process for the feed preparation unit.

Operating unit 2: Feed Preparation Unit

Segregated waste cannot be directly feed into the anaerobic digester. Organic municipal waste for biogas process will be chopped before feeding into the digester in order to decrease the particle size. This aims at facilitating improved degradation and higher biogas yield. The smaller particles are also easier to convey into the digester and facilitate technical functions (e.g. prevent blockages). Reduced particle size enhances the surface area accessibility to the microbes, resulting in improved nutrient availability and boosts up the anaerobic process.

Water - Water from the available source is added by using the pump for premashing. Adding water can improve mixture feeding performance on the one hand and on the other hand it can be used to regulate the ammonium content and other constituents of the slurry suspension.

Mixer - Mixer Tanks has got capacity of 10 m³ and are designed as of brickwork tanks. The Substrates are homogenized using the automatic mixer. After all the ingredients have been added, the substrate will be homogenized.



Fig: Inlet tank with automatic mixer

Operating unit 3: Biomethanation Operating Unit

The capacity of main digestion tank is 450 cum. Fermentation substrate is fermented within the mesophilic temperature range between 35°C to 38°C. The Digester is a continuously working reactor in which the fermentation substrate is mixed to create a fully homogenous medium. Feeding takes place via a substrate pipe that ends in the Digester above the fluid level. Feeding is a time-controlled process. Through the holes in the wall for the substrate pipe are above ground level. Based on the amount of substrates (volumes) that have been added, a corresponding volume of fermentation residue is transported to the water recovery unit and solid separation unit.

The Digester is a round RCC container which is covered by the FRP gas holder. To prevent the formation of a thick floating layer of scum agitators will be installed into the digester tank. This leads to the formation of biogas, which consists of methane CH_4 and carbon dioxide CO_2 .

The temperature and pH are the two important factor of the biomethanation process, therefore there is provision of temperature and pH sensor inside the digester.



Fig: Biogas digester

Operating unit 4: Biogas Storage Operating Unit:

The Fiber Reinforced Plastic (FRP) made biogas holder of will be fabricated on site. A skeleton of the Mild Steel (MS) will be provided to meet out the desired weight and strength of holder. MS support central guided pipe and frame will be installed to stable the gas holder. Two manhole, one gas collection and one slurry sample collection point will be provided at top of the gas holder.

Gas holder will be installed on top of main digester tank and moves up and down with gas formation. A water jacket will be constructed of reinforced concrete in digester to allow gas holder to easily float up and down. Water will be filled as lubricating material in jacket.



Fig: Biogas storage unit

Operating unit 5: Biogas Cleaning Unit

The biogas also contains a minor amount of hydrogen sulphide (H_2S) and moisture in raw biogas, which needs to be removed before the gas is used. Both H_2S and moisture leads to corrosion and reduce the life of the involved machine and equipment's. For this reason, H_2S Filter is required to reduce the level of H_2S in the biogas before utilizing it for cooking purpose. Desulphurization reduces high levels of hydrogen sulphide – which is also a foul smelling, toxic and corrosive gas that can severely damage machinery and result in frequent mechanical failures. Moisture removal filter will be installed before H_2S filter to remove the moisture of the raw biogas.



Fig: Biogas cleaning unit

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Operating unit 6: Biogas Genset Unit

Electricity generation is the standard utilisation of biogas and considered very efficient for energy production. The technologies to convert biogas into electricity are numerous and in general it is not complicated to connect to the electricity grid.

As per tender specifications from 5 TPD available waste plant could produce around 400 kW power daily. A biogas genset is used to generate electricity from biogas. Genset consist an internal combustion (IC) heat engine which used biogas as a fuel.

- The biogas collected in the gas holder will be injected to the biogas scrubbing unit, which will remove hydrogen sulphide (H₂S) and moisture before being fed to the genset, as both H₂S and moisture can cause corrosion in the engine parts.
- Biogas cleaning filters will be loaded with the appropriate media to remove impurities, and they will need to be replaced on a regular basis as they become saturate.
- Based on the tender specifications 50 kVA/40 kW capacity 100% biogas genset will be installed. On daily basis installed genset can run around 10 hours continuously.
- Genset will produces 40 kW (3 phase, 415 V, 50 Hz) electricity per hour. Produces electricity passes through a transformer (400 V) which will amplify the voltage & provide constant electricity even if there is a fluctuation in frequency of genset. Received electricity will be directly supply to the grid (TPWODL) with the help of net metering.
- The electricity generated through biogas plant system will pass through transformer and later to be likely feed to the grid by the Municipal Corporation in discussion with local distribution company.



