ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2015; 1(11): 406-411
www.allresearchjournal.com
Received: 20-08-2015
Accepted: 24-09-2015

Parul Jain
Assistant Professor,
Department of Economics,
Maitreyi College, University of Delhi

Correspondence
Parul Jain
Assistant Professor,
Department of Economics,
Maitreyi College, University of Delhi

Converting waste into energy: Ecological, Economic & Social Dimensions

Parul Jain

Abstract
Solid Waste Management has become a serious concern in the states of India. In today's world a huge amount of solid waste is burned in the open or dumped haphazardly, especially in developing countries. Such practices put pressure on land, air, and water quality, and pose threats to human health. Electricity is one option that can be produced from solid waste through waste to energy (WtE) plants. Waste to energy plants generates clean, reliable energy and thus reducing dependence on fossil fuels. The paper tends to examine how management of solid waste can generate electricity. The WtE plants are efficient in generating electricity from solid waste. In general, 166 million ton of solid waste, if treated in WTE plants, can on an average generate approximately 100 TW h or 600 kW h per ton of electricity. According to the Ministry of New and Renewable Energy (2011) estimates, there exists a potential of about 1457 MW from MSW but a very small amount of it have been exploited. The government is offering various incentives/ assistance to companies engaged in waste to energy sector. Thus, WtE plants are an alternative that solves a dual problem of both solid waste management and electricity shortage in India.

Keywords: Greenhouse gases (GHGs), Solid Waste Management (SWM), Waste to Energy (WtE)
JEL Classification: Q42, Q52, Q53

1. Introduction

Pollution and the growing volumes of solid and hazardous wastes are major threats to the environments and sustainable development of the developing countries. Rapid economic development is accelerating the transition of developing countries towards consumer economies, with increasing urbanisation, migration, and participation in international trade. This is resulting in an escalation in the generation of solid and liquid wastes, and these increase the risk of environmental pollution and poses threat for human health.

Solid Waste Management has become a serious concern in the states of India. The growing urbanization and industrialization have led to quantum rise in solid waste. The amount of Municipal Solid Waste (MSW) generated per capita is estimated to increase at a rate of 1–1.33% annually (Mufeed *et al*., 2008) [19]. Lack of management techniques has aggravated the problem. With the growing population, the amount of solid waste will rise further. So there is a need for an effective solid waste management techniques in the country.

In today's technology era, solid waste has resource value. Through the process like recycling, the conversion of waste into energy, composting etc., resources and energy can be obtained from solid waste. Electricity is one option that can be produced from solid waste through waste to energy (WtE) plants. Waste to energy plants generates clean, reliable energy (electricity) from a renewable fuel source, thus reducing dependence on fossil fuels, the combustion of which is a major contributor to GHG emissions (Chouhan *et al*., 2015) [5].

In case of India many alternatives have been proposed and are adopted for generating electricity in rural areas: Coal, diesel, solar PV panels, hydro-power generation, wind mills etc. In spite of so many alternatives the country has not achieved the 100% rural electrification target. Plausible reasons are: high costs, lack of infrastructure, coal and water scarcity, geographical limitations in case of solar energy, wind energy etc. (Khandker *et al*., 2012; Jamasb *et al*., 2008) [11]. The dual pressing needs of waste management and reliable renewable energy source has made WtE plants an attractive alternative. The paper tends to examine how management of solid waste can generate electricity. The available literature focuses on these two problems- solid waste management and rural electrification in isolation. In this paper both the problems that is solid waste management and electricity shortage are linked together so that both problems can be solved simultaneously.

The paper is divided into four sections. The first section deals with the problems associated with solid waste and how they can be managed through different processes. The second section discuss about the efficiency of WtE plants in providing electricity. The third section talks about India's potential in generating electricity from solid waste and the last section concludes it.

