BEFORE THE JOINT ELECTRICITY REGULATORY COMMISSION FOR THE UNION TERRITORY OF ANDAMAN AND NICOBAR ISLANDS

Filling No.
Case No.

IN THE MATTER OF

Sub: Determination of tariff for Procurement of Power by Distribution Company / Licensees from Biomass based Power Generating Company in in the Union Territory of Andaman and Nicobar Islands using the Gasification route (Otto Cycle).

AND

IN THE MATTER OF

Riflex Industries Private Limited
Registered office at New #31, Old #14,
Moore Street, Chennai 600001
And Branch office at Andaman Islands at 2nd Line,
Opposite to Dr. Diwan Singh Gurudwara, Gurudwara Lane,
Port Blair 744101. …….. Petitioner

ELECTRICITY DEPARTMENT
ANDAMAN & NICOBAR ADMINISTRATION
PORT BLAIR. 744101 …… Respondent

Fact of the case/Petition be stated in short

Submission/Ground in support of the case.

Relief clause:

Combustion and Pyrolysis of Biomass in an environment with limited supply of oxygen leads to generation of producer gas. The producer gas can be used as fuel for suitable gas engines for generation of electricity. The Ministry of New and Renewable Energy (Biomass Division) Office Memorandum dated 1st December, 2009 has identified generation of producer gas from biomass using gasifier and subsequent generation of power from the producer gas is a valid route for

producing power for distributed off-grid as well as grid connected projects up to 2-MWe supply capacity. However in the Union Territory of Andaman and Nicobar the determination of the tariff using gasifier based power generation schemes is yet to be done. We Riflex Industries Private Limited hereby Pray to the Commission for determination of the tariff for power through gasification route within the Union Territory and for our following proposed sites at:

1. Mithakhari Industrial Area, Port Blair, South Andaman District

Place: Port Blair
Date: August 4, 2016 Signature of the Petitioner

August 4, 2016

The Secretary
Joint Electricity Regulatory Commission,
'Vanijya Nikunj', 2nd Floor
Udyog Vihar, Phase V
Gurgaon, (122016) Haryana.

Sub: Determination of tariff for Procurement of Power by Distribution Company / Licensees from Biomass based Power Generating Company in the Union Territory of Andaman and Nicobar Islands using the Gasification route (Otto Cycle).

BACKGROUND

Any policy is framed with the idea that based on the policy directives, investment will flow into the sector and thus the sector will grow. When the sector is the biomass sector the responsibility of the policy makers is much larger as this is a resource that can not only be used to generate clean energy, but this is one of few tools that could really push inclusive growth as most of the revenues generated by a plant like this go back to the local people.

To the best of our knowledge, there has been no tariff fixed for generation of power using biomass through the Gasification (Otto Cycle) route in the Union Territory of Andaman and Nicobar and hence The Petitioner above named most respectfully Prays to the Hon'ble Commission for fixation of a higher tariff for their projects and is pleased to submit following details for the kind consideration of the Hon'ble Commission.

1. The details of Biomass Gasification Technology, the process, the schematic diagrams, the producer gas components and its quality, the efficiencies, details on the emissions and the effluents including the waste generation and disposal methods, a brief comparision of Otto Cycle and Rankine Cycle technologies etc. are enclosed herewith as **Annexure-1**.
2. The Petitioner is praying to the Hon'ble Commission for a suitable tariff for their Projects based on Gasification / Otto Cycle technology and wishes to justify the request for a higher tariff by covering notes on the following points:

Components of Tariff: While determining the biomass based power generation tariff, it is essential to consider financial and operational parameters. In the context of tariff determined on cost-plus basis, it significantly depends on the following financial and operational parameters as follows:

1. Capital cost including Evacuation Cost
2. Tenure of Loan
3. Interest on loan
4. Return on Equity
5. Life of plant and machinery and agreement period.
6. Depreciation
7. Debt-Equity Ratio
8. Operations and Maintenance expenses
9. Interest on Working Capital
10. Plant Load Factor (PLF)
11. Auxiliary Energy Consumption
12. Station Heat Rate (SHR)
13. Fuel Related Assumptions
    a) Fuel Mix and types.
    b) Gross Calorific Value (GCV)
    c) Price of fuel.

Brief note on each parameter is being elaborated as below and further the Cost Working / Calculation in an Excel sheet is also enclosed as Annexure-2 for Commission's kind perusal.

1. Capital Cost including Evacuation cost:

While determining the tariff for the biomass gasifier based power generation, it is essential to verify the capital cost for determination of the tariff. Capital cost is the most critical element while determining the tariff in a regulated environment. The capital cost of biomass gasifier based power plant comprises the cost of (i) gasifier and its accessories, (ii) 100% producer gas based engine gensets, (iii) transformer and associated equipments, (iv) land and its development including the Civil constructions (v) transportation of equipments and biomass to

and in A&N island, (vi) erection and commissioning charges (vii) Pre-operative expenses and other assets.

For the proposed Campbell Bay site in the Union Territory of Andaman and Nicobar islands, the above components are grouped and the entire Gross Capital Cost / Project Cost would be around INR 10.41 Crores per MWe including the cost of project switchyard and interconnection facilities at the site upto the point of energy metering. It does not include the cost of transmission lines and associated facilities beyond the point of energy metering at the Project switchyard for the evacuation of power.

Even after considering Central Financial Assistance (CFA) from MNRE of Rs. 1.50 Crore per MW, net project cost will be Rs. 8.91 Crore per MW.

2. Tenure of Loan:

The Petitioner has considered the loan tenure as 10 years.

3. Interest on Loan:

The Petitioner has considered the interest rate @ 13% per annum.

4. Return on Equity:

The Petitioner has considered the rate of return on equity (pre tax) at 15% per annum for the initial 10 years and thereafter there will be cash accrual in each subsequent 10 years.

5. Life of plant and machinery and agreement period:

The useful life of the Plant and machinery is considered as 20 years.

6. Depreciation:

Depreciation is apportioned for 20 years with 10% residual value.

7. Debt-Equity Ratio:

The Petitioner has considered a Debt: Equity ratio of 70:30 for the Capital Investments.

8. Operations and Maintenance expenses:

The Petitioner has considered the O&M cost including insurance cost at the rate of 9.5% of the Gross project cost for the first year (detailed project calculations enclosed **as Annexure-2).** Gasifier maintenance cost at 9% of the Gasifier cost, 9% of Engines cost, and 3% to 4% for Manpower. Escalation @ 5.72% on operations and maintenance year on year has been considered. Escalation of manpower cost in the first 10 years it is 8% and the in the subsequent 10 years it is assumed 4%.

9. Interest on Working Capital:

The fuel storage requirement depends on factors such as types of fuel, their availability on a continuous basis round the year, the availability of storage facilities, procurement arrangements, the price during season/ off-season etc. apart from the fact that the agriculture and forestry residues, which are seasonal and would require storage for longer period.

Therefore, the Petitioner has considered the following items as components of working capital for the purpose of interest on working capital and has considered the rate of 15%. It is assumed that after 10 years the finance cost will come down to 12% as the Project will be giving positive result in first 10 years.

i) Fuel Stock of 60 days in the first 10 years and thereafter as the supply of Fuel will be regular and consistent and with new vendor development the stock holding will be reduced to 30 days.

ii) O&M expenses for one month plus Stores and Spares @ 15% of annual O&M cost.

iii) Receivables equivalent to one month charges for sale of electricity calculated.

10. Plant Load Factor (PLF)

The Plant Load Factor (PLF) is a critical performance parameter for any power plant installation. It depends on factors such as reliable and timely fuel supply, plant availability etc. Though it is necessary for biomass projects to avail some time for stabilization of its operation in initial period and once the plant stabilizes, it can operate at the optimal level.

The Petitioner however has considered the plant to be stabilized and operate at optimum levels right from first year, the PLF has been considered as 75%.

11. Auxiliary Energy Consumption

Auxiliary consumption is the quantum of energy consumed by auxiliary equipment and transformer losses as a percentage of gross energy generated. It is a function of plant efficiency and the energy conservation methods adopted by the developers.

The auxiliary consumption for the plant is 15% of the gross energy generation.

12. Station Heat Rate (SHR)

The SHR depends on several factors such as plant capacity, plant design and configuration, technology, plant operations and maintenance practices, quality of fuel received and operational parameters taking varying load conditions.

The SHR considered by the Petitioner 4200 kcal/kwh and thus the biomass consumption per unit of generation to be 1.20 kgs.

13. Fuel Related Assumptions

a. **Fuel Mix and types**.

The Petitioner intends to use different kinds of biomass as per the seasonal availability like mainly Coconut, Betel nut and other agricultural wastes and if required other woody biomass wastes like fallen branches, twigs and firewood wastes from private land/forest owners or saw mill suppliers.

