

Solid Solution to Solid Waste

Prof. Ajith de Alwis



Introduction

April 14th 2017 while the country was celebrating New Year's Day, the collapse of the garbage mountain at Meethotamulla generated from the dumping of solid waste of Colombo and suburbs (Figure 1), claiming many lives with significant damage to property, changed a prevailing solid waste management situation dramatically and perhaps irreversibly. That irreversibility was to good, as it was driving the decision to take action on the prevailing habit of collection and disposal only (Figure 2). Up to that time some parts of Colombo may have claimed clean status though the 'label' was claimed only by diligently following the cleaning process. But the process was never completed with the collected waste only finding its way to Meethotamulla for open dumping. The height of the dump kept climbing and moving above the recommended height of 30 m by the National Building Research

Organization, and on the day this collapse occurred the height had been recorded to be around 49 m. From April 15th 2017 Meethotamulla was no longer available for solid waste disposal, but with the society not controlling in any way the generation of waste, the issue really burst into the open. For many years and in fact for decades

constrained situation after failing to develop the necessary abilities in manufacturing and technical services. Having ignored that dumps are relics of outdated mindsets, it could not have been possible to do the right thing at short notice.

Few positive developments such as the development of the Sanitary landfill facility at Dompe, some excellent low end composting plants from the Pilisaru program – Kalutara Pohora Watte site etc. were available, but these cannot be scaled up immediately. With the Meethotamulla debacle much more scrutiny was directed to practices island wide, and the fact that there are about 250 more waste mountains of different scale resulting from open dumping came to light. Also it was clear that many an investment made had failed to produce sustainable results as in



Fig 1 : Garbage mountain at Meethotamulla

Sri Lanka failed in addressing the problem properly, and the Capital city and the suburbs immediately had to find an appropriate way to proceed. That was no easy task, and certainly one cannot come up with a feasible solution in such a



Fig 2 : Garbage collection and disposal

the Eastern Province, where all UNOPS (United Nations Office for Project Services) funded sanitary landfill sites have degenerated into open dumps again. Some of the earlier award winning sites too have failed, such as the sites at Nuwara Eliya and Mawanella, demonstrating that it is not always the technical excellence that matter, but the commitment of individuals and the leadership on-site. The significant effect of local political leadership too had been amply demonstrated.

Considering that Colombo in 2017 still carries a lesser population than that of 18th century Paris and Amsterdam combined together, Sri Lanka cannot be stated as facing a significant problem of unmanageable amounts. A cursory glance across universities and institutes clearly indicate that ample human resources have been generated and much training had been imparted. However despite all these achievements, it has been quite clear that a solid solution to solid waste management had failed to appear, and Colombo and the rest of the country still clearly is in search of a solution. It is also apparent that some significant development in solid waste had taken place considering all the discussions, reports and activities that had happened centered on solid waste.

Understand the Problem

It is important to understand the problem if the right solution is to be provided. While all cities anywhere in the world may have the same overall issue, the nature of practices that are unique to each location and country, dictates

the most suitable approach. Also the geographical locations and the available space directly influence the options. Hence the quantity and quality of waste are two key aspects that one needs to understand well. This understanding has to be dynamic too requiring that Sri Lanka should consider carrying out periodic surveys across the country.

Sources of Municipal Solid Waste (MSW) are residences, commercial places, institutions, construction and demolition debris, municipal services, treatment plant sites, industries, agricultural and livestock activities. Solid waste management is an obligatory function of all the Local Authorities in Sri Lanka; Municipal Councils, Urban Councils, and Pradesiya Sabhas. The legal aspects are quite clear and are laid out in the various statutes dealing with these bodies. Sri Lanka has the necessary policies, strategies and technical support documents too with regard to

managing solid waste. Over the years we can clearly see the development of these aspects. What has been missing is the single-minded execution across all these agencies and institutes with the clear focus on a sustainable solution. There had also been a failure in the technical solution selection and application, which actually has a significant role to play in the final answer.