Fig: Biogas Genset

Operating unit 7: Digested Organic Manure Unit

Organic Fertilizer unit would be of the order of 32 L /day with 7 - 87% TS. The Digester Effluent has wide ranging use as organic manure including for grains/ sugar cane farming, but have preferential applications for, short cycle, forage/energy crops & horticulture products farming. It is also non-pollutant because it is free from weed-seeds, foul smell and pathogens. The slurry is rich in main nutrients such as Nitrogen, Potassium and Sodium (NPK) along with micronutrients - Iron & Zinc etc. As such there is no pollution from biogas plant. The effluent from the Biogas Digester is sent to the organic fertilizer unit where the solids & the liquid is separated. The separated solids will be packaged and sell in to the market.



Fig: Slurry dewatering machine

Mode of Operation of Biogas Plant

Biogas Production Unit:

- Waste collection system will be constructed in a manner that allow poultry droppings to easily feed into the digester with minimal manual intervention.
- The available litter will be transferred from litter collection tank to inlet tank with the help of drain and pump.
- Waste will be fed in the digester after homogenizing with water in ration of 1:1.
- Composition of raw biogas:

Methane:	55-60%
Carbon dioxide:	35-40%
Hydrogen Sulphide:	~ 500 ppm
Nitrogen:	2-3%

Power Production Unit:

- Based on the requirement 100% biogas genset will be installed to produce power from biogas.
- Biogas will be passed through two filters to remove moisture and H₂S before injecting in genset, as both moisture and H₂S leads to corrosion in genset.

Organic Manure Unit:

- Digested slurry of the plant contains 8% TS will be directly fed in to the slurry dewatering screw press to separate the liquid and solid part of the slurry.
- Solid part can be directly packaged and market to the farmers, as organic

bio-manure.

- Liquid part of the slurry will again recycle in to the process.
- Also, filtered liquid slurry of plant could be good replacement of irrigation water.

Table: Comparison of plant nutrient content in digested slurry (DS) and farmyard manure (FYM).

Plant Nutrient	DS (%)	FYM (%)
Nitrogen (N)	1.5-2.0	0.5-1.0
Phosphorus (P_2O_5)	1.0	0.5-0.8
Potash (K_2O)	1.0	0.5-0.8

Structural Design Proof Checked and
Found Satisfactory

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Technical Specifications:

S. No.	Particulars	Quantity	Technical Specifications
1. Biogas Production Unit			
i.	Civil Work: Biogas Digester,	1 no.	Capacity – 450 Cum Compete Reinforced Cement Concrete (RCC) Function as main digestion tank, biomethanation process will take place Partial Underground and Overhead Weather effect minimal Diameter – 12.2 meter and Height – 3.9 meter
	Inlet Tank	1 no.	Capacity – 10 cum To homogenize the water with water in ration of 1:2. Tank will be over head and connected with the waste collection platform Material of Construction – Brick Work Diameter – 3 meter and Height -1.5 meter
	Waste collection & Segregation shed and platform	1 no.	Platform will collect the waste and segregation will be done. Waste will be guided to the inlet tank to mix in water. Material of Construction - Brickwork Length – 15 meter and Width – 8 meter
	Outlet tank	1 no.	Capacity – 100 Cum To collect the digested slurry of the plant. Material of Construction – Brick work Diameter – 5 meter and Height – 5 meter
	Buffer tank	1no.	Capacity – 75 Cum To collect the liquid part of the separated digested slurry of the digester. Liquid will be recycled in the process. Material of Construction – Brick work Diameter – 4.4 meter and Height – 5 meter
	Office cum Store room	1 no.	Office cum store room Material of Construction - Brick Work Length – 4.9 meter and Width – 3 meter
ii.	Feeding Unit: Mixing system in Inlet tank	1 no.	Agitators with SS 304 to be installed, consistency inside the Digester will be max 15% solids (on the higher side when biomass is added) pH - ranges from 3 - 8.5 Temperature ranges - 30 – 50° C 2 HP, Three Phase 6 pole cable with timer to be installed in the panel Make – In house