Solid Waste: Problems and Management

Waste is defined as any material that is not useful and does not represent any economic value to its owner, the owner being the waste generator. Depending on the physical state of waste, wastes are categorized into solid, liquid and gaseous. Solid Wastes are categorized into municipal wastes, hazardous wastes, medical wastes and radioactive wastes. Municipal Solid Waste(MSW) usually contains food wastes, paper, cardboard, plastics, textiles, glass, metals, wood, street sweepings, landscape and tree trimmings, general wastes from parks, beaches, and other recreational areas (UNEP report, 2004) [7]. Sometimes other household wastes like batteries and consumer electronics also get mixed up with MSW.

Managing solid waste generally involves planning, financing, construction and operation of facilities for the collection, transportation, recycling and final disposition of the waste (Gaviota *et al*., 2011) [10]. A solid waste management (SWM) system includes the generation of waste, storage, collection, transportation, processing and final disposal. Table 1.1 gives a brief description of different types of municipal solid waste.

Table 1.1: Sources and Types of Municipal Solid Waste

Sources	Typical waste generators	Components of solid waste
Residential	Single and multifamily dwellings	Food wastes, paper, cardboard, plastics, textiles, glass, metals, ashes, special wastes (bulky items, consumer electronics, batteries, oil, tires) and household hazardous wastes
Commercial	Stores, hotels, restaurants, markets, office buildings	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes
Institutional	Schools, government center, hospitals, prisons	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes
Municipal services	Street cleaning, landscaping, parks, beaches, recreational areas	Street sweepings, landscape and tree trimmings, general wastes from parks, beaches, and other recreational areas

Source: UNEP Report, 2004

Problems with Solid Waste

Solid waste has a detrimental effect on the environment. Municipal solid waste results in ugliness of streets, degradation of the urban environment and harms the beauty of the city. Dumping of waste around waste bins, on the streets and in water bodies, results in air and water pollution. In the case of waste dumped at landfill sites, improper selection of the site causes groundwater pollution. During periods of heavy rains, it causes surface water pollution. Waste can also be carried away by run-off water to rivers, lakes, and seas, thereby affecting these ecosystems. Without adequate controls over solid waste disposal; pollution of essential surface and ground water resources caused by solid wastes can be more severe. Air pollution can be caused by inefficient local open air dumping and burning of waste which releases harmful gasses like ammonia in the atmosphere.

It is said by Medina (2010, p. 2) [14] that "The decomposition of organic materials produces methane, which can cause fire and explosions, and contributes to global warming. The biological and chemical processes that occur in open dumps produce strong leachates, which pollute surface and ground water. Fires periodically break out in open dumps, generating smoke and contribute to air pollution. In the Mexican city of Tampico, on the Gulf of Mexico coast, for instance, a fire burned for over six months at the local open dump. Fires at open dumps often start spontaneously due to methane and heat generated by biological decomposition."

Increasing volume of solid waste poses threats to human health. As noted by Venkateswaran (1994, p. 2909) [22] that "Workers handling waste come in constant direct contact with waste and remain exposed to the impact of wastes," general public generally face indirect health risks from solid waste which arise from the breeding of disease vectors such as flies and rats.

It is stated in one of the World Bank policy research papers (Bartone, Bernstein and Wright; 1990, p. 4) [2] that "Poorly located and illegal dumps consume valuable land that could be better used for other purposes. These unsightly facilities also lower the value of land in the surrounding area. Refuse thrown into the drainage system blocks the flow of water which eventually causes flooding and consequent traffic blockages, road deterioration, and property damage. In addition, piles of uncollected garbage and fallen waste storage bins on city streets exacerbate already congested traffic conditions and impede necessary road improvements until the solid waste problem is resolved."

In India, solid waste is handled by Municipal Corporations. These corporations are ill-equipped, lack technical know-how and do not have adequate funds. Most of the solid waste collected is either dumped in open fields situated at the outskirts of the city or landfills. The survey done by FICCI in 2009 reveals that "there is lack of adequate number of sanitary landfills in Indian cities. Out of the 22 surveyed cities, only 6 have sanitary landfills (Ahmedabad, Chandigarh, Jamshedpur, Mangalore, Surat and Vadodara). Ten out of the 22 cities do not have sanitary landfills given the fact that large cities like Greater Mumbai, Delhi and Kanpur are included in this list. Guwahati, Indore and Jaipur are in the process of constructing sanitary landfills; and Agartala and Lucknow are considering construction of SLFs". (FICCI; 2009, p.6) [9] "Waste treatment options such as composting and waste-to-energy plants are not being adequately explored by even those cities which are larger not just in terms of size and population but also in generation of waste". (FICCI; 2009, p.9) [9]

The growing public awareness and rising pollution levels demand a proper management strategy for solid waste. In absence of proper policies and mechanisms the problems caused by solid waste will become more serious.