Status and trends

The current population of Sri Lanka is approximately 21 million, with an annual population growth rate of 1.1%. Present Municipal Solid Waste (MSW) Generation in Sri Lanka is around 6,500 to 7,000 Mt/Day (Mannapperuma, 2017), while present MSW collection is around 3500 Mt/Day (50% of generation). Western Province contributes 60% to the National MSW generation and other eight provinces contribute 40 % to the

Table 1: Waste generation rate at Provincial Level
(Source: Ilangasinghe, 2017)

Province	Waste generation rate (%)
Western	58.68
Southern	6.99
Central	8.08
North Western	6.00
Sabaragamuwa	3.23
Uva	3.02
North Central	2.61
Eastern	8.20
Northern	3.29

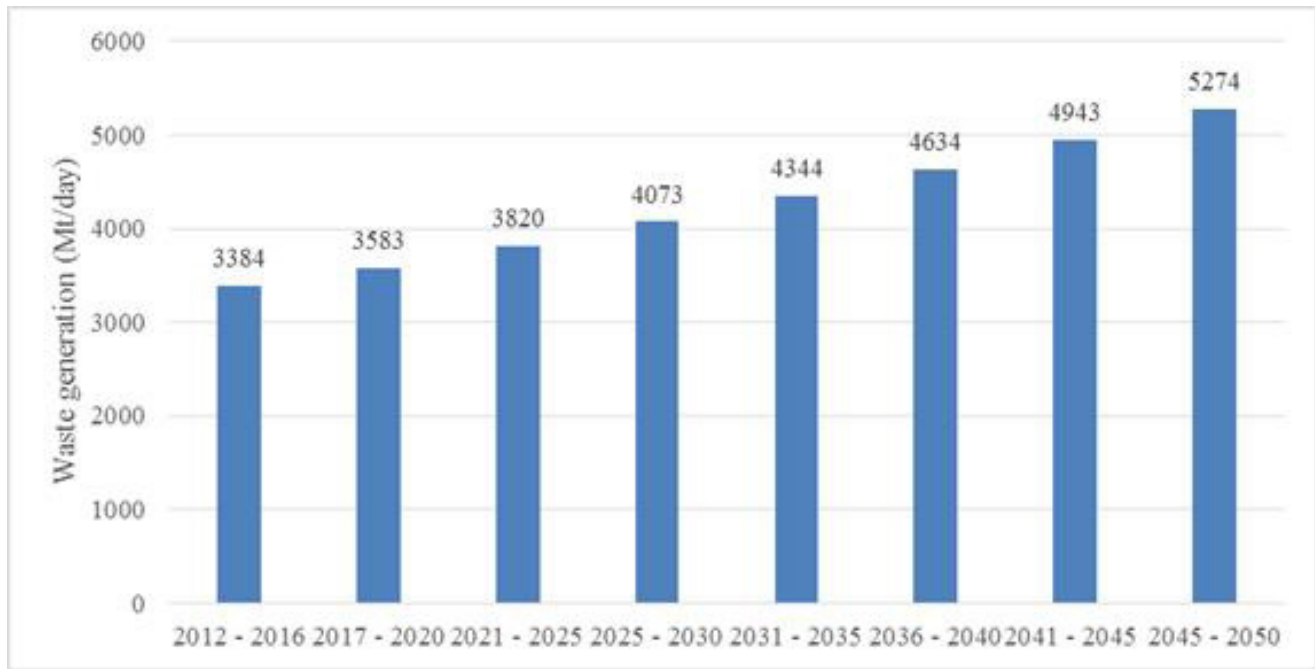


Figure 3: Predicted MSW generation until 2050 in Western province (Source: Mannapperuma, 2017)

total waste generation.

As per Western Province Waste Management Authority, the annual growth rate of garbage generation in Sri Lanka is around 1.2-2.0%.

The above figure shows the expected growth pattern of waste generation in the Western Province of Sri Lanka. Daily waste generation in Western Province is expected to be 3583 MT and 4073 MT respectively by 2020 and 2030. With much development work planned there is likely to be a significant increase in waste over the years and all these scenarios points to the need of a solution that is suitable with future in mind too.