	Feeding Pump	1 no.	Submersible pump with float control, 4 m ³ /hr and 10 m – 12 m head. TS in the feed: 12-15% Particle size: 5mm Maximum size Cutter: SS inbuilt Cutter required MOC: Stainless Steel, Three phase, 3 HP Make - Crompton Greeves, Lubi, Green pumps
	Agitators	2 nos.	Submersible agitator with SS fitting will be installed, Consistency inside the digester will be max 10% solid. pH - range from 4-8 Temperature – range from 30 - 45° C Three phase, 5 HP MOC: SS 304, Side entry type, RPM: 150 Shaft, blades, mechanical seal, support, motor, gear box. Make – In house
iii.	Gas Storage Unit: Digester top cover – Double Membrane Roof, including inner and outer membrane	1 no.	Capacity – 270 m ³ Fiber Reinforced Plastic (FRP) gas holder with MS skeleton structure MS Sheet – 16 gauge, MS angles – 45X45X5 mm Diameter – 13 meter Side Height – 1.5 meter, Centre Height – 2 meter Shape – Conical Work pressure – Max 15 mm WC Gas Outlet = 2” , Colour - Green Make: Indigenous

2. Biogas Cleaning and Power Production Unit

i.	H ₂ S Scrubber	1 no.	Complete Set Since biomass will be used as a feed stock so approximately 0.5-1% (max) levels of H ₂ S shall be present in the raw biogas. 2000 – 3000 ppm levels shall be detected in the raw biogas. Outlet biogas from the H ₂ S Scrubber shall have less than 50 ppm of H ₂ S in the clean biogas. Complete set with inlet outlet pipes, scrubber, storing tank, electrical panel, switch board, switches and gas flow meter, etc Make – In house
ii.	Moisture removal filter	1 no.	To remove moisture from the produced biogas. MS cylindrical in shape Biogas will be inserted through side entry. Silica gel as a media Top outlet to collect gas, Bottom outlet to drain Make – In house
iii.	Biogas Genset	1	Capacity – 50 kVA/40kW Three Phase, 415 Volts, 50 Hz

			Water – cooled, Biogas as fuel Make – Kirloskar, Ashok Leyland, Prakash, Hi-Tech
4. Digested Slurry Management Unit:			
i.	Slurry separator	1 no.	4 m ³ /hr at sludge concentration of 1% or 30 Kg/hr @ dry solid basis Biogas digested slurry treatment Total Power – 5 HP Power Supply – 440V/ 50 Hz, Three Phase Material - Nylon in thickening zone and SS304 in pressure zone Make - Envicare, Ganesh Marine Services, Auric, snp water infra,
ii.	Mud pump	2 nos.	2 HP pump cutter pump with MOC: SS Slurry Handling Particle size: 4-5mm, Delivery Head: 8 mtrs To pump biogas digested slurry to dewatering Flow rate – 4 m ³ /hr Total Power – 2 HP Head – 5-7 m Power Supply – 440V/ 50 Hz, Three Phase Make – Crompton Greeves, Lubi, Green pumps
5. Miscellaneous Items:			
i.	Miscellaneous	LOT	Wiring of the whole unit Flame arrestor to resist back fire while using for thermal application – 1no. Pressure gauge to measure pressure at different stages of plant – Proper lighting system in whole unit
ii.	Piping and Valves	LOT	Biogas Plant Slurry Piping, Biogas Piping, Water Piping & Valves of desired sizes. HDPE & Mild Steel for slurry and Biogas piping (drawings will be provided)
iii.	Biogas Electric Panel	LOT	Supply Cable, Aluminum, armored cable and other electrical accessories for lighting purpose Painting shall be Epoxy based powder coating (RAL 7032). Thickness of panel shall be 16 SWG. Panel to be provided with gaskets. Cable entry shall be from the bottom as a standard feature. Earthing to be done for all electrical equipment and non-current carrying structures, Tanks, equipment's etc.

