

More Jobs, Less Pollution:
Growing the Recycling Economy in the U.S.

EXECUTIVE SUMMARY

Prepared by: Tellus Institute with Sound Resource Management

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KEY FINDINGS

This study provides strong evidence that an enhanced national recycling and composting strategy in the United States can significantly and sustainably address critical national priorities including climate change, lasting job creation, and improved health. Achieving a 75 percent diversion[1] rate for municipal solid waste (MSW) and construction and demolition debris (C&D) by 2030 will result in:

- A total of 2.3 million jobs: Almost twice as many jobs as the projected 2030 Base Case Scenario, and about 2.7 times as many jobs as exist in 2008. There would be a significant number of additional indirect jobs associated with suppliers to this growing sector, and additional induced jobs from the increased spending by the new workers.

- Lower greenhouse gas emissions: The reduction of almost 515 million metric tons of carbon dioxide equivalent ($eMTCO_2$) from diversion activities, an additional 276 million $eMTCO_2$ than the Base Case, equivalent to emissions from about 72 coal power plants or taking 50 million cars off the road.

- Less pollution overall: Significant reductions in a range of conventional and toxic emissions that impact human and ecosystem health.

- Unquantified benefits of reducing ecological pressures associated with use of non-renewable resources, conserving energy throughout the materials economy, and generating economic resiliency through stable, local employment.

[1] *By "diversion" we mean diversion from waste disposal either in landfills or incineration facilities. Waste diversion approaches include waste reduction, reuse and remanufacturing, recycling, and composting.*

EXECUTIVE SUMMARY

We face a series of crises in America today. Nationwide unemployment currently hovers just below 10 percent. Climate change is already disrupting the American economy and will have greater impacts in coming years, and a range of pollutants continue to degrade our ecosystems and burden public health. Transforming the "waste sector" into a "recycling sector" will create more jobs, reduce greenhouse gas emissions that cause climate change, and lower other types of pollution and related public health consequences.

While the vast majority of municipal solid waste can be readily recycled, re-used, or composted, only 33 percent is currently diverted from disposal. Most of our discards are still sent to landfills and incinerators.

While waste diversion nationally is relatively low, because of the sheer size of the waste stream, recycling has grown into an important part of the U.S. economy. Moreover, a number of cities have achieved considerably higher waste diversion rates and provide successful models that show a path to a significantly stronger recycling economy.

This report assesses the impacts of implementing a bold national recycling and composting strategy in the United States over the next two decades. Specifically, we explore the impact on jobs and environmental pollutants if the U.S. were to achieve a 75 percent national waste diversion rate by 2030.

The report analyzes both municipal solid waste (MSW), as well as construction and demolition debris (C&D). MSW is generated by households as well as commercial and institutional entities. It does not include industrial waste. C&D is generated from construction and demolition activities in the residential and commercial sectors. Although less visible than MSW, C&D debris is included in this analysis because of its importance relative to MSW (building-related C&D alone is roughly 70 percent as large as MSW generation) and because it presents strong opportunities for reuse and recycling.

To conduct the analysis, we compared two waste management scenarios: the "Base Case Scenario," characterized by a continuation of current practices and trends over the next two decades; and the "Green Economy Scenario," based on a national enhanced recycling and composting strategy that achieves an overall diversion rate of 75 percent by 2030.

THE CURRENT WASTE STREAM

In order to construct the alternative scenarios for 2030 we must first understand the magnitude and composition of the existing waste stream. In terms of MSW, five materials comprise about 77 percent of the almost 250 million tons of total MSW generated in 2008: paper and paperboard, yard waste, food scraps, plastics, and metals. Organic components made up about 64 percent of total 2008 MSW generation. [1]

Specific materials are recovered for recycling and composting at very different rates. As summarized in Figure ES-1, the U.S. diverted approximately 33 percent of MSW in 2008. This is considerably below the diversion rates of many cities and states with robust MSW recycling and composting programs, leaving considerable room for additional diversion.