Gasification technology (Otto Cycle) cannot use coal as fuel.

b. Gross Calorific Value (GCV)

The Gross Calorific Value (GCV) is the heat produced in kCal by complete combustion of one Kg of fuel. There are various types of biomass available from agricultural and forestry residues as mentioned above. Each biomass has different Gross Calorific Value (GCV) and its availability also varies from season to season.

Hence, the Petitioner has considered appropriately the weighted average calorific value of the available various types of biomass fuel sources to be around 3500 kcal/kg and the expected consumption of 1.20 kg /kWh.

c. Price of fuel.

The price of biomass fuel depends on price paid to farmers / suppliers, cost related to collection, storage, transportation, loading and unloading cost, agents commission etc.

The fuel procurement and transportation are handled by unorganized sector and thus the prices are influenced by the local factors.

The energy that can be generated using biomass as fuel depends on properties such as moisture content, calorific value and non-combustible materials in the biomass. The heat energy content of biomass of one crop residue differs from that of another. The projects may have a fuel mix of various combinations and varying percentages.

The price of the fuel with 20% moisture content including the sizing and storage cost including losses is estimated to be Rs. 7500 per tonne. (Please refer Annexure-1 for note on the moisture content and sizing of biomass that would be required in Gasification Technology).

The Price of Fuel has been taken to be INR 7,500 per MT with an escalation of 2% per annum.

Based on the above costs, the price per kW-hr levelised is <u>INR 17.55 in the first 10 years and for there will be increase of tariff in each 5 years @5%.</u> Kindly see the detailed Project IRR calculations enclosed as Annexure.

Advantages of upto 2 MWe (net feed-in to the grid) Biomass Gasification Power Plants:

Based on the tariff above, it may seem as if the consumer will be burdened with additional cost. Below is a summary of study carried out by M/s. Ernst & Young on Small Biomass Power Projects with focus on Transmission Losses. Estimations made by M/s. Ernst & Young on the benefits of smaller sized tail-end grid plants over large size biomass power projects key points are listed below:

i. Small plants of upto 2 MW help in improving the voltage of the 11 KV Grid. For instance, Karnataka Power Transmission Corporation Limited (KPTCL*)* gets a voltage boost of over 100 volts i.e. 1%.

ii. They help in improving the power factor. This is crucial as usually when irrigation pumps are connected the power factor deteriorates.

iii. Grid frequency stabilises.

iv They limit T&D losses to a large extent. For instance, if a 10 MW biomass based plant is connected to a 132 KV grid and the next 66 KV or 33 KV sub-station is about 30 km then losses would be about 4.7 %. If the 11 KV grid is 10 km. from the 33 KV grid then another 2% losses will result. Therefore if smaller power plants connected to 11 KV transformers about 7% losses are prevented. About 4.29 million units (10,000 kW x 8760 hrs x 0.70 PLF x 0.070 losses) will be lost annually from 10 MW project. With biomass power tariff being in the range of Rs.4.50 per unit, the losses would be over Rs.1.93 crore per year i.e. a total of Rs.28.95 crores for a plant of lifespan 15 years. On the other hand, if a 2 MW biomass based plant is connected to 11 KV grid, this would result in the saving of about 8.58 lakh units (2,000 kW x 8760 hrs x 0.70 PLF x 0.070 losses) amount to Rs.38.63 lakh annually (TRANSLATES TO A SAVING OF INR 0.50 PER KW-HR), aside from other benefits.

Apart from the above economic benefits there are some more advantages of smaller plants:

- Much greater probability of success and long term sustenance.
- More equitable distribution of economic development (revenues from sale of residues and employment generation).
- Creation of large scale employment for unemployed / partially employed rural people.
- Likely creation of a large number of small entrepreneurs in rural areas.
- Rural / 11 KVA grids become net producers of electricity thus ensuring uninterrupted power supply to rural areas.

- Round-the-clock / on-demand generation of electricity and hence ability to meet peak demand.
- Very short gestation periods of a few months.
- Almost 80% of the cost of generation is returned to the local economy through purchase of biomass and local jobs.) This is in total contrast to solar and wind where almost no revenues get returned to the local economy).
- Perennial and Sustainable Green Power
- Mitigation of Global Warming.
- Increased, long term self-sufficiency on the energy front.
- Potential for Co-Generation through inclusion of cold chains in the power projects.
- Greening of barren and waste lands through production of sturdy energy species as small plants are conducive to Energy Plantations, leading to afforestation.

Thus it can be seen that biomass gasification plants rated 2MW or lesser, based on the Otto cycle are more cost effective and can contribute significantly to decentralized & distributed power generation and thereby facilitate the achievement of India's rural electrification goals.

However, in the absence of an encouraging tariff order in respect of Biomass Gasification plants rated upto 2 MW (net feed-in to the grid) or lesser, based on the Otto cycle, the Petitioner's project cannot commence or achieve financial closure.

The Petitioner therefore submits that Biomass Gasification Plants based on Otto Cycle deserve a higher tariff on account of the following:

- Higher Capital Expenditure. A smaller plant (less than 2 MWe (net feed-in to the grid)) the cost per MWe is higher as the land, the grid interconnection equipments, the civil works become proportionately more, specifically in the Union Territory of Andaman and Nicobar.

- Higher Expenditure towards feed-stock preparation: Extra cost on processing of biomass and agri-residues to obtain quality as required as feedstock for Biomass Gasification Plant. Gasifiers are typically feedstock specific and thus they need specific feedstocks to operate

successfully. Moreover transportation cost in the Union Territory of Andaman and Nicobar islands is high and thus these would increase the cost of the biomass itself.

- Higher O&M Expenditure: Maintenance costs specifically in the Union Territory of Andaman and Nicobar islands are high since all spares, personnel etc. will need to be flown into from various parts of India.

P R A Y E R

In the facts and circumstances stated herein above it is therefore evident that Biomass Gasifier based on Otto Cycle deserves a higher electricity tariff specifically in the Union Territory of Andaman and Nicobar islands, therefore it is most respectfully prayed that this Hon'ble Commission may be pleased to pass an order for the following:

1. Determining the tariff for Biomass Gasifiers Power Plant at Mithakhari Industrial Area, Port Blair site rated upto 1 MW (net feed-in to the grid) at INR 17.55 per kW-hr.

PETITIONER

Place: Port Blair
Date: August 4, 2016

Riflex Industries Private Limited

BIOMASS GASIFICATION SYSTEM FOR POWER GENERATION OF 1.2 Mwe GROSS PEAK POWER - MITHAKHARI SITE

				INDIAN RUPEE	
S. No.	Assumption Head	Sub-Head	Sub-Head (2)	Unit	Base Case
1	**System Requirement**	**2 x FBG-850 GASIFIER SYSTEM WITH DRY GAS CLEANING SYSTEM 5 X 240-Kwe 100% PRODUCER GAS ENGINES FROM CUMMINS, INDIA.**			
2	**Capacity**				
		Capacity	Installed Power Generation Capacity	MW	1.20
			Auxillary Consumption during stablisation	MW	15%
			Auxillary Consumption after stabilisation	%	15%
			PLF(Stablization for 6 months)	%	65%
			PLF(during first year after Stablization)	%	70%
			PLF(after above two conditions)	%	75%
			Life of Engine	Years	20
			Life of Power Plant	Years	20
3	**Project Cost**				
		Capital Cost	**Total Cost**	**Rs Lacs**	**1,249**
			Land & Civil Construction	Rs Lacs	90
			Gasifier Cost	Rs Lacs	350
			Engine Cost	Rs Lacs	385
			Distribution system	Rs Lacs	280
			Other Assets (Incl. Contingencies)	Rs Lacs	144
3A	**CFA from MNRE**		Subsidy from MNRE	Rs. Lacs	180
4	**Net Project Cost**		Project Cost (Net of Subsidy)	Rs. Lacs	1,069
5	**Sources of Fund**				
		Debt: Equity			
			Debt	%	70%
			Equity	%	30%
			Total Debt Amount	Rs Lacs	748
			Total Equity Amout	Rs Lacs	321
		Funding Source Loan			
			Loan Amount	Rs Lacs	748
			Moratorium Period	years	2
			Repayment Period after Moratorium	years	8
			Interest Rate	%	13.00%
		Funding Source Equity			
			Equity amount	Rs Lacs	321
6	**Financial Assumptions**				
		Fiscal Assumptions			
			Tax holiday	Yes/No	Yes for 10 years
			Income Tax MAT (for first 10 years)	%	20.00%