Composition of Solid Waste

There is no annual or regular program to understand the nature of waste in a Sri Lankan context. All available data usually comes from project reports and research

studies. This means that the picture available is usually a snap shot of a particular situation and taken over in a small time period. However, when considering all published data, three main aspects stand out, – that is, high organic content, high moisture content and low calorific value. This needs to be clearly understood when planning for the solution. A detailed analysis is presented in Table 2, which presents a solid waste analysis in Colombo.

An aspect that is revealed in the analysis is that there is no major difference between the composition of Colombo and other urban wastes.

Technical Aspects of Service Provision

Planners need to factor in solid waste management as a service that needs to be considered and supported in a city. We are ready to give space to Transport Board,

Water Board, Electricity Board Telecom, sports ground etc. The residuals of our stay in town do not get the same consideration. The people who had to handle waste, sadly have to occupy a very low strata of the society. While the society boasts of 3-Phase electricity, clean water etc, the only waste that is incapable of flowing or moving finds itself neglected in planning. It was in ancient Athens that one decreed that the waste should be more than a mile away from the city wall. Athens concept not being valid today, there is the importance of managing waste closer to the place of generation (Proximity Principle). One can keep the city clean and allow the city to benefit too if we make use of the knowledge that we have today.

Collection has to be done methodically and periodically. It should also support the basic principle of 3R (reduce, reuse and recycle) as is the accepted national policy. There had been

Table 2 : Solid waste analysis in Colombo.

WASTE CHARACTERISTICS - CMR

Category	Estimate		Analysis		Characterisation				
	CV	MC	Waste AM	SD	Area - 1 % by Mass	Area - 2 % by Mass	Area - 3 % by Mass	Area - 4 % by Mass	Area - 5 % by Mass
Easily Biodegradable	18	80%	54%	18%	39.6%	28.2%	71.2%	59.9%	74.1%
Long term biodegradable	18	60%	25%	18%	35.2%	55.6%	7.7%	18.9%	13.1%
News Paper	16	10%	4%	2%	8.0%	2.8%	2.6%	5.1%	2.2%
Cardboards	16	10%	1%	1%	3.2%	1.4%	0.0%	1.1%	0.0%
Plastic	30	0%	2%	1%	1.1%	1.1%	2.9%	0.8%	3.5%
Polythene	45	0%	9%	5%	5.2%	7.1%	9.0%	7.8%	5.1%
PVC	15	0%	0%	0%	0.9%	0.0%	0.0%	0.0%	0.0%
Rubber	20	0%	0%	0%	0.0%	0.4%	0.0%	0.0%	0.0%
Construction Demolitions	0	0%	1%	0%	1.3%	0.1%	0.7%	0.8%	0.2%
Glass	0	0%	1%	1%	1.4%	0.6%	2.3%	0.7%	0.0%
Cotton	19	50%	2%	1%	2.8%	1.3%	1.8%	3.4%	1.7%
Nylon	15	0%	1%	1%	0.9%	0.4%	1.7%	1.4%	0.1%
E-Waste	0	0%	0%	0%	0.0%	0.3%	0.0%	0.0%	0.0%
Clinical Waste	0	0%	0%	0%	0.1%	0.1%	0.0%	0.1%	0.0%
Others	0	0%	0%	0%	0.3%	0.6%	0.1%	0.0%	0.0%
Total					100.0%	100.0%	100.0%	100.0%	100.0%

AM Moisture Content	55.0%	57.0%	63.0%	62.0%	68.0%
CV MJ/kg	7.4	8.0	7.3	7.1	5.7
CV kcal/kg	1765	1917	1743	1706	1373

	AM	min	max	SD
Calculated Moisture Content	61%	55%	68%	8%
Calculated CV Kcal/kg)	1698.6	1363.6	1913.9	12%

a tendency to seek the most expensive solution as per collection vehicles compactors, etc for service delivery. Considering that the rate payments are almost insignificant in many situations from residences, there is no significant generation of finances via taxes to provide an efficient service. However it is clearly seen in cities across, that proper service delivery does not mean the availability and use of

expensive vehicles and related equipment. This is an area that Sri Lanka should support via manufacture, as there will be dramatic reduction in costs etc with added flexibility and lower costs. Consider Figure where cycles are used in Beijing and small vehicles are to be seen in Tokyo. These are metros that are maintained clean and with much higher citizen numbers.