In addition to MSW, 178 million tons of C&D waste was generated in 2008. The C&D stream includes wastes generated from demolition, renovation, and new construction. Two materials dominate C&D waste and comprise roughly 70 percent of the total: concrete and mixed rubble (45 percent), and wood (25 percent). In 2008 approximately 30 percent of C&D debris generated in the U.S. was diverted (recycled) and

[1] *Based on "Municipal Solid Waste Generation, Recycling and Disposal in the United States: Facts and Figures for 2008," U.S. EPA, November 2009.*

70 percent was disposed.[2] Virtually all recovered C&D waste was recycled; almost none was composted. Similarly, virtually all C&D disposal was via landfill and very little was incinerated. As with MSW, much higher C&D diversion rates have been achieved in various jurisdictions throughout the U.S., indicating that there are significant opportunities for increased diversion on a national scale.

2030 BASE CASE SCENARIO

The Base Case Scenario represents a "business as usual" approach to solid waste management in which current practices and trends continue until 2030. No major new policy interventions or lifestyle changes are introduced, and most basic assumptions remain unchanged.

Based on trends over the past decade, per capita MSW generation is projected to remain unchanged from 2008 levels (1,697 lbs. per person),[3] and population is expected to grow from 304 million in 2008 to 374 million in 2030.[4] Thus, the overall MSW stream is expected to grow at the rate of population growth, from 250 million tons in 2008 to about 314 million tons in 2030. In addition, the modest growth in the MSW diversion rate that has been experienced in the U.S. over the past decade (one percent per year) is assumed to continue, reaching 41 percent in 2030 in the Base Case Scenario.

Similar projections are made for C&D in the Base Case Scenario, based on the best available data. As a result, C&D generation is projected to reach almost 219 million tons in 2030. The diversion rate increases to 37 perent by 2030, accounting for almost 82 million tons, while 137 million tons of C&D continues to be disposed in landfills.

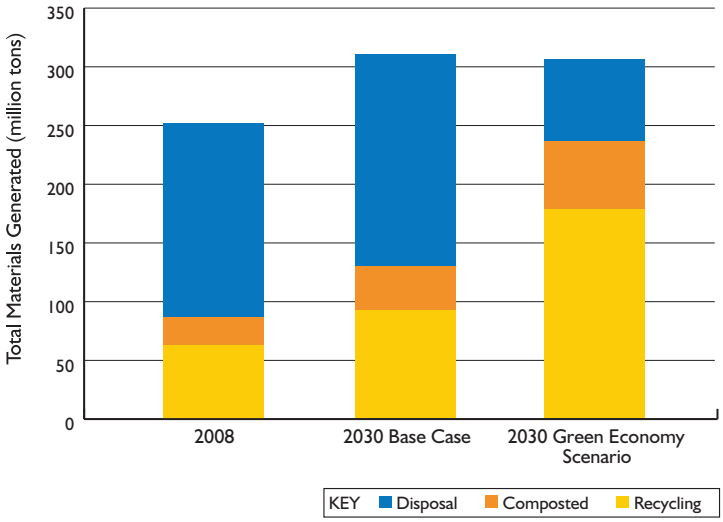
THE GREEN ECONOMY SCENARIO

The Green Economy Scenario is based on the same assumptions used in the Base Case in terms of the growth of MSW and C&D, driven by expected population growth through 2030. The fundamental difference is that the Green Economy Scenario **reflects an overall waste diversion rate of 75 percent**. This figure represents what is achievable through implementation of a set of enhanced policy, regulatory, and lifestyle changes to reach this level of recycling and composting. Though considered aggressive by today's practices, the policies, regulations and behavior changes driving this scenario are based on what are considered "best practices" currently in place in a number of jurisdictions in the U.S. and abroad.

While we do not attempt to provide detailed descriptions of each of the specific best practices and their respective impacts on emissions and jobs in the Green Economy Scenario, we do provide examples of the kinds of policy, regulatory, and lifestyle initiatives that will be necessary to achieve the higher level of recycling and composting in this Scenario.

Figures ES-1 and ES-2, below, provide a comparative summary of the MSW and C&D waste flows and management practices in 2008 and for the two scenarios in 2030.

