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WASTE MANAGEMENT BIOTECHNOLOGY

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ENVIS Newsletter on Environmental Biotechnology published two volumes (4 Nos.) in a year. The articles related to the thematic area of the ENVIS Centre are published in each volume. Popular or easily intelligible expositions of new or recent developments are welcome.
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Articles should be sent to

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EDITORIAL

With rapid urbanization, the country is facing massive waste management challenge. Over 377 million urban people live in 7,935 towns and cities and generate 62 million tones of municipal solid waste per annum. Only 43 million tones (MT) of the waste is collected, 11.9 MT is treated and 31 MT is dumped in landfill sites. Solid Waste Management (SWM) is one among the basic essential services provided by municipal authorities in the country to keep urban centres clean. The environment is a very important component necessary for the existence of both man and other biotic organisms. Various techniques are adopted for waste management. The best method of sustaining the environment is such that returns back all the components (wastes) in a recyclable way so that the waste becomes useful and helps the biotic and abiotic relationship to maintain an aesthetic and healthy equilibrium that characterizes an ideal environment. In recent biotechnology finds the application fields in the treatment of wastewaters by biological methods and disposal of solid wastes by composting technique in waste management. In these methods, it is essential to find suitable microorganisms that will degrade organic substances and to complete the treatment process in favorable conditions. So the management of wastes using biotechnological tools are the eco-friendly and cost effective methods in the recent time.

(Ashis Kumar Panigrahi)

IN THIS ISSUE:

Waste Management Biotechnology

Waste is any substance which is discarded after primary use, or is worthless, defective and of no use. We generate a huge amount of wastes in our day to day life. Everyone creates waste, although some people are very environmentally conscious and create very little. Now it is a major environmental issue everywhere since the industrial revolution. There are about 25 million tones of urban solid waste of diverse composition generated in India per year. The per capita waste generation in India is estimated about 0.4 kg/day with the 50-60% are compostable matter. Since 1970 the term 'biotechnology' introduced as new technology to solve various environmental problems including waste management. The application of biotechnology in solid waste management involves microorganisms to enhance the decomposition process which is a effective method to manage the solid waste problem of the environment.

Sources of waste

There are various sources of generation of wastes to the environment. Recognizing the types of wastes the different source of wastes can be identified.

Municipal sources of wastes: This includes trash or garbage from residencial areas, market places, restaurants, small scale industries, commercial and other public places (Fig. 1 & 2).

Figure: 1 Sources of municipal waste
Source: https://www.researchgate

Agricultural sources of wastes:
This includes the waste generated by various agricultural activities, horticulture, livestous breeding, market gardens and seedling nurseries.

Industrial Sources of Wastes:
The solid, liquid and gaseous wastes produced from manufacturing and processing industries like chemical, cement, power plants, textile, food processing, petroleum industries etc.

Medical or Clinical sources of wastes:
Wastes produced from hospitals, clinics, surgical theaters, veterinary hospitals, and labs. This includes surgical items, pharmaceuticals, blood, body parts, wound dressing materials, needles and syringes.

Wastes from Construction or Demolition:
The waste generated from the construction of roads and building including concrete debris, wood, huge package boxes and plastics from the building materials. The demolition of old buildings and structures generated demolition waste.

Figure: 2 Domestic weaste
Source: https://www.shiftitwaste.co.uk

Commercial Sources:
Industries and automobiles, wastes are generated daily on a large scale from commercial enterprises. These may include food items, disposable medical items, textiles and much more (Fig. 3).

Figure: 3 Industrial waste
Source: http://www.newindianexpress.com

Mining Sources:

Mining activities also generate wastes that have the potential to disturb the physical, chemical and biological features of the land and atmosphere.

Radioactive Sources:

Radioactive sources of wastes include nuclear reactors, mining of radioactive substances and atomic explosions.

Electronic sources of waste:

The DVD and music players, TV, Telephones, computers, vacuum cleaners, which are of no more use, are electronic wastes. Some e-waste (like TV) contains lead, mercury and cadmium, which are harmful to humans and the environment.