			Income Tax (thereafter)	%	33.00%
		Depreciation			
			Depreciation/amortisation rate (power plant)	%	5.00%
			Depreciation/amortisation rate (Engine)	%	5.00%
			Residual Value after 20 years		
			Land	%	100
			Building	%	0
			Gasfier System	%	0
			Engine	%	0
			Grid Feeding Equipment	%	0
			Other Assets	%	0
			Contingencies	%	0
7	**Working Capital**				
		For Fixed Charges			
		Maintenance Spares	(% of O&M exepenses)		20%
		Other expenses		Months	1
		Receivables for	Power, Charcoal & Steam	Months	1
			Carbon Credit	Months	15
		For Variable Charges			
		Biomass Stock		Months	60
		After 10 years			30
		Interest On Working Capital		%	16.00%
		After 10 years			12.00%
		Working loan		%	75.00%
		Promoters' Contribution		%	25.00%
8	**Fuel Related Assumptions**				
		Heat Rate	During Stablization Period	kcal/kWh	4,200
			After Stablization Period	kcal/kWh	4,200
		Biomass			
			Base Price	Rs/MT	7,500
			CV - Biomass	kcal/kg	3,500
			Handling ,Storage & Moisture losses	%	0%
9	**Operation & Maintenance**				
		Gasifier	% of base capital cost	%	9.0%
		Engine	% of Engine cost	%	9.0%
		Other assets	% of other assets	%	

Cost of Bio mass at Mithakhari - Coconut Shell

	Unit	Mithakhari
Cost of Material / Kg	INR	3.5
Volume transportable truck	KG	4500
Cost of Material / Truck	INR	15750
Transportation Cost / Truck	INR	3000
Labour for Loading/Unloading/Truck	INR	3000
Total cost /truck of mateiral till factory	INR	21750
Deliverd cost of Material at Factory/Kg	INR	4.833
Approx Dryness of Raw Material		60%
Desired Dryness		80%
Cost of Materal /Kg with Desired Moisture cotent	INR	6.44
Cost of Drying / Kg	INR	0.35
Storage charges	INR	0.71
Cost of Biomass/Kg	INR	7.50
Cost of Biomass/MT	INR	7500

Cost of Briquette made from Biomass (Husk,Leaves and Branches of Coconit and Beetel Nut)

	Unit	Mithakhari
Raw Material (With 50% Moisture)	INR	181.6
Wages & Salaries (@ Rs.350 per ton)	INR	21.6
Power (tons production X 80 units per ton x Rs. 5.40 per unit)	INR	23.3
Fuel Cost for Dryer Furnace (200 kg briquette @ Rs.7.50/ kg for 1 MT output)	INR	81.0
Wear Parts, Consumables, Spares Etc. @ Rs.400 per MT	INR	21.6
Misc. & Administration Expenses @ Rs.400 per MT	INR	21.6
Total Direct	INR	350.8
Debt Servicing @ Rs.1000 per ton	INR	54.0
Production cost (per Ton)	INR	7,500

August 04, 2016

The Secretary
Joint Electricity Regulatory Commission,
'Vanijya Nikunj', 2nd Floor
Udyog Vihar, Phase V
Gurgaon, (122016) Haryana.

Dear Sir,

Sub: Detailed Project report for Setting Up of 1.2 Mwe PowerGeneration Facility Using Biomass Gasification at Andaman Islands.

We are submitting herewith our Detailed Project Report (DPR) for Determination of tariff for Procurement of Power in the Union Territory of Andaman and Nicobar Islands by Distribution Licensees from Biomass based Power Generating Company using the Gasification route (Otto Cycle). DPR for below mentioned three (3) different sites at 3 different islands are submitted for your kind perusal

1. Mithakhari Industrial Area; Port Blair, Dist. South Andaman

We hope that you will kindly consider our Prayer positively for determination of Tariff for Power Plants of upto 1.2-MWe size within a reasonable time period so that we can proceed with the setting up of the proposed power plants at the earliest.

Thanking you,

Yours truly,

Shyamal Chowdhury
Director
Riflex Industries Private Limited

RIFLEX INDUSTRIES PRIVATE LIMITED

Regd. Office : 14, Moore Street, Chennai, Tamil Nadu, Pin – 600 001.

Phone : 91-44-25247905, Fax : (044) 25232332, E-mail : info@riflexindustries.com

CIN U27100TN2009PTC072825, TAN NO. CHER1164G, PAN NO. AAECR 5121Q

Postal Address:

Admn Office : 2nd Line, Opp : Dr. Diwan Sing Gurudwara Bld. Gurudwara Lane, Port Blair-744 101

Phone & Fax : 03192 – 230720 e-mail : info@riflexindustries.com

August 4, 2016

The Secretary
Joint Electricity Regulatory Commission,
'Vanijya Nikunj', 2nd Floor
Udyog Vihar, Phase V
Gurgaon, (122016) Haryana.

Sub: Determination of tariff for Procurement of Power by Distribution Company / Licensees from Biomass based Power Generating Company in the Union Territory of Andaman and Nicobar Islands using the Gasification route (Otto Cycle).

We are forwarding herewith our Petition for Determination of tariff for Procurement of Power in the Union Territory of Andaman and Nicobar Islands by Distribution Licensees from Biomass based Power Generating Company using the Gasification route (Otto Cycle).

This is to inform that we have identified the sites to be in at

1. Mithakhari Industrial Area, Port Blair, South Andaman District

for our proposed 1.2-Mwe Power Plants based on Biomass Gasifier systems (Otto Cycle) from Ankur Scientific Energy Technologies Pvt. Ltd. and 100% Producer Gas Engine Gensets from Cummins, India. We have also surveyed the areas surrounding the proposed plants and have found the areas to be a rich Coconut, Betel nut and other agricultural and woody biomass growing areas and have agreements at place with the local farmers and suppliers, who are more than willing to give us the required volume of biomass at an agreeable price, which otherwise are being burnt off or simply a waste.

We also wish to put on record that these biomasses are not being taken by any other people, industries or any other biomass power plants and can support our claim by furnishing documents of the agreements with the farmers / suppliers.

We hope that you will kindly consider our Prayer positively for determination of Tariff for Power Plants of 1.2-MWe (with 1-MW net feed-in to the grid) size within a reasonable time period so that we can proceed with the setting up of the proposed power plants at the earliest.

Thanking you,

Yours truly,

Shyamal Chowdhury
Director

DETAILED PROJECT REPORT

For Setting Up of 1.2MWe Power Generation Facility Using Biomass Gasification

Atsite:Mithakhari Industrial Area
Port Blair, Dist. SouthAndaman

by

Under

NATIONAL BIOMASS GASIFIER PROGRAMME (NBGP)

Of

MINISTRY OF NEW & RENEWABLE ENERGY (MNRE)
GOVERNMENT OF INDIA, NEW DELHI

Report prepared by:

Ankur Scientific Energy Technologies Pvt Ltd.,
'Ankur', Near Navrachana School, Sama
Baroda 390 024, India
Phone:- 0091-265-2793098 / 2788447
Website: www.ankurscientific.com

CONTENTS

	7.5 Term loans with rate of Interest (FI wise) 7.6 Any other source Name of the Lead FI (and other FIs, Lending to the Project) complete Bank & Branch Name with address, Branch Code, RTGS code, Account No., telephone number, fax number, email etc., and name & designation of the contact person with bank.
8	**TECHNICAL** 8.1 Design & make of Gasifier with detail 8.2 Capacity 8.3 Capacity of 100% gas engines & make 8.4 Grid Voltage at which interconnection is to be done
9	**ATTACHMENTS / ANNEXURES** • **Annexure-1:** Memorandum of Articles / Articles of Association. • **Annexure-2:**Schematic, Plan Layout and Foundation drawings. • **Annexure-3**: Indicative Time Lines

EXECUTIVE SUMMARY

BRIEF NOTE ON M/s.RIFLEX INDUSTRIES PVT LTD:

M/s.Riflex Industries Private Limited having its Registered office at New #31, Old #14, Moore Street, Chennai 600001(hereon referred as "Riflex") is established in 2009.It also has branch office in Andaman islands at 2nd Line, Opposite to Dr.Diwan Singh Gurudwara, Gurudwara Lane, Port Blair 744101.One of the main objectives of the company is to set up Agro based industry at various places in Andaman & Nicobar Islands thus providing economical upliftment for islanders and local farmers. As of now, two (2) such units are operating successfully for the last 3 (Three) years manufacturing 'Defatted Desiccated Coconut' at Campbell Bay and Hut Bay areas of Andaman islands.Riflexhas Demonstrated its capacity to utilize and develop strategic technologies. Five (5) more similar units are being planned at nearby islands of Andaman and Nicobar to provide specialist business development of the locality.

Riflex Industries Private Limited is promoted by below entrepreneurs
Mr. D.R.Shete
Mr.S.R.Shete
Mr. ShyamalChowdhury
Mr. GirishArora

BRIEF ON THE PROPOSED PROJECT:

Given the huge climatic challenges posed by fossil fuel based Thermal Power Plants, the importance of using "greener" mode of generating of power cannot be over-emphasized. Among the various types of renewable sources available for power generation, Hydro and Wind Energy have got very wide acceptance, despite the fact that Hydro Energy is location specific and Wind energy suffers from very low capacity utilization factor (CUF). Solar energy has a great potential too but the Plant Load Factors are too less. Therefore, power generation using biomass is a viable alternative specifically in the Andaman and Nicobar Islands given the availability of huge resources of biomass. This proposal describes a project to generate electricity from biomass. The objective is to set up a 1200kWe gross peak power generating plant and the Power Generated will be sold to the grid / state utility utilizing the state utility grid. The average generation cost will work out to be about Rs. 15.78and the power will need to be soldat a minimum special price of Rs.17.55per unit to the State Utility.

