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SQ
raising the Sustainability Quotient

In this Issue

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Editorial

Waste or Resource Management? We need Circular Economy

Environmental Governance in India is more focused on the management of wastes and residues. The resource management perspective is not yet mainstreamed. The emphasis is still limited to waste treatment for protection of human health and ecosystems and not on waste prevention or on waste recycling, reuse and recovery.

Indeed, we do not consider waste as an opportunity to substitute extraction of virgin resources. We have a siloed approach to waste and resources and this questions sustainability and ecological security. Countries such as China, Korea and Japan have recognized the importance of waste and resource linkages at local, regional and national levels. These countries are applying this concept today by promoting policies and regulations towards achieving *circular economy*.

> *A circular economy is an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life.*[1]

[1] *http://www.wrap.org.uk/content/wrap-and-circular-economy*

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Reader's Column

We invite feedback suggestions
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In this issue of SQ, we present four interesting articles to our readers. These articles cover topics such as energy generation from agricultural waste, Nisargruna technology for biomethanation of Municipal Solid Waste (MSW) and a case study on net energy gain in the management of food waste. Apart from these case studies and knowledge articles, we present waste recycling initiatives of an NGO in Mumbai. This initiative could be rather inspiring given the movement "Swatch Bharat Abhiyan" launched by the Prime Minister.

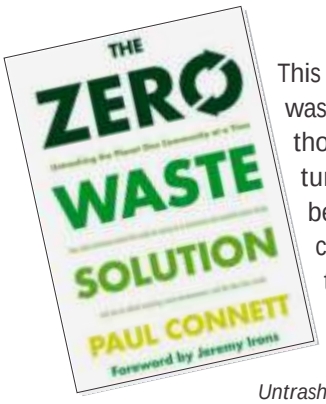
It is often said that the driver to waste to resource thinking is sheer economics. If there is money to gain, no one would simply waste! Waste then becomes a resource – just as a business logic. But when project economics is not favourable, how can we promote waste as a resource more on a holistic basis and in the framework of "total cost accounting"?

How can we go beyond project limited economics to more socially responsible behaviour and bring sustainability related considerations? We need here enabling policy frameworks, financing schemes and partnership approach. Only then we could upscale, replicate and sustain the waste to resource business.

We need to therefore promote more of decentralized waste processing models involving communities. Again, partnerships between informal and formal sectors have the potential to demonstrate innovative business models. These business ventures can help in creating green and safe jobs, lead to sustained livelihoods and promote entrepreneurship. We need to build a repository of case studies to guide and stimulate the waste to resource industry. The BCCI could play a key role in facilitating above.

- Prasad Modak

BOOK: THE ZERO WASTE SOLUTION



This book describes some of the most successful zero-waste initiatives around the world and puts forth a food for thought on whether incinerators are safe. Scientist-turned-activist Paul Connett, the author of this book is best known around the world for leading efforts to help communities deal with their waste in sustainable ways: to eliminate and reuse waste rather than burn it or stow it away in landfills.

Source: http://www.amazon.com/The-Zero-Waste-Solution-Untrashing/dp/1603584897

Sugar Waste to Energy via Co-generation

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Sugar Co-generation

Sugar is a seasonal industry operating for only about six months a year or less in many states of India. Sugar is the primary product while the four main by-products are cane tops, bagasse, filter muds and molasses. Heat and power can be obtained from bagasse through co-generation, which is the focus of this article. Co-generation means the generation of two forms of energy – heat and power - from one single source. It is also known as Combined Heat and Power (CHP). The sugar industry is designed to be sustainable by using the bagasse to generate steam and power during off season. Co-generation also is a carbon neutral process which adds value to the whole operation.[2]

It's not just the sugar industry that benefits from sugar co-generation, but it can also be used as an alternative to the more fossil-fuel based electricity. An example of which is the proposed Clean Development Mechanism (CDM) project: 35 MW Bagasse Based Co-generation Project by Mumias Sugar Company Limited in Kenya.[3]

Figure 1 shows basic flow diagram of how bagasse produced from the sugar mill is transferred to the power house for power and steam generation. The excess of the generation is then sent to the national electricity grid.

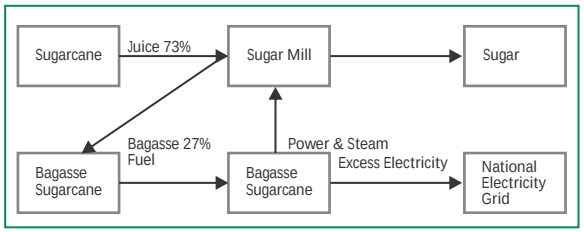


Figure 1 : Schematic diagram of power co-generation in sugar mills[4]

Sugar Co-generation in India

Box 1 : India's Power Scenario

India is world's fourth largest energy consumer, after China, USA and Russia (contributing to 4.7% of global primary energy consumption).[5] The increase in energy consumption in India along with that of China, has substantially added to an already stretched global energy demand. Even though private sector participation has resulted in substantial growth in power sector infrastructure, the Indian power market still faces shortages. This deficit in power availability in India presents a significant impediment to the smooth development of the economy. Demonstrating the supply-demand mismatch faced by the country, the energy deficit in FY13-14 was 4.5% and the peak power deficit was 4.2%.

India is the world's second largest producer of sugar. The sugar industry in India is an important agro-based industry that impacts the livelihood of about fifty million farmers and half a million employed in sugar mills. With about 600 mills and an annual production of about 24 million tonnes of sugar, the industry is a huge generator of direct and indirect rural employment.