1.1 Management of Solid Waste

Now a days, a major challenge for cities in the developing world is the management of solid waste. Effective solid waste management has an important role in protecting the environment, eliminating health risks and improving urban productivity.

In a populous country like India, one cannot assure the significant reduction in waste by following some specific policies. Despite that, waste will be generated. Thus, focus of this paper is how the management of the solid waste can be done in order to achieve efficient outcome. Managing waste will surely reduce the burden of waste disposal.

There are several ways in which solid waste can be managed:

1. Open dumping
2. Land filling
3. Composting
4. Incineration
5. Recycling

Open dumping is not a viable method as it generates no benefit and no electricity. Composting is a method of degradation of bio-degradable waste which can be utilized as manure but other waste materials are left untreated. Recycling is a commonly used way of managing solid waste where things are reproduced using the trash but like composting, the residue is left untreated. Moreover with the degrading quality of the recycled materials specially paper, and hence fall in demand, private entities do not find recycling a profitable venture. Landfill, however, is relatively a better way to manage the solid waste. But in landfills, it's difficult to control the leakage of the harmful gases (Kaplan *et al*., 2009) [17]. In incineration method solid waste is burnt in outskirts of the city in large incineration plants. Apart from these, there is one more way to manage solid waste: electricity generation through waste to energy plants. The next section discuss about the efficiency of electrification process through WtE plants.

Electrification Efficiency of Wte Plants

A Waste-to-energy (WtE) plant can be defined as the process of energy recovery by conversion of non-recyclable waste materials into useable heat, electricity, or fuel through a variety of processes, including combustion, gasification, pyrolization, biomethanation, and landfill gas.1 WtE plants reduce the quantity of wastes, generate a substantial quantity of energy from them, and greatly reduce pollution of water and air, thereby offering a number of social and economic benefits that cannot easily be quantified. In general, 166 million ton of solid waste, if treated in WTE plants, can on an average generate approximately 100 TW h or 600 kW h per ton of electricity (Kaplan *et al*., 2009) [17].

It is necessary to analyze whether the electricity generated through WtE in different countries is efficient in comparison to other available conventional means to generate power. Thus, we look into the cost-benefit analysis in order to get a clear image about the efficiency of WtE plants.

Looking at the cost front, there are both direct and indirect private costs involved in construction and operation of waste treatment facilities. Direct costs (variable costs) include operating and management costs- cost of raw materials, labor cost, costs of maintenance of equipment and training programs. It requires a huge capital costs for the construction and predevelopment of such facilities. Also there are interest costs or lost earnings due to delays in the planning permission and licensing process, and a tipping fee for disposing of unwanted residual material from the combustion process. Plant size also affects the profitability and feasibility of such plants. Larger the size of plant more economic it is. Other factors that can influence costs include (i) plant efficiency, (ii) composition of the waste stream, and (iii) alternatives for both waste management and electricity generation (Jamasb *et al*., 2008) [11].

As far as revenues are concerned (private benefits) there are four sources of revenues for such plants: gate fees[2], energy sales, recycling metal post incineration, and combustion residuals. The gate fees and the sale of energy (electricity and heat) are the main sources of revenue though it varies across countries. The other revenue sources are: revenues are from recycling of the metal collected after combustion and selling non-landfilled combustion residuals (e.g. ash) as aggregate materials to the construction industry (Jamasb *et al*. 2008) [11].

