



Food Waste: Tier 1 Assessment

Prepared for GMA/FMI
March 2012



About this Report

The Grocery Manufacturers Association (GMA) and Food Marketing Institute (FMI) Leadership Committee sought BSR's support in undertaking a comparative assessment of the secondary data available about the sources of food waste, from "post agriculture" to "fork" within the U.S. The Committee also sought to gain a better understanding of the infrastructure in place in the U.S. to recycle organic waste.

This information is presented as an initial assessment, based on the data that was available publicly in December 2011. A number of assumptions and extrapolations have been made in order to derive food waste estimations. **As a consequence, this paper is not for public distribution or citation at this time.**

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Introduction

The GMA and FMI have launched a three-year industry-wide effort focused on addressing food waste, in particular from the food manufacturer to pre-consumer. The initiative aims to decrease the amount of food sent to landfills and increase the amount that is available for higher value diversion elsewhere, including to food banks. The companies and organizations involved in this effort have been undertaking an assessment that will include a comprehensive survey of the sources of food waste. The initiative is also focusing on identifying public policies that could expand the diversion of food from landfills (whether to food banks or other beneficial uses) and new technologies and industry practices that support its goals.



In order to gain a better understanding of how much food waste in the U.S. is generated and disposed of by various sources/ sectors, from “post agriculture” to “fork”, BSR:

- » Analyzed more than 20 reports covering food waste at the global, regional, national, and local levels
- » Conducted interviews with select members of the GMA/FMI Leadership Committee and key external stakeholders such as the US Environmental Protection Agency (EPA), and the U.S. Department of Agriculture (USDA)
- » Recast available data to allow for comparison across the value chain within the U.S.

BSR was also engaged to better understand the infrastructure in place in the U.S. to recycle organic waste. In order to do so, BSR reviewed existing data (websites, published reports) conducted on organics waste recycling infrastructure in the U.S. A summary of findings is provided in Appendix I.

Executive Summary

Converting to Pounds:

- » Food waste disposal = 79.4 billion pounds
- » Food waste diversion = 42 billion pounds
- » Food waste generation = 121.6 billion pounds

- » **Food waste disposal = 39.7 million tons per annum.** BSR's estimate suggests that on an annual basis **39.7 million tons of food is sent to landfill or incinerated post harvest** (between the industrial and residential categories of the food value chain) in the U.S.
 - This equates to approx. 12-20%¹ of the total U.S. food supply and is broken down across sectors as follows:
 - Residential = 44%
 - Restaurants (full-service and QSR) = 33%
 - Grocery stores = 11%
 - Institutional = 10%
 - Industrial (i.e. manufacturers) = 2%
- » **Food waste diversion = 21 million tons per annum.** BSR estimates that **at least 21 million tons of food is diverted from landfill/incineration** across sectors per annum in the U.S., with the majority of this being diverted to animal feed. The accuracy of the food waste diversion numbers will be improved when primary data is collected from an upcoming food waste survey.
- » **Food waste generation = 60.8 million tons per annum** - When the food waste diversion estimate is combined with the total food waste disposal estimate, this results in a **food waste generation estimate of 60.8 million tons per annum** for the U.S..
- » **Numerous data gaps exist** - The majority of reports reviewed for this assessment acknowledge the need for **new, comprehensive, nationwide estimates of food waste in the U.S.** to allow for more precise numbers to be generated.
- » **Data is lacking on infrastructure for recycling organic waste** - The **available infrastructure for organics waste recycling in the U.S. is, at best, a "patch-work quilt"**. More data gathering is required (both primary and secondary) to obtain a true picture of the existing infrastructure

¹ Percentages vary depending on total food supply numbers for the US, since USDA and FAO numbers vary. USDA estimates total food supply at approx. 214 million tons (2008 figures); FAO estimates total US food supply at approx. 318 million tons (2007 figures)

Definitions

Food Waste Loss, Generation, Diversion, and Disposal

Building on the EPA's Food Waste Disposal Data

This assessment builds on the EPA's Food Waste Disposal data to generate a **more robust estimate** of the amount of food waste sent to landfill or incinerators (less commonly) in the U.S. Where needed, we have used assumptions from the Waste & Resources Action Programme (WRAP) in the UK to fill in data gaps. These assumptions are described in greater detail in this paper. This assessment also provides an extrapolated estimate of Food Waste Diversion based on an analysis of multiple sources. It is important to note that the data presented here may underestimate total food waste diversion given the lack of data availability.

It is important to understand the different definitions used to describe food waste. Food loss, generation, diversion and disposal are the four most commonly used terms to describe 'food that is not sold or consumed'.

The EPA has developed a food waste recovery hierarchy of options for mitigating waste to landfill. This well recognized schematic is used below as a tool to differentiate between the terms "food waste diversion" and "food waste disposal". As seen in this schematic, **Food Waste Diversion** pertains to all food that is not sold or consumed, which could be diverted to a higher value use than landfill or incineration. By comparison, **Food Waste Disposal** refers to food or food scraps which are disposed via landfill or incineration. As used in this document, the term **Food Waste Generation** is the sum of Food Waste Diversion plus Food Waste Disposal.

To date, the EPA and individual U.S. state food waste characterization studies have focused on accurately measuring the amount of Food Waste Disposal. Since U.S. level data is lacking on many of the food diversion practices, BSR and others have estimated the amount of Food Waste Diversion based on a mix of assumptions and extrapolations.



Food Loss is the fourth term commonly used to describe 'food waste'. For the purposes of this document, it refers to data provided by the U.S. Department of Agriculture's Economic Research Service (USDA ERS) as part of its Loss-Adjusted Food Availability (LAFA) dataset. The primary purpose of these datasets is to more closely approximate actual per capita consumption in the U.S. of certain commodities and aggregated food groups by taking into account food spoilage and other losses that take place at home by consumers and throughout the marketing system. For example, in the meat, poultry, and fish category, the LAFA provides a loss estimate of 32 percent at the **consumer**

level for beef. Thus, for every 100 pounds of beef bought by the consumer (either at home or away from home) it is estimated that 32 pounds are lost due to factors such as spoilage and plate waste/loss.