Figure ES-1
U.S. MSW Waste Flows, 2030 Scenario Comparison

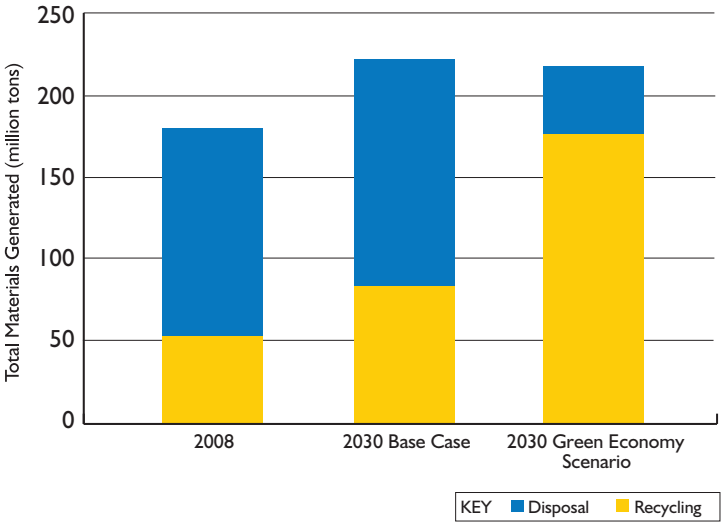


[2]*Based on "Characterization of Building-Related Construction and Demolition Debris in the United States," prepared by Franklin Associates for U.S. EPA, June 1998.*

[3]*Background data table from "Municipal Solid Waste Generation, Recycling and Disposal in the United States, Detailed Tables and Figures for 2008," U.S. EPA, November 2009.*

[4]*Table 1. Projections of the Population and Components of Change for the United States: 2010 to 2050 (NP2008-T1), Population Division, U.S. Census Bureau, Release Date: August 14, 2008.*

Figure ES-2
U.S. C&D Waste Flows, 2030 Scenario Comparison



JOB CREATION IMPACTS

Based on the waste stream characteristics and management practices developed for the Base Case and Green Economy Scenarios, the employment implications of each scenario were analyzed. The analysis includes the various stages of materials management including collection, hauling, and processing (if any), as well as the ultimate disposition of the collected materials through reuse/remanufacturing, new product manufacturing, composting, or disposal via landfilling or incineration.

Based on several existing data sources[5] we derived estimates of jobs produced per 1,000 tons of MSW managed for each of the diversion and disposal management activities (collection, processing, manufacturing, reuse/remanufacturing, landfilling, and incineration), for each material in the waste stream (paper, glass, metals, plastics, rubber, textiles, wood, food scraps, yard trimmings, miscellaneous organic wastes, and other wastes).

In addition to job impacts from waste disposal (landfilling and incineration), we estimate job creation for three categories of recycling: (1) Recycling Industries, including collection and processing of recyclables to make them available for use in new industrial processes; (2) Recycling Reliant Industries, including industries that purchase secondary materials from the Recycling Industry; and (3) Reuse and Remanufacturing Industries, including those industries that directly reuse and/or remanufacture products for their original use.

The job creation data reveal that waste disposal is not labor intensive and generates the fewest jobs per ton of waste (0.1 job per 1,000 tons) for the various management activities. This is not surprising given that the capital intensive equipment used at disposal facilities can handle large tonnages with few employees. Materials collection also generates relatively few jobs, but more than disposal.

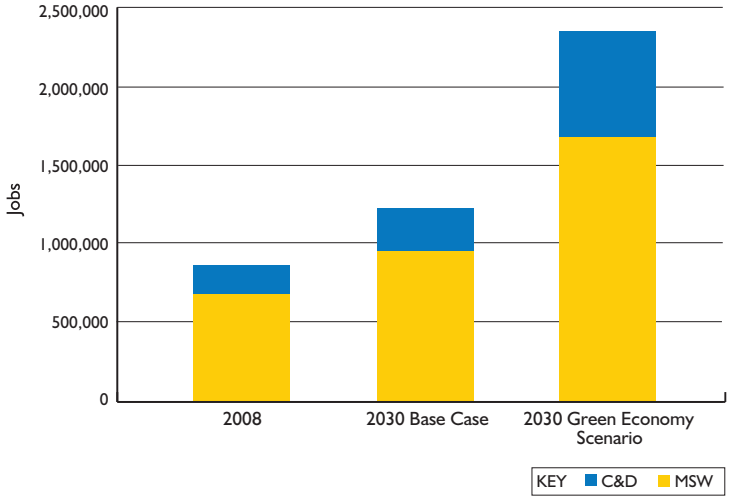
The Green Economy Scenario with a 75 percent diversion rate generates 2,347,000 total direct jobs—over 1.1 million more jobs than in the Base Case, and nearly 1.5 million more jobs than in 2008.