The sugar sector as a whole has not been a highly profitable venture in recent years, primarily because of regulation on the purchase price of sugarcane from farmers and lower sale price of sugar. However, the mills are extremely important since the livelihood of thousands of farmers in the cane area is dependent on them. The Indian sugar industry is a key driver to rural development and plays an important role in the country's economic growth, encompassing nearly 7% of the country's rural population. It is a symbiotic relationship

[2] *Co-generation. Punjab Energy Development Agency (PEDA) - http://peda.gov.in/eng/cogeneration.html*
[3] *35 MW Bagasse Based Cogeneration Project by Mumias Sugar Company Limited (MSCL). UNFCCC Clean Development Mechanism Project Design Document. http://cdm.unfccc.int/filestorage/d/b/67QPTS14GX0JZOV9DK5L3BM2NCHEAF.pdf/Mumias%20clean%20version.pdf?t=WG58bmdvNnB5fDCF-WyRXpdvg7VjoTbjUu7O*
[4] *Mishra M K; Khare N; Agrawal A B. (2014) Bagasse Cogeneration in India: Status, Barriers. IOSR Journal of Mechanical and Civil Engineering. 11 (1): pp 69-78. https://www.princeton.edu/pei/energy/publications/texts/International-Sugar-Journal.pdf*
[5] *BP Statistical Review of World Energy June 2014, British Petroleum, 2014. http://www.bp.com/content/dam/bp/pdf/Energy-economics/statistical-review-2014/BP-statistical-review-of-world-energy-2014-full-report.pdf*

between the farmers and the mill, where mill's success depends on long term relationship with farmers and cane development activities undertaken in the area.

Although the industry has been facing problems, but with a new business friendly government at centre and the initiation of the much needed reforms process the long term sustainability of the sugar sector and the private sugar mills is very much intact.

Apart from being an environmentally friendly source of power, clean energy from bagasse can also contribute to India's power needs. Together with an increased awareness of the benefits of clean energy and long timelines required for installing conventional capacity, there is a greater emphasis on developing renewable power. In 1990, India had an installed capacity of 18 MW from renewable energy sources. Recognizing the need to tap into their vast renewable sources, India's renewable energy capacity has surged from 7,761 MW in 2007 to 32,424 MW as of August 2014 – a 300% increase over seven years. The installed capacity of renewable based plants in India is given in Table 1. As seen from Table 1, bagasse co-generation offers 8.26% of the total installed capacity, next to wind power; small hydro power; and solar power.

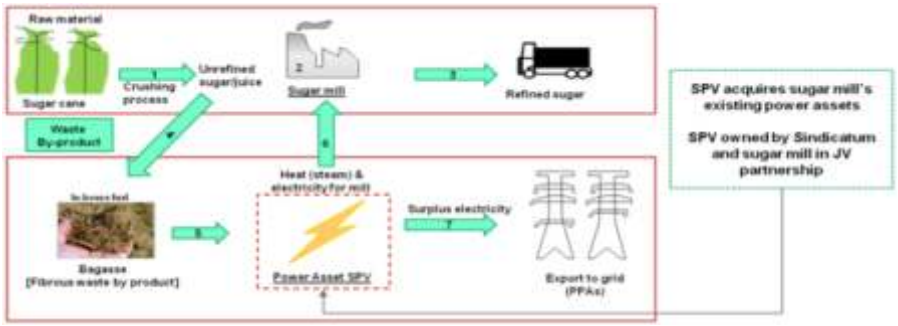
Table 1 : Installed capacity of renewable based plants in India

Grid-interactive Renewable Power	Installed Capacity (MW)
Wind Power	21,692
Small Hydro Power	3,826
Biomass Power	1,365
Bagasse Co-generation	2,680
Waste to Power	106
Solar Power (SPV)	2,753
Total	32,424

Source: Ministry of New and Renewable Energy, Government of India

Box 2 :Sindicatum's Waste-to-Energy Business Model

Sindicatum enters into a project through a Joint Venture (JV) with a sugar mill. Once a JV is formed, the sugar mill's existing power assets are acquired by a newly formed Special Purpose Vehicle (SPV), to be jointly owned by Sindicatum and the mill owners. Electricity from the plants is then exported under long-term Power Purchase Agreements (PPAs). During the modernization and upgradation of equipment (if required) the existing plants remain in operation and continue generating power and revenue. This is illustrated by the diagram below:



The power units, in joint ownership with the mill owners, benefit from a secure fuel supply base comprising 100% of the host's bagasse supplemented, if necessary, by biomass from surrounding areas to allow for extended power generation beyond the five-seven months sugar season.

Using this sector as a platform, Sindicatum intends to position itself with the goal of becoming a leading biomass player in India. It currently has contracted 212 MW of funded bagasse-to-power projects in India – 15 MW in Punjab and 125 MW in Uttar Pradesh.

Conditions That Make Sugar Co-Generation Favorable In India

As per the Ministry of New & Renewable Energy (MNRE), the potential for power generation from biomass in India is nearly 18,000 MW (agro residue and plantations), while an additional 5,000 – 7,000 MW potential exists in bagasse-based co-generation.

Grid-interactive renewable power projects based on wind power, biomass, solar and small hydro are mainly private investment driven, with favorable tariff policy regimes established by State Electricity Regulatory Commissions (SERC), and almost all renewable power capacity addition during the year has come through this route. Roll out of 'green energy corridor' project to facilitate the flow of renewable energy into the national grid and synchronization with conventional power will further assist India in meeting its goal of 55 GW of energy capacity by 2017.

India launched the Bagasse Co-generation Programme in 1994. In 2010, the ministry initiated a new scheme on Build, Own, Operate, Transfer (BOOT) model co-generation project in cooperative/public sector sugar mills and another scheme for

providing Central Financial Assistance for boiler up-gradation of co-generation project in cooperative sugar mills.[6] The country reached a cumulative co-generation capacity of 1,932 MW from 117 such projects in 2011.