As used in this document, the term **Food Waste Generation** is the sum of Food Waste Diversion plus Food Waste Disposal, i.e. the food waste which is generated as a result of human action or inaction. The studies undertaken by the Waste & Resources Action Programme (WRAP) in the UK are the most comprehensive sources available which discuss food waste generation.

The table below provides a comparison of the main sources reviewed for this report, and the definitions used.

Country	Source	Definitions	Reference
US	USDA	FOOD LOSS: <i>In 1997, Kantor et al. published a seminal study on food loss in the United States that estimated that in 1995, roughly 96 billion pounds of food was lost, or 27% of the 356 billion pounds of food available for human consumption. Kantor et al.'s conversion factors for food losses serve as the foundation for what is now called the Loss-Adjusted Food Availability (LAFA) data series, which was first posted on the ERS' website in 2005</i>	<i>The value of retail and consumer level fruit and vegetable losses in the US - The Journal of Consumer Affairs, Fall 2011</i>
	EPA	DISPOSAL - <i>EPA's figures include municipal solid waste from homes, institutions such as schools and prisons, and commercial sources such as restaurants and small businesses</i>	<i>Municipal Solid Waste in the United States, 2010 Facts and Figures, EPA</i>
	State Level Waste Characterization Studies	DISPOSAL - <i>State Level waste characterization studies for California, Iowa, Georgia, Nebraska, Oregon, Pennsylvania, Illinois, Wisconsin are based on actual waste sorts at landfills</i>	<i>Various</i>
EU 27	BioIntelligence Service	GENERATION - <i>Food waste is composed of raw or cooked food materials and includes food materials discarded at anytime between farm and fork; in households relating to food waste generated before, during or after food preparation, such as vegetable peelings, meat trimmings, and spoiled or excess ingredients or prepared food. Food waste can be both edible and inedible</i>	<i>Preparatory Study on Food Waste Across the EU27, October 2010, BioIntelligence Service</i>
UK	WRAP	DIVERSION AND DISPOSAL - <i>Food or drink products that are disposed of (includes all waste disposal and treatment methods) by manufacturers, packers/fillers, distributors, retailers and consumers as a result of being damaged, reaching their end-of-life, are off cuts or deformed (outgraded). Reports also break out amount of waste that is diverted from landfill.</i>	<i>Household Food and Drink Waste in the UK, WRAP, November 2009</i>
Canada	Value Chain Management Centre	GENERATION - <i>The quantifiable difference in value between what is produced on farms, then processed, distributed and sold every year, compared to what is consumed.</i>	<i>Food Waste in Canada - opportunities to increase the competitiveness of Canada's agri-food sector, while simultaneously improving the environment, Value Chain Management Centre, November 2010</i>

The GMA/FMI initiative has defined food waste as “*Any solid or liquid food substance, raw or cooked, which is discarded, or intended or required to be discarded. Food wastes are the organic residues generated by the processing, handling, storage, sale, preparation, cooking, and serving of foods.*”

This definition is broader than the Food Waste Disposal definition used by the EPA and closer to the “food waste generation” term used by WRAP UK, and studies reviewed in the European Union and Canada for this assessment.

The Food Value Chain

In order to understand where food waste occurs along the value chain, we analyzed data from “post agriculture” to “fork”. Specifically, this meant reviewing data for the following sectors:



» **Industrial—**

- Food processing centers
- Manufacturing centers



» **Commercial—**

- Grocery stores and supermarkets
- Restaurants and caterers
- Convenience stores
- Warehouses and distribution centers



» **Residential—**

- Single and multi-family households



» **Institutional*—**

- Hospitals
- Universities
- Schools
- Prisons

*Note: Only the sectors noted here have been included in the data presented. To the best of our knowledge, data on other sectors such as hotels, entertainment venues (incl. stadia and amusement parks) has not been considered by the studies from which we drew the information used in this assessment.

Detailed Analysis

Comparing food waste data collected in the U.S.

A number of estimates exist detailing total food waste in the U.S. Below we describe three such estimates—by the EPA, USDA, and BSR—and explain how each estimate has been derived.

EPA US tons
34,760,000

EPA's estimate of total food waste disposal per annum

The EPA's 34.8 million ton estimate of *food waste disposal* in the U.S. is most often cited in the available literature and studies outlining the “waste problem” in the U.S. The EPA limits its analysis to food waste that is collected as part of the municipal solid waste (MSW) system. If waste is put to use (for example, if it is diverted to animal feed, or digestion), then it is not included in the EPA numbers. Composting, however, is counted in this estimate (0.97 million tons). The EPA readily accepts the limitations of this “curb to landfill/ incineration” estimate. Moreover, generally, industrial food waste from manufacturing and processing, even if it goes to landfill, is not captured by the EPA figure since it falls outside the MSW system. Another limitation of the data is that the methodology to account for food and food scraps disposed of in landfills is not immediately transparent and one that is more challenging to apply to food. For the most part, the data reported by the EPA is based on a material flow methodology to estimate waste. This can be applied to manufactured products with a high degree of accuracy (for example, if a certain amount of glass is produced, one can say how much is recycled, then the rest is assumed to be ‘waste’). For food, the same is not true. EPA outsources its analysis to a third party (Franklin). As we understand it, Franklin gathers data on food and food scraps sent to landfill through select “dumpster dives” plus some statistical sampling, and then adds in data reported by composters.

USDA US tons
62,863,129

USDA's estimate of total food loss per annum

The USDA's Economic Research Service (ERS) estimates *food loss* at the consumer and retail levels at 62.9 million tons in the U.S. It is important to note that while the ERS has the most comprehensive data sets for estimating food waste, the ERS considers this data to be preliminary and incomplete. It is undertaking a series of initiatives to update and document the underlying assumptions, many of which are based on data and studies from the mid-1970s or earlier.

The ERS estimates are derived from a different starting point than those of the EPA. The ERS Food Loss data starts with per capita food availability data across a number of product categories, then adjusts the data for estimated spoilage and losses in the home and marketing system. In addition to taking a different approach, there are a number of reasons why the ERS estimate is larger than both the EPA's estimate and our own (below), including:

- » Fluid milk, creams, oils, and fruit juices are included by ERS whereas fluid waste to the sewer is not included in the EPA or BSR estimates.
- » The ERS accounts for natural shrinkage (for example through moisture loss), loss from mold, pests or inadequate climate control, and cooking losses. The weight of such natural shrinkage is not accounted for in the EPA or BSR estimates.
- » The methodology ERS uses does not allow for breaking out food losses by each element of the value chain, i.e. at the industrial, commercial, residential, and institutional levels. Consequently, the ERS estimate likely includes both municipal solid waste (MSW) and non-MSW, while EPA estimates only include MSW.

