Potential for Waste to Energy Facilities in Abu Dhabi

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1. ABSTRACT

Centre for Waste Management (CWM) was setup in February 2008 by Government of Abu Dhabi to lead and coordinate waste management activities in the entire emirate covering the Greater Abu Dhabi region and the Western region. CWM and private companies share the responsibility of collection, transportation and disposal of MSW in Abu Dhabi emirate. MSW management services in Abu Dhabi are privatized through short term and long term contracts.

Presently, the waste generated from the emirate is disposed through landfills. Abu Dhabi emirate is currently working on a 10 year agreement with a private company for MSW collection and treatment. The proposed facilities include enhancement and development of transfer station and landfills.

Data reveals that the per-capita MSW generation rate in the emirate ranges between 1.76 to 2.3 kgs/day, however there is a pressing need to collate the MSW generation and characteristics data for the emirate as a whole.

In this paper an attempt has been made to ascertain the potential of implementing the waste to energy facility in the emirate of Abu Dhabi. The potential for waste to energy facility is assessed by evaluating the suitability of waste, available technology aspects, environmental benefits, commercial aspects and social aspects.

2. INTRODUCTION

Abu Dhabi, the capital of United Arab Emirates (UAE) is one of the fast growing economies in the Middle Eastern countries. The emirate holds 95 % and 92 % of UAE’s total oil and gas reserves, respectively. With a strong back up of the oil and gas revenues and economic diversification, the Gross Domestic Product (GDP) of Abu Dhabi is rising. The emirate registered a GDP of US$ 100 billion in 2006, which was close to US$ 40 billion in 2002 and this trend is expected to continue further. Research suggests that there is correlation between the GDP and solid waste generation. In addition to the growth in the GDP, the emirate has seen exponential growth in the population. The urban development framework for Abu Dhabi anticipates the population to grow from 0.93 million residents in 2007 to 3.1 million residents in 2030, which is around 233 % growth over a period of two decades. This rapid growth in the GDP and population will strain the existing infrastructure, especially on Municipal Solid Waste (MSW) management.

3. MSW MANAGEMENT IN ABU DHABI

Centre for Waste Management (CWM) was setup in February 2008 by Government of Abu Dhabi to lead and coordinate waste management activities in the entire emirate covering the Greater Abu Dhabi region and the Western region. MSW management services in Abu Dhabi are privatized through short term and long term contracts. Both, the services and construction of waste
management facilities are procured through these contracts. CWM and private companies share the responsibility of collection, transportation and disposal of MSW in Abu Dhabi emirate.

MSW generated in the Greater Abu Dhabi region is partially collected through private companies and CWM, whereas CWM is solely responsible for the western region. The waste from the Greater Abu Dhabi region is transported to Al Dhafra landfill through Al Mafraq transfer station, which has a capacity of around 2000 t/d. In the western region, MSW is transported and disposed in seven official landfills.

- Al Ruwais
- Al Mirfa
- Madinat Zayed
- Al Sila/Baya
- Yathi
- Gogeven
- Khannur

In addition to the seven landfills, the western region also accommodates two composting plants for processing the green waste. These facilities with mobile composting equipment are located at Liwa and Ghayathi.

4. FUTURE PLANS

Abu Dhabi emirate is currently working on a 10 year agreement with a private company for MSW collection and treatment. The proposed facilities include:

a. Greater Abu Dhabi Region

- Transfer/Sorting Facility in Al Mafraq
- Green Waste Composting Facility in Al Dhafra
- Sanitary Landfill besides the existing landfill at Al Dhafra
- Inert waste landfill at Al Dhafra

b. Western Region

- Transfer stations at Al Si'la, Ghayathi, Al Mirfa, Madinat Zayed and Liwa on the existing MSW disposal sites
- Sanitary Landfill besides the existing landfill at Ruwais
- Green waste composting facility at Ruwais
- Upgrading of green waste composting facility at Liwa and Ghayathi

At the time of writing this paper much details of these facilities such as design capacities, are not known, however it is anticipated that these facilities will serve for at-least 10 years from the date of commissioning.

5. Potential for Waste to Energy Facility

Integrated solid waste management is a need of a city, state, or country and it becomes more evident for a city like Abu Dhabi due to the economic and urban growth. The case for a potential waste to energy (WTE) facility is discussed by
• estimating the MSW quantities and characteristics
• elaborating the benefits of the WTE facility as applicable to Abu Dhabi.

a. MSW Generation

CWM has grouped waste generation in Abu Dhabi into eight different categories and they are:

- Household waste;
- Commercial waste;
- Industrial waste;
- Agricultural waste;
- Medical waste;
- Marine waste;
- Packaging waste; and
- Hazardous waste

Even though, CWM has clear definition for all the above categories, there is lack of data in terms of waste generation and disposal from each of these categories.