iv.	Transformer	1 no.	Description - Voltage Nominal Voltage – 400 V Highest System Voltage – 416 V Number of Phases – 3 Frequency – 50 Hz Neutral Point – Directly Earthed Cooling – Self Cooled Power rating – 62.5 kVA
v.	Biogas Flow meter	1 no.	Biogas meter End connections – Both end flanged Seal Material – SS 316 L Foil Type Converter Mounting – Integrate Accuracy - +-1%, Quality – Raw Biogas Flow – 0-25 m ³ per hour Temperature – 0-40° C Line sizing 1.5 inch, Quality – Raw Biogas Pressure – would range between 1-2 Bars (less than 2 bars) Make - Zenner or Itron, Biogas meter

Structural Design Proof Checked and
Found Satisfactory

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III. Technical Information

Technical Information

Particular	Units	Value
Biogas	m ³	450
Electricity	kWh/Day	400
Biofertilizer	Kg/Day	800

Feed Material	Availability (Tones Per day)	Availability (Tones per year)
Municipal waste	5	1750
Other Material (Poultry, agriculture etc)	-	-

1.2 Pretreatment slurry preparation and Handling

No of days of treatment to be mentioned for each of the feed-materials types	30 days
Estimated Requirement of each feed Material per cubic meter of raw biogas	10-12 kg
Slurry consistency	8% slurry
Dilution water requirement(liters)	5000
Possibility of water recycling	Yes
Size reduction	Yes
Agitation	Yes
Type of Agitation	Automatic
Slurry Charging	With Gravity
Slurry consistency	8% slurry
Special Requirements	Water Storage tank with Water pump

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1.3 Biogas Digester Design and Sizing Suitable for multi feed stock

Digester Retention Time HRT (HRT)	30 days
Type of biomethanation Digester	Anaerobic
Digester Model	Plug Flow- Mixing
Operation Maintenance Requirement	Pump for recirculation
Size reduction	Yes
Agitation	Automatic
Special Design Features over conventional Models	Better handling of Recirculation and scum removal, Cheap cost, Indigenous Technology

1.4 Biogas Storage

Storage Details	270 m ³
Type	Fiber Reinforced Plastic (FRP) type
Special Material Requirement	Fibre Mat, Resin, Cobalt, Catalyst, MS sheet & angles
Expected Lifetime of Storage	20 years
Cost Effectiveness of Storage	Yes

2.0 Biogas Purification Technology

Technique	H ₂ S and Moisture Removal Filter
Quality of Upgraded Gas(% Methane)	-
Utilities / Chemicals Required	NA
Technology Available In India	Yes

3.0 Biogas Utilization

Power Generation for Captive Utilization	100% biogas genset, 50 kVA/40 kW

4.0 Post Treatment of Digested Slurry	
Dewatering and recycling system	Slurry dewatering with static sieves and reciprocating sieves
Drying, Manure management	Manual
Mechanical, Pneumatic concentration	NA
Composting- vermi, mechanical	NA
Value addition and packaging	NA

5.0 Biogas Distribution	
Pipeline	NA

6.0 Utility Requirement	
Captive Power (in house/ outside)	kW
Water	5000 lit/day
Chemicals and other Requirements	NA

7.0 Land Requirement	
	10000 sqft

8.0 Operation and Maintenance requirement	
Operation and maintenance Manuals	Yes – daily, weekly, monthly and yearly maintenance schedule
Availability of spares	Yes
Training facility	Yes

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Found Satisfactory

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**IV. DESIGN
AND
EXECUTIO
N**

2022



Project Site – Kine House, Sector-14, Rourkela,
Odisha

4.METHODOLOGY & CONSTRUCTION OF THE PLANT:

Site Selection and Designing of Unit

The methodology adopted by poultry droppings for implementation of this idea of biogas plant included 7 main steps:

Feasibility survey for selection of site.

- Geographical condition of site.
- Optimum space for the project
- Acceptance of new technology
- Easy availability of Water, Electricity facility
- Proximity to forest lands
- Optimum space for slurry handling

Based on the above criteria, site near litter collection tank and staff quarter has been selected.

After selection of the site, a Project team is formed for study the following aspects:

- Project details (Physical)
- Project Cost (Financial)
- Material required

Also, the following parameters related to the plant will be finalized:

- Time frame of the implementation of the project
- Operation and Maintenance of the project
- Use of output (Slurry) to produce fertilizer.

