

Doubling the Energy Advantage of Waste-to-Energy: District Heating in the Northeast U.S.

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Abstract

In District Heating (DH), a large number of buildings are heated from a central source by conveying steam or hot water through a network of insulated pipes. Waste-to-Energy (WTE) signifies the controlled combustion of municipal solid wastes to generate electrical and thermal energy in a power plant. Both technologies have been developed simultaneously and are used widely in Europe. In the United States, however, WTE is used principally for the generation of electricity. The advantages of district heating using WTE plants are: overall fuel conservation, by increasing the thermal efficiency of WTE, and overall reduction of carbon dioxide emissions to the atmosphere. The purpose of this study was to examine the current situation of district heating in the U.S. and determine the potential for applying DH to existing WTE plants. A preliminary evaluation was conducted of DH application at two WTE facilities in Connecticut: the Wheelabrator Bridgeport and the Covanta Preston facilities. Using a Canadian methodology, the minimal distribution heating network costs for Bridgeport were estimated at about \$24 million dollars for providing heat to a surrounding area of one square mile and the DH revenues at \$6.8 million.

Keywords: waste-to-energy, district heating, combined heat and power, cogeneration, municipal solid wastes

Introduction

District Heating is defined as the distribution of thermal energy from a central source to a large number of residential, commercial and industrial consumers for use in space heating, water heating and process heating. The central source may be an oil-fired boiler, a Waste-to-Energy (WTE) plant, or the by-product steam of a utility. This approach, also called “cogeneration” or “combined heat and power (CHP)”, has a very high energy utilization efficiency that can reach 80%.

There are significant advantages to be gained from a co-generation WTE plant. First, the energy efficiency can be increased by means of DH from 22% (electricity production only) to 80%. For example, Danish WTE facilities obtain an average of 0.6 MWh of electricity and 2 MWh of heat per metric tonne of MSW, thus tripling the amount of total energy obtained from MSW. Second, the high efficiency and low emission levels of WTE facilities make them environmentally friendly solutions, as compared to other technologies.

Currently, a conventional Waste-to-Energy plant in the U.S. loses over two thirds of the energy released from the controlled combustion of municipal solid wastes (MSW). This energy is rejected in the condenser in the form of low-temperature water that is not used effectively. Therefore, DH presents WTE facilities with the opportunity to increase thermal efficiency. However, there are some challenges that

should be addressed. For example, it may be necessary to modify the steam turbine and provide equipment in the facility to recover heat in the form of hot water. Moreover, the thermal efficiency of electricity generation will be reduced somewhat when co-generating heat and electricity, though the total efficiency will increase. Also, it takes several years to build an extensive district heating system and requires long-term planning. Thirdly, District Heating is capital-intensive and requires vision and commitment.

The purpose of this study is (1) to examine the current situation of the district heating in the U.S. and (2) to present the technical and economic aspects of applying DH to existing WTE plants in the United States. The study examines the retrofitting of two WTE facilities in Connecticut. These facilities were chosen because of their location in the northeastern region, where energy prices and population density are relatively high and encourage such a project. The study presents the advantages and disadvantages of retrofitting these plants to co-generate heat and electricity and provide DH to their region. Finally, the study provides a very preliminary cost analysis of implementing this technology.

District Heating in the United States

District heating in the United States is mainly based on the use of steam, such as the Con Edison Steam district heating system in New York City and the Citizens Thermal Energy