Citizen's role

Colombo is throwing out 700 to 800 MT of waste per day and leads the league table of Sri Lankan cities in the amount of waste generation. This quantity when analyzed indicates that the water

content is around 60- 70%. The solid waste also indicates 70% of organic waste, which is also largely biodegradable. It is this fraction that contains most of the moisture. The balance portion is non biodegradable, and is usually quite suitable to be recycled. Therein comes out the citizen's opportunity. If one takes care of the organic fraction within ones premises, the tonnage can be



Figure 4 : Cycles used in Beijing



Figure 5 : Garbage collection trends in past & today

reduced drastically. Separating recyclables again will mean no waste to dispose. Then when the disposal amount drop down to may be even less than 100 MT/day, the projects are not as exciting as dealing with 800 MT/day! Hence instead of pointing fingers and shouting against corruption, steps for reducing individuals disposals will solve many an issue. The government will be richer too as all these unnecessary solid wastes have to be transported, and even if the final operation is dumping, costs incurred are saved. At this juncture the best that the Colombo citizen should do is to take a very close look at one's own waste generated. This is applicable to all cities across the country, and should not be considered as a recommendation only to Colombo. A little investment on a compost bin, or better still, if one has some space, a biogas unit can revolutionize the Colombo city. Yet there will be some waste that an individual may not be able to handle comfortably and it is for this minimized quantity together with the other household hazardous wastes (medicines, batteries etc) that the CMC will be called into serve with the State in ensuring the availability of processing space. If no one wants to reduce their waste, then the usual waste matter generated will have to be placed somewhere. We have seen how some desperate efforts to dispose waste in unauthorized places have resulted in strong protests. This is where enlightened decision-making is vital to ensure successful disposal of waste.

Recycling Network

Colombo City needs to improve on its recycling network and related

infrastructure, and the same applies across the country. Processes for reverse logistics need to come in. One should have access to recyclable collecting centers. The current system needs definite upgrading and hopefully some of the existing shops and centres would rise up to the challenge of becoming better. Recycling has spun billionaires and in China there are many examples. A Sri Lankan Green Pages is much awaited for



the benefit of all citizens.

Means to support separation should be visible on streets and cities. There should be the proper recycling collection points available too. As one can observe in cities there are places that are available but they do not project a proper business outlook. These can be better organized with even training and financial support to evolve into a national network for recycling service provision.

Technical Solutions for Solid Waste

Generation of solid waste is synonymous with urban living. As cities evolved it is seen from the

past that what the city dwellers had done was to shift solid waste to the periphery of cities for dumping. This obviously is a poor way of waste management and in addition, health related issues surfaced with further growth, while different technologies came into manage the growing problem. Over the years many technological pathways have appeared. In USA the Freshkills landfill on the Staten Island, which catered to the solid waste of New York, assumed gigantic proportions, and it had been stated to be visible from space along with the Great Wall of China – apparently a myth though indicating the vastness of the garbage mound! Landfills came after the practice of dumping waste into the oceans was stopped from cities



Figure 6 : Different garbage collection points

near the coastal belt. Thereafter incineration techniques were introduced. It is easy to understand the fascination with

incineration. With burning

at high temperatures, which is what incineration is all about the mountains of waste simply disappeared. This reduction of volume proved to be quite appealing as incineration is still practiced and for many what is not visible is not a problem as with air pollution. However the method has been vastly improved and usually energy is recovered either as electricity or heat. Countries with small land areas such as Singapore and Switzerland

