EXECUTIVE PROJECT REPORT

WASTE TO ENERGY

G.K.N.S. ENERGY PRIVATE LIMITED

8.5MW OF MSW TO POWER

PROJECT SUMMARY

TECHNOLOGY & FINANCIAL DETAILS

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GUDUR (Village), BIBINAGAR (Mandal), NALGONDA (Dist), ANDHRA PRADESH, INDIA.

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ABSTRACT

The aim of this Document is to perform a technology assessment on the proposed 8.5 MW waste to energy plant of GKNS Energy Pvt Ltd, at Gudur Village, Bibinagar Mandal, Nalgonda District. The plant is situated in a distance of 30 km from Hyderabad. This particular project will utilize 600 TPD of MSW allotted by GHMC to generate electricity. Apart from power generation benefit, its operation would provide an effective means of dealing successfully with municipal waste-handling problem, which has escalated to enormous proportions in the last few years in twin cities threatening the prosperity of the area. This technology study covers the areas of Plant Set-up Analysis, Combustion system and Environmental Impact Assessment.

ABOUT US

GKNS Energy privately owned Integrated Solid waste and recycling Company of passionate innovators and thought leaders who are working strategically with global partners to foster awareness about Green/ Sustainability, while supporting development of next generation with this technologies and Resources that will lead to a sustainable planet for current and future generations

CHARTERTICS OF MSW IN INDIAN CITIES

Total quantity generated in GHMC Area: 3600 tons per day and 131400 tons per annum

PHYSICAL CHARACTERISTICS OF MSW IN INDIAN CITIES

Cities having Population Range (million)	Paper %	Rubber, Leather & Synthetics %	Glass %	Metals %	Total Compostable /Combustible Matter %	Inert %
0.1 -0.5	2.91	0.78	0.56	0.33	44.57	43.59
0.5 - 1.0	2.95	0.73	0.35	0.32	40.04	48.38
1.0 -2.0	4.71	0.71	0.46	0.49	38.95	44.73
2.0 -5.0	3.18	0.48	0.48	0.59	56.67	49.07
> 5.0	6.43	0.28	0.94	0.80	30.84	53.90

CHEMICAL CHARACTERISTICS OF MSW IN INDIAN CITIES

Cities having Population Range (million)	Moisture %	Organic Matter %	Nitrogen as Total Nitrogen %	Phosphorous as P2O5 %	Potassium as K2O %	C/N Ratio %	Calorific value (kcal/kg) %
0.1 - 0.5	25.81	37.09	0.71	0.63	0.83	30.94	1010
0.5- 1.0	19.52	25.14	0.66	0.56	0.69	21.13	901
1.0-2.0	26.98	26.89	0.64	0.82	0.72	23.68	980
2.0-5.0	21.03	25.60	0.56	0.69	0.78	22.45	907
> 5.0	38.72	39.07	0.56	0.52	0.52	30.11	801

TECHNOLOGICAL BARRIER

The proposed project activity will be implementing a reverse acting and reciprocating combustion grate for the first time in the country. No fossil fuel will be required for sustained combustion.

The project proponent is taking substantial risk in implementing this technology for the first time in the country.

Successful implementation of this technology will lead to replication of the same which will in turn the problem of disposal MSW in the country.

INVESTMENT BARRIER

The proposed project activity involves a capital expenditure of INR 754.3 million. Considering the debt equity ratio of 85:15, the proposed project activity requires a debt of INR 641.1 million. The capital cost of the similar capacity fossil fuel based Power Plant will be half of the Waste to Energy Project. The project proponents face a barrier in investment.

The financial viability of this project largely depends up on central and state subsidies and revenues received by selling CER proceeds. However, able management, ethical practices, proven HR practices will also contributes more in enhancing the success rate of any business establishment.

METHODOLOGY

The method of generation assessment commences by establishing the total quantity of MSW available for GKNS Energy Pvt. Ltd (Tones/Year) and its average calorific value. A breakdown of the MSW in terms of the nature of the constituents.

