# Municipal Solid Waste Management

NREL
National Renewable Energy Laboratory

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# Municipal Solid Waste Management at NREL

The effort focuses on the productive and responsible use of municipal solid waste (MSW) as a renewable resource. The goal is to provide waste managers with the science, technology, and information necessary to design and operate cost-effective, publicly acceptable MSW management systems. The work falls into three broad categories: data collection and analysis, technology development, and technology and information transfer.

MSW is one of this country's important renewable energy resources, and NREL is improving our ability to tap it. MSW has the potential to supply 4% of the energy used annually in the United States. Currently, though, about 62% of our waste is being buried in landfills. Improving technologies and transfering these improvements to the waste management industry helps make the most of our MSW resource.

Municipal Solid Waste Management activities are being conducted by industry, national laboratories, professional waste management associations, and universities. Many projects are cost shared with industry or other organizations. ■

# Examples of Research Completed

### Energy Implications of Glass-Container Recycling

Recycling glass doesn't save much energy or valuable raw material and doesn't reduce air or water pollution significantly. The most important impacts are the small reduction of waste sent to the landfill and increased production rates at glass plants.

*NREL Report No. TP-430-5703.*

### Data Summary of Municipal Solid Waste Management Alternatives

The objective of this study was to gather data on waste options and compare alternatives for managing MSW. The study also compiled detailed data for existing waste management options; identified missing information necessary to make energy, economic, and environmental comparisons of various MSW management options; and developed a data base that identifies the options to best meet a community's criteria. In 12 volumes.

*NREL Report No. TP-431-4988.*

### Research, Development and Demonstration Priorities for Municipal Solid Waste

Research, development, and demonstration needs and priorities are identified. This assessment recognizes the many changes that have occurred in MSW management during the past decade.

*NREL Report No. TP-431-4982.*

### Anaerobic Digestion as a Waste Disposal Option for American Samoa

Tuna sludge and MSW from American Samoa represents an ongoing disposal problem as well as an emerging opportunity for renewable fuel production. This research project focuses on converting the organic fraction of these wastes to useful products including methane and compost through high-solids anaerobic digestion.

*NREL Report No. TP-422-5043.*

### Mercury Emissions from Municipal Solid Waste Combustors: An Assessment of the Current Situation in the United States and Forecast of Future Emissions

This report examines issues related to mercury from MSW combustors and is principally concerned with source strength characterization. The report provides a forecast of potential emissions reductions, which is based on assumptions for reducing the amount of mercury that enters MSW combustors.

*NREL Report No. TP-430-5399.*

### Waste-To-Energy in the United States: Socioeconomic Factors and the Decision-Making Process

This report examines: (1) the relationships between a municipality's decision to consider and accept or reject waste-to-energy (WTE) and key socioeconomic parameters; (2) the potential impacts of recent changes in financial markets on the viability of WTE; and (3) the WTE decision-making process and the socioeconomic parameters that are most important in the municipality's decision.

*NREL Report No. TP-430-5694.*

### *Oxygen-Enriched Coincineration of MSW and Sewage Sludge*

Pilot-plant testing showed that oxygen enrichment of combustion air will permit burning high concentrations of sewage sludge with MSW in waste-to-energy facilities. MSW combustion capacity was not affected under the test conditions.

*NREL Report No. TP-430-6082.*

### *Controlling Acid Gas Emissions from MSW Combustion Units*

This research evaluated lime (Ca(OH)2) and sodium bicarbonate (NaHCO3) injections used to neutralize acid gas emissions from waste-to-energy combustion facilities. The technology, known as dual sorbent injection for acid gas control, has been studied previously, but not on a long-term proof-of-concept scale for commercial use. The research results provided some useful and some unanticipated information pertinent to low-cost retrofitting of waste-to-energy facilities.

*NREL Report No. TP-430-6735.*

### *A Bibliography of U.S. Department of Energy Contractor Reports Through 1993*

The bibliography provides information about technical reports on energy from municipal waste that were prepared under grants or contracts from the U.S. Department of Energy from 1987 to 1993. The reports focus on energy from municipal waste technologies and energy conservation in wastewater treatment. There are three indexes—an author index, a subject index, and a title index.

*NREL Report No. TP-430-6078.*

### *Results of Combustion and Emissions Testing when Co-firing Blends of Binder-Enhanced Densified Refuse-Derived Fuel Pellets and Coal in a 440 $Mw_e$ Cyclone Fired Cumbustor, Vols. 1–3.*

This research project characterized the effects of burning a combination of binder-enhanced densified refuse-derived fuel (b-dRDF) pellets and coal in a commercial-scale electrical generating facility. Pelletized b-dRDF has been burned in coal combustors, but only in quantities of less than 3% in large utility systems. This research investigated using b-dRDF in quantities up to 20%. The report covers operating, technical, and economic viability data that will be critical for the near-term commercial use of b-dRDF.

*NREL Report No. TP-430-6322 a, b, c.*

### *$NO_X$ Control Technologies Applicable to Municipal Waste Combustion*

A cooperatively supported effort by NREL and the U.S. EPA. The report describes several technologies available for reducing $NO_X$ emissions from municipal waste combustors. These include combustion controls, natural gas injection, selective non-catalytic reduction, and selective catalytic reduction.

*NREL Report No. TP-430-6742.*

### *Integrated Municipal Solid Waste Management (IMSWM) in Germany*

This report details Germany's experience with IMSWM programs. The MSW practices of four cities include practices and procedures that waste facility managers with local and state governments may consider for managing their own day-to-day operations.

