ANNEXURE – 15.1

Waste-to-Energy Case Studies

1. Puente Hills Landfill, Los Angeles County, California, USA:

Puente Hill landfill is owned and operated by the Sanitation Districts of Los Angles County. It encompasses an area of 1,365 acres, only half of which is ear-marked for use as landfill. The entire site is being developed, in cooperation with the County Department of Parks and Recreation, into recreational facilities to benefit the surrounding Communities.

The land fill receives 12,000 tons of waste per day Part of the landfill is already closed and producing 27000-28000 CFM gas with typical composition of 36-40% methane, 35% CO_2, 5% O_2 and 90-100 ppm H_2S. The gas collected from the landfill is delivered to the Puente Hills Energy Recovery Facility, where it is burned in a boiler to produce steam which is fed to a turbine generator set (two steam boilers each of the rating of 264,000 lb/hr at 1000^{o} F and one turbine of 1850 lb/hr.). The power generation is close to 50 MW which makes it the largest Landfill Gas to Energy Facility in the world.

The landfill started commercial production of power from Jan.1, 1987. The complete power plant was financed by the Banks and the plant has repaid all the money within first 5 years of its operation. The total cost of the project including interest which was repaid to bank was nearly US$ 35 mln.. During 1st year of operation i.e. 1987 the company charged 12 cents/kwh from the grid. The charge was 15 cents/kW-hr during 1996, the last year of the initial 10 year agreement. As per the new agreement subsequently entered, the company is selling power to the grid at 8 cents/ kW-hr.

The Operations Report of the Energy Recovery Facility for the month of March 1997 was as under :

Gross Power	37,766,000	kW-hr
Parastic Power	2,832,000	kW-hr
Net Power	34,934,000	kW-hr
Net average	47,000	kW
Average LFG used	23,800	SCFM
Availability	100.0	%
Capacity Factor	101.5	%
Dispenser Availability	100.0	%
'Solar' on line	87.0	%

The net energy generation and total income during the years 1993 - 96 has been as under:

Year	**Total Income ($)**	**Total Net kW-hr (approx)**
1993	49219330	394 MU
1994	52445031	394 MU
1995	56276480	397 MU
1996	60235255	408 MU

No manure is being sold at present but the same is planned in near future.

The company also has a CNG facility producing 100 cfm of high quality CNG containing on an average 97.5% methane. In this facility Methane gas coming from landfill is dewatered, purified by membrane purification technology which requires minimal maintenance, and pressurised to produce high quality CNG. The total project cost of this component was approximately US$ 1 million. The facility is projected to be capable of producing clean fuel at an equivalent gasoline cost in the range of US$ 0.5-1.0 per gallon.

The tipping fee charged by the company was US$8/tonne in 1988, US$18 to US$26/tonne in 1995 and is presently US$ 26/ton.

The Puente Hill Landfill has the capacity to provide environmentally sound disposal for the residents and business of Los Angeles county until the year 2013.

2 Belrose Power Plant:

Project Location	Belrose, New South Wales, Australia
Power Generation Capacity	4 MW
Fuel	Landfill Gas
Power Purchaser	Energy Australia
Start of Operation	1995

Landfill gas is extracted from the landfill site, processed to remove moisture and particulate matter and utilised as fuel for power generation. The power produced is supplied to the utility distribution system.

The gas extraction system comprises gas production wells drilled into the landfill. The wells are fitted with wellheads comprising valves and flow meters to control the flow from each well. An underground pipeline network connects the wells to a central gas compression and processing plant. Gas is produced at approximately 50% methane content. Gas blowers maintain vacuum on the gas extraction system and compress the gas to the pressure required for supply to the generating plant.

The generating plant comprises four gas engine generator sets. Generation voltage is 415volts which is stepped up by the unit transformers for each generator set, to 33KV at which it is electrically interconnected with the utility distribution system.

3 The Tiburg Plant (The Netherlands):

The plant based on biomethanation was built in 1993 for the processing of 52000 tons/ year of source-sorted organic fraction of municipal solid waste known as Vegetable Garden and Fruit Waste. The salient features of the plant are as follows:

Treatment capacity	52 000 t/y VGF
Digester volume	2 x 3 300 m^3
Waste composition	46% TS - 45% VS
Retention time	20 days minimum
Biogas production	80-85 Nm^3 / ton feed in digester
Specific methane yield*	220 - 250 Nm^3 /ton VS fed in digester
Biogas end -use	Injection into the gas network after purification.

Compost Characteristics:

Heavy metals	mg/ kg TS
	Cd = 0.5
	Hg = 0.1
	Pb = 67.0
	Se = 5.0
	Cu = 23.0
	NI = 7.6
	Zn = 190.0
Salmonella	absence on 25 g.

**after storage and screening.*

4 The Amiens Plant (France):

The plant was built in 1987 for the processing of 55,000 tons/ year of Amiens municipal solid waste. A mechanical sorting unit allows for the separation of the organic fraction from MSW.