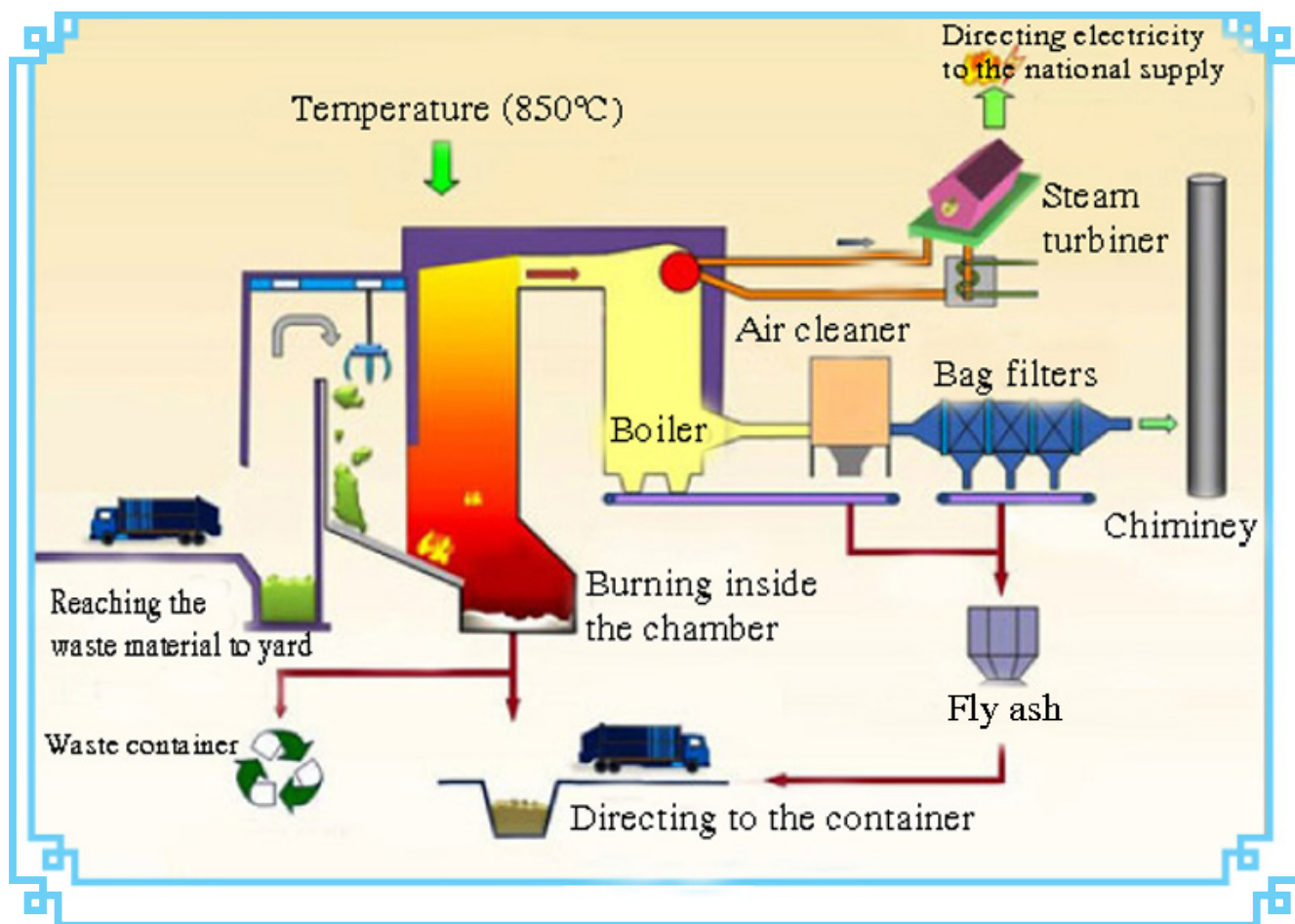


Figure 7 : Waste management system

continue to use this practice of Waste to Energy with incineration as the prime technology. There is today however, a growing body of evidence against incineration as the technology of choice. With sustainable development as the main feature for growth, incineration, which reduces material to ash is frowned upon.