*NREL Report No. TP-430-7978*

### *Using Ash from Municipal Solid Waste Combustion*

Ash from MSW combustion in waste-to-energy facilities is usually landfilled. Several development projects are targeting the productive use of the ash resource in applications like asphalt highways, concrete structures, and landfill protective cover. An applications report describes available technologies and the results of preliminary tests on highway and landfill use.

*NREL Report No. TP-430-7382.*

### *Environmental Legislation and the Regulation of Waste Management in Sweden*

Sweden's integrated waste management system incorporates source reduction, reuse, recycling, separation and composting, waste-to-energy, and landfilling. The report covers Sweden's regulatory environment, its history of setting emissions limits on waste management facilities, and the current status of regulations.

*NREL Report No. TP-430-7974.*

### *Evaluating Material Recovery Facilities*

This report contains data for municipal planners, waste managers, and the scientific community to better assess material recovery facilities (MRF) as a waste-management option. Insufficient information existed on the energy, economic, and environmental factors associated with operating a MRF

.*NREL Report No. TP-430-8130.*

### *Landfill Gas Research*

Two areas of study were examined for this report: effect of leachate on methane production and the way methane migrates within a landfill. The report gives a better understanding of methane balance in landfills and more efficient methane collection techniques.

*NREL Report No. TP-430-7973.* ■

# Examples of Research Under Way

### Using a Molten Carbonate Fuel Cell to Produce Electric Power from Landfill Gas

The objective of the overall project is to determine the level of clean-up needed to make landfill gas useful for power generation in a molten carbonate fuel cell and to establish a cost effective technology to provide this degree of clean-up. Additionally, the consortium conducting the research will demonstrate the technology through 4,000 hours of operation of a 100 kw molten carbonate fuel cell at the Anoka, Minnesota landfill.

### Legislator's Guide for Municipal Solid Waste Management

A concise MSW guide for state legislators will be derived from the many lengthy and pertinent documents on MSW management and technology. The guide will aid legislators in understanding and evaluating MSW program and policy issues. Informed decisions and appropriate directions will flow from the use of the guide.

### Technical Articles on Municipal Waste Management Options

This project disseminates up-to-date information on municipal solid waste management options and technologies to planners and waste managers. A series of 24 technical articles have been published which cover a variety of waste management issues.

### Assessment of Tube Life in Waste-to-Energy Steam Generators

This work will give the waste management industry a better understanding of the metal degradation that occurs in steam boiler tubes of waste-burning systems. The project will augment the numerous studies that have been conducted on identifying the specific mechanisms of tube surface corrosion with research on the effect this phenomenon has on plant operation, planning, and reliability. Also, the project is identifying research that should be pursued to increase tube life and boiler performance.

### Recovering and Using Methane from Landfills

This program involves research, development, and demonstration activities to increase the recovery and use of methane from MSW landfills. A focus group of landfill gas (LFG) experts was established to evaluate models currently used to predict gas generation rates. A manual of practice for the operation and maintenance of an LFG system will also be developed.

### High-Solids Content Anaerobic Digestion of MSW

This work is being conducted to design, fabricate, and test an anaerobic digester than can process an MSW stream containing high concentrations of solids. Increasing the amount of solids that can be processed should improve the economics of anaerobic digestion as an MSW management alternative. The high-solids fermenter can process solids concentrations of up to 35%, which far exceeds the 10% solids content typical of existing fermenter designs.

### *Assessing Management Practices of Wood and Wood-Related Wastes in the Urban Environment*

Wood and wood-related wastes, sometimes referred to as "urban wood waste" (as opposed to forest waste), are often an element of municipal and commercial solid-waste streams. A three-part study of wood waste management is under way and consists of: (1) assessing the quantity and characteristics of wood and wood-related wastes; (2) assessing present regulatory status, current management practices, and available options for wood and wood-related wastes; and (3) assessing future needs for wood waste management and providing recommendations for action.

### *Evaluating Integrated Municipal Solid Waste Management Systems*

The objective of this program is to fill knowledge and data gaps on the subjects of energy, environmental, and economic effects of integrated MSW management systems by detailed evaluations of six different integrated MSW systems. Reports on each system that is studied and a final report will contain the complete data analyses of the performance of each system.

### *Gasification of Municipal Solid Waste*

New developments in an old thermal process, gasification, hold promise for converting MSW into clean fuel gas. Several gasification and other novel thermal processes will be critically evaluated. Results will provide decision makers with the information needed to judge the commercial readiness of the various processes.

### *WasteWorld: Teaching Students about Municipal Solid Waste*

This project will complete the *WasteWorld* educational package in preparation for marketing it to schools in the United States. *WasteWorld's* interactive curriculum is designed to educate students between 11 and 13 years old about municipal solid waste issues and involves the students in developing a waste management plan for their community. Testing in 500 schools was successfully completed.

### *Densified Refuse Derived Fuel (dRDF) Commercialization and Technology Transfer*

Burning dRDF with coal in utility and industrial boilers conserves natural resources and reduces air emissions. Corporations may obtain information about environmentally sound alternatives to landfilling non-recyclable organic wastes through an Environmental Corporate Assistance Program (ECAP). ECAP offers assistance in meeting unique industrial and commercial waste management opportunities. ■

***For copies of reports or fact sheets on research call Sally Evans at NREL at (303) 275-4363.***