The gasifier based power generation facility chosen by Riflexwill be from Ankur Scientific Energy Technologies Pvt. Ltd. (hereon referred as “Ankur”) has several advantages:

- Very small plants to moderately sized plants (from 10 KW to 2 MW) are possible.
- On-demand generation of electricity and hence such plants can be used both as a base-load as well as peak-load plants
- The remnants of the biomass i.e. charcoal could be sold to industries or given to the villagers for their cooking purpose and the biochar / fines can be used as instant manure for increasing the productivity of soil.
- Simple and Robust technology based on Internal Combustion Engines facilitating O&M management by local, trained people. Hence, increase in rural employment.
- Almost 70 to 80% of the cost of generation is returned to the local economy through purchase of biomass and local jobs [This is in total contrast to solar and wind where almost no revenues get returned to the local economy].
- Rural / 11 KVA grids become net producers of electricity thus ensuring uninterrupted power supply to rural areas.
- Perennial and Sustainable Green Power.
- Mitigation of Global Warming.
- Increased, long term self sufficiency on the energy front.
- Potential for Co-Generation through inclusion of cold chains in the power projects.
- Greening of barren and wastelands through production of sturdy energy species as small plants are conducive to Energy Plantations, leading to forestation.

Riflexintends to deploy Biomass Gasifier Systems of FBG-850modeldesigned by Ankur, to generate power from woody biomass. The company will deploy2Unitsof the mentioned gasifier for a total gross peakoutput of 1200 kWe.

With 2 x FBG-850Gasifier Systems used for power generation, about 1.2 ± 0.1kg/hour of Woody Biomass(with moisture content less than 20%) will be needed to produce 1 unit of electricity. Hence, the maximum biomass consumption for 1200 kWe capacity would be approximately 1,440 kg / hr.

To ensure continuous supply of biomass, the company has identified location of the plant to be in Mithakhari Industrial Area, Port Blair, South Andaman District andhas identified the land of area of about two acres for the project and the acquisition of the land and the formalities are in process. The land would be sufficient for the planned 1200 kWe capacity power plant and storage of biomass.

The company has also secured supply for ready to use biomass at an average costofRs.7500 per ton delivered at siteincluding sizing, drying, briquetting etc. (for financial modeling, same rate of Rs. 7500 per ton has been taken). The Biomass to be used will be variousbiomasses like Coconut Husk, Coconut Shell, Betel Nut Husk, Wood chips, Briquettes etc.

It is planned to complete the commissioning of the power plant within Ten to Twelve months from the date of sanction from MNRE / JERC Nodal Agency.

The total cost of plant &machinery (Gasifier systems and Engine Gensets)for 1200kWe plant is Rs.6.65 crores. An additional Rs.0.90crore will be needed for land & itslandpreparation, approach roads, fencing, all civil, shed, ancillary works including and other miscellaneous expenses like weighbridge, weighing scales, bore well, overhead tanks etc. Biomass preprocessing and storage equipment cost is estimated at Rs. 0.70 crore, the synchronization, voltage step up and grid connectivity cost estimated is Rs. 2.80 Crores, Transportation, Taxes & dutieswill be approx. Rs. 1.27 crores, and other miscellaneous and contingencies etc. will cost further Rs. 0.17 crore. Thus, the total investment requirement is estimated to be aroundRs. 12.49crores.

As per the administrative approval of MNRE for the biomass gasifier Programme of year 2010 - 2011, the Central Financial Assistance (CFA) for a 100% Gas Power Plant will be Rs.15.00 lac per 100 kWe for grid connected application system on pro-rata basis or in multiples thereof. Thus for this project the CFA works out to be Rs. 1.80crores.

The means of finance for the project would be as follows:

Particulars	**Rs. In crores**
CFA from MNRE	1.80
Equity / Debt / Bank Financing	10.69
TOTAL (Project Cost)	12.49

CHAPTER –1

GENERAL

1.1 NAME, ADDRESS, PHONE, FAX & EMAIL OF COMPANY

NAME	**:**	**RiflexIndustries Private Limited**
ADDRESS	**:**	**2nd Line, Opp.to Dr.Diwan Singh Gurudwara, Gurudwara Lane, Port Blair 744 1010**
PHONE	**:**	**03192 230720**
FAX	**:**	**03192 244667**
EMAIL	**:**	

1.2 NAME & DESIGNATION OF AUTHIRIZED SIGNATORY

1	**NAME OF AUTHORIZED SIGNATORY**	**:**	**Mr.ShyamalChowdhury**
	DESIGNATION	**:**	**Director**
2	**NAME OF AUTHORIZED SIGNATORY**	**:**	**Mr. Sunil R Shete**
	DESIGNATION	**:**	**Director**

1.3 CONSTITUTION

Riflexis a private limited company and it has been incorporated on 08th September 2009. It has an eminent Board of Directors and the day to day affairs of the company are managed by a group of experienced managers.The Memorandum of Articles / Articles of Association (Annexure-1) is enclosed for perusal.

1.4 LOCATION ADDRESS OF PROJECT

Riflexhas planned site for the proposed project at Mithakhari Industrial Area, Port Blair, South Andaman District.The Map indicating the project site shall be included for reference.

CHAPTER-2

PROJECT DETAILS

2.1 PROPOSED INSTALLED CAPACITY (MW)

The project is to install and run a 1200kWe biomass power plant and generated power to be sold to the state utility / electricity department utilizing the local grid.

2.2 PROPOSED CAPTIVE / DISTRIBUTED COMPONENT & SURPLUS TO GRID

The Captive requirement for the Power Plant has been consideredabout180kWe. Therefore, the net exportable power will be about 1020KWe.

2.3 WASTE HEAT UTILIZATION / CO-GENERATION APPLICATION

There will be ample amount of waste heat that can be recovered from Engine Exhaust. As the project is in initial stage, Riflexhas not proposed for any waste heat recovery system as yet.However the Waste Heat is planned to be recovered for drying of the biomass.

2.4 COST OF PROJECT

Sr.No.	Particulars	Cost.
1	Gasifier systems, Engine gensets and other accessories	Rs. 6.65 Crores
2	All civil, shed, ancillary works including and other miscellaneous expenses like weighbridge, weighing scales, bore well, overhead tanks etc.	Rs0.90Crore
3	Biomass preprocessing and storage equipments	Rs. 0.70 Crore
4	The synchronization, voltage step up and grid connectivity	Rs. 2.80 Crores
5	Transportation, Taxes & duties	Rs. 1.27 Crores
6	Other miscellaneous cost on manpower, their lodging, boarding, installation cost and contingencies.	Rs. 0.17 Crore
7	Total Estimated Project Cost	Rs. 12.49 Crores

2.5 ANTICIPATED COMMISSIONING SCHEDULE

Below is an indicative time schedule for the Power Plant – from manufacturing of Unit to Commissioning.

(As per enclosed Annexure-3)

CHAPTER-3

TIE-UP / AGREEMENT

3.1 POWER PURCHASE AGREEMENT

For the first project of this nature, our idea is to sell the total generation of electricity to the State Utility / Electricity Department of Andaman and Nicobar and sincerely request for a minimum tariff of Rs.17.55per unit.

3.2 FIRMING OF EQUIPMENT / TECHNOLOGY

Riflexhas decided to go for Ankur Biomass Gasifier as they are the most experienced turnkey suppliers of gasifier systems in India&Globally. We therefore would be using Ankur Biomass Gasifier systems andEngine Gensets from Cummins India Limited.

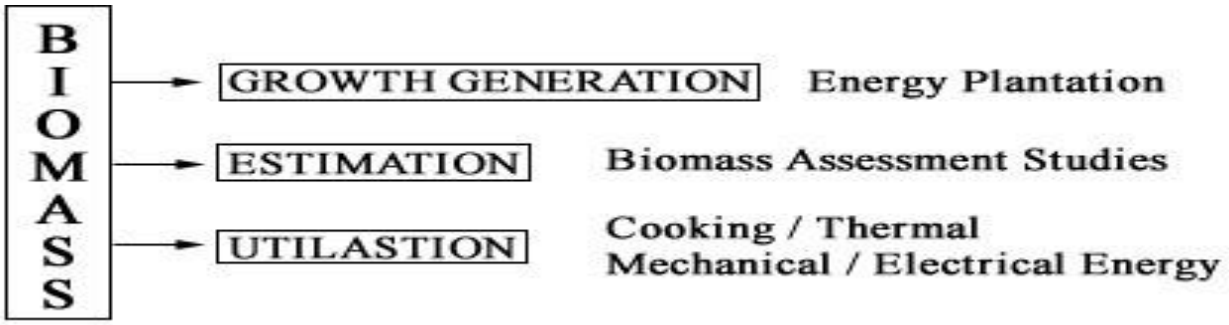
Cummins' presence in India stems from a joint venture incorporated in 1962. Ground was broken for a factory in Pune the same year and the plant began manufacturing engines at the beginning of 1964. Cummins had formed multiple legal entities in India including joint ventures. Today, eight legal entities of the Group represent all of the Cummins global business units. Cummins in India reported combined sales of approximately Rs. 10,500 crores in 2011.