It is important to identify the final solution as well. With a decent level of segregation and with proper recycling infrastructure and a franchise of recycle collection centers established, the organic fraction can then be tackled. A need for landfill space will not be totally out, but the requirement will be quite different and easily manageable. Today interestingly

we have home composters who diligently compost the food and other green waste but burn plastic waste in the backyard. There are significant numbers who burn the whole collection by using some additional kerosene, and some expect the plastics to serve as a fuel. We also have a technically designed landfill site at Dompe after many years, and few countries are known to benefit from some of the recycled products exported out from Sri Lanka. There is the significant need for awareness on integrated solid waste management. Awareness should address the attitude towards waste too. It is known that across the country the organic fraction of the waste is more than 60% and can even reach 80%. This considerable fraction

with its inherent moisture content is suited for the anaerobic digestion process, which yields biogas and a biofertilizer (soil conditioner). Biogas is without doubt a more versatile renewable energy source due to its determinate energy value and ease of storage. Hence, potential utilization is independent of factors such as geographical location and season – a factor that most renewable fail on. It can be used directly for heating and electricity generation, and as substitute for fossil fuel applications, e.g., transport fuel. The potential utilization of the digestate as fertilizer can also reduce dependence on energy intensive mineral fertilizers. With about 700 and more tonnes of waste per day there is the potential

to generate around 4 MW electricity or generate transport fuel. CEB (Ceylon Electricity Board) may frown on just 4 MW, but the salient fact that planners fail to realize is that the waste get managed, energy gets generated and a fertilizer is produced.

There is no question that the identification of the Solid Waste treatment technique has taken far too long. A clear hierarchy for technology choice had been presented in EU (European Union) for its proposed strategy of circular economy drive. In the absence of such an understanding in the country, all

proposals have the ability to pick on the process by themselves. Waste to Energy via the thermal route had been the popular choice and some exotic process schemes have been suggested for Colombo. Implementing some of these solutions will mean not separating the paper and plastic fraction from the generated waste, but on the concept of 3R – reduce, reuse and recycle – which is the stated strategy for solid waste management. Even with plastic and paper in our solid waste there is a higher content of organic waste and a significant quantity of moisture. The wetness and the higher organic fraction points to a biochemical route of waste management. All sewage and sludge should come into this process as well, though this stream in the current mechanism belongs

to another Ministry. This would add some needed ingredients to make the biochemical process more sustainable. Further, many other organic waste streams can be directed to this process thus enabling co digestion and a better gas generation via biogas,

the failures. At PATTIYAPOLA down south, Sri Lanka had the first renewable energy driven village of the world with UN (United Nations) funding. Electricity was supplied to the village including street lights. The biogas was derived from the digestion of waste

cow dung. Biogas based systems are much more suitable as decentralized systems, and perhaps this experience was out of step with the times. However the needs and the technologies are changing, and with smart grids, decentralized systems, fuel cells, sustainable city concepts along with climate change pressures,

the ground situation is changing rapidly. Thus solid technical solutions are available which can actually add to the economy rather than be a burden, and that is the recommendation.

Sanitary and Secure landfill availability

Subsequent to recycling and processing there is also a fraction that cannot be utilized readily. Such waste streams need to be located in a landfill. Hence landfills are needed in a decentralized manner to serve the country. Today with the knowledge and experience gained from Dompe, this process can be implemented. Dompe is a purpose built landfill with the non-organic segregated waste as the target waste stream. For hazardous waste streams and