Processing of recyclables (2 jobs per 1,000 tons) and organics (0.5 jobs per 1,000 tons) is somewhat more labor intensive. Manufacturing using recycled materials creates a relatively high number of jobs per 1,000 tons, varying by material/sector (e.g., about 4 jobs per 1,000 tons for paper manufacturing and iron and steel manufacturing, and about 10 jobs per 1,000 tons for plastics manufacturing). Though relatively small tonnages of material are involved, MSW reuse and remanufacturing activities are particularly job intensive owing to the labor required for disassembly, inspection, repair/refurbishment, reassembly, and testing.

The job creation impacts of the Base Case and Green Economy Scenarios are summarized below in Figure ES-3.

[5] *U.S. Recycling Economic Information Study, National Recycling Coalition, July 2001. Prepared by R.W. Beck; Recycling Economic Information Update: Delaware, Maine, Massachusetts, New York, and Pennsylvania, Northeast Recycling Council (NERC), February 2009. Prepared by DSM Environmental Services, Inc. (DSM) and MidAtlantic Solid Waste (MSW) Consultants; and Resource Management in the State of Delaware, Report to the Secretary, Delaware Natural Resources and Environmental Control, prepared by Neil Seldman and Richard Anthony, The Institute for Local Self-Reliance, 2007.*

Figure ES-3
Total MSW and C&D Job Impacts
2030 Scenario Comparison



In 2008 there were approximately 861,000 jobs directly associated with the management of MSW and C&D (666,000 and 195,000, respectively). Though more than two-thirds of MSW and C&D waste was disposed in 2008, only about 15 percent of the jobs associated with managing these wastes were from disposal related activities (collection and landfilling or incineration). By contrast, because of the labor intensity of waste diversion, 85 percent of the jobs were associated with various diversion activities (collection, processing, manufacturing with recycled materials, and composting). Jobs associated with manufacturing using recycled inputs accounts for about 44 percent of the total jobs created related to MSW management and 24 percent of C&D management related jobs. Recycled material collection and processing also creates a significant fraction of the overall jobs for both MSW (37 percent) and C&D (33 percent).

> The Green Economy Scenario represents a powerful opportunity to reduce the human health and ecosystem impacts of pollution from waste management activities.

In the Base Case Scenario, due to growth in the waste stream and modest increases in the recycling and composting rate (from 33 percent to 41 percent), about 368,000 incremental jobs are created by 2030, resulting in a total of almost 1,229,000 jobs associated with the management of both the MSW and C&D waste streams. Due to the increase in the recycling rates, diversion related activities account for about 89 percent of the total jobs.

In contrast, **the Green Economy Scenario with a 75 percent diversion rate generates 2,347,000 total direct jobs—over 1.1 million more jobs than in the Base Case, and nearly 1.5 million more jobs than in 2008**. The combination of the higher diversion rate and the relative labor intensity of diversion activities means that in the Green Economy Scenario 98 percent of total waste management jobs are related to MSW & C&D diversion activities and only 2 percent are associated with disposal. Manufacturing jobs using recycled materials accounts for the largest share by far of the projected jobs in 2030; 49 percent of MSW management jobs and about 44 percent of C&D related jobs. We provide a detailed breakdown of job creation by management activity in the report.

ENVIRONMENTAL EMISSION IMPACTS

An increased diversion rate not only spurs job creation, but also significantly reduces greenhouse gas emissions that contribute to climate change, as well as emission of toxic pollutants that are dangerous to human lives and our ecosystems.

To assess the relative environmental impacts of the Base Case and Green Economy waste management scenarios in 2030 we utilized the Measuring Environmental Benefits Calculator (MEBCalc) model, a life-cycle assessment (LCA) tool.[6] The model employs a life-cycle approach to capture the input of energy and the output of wastes and pollution that occur not just at the end of use, but over the three phases of a material's or product's life cycle:

- Upstream phase: resource extraction, materials refining, and product manufacture;
- Use phase: product use; and
- End-of-life phase: management of product discards.