Following programs will be conducted:

- Training of employee's operation of the Project
- Regular review of the project and further improvement of the Project.

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Design of the Plant

Flawless design is the key to smooth and efficient operation of the plant. A small design error can lead to high loss of efficiency or even complete failure of the plant. This plant being a large-scale biogas plant further emphasizes the need for accurate design. Considerably large design errors can be tolerated in the case of small, individual plants but not in the case of a big plant which is many-fold in size, operational cost, revenue etc.

The Biogas Plant at Kine house, Sector-14, Rourkela Municipal Corporation, Rourkela, Odisha has following major systems viz. the biogas plant itself, the gas distribution, power production and the slurry management unit.

Design:

The design of the plant is based upon many factors. Some of the major factors imposing specific design constraints have been discussed below.

Location of the Plant:

The site of the plant had to be chosen in the close vicinity of the gas utilization and availability of waste. This constraint is imposed as the plant cannot be far off from the beneficiary owing to the daily transport of waste to the plant and piped gas supply to genset.

Sizing:

The size of the plant was primarily decided by the technical limitations of size. Plant has a design capacity to handle approx. 5000 kg per day of waste.

Civil Construction

Codes and Standards: The Indian Codes and Standards as applicable will be generally used for design of civil and structural works.

General Design Specification

Concrete Structures:

The following grades of concrete as per IS: 456 will be adopted for the type of structures noted against each. Design mix shall be used for RCC work as per standards.

M15 – For PCC, drain etc., and M20 – For RCC foundation.

5.1.1 All structural concrete will be made dense and nonporous with water cement ratio not exceeding 0.45. Plasticizers will be used, if required, to maintain the required slump. For structural concrete items, Ordinary Portland Cement (33/43/53 Grade) conforming to IS:8112 will be used. High yield strength deformed bars conforming to IS 1786 will be used for reinforcement.

Steel Structures:

Design of steel structures will be carried out by working stress method as per IS:800. Generally, all shop and field connections will be welded. Structures will be generally designed as rigid frames in the transverse direction and as braced frame in the longitudinal direction. All moment connections, will be of High strength friction grip. Shear and other minor connections, if bolted may be made with mild Steel / High strength bearing bolts.

Foundation:

Foundations for Vibratory Equipment: All machine foundations will be designed in accordance with the provisions of the latest edition of national standards, international standards and manufacturer's standards.

Structural Design Proof Checked and Found Satisfactory
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PERT CHART

450 Cum Capacity Biogas Unit at Rourkela, Odisha														
PERT CHART	1Week	2Week	3Week	4Week	5Week	6Week	7Week	8Week	9Week	10Week	11Week	12Week	13Week	14Week
Approvals and Documentation														
Agreement , survey, site selection														
Pre-approvals, permission from local authourity	✓	✓												
DPR, Detail Designing, BOQ														
DPR Approvals														
Completion of Civil Work														
Digester Tank														
Outlet tank and water tank														
Inlet tank and feeding tank														
Genset shed			✓	✓	✓	✓	✓	✓	✓	✓	✓			
Office room and store														
waste collection shed														
Paint and finishing														
Outlet and buffer tank														
Completion of Mechanical & Electrical Work														
Double membrane gas holder														
Mixing tank agitator														
Feeding pump														
Digester agitators								✓	✓	✓	✓	✓	✓	
Slurry separator with mud pumps														
H2S scrubber and Moisture removal filter														
Food waste crusher														
Transformer and Bi-directional meter														
Biogas genset														
Miscellaneous items: Piping, wiring, switches, control panel Biogas flow meters, weighing machine, epoxy, resin, instruments											✓	✓		
Commissioning, Optimization & Training											✓	✓	✓	✓

