Clean Energy from Urban Waste by Plasma Gasification

P.K.PATNAIK *

Transition from fossil fuel dominated energy to clean, carbon compliant sources demand its generation from alternative sources that could provide flexible and scalable solutions.. This is the big challenge in view that the gas and coal fired installations continue to increase unabated notwithstanding the harsh realities of global warming and climate change consequences.

It is well known that Renewable Energy (RE) provide the answer in terms of their abundant distributed availability of resources and carbon neutrality in the operating life cycle. On the flip side, it suffers inherent deficiencies on one or more counts of discontinuous supply of power, high capital cost, constraints of grid connectivity (as the systems are built around large capacity fossil fuel fired plants), comparatively lower stand alone station capacity and the like. These constraints probably explain why renewable energy production don't grow at the pace the world community would like it to do for a near carbon stabilization.

There are a number of known sources for generation of renewable energy. but their economics, potential scale up and logistics need to be evaluated for viable commercial application to be emergent sources in future energy mix. Fossil fuels, drawn from concentrated sources, are limited to their known extractable reserves and considering their consumption pattern, they will deplete in foreseeable future. On the other hand, renewable energy sources are varied and widely dispersed the world over and their total power production possibilities far exceed what the fossil fuels cumulatively could possibly offer. Though conscience is building up to increase the share of renewables in the energy spectrum, needless to say the carbon factoring is to be done scrupulously by legislation for fossil fuel based plants to realize the comparative economics with renewables. It will offset the cost advantage coal based plants in particular, seem to currently enjoy and save environment from attendant damage by them. Time has probably come when production and utilization of energy have to undergo a radical change by economic evaluation from the global warming and climate change perspective.

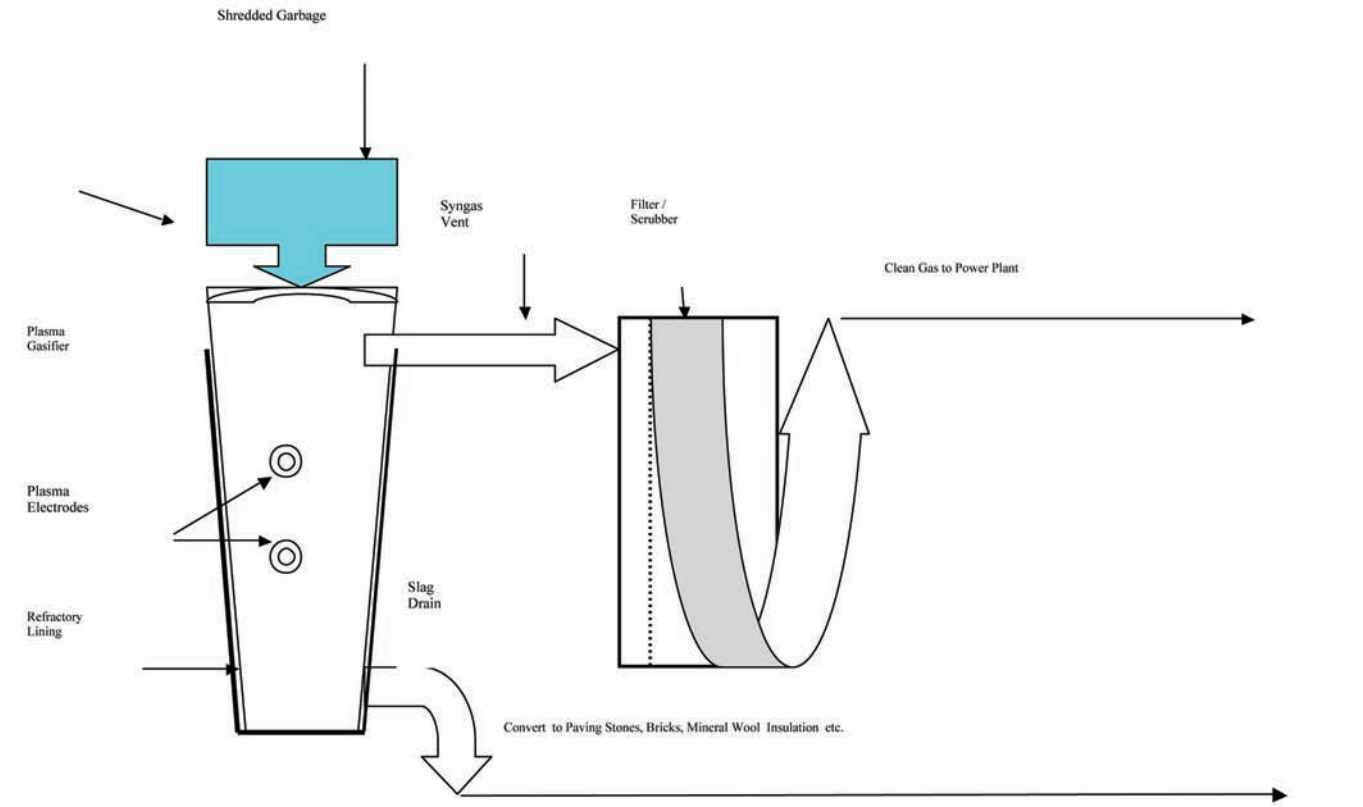
Energy From Waste is Solution to Manage Garbage In our Cities