BSR estimate
US tons

39,686,955

BSR's estimate of total food waste disposal per annum

BSR reviewed a number of sources to generate a revised food **waste disposal** estimate for the U.S. of 39.7 million tons. The box below describes the sources used and the reasons why they were used.

Sources used for BSR's total food waste disposal estimate

- *Commercial and residential food waste estimates:* BSR relied on the state waste characterization studies for California; Iowa; Georgia; Nebraska; Oregon; Pennsylvania; Illinois; Wisconsin (dating from 2002-2008) because they were:
 - Representative of reasonable geographic diversity
 - Based on actual waste sorts at landfills
 - Produced similar data elements which allow for simple extrapolation
- *Industrial food waste estimate:* BSR relied on "Waste arising in the supply of food and drink to households in the UK" (WRAP 2010) given that the data on food waste was broken down at the industrial level - data which was not provided by other reports reviewed for this analysis
- *Institutional food waste estimate:* BSR relied on the following studies and data sets given the lack of information at the national level available in other aggregated studies - Identification, Characterization, and Mapping of Food Waste and Food Waste Generation in MA, MA Dept of Environmental Protection (2002); U.S. Census Bureau; National Center for Education Statistics; American Hospital Association; U.S. Dept of Justice; U.S. Association of Homes and Services for the Aging.

The table below compares and contrasts the three estimations, while also contextualizing them in terms of total food supply (based on both FAO and USDA estimations of U.S. food supply) and per capita waste. The BSR estimation is disaggregated further in the sections below.

	Total Food Waste DISPOSED (US tons)	Total Food Waste (Pounds per capita* per year)	Total Food Waste as a % of Total Supply (based on FAO data, 2007)	Total Food Waste as a % of Total Supply (based on USDA food supply data, 2008)	Additional Information	SOURCES
BSR estimate	39,686,955	271.20	12%	20%	Includes entire value chain from manufacturing to residential. Based on extrapolation of 8 state waste characterization studies using site specific methodology combined with data on industrial and institutional food waste from combined sources (incl. WRAP UK).	Based on review of 8 state waste characterization studies: California, Iowa, Georgia, Nebraska, Oregon, Pennsylvania, Illinois, Wisconsin; plus WRAP study factors applied to industrial category; plus estimation for institutional category food waste disposal
EPA	34,760,000	229.16	11%	18%	Preconsumer food waste generated during the manufacturing and packaging of food products is considered industrial waste and not included in waste generation estimates. Food scraps are accounted for by compiling data from a variety of waste sampling studies. Product residues not included in estimate (e.g. food left in a jar). Food waste diversion takes place prior to food scrap generation and is not included in generation estimates. 2.8% is 'recovered' through composting, i.e. 970,000 tons is put to beneficial use.	Municipal Solid Waste in the United States, 2010 Facts and Figures, EPA
	Total Food LOSS (US tons)	Total Food Waste (Pounds per capita* per year)	Total Food Loss as a % of Total Supply (based on FAO data, 2007)	Total Food Loss as a % of Total Supply (based on USDA food supply data,	Additional Information	SOURCES
USDA	62,863,129	414.43	20%	32%	Covers retail and consumer level food loss estimates using assumptions in the ERS Loss-Adjusted Food Availability data as of March 2010 and the US population on July 1, 2008 (304.06 million). Losses on farm and between the farm and retailer were not estimated due to data limitations for some of the food groups.	The value of retail and consumer level fruit and vegetable losses in the US - The Journal of Consumer Affairs, Fall 2011

*Per capita numbers based on US population figure of 304.06 million July 2008 (US Census Bureau)

BSR's Food Waste Disposal Estimates—Disaggregating and Extrapolating the Data

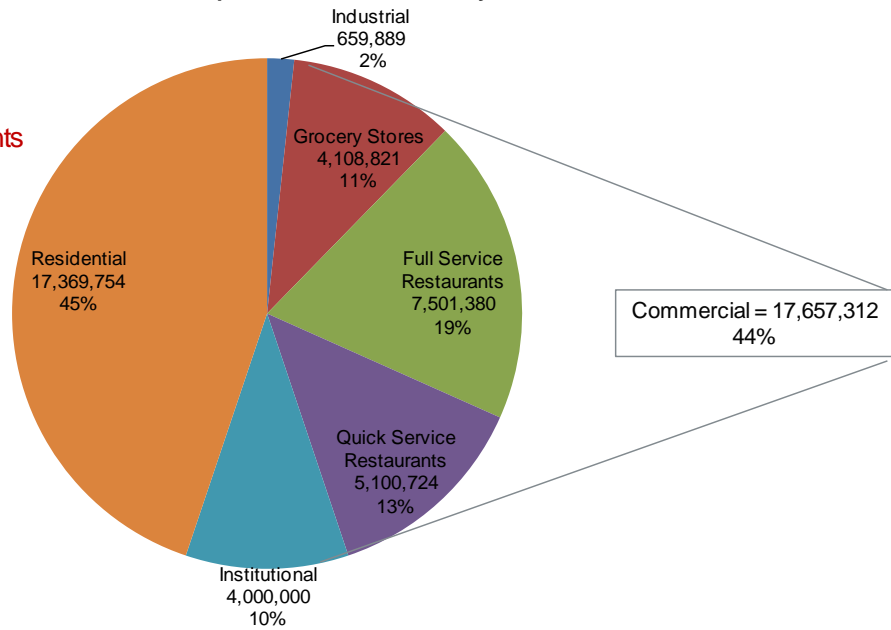
According to our analysis, much of the food waste disposed in the U.S. occurs at the commercial level—approximately 17.7 million tons, representing 44 percent of the total sent to landfill or incinerated on an annual basis. This figure is slightly higher than the amount of estimated residential food waste (17.4 million tons). Industrial food waste (660,000 tons) and institutional food waste (4 million tons) make up the difference. The pie-chart below breaks down these numbers further, presenting them as a percentage of the total food waste disposal estimate for the U.S.