After great deal of due diligence, Riflexfinally decided to go for their 240 KWe – C240PG5C Model Engines and totally five such Engines.

CHAPTER-4

TECHNOLOGY PROPOSED

The conventional resources of energy such as fuel oil, gas and coal are finite and the already depleting very rapidly, Being our country an agricultural one and more than 70 % of the Indian Population living in the villages, about 80% of their energy need is for domestic purpose (i.e. for cooking, lighting, water pumping etc.)and same is fulfilled by noncommercial sources of energy like firewood, agricultural waste, forest waste, etc. The energy produced from such **Bio-mass** is well known as **BIO-ENERGY.**



BIOMASS GASIFICATION PROCESS

Biomass Gasification is basically thermo-chemical conversion of solid Biomass (i.e. biomass/biomass waste, agricultural residues etc.) into a combustible gas mixture normally called producer gas (or low Btu gas). Direct burning of biomass in stoves, and in open fires is an example of combustion, in which the supply of oxygen is generally higher than that required stoichiometrically. Under conditions of lower rates of oxygen supply, pyrolysis and gasification occur. Given that biomass contains Carbon, Hydrogen and Oxygen molecules, complete combustion would produce Carbon dioxide (CO_2) and Water vapor (H_2O). Partial combustion produces Carbon monoxide (CO) as well as Hydrogen (H_2), which are both combustible gases.

- Advantages of gasification are

- It converts a traditional low-quality fuel inconvenient to use into high quality, combustible gaseous fuel with associated convenience.
- Such conversions at relatively high efficiencies results in total convenience and process control.
- Almost all environment pollution associated with biomass use can be eliminated.
- Gestation period is very less. It can be completed within 10 months.

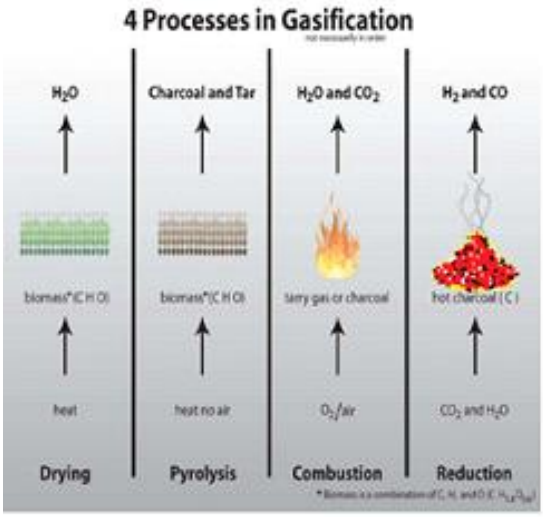
➢ Basic steps involve in Gasification are as follows:

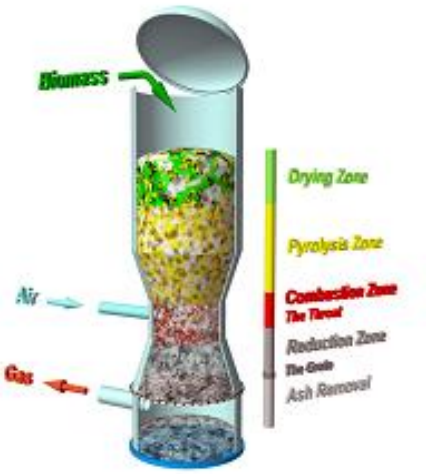
FEED STOCK PREPARATION AND FEEDING –

Feedstock preparation is one of the most vital stages in ensuring production of desired quantity and quality of gas. Relatively dry and properly sized biomass is necessary for Gasification to be efficient.

For the FBG series, the tested fuels are Coconut Husk, Coconut Shell, Betel Nut Husk, etc. with maximum moisture content of 20%. Other fuels that can be reduced to rice husk-like size distribution and bulk density can also be used in the FBG series.

◆ **GASIFICATION** – The gasifier is essentially a chemical reactor where various complex physical and chemical processes take place. Four distinct processes take place in a gasifier, namely drying of fuel, pyrolysis, combustion and reduction.





Process Zones

Four distinct processes take place in a gasifier as the fuel makes its way to gasification. They are:

a) Drying of fuel

b) Pyrolysis – a process in which tar and other volatiles are driven off

c) Combustion

d) Reduction

Though there is a considerable overlap of the processes, each can be assumed to occupy a separate zone where fundamentally different chemical and thermal reactions take place. Above figure shows schematically gasifier with different zone.

Reaction Chemistry

The following major reactions take place in combustion and reduction zone.

1. Combustion zone

The combustible substance of a solid fuel is usually composed of elements carbon, hydrogen and oxygen. In complete combustion carbon dioxide is obtained from carbon in fuel and water is obtained from the hydrogen, usually as steam. The combustion reaction is exothermic and yields a theoretical oxidation. The main reactions, therefore, are:

$C + O2 = CO2$

$2H2 + O2 = 2H2O$

2. Reaction zone

The products of partial combustion (water, carbon dioxide, and uncombusted partially cracked pyrolysis products) now pass through a red-hot charcoal bed where the following reduction reactions take place:

$C + CO2 = 2CO$

$C + H2O = CO + H2$

$CO + H2O = CO + H2$

$C + 2H2 = CH4$

$CO2 + H2 = CO + H2O$

Reactions (3) and (4) are main reduction reactions and being endothermic have the capability of reducing gas temperature.

3. Pyrolysis zone

The real pyrolysis, which takes place between 280 to 500°C, produces large quantities of tar and gases containing carbon dioxide. Besides light tars, some methyl alcohol is also formed. Between 500 to 700°C the gas production is small and contains hydrogen. Thus it is easy to see that updraft gasifier will produce much more tar than downdraft one. In downdraft gasifier the tars have to go through combustion and reduction zone and are partially broken down.

4. Drying Zone

Finally in the drying zone the main process is of drying of wood. Wood entering the gasifier has moisture content of less than 20%. Various experiments on different gasifiers in different conditions have shown that on an average the condensate formed is 6-10% of the weight of gasified wood.

Biomass is fed into gasifier at specified intervals. The equipment is designed in such a way that it takes in air in controlled quantities, resulting in partial oxidation of biomass into producer gas.

GAS COOLING AND CLEANING SYSTEM – The gas coming out of gasifier is hot (300 - 500^{o}C) and contains some contaminants, particulates and volatiles, which needs to be cooled and cleaned before feeding into the generators. The cooling – cleaning system consists of High Temperature Filtering Equipment, Condensate Removal Sub Systems and associated accessories. The offered Gas Cleaning & Cooling system is a State-of-the-Art Dry Gas Cleaning System in which there is no water that comes directly in contact with the gas for its cooling and cleaning needs. Thus there is no process water generated and hence there is no need for any cooling ponds, waste water treatment system, no evaporative cooling of process water etc. Hence the systems are much cleaner and simpler to operate and maintain. However, there will be some amount of condensates generated for which a condensate neutralization or evaporation system will be installed, making the disposal an easy process.

- . Cold clean gas thus produced can be fed to generator set, along with air.

The 'Ankur' Gas cooling and cleaning system consists of the following:

1. **Cyclone**
2. **High Temperature Filtering Equipment**
3. **Condensate Removal Sub-system (CR)**
4. **Chiller System**
5. **Mist Eliminator (ME)**
6. **Fine Filter (FF)**
7. **Pleated Cartridge Filter (PF)**
8. **Dry Gas Blower (DB)**

- **100% PRODUCER GAS ENGINE GENSET -** After great deal of due diligence by our technical experts,Riflexfinally decided to go for Cummins, India Engine with their 240 kWe (Gross Peak)– C240PG5C Modelon 100% producer gas. Total of 5Nos. of these Engines will be installed to get a

gross power generation of 1200kWe/hr. The same will be procured by Ankur before the installation and commissioning of the system at proposed site of Power Plant.

CHAPTER -5

BIOMASS

5.1 BIOMASS USED

The biomass used will be wood chips, coconut husk (clean cut in rectangular shape), coconut shell, coconut branches, dead coconut trees, betel nut husk and branches, dead betel nut trees, red palm branches, waste fire wood, briquettes etc.

The biomass availability survey has been done and supplies and vendors established. Further details could be provided on demand.

