PikeResearch
Cleantech Market Intelligence

## Research Report

# EXECUTIVE SUMMARY:
# Waste-to-Energy Technology Markets
## Thermal and Biological Processes for Electricity and Heat Generation from Municipal Solid Waste: Market Analysis and Forecasts

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**Published 4Q 2010**

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# Section 1

## EXECUTIVE SUMMARY

### 1.1 Introduction to Waste-to-Energy

Ancient human settlements unearthed by archaeologists tell their history – layer by layer – through food waste, animal bones, rubble, and garbage. The composition and amount of generated waste is a visible expression of civilization and a way to measure the standard of living of nations. Due to the advent of industrialization, growing urbanization and population, and expanding gross domestic product (GDP), the throughput of waste has dramatically increased. In fact, the amount of waste generated by households, agriculture, and industries in most countries seems gravely linked to population increases and rising GDP.

The gigantic amounts of waste that are hauled to dumps and accumulate in heaps and open pits have grown to become a major environmental issue. Landfilling is still the world's most widely used method for managing and treating waste. This practice has detrimental effects on the environment: land occupation, greenhouse gas (GHG) emissions, groundwater pollution, odor, and aesthetics. In cases where landfilling is impractical and no space is available, incineration is the preferred method to reduce the volumes of waste.

In the absence of governmental regulations and economic stimulus, dumping in landfills would persist as an unsustainable method for getting rid of waste and incinerators would operate without pollution control. However, industrialized countries have adopted regulations to divert waste from landfills through recycling, treatment, and materials and energy recovery. In addition, economic conditions and regulated markets have stimulated the use of waste as a resource and a source of energy.

Waste-to-energy (WTE) encompasses methods by which to extract the valuable energy entrapped in waste for the production of electricity and heat. Waste collected in cities contains a large amount of biological and renewable materials. It is therefore a source of renewable energy. As a consequence, energy-from-waste contributes to energy security and diversification, and matches the growing demand for renewable energy in a carbon constrained world.

Policies, regulations, and changing economic conditions are driving the growth of WTE capacity worldwide, creating attractive business opportunities for providers of WTE technologies and related components. Combustion is the dominant technology and is entrenched in the market. Yet, advanced thermal treatment (ATT) technologies such as plasma arc gasification are emerging in the market. Moreover, biological technologies for treating waste offer an attractive alternative to thermal treating methods.

Today, more than 900 thermal WTE plants operate around the globe. These plants treat an estimated 0.2 billion tons of municipal solid waste (MSW) with an estimated output of 130 terawatt hours (TWh) of electricity.

## 1.2 Market Issues

### 1.2.1 Waste to be Considered

The WTE, or energy-from-waste, technology market is essentially structured as a method to treat and manage MSW. The definition of MSW varies across the industry, and different nations and international organization have different definitions. This report utilizes the definition of the International Energy Agency (IEA): Waste in WTE is MSW where MSW is described as household waste and commercial and industrial waste that has a composition similar to the composition of household waste.

Specifically, this report covers MSW that is diverted from landfills to a WTE treatment facility. Note that Pike Research does not consider the extraction of energy from decaying waste in landfill and the harnessing of landfill gas (LFG) in this report.

### 1.2.2 Technologies Considered

Pike Research has focused the scope of this study on the thermal and biological treatment methods that yield energy in the form of heat and electricity. As such, waste-to-fuel applications, such as purified biogas for injection in natural gas grids, are excluded. Thermal methods include combustion, gasification, and pyrolysis. Biological treatment is limited to anaerobic digestion.

### 1.2.3 Waste Generation

In 2010, the world population will produce an estimated 1.7 billion tons of MSW. More than 1 billion tons will end up in landfills; while close to 0.2 billion tons will fuel thermal WTE plants. The data for the amounts of waste generated in a large number of countries are inaccurate and not up to date. Data for Western Europe, the United States, and Japan show that the growth rates of waste are comparable to the growth of GDP and energy consumption. Only a few countries, such as the Netherlands and Germany, are nearing the decoupling of waste and GDP. As a result, the potential for WTE capacity buildup is increasing with waste growth and landfill diversion.

### 1.2.4 Waste Policies and Regulations

Policies, regulations, and rules have had a fundamental impact on the evolution and structure of the WTE market. A dramatic illustration is the U.S. Supreme Court ruling of 1994 on waste flow control that abruptly stalled the development of thermal WTE in the United States. Another example is the Landfill Directive of the EU, which acts as a strong driver for market growth.