Category breakdown based on BSR
Estimate of
(Food Waste Disposal)
Total = 39.7 million tons

US - Food Waste Disposal Data - breakdown by sector

Breakdown by sector:

- 44% Residential
- 20% Full Service Restaurants
- 13% Quick Service Restaurants
- 11% Grocery Stores
- 10% Institutional
- 2% Industrial
- 100%



Note: "Commercial" category split between grocery, full service restaurants, Quick Service Restaurants based on factors outlined in California Solidwaste Characterization Database + Waste Disposal and Diversion Findings for Selected Industry Groups, June 2006

The following sections provide additional detail on how BSR developed these estimates for the four main sectors:

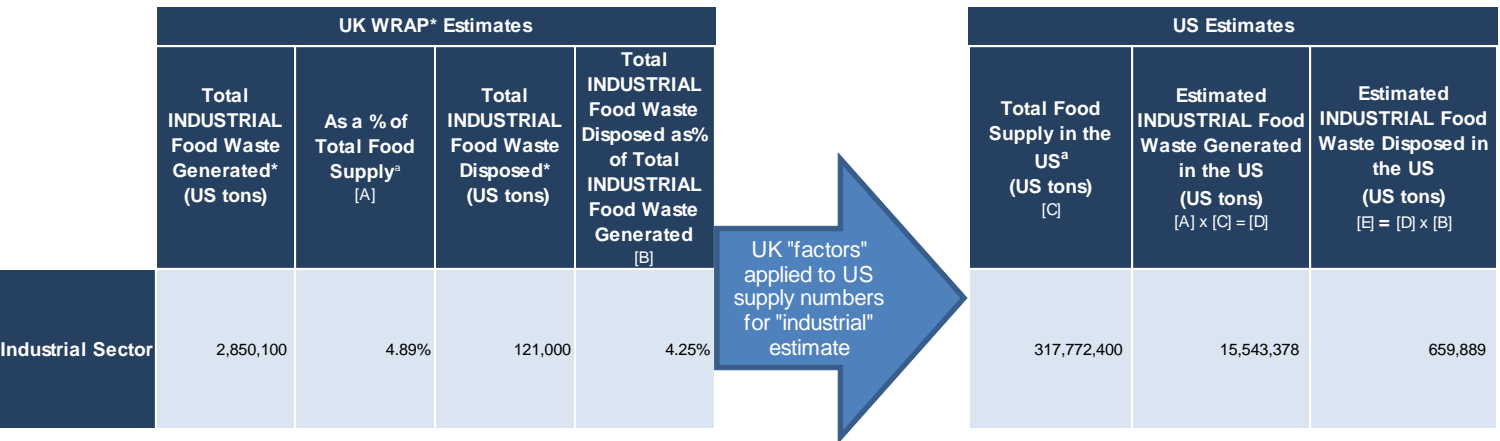
- » Industrial
- » Commercial
- » Residential
- » Institutional

Industrial Food Waste Estimates—more analysis required

Given the assumptions used to derive an estimate of total industrial food waste disposal in the U.S., it is clear more data collection and analysis is required to achieve greater comfort with the absolute number. This point was also raised at the GMA/FMI Food Waste Leadership Committee meeting in Orlando, FL on December 6-7, 2011.

INDUSTRIAL FOOD WASTE DISPOSAL

Industrial waste breakdowns are not counted in MSW (they are classified as pre-consumer scrap and not included in the estimates of EPA). Additionally, industrial waste numbers are not split out from agricultural waste by the USDA—the Loss-Adjusted Food Availability Data details loss from primary (agricultural weight) to retail weight so does not allow for an estimate of industrial food loss. Thus, in order to derive an estimate for industrial food waste disposal in the U.S., BSR used a factor originating in a study by WRAP in the UK², which estimated total industrial food waste generation and disposal. Based on FAO total food supply numbers, we developed proportions for the UK in relation to the industrial sector (i.e. industrial food waste generated as a percentage of total food supply — see A below; and food waste disposed as a percentage of total industrial food waste generated — see B below;) and then applied these factors to total food supply numbers for the U.S., (see D and E below) thus resulting in a total estimate of approximately 660,000 tons of food waste disposed annually by the industrial sector in the U.S. The chart below provides greater detail on the factors used.



* UK WRAP, March 2010
^aSupply numbers based on FAO data, 2007

COMMERCIAL FOOD WASTE DISPOSAL

BSR developed the estimate of 17.7 million tons of food waste disposed, based on data provided from 8 state waste characterization studies in the U.S.³, dating from 2002-2008. One of our primary assumptions is that, according to the consulting firm which authored a number of these studies R.W. Beck, commercial waste typically represents 50 percent of all municipal solid waste —the balance is from the residential sector.⁴ We multiplied 50 percent by the total quantity of MSW disposed in each state, thus deriving an estimation of total MSW waste for the commercial sector by state. Next, we used U.S. Census Bureau population figures to estimate the per capita food waste per year across the 8 states we reviewed. This factor was then multiplied by the total U.S. population estimate for 2007 to arrive at an extrapolated food waste disposal figure for the commercial sector. The chart below shows how we aggregated and extrapolated the data for the U.S. total.

Commercial Sector includes:

- » Grocery stores and supermarkets
- » Restaurants and caterers
- » Convenience stores
- » Warehouses and distribution centers

² Waste arisings in the supply of food and drink to households in the UK (WRAP), March 2010
³ Individual waste characterization studies for California, Iowa, Georgia, Nebraska, Oregon, Pennsylvania, Illinois, Wisconsin, dating from 2002-2008
⁴ Georgia State Waste Characterization Study, 2005, R.W.Beck