5.2 QUANTITY REQUIRED

The woody biomass required to generate 1 kWe would be around 1.2±0.1 kg/hr with moisture content less than 20%. Hence, for 24 hrs of operation, the amount of woody biomass needed would be about 35 tons. On an annual basis (consideringapprox. 292days per year), the total woody biomass requirement would be a little more than 10,000tons.

5.3 ENVISAGED FUEL LINKAGE MECHANISM

As informed above, ample amount of Coconut based biomass is produced out of Riflex's own 'Desiccated coconut' manufacturing units. In addition, procurement of other locally available biomass from local farmers and suppliers has been planned. Further details could be provided on demand

CHAPTER-6

AVERAGE COST OF GENERATION

Below is detailed working on deriving the approx. cost of Generation of Power (Rs.15.78 / kWe)

Description	Ist Year	IInd Year	IIIrd Year
Net Power Generated (kW/yr)	7,148,160	7,148,160	7,148,160
Consumption of Biomass (kg)	10,091,520	10,091,520	10,091,520
Cost of Biomass (Rs/kg)	7.50	7.88	8.27
Total cost of Biomass (Rs)	75,686,400	79,470,720	83,444,256
Manpower Cost (Rs)	3,720,000	3,906,000	4,101,300
Repairs & Maintenance (Rs)	1,239,300	1,301,265	1,366,328
Total Cost of Generation (Rs)	**80,645,700**	**84,677,985**	**88,911,884**
Unit Cost of Generation (Rs/Unit)	**11.28**	**11.85**	**12.44**
Average indicative Engine Maintenance Cost (Rs/Unit)	**0.50**	**0.53**	**0.55**
Finance cost	**4.00**	**4.20**	**4.41**
Total Cost of Generation (Rs/Unit)	**15.78**	**16.57**	**17.40**

CHAPTER-7

FINANCING

7.1 TOTAL COST OF PROJECT AS APPROVED BY Financial Institutions

The cost of plant &machinery (Gasifier systems and Engine Gensets) as appraised by management (based on internal evaluation) is Rs. 6.65crores which would include the following:

Sr. No.	Item Description
Biomass Pre-Processing Equipments	
1.	**Skip-Charger –** *this is a bucket elevatorfor conveying the biomass from ground level to top of the gasifier reactor. (Alternatively this could be done by the client locally)*
Gasifier & Its Related Accessories	
2.	**'Ankur' Biomass Gasifier Model FBG-850**along with basic accessories and auxiliaries with **Dry Gas Filtration System** The Gasifier system will consist of the following**:-** → *Reactor and Hopper with various proprietary and patented devices and interventions.* → *Dry Ash Char Removal System with Water Cooled Screw Conveyor.* → *Necessary alarm/annunciation system along with provision for emergency shutdown.* → *Biomass Level Sensor* → *Moisture Meter* → *PLC based control panel* **State-of-the-Art Dry Gas Filtering System consisting of the following:-** → *Start-up sub system* → *High Temperature Filtering Equipment* → *Condensate removal Sub System* → *Mist Eliminator* → *Fine Filter* → *Pleated Filter* → *Parallel line of Fine filter* → *Dry Blower* → *Header Box* → *All necessary fittings and connections between the listed equipment items* **State-of-Art Flare system consisting of:-** → *Flare Head with flame arrestor and spark ignition system with auto ignition.* → *Flare Valves assembly with swing valve, pneumatic isolation valve, manual valve and a motorized valve.* *The middle portion connecting the above two will be in client scope as per site requirement or as per*

	local laws (in terms of routing and final height etc.). The client will also need to provide HT wire for the spark ignition system supplied as part of flare head
3.	**Cooling Tower** – *Clean Water*
4.	**52 – TR Chiller**
5.	**Condensate Neutralization / Evaporation System**
Service Charges	
6.	**Detailed Design and Engineering For The Entire Power Plant**
7.	**Supervision of Installation & Commissioning of the System**
Engine Generator & Its Related Accessories	
8.	**100 % Producer Gas Engine from Cummins – India** of 240 kWe gross peak output.
9.	**Radiator for Engine Cooling**
Other Line items needed for the Power Plant	
1.	**Nitrogen Plant with suitable piping**
2.	**Producer Gas Piping from Gasifier Header Box to Engines**
3.	**Electrical Wiring and Cabling within Gasifier systems and Accessories**
4.	**Suitable Rated Air Compressor, Compressed Air lines & Hot and Cold Insulation**
All above other line items material will be supplied by Ankur as per standard, while installation will be done locally by us under supervision of Ankur.	

CAPITAL COST OF THE PROJECT

The total capital cost of project based on above cost of plant and machinery has been worked out as Rs. 12.49Crores as detailed below:

Sr. No.	Particulars	Cost.
1	Gasifier systems, Engine gensets and other accessories	Rs. 6.65 Crores
2	All civil, shed, ancillary works including and other miscellaneous expenses like weighbridge, weighing scales, bore well, overhead tanks etc.	Rs 0.90 Crore
3	Biomass preprocessing and storage equipments	Rs. 0.70 Crore
4	The synchronization, voltage step up and grid connectivity	Rs. 2.80 Crores
5	Transportation, Taxes & duties	Rs. 1.27 Crores
6	Other miscellaneous cost on manpower, their lodging, boarding, installation cost and contingencies.	Rs. 0.17 Crore
7	Total Estimated Project Cost	Rs. 12.49 Crores

7.2 MEANS OF FINANCE

Particulars	Rs. In crores
CFA from MNRE	1.80
Equity / Debt / Bank Financing	10.69
TOTAL (Project Cost)	12.49

7.3 DEBT EQUITY RATIO

Considered as 70 :30

7.4 PROMOTORS CONTRIBUTION (EQUITY)

As per the administrative approval of MNRE for the Biomass Gasifier programme of year 2010 - 2011, the central financial assistance will be Rs.15 Lac per 100 KWe for Power Plant in Grid Connectivity mode on pro-rata basis or in multiples thereof &thus for this project the CFA works out to be Rs.1.80 crores.

Therefore, for the purpose of financing and feasibility calculation, the means of finance for the project has been considered as follows.

Particulars	Rs. In crores
CFA from MNRE	1.80
Equity (30%)	3.207
Bank Financing(70%)	7.483
TOTAL	12.49

7.5 TERM LOANS WITH RATE OF INTEREST (FI WISE)

We are in the process of finalizing the terms and conditions of debt funding with various lenders and a copy of sanction letter will be forwarded to MNRE after finalization of same.

7.6 ANY OTHER SOURCE

Company will be utilizing its internal accruals for Equity portion and no fresh Equity is planned to be raised.

7.7 NAME OF THE LEAD FI (AND OTHER FIS, LENDING TO THE PROJECT) COMPLETE BANK & BRANCH NAME WITH ADDRESS, BRANCH CODE, RTGS CODE, ACCOUNT NO., TELEPHONE NUMBER, FAX NUMBER, EMAIL ETC., AND NAME & DESIGNATION OF THE CONTACT PERSON WITH BANK.

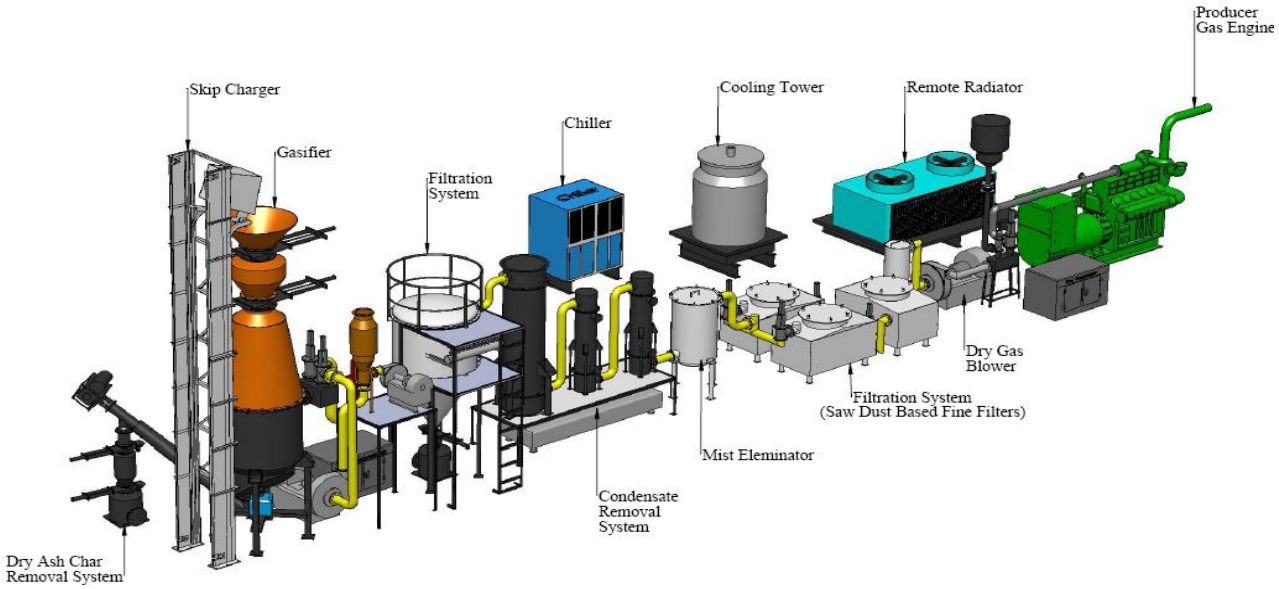
We are in the process of finalizing the terms and conditions of debt funding with various lenders and a copy of sanction letter will be forwarded to MNRE after finalization of same.