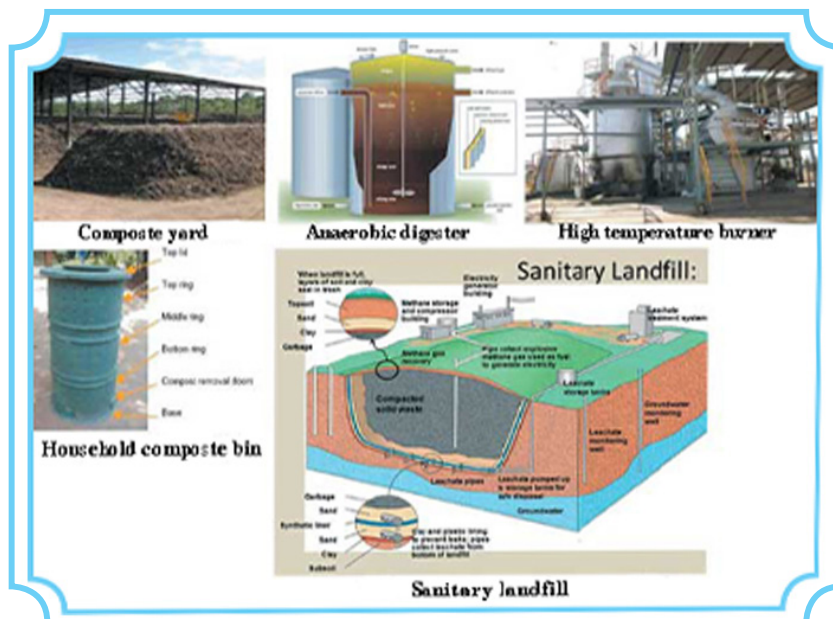


Figure 8 : Sanitary landfill

which results in more power and energy. In some countries such as in European Union biogas is processed to serve as a transport fuel. This process was demonstrated at the University of Moratuwa by driving a three wheeler from biogas generated through biowaste including that of the university canteen (<http://www.ft.lk/article/23871/Our-waste-for-our-energy>). This points to gas being utilized as a transport fuel and Colombo can aspire to have service stations with biomethane. The technology needs to suit the scale required. Sri Lanka has experienced biogas installations including in Colombo. However, we have failed in scaling up the low end technology scheme, and paid the price of people remembering

similar streams from industry, a secure landfill system is necessary. A useful area to site such a facility as a national facility may be found around Puttalam.

For secure landfills the use of quarry sites with some planning should be considered as feasible. There is the need to stabilize waste before being placed in the secure landfill. There is the need for proper communication measures to educate people on these systems, as the current understanding is inadequate and negative, which are based on past failures.

Solution to Dumpsites

We have a long-standing issue with the Blomendhal dump site in Colombo which grew to be a small man made mountain until the supreme court decision in 2009. Today the site is slowly reclaiming itself, but a planned approach is necessary to make use of it. An interesting example is the garbage mountain that was outside Israel's capital "Tel Aviv – the Hiriya" Landfill. Today it has been capped, and land fill gas which is essentially biogas, is extracted, cleaned to produce methane, while electricity is produced and a pumping station for vehicles planned by the side. The waste mountain is known as the "Ariel Sharon Park" and is also a study centre for waste management! They also claim that tourists can have a breathtaking view of "Tel Aviv from a top" the mountain a possibility too with

Blomendhal! All these have been achieved through science and technology. There is a lot to learn when a project of this nature is carried out internally and it is clear that technical solutions can be engineered locally. As for dump rehabilitations some detailed work exists in local universities. Total outsourcing may not only mean loss of hard earned money and waste of precious time on endless



Fig 9 : "Ariel Sharon Park" (Hiriya landfill) Situated in Tel Aviv city

negotiations, but many lessons that could be learnt will also be lost.

In Conclusion

Marshall McLuhan a Canadian philosopher stated that the new clothing for the planet to be garbage. We certainly see the applicability of this comment when we observe that three quarters have come into fashion! When are we going to put our heads together to realize some of the potential benefits that we have from our waste instead of ignoring it or suffering from its presence.

In the months before the tragedy, some steps were taken by UDA (Urban Development Authority)

and the Ministry of Megapolis, and projects too had now been awarded. These projects should have catered to almost all the stated waste quantities of Colombo. All these projects however, will take a minimum of around 2 to 3 years to complete. With the disaster and the site becoming not available for the traditional disposal, a crisis was inevitable. However, the responsibility of the state is now

to change the attitudes, explain the situation, be amenable to listening and ensure steps that result in a disciplined urban community. The crisis can only deepen if the emphasis is only in finding places to dump and adopting weak practices. We must rise up to the challenge, and once and for all transform our cities.

In an era where sustainable cities, livable cities, smart cities

and green cities are talked about, assessed and awarded the templates for action, we should have the learning mind and the courage to source solutions from within.



Prof. Ajith De Alwis

Project Director – COSTI
Professor of Chemical and Process Engineering
University of Moratuwa
077-7342476
011-2879254-costi
011-2650281-Uni. Moratuwa
(ajith@cheng.mrt.ac.lk)

