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### POTENTIAL FOR REDUCING THE CAPITAL COSTS OF WTE FACILITIES

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#### ABSTRACT

The dominant waste-to-energy technology is combustion of “as-received” municipal solid wastes (MSW) on a moving grate. By far, the largest cost item in the operation of such plants is the repayment of the initial capital investment of \$600 to \$750 per annual metric ton of capacity which results in capital charges of \$60-75 per ton of MSW processed. On the average, such plants generate about 650 kWh of electricity per metric ton of MSW combusted. Therefore, on the basis of 8,000 hours of operation per year (90% availability), the capital investment in WTE facilities ranges from \$7,500 to \$9,000 per kW of electric capacity. This number is three times higher than the present cost of installing coal-fired capacity (about \$2,500 per kW). Of course, it is understood that WTE plants serve two purposes, environmental disposal of solid wastes and generation of electricity; in fact, most WTE plants would not exist if the fuel (i.e. the MSW) had to be paid for, as in the case of coal, instead of being a source of revenue, in the form of gate fees. However, the question remains as to why WTE plants are much more costly to build, per kWh of electricity generated, than coal-fired plants, even when the coal supply is lignite of calorific value close to that of MSW (about 10 MJ/kg). This study intends to examine the possible contributing causes, one by one, in the hope that the results may lead to the

design of less costly WTE plants. Some of the factors to be examined are: Feed-stock handling; heat generation rate per unit volume of combustion chamber; heat transfer rate per unit area of boiler surfaces; % excess air and, therefore, volume of gas to be treated in Air Pollution per kW of electricity; differences in gas composition and high temperature corrosion in boiler that limit steam temperature and pressure and thus thermal efficiency; cost of APC (air pollution control) system because of the need to remove volatile metals and dioxin/furans from the process gas; and the handling of a relatively large amount of ash. In seeking the answers to the above questions, the study also compares the operational performance characteristics and engineering design of various existing WTE plants.

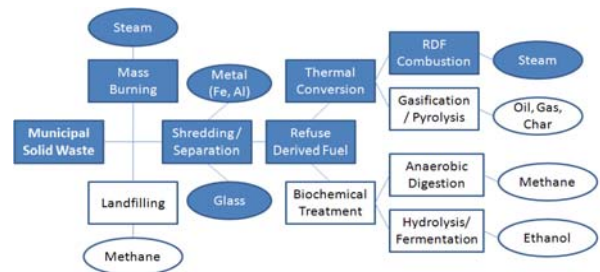
This study is at its very beginning and it is presented at NAWTEC 17 in the hope of generating useful discussion that may lead to significant improvements in the design of future WTE facilities. The WTEs built in the U.S. until 1995 were designed for efficient and environmentally benign disposal of MSW, with energy recovery being a secondary consideration. There have been three principal changes since then: (a) the capital cost of WTEs, per daily ton of capacity has doubled and in some cases nearly tripled, (b) energy recovery per unit of carbon dioxide emitted has become an important consideration, and (c) the price of

renewable electricity has increased appreciably. All these three factors point to the need for future WTEs to become more compact, less costly to build, and more energy-efficient. It is believed that this can be done by combining developments that have already been tested and proven individually, such as shredding of the MSW, higher combustion rate per unit surface area of the grate, oxygen enrichment, flue gas recirculation and improved mixing in the combustion chamber, superior alloys used for superheaters, and steam reheating between the high-pressure and low-pressure sections of the steam turbine. For example, oxygen enrichment is practiced at the Arnoldstein, Austria, WTE where parts of the primary air stream are enriched between 23% and 31% oxygen; steam reheating has been proven at the Waste Fired Power Plant of AEB Amsterdam where electricity production for the grid has been increased to over 800 kWh per ton MSW.

## INTRODUCTION

The tonnage of global post-recycling MSW in urban centers is estimated at about 1.2 billion metric tons. Of this amount, 0.2 billion are combusted in waste to energy (WTE) facilities, 0.2 billion are landfilled in modern regulation landfills, and 0.8 billion are disposed in traditional dumps without methane recovery, thus contributing over 3% of global CO<sub>2</sub>-emissions. Therefore, there is a lot of room for adding to the world's thermal treating capacity. This can be done either by means of the dominant technology of grate combustion (mass burn) with energy recovery or by means of more elaborate thermal treatment technologies, such as Refuse-Derived Fuel (RDF), Direct Smelting and Thermoselect Gasification process, and others that are still under development. In the case of "gasification" processes, that is partial combustion and production of "syngas" by the Thermoselect (oxygen enrichment) or the Plasco (thermal

plasma) processes, the syngas product can be combusted in a gas turbine or engine operating at a higher thermal efficiency (e.g. 35-40%) than the steam turbine used in conventional waste-to-energy (WTE) facilities where the thermal efficiency may be as low as 20%. This advantage may compensate for the use of electricity to power the oxygen plant or the plasma torch. Another advantage of such energy-assisted processes is that they generate high enough temperatures to vitrify the ash product. Figure 1 illustrates the methods for energy production from municipal solid waste leading to electricity production. The mass-burn and RDF combustion technologies are the focus of this study.



**Fig. 1 Energy generation from MSW**

Figure 2 shows how WTE technologies may be placed on a "technology" vs. "market" maturity plot (Navigant Consulting, 2004). The technology maturity axis indicates the potential for improving performance and reducing capital costs. Mass Burn technology has captured a larger fraction of the market than RDF; about 77% of the U.S. WTEs and nearly 90% of the global WTE industry are based on grate combustion of as received MSW. Also, the mass burn technology is judged to be at a lower technological level than RDF and thus there is more room for technological advancement.