The concept of generating Energy from Waste (EfW) produced from household and commercial sources have been around for decades. It has got high potential for meeting part of the energy requirement besides providing sustainable solution to the mounting problem of waste disposal in cities. As cities have grown horizontally landfill sites have become scarce and transport distance of the garbage have become longer, costlier and more difficult ; simultaneous growth of cities vertically in terms of high rises and multi-storeyd residential and commercial complexes have multiplied the problem, as far larger quantities of waste is now produced in these areas (Higher Garbage Pressure measured in Tons per square kilometer) due to high population density combined with huge floating population that visit the cities every day. Life style, food habits and household consumption pattern are changing fast and the change produces garbage quantities more than before. Urban waste management has thus become crucial to avoid potential hazard to public health. It is imperative that reliable systems are put in place for segregation, collection, storage, transport and safe disposal of day streams of waste materials. It is a well known experience that 3Rs of waste management - Reduction, Reuse and Recycle are less realized in developing countries than in developed ones. The waste generation being high and recycling of materials being at miserably low levels, practical management solutions for bulk of the garbage need to address twin purpose of climate concerns and community health risks. .

Energy from Waste (EfW) is being steadily embraced by countries as a sustainable solution to waste management. It has been accepted as the preferred method of waste management in Japan, Korea, Sweden, Denmark, Germany, USA, North America, China. and several other countries in the world. It is said to have less environmental impact than almost any other source of electricity while reducing waste to minimum residual volume. A major advantage of EfW facility is tht it could generate electricity round the clock throughout the year, unlike solar or wind power. More than 140 million tonnes of waste is reported to be processed annually in EfW plants in the world. It is .likely to increase to 153 million tonnes when 100 more new plants get commissioned by 2012.

Urban India produces over forty two million tons of solid waste a year. Per capita solid waste generation in the country varies between 0.4 -0.6 Kilogram per day. Population as well as per capita waste generation show fast increasing trends, thereby they together will push up

SCHEMATIC PLASMA GASIFICATION PROCESS



waste generation quantities at an alarming rate in coming years. Regrettably the current practice of waste management is in a terribly bad state in our metros and big cities and unless efficient and reliable methods for waste management are put in place sooner than later, it will pose grave problems to the society. It is time no new landfills and incinerations permitted and gasification is encouraged as the select route for waste management and gas produced is utilised for onsite power generation. The government initiative, policy changes, tariff advantage, incentives, grants, grid connectivity are all packaged in a way in favour of setting up of plants in a Public Private Partnership (PPP) format to save the cities. India is reported to have the potential to produce 2,700 MW energy from waste. A lot needs to be done on war footing to increase the share of EfW in the renewable energy basket in the country. Its contribution could be significant in taking the current share of renewable energy from 4% to targeted 10% by 2012.

Fugitive Methane from Landfill Gases add to Carbon Risk

Due to poor financial status and weak administration of the Urban Local Bodies, systematic collection of garbage and its efficient disposal methods are far below the expected levels. Typically 30-60 percent garbage is not collected, allowed to lie in community collection sites, indiscriminately dumped in streets and drains and eventually may find way to uncontrolled landfills as that seem to be the least cost way for waste management. The sites in all our metros and major city peripheries are overfilled due to rapid urbanization and at the top of it, most of them are just dumpsites and not engineered sanitary landfills with proper design for compacting, isolating and garbage conditioning to safeguard public health and environment. The landfill organics decompose over a period of time and produce a variety of off gases. Methane is the principal landfill gas constituting about fifty percent of the total gas produced. It is a greenhouse gas more than twenty times potent than carbon dioxide to global warming. In absence of effective capturing system for collection and utilization of its heat value, gases escape into atmosphere and severely impact global warming. Even with a good landfill cover layer and efficient capturing system more than half of the useful methane find way to the atmosphere. Contrary to general belief, landfill doesn't even work out cheap, if the carbon is factored, space requirements is accounted for, carrying cost is calculated and the potential loss of energy generating landfill gas is added up.

Municipal Solid Waste (Management & Handling) Rules – 2000, notified under Environment Protection Act 1986, Government of India's guidelines specify that landfill deposits be restricted to non bio-degradables, inert wastes and other wastes which are not suitable either for recycling or for biological processing. Prohibiting deposition of biodegradables in landfill reduces the possibility of substantive emission of methane which otherwise would have come from them over

the period of time. This is a departure from the indiscriminate waste containing 41-62 % compostables and 11-22 % recyclable materials to landfills. For each ton of waste that could be gasified instead of going to landfill, there is an emission reduction of equivalent of almost one ton of carbon dioxide.