Types of waste

Depending on their physical state they are classified as:

- ✓ Solid waste
- ✓ Liquid waste
- ✓ Gasous waste

Solid waste

Solid waste is the unwanted or useless solid materials generated from combined residential, industrial and commercial activities in a given area.

Based on their sources of origin solid waste are:

Residential wastes:

Solid waste comprising of garbage and rubbish (such as bottles, cans, clothing, compost, disposables, food packaging, food scraps, newspapers and magazines, and yard trimmings) that originates from private homes or apartments are called domestic waste or residential waste.

Commercial wastes:

waste from premises used mainly for the purposes of a trade or business or for the purpose of sport, recreation, education or entertainment.

Institutional waste:

Waste produced from institutions such as schools, hospitals, or prisons.

Municipal wastes:

Municipal waste consists of waste collected by or on behalf of municipal authorities, or directly by the private sector

Industrial wastes:

Industrial waste is the waste produced by industrial activity.

Agricultural wastes:

It includes manure and other wastes from farms, poultry houses and slaughterhouses; harvest waste; fertilizer run- off from fields

Methods for the treatment of the solid waste:

With different types of wastes, different treatment methods are applied. These treatment processes has been listed below:

Open dumps

An open dumping is defined as a land disposal site at which solid wastes are disposed of in a manner that does not protect the environment, are susceptible to open burning, and are exposed to the elements, vectors, and scavengers. It is the breeding ground for files, rats, and other insects that spread disease. The rainwater run-off from these dumps contaminates nearby land and water, thereby spreading disease.

Landfills

A landfill may also refer to the ground that has been filled in with soil and rocks instead of waste materials, so that it can be used for a specific purpose, such as for building houses. Landfill, also known as a dump or tip, is a site for disposal of waste materials by burial. Some old and unmanaged landfill can create various adverse environmental impacts, like bad odour, wind blown liter, favourable for vermin and leaching of liquid waste to adjacent areas.

Anaerobic digestion

Anaerobic digestion is the regulated process of fermentation using anaerobic bacteria in absence of oxygen to degradation the organic matters and produce methane CH_4 and carbon dioxide CO_2. The release of huge amount of methane-rich biogas can be use as potential energy sources from wastes.

Composting

It is the biological decomposition of organic waste under regulated condition. Some industries like, agriculturel, paper, food processing etc. produces almost 100% organic wastes. This organic matter can be decomposed to produced good composted manure. Compost is the end product of the organic fraction of solid waste after aerobic or anaerobic decomposition to yield solid humus like fertilizer, CO_2, CH_4, water vapour and energy (Fig. 4).

Figure: 4 Composting of solid waste
Source: http://www.sundruwater.com

Vermicomposting

It is the biotechnological process of composting using efficient species of earthworms to enhance the waste conversion process and produce good quality of compost fertilizer. The vermicomposting process is a faster composting process differs from microbial composting in several ways.

Incineration

Incineration is the most common thermal treatment process of wastes. In this process the wastes were burnt in compact chamber at a temperature of around 1000°C in the presence of oxygen so as to eliminate all odours and to ensure good combustion. After incineration the wastes are converted to ash with production of carbon dioxide and water vapour. It converts hazardous organic substances of mainly biomedical wastes into less hazardous components.

Management of Solid waste:

Waste processing is to reduce the amount of wastes through recycling and disposal of waste in a way not to impair environmental conservation. Four R's should be followed for waste management: 1. Refuse 2. Reuse 3. Recycle 4. Reduce

Management of Medical solid waste

Hospital waste is generated during the diagnosis, treatment, or immunization of human beings or animals or in research activities in these fields or in the production or testing of biological. Medical solid waste includes both non-hazardous and hazardous waste constituents.