Taking in account direct costs and benefits, the cost-benefit analysis of Municipal Solid Waste Management System for Taiwan's Taichung Special Municipality was done by Yao-Jen Chang and Min-Der Lin in 2011. The linear programming technique was used with the least cost objective function to establish a MSWM optimization model capable of solving MSWM problems in the Taichung Special Municipality. The results show that the optimal strategy can obtain a least net cost of -864,827 NT$/day, indicating a benefit of 864,827 NT$/day. The benefits were mainly achieved from the sale of recycled materials, electricity and food waste for animal feed. The sale income from recycled materials exceeded treatment costs and resulted in net benefit. Electricity sales from incinerators of 1,678,809 NT$/day were another major source of income for the MSWM system. However when other transportation and disposal costs were included there was no significant net benefit from electricity sales. Though composting is known to be one of the safest and least harmful treatment methods for food waste, it was not an attractive treatment method as per study. (Yao-Jen Chang and Min-Der Lin, 2011) [23].

As stated earlier, there are also indirect costs and benefits attached with solid waste management. So while considering cost-benefit analysis, it becomes essential to include such costs and benefits. There are various types of indirect costs involved. These plants emit some pollutants, which include sulphur dioxide, lead, and dioxins which, if occurred in high concentration, are hazardous for health and environment. Also, the people who reside nearby these plants suffer from the congestion, odor and other health issues. (Jamasb *et al*., 2008 ; Kaplan *et al*., 2009) [11, 17].

These plants generate positive environmental externalities (indirect benefits) and for each tonne of MSW used, they reduce consumption of oil by about one barrel and for coal by 0.26 tonnes (Jamasb *et al*., 2008) [11]. Also, there is reduction in emissions of GHGs. The net change in greenhouse gas emissions from these plants can be assessed the amount of energy it generates and waste management alternatives that it would replace. With the increase in amount of solid waste generated (due to increase in population), electrical energy generation potential increases. This can potentially replace coal-fired generation capacity. In case of Dhaka, the electrical energy generation potential increased from 456900MWh in 1995 to 1894400MWh in 2025 (projected) (Sufian and Bala, 2005; Kaplan *et al*., 2009). [13, 17]

[1]. *http://www.epa.gov/osw/nonhaz/municipal/wte*

[2] A gate fee (or tipping fee) is the charge levied upon a given quantity of waste received at a waste processing facility from a neighborhood.

The GHG which produced majorly is Methane and has a warming potential that is 21 times that of carbon dioxide. The degradation of materials in landfills generates a toxic component leachate which causes groundwater pollution if it escapes. The combustion of biodegradable substances in landfill generates, when comes in contact with oxygen, 65 percent methane and 35 percent carbon dioxide. Thus, when the solid waste left untreated in landfills results in net increase of GHG. Reduction in such emissions has environmental and health benefits (Jamasb *et al*., 2008) [11].

The other positive externality which these plants generate is the reduction in the space required by landfill by about 90 percent with an additional benefit of avoiding the aqueous emissions from landfills. Recovery of ferrous and non-ferrous metals is also possible from such plants. (Kaplan *et al*., 2009) [17]