The calorific values of the MSW synthesis components (MJ/kg) are specified values (Energy Recovery from municipal Solid Waste in Dhaka City, Bangladesh,Md. Alam Jahangir, 2002) used in order to calculate the calorific values of Domestic, Commercial and Industrial Waste. The percentage of Domestic, Commercial and Industrial waste is also calculated excluding the small portion of street sweeping. The summed product of the percentages of Domestic, Commercial and Industrial waste times the Calorific values of Domestic, Commercial and Industrial Waste provides the Average calorific value of waste generated in Hyderabad (MJ/kg). The Calorific Value of waste generated in Hyderabad is converted in kWh/tone in order to evaluate the Specific Energy output per ton of waste at a conventional thermal efficiency 35% (kWh/tone). Finally, the Power Potential (MW) for a plant sourcing from the MSW Grate burning utilization is estimated.

In order to estimate the daily and annual combustible quantity of MSW in relation to a load factor range from 65% to 85% the standardized values of Btu/kg of MSW according to their synthesis are introduced and an average value (Btu/kg) is calculated. The selection of the average Btu/kg value designates the random collection of MSW that takes place in the feeding area before the combustor after which burning occurs.

The burning process that leads to utilization of the MSW is completed in 60 minutes. At this stage the values of Btu/hr of a water-walled combustor for a load factor ranging between 65% and 85% are introduced. Dividing these to the average Btu/kg value of MSW leads to the establishment of the daily and annual quantity of MSW utilized in the combustor. Thermax Bobcox Will Cox Limited, who is leading manufacturers of water-walled rotary combustors, provided the Btu/hr values. The annual production of kWh follows, estimating levels of energy generated from the MSW plant for the ranging load factor parameter, which includes the actual load factor for the examined site. Finally the Heat Rate is calculated and acts as a verification tool for the validity of calculations.

TECHNOLOGY DESCRIPTION

The reverse acting reciprocating grate technology used for the proposed project activity is a state of an art technology and is being implemented for an Integrated Waste Management Project. Implementation of the proposed project activity would help in promotion and replication of similar technology in other areas of the country.

The two-segment reciprocating stroke system, which considers the characteristics of municipal solid waste such as lower heat value and higher water content, owns advantages of being applied to a broad heat value, having a good load adjusting capacity and operation performance and highly automatic. These technologies can efficiently combust RDF fluff without the support of any other fossil fuel and also lead to sustained combustion.

Preparation of Waste Input Material:

All "hard" materials such as stones, glass, metals, ceramics and the like, have to be removed. The incoming waste which arrives at the plant with moisture of 60-65% has to be dried to residual moisture of less than 17%.

The waste is dumped into the receiving area and then picked up by a Payloader equipped with a crusher shovel. A coarse grinding mechanism built into the shovel opens plastic bags and reduces the particles to <50 mm. Oversize parts such as bicycle frames, refrigerators, etc. remain in the shovel and can be simply tilted out.

The pre-shredded material passes a magnetic separator as well as an Eddy-current separator and is subsequently sent through our proprietary autoclave system where it is broken down to fluff.

PRODUCTION ASSESSMENT

INTRODUCTION:

The Production Assessment process aims to identify and satisfy three areas of research. Initially, the Power Potential sourcing from the RDF grade II burning utilization at RDF Power Project is forecasted. At a second stage, the evaluation of the daily and annual combustible quantity of MSW is calculated in relation to the MSW combustion plants' load ranging factor. Finally, the evaluation of annual kWh production is performed taking into account the examined plant's actual load factor parameter. The concurrent evaluation of the heat flow rate (Btu/kWh) acts as a verification method to the calculations certifying their validity.

LOAD FACTOR:

The plant load factor is defined as the ratio of Actual Operational Capacity to the Optimal Operating Capacity. In the particular MSW plant the Optimal Operating Capacity is 11 MW and the Actual Operational Capacity is accounted in the range between 65% to 75% PLF. Load Factor = Actual Operational Capacity / Optimal Operating.