Management of non-degradable solid waste

Management of non-degradable solid waste: Ferrous & non-ferrous metals: Eg: Iron, Steel and Aluminium etc. Glass Plastics Textiles Treatment options: Recycling Sanitary landfill Incineration

Management of Hazardous waste

Physical separation Gravity separation Dissolved air floatation Solvent extraction Sorption on activated carbon iii. Management of Hazardous waste

Management of non-hazardous & biodegradable solid waste

Non-hazardous solid waste is comprise of all municipal waste, industrial waste, agricultural waste and sewage sludge. The non-hazardous and biodegradable solid wastes can be managed by the process of Open dumps, Landfills, Anaerobic digestion, Composting and Vermicomposting etc.

Management of electronic waste "e-waste"

Electronic waste is of concern largely due to the toxicity and carcinogenicity of some of the substances due to unscientific disposal. Lead, mercury, cadmium, PCBs etc. are the toxic substances produced from electronic waste. A desktop computer may contain more than >6% lead by weight along with PVC insulated wires of polychlorinated biphenyls (Fig.5).

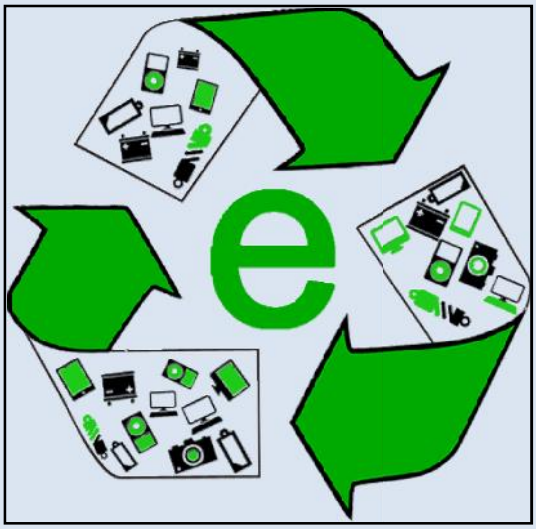

Figure: 5 Electronic waste
Source: http://tryforgood.com/

Liquid waste

Liquid waste includes effluents of industries, fertiliser and pesticide solutions from agricultural fields, leachate from landfills, urban runoff of untreated waste water and garbage, mining wastes etc. The liquid waste may contain nontoxic inorganic substances or toxic organic substances.

The sewage waste water release from a community, containing solid and liquid excreta of residential area, street and yard washing, factories and industries. There are three types of sewage treatment

Treatment of the liquid waste:

Primary traetment

- Primary treatment removes solids and suspended sediments
- First, a screen removes large debris
- In a grit tank, heavier particles like sand and gravel settle out
- In a primary sedimentation tank, about half the organic solids settle to the bottom. This semi-solid material is called sludge.

Secondary treatment

Secondary treatment breaks down the organic material biologically in one of the following ways:

1) Aeration tank digestion: sewage is aerated and mixed with aerobic bacteria, which digest the organic matter. The sewage then goes into a final settling tank, and the sludge is removed.
2) Trickling filter bed: Sewage drips from perforated pipes or overhead sprayer through a stone bed or corrugated plastic sheets. Bacteria on the bed decompose the organic material.
3) Sewage lagoon: Outdoor lagoons expose sewage to sunlight, algae and air, which break down the organic material (a slower but cheaper method)

After secondary treatment, the fluid is disinfected with chlorine, UV light, or ozone to kill harmful bacteria.

Tertiary

After secondary treatment, sewage still contains nitrates, phosphates, and other inorganic substances. It is passed through a natural wetland or artificial filtering system to filter out these nutrients, or chemical flocculants are added to bind to the nutrients so they settle out (Fig. 6).