	Data year	Population in Data Year	Total MSW disposed (tons)	Total Commercial MSW (tons)	% of Commercial MSW that is food waste (tons)	Commercial Food Waste (tons)		Sector	Food Waste/ Year (tons)	Per Capita Food Waste/ year in data year (tons)	US population (2007)	Extrapolated Food Waste (tons)
California	2006	35,307,398	reports tonnage of food waste disposed to MSW	14,347,949	18.8%	2,697,414		commercial	4,715,193	0.059	301,290,332	17,657,312
Iowa	2005	291,775	2,122,600	1,061,300	10.3%	109,314						
Georgia	2004	8,910,741	10,037,540	5,018,770	12.4%	622,327						
Nebraska	2008	1,783,432	1,342,000	671,000	15.9%	106,689						
Oregon	2002	3,517,982	2,747,475	1,373,738	22.7%	311,838						
Pennsylvania	2002	12,298,775	9,369,082	4,684,541	11.8%	552,776						
Illinois	2008	12,901,563	1,838,100	919,050	12.2%	112,124						
Wisconsin	2002	5,444,638	reports tonnage of food waste disposed to MSW	1,535,680	13.2%	202,710						
Total		80,456,304				4,715,193						

The data have been split into separate industry sub-segments to account for differences in food waste disposal between grocery stores, full service restaurants, and quick service restaurants. We used the California state waste characterization study⁵ as the basis for further disaggregating the numbers for these three industry segments in the commercial sector. The California study estimated food waste disposal through measurements of waste accumulation in dumpsters or through interviews and examination of waste disposal records. In order to estimate food waste disposal figures for each of the three sub-sectors for the U.S. as a whole, BSR identified the relative proportions collected in the California study and applied them to the 17.7 million ton total we estimated for the commercial sector as a whole. The schematic below provides more detail.

⁵ CA Solidwaste Characterization Database + Waste Disposal and Diversion Findings for Selected Industry Groups, June 2006

		% of total estimated food waste DISPOSAL for "commercial" sector in CALIFORNIA		Revised estimates for "commercial" sector across US
Grocery	This group includes retail stores primarily engaged in selling food for home preparation and consumption. Food stores that have approximately 15 fulltime employees or more were eligible to participate.	25%		4,342,018
Full Service	This group includes retail establishments selling prepared foods and drinks for consumption on the premises. The customer generally orders and is served at the table.	45%		7,925,482
Fast Food	This group includes retail establishments selling prepared foods and drinks for consumption on the premises or to be taken away; and also lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption. Generally, customers order and pick up food at the counter.	31%		5,389,811

^aCA Solid waste Characterization Database + Waste Disposal and Diversion Findings for Selected Industry Groups, June 2006

^b US Census Bureau - 2007 Economic Census and Country Business Patterns

RESIDENTIAL FOOD WASTE DISPOSAL

As with the commercial sector above, BSR's estimation of residential food waste disposal is based on data provided from 8 state waste characterization studies in the U.S., dating from 2002-2008. It is estimated that 17.4 million tons of food waste ends up in landfill or being incinerated each year from this sector in the U.S.

A key assumption we used to derive this estimate is that residential waste typically represents 50 percent of **all** municipal solid waste—the balance is from the commercial sector.⁶ This factor was applied to each state waste characterization study to gain a total estimate of residential MSW by state in the U.S. Each state study, based on actual waste sorts at landfills, provides a breakdown of percentages of residential MSW which may be classified as food waste. Census Bureau population figures were used to estimate a weighted average of the residential food waste disposed per year and multiplied by the total population estimate for 2007 to arrive at an extrapolated food waste disposal figure for the residential sector in the U.S. as a whole.

⁶ Georgia State Waste Characterization Study, 2005, R.W.Beck

	Data year	Population in Data Year	Total MSW disposed (tons)	Total Residential MSW (tons)	% of Residential MSW that is Food Waste	Residential Food Waste (Tons)	Sector	Food Waste/ Year (tons)	Per Capita Food Waste/ year in data year (tons)	US population (2007)	Extrapolated Food Waste (tons)
California	2006	35,307,398	reports tonnage of food waste disposed to MSW	14,347,949	17.3%	2,482,195	residential	4,638,404	0.058	301,290,332	17,369,754
Iowa	2005	291,775	2,122,600	1,061,300	11.2%	118,866					
Georgia	2004	8,910,741	10,037,540	5,018,770	13.4%	672,515					
Nebraska	2008	1,783,432	1,342,000	671,000	17.2%	115,412					
Oregon	2002	3,517,982	2,747,475	1,373,738	24.6%	337,939					
Pennsylvania	2002	12,298,775	9,369,082	4,684,541	12.2%	571,514					
Illinois	2008	12,901,563	1,838,100	919,050	14.6%	134,181					
Wisconsin	2002	5,444,638	reports tonnage of food waste disposed to MSW	1,535,680	13.4%	205,781					
Total		80,456,304				4,638,404					

If one compares this estimate for the U.S. with residential food waste numbers in other developed markets, those for UK are the highest as defined by kg per capita per year and as a percentage of total food supply. Part of the reason for this is that the WRAP estimates for the UK include the disposal of food and drink waste to the sewer (drink adds an additional 1.8 million metric tonnes) while other studies reviewed do not include waste to sewer (in other words, food **and** drink). Because drink is not included, it is likely that the residential numbers for the U.S. underestimate total food waste disposed. For example, in the recent *Journal of Consumer Affairs* publication, Jean Buzby et al recognize the inherent flaws in recording residential food waste numbers, noting, “Participants in household food waste studies tend to be highly “reactive,” changing their behavior and wasting less when they know they are being observed during the survey period or tend to be biased when estimating waste. Studies that observe food loss by inspecting landfill garbage are also prone to errors. Such studies are not nationally representative and may not account for food fed to pets and other animals, put in garbage disposals or composted at home.”⁷

⁷ The value of retail and consumer level fruit and vegetable losses in the US - The Journal of Consumer Affairs, Fall 2011; Jean C. Buzby, Jeffrey Hyman, Hayden Stewart, and Hodan F.Wells

INSTITUTIONAL FOOD WASTE DISPOSAL

Institutional waste is not accounted for in the state waste characterization studies undertaken in the U.S. which were analyzed for this study. In order to estimate total food waste disposal for this sector, data were analyzed for so-called “cost caterers” (hospitals, schools, prisons etc.) per the chart below:

	Category	Amount	Source/ Explanation
Hospitals	A Beds	945,199	American Hospital Association
	B Meals/bed/day	5.7	Identification, Characterization, and Mapping of Food Waste and Food Waste Generators in Massachusetts, Draper/Lennon, 2002
	C Food w aste/meal (lbs)	0.6	<i>ibid</i>
	D Days/year	365	
	E Extrapolated food w aste (lbs)	1,179,891,912	$[E] = [A] * [B] * [C] * [D]$
	F Extrapolated food w aste (US tons)	589,946	$[F] = [E] / 2000$
Nursing Homes	A Beds	1,670,532	American Hospital Association
	B Meals/bed/day	3.0	Identification, Characterization, and Mapping of Food Waste and Food Waste Generators in Massachusetts, Draper/Lennon, 2002
	C Food w aste/meal (lbs)	0.6	<i>ibid</i>
	D Days/year	365	
	E Extrapolated food w aste (lbs)	1,097,539,524	$[E] = [A] * [B] * [C] * [D]$
	F Extrapolated food w aste (US tons)	548,770	$[F] = [E] / 2000$
Universities	A Students	11,280,000	National Center for Education Statistics
	B Meals per student/ year	405	Identification, Characterization, and Mapping of Food Waste and Food Waste Generators in Massachusetts, Draper/Lennon, 2002
	C Food w aste/meal (lbs)	0.35	<i>ibid</i>
	D Extrapolated food w aste (lbs)	1,598,940,000	$[D] = [A] * [B] * [C]$
	E Extrapolated food w aste (US tons)	799,470	$[E] = [D] / 2000$
Community Colleges	A Students	6,696,000	National Center for Education Statistics
	B Meals per student/ year	108	Identification, Characterization, and Mapping of Food Waste and Food Waste Generators in Massachusetts, Draper/Lennon, 2002
	C Food w aste/meal (lbs)	0.35	<i>ibid</i>
	D Extrapolated food w aste (lbs)	253,108,800	$[D] = [A] * [B] * [C]$
	E Extrapolated food w aste (US tons)	126,554	$[E] = [D] / 2000$
K-12 schools	A Students	49,470,000	National Center for Education Statistics
	B Meals per student/ year	180	Identification, Characterization, and Mapping of Food Waste and Food Waste Generators in Massachusetts, Draper/Lennon, 2002
	C Food w aste/meal (lbs)	0.35	<i>ibid</i>
	D Extrapolated food w aste (lbs)	3,116,610,000	$[D] = [A] * [B] * [C]$
	E Extrapolated food w aste (US tons)	1,558,305	$[E] = [D] / 2000$
Prisons	A Inmates	1,610,584	US Department of Justice
	B Food w aste/meal (lbs)	1	Identification, Characterization, and Mapping of Food Waste and Food Waste Generators in Massachusetts, Draper/Lennon, 2002
	C Days/ year	365	
	D Extrapolated food w aste (lbs)	587,863,160	$[D] = [A] * [B] * [C]$
	E Extrapolated food w aste (US tons)	293,932	$[E] = [D] / 2000$
TOTAL		3,916,977	

Estimating Hospital Food Waste in the U.S.

As an illustrative example, in order to estimate food waste disposed by the hospital sector, we took the number of hospital beds in existence in the U.S. (945,199, according to the American Hospital Association), and multiplied this by the number of meals served per patient (or bed) per day (5.7, according to a study by Draper/Lennon for Massachusetts in 2002⁸). The Draper/Lennon study also provides a factor estimating food waster per meal in pounds (0.6 for the hospital sector). The product of this combined multiple (945,199*5.7*0.6) was then multiplied by 365 to derive an extrapolated food waste estimate for the hospital sector on an annual basis in pounds (1.2 billion pounds). Finally, this figure was divided by 2000 to derive an estimate for total food waste for the U.S. hospital sector in tons per annum (589,946 tons).

As noted in the table above, BSR developed the food waste factors applied to each of the sub-segments from a study conducted in Massachusetts in 2002⁹. Given the date of the study and its scope, it is likely the estimate provided is questionable, since it assumes uniformity in each sub-sector **across** the U.S. It is also important to note that food waste from other sectors, such as hotels, entertainment facilities etc. are not included in the above estimations.

Setting food waste targets—comparison with the UK hospital sector

	Upper Level	Measured By
Plated Meal Systems		
Un-served Meals	6%	Numbers of whole main course meals
Plate Waste	10%*	Visual inspection
Bulk Trolley Systems		
Un-served Trolley Waste	12%	Number of main courses remaining
Plate Waste	10%*	Visual inspection

The UK National Health Service has set upper level limits to different types of food waste within hospital food systems (see chart). Indeed, such an approach recognizes there is a lack of uniformity of waste within different food systems. This aligns with the UK government's approach to classification of residential food waste, whereby waste is defined as edible, possibly edible, and inedible in order to truly distinguish between avoidable and unavoidable food waste.

*Hospital catering, delivering a quality service", NHS Executive, 1996

Source : NHS, UK

⁸ Identification, Characterization, and Mapping of Food Waste and Food Waste Generators in Massachusetts, Draper/Lennon, 2002
⁹ *Ibid*

BSR's Food Waste Diversion Estimates—Extrapolations

As noted previously, food waste diversion figures for the U.S. are problematic to estimate given the lack of data availability by sector and practices. BSR developed the table below however to give what is likely a conservative estimate of food waste generation **across multiple sectors** in the U.S. The EPA food waste hierarchy has been used to estimate diversion numbers by the various practices noted as higher beneficial use than landfill or incineration. Using multiple sources, total food waste diversion is estimated at approximately 21 million tons per annum which, when added to the total Food Waste Disposal estimate, results in a total Food Waste Generation estimate of 60.8 million tons¹⁰ for the U.S. as a whole.