Sugar Co-generation Technologies

Commercial co-generation systems that are widespread are:

- Steam Turbine Co-generation systems - backpressure and the extraction steam turbines
- Gas Turbine Co-generation Systems - gas turbine with heat recovery boiler (with or without bottoming steam turbine)
- Reciprocating Engine Co-generation Systems - with heat recovery boiler[7]

Selection of these systems can be made based on:

- Heat-to-Power Ratio
- Quality of Thermal Energy Needed
- Load Patterns
- Fuels Available
- System Reliability
- Grid Dependent System Versus Independent System
- Retrofit Versus New Installation
- Electricity Buy-back
- Local Environmental Regulation

Out of these, sugar industry specific criteria include energy utilization factor; heat-to-power ratio; fuel energy savings ratio; exergetic efficiency; and power generated per tonne of cane (tc). The existing high pressure, high efficiency steam turbine co-generation plants generate 115-120 kWh/tc, while biomass-integrated gasifier/gas turbine co-generation (BIG-GT) and biomass gasifier combined with steam injected gas turbine co-generation (BIG-STIF) can generate up to 270-275 kWh/t.[8]

Case study: Advanced co-generation power system in Tamil Nadu Sugarcane Corporation Ltd.[9]

Case : Co-generation in sugar mill (2500 tonnes of crushed sugarcane per day (TCD))

Technology : Low efficient mill turbines were replaced with hydraulic drives and DC motors.

Benefits :

- Co-generation power increased with an efficiency of 65-70% after upgradation of technology
- Generation : During season 3 MW to 15 MW while off-season 16.5 MW
- Export capacity: Nearly 41 million units of electricity in the season (172 days) and 36 million tonnes in the off-season (100 days)
- Total CO_2 offset : 62,950.75 tonnes of CO_2 per year
- CDM revenue : Rs. 17 crores per year

Conclusion

Sugar co-generation strengthens all three pillars of sustainability. It is an environmental friendly process that is carbon neutral. From an economic standpoint, bagasse co-generation is a win-win for the sugar industry. It not only creates an additional revenue stream for the sugar company, but also provides it with much needed financial stability. Other social benefits include more widespread availability of electricity, more secure and reliable supply of electricity for existing consumers, increased employment for neighboring populations and increased income for farmers (through the sale of otherwise wasted biomass residues to supplement bagasse as a fuel).

Until now only a small percentage of the total potential of bagasse-based co-generation has been exploited and a significant opportunity exists, particularly in the leading sugarcane producing states of Uttar Pradesh and Maharashtra. There is sufficient capacity in the sugar mill industry to roll-out 5,000 MW of bagasse-to-power plants in India within the next 3 to 5 years.

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[6] *Annual report 2011-12. Chapter 5: Power from Renewables - Grid Interactive and Off Grid Renewable Power. Ministry of New and Renewable Energy. Government of India. - http://mnre.gov.in/file-manager/annual-report/2011-2012/EN/Chapter%205/chapter_5.htm*

[7] *Bureau of Energy Efficiency*

[8] *Kamate S C; Gangavati P B (2009) Cogeneration in Sugar Industries: Technology Options and Performance Parameters—A Review. Cogeneration & Distributed Generation Journal. 24 (4)*

[9] *Premalatha M; Shanmuga Priya S; Sivaramakrishnan V (2008) Efficient cogeneration scheme for sugar industry. Journal of Scientific & Industrial Research. 67: pp 239-242*

Net Energy Gain from Food Waste

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Waste water treatment process as the name goes would not naturally be a choice of food waste treatment where it is generally disposed of in landfills or is composted. During the course of advocating for disposers as a sustainability tool in managing food waste, and through study of a few decades' worth of research, the existence of a scientific gap was observed that had not been previously addressed in an adequate manner. As a student pursuing Masters' Degree it was an exciting finding. Diversion of organics from landfills and resource recovery at wastewater treatment plants was found to be a relevant research project and is discussed in this article in detail. The project included creation of a model to quantify the impacts of food waste on wastewater treatment.

Quantifying Food Waste BOD Reaching Aeration Tanks

The project quantified how much Biochemical Oxygen Demand (BOD) from food waste reached energy-intensive aeration tanks at wastewater treatment plants. Existing literature in *Wastewater Engineering* lists the value at 20 grams of BOD per capita per day where food waste disposers are used, but this number does not take into account how much of it decayed in sewers, or how much settled out during primary clarification. Such issues are critical for wastewater professionals in order to assess how much food waste actually reaches the treatment plant, and if there is a net energy demand on the entire system. This is important in rendering judgment whether or not disposers should be viewed as environmentally responsible.

With the help of the research done by Willie Gonwa and Symbiont Engineers on settleability of food waste in the year 2010 and existing knowledge on particle sizes of ground food waste, two mathematical models were created to describe potential aerobic decay in sewers. The models were then validated by creating a third model using laboratory results from analytical techniques that can be described by Equation 1. Considering a scenario where the food waste took ten hours to reach the treatment plant, there would be about 15% aerobic decay of the BOD. Equation 2 developed provided quantification of how much food waste BOD entering sewers (from household disposers) ultimately reaches secondary operations at wastewater treatment plants.

Box 1 : Food Losses Worldwide

Over 40% of food losses take place in developing countries in the post-harvest and processing stages, whereas in industrialized countries they occur chiefly in the distribution and consumption stages.[11] Many wastewater treatment facilities already have existing anaerobic digesters. If 50% of the food waste generated each year in the U.S. was anaerobically digested, enough electricity would be generated to power over 2.5 million homes for a year.[12]

$$BOD_t = UBOD\ (1 - e^{-0.39t}) \text{.....Equation (1)}$$

where,

UBOD = Ultimate Biological Oxygen Demand

BOD_t = Biological Oxygen Demand in time t

t = time in sewers in days

$$BOD_{SA} = A \times (0.12\ kg\ BOD_5/A) \times (e^{-0.39t}) \times (1 - B) \text{ .....Equation (2)}$$

where,

BOD_{SA} = BOD_5 to Secondary Aeration in kg

BOD_5 = 5 day BOD

A = Food waste in kg

B = Primary Removal Efficiency

[10] *Michael Keleman can be found writing such insightful articles on his website WasteFull Thoughts. http://www.wastefullthoughts.com/*
[11] *Opinion of the European Economic and Social Committee on Civil society's contribution to a strategy for prevention and reduction of food losses and food waste*
[12] *Turning Food Waste into Energy at the East Bay Municipal Utility District (EBMUD). http://www.epa.gov/region9/waste/features/foodtoenergy/*

Table 1 describes results from making a range of assumptions regarding how much food waste is removed during primary clarification. It also includes other key factors impacting the overall energy balance. Even at the most conservative level of only 25% settleability of the food waste BOD, there is a net energy gain.