CWM reported that the total waste generation in Abu Dhabi emirate was around 5.9 million tonnes during the year 2007/2008, which was around 670,000 tonnes in 2006. However, it is not known how much MSW constituted the reported 5.9 million tonnes.

Thus, an attempt has been made to project the waste quantity based on the per capita waste generation and population figures. The average annual per capita waste generation in Abu Dhabi was reported to be 730 kgs. This works out to be around 2 kgs/day/capita and there are other studies which report around 1.76 kgs/day/capita. Abu Dhabi state of environment report estimates a MSW generation of around 2.3kgs/day/capita.

The waste generation data for the Abu Dhabi emirate is very scattered. Therefore waste quantities are estimated considering a conservative per capita waste generation of 1.76 kgs/day. The anticipated MSW generation in the emirate of Abu Dhabi is presented in Figure 1.

Figure 1 MSW Generation in Abu Dhabi
MSW generation in 2020 and 2030 is estimated to be around 3500 and 5500 tonnes per day respectively. It should be noted that the MSW generation estimates is based on the increase in the population only and does not include the increase in the per-capita waste generation.

b. Characteristics of MSW

Similar to the MSW generation data, MSW characteristics data for the emirate of Abu Dhabi is inadequate. Therefore a comparison is made with Dubai emirate as there are number of similarities between these two emirates.

The MSW generated in the emirate of Abu Dhabi is reported to consist primarily of wet organics (primarily food waste) (49%), recyclables comprising paper, metals, glass, plastics (35%). Table 1 gives the composition of MSW in Abu Dhabi, Dubai and the characteristics considered for evaluating the potential for a Waste to Energy facility.

Table 1 : Waste Composition in Abu Dhabi

<table>
<thead>
<tr>
<th>Fraction</th>
<th>Abu Dhabi data</th>
<th>Dubai data</th>
<th>Considered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organics</td>
<td>49%</td>
<td>28%</td>
<td>40%</td>
</tr>
<tr>
<td>Paper</td>
<td>6%</td>
<td>22%</td>
<td>25%</td>
</tr>
<tr>
<td>Metals</td>
<td>8%</td>
<td>6%</td>
<td>7%</td>
</tr>
<tr>
<td>Plastics</td>
<td>12%</td>
<td>20%</td>
<td>15%</td>
</tr>
<tr>
<td>Glass</td>
<td>9%</td>
<td>7%</td>
<td>8%</td>
</tr>
<tr>
<td>Wood</td>
<td>-</td>
<td>4%</td>
<td>-</td>
</tr>
<tr>
<td>Textiles</td>
<td>-</td>
<td>5%</td>
<td>-</td>
</tr>
<tr>
<td>Inert</td>
<td>-</td>
<td>3%</td>
<td>5%</td>
</tr>
<tr>
<td>Others</td>
<td>16%</td>
<td>5%</td>
<td>-</td>
</tr>
</tbody>
</table>

c. Assessment

In today’s world, a number of technologies are available to convert waste in to a useful form of energy. The selection of an appropriate technology to convert a specific waste in to energy is a crucial task that requires a certain degree of evaluation of the options that are available with respect to its location and characteristics of the waste. However, the scope of this paper is to indicate the potential and not to evaluate or identify a specific technology.

The potential for waste to energy facility is assessed by evaluating the

- suitability of waste,
- available technology aspects,
- environmental benefits,
- commercial aspects and
- social aspects.

i. Suitability of Waste Stream

The quantum and characteristics of waste available will play a crucial role in deciding the viability of a waste to energy facility. The waste quantum will decide the capacity of the plant, whereas, the constituents making up the organic fraction, net calorific value, moisture content will determine the technology needed.
Based on the waste quantity and characteristic estimated in the previous paragraphs, it can be concluded that at-least two 500 TPD WTE facilities one each for biological and thermal process can be accommodated in the Greater Abu Dhabi Region.

The ideal location for these facilities can be close to Al Mafraq Transfer Station, however land availability to establish these facilities has to be further ascertained. The other major advantage of siting WTE facility close to Al Mafraq is that the sewage sludge from the Al Mafraq wastewater treatment plant can be used as a feedstock to the biological process. In addition to this, the energy generated can be used within the sewage treatment plant, by which the transmission losses can be avoided.