	Food Weight (US tons)	Explanation/ Source
<i>Feed Hungry People (food donation)</i>	550,000	Taken from AT Kearney/ Feeding America study (2011) Note: includes current donations from programs involving food manufacturers, retailers and produce suppliers (0.4bn lbs; 0.2bn lbs, and 0.5bn lbs respectively)
<i>Feed Animals</i>	13,187,555	Derived from WRAP UK study (2010) which estimates 4.15% of total UK food supply (i.e. 2.42 million tons) is diverted from industrial stream to animal feed. This factor (4.15%) has been applied to FAO U.S. food supply estimates (317.7 million tons) to generate the 13.2 million ton estimate here. Note: food waste to animal feed typically includes waste from business sphere, although can include residential.
<i>Industrial Uses (oils for rendering and fuel conversion)</i>	3,381,147	Derived from Urban Grease Resource Assessment, NREL (1998) as follows: - Weighted average yellow grease estimated at 8.87 lbs per capita (1.35 million tons based on U.S. population numbers (2007) - Weighted average brown "trap" grease collected by restaurants estimated at 13.37 lbs per capita (2.03 million tons based on U.S. population numbers (2007) Note: Yellow and brown grease estimates only vs. other biofuels
<i>Composting</i>	4,043,489	Derived from Biocycle's national composting survey (2008) as follows: - Composting estimates from commercial facilities (3.4 million tons); colleges and universities (33,745 tons); municipal facilities (616,040 tons) and "other" (35,834 tons)
TOTAL (DIVERSION)	21,162,191	<i>Conservative estimate based on above</i>
TOTAL (DISPOSAL)	39,686,955	<i>Combined BSR estimate based on extrapolated data from multiple sources</i>
TOTAL (GENERATION)	60,849,145	

¹⁰ The similarity between this food waste generation estimate and the USDA's ERS food loss estimate at the consumer and retail levels of 62.9 m tons is purely coincidental as the estimates have been derived from very different methodologies. An explanation of the USDA estimate is provided on p. 9 of this report

Areas for Additional Research and Analysis

As referenced in the text above, there are a number of areas where additional research and analysis is warranted to arrive at a more accurate estimation of food waste in the U.S. across the different sectors from “post agriculture” to “fork”. Irrespective of these data limitations, the estimates indicate significant potential to reduce the amount of food sent to landfill in the U.S.

The areas that we suggest would particularly benefit from additional research and analysis include:

- » **Industrial waste**—applying the food waste disposal and generation factors from a UK study (WRAP, 2010) to U.S. food supply numbers in order to estimate total industrial food waste disposal is a key assumption that should be tested further. Since the regulatory environment and infrastructure in the UK differs from the U.S., the nature and amount of industrial waste may not be comparable to the U.S. environment. It is anticipated that this number will change as primary data is gathered.
- » **Institutional waste**—the total food waste disposal estimation currently does not include data from various sectors such as hotels, or corporate and government office cafeterias.
- » **Food waste diversion**—the estimate of total food waste diversion is currently conservative given it is based on a number of assumptions. It is anticipated that data gathered from a forthcoming survey will allow for significantly more granularity on the diversion rates by different segments of the industrial and commercial sectors.
- » **Contextualization of information**—a number of sources reviewed for this assessment present absolute food waste data in conjunction with data on the embedded water and energy wasted, as well as the wasted calories and economic impact on households and businesses. Additional research to provide further context would provide a greater appreciation of the magnitude of the problem and associated opportunities.

Next Steps

The companies and organizations involved in this will be conducting a survey of the sources of food waste. These primary data will be aggregated and compared with the estimates generated from this secondary data review, to arrive at a more comprehensive estimation of the sources of food waste (both diversion and disposal) within the U.S.

Appendix I: Organics Waste Recycling Infrastructure

Introduction

BSR conducted secondary research to identify the current recycling infrastructure for organic waste (with a primary emphasis on food waste collection) in the U.S. by location, type, and capacity.

Findings

DATA AVAILABILITY

- » There is scarce data available at the national and state level
- » When available, information is dated (often pre-2005)
- » Data on food recycling efforts is usually conducted at the county level and information is not uniform in terms of how waste is measured
- » Low priority is given to documenting this activity (compared to metal recycling for example)
- » These types of studies appear to be costly and time consuming to conduct

INCENTIVES FOR FOOD RECYCLING

- » Mandatory (regulatory based) recycling programs appear to be a strong incentive for establishing organics waste recycling infrastructure
- » There is currently a lack of public guidance on opportunities and ways to conduct food recycling
- » Businesses which have chosen not to participate in food recycling programs cite the following reasons:
 - Cost
 - Lack of guidance
 - Not enough space for recycling
 - The city does not require it
 - Not enough recyclable material is produced to justify the program