An in-depth analysis of the legal aspects of WTE shows important disparities between countries – even among the member states of the supranational European Union (EU). The EU Commission's Directives have been interpreted differently in the various member countries. As a consequence, market players must adapt to local regulations. Market presence and deep knowledge of and experience with local conditions are key success factors.

Policies and regulations affecting the WTE market include:

- Waste management laws, including the possible ban on landfills and the promotion of recovery and recycling of waste
- Air emissions standards and regulations on the disposal of ashes and residues

- Definition of waste as a renewable feedstock
- Subsidies and support for the production of renewable energy from waste
- Policies for reduction of fossil fuel dependence and increase of energy security
- The classification of incinerators as a waste disposal or recovery method
- Policies for the reduction of GHG emissions
- Policies that promote and finance technological developments in WTE
- Incineration and landfill taxes

### 1.2.5 Economic Aspects

In the absence of governmental policies that rule waste management and the recovery of energy from waste, economic and market conditions dictate the evolution of the market. Waste dumping in landfills is still the cheapest method for managing waste for an overwhelming majority of countries. Thus, the decision to implement WTE is based purely on economic factors. Pike Research has identified an array of factors that can affect the economic viability of WTE projects, such as the market prices for heat and electricity, landfill gate/tipping fees, land costs, materials costs, waste haulage costs, and the energy efficiency of WTE plants.

## 1.3 Market Restraints

Political and public opposition appear as the major non-economic restraints on the wider acceptance of thermal WTE. The opposition seems rooted in historic data and issues related to flue gas emissions and environmental hazards. Environmental activists tend to believe that the development of WTE capacity decreases the rate of waste recycling. Yet, recent statistics show the opposite. Countries like Sweden have made intensive efforts to communicate the benefits of WTE to the municipalities and the population. As a result, the acceptance of WTE in those countries is higher.

## 1.4 Technology Issues

Mass burn, or as-received combustion, dominates the WTE market. The market share of mass burn and refuse derived fuel (RDF) combustion is 98% globally, which dwarfs the share of other thermal and biological treatment technologies. Combustion is durably entrenched in the market and the other technologies face high barriers for market acceptance and market share capture.

The technology issues are tightly related to the market issues. Suppliers, technology developers, and researchers need to address compliance with regulations, higher energy efficiency, more resistant materials, lower costs, larger capacity, and smaller footprint.

For example, at higher efficiencies a WTE plant can export more renewable electricity and heat and generate more revenue. In addition, with higher renewable energy (RE) output, the plants can obtain revenue through RE feed-in tariffs (FITs), incentives, and carbon credits. Higher energy efficiency can improve the profitability of WTE plants and render them more competitive with other waste management routes. In this context, advanced thermal treatment methods such as gasification offer the potential of higher energy efficiencies through the combustion of synthesis gas in gas turbines.

Pike Research has also analyzed other technological challenges that the industry will have to tackle to gain wider market acceptance and compete with landfill disposal.