Conclusion

The conclusion is that at all three primary removal rates, there is a net energy gain for sending food waste through disposers to a conventional activated sludge wastewater treatment plant using anaerobic digestion. Using disposers results in a net energy gain and lowers costs for municipalities. Given the results, using disposers to divert food waste from landfills to advanced wastewater treatment plants is not only environmentally responsible, where the biogas is captured for energy and the biosolids are beneficially reused, disposers are, indirectly, a fiscally responsible tool for municipalities.

Table 1 : Net energy gain from food waste

	Criteria	*Assumption*	*Value*			
Model City	Size of WWTP	Typical Facility	5			million gallons per day (MGD)
	Population	100 gallons/capita per day	50000			people
Energy Demand from Food Waste	Mass of Food Waste to WWTP	0.3 pounds/person per day 50% with disposers	7500			pounds of food waste/day
	Pounds of Food Waste BOD	0.12 pounds BOD5/pound of food waste	900			pounds of BOD5 / day
	Amount of BOD to WWTP	Primary Removal	760			pounds of BOD5/day
	Amount of BOD to Secondary Aeration	15% decay after 10 hours in sewer	25%	45%	61%	Efficiency
			570	418	296	pounds of BOD5/day
	Energy Demand to WWTP	1.6 kWh/pound of BOD5 removed	0.912	0.669	0.474	MWh/day
Energy Production from Food Waste	Mass of Food Wsaste to WWTP	0.14 kg/person per day 50% with disposers	3500			kg of food waste/day
	Amount of BOD to WWTP	15% decay after 10 hours in sewer	3000			kg of food waste/day
	Amount of Food Waste to Anaerobic Digestion	Primary Removal	25%	45%	61%	Efficiency
			750	1350	1830	kg of food waste/day
	Biogas production	367 M3/MT of food waste	275	495	672	m3 of biogas/day
	Gross Energy production	6.25 kWh/m3 of biogas	1.72	3.1	4.2	MWh/day
	Net Energy Production from Anaerobic Digestion	70% efficient combined heat and power system	1.2	2.17	2.94	MWh/day
		Total Net Energy	0.29	1.5	2.46	MWh/day

Sustainable Bio-cycles for Better Quality of Life

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The concept of "waste" has developed in last few decades. The idea that something is not useful and therefore it is labelled as waste has to be changed. "Not in My Backyard" is the buzzword! Since any waste is a resource, it has to be treated like a resource. This article explains one way to do this - biomethanation with Nisargruna plants.

Nisargruna Plants

Nisargruna plants are designed for handling and processing the biodegradable waste materials generated in kitchens, vegetable markets, slaughter houses, food and fruit processing industries, agro-waste, biological sludge generated in effluent treatment plants of food, paper and textile industries and biomass in a decentralized manner.

We can have various capacity Nisargruna plants at various locations based on population density. Nisargruna plant supplemented with a dry waste resource shed can reduce more than 80% of waste resource reaching at dumping yards. These dumping yards may be replaced with scientific landfill sites. Segregation at source is the key to such a system.

How do the Nisargruna Plants work?

Nisargruna technology produces organic manure (soil conditioner) and biogas based on the process of biomethanation from biodegradable waste resources as shown in Figure 1. The organically rich bio-degradable portion of solid waste is homogenized with recycled water to form slurry. The slurry is then aerobically digested in predigester, where organic matter is converted to organic acids. The predigestion is accentuated by addition of hot water and intermittent aeration. Predigestion

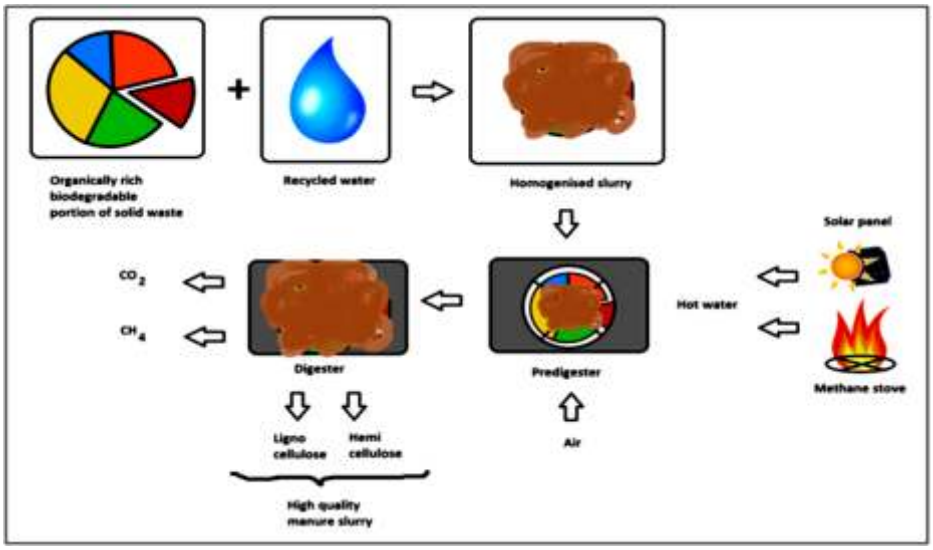

Figure 1 : Nisargruna process diagram

reactions are exothermic and temperature rises to 40°C by itself. Hot water obtained using solar energy is added to raise the temperature to 50°C. If sunlight is not sufficient especially during winter, provision can be made to use part of the biogas generated to heat the required quantity of hot water using methane stoves. The main role of predigester is to digest proteins and low molecular weight carbohydrates

to produce volatile fatty acids. It also helps in removing the scum forming materials. This important step is needed for making the process sustainable.