CHAPTER-8

TECHNICAL

8.1 DESIGN & MAKE OF GASIFIER WITH DETAIL

Ankur have decided to commission our own “Ankur” Biomass Gasifier model 2 x FBG-850 in Ultra Clean Gas Modewith Dry gas Cleaning System which is most suitable for Power Generation Application. Below is detail of Gasifier with all its related accessories & auxiliaries.



Main components of Gasifier Unit are as under:

Skip Charger:

This is a bucket elevator to feed the woody biomass from ground level to the top of gasifier

Feeding System/Feed shell:

The feed shell stores biomass in air tight compartment before discharging it into the hopper of the gasifier. The feed shell has two pneumatically operated doors, one on top and other at the bottom. This is to prevent excess air into the gasifier. There’s a vibrator motor fitted on the feed shell which operates only when the bottom feed door is in open condition & assists in discharge of biomass into the hopper.

Hopper:

It performs three functions of gasification viz, drying, pyrolysis & combustion. It has Pneumatic/ manual air nozzles for induction of air into combustion zone. Depending on the system rating and mode, upto

two wood level sensors could be provided to give signals for controlling biomass feed as well as safe shut down of the gasifier system. There are two vibrator motors fitted on the opposite side for uniform flow of biomass. A pressure point is provided for reading of pressure drop across nozzles (ΔP_N) to determine air flow.

Reactor:

It performs the reduction function and thus production of producer gas. Initially the reactor is filled with recommended size charcoal. The reactor table with proprietary rotor holds the charcoal bed and the comb rotor helps in maintaining a consistent charcoal bed by removing ash from it. The comb rotor is coupled with a gear box and a motor. The Ash removal system from the reactor can be either dry or wet ash discharge.

Dry Ash Char Removal System:

In case of dry ash discharge system, there are two pneumatic/manual valves and an ash collection box at the bottom of the reactor. While gasifier is in operation, the top valve provided before dry ash collection box is to be kept OPEN and the bottom valve after the dry ash collection box is kept CLOSED. For periodically removing the hot ash online from the gasifier, the top valve is CLOSED first and then only the bottom valve should be OPENED to prevent any air ingress into the system and ash can be collected in pit/container placed below. After the ash drops down, the bottom valve of dry ash collection box is closed and then the top valve OPENED. At no time, both the valves are open at the same time. This dry ash will be conveyed through a water jacketed screw conveyor for bag filling and further for storage at suitable place.

GAS COOLING & CLEANING SYSTEM-UNIQUE & PROPERIETARY DRY GAS COOLING CLEANING SYSTEM IN "ANKUR"GASIFIERS

ANKUR biomass gasifiers are well known for their extremely clean and consistent gas quality. The process of generating an ultra-clean gas with tar and particulate levels of just a few mg. per cubic meter of gas begins in the gasifier itself and along with gas cooling and cleaning system, involves the following steps.

High Temperature Filtering Equipment:

Consists of a Filter, reverse pulsing system, clean air compressor with FRL, an ash/char collection bin. The hot producer gas at 350°C - 450°C enters to the filters from outside of the filter through the filter to the inside and then out through the upper end leaving the tar and particulate which are

collected in ash/char bin at bottom. High temp operation makes dust comparatively free flowing; pulse jet cleaning of candles is very effective.

Condensate Removal Sub-system

Consist of a gas condenser by cooling water of 32°C, a gas condenser by chilled water of 32°C, a cooling tower with pump and rotameter, a chiller with pump, a condensate collection tank and a mist Eliminator. The hot &cleaned gas of 200°C - 240°C is cooled in this sub system to remove condensate using a twin condenser with circulating the ambient temperature water in the first and chilled water in the second & third condenser. The condensate is collected in the common condensate collection tank provided at the bottom of both the condensers. The cooled gas is then passes through the mist eliminator to remove condensate mists from the clean producer gas.

Condensate after neutralization can be further treated as per local govt. norms for disposal.

Chiller System:

The chiller is used to circulate chilled water to the external jacket of heat exchanger. The chilled water from chiller outlet is fed to heat exchanger inlet. Part of the water from heat exchanger outlet is then fed to the inlet of jacket cooling for screw conveyor through a Tee and reducer. The water from Heat Exchanger is then fed back to the chiller for cooling. The chilled water in heat exchanger is used to condense the vapor content in the producer gas.

Mist Eliminator:

It assists in removal of mist present in the producer gas after the passing through heat exchangers, but before the Fine filters

Fine Filtering System:

This has been a major advancement in the state-of-the-art as far as on line gas filtering for gasifier systems goes. The proprietary (patent applied for) filtering system is capable of removing both tar and particulates and can also be rejuvenated on line for extended uninterrupted operation. The filter media is also proprietary though the same is easily available at almost all sites and is by-product of the basic feedstock. The gas cleanliness levels obtained through this proprietary filtering system are amazing with even particulate levels dropping to less than 5-10 mg. per cu. mt. The pressure drops in the filtering systems are maintained within a certain range through the proprietary control mechanism. Incorporation of such a device allows gasifiers to be coupled to turbo-charged and after-cooled engines for the first time. This filtering system also ensured that no engine parts have any harmful effect due to gas contamination.

These are graded sawdust filters that trap all the particulate and ash particles. The filter media in these is changed periodically. Fine Filter system with built in rejuvenation process resulting in very long operating hours between filter media changes. The cleaning efficacy of this filter is extremely high such that the gas coming out of this Fine Filter I is extremely clean – just like clean ambient air. Fine Filter II is basically a passive filter and provides redundancy and safety for the gas cleaning process.

Pleated Cartridge Filter

It performs the function of final cleaning of the producer gas and also acts as a check / safety filter to block the gas flow in case of dirty gas reaching up to this point. It has set of pleated cartridge filters. Proper installation of the cartridge filters totally eliminates any direct gas flow Passages and is extremely critical for proper function of pleated filter. Pleated filter is provided with pressure tapings to measure the pressure drop across the cartridge filters. When becomes dirty, the used cartridge filters should be cleaned by recommended procedure for future use till then standby to be use. Long life of pleated filter mostly depends on proper maintenance of the filtering system before it and also normal operation of gasifier.

Dry Gas Blower:

The blowers help in suction of controlled amount of air into the gasifier for partial combustion and suction and delivery of producer gas to the point of end use.

OTHER MISCELLANEOUS ITEMS

One set of Jib cranes of 5 MT capacities for lifting and lowering of gasifiers will be installed.

CONTROL PANEL FOR GASIFIER

FLARE WITH FLARE VALVE

Main Flare is used at the start up of the Gasifier. When sufficient quality of producer starts generating, the main flare is by-passed and the gas goes to the engine.

CONDENSATE NEUTRALIZATION SYSTEM

During dry gas cleaning process, the producer gas after cleaning is cooled to 25-40°C depending upon application. This results in condensate generation of around 200-300 ml/kg of biomass used. The condensate is dark brown in colour and has very high pH, TDS, ammonia, BOD and COD.The expected characteristics of this effluent would be as under:

Characteristics of Raw Condensate

Parameters	Value
Colour	Brown
pH	9-9.5
TDS	2,000-3,000 mg/L
TSS	70-100 mg/L
Free Ammonia	4,500-5,000 mg/L
BOD	5,000-6,000 mg/L
COD	17,000-20,000 mg/L
Oil and Grease	600-700 mg/L
Phenolic compounds	6-7 mg/L

This condensate is treated first by neutralizing with sulfuric acid and then passing the neutralized condensate through charcoal filter. The characteristics of this treated condensate are given below:

PHYSICO-CHEMICAL ANALYSIS REPORT OF TREATED CONDESATE SAMPLE			
NO.	**PARAMETERS**	**UNITS**	**RESULTS**
01	pH Value		*6.97*
02	Colour	pt.co.unit	*45.00*
03	Odour	T.O.N	*Distinct*
04	Total Suspended Solids	mg/l	*39.00*
05	Total Dissolved Solids	mg/l	*44776.0*
06	B.O.D. (3 Day at 27°C)	mg/l	*96.00*
07	C.O.D.	mg/l	*354.31*
08	Oil & Grease	mg/l	*10.00*
09	Total Hardness	mg/l	*360.00*
10	Chlorides as Cl	mg/l	*495.53*
11	Sulphates as SO4	mg/l	*17212.10*
12	Sulphides as S	mg/l	*16.18*
13	Chromium as Cr	mg/l	*0.86*
14	Arsenic as As	mg/l	*N.D.*
15	Lead as Pb	mg/l	*0.08*
16	Selenium	mg/l	*N.D.*
17	Ammonical Nitrogen NH3-N	mg/l	*6874.800*
18	Free Ammonia	mg/l	*41.730*
19	Phenolic Compounds	mg/l	*0.87*

20	Cyanide as CN	mg/l	*0.002*
21	Copper as Cu	mg/l	*1.20*
22	Iron as Fe	mg/l	*0.458*
23	Manganese	mg/l	*0.30*
24	Zinc	mg/l	*0.50*
25	Nickel as Ni	mg/l	*0.11*
26	Boron as B	mg/l	*4.10*
27	Sodium Absorption Ratio		*7.36*
28	Phosphate	mg/l	*4.01*
29	Residual Chlorine	mg/l	N.D.