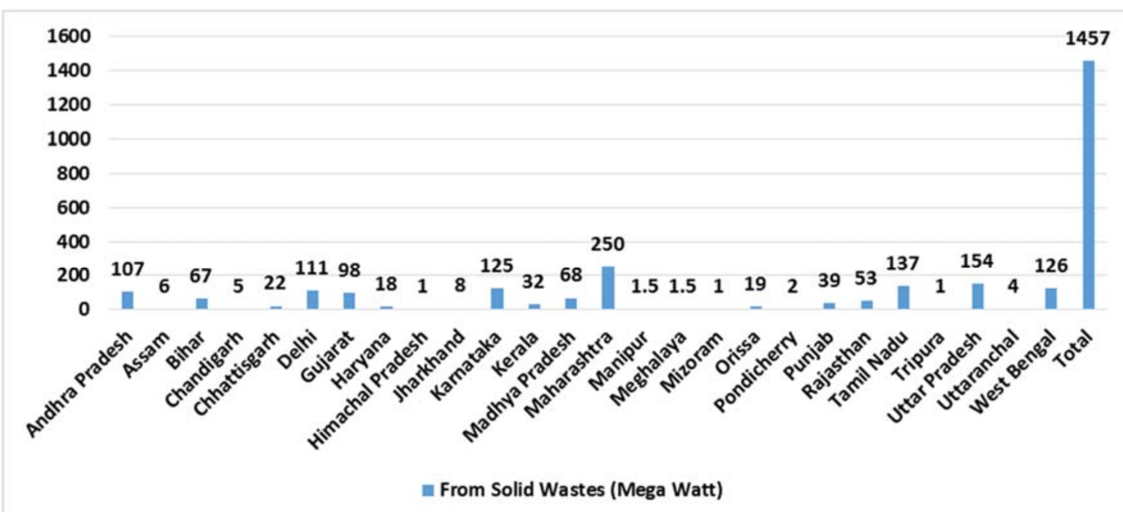
The cost-benefit analysis by Jamasb *et al*. (2008) [11] found that in U.K, assuming the price of coal does not increase, coal power is cheaper than the incineration plants in terms of private costs. However, the contribution of a coal fired plant towards global warming is higher than those of waste treatment options. External costs from a coal fired plant may be higher than that of the incineration plants. Also, the benefits are significantly higher when electricity is produced through solid waste than coal in terms of social cost- benefit. It was also found that this benefit would increase with time due to technological up gradation and innovation and the price of coal will tend to increase in coming future. In a study done by Kaplan *et al*. (2009) [17] in U.S, found that the sulphur oxide emissions from Landfill-Gas-to-Energy and Waste-to-energy were 10 times lower than that of emissions from coal and oil fired power plants. Also, the emissions of nitrogen oxide were significantly higher than Landfill-Gas-to-energy and coal power plants (Jamasb *et al*., 2008) [11]. All the above analysis indicates that electricity generation and solid waste management can be efficiently done by WtE plants.

India's Potential of Energy Recovery from Solid Waste

Solid waste can be managed efficiently by utilizing it to generate electricity which can help India to achieve its target of 100% household electrification. Looking at the current scenario, only around 55% of households are electrified (MOSPI; 2006) leaving over 20 million households without power. The supply of electricity across India currently lacks both quality and quantity with an extensive shortfall in supply, a poor record for outages, high levels of transmission and distribution (T&D) losses and an overall need for extended and improved infrastructure (MOSPI; 2006) [1].

The rise in energy-intensive lifestyles being adopted by the India's growing middle and high-income population is having an influence on the country's energy consumption patterns and has resulted in increasing the country's energy demands at a phenomenal rate. "The key challenge India's energy sector is facing is the huge 'Demand and Supply' gap that exists with regard to electricity and energy requirements on the whole. The country already faces an enormous and substantive peak demand shortage of electricity almost all through the year. The rural population is invariably the worst affected as more often than not in case of any demand and supply-based energy deficit, the priority is always given to meet the energy requirements of urban areas" (Mohan *et al*., 2006) [15].

According to the Ministry of New and Renewable Energy (2011) estimates, there exists a potential of about 1457 MW from MSW but a very small amount of it have been exploited. Figure 3.1 gives description of potential of energy recovery from waste.



Source: Ministry of New and Renewable Energy, 2011

Fig 3.1: Potential of energy recovery from waste

According to the Central Electricity Authority, during the year 2010–11, demand for electricity in India far outstripped availability, both in terms of base load energy and peak availability. Base load requirement was 861,591 MU against availability of 788,355 MU i.e. 8.5% deficit. During peak loads, the demand was for 122 GW against availability of 110 GW, a 9.8% shortfall. In India, villages in remote far flung areas can only be electrified by using renewable resources since they are not economically viable to connect through conventional grid systems. Thus Waste-to-energy provides the solution for the India's growing electricity demand.

The available literature indicates that there are potential benefits of rural household electrification. The people without electricity depend on fuel wood, cow dung, crop residue and kerosene for their energy needs in the rural areas. Kerosene is the primary source of lightning in houses with no electricity.