The smaller molecules like proteins and simple carbohydrates are degraded during Predigestion. The pH of the feed slurry to predigester is around 7-8. The retention time (*Hydraulic time)* of 4 days is maintained in the predigester. After the Predigestion the pH reduces to 4-5 pH units. The predigested slurry is further digested under anaerobic conditions for about 15 days. The process of methanogenesis takes place in this digester. Methane and carbon dioxide are the terminal products of this process. Methane is produced from two primary substrates viz. Acetate and Hydrogen/ Carbon dioxide (Formate). At this stage the organic acids are converted by consortium of methane bacteria to methane and carbon dioxide.

The undigested lignocelluloses and hemicelluloses then flow out as high quality organic manure slurry. The pH of this slurry ranges from 7.5-8. Since the waste is processed at higher temperature, weed seeds are killed completely and the manure becomes weed free.

Biogas Production

The three steps of Biogas production are as follows; 1) Hydrolysis 2) Acidification and 3) Methanogenesis. Various bacteria are involved in these processes.

Hydrolysis

In the first step (hydrolysis), the organic matter is attacked by bacteria through extracellular enzymes (cellulase, amylase, protease and lipase) in the pre-digester tank. Converting solid waste into liquid form in the mixer stimulates this step. Bacteria start decomposing the long chains of the complex carbohydrates, proteins and lipids into shorter parts. Proteins are split into peptides and amino acids. Simple carbohydrates and proteins are degraded completely.

Acidification

Acid-producing bacteria involved in the second step convert the intermediates of fermenting bacteria into acetic acid (CH_3COOH), hydrogen (H_2) and carbon dioxide (CO_2) in the predigester. These bacteria, of the genus bacillus, are aerobic and facultatively anaerobic, and can grow under acidic conditions. An air compressor maintains aerobic conditions in the predigester. To produce acetic acid, the bacteria use the oxygen dissolved in the solution or bonded oxygen. Hereby, the acid-producing bacteria reduce the compounds with a low molecular weight into alcohols, organic acids, amino acids, carbon dioxide, hydrogen sulphide and traces of methane. The pH of the raw slurry falls from 7.5 to about 4.5 to 5.5 in the pre-digester. It appears that in the predigester, various zones are formed and different bacteria dominate these zones.

Addition of hot water helps in eliminating the mesophilic bacteria and selection of thermophilic bacteria. But these thermophilic bacteria can operate at lower temperatures also. Hence hot water added even once a day should be sufficient for maintaining the pure consortium in the predigester. However if it is possible to maintain the temperature of predigester in the range of 42-45°C throughout the day, the performance of predigester will definitely be better and the holding time may be further reduced. The hot water helps in hygeinisation of the slurry by killing the enteric bacteria that may be present in the waste. Some Gram negative Enterobacteria and Coliform bacteria have been isolated in the raw slurry. However in the second zone these bacteria are totally eliminated. From the pre-digester tank, the slurry enters the main tank where it undergoes anaerobic degradation by a consortium of Archaebactereacea belonging to Methanococcus group. These bacteria are naturally present in the alimentary canal of ruminant animals (cattle). They produce methane from the cellulosic materials in the slurry. The undigested lingo-cellulosic and hemi-cellulosic materials are then passed on to the settling tank. After about a month, high quality manure can be dug out from the settling tanks. There is no odor in the manure and the organic content is high, which can improve the quality of humus in soil.

Methane formation

Methane-producing bacteria, involved in the third step, decompose compounds with a low molecular weight. Under natural conditions, methane-producing microorganisms occur to the extent that anaerobic conditions are provided, for instance

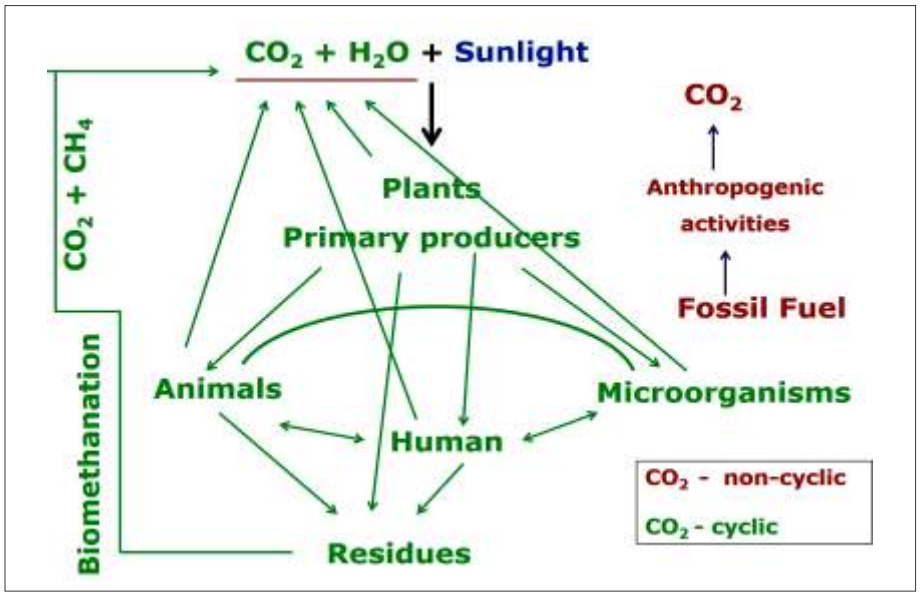

Figure 2 : How Biomethanation maintains Living Carbon cycle

under water (in marine sediments), in ruminant stomachs and in marshes. They are anaerobic and very sensitive to environmental changes. In contrast to acidogenic and acetogenic bacteria, methanogenic bacteria belong to the archaebacteria group, a group of bacteria with a very heterogeneous morphology and a number of common biochemical and molecular-biological properties that distinguish them from all other bacterial genera. It is advisable to circulate the generated biogas back into the system using a small compressor. This would enhance the reduction of carbon dioxide to methane and enrichment of methane fraction in the biogas.