The treated condensate has neutral pHand acceptable levels of BOD, COD &other majority of parameters for disposal. However, it has very high TDS, ammonical nitrogen and sulphates. The high values of these are because of formation of water soluble ammonium sulphate salt as a result of reaction between sulphate ion and ammonium ion. The possible use/ disposal of such water is as under:

Use as irrigation water:

Irrigation water should have <50 mg/l ammonical nitrogen, <2100 mg/l TDS and < 1000 mg/l sulphates. All these are very high primarily because of ammonium sulphate formation during neutralization. Hence, the treated condensate water needs to be diluted by mixing it with irrigation water in proportion of 1:140 for applying it in the field.

Use as fertilizer:

Since the treated condensate has high concentration of ammonical nitrogen which is one of the essential and important nutrients for most of the crops,it can also be used as fertilizer. The nitrogen requirement for most of the crops is around 150-250 kg/ha and half of it is given at the time of sowing and half within 30-45 days after sowing. Hence, ~15 m^3 of treated condensate can be applied per hectare of crop at the time of sowing and ~15 m^3 after 30-45 days of sowing as source of nitrogen and sulphate for crop.

Evaporation (an alternative to Neutralization):

Alternate to the condensate neutralization system, we will mostly install an evaporator in which case the Emission level in the vapours/air of the condensates are extremely low and hence the condensates can

be evaporated without causing any environmental hazard. Table below gives the emission level in the vapours of the evaporating condensates:

AIR EMISSION ANALYSIS REPORT

Sr.No.	Parameter	Unit	Result
1.	Particulate Metter PM	mg/m3	3.2
2	Sulphur Dioxide as SO2	ppm	2.08
3	Oxides of Nitrogen as NO_2	ppm	0.0149
4	Ammonia as NH_3	mg/m3	B.D.L
5	Acid Mist	mg/m3	B.D.L
6	Carbon Monoxide as CO	ppm	0.277
7	VOC	ppm	B.D.L

DRY ASH-CHAR REMOVAL SYSTEM WITH SCREW CONVEYOR SYSTEM.

In dry ash discharge system, there are two valves and an ash collection box at the bottom of the reactor. While gasifier is in operation, the top valve provided before dry ash collection box is to be kept **OPEN** and the bottom valve after the dry ash collection box is kept **CLOSED**. For periodically removing the hot ash online from the gasifier, the top valve is **CLOSED** first and then only the bottom valve should be **OPENED** to prevent any air ingress into the system and ash can be collected in pit/container placed below. After the ash drops down, the bottom valve of dry ash collection box **is CLOSED** and then the top valve **OPENED**. At no time, both the valves should be open at the same time. This dry ash can be either collected in a pit and then shifted to an appropriate storage place for disposal or it can be conveyed through a water jacketed screw conveyor for bag filling/storing at suitable place.

SKIP CHARGER.

Skip Charger is the equipment, which is needed for feeding of Biomass to the Gasifier. It receives signal from level sensors of biomass, which sense the biomass level in the gasifier. Skip charger motor is having interlocking above level switches of wood.

Skip Charger has a bucket in which Biomass is to be fed manually and then it further feeds into the Gasifier.

It operation is as under:

1. Feeding Biomass as per Biomass Specification in to Bucket of Skip charger at Ground level.
2. When Skip Charger receives signal, Bucket will carry Biomass to the top of Gasifier.
3. After reaching top of Gasifier it will unload Biomass into the Gasifier.

4. Then the empty bucket will come back to the ground level for charging biomass.

Thus, the operation will be in continuous manner.

8.2 CAPACITY

Below is the technical specification for "Ankur" Biomass Gasifier Model 1 x FBG-850

Gasifier Model	FBG-850
Gasifier Type	Down Draft
Gasifier Output	
Peak Rated Gas Flow (Nm3/hr)	1912.5
Average Gas Calorific Value (Kcal/Nm^3)	≥ 1,100
Peak Rated Thermal Output (Kcal/hr)	2,103,750
Continuous Duty Rated Thermal Output (Kcal/hr)	1,683,000
Peak Rated Biomass Consumption (Kg/hr)	Maximum 765 Continuous Duty rating will be 80-90% of Peak Rating
Gasification Temp. (C)	1050 - 1100
Turn Down Ratio	Not less than 50% of Rated Capacity
Indicative Gasification Efficiency (%)	
Hot Gas Mode (No Scrubbing)	> 75%
Cold Gas Mode (With Scrubbing)	> 65%
Temperature of Gas at Gasifier Outlet (C)	300 to 500 C
Biomass Feeding	
Mode	Manual / Automated
Frequency	Continuous through gravity (from a bunker)
Ash Removal	Continuous, through proprietary control and water seal/ Dry Ash Char Removal System
Gas Cooling ***(For Scrubbed and Ultra Clean Gas Modes)***	Heat Exchangers
Gas Cleaning ***(For Ultra Clean Gas Mode)***	Dry Filtration System
Start-Up	Through Blower – startup power to be provided by client
Typical Gas Composition	CO – 19 ± 3% H_2 – 18 ± 4% CO_2 – 11± 3% CH_4 – <3% O_2 – <0.9% N_2 – Rest

8.3 CAPACITY OF 100% GAS ENGINES & MAKE

RIFLEX finally decided to go for Cummins240 KWe – C240PG5Cseries of Engines which are capable of working totally on 100% producer gas. Total of 5 Nos. of these Engines will be installed to get a gross power generation of 1200 kWe/hr. The technical details are appended below:

Generator set specification

Genset Model	C240PG5C
Rating	240 kWe
Voltage	415 Volts AC
Power Factor	0.8 lag
Current	417 Amps
Voltage Regulation	+/- 1%
Approx Weight - static	6500 kgs

Engine specifications

Engine model	GTA28G
Design	4 cycle, 12 cylinder, "V" type turbocharged aftercooled
BHP	350 BHP @ 1500 RPM
Displacement	28 liters
Bore X stroke	140 mm X 152 mm
Compression ratio	10:1
Fuel	Producer Gas
Fuel system - Producer gas based	Mechanical carburetion
Ignition system	Altronic Ignition Timer, Spark ignited
Engine Governor	Electronic
Cooling system	Remote Radiator or Heat Exchanger
Cooling system capacity (Engine only)	90 liters
Lube oil filters	3 no. Full flow + 2 nos. By-pass
Lube oil change period	500 hours
Lube oil consumption	0.11 lit/hr (max)
Lube oil specifications	GEO15W40
Lube oil system capacity	95 liters
Starting system	24 Volts DC
Battery Capacity	180 ampere-hours
Battery Charging Alternator	35 amperes

Alternator specifications

Frame Size	HC4
Insulation Class	Class H
Protection	IP23 standard
Rated power factor	0.8 lag
Stator winding	Double layer lap
Winding pitch	Two third
Winding leads	12
Voltage series star (Y)	415 / 240
Frequency Hz	50
Bearing	Double Bearing
Weight comp. Generator kg	1160
Weight wound stator kg	535
Weight wound rotor kg	440
% Efficiency @ 0.8 pf and 100% load	94 %

8.4 GRID VOLTAGE AT WHICH INTERCONNECTION IS TO BE DONE

Essentially for interconnecting a power plant to the grid, the voltage and frequency parameters of the generator need to be synchronized to the grid's parameters.

Thus the hardware needed is as below:

1. A synchronizing relay. One relay is needed per engine. This essentially matches the generator parameters to the grid parameters.

2. A voltage transformer. Most engines generate electricity at 415 Volts. We need to step this up to 33000 Volts. Thus a step up transformer is needed. The electricity can be exported at 33KVA to the nearest feeder line which is located @ approx. 7000 meters from the proposed site.
3. The ability to isolate each engine from the grid and the transformer from all the items is a must. This then means the need for various circuit breakers. There are thus circuit breakers after each engine and a circuit breaker after the transformer. With this arrangement any hardware can be isolated from any other hardware.
4. Various interconnecting cables etc. will be needed.

s----xxx END OF THE DETAILED PROJECT REPORT XXX ---