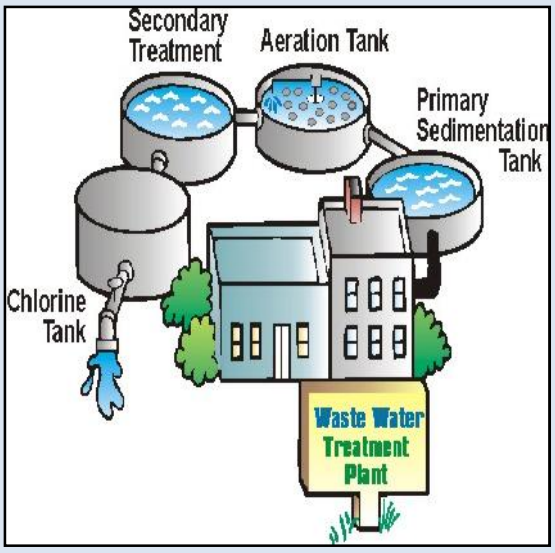

Figure: 6 Waste water treatment plant
Source: https://bengkeltip.wordpress.com

Gaseous Wastes:

The gaseous wastes are generated in to environment mainly due to anthropogenic activities. The gaseous wastes include carbon dioxide (CO_2), methane (CH_4), chlorofluorocarbon (CFC), oxides of nitrogen (NOx), carbon monoxide (CO), oxides of sulphur (SOx) etc. These gaseous wastes can cause serious environmental hazards. Therefore, it is highly essential to take appropriate steps for the proper management and control of gaseous wastes in the environment.

Management of gaseous waste

(i) The gaseous pollutant like SO_2, H_2S, HC1, Cl_2, NH_3, etc. can be removed by absorption in (using appropriate liquid) wet scrubbers.

(ii) The use of smokeless chulhas, solar cookers and biogas can reduce the production of smoke.

(iii) The industries should use precipitators, scrubbers and filters to check production of particulate matter.

(iv) The emission of hydrocarbons from vehicles can be checked by the use of unleaded petrol.

(v) The large scale of plantation which will reduce CO_2 level and increase O_2 level of atmosphere.

(vi) There should be high chimneys in industries.

Biotechnological Applications in Waste Management

Aerobic method treatment

Composting

Composting is the process of decomposing organic solid wastes and recycle organic materials to form good compost fertilizer for plants.
Composting is the fundamental method that suits various scales of application, from individual level to community level. The process of the decomposition of waste in controlled conditions with the help of micro-organism.

The common materials which are composted easily are leaves, grass, animal food, old herbs & spices, newspapers, vegetable, bread, cereals & organic waste etc. The materials to avoid for composting are plastic, bones, meat, synthetic chemicals, diseased plants and animals etc. Additional materials such as saw dust and fibre powder can be used for quicker breaking of organic compounds. Wastes generated in the hospitals are very dangerous and need to be disinfected completely prior to their disposal. Study has shown that the infected waste which is biodegradable in nature can be disinfected by using the process of vermicomposting.

Vermicomposting

Vermicomposting is essentially an environment friendly technology generating wealth from waste (Fig.7). It is a another bio-technique for converting the solid organic waste into compost (Ghosh, 2004). An innovative discipline of vermiculture biotechnology, the breeding and propagation of earthworms and the use of its castings has become an important tool of waste recycling the world over. Essentially, the vermiculture provides for the use of earthworms as natural bioreactors for cost-effective and environmentally sound waste management. This technology does not cause any negative impact on the surrounding or on human health (Fig.7).

Figure: 7 vermicomposting
Source: https://www.diynetwork.com/

Anaerobic degradation process

Some of the pollutants are not degradable by aerobic degradation they are some pesticides like DDT and chlorinated dioxins. The waste from the pesticides have the bad effect on the environment and it is important to degrade the pesticides waste.

Bioremediation:

It is the natural process which makes the use of microorganism to remove waste or pollutant from the water and soil. This method is environment friendly as it involves eco-friendly microbes in treating the solid waste (Fig. 8).