The separation of two stages in methane production helps in improving the purity of methane gas, thereby increasing its fuel efficiency. However, the average composition round the year would depend on how effectively pre-digester temperatures can be maintained. It is taken through a galvanized iron (GI) pipeline to utility points. Drains for condensed water vapor are provided online. The biogas burns with a blue flame and is ideal for cooking. Alternately, it can be used to produce electricity in a dual fuel biogas-diesel engine.

Enviro-Economics of the Process

1 MT/day Nisargruna plant needs about Rs. 20 lakhs for installation and commissioning while O&M expenses would be about Rs. 1.5 lakhs per annum. The plant life is expected to be 40 years. It would save daily Rs. 1,000 (in urban area) per day on transportation when waste generated in a given area get processed in a decentralized Nisargruna plant in the same area and is not carried to dumping yard. It would generate about 80 m^3 biogas daily which has a commercial value is about Rs. 2,000. It would generate 45-50 kg manure which has a commercial value of Rs. 250. Thus the annual commercial value of these two byproducts is about 7.5 lakhs. The total saving would be 10.8 lakhs including saving on transportation per year. There are two more important factor for enviro-economics which are shown in Figure 3.

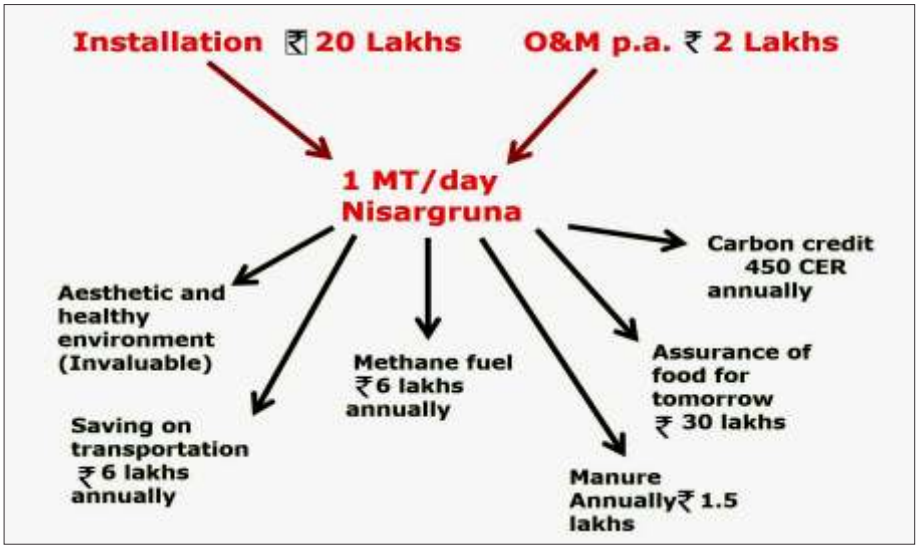

Figure 3 : Enviro-economics of Nisargruna plant

Advantages of Nisargruna Technology

1. Environmental friendly processing of biodegradable waste is achieved. This waste is completely zeroed and by-products are generated.

2. The elemental cycles like nitrogen, carbon, hydrogen, oxygen etc. cycles expect that the biodegradable waste has to go through microbial route for ensuring their availability for future life. Nisargruna achieves this objective fully.

3. The processing cost of biodegradable waste is far lesser compared to any other foreign technology.

4. Decentralized handling of the waste will reduce the transportation costs, dumping yard needs and assured processing. In long run, it means that dumping yards could be totally eliminated. If proper segregation occurs at the source, then the requirement of land-fill sites can be reduced by 60-70%.

5. Transportation of this waste through crowded areas could easily be avoided if decentralized Nisargruna plants are made available.

6. By-products like Nisargjyoti (biogas) and manure can make the process economically attractive.

7. Processing of solid biodegradable waste in this manner would ensure that this material won't be carried to dumping yards and release methane there, in slow and unplanned composting. Since the Nisargjyoti (biogas) is trapped to burn, the contamination of environment with a vast quantity of methane will be completely avoided. This would earn carbon credit.

8. The use of Nisargjyoti (biogas) as fuel will save the classical fuel consumption including petrol, LPG and diesel. This is another reason which will ensure the carbon credit for the process.

9. In rural areas where biomass can be made available to run these plants, energy-freedom can easily be achieved. The stand-alone Nisargruna plants can be rural power houses.

10. In rural areas it will reduce the use of wood as fuel thereby helping indirectly in afforestation.

11. The aesthetic looks of the country can be changed using Nisargruna technology.

12. It offers a long-life methodology to treat the biodegradable waste in a very limited space. The continuity of the process makes it possible to treat a large quantity of waste at a single site without any need of adjoining areas.

13. The technology is relatively simple and does not involve any imports. The plants can be operated by unskilled workers after training them initially for about 3-4 weeks. It is developed keeping in mind local environment and the types of wastes.

14. The manure generated in the process will help in rejuvenating the depleting organic carbon contents in our agricultural soils.

15. The processing of biodegradable waste and making it zero would tremendously improve the hygiene of the country, reduce the epidemics and make people in general healthy. The substantial reduction in health bills is a distinct possibility. It would also influence the human efficiency.

REPORT OF THE TASK FORCE ON WASTE TO ENERGY PUBLISHED

Report of the Task Force on Waste to Energy was published by Indian Planning Commission this year. The report focuses on the current situation of MSW management and various technologies that can be supported at a Decentralized and Centralized level on Public Private Partnership (PPP) mode to enhance resource recovery and deriving energy and nutrients from waste.

To read the report visit: http://planningcommission.gov.in/reports/genrep/rep_wte1205.pdf

In Search of Black Gold - An Interview with RUR

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Land of Black Gold

Avid readers of the comic series Tintin, will recall the issue on Black Gold, the reference here was to crude petroleum found in the deserts of the gulf. Nowadays, Black Gold has taken on an astute meaning quite the contrary to fossil fuel. Ask any ardent organic farmer and they will tell you that Black Gold is the synonym used for that most nutritious component of soil uncommonly known as 'humus' and more commonly known as compost.