The benefits of substituting kerosene with electricity are much higher in terms of quality of the lightning. It also eliminates air pollution caused by burning of kerosene which accounts for about half a million premature deaths per year in India (Khandker *et al*., 2012) [18]. At the same time rural electrification can bring information from the outside world – this will be critical in eliminating several social practices in the villages. People would become more aware of their own rights and responsibilities. It would be easy to connect the rural communities through televisions and even the internet (Mohan *et al*., 2006) [15].

Despite these benefits there are many constraints faced by Indian companies in supplying of electricity through WtE plants. These include: lack of financial resources with Municipal Corporations/Urban Local Bodies, Lack of conducive policy guidelines from State Governments in respect of allotment of land, supply of garbage and power purchase / evacuation facilities, difficulties in importation of equipment and biomethanation technology.3

However, given these constraints there exist many companies in India which are providing electricity through WtE plants. These include M/S Asia Bio-Energy Private Limited in Chennai, Cicon Environment Technologies in Bhopal, Bermaco/WM Power Limited in Navi Mumbai, Hanjer Biotech Energies in Mumbai, East Delhi Waste Processing Company Private Limited in Delhi and many more.

The MNRE also offers financial incentives to companies who wish to set up a waste-to-energy project as per the policies of the ministry. The incentives are given to both private as well as public sector entrepreneurs and investors having technical and managerial capabilities. The incentives offered are:

i. For commercial projects, financial assistance is provided by way of interest subsidy in order to reduce the rate of interest to 7.5%, capitalized with an annual discount rate of 12 %. The assistance is routed through financial institutions (FIs)/ Lead FI of the project, etc.
ii. For demonstration projects comprising innovative projects for generation of power from municipal solid wastes and selected industrial wastes, financial assistance up to 50% of capital cost of the project limited to Rs. 3.00 crore per MW is provided to the project proponent.
iii. In addition to the above, financial incentive at the rate of Rs. 15.00 lakh per MW is given to Municipal Corporations/ Urban Local Bodies, for supplying the garbage free of cost at the project site and providing land on a long-term lease, viz. 30 years and above, at a nominal rent.
iv. State Nodal Agencies are given an incentive @ Rs.5.00 lakh per MW of power for promotion, co-ordination and monitoring of projects.

Given the assistance, if we look at the physical progress in terms of achievement in capacities of generating electricity from waste, then for the year 2015-16(August, 2015) we have achieved only 0.50 MW of capacity given the target of 10 MW.4

Thus there is a need to efficiently plan, manage, and implement the electrification programme through waste to energy plants. This requires learning from international experiences, but adapting our solutions to the ground realities of rural India.

Conclusion

The rate of generation of solid waste is increasing in India with increasing modernization and urbanization and with increasing population it is expected to rise further in future. It is very common to find large heaps of garbage in disorganized manner at every nook and corner of the cities. These large chunks of waste if not treated properly cause lot of problems-health, environment etc. From the above discussion, we find that solid waste management is a problem which has not been taken seriously in India. One way of managing waste is the generation of electricity in WtE plants and it's indeed an efficient way. This will solve the problem of Solid Waste-disposal and management together with providing an alternative for power generation, which in a way also provides a solution to energy crisis.

The cost-benefit analysis indicates that WtE plants are efficient not only in cost terms, but also in lower emissions of poisonous gases. In the Indian case, the MNRE has realized the potential of the country in providing electricity through waste management and has thus, offered various incentives/ assistance to companies engaged in waste to energy sector.

In this hi-tech and mechanized world, it is the poor who is gets the least attention and enjoyment of benefits, providing them electricity (reliable and continuous supply) will be a step towards their betterment. Solid Waste Management though electrification, thus requires attention in this carbon- crunch world.