1. In-situ bioremediation:

It is the process in which treatment of contaminated soil or water takes place without excavation and transport of containments. Biological treatment on surface of the waste is carried out by bacteria. The contaminated spots are in the form of aqueous solution from which the bacteria develop further and result in degradation of organic compounds. It is the alternative method of treatment of soil and ground water. This method is economical and makes the use of non-toxics microbes for the treatment of chemicals. The in-situ bioremediation is dividing into 3 types (Fig.8)

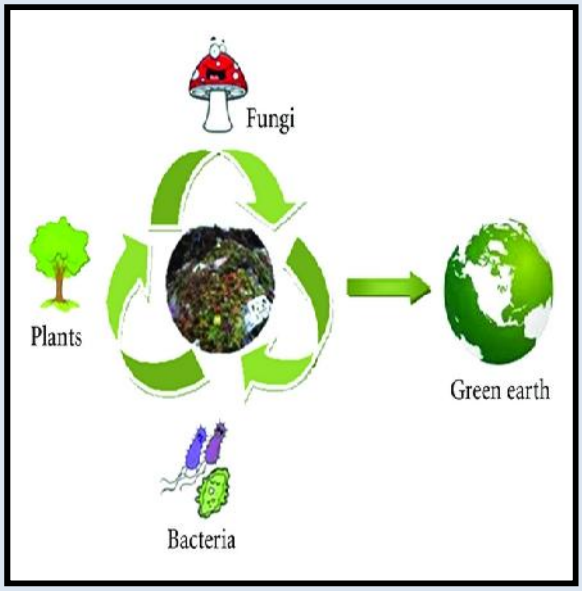

Figure: 8 Bioremediation
Source: http://www.pinsdaddy.com

a) Biosparging:

Is the process of treatment of waste used where the sites having petroleum products like diesel, gasoline, lubricating oil. In this method the concentration of oxygen is increased by injecting the air below ground water under pressure. The proper control of air pressure has to avoid the liberation of volatile particles to atmosphere, in turn causing air pollution.

b) Bioventing:

This is the process of degradation of waste compounds which are degradable by aerobically. Solid wastes generated from oil reservoirs during extraction of gasoline and petroleum are treated using bioventing. The waste treatment rate varies from site to site, as the different composition of hydrocarbons and difference soil texture, and in this process the contaminated site is injected by oxygen and nutrients like phosphorus and nitrogen to increase the rate of removal process.

c) Bio augmentation:

The process of enhancing the degradation of waste takes place at the contaminated site by introducing the microorganism which having the specific metabolic capacity. This process ensures that the in situ microorganisms also

degrade contaminates present in the ground water and soil to non- toxic compound like chloride and ethylene.

2) Ex-situ bioremediation:

In this bio technique, the soil contaminated by waste is sampled and excavated, transferred to another place for treatment. The following are the types of ex situ bioremediation:

i) Composting: Is the process of degradation of waste by controlled conditions the temperature should be around 55-65.

ii) Bio piling: The hybrid process of land forming and composting is biopiling and it is used where the cleaning of the surface contaminated by the petroleum hydrocarbons. This process takes a time around 2 to 3 months.

iii) Land forming: The process in which the excavation of contaminated soil and spreading it periodically tilled on a prepared surface till it degrades.

Some Case Studies on Waste Mangement in India

Village – Purnanagar, Nokari Gram Panchayat, Ranaghat-II Subdivision, Nadia, West Bengal

The Purnanagar village under Nokari Gram Panchayat was purposively selected for recording solid waste management strategies. This village is very famous for floriculture. So here study had been conducted on bio solid waste management.

Method of waste management: The village mostly consists of two methods of waste management strategy.

On one hand, organic fertilizer is produced from household wastes.

On the other hand, livestock wastes as cow dung is used as Bio-gas for cooking.

Rudrapur Village Gram Panchayat : Icchapur- Nilganj Gram Panchayat District: North 24 Parganas, West Bengal

Rudrapur Board mill is totally depends on paper waste which they collect from the surrounding villages, shops, malls, waste collectors etc. Paper wastes are dumped into the pulper. The wastes are mixed with water within the pulper. Then the semi solid material is run through a pipe in a rolling machine. In the rolling machine, the semi solid wastes are cut according its size and loaded in van. In the next step the wet paper boards are taken to an open place, where they are dried. After drying, the boards are then again taken within the mill for rolling.