Mumbai is a space starved city; something that every citizen cribs about at least once a day in their daily commute. Fortunately there are 'green thumbs' amongst us who can see possibilities, where we see window sills and terraces. Having known of such a group from its inception in 2009, it didn't come as a surprise to learn of their entry into 'urban terrace farming' in Mumbai.

War on Waste

RUR *('Are you reducing, reusing, recycling?'*) was founded by an engineer from Stanford University, living in Mumbai, when she realized the impact of the staggering amount of waste generated in Mumbai every day. Her concern was the devastating consequences of this waste on future generations, including her family. Sensing the urgency of the problem, Monisha Narke got together a team of equally passionate women and started their war on waste through their organization, RUR.

Over the past six years, with the help of her team of three and countless volunteers/supporters, RUR embarked on partnership projects with big names in the corporate world like Panasonic; Johnson & Johnson; Reliance Retail; Tetra Pak India; and Sahakari Bhandar. The programs included waste audits, collection and recycling drives/campaigns and implementation of waste segregation, composting and management solutions. A large part of their repertoire includes awareness generation programs for the general public and schools through interesting and interactive campaigns. For a small group, they have made a big impact reaching out to 6 lakhs individuals, 50 schools, 20 colleges, 15 corporates and 2 retailers.

Box 1: Amount of waste generated in Mumbai

Every day, Mumbai generates 7,500 metric tonnes of waste according to the yet-to-be released ESR of Mumbai for 2013-14. Of the 1,27,486 tonnes of waste generated daily in India in 2011-12, Mumbai alone accounted for 6.11 per cent. It is estimated that every resident in the metropolis now generates about 630 grams of waste daily, a figure that is expected to touch 1 kg in the coming years.

One-on-one with the 'Waste to Resource' Crusader

An interview with Monisha at her current project at Fortune Heights, Mahim, Mumbai where RUR has implemented a holistic waste management solution for the residential tower of 28 families, gives an insight on how RUR functions. “Convincing people is perhaps the biggest challenge. But once they understand the impact of waste to their own families and see the benefits of composting in the form of freshly grown produce, they are converted” says Monisha explaining the work at Fortune Heights which also happens to be her place of residence. The children of the families have a big role to play; something that they take on with all the enthusiasm and sincerity that comes with their age. Their whole hearted participation convinces their parents and very soon the entire family is taking the job seriously.

Trial and Error to Perfect the Art

From demonstrating segregation of household waste into dry and wet to training the *kachrawala* or door-to-door waste collector to use the composting equipment, it is all handled by RUR. Harvesting the compost includes a fortnightly cycle during which it is regularly monitored to ensure the right conditions for the wet waste to break-down and turn into black gold. The families then

come together to help layout the beds and pots for growing a terrace garden comprising of easy-to-grow herbs and seasonal vegetables. "Trial and error with how, when and what to grow has helped us perfect the art of sustaining a vegetable garden" explains Monisha.

Case Study: 'Waste to Kitchen' Urban Terrace Farming in Mumbai, October 2014

2 years ago, RUR took up the initiative to recycle bio-degradable waste into compost. They embarked on a sensitization campaign on Sustainable Waste Management using circulars, posters and sessions. 'Waste to Kitchen' Urban Terrace Farming took place at Fortune Heights in Mahim West in Mumbai, a residential tower of 13 floors with 28 families and terrace on the 14th floor.

Total cost of the management unit amounted to Rs. 20,000 between 28 families, around Rs.700 per family. Daily 15 to 20 kg of wet waste from the kitchens like vegetable and fruit peels, flowers, leaves from the compound etc. were placed into the composting bin. Every 2 months they generated 240 kg of compost. In a year they recycled 600 x 12 = 7200 kg of wet waste: excluded from going to the landfill/dumping and equivalent carbon emissions prevented from being released into the atmosphere. Dry recyclables like paper, plastic and metal were also collected and responsibly disposed. All the compost was given to the families as well as for the trees and the terrace garden. Harvests so far from the terrace garden include brinjal; cabbage; spinach; ridge gourd; sweet gourd and herbs like mint; basil; chilli, and flowers like hibiscus and mogra. They hired one person on a monthly basis to help.

Residents have come close as a result working together as a community while spreading the word of their work. They have signed a Green Pledge and become Champions for the cause!

Small Solutions for a Big Problem

Encouraged greatly by the success of this project, the team at RUR were invited to implement a similar solution at the much larger Housing Colony of Marathon Era in Lower Parel. Here they handle much larger volumes of a different kind of waste. Also, in the offing are waste audits and green school awareness programs as well implementation of waste management solutions across the city.

Monisha said, gazing at the vista of a sprawling Mumbai, "Look at the number of terraces out there that can all be converted into a landscape of green while lowering our collective waste footprint". RUR and others like them have a potential to grow substantially to help Mumbai city from drowning in its rising mountain of waste!


Monisha demonstrating the composter at Fortune Heights


Monisha demonstrating the shredder/composter


Core team of RUR: Monisha, Malvika, Sejal & Smita


Families with children setting up the garden using compost


Monisha and her daughter harvest vegetables on the terrace


Terrace garden with raised bed for growing vegetables

Living in a Plastic Home

Lise Fuglsang Vestergaard, during her visit to a small village just south of Kolkata, noticed that building supplies were in less supply. She also noticed a lot of plastic waste around. In response to these observations and as a design graduate student, she came up with a solution that would solve the two issues at the same time. She designed a manufacturing method that would melt and mould plastic waste into bricks. Coupling this technology with a solar-powered grill, these bricks can be produced in a power-deficient country like India. Manufacturing of these bricks would require an ordinary oven and plastic waste with a ratio of 60:40 plastic snack bags and a combination of other plastic products. These bricks can withstand up to six tonnes of pressure, equivalent to six small sized cars on one square meter. A study conducted by the Central Pollution Control Board (CPCB) and Central Institute of Plastic Engineering and Technology for 60 cities in India during 2010-11 revealed that Kolkata is one of the top ten cities producing a lot of plastic waste. In the light of this study, Lise's plastic bricks can offer an inexpensive and useful way of plastic waste management.