HEAT RATE:

The Heat Rate is the method of evaluating the Energy Efficiency of a plant. Energy Efficiency, in general, measures the amount of primary energy from the raw fuel needed to produce a specified amount of delivered energy. The Heat Rate is the amount of energy (Btu) in the fuel needed to produce one kilowatt-hour (kWh) of electricity. The lower the heat rate the more energy efficient the plant is. Heat rate is not applicable for wind and solar plants, since they don't use fuel in the traditional sense of the word. In case of the current study, the Heat Rate for electricity production of one kilowatt-hour is given with a value of 3412 Btu/kWh. Other average fuel conversion factors are listed below:

Source	Average Fuel Conversion Factors
Electricity	3,412 Btu/kWh
Fuel Oil	138,700 Btu/gallon
Natural Gas	1,030 Btu/cubic foot
LPG/Propane	95,500 Btu/gallon
Coal	24,580,000 Btu/ton

EQEIPPED WITH THE FOLLOWING UTILITES

• Electrical system.

• Emergency power generating unit.

• Air supply system.

• Re-circulated flue-gas system.

• Compressed air system.

• Hydraulic system.

• Water cooling system.

• Oil cooling system.

• Leach ate from MSW Receiving Yard and Fuel Storage Pit will be collected in Neutralization Tank for COD and BOD as per local Norms.

CONVERSION OF MSW TO RDF FLUFF

RECEIPT OF MSW:

GKNS Energy Will collect daily 600 TPD from GMCH Dumping Sites to plant having a distance of 38 KM with the help of Tipper trucks or *Lorries* that will bring the MSW will be weighed on the weighbridge station at the plant before they are unloaded in the MSW Receiving Yard of the plant. MSW from the MSW Receiving Yard will be lifted by Grab Crane and put on the Inclined Feeding Belt Conveyor. The MSW feeding by Grab crane is also expected to homogenize the MSW prior to feeding and will be considered as an alternative. Herbal disinfectant-cum-deodorant will be sprayed on the MSW to reduce mal-odor and repel insects and birds.

HOMOGENIZATION:

Inclined Feeding Belt Conveyor will feed MSW into a Rotary Screen-I to de-lump and to remove dust, sand, earth and other inert materials of less than 40 mm particle size. Dust, sand, earth and other inert materials separated in this process will be extracted and transferred to a Composting Yard through a Compost Transfer Belt Conveyor. Rotary Screen-I will deliver MSW on a Horizontal Sorting Conveyor Belt to separate big objects by manual activity, which may spoil the downstream equipments like machinery parts, lead acid batteries, stones, tires,etc.

The big objects that are separated will be picked up and dropped through gravity – chutes on the ground for on-ward disposal. Large sized inert and noncombustible objects like boulders, construction debris, large trees cuttings, etc. will be lifted manually and disposed to designated landfill sites.

The Horizontal Sorting Conveyor will deliver MSW to Rotary Screen-II. Rotary Screen-II will separate MSW into two fraction: Fraction#1 RDF fluff – = 100 mm.
Fraction # 2 RDF fluff will fall on the Belt Conveyor and will be delivered to the Fuel Storage Pit For feeding into the boiler.

MAGNETIC SEPARATION:

Fraction#1 RDF fluff will be transferred from Solar Drying Yard to Magnetic Separation Unit for removal of ferrous components from the garbage for recycling. RDF fluff from Magnetic Separation Unit will fall on the Belt Conveyor and will go to Fuel Storage Pit for feeding into boiler.

Flue-gas cleaning system:

•The flue-gas enters the flue-gas cleaning system downstream of the HRSG. The plant is equipped with a dry flue-gas cleaning system consisting of a bag-house filter, a storage silo for lime and activated carbon and a filter dust silo

•Lime and activated carbon is injected at the inlet of the bag house filter

•The lime absorbs acid components in the flue-gas, while activated carbon adsorbs dioxin, TOC and heavy metals.

SOLAR DRY:

MSW in the country has been generally found to have high moisture content even during non rainy days and requires drying to produce fuel with reasonable heating value. Fraction#1 RDF fluff will be transferred by Extraction and Transfer Belt conveyor to the Intermediate Storage Yard and will be dried in the Solar Drying Yard.

RDF FLUFF:

It will be combusted in the boiler on reverse acting reciprocating grate to generate steam.
Following are the boiler specification of boilers to be used:
Steam Generation 56 TPH
Pressure 40 ata. Temperature 400^{o}C + 5^{o}C
Steam generated in boilers will be fed to the single extraction condensing turbo generator.

