



## Municipal Solid Waste Resources

Municipal solid waste (MSW) is a source of biomass material that can be utilized for bioenergy production with minimal additional inputs. MSW resources include mixed commercial and residential garbage such as yard trimmings, paper and paperboard, plastics, rubber, leather, textiles, and food wastes. Waste resources such as landfill gas, mill residues, and waste grease are already being utilized for cost-effective renewable energy generation. MSW for bioenergy also represents an opportunity to divert greater volumes of residential and commercial waste from landfills.

### Summary

*The 2016 Billion-Ton Report: Advancing Domestic Resources for a Thriving Bioeconomy* summarizes the most recent estimates of potential biomass available for biorefining in the future. This report is the first in the *Billion-Ton* series to include MSW in the biomass resource potential assessment. Along with projecting potential volume of MSW available, the report estimates the price ranges at which those supplies may be procured.

The *2016 Billion-Ton Report* estimates that annual gross potential of MSW biomass supply is about 51 to 55 million dry tons at prices of \$40 per dry ton and \$60 per dry ton. These estimates represent cost and availability from 2017 to 2040.

Potential MSW biomass supply is dependent on several factors, including future population growth; innovations in logistics and handling; efforts to reduce, reuse,



Municipal solid waste can come in different sizes and have many functions as biomass. Photo courtesy of Getty Images.

and recycle; and local waste handling contract challenges and opportunities.

In 2013, 134 million tons of residential and commercial garbage was sent to landfills. This figure represents about 35% of total MSW generated (the remainder of which was recycled, composted, or used for bioenergy production). The *2016 Billion-Ton Report* estimates that the majority of MSW biomass supply is in the form of plastics. There are potentially 20 million dry tons of plastics available for use in bioenergy production, representing 39% of the total MSW supply.

Yard trimmings are approximately 13.5% of the MSW generated and 8% of MSW discarded to landfills. Roughly 4.3 million dry tons are being used for waste-to-energy purposes, with a potential increase in availability at a higher price point. And, approximately 3.3 million dry tons are estimated to be recoverable at \$60 per dry ton.

Urban wood waste is not included in the estimates of MSW biomass supply; it is categorized along with forestry wood waste. Examples of urban wood waste include construction and demolition

materials, which account for approximately 23.3 million dry tons at a cost ranging from \$24–\$49 per dry ton. Cooking oils, food processing wastes, utility tree trimmings, and biosolids are categorized with landfill gas, and together, they account for an additional 19.3 million dry tons in 2040.

### Approach

From 2009 to 2013, discards to landfills have been relatively flat, so the *2016 Billion-Ton Report* assumes that this figure will remain constant over the projection period. Any increased generation of MSW from population growth is assumed to be offset by increased recycling and composting.

Supply estimates were derived based upon landfill generation rates and MSW category proportions from the U.S. Environmental Protection Agency.<sup>1</sup> The assumption of 2.36 pounds per person per day of landfill generation was multiplied by 2012 U.S. Census Bureau county-level population data. The resulting aggregate MSW figures were divided into the various categories based on EPA proportions.

<sup>1</sup> "Advancing Sustainable Materials Management: Facts and Figures 2013, Assessing Trends in Material Generation, Recycling and Disposal in the United States." U.S. Environmental Protection Agency, Office of Resource Conservation and Recovery, 2015. [https://www.epa.gov/sites/production/files/2015-09/documents/2013\\_advncng\\_smm\\_fs.pdf](https://www.epa.gov/sites/production/files/2015-09/documents/2013_advncng_smm_fs.pdf).

Cost estimates were derived from state-level average MSW tipping fees, which range from \$18 per green ton in Idaho to \$105 per green ton in Massachusetts. For counties with populations less than 250,000, all material is assumed to be available at the state-level tipping fee, plus a sorting cost of \$60 per green ton. For counties with populations greater than 250,000, half of the material is assumed to be available at the state-level tipping fee, plus a sorting cost of \$40 per green ton; the remaining half of the material is assumed to be available at the state tipping fee, plus a sorting cost of \$60 per green ton.

In the United States, the majority of plastics are disposed in the landfill, rather than being utilized for energy recovery. This is due to a perceived risk of atmospheric release of chemicals. The concern is related to hydrogen chloride and dioxins/furans contained within halogenated plastics. Halogenated plastics as MSW are primarily composed of polyvinyl chloride materials. The *2016 Billion-Ton Report* assumes that approximately 1.0 million tons of halogenated plastics are landfilled annually.

Internationally, countries that utilize significant portions of MSW for bioenergy production have demonstrated the viability of energy recovery from halogenated plastics. Japan, Sweden, and Denmark have all set an example for an environmentally sound use of plastics as biomass material. There are options for recovering energy from halogenated plastics using fast pyrolysis methods and with extensive incinerator infrastructure. Due

### Supplies Available from MSW Sources, Excluding Wood and Construction and Demolition Wastes, 2017 to 2040

	\$40 per dry ton	\$50 per dry ton	\$60 per dry ton
Paper and paperboard	15.7	17.0	17.1
Plastics	20.0	20.1	20.1
Rubber and leather	4.4	4.4	4.4
Textiles	8.0	8.2	8.2
Other	2.5	2.6	2.7
Food waste	0	0	0
Yard trimmings	0	3.1	3.3
<b>Total</b>	<b>50.6</b>	<b>54.7</b>	<b>54.8</b>

to this precedent, the *2016 Billion-Ton Report* includes halogenated plastics in the estimate for potential MSW biomass supply availability.

### The Path Forward

MSW represents a meaningful biomass resource as nearly 40% of the total national potential biomass waste resource (54.8 million dry tons out of a total 142 million dry tons available at \$84 or less per dry ton). In the *2016 Billion-Ton Report* baseline scenario, modeled at \$60 per dry ton or less, total waste resource potential is approximately 20% of all feedstock potential, meaning waste resources are approximately 139 million

dry tons out of a total feedstock volume of 707 million dry tons available in 2017.

The *2016 Billion-Ton Report* does not imply that all of the MSW material is available for biofuels. Estimates of available supply only account for materials sent to landfills and do not conflict with ongoing waste prevention efforts such as reduction, reuse, recycling, and composting. The estimates generated are a representation of supplies and prices that might be available beyond what is currently used. Ultimately, MSW resources will be allocated to the highest-value use, unless there is a market intervention or policy directive that determines otherwise.

This fact sheet refers to the following documents

U.S. Department of Energy. 2016. *2016 Billion-Ton Report: Advancing Domestic Resources for a Thriving Bioeconomy*. M. H. Langholtz, B. J. Stokes, and L. M. Eaton (Leads), ORNL/TM-2016/160. Oak Ridge National Laboratory, Oak Ridge, TN. 448p.

Download and view the report, explore its data, and discover additional resources at [www.bioenergykdf.net](http://www.bioenergykdf.net).