Incineration is Thermally Inefficient and May Cause Air, Water and Land Pollution

Incineration, that is burning of garbage at round 900 degree Celsius is an age old practice. The hot combustion gas produced is used to convert water to steam. The steam could be used for domestic purpose or process heating or it could be utilized for driving turbine and that in turn could drive the generator for producing electricity. It is a thermally inefficient process and very little electricity production possibilities could be realised. Incinerator backed power emit more carbon dioxide per megawatt than the coal fired power plants. Incineration produces only a fraction of energy as compared to gasification besides being a potential source of emission of heavy metals, dioxins and furans that could cause air, water and land pollution.

Gasification is a Two Pronged Approach To Reliable Waste Management & Useful Electricity Generation

In a scenario of alarming proportion of increasing household garbage or trash (what in industry parlance is known as Municipal Solid Waste), and growing concern for safe disposal, gasification of the waste scores over landfills and incineration on many counts. Gasification essentially means combustion in a controlled atmosphere in near absence of oxygen. It facilitates conversion of organic components into a mixture of several gases, mainly comprising of hydrogen and carbon monoxide, instead of their burning out. The gas so produced is commonly known as Syngas which can then be burnt to produce energy or processed further to yield ethanol and diesel. Gasification is carried out at 1,000 – 1,600 degree Celsius and is a fairly satisfactory way for disposal of garage. It is adaptable for seggregated waste containing larger proportion of organic materials and plastics and no incombustibles and metals. Wastes with higher organic content yield more Syngas and in turn can generate more electricity.

PLASMA GASIFICATION IS A HUGE ADVANCEMENT OVER CONVENTIONAL GASIFICATION AND BRINGS WITH IT THE VERSATILITY TO PROCESS ALL KINDS OF GARBAGE INCLUDING HAZARDOUS HOSPITAL WASTE IN THE CITIES IN ONE GO

Plasma Gasification Can Accept All Types of Waste : Energy and Construction Material are ByProducts

The real improvement in gasification has come with introduction of plasma technology into the process. Plasma in simple language means a field of intense radiant energy. This could be created by passage of high voltage current between two electrodes when plasma arcs like lightning are produced. The temperature in plasma gasification chambers may go upto ten thousand degree Celsius. The process is thus capable of disintegrating almost all types of waste materials with exception of nuclear waste. It converts organics to Syngas and inorganics to Slag. Syngas produced is cleaner than in conventional gasification process and could be used for power generation after filtering and scrubbing. Slag, the black glassy liquid byproduct could be used as a construction material and be made into concrete, bricks, paving stones or insulating rockwool. These products are unleachable and thus there is no fear of their adding to pollution of any kind during use.

Typically the process involves size reduction of waste in a shredder and feeding them into a Plasma Chamber. It consists of a stainless steel vessel lined with refractory or water cooled panels to withstand high temperature operation. The inside is filled with ordinary air or an inert gas like argon or nitrogen. Electrodes are fitted in the walls of the chamber at different levels. High voltage current is passed thru electrodes to create plasma. The shredded waste passing thru the field are reduced to their component elements at the high temperature. It produces Syngas which is collected at about 1200 degree Celsius at the outlet at the upper part of the chamber. The inorganics melt down, get vitrified and convert into a liquid glassy substance called "slag" and it pours out thru slag drain at the bottom of the chamber. Plasma Gasification Plant. consumes about 2/3 of energy produced by Syngas fired Power Plant, one third of power generated being still available for community use.

Plasma Gasification : The Way Ahead

Plasma Gasification is a huge advancement over conventional gasification and brings with it the versatility to process all kinds of garbage including hazardous hospital waste in the cities in one go. Suspicion raised regarding formation of dioxin at high temperature and presence of metals in syngas is overcome by pretreatment of waste inputs for removing chlorine and effective filtering and scrubbing of gas before it goes for combustion for power generation. The The operating plants in Japan, Taiwan, Canada, England and United States and in some other countries have been functioning satisfactorily over a period of time and a number of technology suppliers and EPC contractors are available for project execution. In view of huge piles of accumulated ageing wastes, increasing garbage outputs and current waste management practices in metros and big cities, urban planners, environmentalists and technologists must come together and find innovative ways to execute such projects to make the cities clean, hygienic and safe for the communities to live in. Gasification must be seen as a sustainable solution to climate and community health and the byproducts be deemed as bonus helping in reducing cost of waste management.

(*) Mr. P.K Patnaik is engaged in development of IPPs since liberalisation of the sector in 1991-92. He writes regular columns and contributes to national and international business magazines on subjects of power and infrastructure. He could be reached at pkpatnaik1@yahoo.co.in. Mr. P. K. Patnaik is also Consulting Editor of Energetica India.