The uncontrolled extraction from the turbine at 5.4 ata will give approximately 6.87 TPH of steam at a temperature of 180°C. This steam will be entirely used for heating up the feed water in the thermal deaerator. In addition to this steam, the flash steam recovered from the boiler blow down tank can be used in the deaerator. The flash steam from the continuous blow down tank, equivalent to 0.237 TPH will be led into the deaerator for supplementing the steam supplied from the turbine extraction for deaeration. Balance of steam will be supplied to the turbine, a quantity of 52.6 TPH of steam, being the difference between input and extracted steam quantities will be exhausted to the surface condenser of the power turbine. Condensate from the condensate tank of surface condenser will be pumped to the feed water system by the condensate extraction pumps. In addition to the above quantity, the condensate from the gland steam condenser and the ejector condensers amounting to a total approximate quantity of 0.476 TPH will be added to the feed water system through the condensate tank the power project, after meeting its in house consumption, will export to Grid.

Control and monitoring system

• the plant is equipped with a separate proprietary control-and-monitoring-system
• the system performs automatic control of the process during normal operating conditions and gives the opportunity to monitor the different process sections through the man-machine interface. All information is available for the operator via a screen
• the system is designed for remote control and monitoring of the plant. Safety and security is paramount in all aspects of the design
• Logging of process parameters, including emissions monitoring parameters, is controlled in a separate data logging system
• Safety is taken care of in a separate and independent emergency shutdown system
• The emissions to air such as dust, CO, HCl, Hg, TOC, SO2, NOx, O2, H2O and CO2 are continuously monitored and displayed.

STEAM GENERATING SYSTEM:

The steam generating system for the power plant will consist of Two (2) No. Reverse acting and reciprocating type grate fired boiler of capacity 28 TPH with outlet steam parameters of 40 ata, 400 Deg.C. The boiler shall be semi-outdoor unit and shall be of single drum, natural circulation, balanced draft, and membrane wall radiant furnace design with two-(2) stage super heaters and inter stage de-super heater. The main and design fuel will be MSW to RDF

POWER GENERATION SYSTEM:

The power generation plant will support combustion of RDF fluff. It will include receiving and feeding system, refuse incineration, waste heat utilization, flue gas treatment, automatic control system, electrical equipment, ash disposal system, water supply and drainage system and compressed air system. The power project will install two boilers and one extraction cum condensing turbo generator for power generation. The project will optimize power generation with one stage of feed water heating. Extraction of steam and its usage in the Deaerator for feed water heating will improve the efficiency of the plant.

STEAM BOILER COMBUSTION CALCULATIONS

Units: MKS Fuel Type: Solid

Carbon	22.07	S02	0.029
Hydrogen	1.52	O2	8.864
Nitrogen	0.83	N2	67.968
Oxygen	10.79	C02	8.634
Sulphur	0.20	H2O	14.504
Ash	29.60	Gross Calorific Value	2004.900
Moisture	35.00	Net Calorific Value	1726.300
Excess Air	100.00	Unit Wet Air	5.324
		Unit Wet Gas	6.028
		Unit Dry Gas	5.471

MKs Units: Solid Fuel - % Weight; Gas composition - % Volume;

Calorific Value – Kcal / Kg; Unit Air / Gas- Kg/Kg of Fuel

The average results obtained from dulongs formula and fire cad stimulation software are reproduced as under:

As per dulong formula the result is = 7699.19375 MJ/KG

= 1840.15 Kcal/kg

As per FIRE CAD = 2004.90

The average of two values has taken for Power Potential Assessment

(1840.15+2004.90)/2 = 1922.52

Net Calorific Value of the fuel = 1538.01 Kcal/Kg

Total Quantity of Waste available for the project (W) tones

Net Calorific Value (NCV) in Kcal/Kg NCV

Energy Recovery Potential (KWH) NCV x W x 1000/860 = NCV x W x 1.16

Power Generation Potential (in KW) = 1.16 x NCV X W/24 = 0.048 X NCV x W

Conversation Efficiency (in percentage) 25%

Net Power Generation Potential (KW) = 0.012 x NCV x W

Case - 1

Quantity of MSW = 600 tones

Net Calorific Value = 11508 Kcal/kg

Conversation efficiency = 25%

The Power Generation Potential in the above case shall be = 8285.8 KW

= 8.28. in MW

In all the above cases, for computation purpose we have taken conversion efficiency as 25% only in order to validate power potential conservatively. The coal based power projects will work with a conversion efficiency of 45% to 48%. We are in an opinion the power generating potential of this project not in question.