[6] *MEBCalc was developed by team member Jeffrey Morris. The model utilizes the best data sources available and has been utilized in numerous government sponsored studies concerning the environmental impacts of recycling and composting. See Section VI for details.*

This approach accounts for how reuse and recycling eliminate the need for much of the upstream phase, thereby conserving energy and reducing waste and pollutants in the production of goods and services, in addition to the benefits achieved in the end of life phase.

For key materials in the MSW and C&D streams the methodology aggregates pollutants for seven environmental impact categories in the following indicator pollutants:

- Climate change – carbon dioxide equivalents (eCO_2);
- Human health-particulates – particulate matter less than 2.5 microns equivalents ($ePM_{2.5}$);
- Human health-toxics – toluene equivalents (eToluene);
- Human health-carcinogens – benzene equivalents (eBenzene);
- Eutrophication – nitrogen equivalents (eN);
- Acidification – sulfur dioxide equivalents (eSO_2); and
- Ecosystems toxicity – herbicide 2,4-D equivalents (e2,4-D).

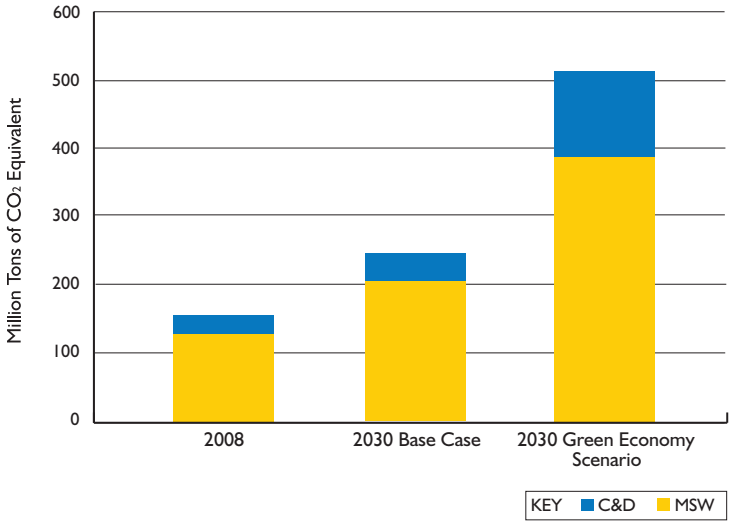
The Green Economy Scenario avoids about 515 million $eMTCO_2$ in 2030, more than twice as much as the Base Case.

For each of the seven emissions categories modeled, the assessment indicates that recycling/composting reduces emissions considerably relative to waste disposal. These environmental benefits come primarily from pollution reductions in the manufacture of new products with recycled materials instead of virgin raw materials, and the replacement of synthetic petroleum-based fertilizers with compost. For most pollutants, the relative upstream benefits of diversion are quite dramatic. For example, recycling reduces energy-related eCO_2 emissions in the manufacturing process and avoids emissions from waste management. Moreover, in the case of paper, recycling maintains the ongoing sequestration of carbon in trees that would otherwise need to be harvested to manufacture paper.

Given the prominence of climate change in current U.S. and global policy debates, the impacts of the different waste management scenarios on greenhouse gas emissions is important.

Figure ES-4, below, presents the relative GHG savings that accrue from diversion activities in the MSW and C&D management systems.

Figure ES-4
Climate Change Emissions Reductions from Diversion: 2030 Scenario Comparison



MSW and C&D diversion activities in 2008 reduced GHG emissions about 153 million $eMTCO_2$. In the Base Case Scenario the modest growth in recycling rates combined with a growing waste stream result in annual GHG emission reductions in 2030 of about 238 million $eMTCO_2$, while in the Green Economy Scenario GHG reductions of about 515 million eMTCO2 are achieved. This is equivalent to shutting down about 72 coal-fired power plants or taking 50 million cars off the road.[7]