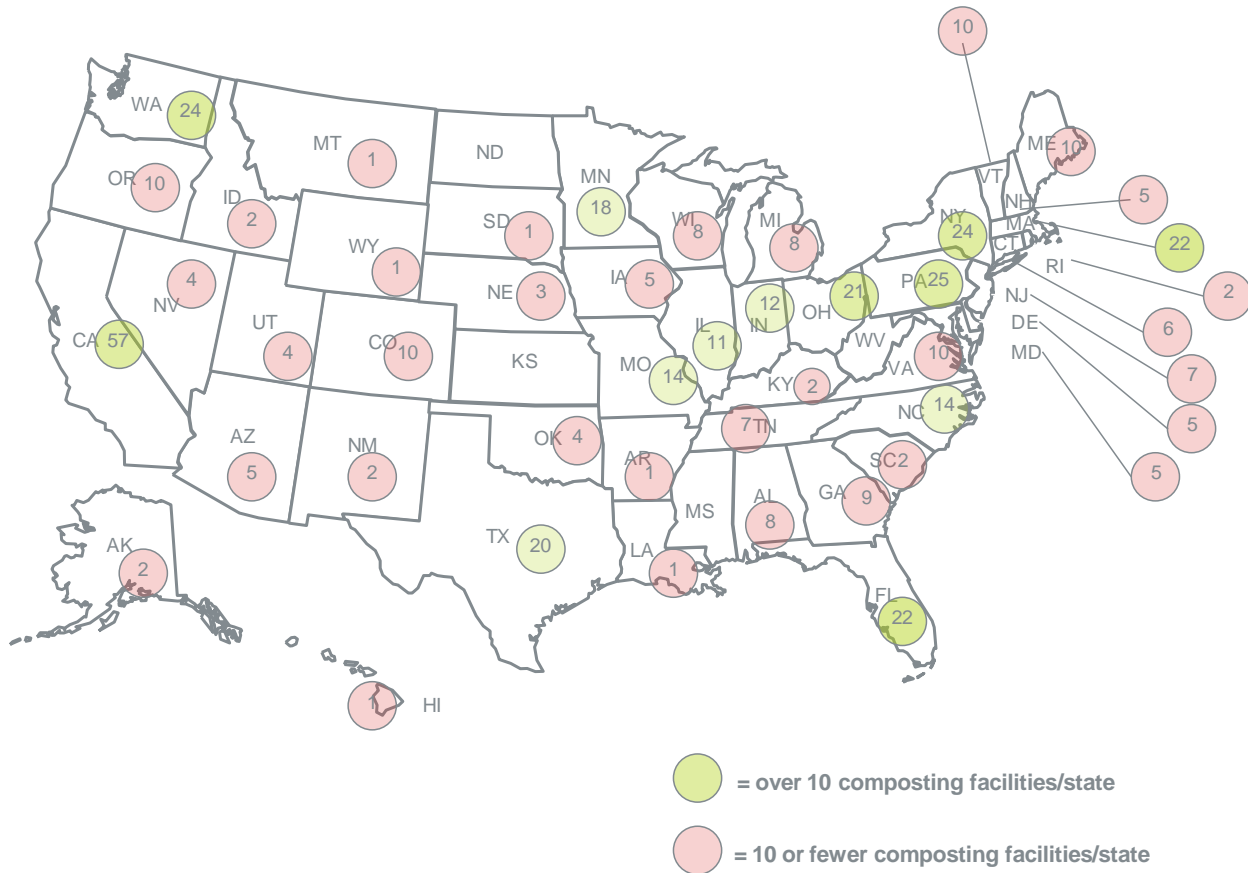
A NOTE ON FOOD COMPOSTING

- » Information on food composting in the U.S. provides the best picture of organics waste recycling infrastructure
 - A BioCycle national survey of food composting infrastructure in 2008 identified 264 food waste composting facilities across 4 categories (municipal, commercial, on-farm, and university)
 - 126 facilities responded to survey with actual tonnage of food waste composted per year
 - Study did not include composters established solely to manage food residuals from single generators (e.g. industrial facilities processing own material; farm-based operating servicing single food processors)

- » Analysis from Findacomposter.com (run by BioCycle) details 445 composting facilities for food service items (meats/bones/soiled paper/packaging) in the U.S.¹¹
 - 251 of these also compost fruits, vegetables and trimmings
 - The number of composting sites per state appears to be a function of population size and density. Washington State is an outlier with 24 composters—higher than many states with larger populations, likely due to supportive regulatory environment.

The following map shows the number of composting sites by state in the U.S. as of late November, 2011.

MAP OF COMPOSTING SITES BY STATE IN THE U.S.



Source: findacomposter.com

¹¹ As of November 28, 2011

Appendix II: Food Waste Information Sources

The following is a full list of resources reviewed in this assessment, listed in order of publication by market.

Geography	Document Name	Author	Year
Global	Food Waste Within Food Supply Chains: Quantification and Potential for Change to 2050 - the Royal Society	Parfitt et al	2010
	Global Food Losses and Food Waste - FAO, 2011	Jon Bloom, Nick Saltmarsh	2011
US	USDA - Estimating and Addressing America's Food Losses	Linda Scott Kantor, Kathryn Lipton, Alden Manchester, and Victor Oliveira	1997
	Identification, Characterization, and Mapping of Food Waste and Food Waste Generators in Massachusetts	Draper/ Lennon Inc, for Massachusetts Dept. of Environmental Protection	2002
	Oregon Solid Waste Characterization and Composition	Dept. of Environmental Quality; Sky Valley Associates	2002
	Pennsylvania State-wide municipal solid waste (MSW) characterization study	Dept. of Environmental Protection; R.W. Beck	2002
	Wisconsin State-wide waste characterization study	Cascadia Consulting Group	2002
	Georgia State-wide waste characterization study	R.W. Beck	2004
	Iowa State-wide waste characterization study	R.W. Beck	2005
	California Solidwaste Characterization Database + Waste Disposal and Diversion Findings for Selected Industry Groups, June 2006	Cascadia Consulting Group	2006
	State of Nebraska waste characterization study	Engineering Solutions and Design, Inc,	2008
	Illinois Commodity/ Waste Generation and Characterization study	CDM	2008
	USDA - Supermarket loss estimates for fresh fruit, veg, meat, poultry, and seafood, and their use in the ERS loss adjusted food availability data	Jean C. Buzby, Hodan Farah Wells, Bruce Axtman, and Jana Mickey	2009
	The Progressive Increase of Food Waste in America and Its Environmental Impact; PLoS ONE 4(11): e7940. doi:10.1371/journal.pone.0007940	Hall KD, Guo J, Dore M, Chow CC	2009
	USDA - Loss Adjusted Food Availability Series	Jean Buzby, Hodan Farah Wells et al	Up to 2009
	Wasted Food, Wasted Energy: The Embedded Energy in Food Waste in the United States,” Environ. Sci. Technol. 2010, 44, 6464-6469, American Chemical Society	Amanda Cuellar, and Michael Webber	2010
Save the Planet, Feed the Planet - AT Kearney and Feeding America work	Dave Donnan - AT Kearney	2010	

	Municipal Solid Waste in the US - EPA report - 2010 facts and figures	Jean Schwab et al	2010
	USDA - Consumer level food loss estimates and their use in the ERS loss adjusted food availability data	Mary K. Muth, Shawn A. Karns, Samara Joy Nielsen, Jean C. Buzby, and Hodan Farah	2011
	The value of retail and consumer level fruit and vegetable losses in the US - The Journal of Consumer Affairs	Jean C. Buzby, Jeffrey Hyman, Hayden Stewart, and Hodan F. Wells	2011
EU	Preparatory Study on Food Waste Across the EU 27	BioIntelligence Services; Véronique Monier, Victoire Escalon, Clementine O'Connor	2010
UK	Food Matters - towards a strategy for the 21st century	UK Cabinet Office	2008
	Household Food & Drink Waste/the Down the Drain Report, Waste & Resources Action Programme (WRAP)	Tom Quested (WRAP), Hannah Johnson	2009
	Waste arisings in the supply of food and drink to households in the UK (WRAP)	Dr. Peter Lee and Peter Willis	2010
	Water and Carbon Footprint of Household Food and Waste in the UK	WRAP and WWF	2011
	WRAP - food waste facts and figures	WRAP	2011
Canada	Waste Management Industry Survey: Business and Government Sectors	Environment Canada	2008
	Food Waste in Canada - opportunities to increase the competitiveness of Canada's agri-food sector, while simultaneously improving the environment	Martin Gooch, Abdel Felfel, Nicole Marenick (George Morris Center)	2010