EXTRACTION TURBINE CHARACTERISTICS

The turbine casing is horizontally split. Two materials have been specified for the high-pressure section: low-alloy steel for intermediate steam pressure and temperature applications and medium-alloy steel for high steam pressure and temperature applications. The shaft is made of forged steel. Two types of shaft material have been specified: low-alloy steel for low-pressure applications and high- alloy steel (13% chromium steel) for high-pressure applications.

The front and rear sections of the turbine are identical. The intermediate section has been designed to accommodate intermediate pressure valves. Cylindrical moving blades of reaction stage(s) have 'T' roots and integral shrouds. Two materials are employed for the construction of the moving blades: 13% chromium steel with molybdenum and vanadium is applied for temperatures over 350 °C and 13% chromium steel is used for lower temperatures. The reaction stage fixed blades are cantilevered in the blade carriers and held together by a riveted shroud or inserted in the blade carriers as complete diaphragms. They are made of 13% chromium steel. There is an emergency stop valve (Push-to-Close type), which protects the turbo- unit against the un-wanted effects of over-speed. The valve's response time is set at 50 milliseconds and possesses a high reliability factor. It is installed on each live steam inlet flange and is mounted directly on the casing, thus minimizing the steam volume that continues to expand through the turbine after valve closure. The steam extraction can be performed by bleeding or controlled by one or more intermediate pressure controls. Tilting-pad journal bearings are used in general. Double acting, tilting-pad thrust bearings are installed with a thrust equalizing device. Both journal and thrust bearings are fitted with thermo-elements for temperature detection and monitoring. Labyrinth-type end seals are applied. Lubrication and control oil systems have a common reservoir, pumps, filters and coolers.

ESTIMATION OF POWER GENERATION

Based on the documents furnished by GKNS Energy Pvt. Ltd, it is observed that the project has an allotted quantity of 600 tones MSW per day. We have tried to elevate power generation potential as under. The gross calorific value of MSW computation is based on the ultimate analysis available with us in our date base after analyzing numerous samples:

		Percentage
Carbon	% by wt	22.07
Hydrogen	% by wt	1.52
Oxygen	% by wt	10.79
Sulphur	% by wt	0.20
Nitrogen	% by wt	0.83
Ash	% by wt	29.6
Moisture	% by wt	35

To determine the higher heating value (GCV) of an organic waste, the following dulong formula can be used.

$$GCV \text{ in kj/kg} = 337C + 1419(H - 1/8O) + 93S$$

Where C, H, O, and S are mass percentage of carbon, hydrogen, oxygen, sulfur and nitrogen. The 8 O accounts for the hydrogen in the bound water in the dry combustible material. The equation assumes that the entire O in the waste is in the form of bound water.

Substituting the values of elemental analysis in the formula, result arrived is 7699.194 Kj/Kg and in terms of Kcal/kg will be 1840.15.

MARKETING

We recommend that the company need to enter into a power purchase agreement with The Tata Power Trading Company Limited a wholly own subsidiary of TATA Power Limited for purchasing power from this project @ Rs.5.00/- per unit. It is noted from the Power Purchase Agreements concluded by the other companies with M/s.Tata Power Trading Company Limited, it has been agreed by Tata's that they would share profit earned by selling projects power at 70:30 ratio, i.e., 70% to the project and 30% for the power buyer. According to Tata's the net realization to the proposed project may be anywhere between Rs.5.00 to Rs5.20 per unit. This escalated revenue will contribute to certain extent to the viability of the project along with CDM revenues.

CONCLUSIONS

Based on the study and review we have the following comments.

The performance of the project is a function of success of proposed two-segment reverse acting and reciprocating grate which the company proposes to import.

In India no such projects are under operation with the above grate technology. However we endorse the above grate has been proven successful in many countries.

This project stands viable with government support and CDM revenues. The proposed project activity will lead to GHG emission reduction in the following manner.

Avoidance of methane emission which would otherwise happen due to anaerobic decomposition of MSW in the existing waste disposal site. Power exported from the proposed project activity will replace fossil fuel based power from the grid.