References

1. Annual Report, MOSPI, 2006.
2. Bartone Carl, Bernstein Janis, Wright Frederick. Investment in Solid Waste Management Opportunities for Environmental Improvement, Working paper. Policy Research and External Affairs. Infrastructure and Urban Development Department. The World Bank. WPS 405. 1990, 1-85.
3. Beede David N, Bloom David E. The Economics of Municipal Solid Waste, The World Bank Research Observer, Oxford University Press 1995; 10(2):113-150
4. Bureau of Land & Waste Management, Division of Mining & Solid Waste Management. Regulation SWM: Solid Waste Incineration and Solid Waste Pyrolysis Facilities. South Carolina Department of Health and Environmental Control. [Online] 1999; 12:67-107.
5. Chouhan MS, Verma S, Sharma S, Metha N. Review on waste to energy potential in India. IJCS, 2015; 2(5):51-53.
6. Cust James, Singh Anoop, Neuhoff Karsten. Rural Electrification in India: Economic and Institutional aspects of Renewables, *EPRG 0730 & CWPE 0763* University of Cambridge, UK, 2007, 1-36.
7. Division of Technology, Industry and Economics. State of Waste Management in South East Asia, Types of Wastes - Sources and Composition. United Nations Environment Programme. UNEP Report, 2004.
8. Dominique van de Walle, Martin Ravallion, Vibhuti Mendiratta, Gayatri Koolwa, Long-Term Impacts of Household Electrification in Rural India, The World Bank, Development Research Group, Human Development and Public Services Team, 2013.
9. FICCI, Survey on the Current Status of Municipal Solid Waste Management in Indian Cities and the Potential of

[3] http://www.eai.in/ref/ae/wte/concepts.html

[4] http://mnre.gov.in/mission-and-vision-2/achievements

Landfill Gas to Energy Projects in India, FICCI, 2009, 1-18.

10. Gaviota Maria, Alonso Velasco Perez, Themelis Nickolas. Generation and Disposition of Municipal Solid Waste in Mexico and Potential for Improving Waste Management in Toluca Municipality, Waste-to-Energy Research and Technology Council (WTERT). [Online], 2011.
11. Jamasb T, Kiamil H, Nepal R. Hot Issue and Burning Options in Waste Management: A Social Cost Benefit Analysis of Waste-to-Energy in the UK, *EPRG* Working Paper 0802, Cambridge Working Paper in Economics 0801, University of Cambridge: Electricity policy research group, 1-46
12. Load Generation Balance Report 2011-12". Central Electricity Authority, Government of India Ministry of Power, 2011
13. Sufian MA, Bala BK. Modelling of electrical energy recovery from urban solid waste system: The case of Dhaka city, Available online, 2005.
14. Medina Martin, Solid Wastes. Poverty and the Environment in Developing Country Cities Challenges and Opportunities. Working 2010/23. United Nations University. World Institute for Development Economics Research. 2010, 1-15.
15. Mohan Prashant, Zain Azmir, Schiller Michael. Rural Electrification in India: A Bottom up Development Initiative, INSEAD Publications, 2006.
16. Power Sector at a Glance ALL INDIA as on 31-12-2012 - Installed capacities for power generation in India, Ministry of Power, GOI
17. Ozge Kaplan P, Joseph De Carolis. Susan Thorneloe. Is It Better To Burn or Bury Waste for Clean Electricity Generation? Environ. Sci. Technol., 2009; 43(6):1711-1717
18. Shahidur R. Khandker Hussain A, Samad Rubaba Ali, Douglas F Barnes. Who Benefits Most from Rural Electrification? - Evidence in India, the World Bank, 2012.
19. Sharholy Mufeed Ahmad, Kafeel Mahmood Gauhar Trivedi RC. Municipal solid waste management in Indian cities: A Review; Science Direct; Waste Management 2008; 28:459-467.
20. Thomas C, Fullerton Kinnaman Don. The Economics of Residential Solid Waste Management, Working Paper 7326, National Bureau of Economic Research, 1999, 1-47
    http://www.nber.org/papers/w7326,
21. Ranganathan V, Ramanayya TV. Long-Term Impact of Rural Electrification: A Study in UP and MP, Economic and Political Weekly, 1998; 33(50):3181-3184.
22. Venkateswaran, Sandhya, Managing Waste: Ecological, Economic and Social Dimensions, EPW, 1994, 5-14
23. Yao-Jen Chang, Min-Der Lin. Economic Evaluation of Municipal Solid Waste Management System for Taiwan’s Taichung Special Municipality, 2nd International Conference on Environmental Science and Technology, IPCBEE, IACSIT Press, Singapore, 2011, 6.