In 1996, as the process was considered fully reliable and economical by the other municipalities in the district of Amiens, the treatment capacity was extended to 85,000 tons/ year with the construction of an additional digester. Details of the plant are as follows:

Treatment capacity	85000t/y MSW
Digester volume	3 x 2 400 m^3 (start-up in 1988) 1 x 2 500 m^3 (start-up in 1996)
Sorted Waste composition	60% TS - 63% VS
Retention time	18 - 22 days
Biogas production	140 - 160 Nm^3 / ton fed in digester
Specific methane yield	220 - 250 Nm^3 /ton VS fed in digester
Biogas end -use	high pressure steam for industrial consumption purpose - (5500 kW)

5 Chitose Incineration Plant (Metropolitan Tokyo):

Capable of handling up to 600 tons of garbage per day, the Chitose Incineration Plant is Japan's largest urban incinerator. Because the plant is situated in a residential area, the most pressing concerns in its design were pollution and an appealing external appearance. The Kumagai Gumi facility is innovative both in terms of its technology, design and building arrangement. Because all operations are computer controlled, the facility's construction required accuracy down to the millimeter. Moreover, electricity generated by heat from the incinerator provides all the plant's electricity requirements. All in all, the state-of-the-art plant is at the vanguard of waste disposal in Japan.

Owner	Tokyo Metropolitan Government
Design	Kumagai Gumi Co., Ltd.
Structure	Steel reinforced concrete 7/3
Area	20,998 square meters
Height	130 meters
Smokestaack	Reinforced concrete

6 Refuse Incineration cum Power Generation Plant, Timarpur, Delhi:

This R&D/ Pilot Plant for incineration of municipal solid waste of Delhi city and generation of power as a by-product, was set up in the year 1987 with assistance from Government of Denmark..

Location	Timarpur, Delhi
Year of installation	1987
Feed-stock Incineration capacity	300 TPD Municipal Solid Waste Net Calorific Value (NCV) : 1462.5 k-cal/kg. (for rated power output)
Rated Power Generation Capacity	3.75 MW
Technology	Incineration
Capital Cost	Rs. 25 crore (approx.)
Supplier of Technology/ Turn-key contractor	M/s Volund Miljotecknik A/S, Denmark

The plant was on trial run and was operated for a few months and was subsequently closed down in the year 1990 due to mismatch of quality of incoming Refuse (MSW) with the plant design.

The up-keep and shutdown maintenance of the plant is continuously being carried out through the Delhi Vidyut Board, till the plant assets are put to an alternative / effective use.

A possibility is being explored to lease out the entire facility, on 'as is where is basis' to entrepreneurs interested in taking over the plant and making their own investment to carry out necessary modifications or additions to the plant and for operating it on commercial basis.

7. Waste Recycling Park, Wels, Austria:

The Wels Waste Recycling Park is a modern waste processing & disposal facility set up in 1995 for integrated waste management. It is owned by a consortium of the County, the Municipality, the Utility and the Plant Operating Company/Electricity supplier- M/s Welser Abfallverwertung, G.m.b.H.

The total processing capacity of the plant is 160,000 tonnes per annum (TPA) of different waste streams :

25,000 TPA	organic waste
30,000 TPA	industrial waste
60,000 TPA	construction sites waste
45,000 TPA	households waste
160,000 TPA	

The plant handles these wastes through different processing routes depending on their nature:

(i) 60,000 TPA waste from households and other sources is of combustible nature and is combusted in an Incineration Plant which generates 7 MW power. The captive consumption is 1.5 mw and the rest is exported to grid, corresponding to an annual energy production of 36 MU. The facility has a 63 m high chimney and has the most modern treatment system for emission control and also for Ash Treatment, and which accounts for a major position of the total plant cost of 980 mln. Shillings. It comprises of ESPs, Wet scrubbers, Activated Carbon Filter, Catalytic Converter. The emission levels achieved are understandably the best in the world and are as under :

Dust	8	mg/m^3	C(org)	8	mg/m^3
HCl	7	,,	Col	0.05	,,
HF	0.3	,,	Hg	0.05	,,
SO_2	20	,,	Dioxin	0.1	ng/m^3
NO_x	100	,,			
CO	50	,,			

(ii) 25000 TPA of Industrial waste is fed to a sorting station. 20,000 TPA of the sorted waste goes to the Incineration plant and the remaining 5000 TPA to far-away Landfill site.

(iii) 19000 TPA of Organic Waste comprising Sewage sludge and other compostibles is processed in a Anaerobic Treatment Plant. It incorporates various steps - shredding, iron separation, slurry formation, Anaerobic Digester, Gas Holder, Cogeneration Power plant. The waste sludge from the reactor is dried by a centrifuge and fed to an Aerobic composting/treatment unit alongwith some other incoming wastes (not treated anaerobically).

The Anaerobic digester has a capacity of $1600m^3$ and produces 1 $mln.m^3$ gas ($6m^3$ per MT per day) . The cost of the AD system is stated to be 100 mln. Shillings. The final compost (9000 TPA) is transported to a far-away Landfill site, and not used or considered suitable as fertiliser .

(iv) 6000 TPA construction waste is fed to a treatment section and most of it is transferred therefrom to far-away Landfill site. About 1000 TPA is combustible and transferred to the Incineration plant. The entire facility is very impressive and is an excellent combination of the latest waste treatment technologies which dispose of nearly 90% of the waste received, and with remarkable environmental pollution control.