To read more about the study visit:
http://www.ndtv.com/article/cities/delhi-among-top-10-largest-plastic-waste-producing-cities-in-india-564505
Source: http://www.takepart.com/article/2014/12/04/monsoons-india-recycle, http://www.technologist.eu/turning-old-plastic-bags-into-bricks/

Boosting Business Resource Efficiency With Is-It-Waste Tool

The 'IsItWaste' tool by EQual was launched in November 2014. It is a free, easy-to-use assessment tool that will help businesses in England to assess waste in terms of its end use. It provides a step-by-step approach to key decision stages including material composition, risk assessment, product use and end markets. As per UK's Resource Management Minister Dan Rogerson, 'Is It Waste' service can help businesses save money and create new products from existing materials to generate growth and new jobs.

EQual is an EU co-funded (LIFE +) programme which aims to provide tools and evidence for industry and regulators to deliver better quality waste-derived products. The main outputs of the programme are:

- the free IsItWaste web tool to help businesses determine whether their material is a waste, a by-product or a non-waste;
- the free online Quality Protocol Checker web tool to help improve compliance with Quality Protocols; and
- field trials of four waste-derived products to assess their environmental performance.

Currently, field trials are being carried out to assess the environmental and human health risks of four materials: poultry litter ash (PLA) and paper sludge applied to arable soils; pulverised fuel ash (PFA) and incinerator bottom ash aggregate (IBAA) used as secondary aggregates in construction.Reporting for all the field trials will be complete by Spring 2015.

Source:
http://www.ciwm.co.uk/CIWM/MediaCentre/Current_pressreleases/PressReleases2014/press_release_111114.aspx,
https://www.gov.uk/government/groups/equal-ensuring-quality-of-waste-derived-products-to-achieve-resource-efficiency

The Update section has been compiled by Anuja Sawant, Environmental Engineer, Prasad Modak & Associates, Mumbai.

National Biogas and Manure Management Programme (NBMMP)

NBMMP is a programme launched by the Bio Energy Technology Development Group of the Central Ministry of New and Renewable Energy (MNRE). The programme has been sanctioned to be implemented this year. It targets a total of 6.50 lakh biogas plants. In 2008, Maharashtra was home to the most number of biogas plants, 18.7% of the total 4 lakh biogas plants, followed by Andhra Pradesh and Uttar Pradesh.

The objectives of NBMMP are as follows:

- To provide clean gaseous fuel mainly for cooking purposes and organic manure to rural and semi urban households through family type biogas plants.
- To mitigate drudgery of rural women, reduce pressure on forests and accentuate social benefits.
- To improve sanitation in villages by linking sanitary toilets with biogas plants.
- To provide bio digested slurry (liquid / semi-solid and dried) as an upgraded source of enrichment for manure to reduce and / or supplement use of chemical fertilizers; by linking biogas digested slurry with enrichment units such as wormy-composting plants and other organic enrichment facilities of slurry.
- To meet 'lifeline energy' needs for cooking as envisaged in "Integrated Energy Policy" report of the Planning Commission.
- To help in combating and reduction in causes of climate change by preventing emissions of carbon dioxide and methane into the atmosphere.

To read more visit:
http://rd.up.nic.in/upload/biogas%20guideline%20june14.pdf

VIDEO: Ashden Award Winner – ARTI, India

Appropriate Rural Technology Institute (ARTI) is an NGO based in Pune, Maharashtra, founded by a group of scientists and social workers in 1996. The mission of the organization is to serve as an instrument of sustainable rural development through the application of scientific and technological knowledge. After 10 years, ARTI won an Ashden Award for Sustainable Energy in 2006.They have developed a compact biogas plant that runs on food waste rather than waste biomass like cow dung, over 700 of which are currently in use. Ashden has uploaded a video in which Dr. Anand Karve talks about why food waste is better than cow dung for these biogas plants. The video also shows the experience of its users.

To see the video visit: https://www.youtube.com/watch?v=BGSI72xZHNk

Sustainability Committee Activities

Is your company throwing money away with your trash! Find out!!! ?

Learn Effective Means
to Manage Industrial Waste

For Details visit at :
http://bombaychamber.com/admin/uploaded/Download/Learn%20Effective%20Means%20to%20Manage%20Industrial%20Waste.pdf

Day 1 - 28.01.2015
Industrial Waste Management
http://bombaychamber.com/admin/uploaded/Download/Industrial%20Waste%20Management%20I_Course%20Description.pdf

Day 2 - 29.01.2015
Waste to Energy
http://bombaychamber.com/admin/uploaded/Download/Waste%20Management_%20Waste%20to%20Energy_II_Course%20Description.pdf

USAID LEAD (Low Emissions Asia Development) Program

Bombay Chamber in collaboration with USAID is working on the LEAD Program. The Chamber has signed an MOU for the tenure of 2 years with USAID.

Objective:
To contribute to the corporate green growth to boost the sustainability and profitability of businesses in the country.

Key Components of the Program are -
1. Conducting training and workshops in the area of green growth
2. Direct Assistance (technical, managerial or advisory) to MSME members
3. Networking opportunities at national and international level

Topics of proposed training programs
1. Greening the supply chain & Financing Green growth
2. Environmental Compliance
3. Product Design for waste minimization
4. GHG Accounting and Reporting
5. Life Cycle Assessment and Carbon Disclosure Project
6. Energy Efficiency – A Corporate Approach

Training Courses offered by the Chamber

Bombay Chamber of Commerce and Industry is 178 years old organisation, an oldest Chamber in the Country. It has been understood that the Sustainability of the business is dependent on the human resource of the organisation. The corporate are investing on their very important Human Resource to enhance their knowledge and skills. As a service to the members and potential members, the Chamber is offering following training courses.

1. Women Safety and Self Defence
2. Road and Travel Safety
3. Office Safety
4. Fire Safety
5. Corporate Social Responsibility for Business Sustainability

We are sure of corporate will take advantage of the opportunity.

For more details contact:
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