It should be noted that the successful implementation of such facility will require an efficient waste management system and an elaborate pre-treatment via shredders, hydralupers, cyclones, air classifiers, etc. for the removal of grits, ferrous/ non-ferrous metals, glass, etc, to obtain a suitable feed-stock.

d. Technology Aspects

One of the major differences between the thermal and biological process is the operating temperature level viz.1000 deg Celsius vs. 35 – 60 deg Celsius, respectively. Effectiveness of a technology will be determined by its flexibility in responding to a variety of wastes, potential future improvements, and its adaptability to changing regulations. This is an extremely important factor in Abu Dhabi as the waste composition may drastically change over the period of Ramadan. However, the WTE technologies are well proven to take care of such fluctuations in other parts of the world.

e. Commercial Aspects

There are two important commercial aspects to be considered for installing a WTE facility: first is the capital and O&M costs, and the second is the revenue generated from the sale of recovered energy and other by-products. Disposal of by-products in an efficient way can not only save disposal costs, but also produce some additional revenue.

Based on the initial calculations the capital cost to process per tonne of MSW is estimated to be US$ 60,000 and US$ 80,000 for a biological and thermal process, respectively. Thus, the total capital cost is estimated to be US$ 30 million and US$ 40 million for a 500 TPD WTE facility based on biological and thermal process, respectively.

In general, O&M cost of thermal process is expected to be slightly higher than the biological process. This is primarily because the relative simplicity of biological systems since the mechanical maintenance will not be a significant issue, except perhaps during mechanical breakdowns of the pre-treatment operations. An O&M cost of US$ 16 and US$ 18 per tonne of MSW processed through biological and thermal process is considered for estimating the annual O&M cost. The annual O&M cost for biological and thermal process works out to be US$ 2.64 million and US$ 2.97 million, respectively.

The possible revenue streams for the suggested WTE facilities include surplus electricity, compost and recovered recyclables such as metals and glasses. A tariff rate of US$0.04 per kwh is used to estimate the revenue from the surplus energy. A conservative market rate of US$ 40 per tonne of metal or glass and US$ 65 per tonne of compost is considered to calculate the revenues.
Based on the capital cost, O&M cost, project revenues an internal rate of return (IRR) analysis is carried out to ascertain the commercial viability of the potential WTE facilities in the emirate of Abu Dhabi.

The analysis reveals that IRR of the potential WTE facilities is 3.8% with a pay back period of 10 years.

UAE being a signatory to the Kyoto protocol, these facilities can be developed as a clean development mechanism projects. In this case the project IRR can further be improved and will yield a better commercial viability.

f. Environmental Benefits

In general, technologies for treatment and disposal of MSW have associated environmental issues and concerns seriously limiting their widespread adoption. Thermal process such as incineration requires elaborate air pollution control system to comply with strict regulatory requirements. Impact of emissions on air quality, water quality, land and other environmental consequences can be resolved and addressed. In turn, WTE facility will avoid the GHG emission from the landfills as reported by CWM. Further, implementation of WTE facility will reduce the land requirement for MSW disposal.

g. Social Aspects

Public acceptance is critical in choosing a site for waste-to-energy facility. Issues such as traffic generation to and from the facility site, odour, noise, air pollution, and other perceived health risks of waste treatment, disposal and energy recovery options all play a role in public acceptance. Most of these issues can be sorted out in the emirate of Abu Dhabi.

6. Implementation Process

As WTE facilities are expected to produce electricity, Law No (2) of 1988, concerning the water and electricity sector will have a major role in the implementation of these facilities. Abu Dhabi Government has established a Regulatory Supervisory Board (RSB) under this law to perform the duties and carryout functions specified under Law No (2) of 1988. RSB enforces the relevant laws and regulates the sector through licensing.

Under the above stated law the WTE facility owner has to seek licences from RSB for implementing a WTE facility.

7. Conclusion

As majority of the states in the world, the emirate of Abu Dhabi faces huge challenges in managing the MSW. These challenges can be converted into opportunities, especially on the treatment and disposal of MSW.

This paper concludes that WTE facilities can be installed in Abu Dhabi emirate and these facilities are commercially viable. Further, by implementing the WTE facility, the land which is used for disposal of MSW can be put to a better use. In addition, there is a potential for co-digestion of sewage sludge and MSW.
As the MSW generation is increasing day by day, the capacity of the facilities can be increased, which in turn may enhance the commercial viability of the project. However, the first step is to collate data on MSW generation and characteristics.

Implementing WTE facilities in Abu Dhabi will cede number of tangible and intangible benefits, such as reduction in the emission of GHG, improvement of the local ambient air quality at the existing land fill site, prevention of land and water contamination, etc. Above all the emirate of Abu Dhabi can lead the way and be an example for other GCC countries.

8. References

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