Structural Design Proof Checked and
Found Satisfactory

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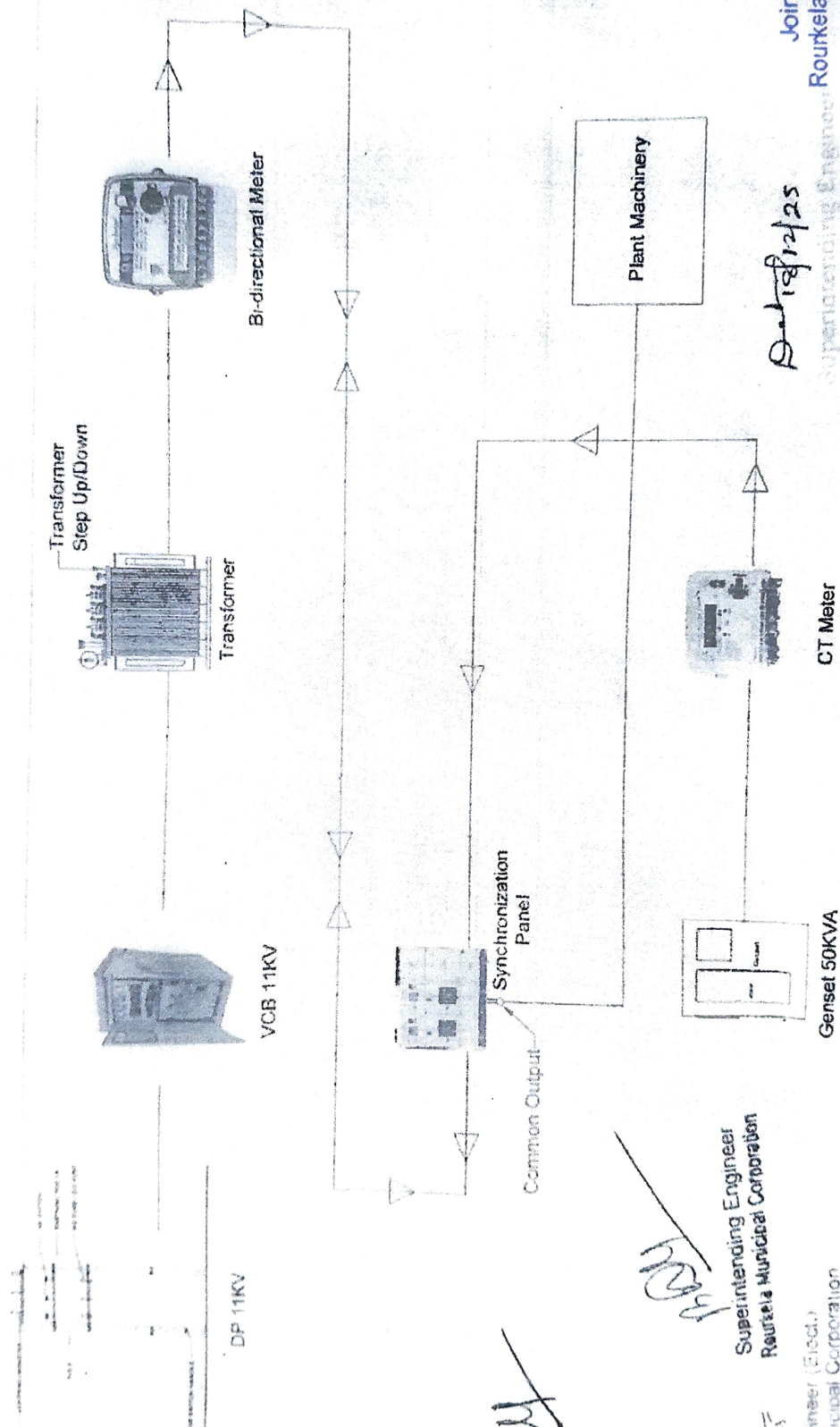
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Biomethanation Plant Sector 14, Rourkela Line Diagram:- Synchronization Between Genset and Grid