Barrackpore Municipality, Barrackpore, West Bengal

In 2011, a project for Vermi-compost was launched in Barrackpore Municipality. The project was carried on at the dumping sight. From here, manure was produced and supplied to various Gram Panchayats at the rate of Rs 1.50/kg. the manure was named as “Jyibanidhi”.

Vivekananda Institute Of Bio-Technology, West Bengal

Vivekananda Institute of Biotechnology is a branch organization of Sri Ramkrishna Ashram, Nimpith has come up a long way since 1991 with support from Department of Bio-technology (DBT), Department of Science and Technology (DST) and CAPART (Govt. of India). The institute is engaged in solid waste management within its campus since long.

Today there are two process of producing Bio-gas with solid wastes excreted from human waste, cow dung and also kitchen waste.

Deenabandhu Model: A domestic bio-gas unit is a digesting chamber where manure, from both cows and humans, ferments to provide biogas, through the release of methane. Biogas is seen as a clean fuel, and provides a feasible alternative to cooking gas.

KVIC Model: The first KVIC Model was established in VIB 24.04.2005 which was financed by WBREDA. Two types of models present at VIB one of 40 m^3 and 60m^3 capacity.

Vermiculture biotechnology for waste management in different seasons:

The study was carried out during the period 2005-2007 in selected hostels of Rajasthan University. The study was carried out in Annie Besant and Mother Terrsa hostels of Maharani's college, University of Rajasthan, Jaipur, India.

On the basis of the results it was observed that winter season is the best season for earthworms rearing and production of vermicompost than rainy and summer season.

Vermicomposting At FRI

At FRI, the division of Ecology and Environment has started a project on vermitechnology. The project "Income generation for women in rural areas of Uttaranchal through vermicomposting of organic solid waste into manure" is sponsored by the Department of Biotechnology, Government of India. The main objective of this project is to develop additional source of income for rural population especially women folk by using the solid waste as useful resource.

First zero waste colony in Delhi!

It is estimated that the total solid waste generated by 300 million people living in urban India is 38 million tonnes per year. About 1,00,000 MT of municipal solid waste is generated daily in the country. Urban local bodies spend about Rs 500 to Rs 1,500 per tonne on solid waste for collection, transportation, treatment and disposal.

Success Story: 20,000 homes in Kerala use indigenous at source Biogas plant

BIOTECH is an NGO based in Kerala, South India, which has developed biogas digesters for managing food waste and other organic waste in more than 20,000 households, 220 institutions and 19 municipal sites. The digesters are prefabricated from ferro-cement and gas collectors made from Fibreglass Reinforced Plastic (FRP) so that they can be installed quickly and easily on site and has no electric or moving parts.

Fabric From Plastic

Arora Fibres recycles discarded plastic bottles into polyester used as packaging material

Plastic bottles can be re-used to make polyester fabric. Rupinder Singh Arora, Chairman of Arora Fibres Ltd, has been recycling discarded plastic bottles into polyester staple fibre since 1994 after he saw the colossal damage to the environment from mountains of bio-degradable plastic being burned in the country.

Hanjer is turning solid waste into fuel to run power plants

Waste management company Hanjer Biotech Energies realised that when it kickstarted India's first green power plant in Jalgaon in Maharashtra this year by using a by product of solid waste as fuel.

Solid Waste Management in Mangalapady Village Panchayat in Kasaragode District-Kerala

The Clean Kerala Mission assisted Mangalapady Village Panchayat inestablishing a waste processing plant using vermi composting and biomethanation.

Decentralized Solid Waste Management in Chunakkara Village Panchayat in Alappuzha District– An example of Panchayat – NGO – Community Partnership

Chunakkara is a backward Village Panchayat of Alappuzha district with 14 Wards covering 5411 households within an area of 17.32 kms^2. Management of Solid waste emerged as a major problem with waste piling up in all publicplaces inviting the protest of the public. The Socio Economic Unit Foundation(SEUF), a leading NGO in the sanitation sector entered into a partnershipwith the Village Panchayat and decided to promote decentralized wastemanagement with focus on the household through a process of intensive awareness building and community education.