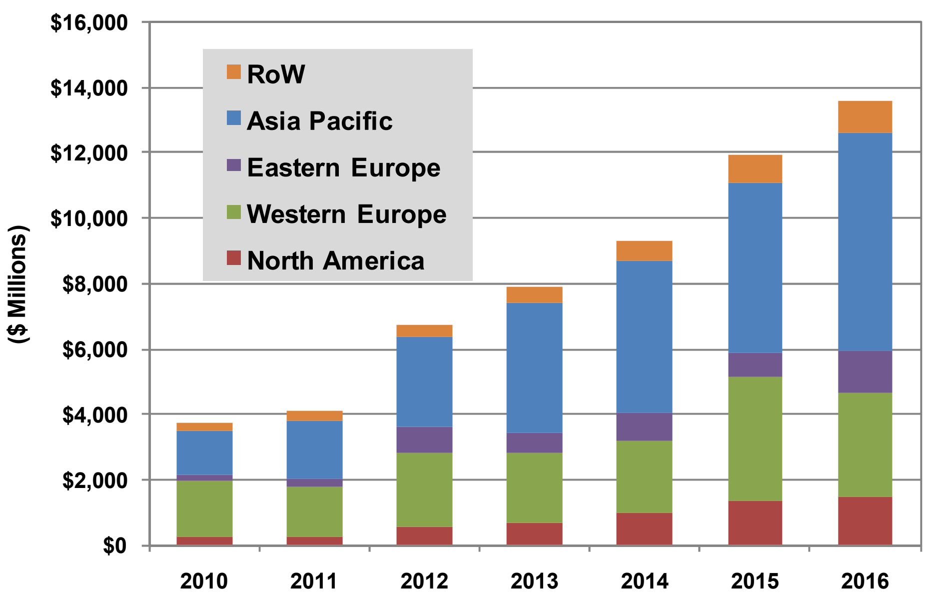
## 1.5 Key Market Players

The WTE technology market offers opportunities for turnkey plant and key equipment suppliers, service companies that provide plant operations and maintenance, and engineering companies. Yet, the barriers to enter the turnkey business are substantial. Strong balance sheets to capture high CAPEX projects and sustain long sales cycles, very reliable technologies and long-standing track records, and in-depth knowledge of market constraints are prerequisites to successfully operate in the market. A handful of specialist companies per region have these capabilities. The market is less concentrated for key equipment such as air pollution control (APC). This is also the case in the biological treatment market, where the capacities and the CAPEX of the projects are smaller.

## 1.6 Market Forecasts

According to Pike Research estimates, the global market for thermal and biological WTE technologies will reach $3.7 billion in 2010 and grow to $13.6 billion in 2016. Asia Pacific will contribute the largest portion of the growth, which will take off in 2012. The market in this region will likely grow to $6.6 billion at a compound annual growth rate (CAGR) of 31%. Market conditions in Western Europe – saturated, slow, or halted – will depend on the country. Certain countries could achieve the decoupling of waste generation and GDP and decrease the amounts of waste that emerge in the WTE market. Pike Research therefore anticipates erratic growth in Western Europe. The Western European market will grow from an estimated $1.7 billion in 2010 to $3.2 billion in 2016 at a CAGR of 11%. The U.S. market, which was dormant for over 15 years, shows a revival of activity. Favorable economic conditions for thermal WTE activity could spur market growth. As such, the U.S. market could grow at a very high CAGR of 40% and attain $1.2 billion in 2016.

***Chart 1.1 Waste-to-Energy Revenue by Region, World Markets: 2010-2016***




*(Source: Pike Research)*

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# Section 10

## Scope of Study

Pike Research has prepared this report to provide participants in the WTE technology market, including equipment and feedstock suppliers, investors, researchers, and market players, with a study of the key issues that drive and restrain the market. The major objective of the report is to examine the direction of the market and the potential revenue that could be generated by new trends, economic conditions, policies, and regulations. Pike Research also discusses the key market players and established technologies, as well as market contenders and emerging technologies, related to the thermal and biological conversion of waste to energy.

## Sources and Methodology

Pike Research's industry analysts utilize a variety of research sources in preparing Research Reports. The key component of Pike Research's analysis is primary research gained from phone and in-person interviews with industry leaders including executives, engineers, and marketing professionals. Analysts are diligent in ensuring that they speak with representatives from every part of the value chain, including but not limited to technology companies, utilities and other service providers, industry associations, government agencies, and the investment community.

Additional analysis includes secondary research conducted by Pike Research's analysts and the firm's staff of research assistants. Where applicable, all secondary research sources are appropriately cited within this report.

These primary and secondary research sources, combined with the analyst's industry expertise, are synthesized into the qualitative and quantitative analysis presented in Pike Research's reports. Great care is taken in making sure that all analysis is well-supported by facts, but where the facts are unknown and assumptions must be made, analysts document their assumptions and are prepared to explain their methodology, both within the body of a report and in direct conversations with clients.

Pike Research is an independent market research firm whose goal is to present an objective, unbiased view of market opportunities within its coverage areas. The firm is not beholden to any special interests and is thus able to offer clear, actionable advice to help clients succeed in the industry, unfettered by technology hype, political agendas, or emotional factors that are inherent in cleantech markets.

## Notes

CAGR refers to compound average annual growth rate, using the formula:

CAGR = (End Year Value ÷ Start Year Value)$^{(1/\text{steps})}$ – 1.

CAGRs presented in the tables are for the entire timeframe in the title. Where data for fewer years are given, the CAGR is for the range presented. Where relevant, CAGRs for shorter timeframes may be given as well.

Figures are based on the best estimates available at the time of calculation. Annual revenues, shipments, and sales are based on end-of-year figures unless otherwise noted. All values are expressed in year 2010 U.S. dollars unless otherwise noted. Percentages may not add up to 100 due to rounding.

Published 4Q 2010


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