Date 18/12/25

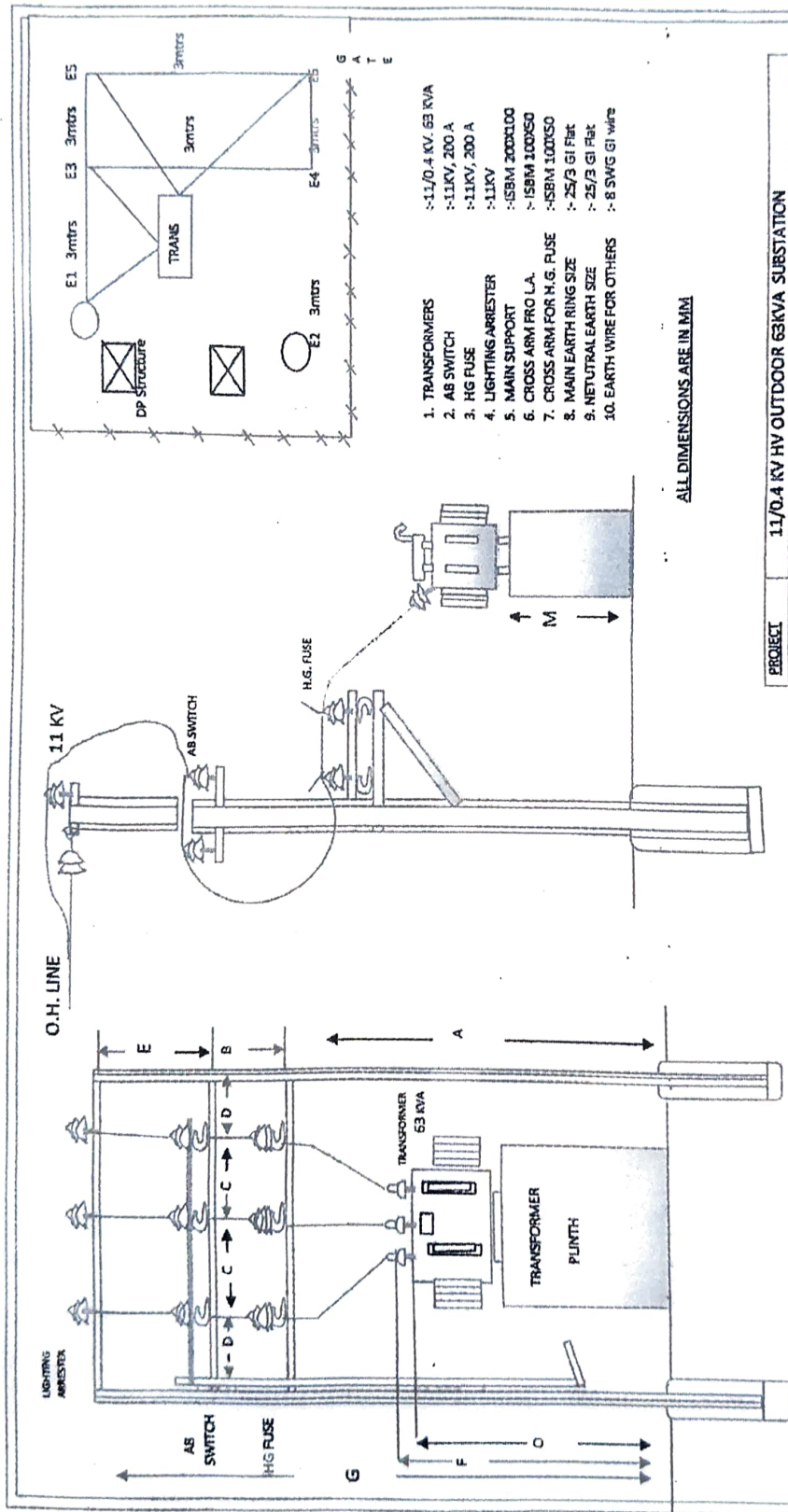
Joint Commissioner
Rourkela Municipal Corporation

Superintending Engineer
MPT Circle, TEWARI, Rourkela

Genset 50KVA

Asst. Engineer (Elect.)
Rourkela Municipal Corporation

Superintending Engineer
Rourkela Municipal Corporation



PROJECT	11/0.4 KV HV OUTDOOR 63KVA SUBSTATION
CLIENT	ROURKELA MUNICIPAL CORPORATION
PREP. CHGO.	
APPLY	
CONTRACTOR	M/s. JUPITER ENGINEERS
DRAWING NO.	
SIGNATURE	

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
3400	3000	760	480	1500	2500	7500	2000	2440	1500	2500	2000	1250	1500	2000

Kishore Chandra Jena
KISHORE CHANDRA JENA
 Govt. Electrical Contractor
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Kishore Chandra Jena
Kishore Chandra Jena
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Joint Commissioner
 Rourkela Municipal Corporation