The high organic content of MSW (paper and paperboard, yard waste, food scraps, and plastics) means that diversion of MSW accounts for the vast majority of GHG emission reductions. By contrast, C&D waste has a considerable fraction of inorganic material (concrete, rubble, brick), so C&D diversion contributes only about 15 percent of overall GHG reductions in the Base Case Scenario and 25 percent in the Green Economy Scenario. The somewhat higher fraction

[7] *GHG reduction equivalents based on U.S. EPA figures at: http://www.epa.gov/cleanenergy/energy-resources/refs.html#coalplant and http://www.epa.gov/otaq/climate/420f05004.htm.*

from C&D diversion in the Green Economy Scenario is driven by the increased recycling/reuse of wood and, to a lesser extent, plastics.

The results of the analysis are similar for human health and ecosystem related impacts. For example, Figures ES-5 and ES-6 summarize the relative emission reduction benefits of the Base Case and Green Economy Scenario for particulate emissions (less than 2.5 microns equivalents, $ePM_{2.5}$) associated with respiratory illnesses and for sulfur dioxide (eSO_2) that leads to ecosystem degradation in terms of acidification of water bodies. As with GHGs, the reductions in emissions of these pollutants in the Green Economy Scenario are significantly greater than those in the Base Case. This trend follows for the other pollutant emissions measured in this study. **The Green Economy Scenario, therefore, represents a powerful opportunity to reduce the human health and ecosystem impacts of pollution from waste management activities.**

Figure ES-5
Respiratory Emissions Reductions from Diversion: 2030 Comparison

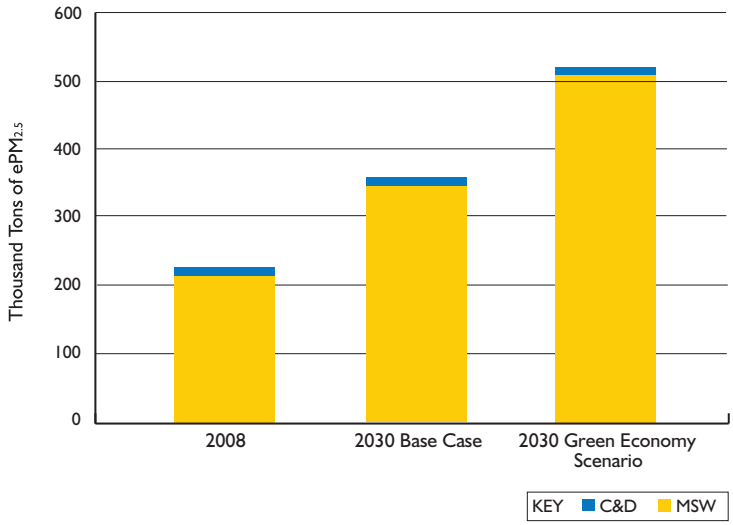
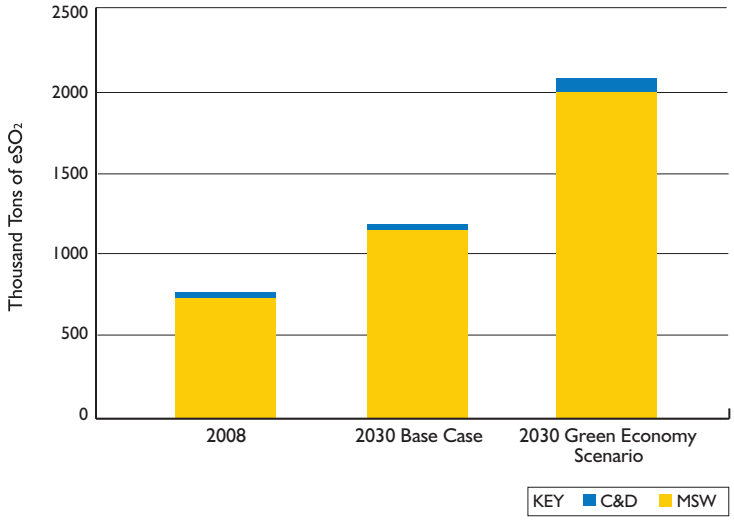


Figure ES-6
Acidification Emissions Reductions from Diversion: 2030 Comparison



Sources for all figures are provided in the full report.