Decentralized Solid Waste Management in Alappuzha Municipality- an example of community based Solid Waste Managementin an urban situation

Alappuzha Municipality having 50 Wards and 32,203 households is spread over 47 kms^2. With only about 50% of the 65 to 75 tonnes of waste generated every day being transported to the dumping yard in the adjacent Panchayat,the remaining waste spilled over into the beautiful ancient Venice like canal system of the town converting it into one of the most insanitary towns in the State.

Zero waste campaign at Kovalam- An example of citizen demand leading to constructive action

Kovalam is an international tourist centre. As the place was getting degraded with all kinds of waste, the Tourism Department decided to set up an incinerator. This proposal was vociferously opposed by local people fearing the emissions of the incinerator.

Biogas plant, Vengidangu Grama Panchayat

A Biogas plant was established in Vengidangu Grama Panchayt for treatment of solid waste from slaughter house. It is located at Muppattuthara of Vengidangu Panchayat.

TERI and JMI launch report on landfill gas recovery from Okhla waste disposal site

The Energy and Resources Institute (TERI) in association with Jamia Millia Islamia (JMI) launched a report entitled, “Demonstration of Clean Technology for Landfill Gas Recovery from the Okhla Waste Disposal site”.
The objective of this pilot demonstration study is to capture and purify the landfill gas being emitted uncontrolled from the Okhla landfill site by using indigenously developed technology options. The captured landfill gas can be used as the source of energy thereby reducing the risk of uncontrolled methane emissions from landfill, which is a potential Green House Gas (GHG).

Waste to wealth: ITC's success story in ITC Sonar Bangla, Kolkata

the electric heaters were replaced by solar heaters; power-guzzling boilers were removed and condensed steam used to generate hot water; and variable frequency valves were used in the fans (needed for the air-conditioning), so that speeds could be adjusted, thereby eliminating energy wastage.
Source:
http://www.rediff.com/money/2006/feb/11spec.htm

East Kolkata Wetlands: A success story of best out of waste

Kolkata is the only metropolitan city in the world where state Government has introduced development controls to conserve the wetlands. The Kolkata Municipal Corporation area generates roughly 600 million liters of swage and wastewater everyday. The wastewater flows through underground sewers to pumping stations in the eastern fringe of the city, and is then pumped into open channels. Threafter, the sewage and waste water is drawn into the fisheries of the East Kolkata Wetland by the owners of the fisheries. The East Kolkata Wetland remains a shining example of symbiotic man nature interaction. The city of Kolkata gets its huge volumes of daily sewage treated at no expense and gets in addition a substantial daily supply of highly edible freshwater fish. In fact kolkota city receives about one- third of its daily requirement of fish from the swage-fed fisheries (about 11, 000 metric tones annually)

Figure: 9 East Calcutta wetland

FORTHCOMING EVENTS		
Events	**Date**	**Place & Correspondence**
7-Day National Workshop On 'Vision towards Environmentally Sustainable Future'	July 24-30, 2018	Department of Environmental Science & ENVIS Centre University of Kalyani, India
An Interdisciplinary Approach in Characterization & Applications of Nanostructured Materials"	August 1-10, 2018	University of Kalyani, India. http://www.klyuniv.ac.in/download/seminar/chemistry_workshop.pdf
9th International Conference on Waste Management and the Environment	September 17 – 19, 2018	Seville, Spain http://www.wessex.ac.uk/conferences/2018/waste-management-2018
2nd International Conference on Bioresource Technology for Bioenergy, Bioproducts & Env. Sustainability	September16 – 19, 2018	Melia Sitges, Spain https://www.elsevier.com/events/conferences
3rd International Convention on Geosciences and Remote Sensing	October 19-20, 2018	Ottawa, Ontario, Canada https://geosciences.conferenceseries.com
Global Warming, Climate Change and Pollution Control	Dec 5-6, 2018	Vancouver,Canada, https://global warming.conferenceseries.com/

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