

# The Climate-Waste Connection

**L**ots of people know that waste reduction is good for the environment and can also help an organization's bottom line. What many people do not realize is that solid waste prevention and recycling also help reduce climate change impacts. Creating less waste decreases the amount of heat-trapping GHG emissions linked to everyday trash. This introduction explains the science behind the greenhouse effect and global climate change, illustrates the connection between solid waste and climate change, and explains how your waste prevention and recycling programs can help reduce climate change.

## Learn More!

Interested in learning more about the connection between climate change and solid waste? Want to see what organizations are doing to mitigate the effects of solid waste management on the Earth's climate? Watch *Why "Waste" a Cool Planet: MSW Solutions to Global Climate Change!*

This two-hour satellite forum video explores global climate change by focusing on the role municipal solid waste (MSW) management plays in this phenomenon.

Other EPA-sponsored satellite forum videos include:

- *Buying Recycled: The Real Story About Cost, Availability, and Quality*
- *Communities: Setting Trends in Waste Prevention and Recycling*
- *Solid Waste Gets a Higher Education: A College and University Waste Reduction Satellite Forum*
- *Waste Prevention Pays: Businesses Cut Costs by Cutting Waste*

To order a free copy of any of these videos, call the WasteWise Helpline at 800 EPA-WISE (372-9473) or e-mail <[www@cais.net](mailto:www@cais.net)>.

## The Changing Climate

According to the National Academy of Sciences (NAS), the federal government's scientific advisory society, GHGs are accumulating in Earth's atmosphere as a result of human activities, causing global mean surface air temperature and subsurface ocean temperature to rise. Rising global temperatures are expected to raise sea levels and change precipitation and other local climate conditions. Changing regional climate could alter forests, crop yields, and water supplies. It could also affect human health, animals, and many types of ecosystems. Deserts might expand into existing rangelands, and features of some of our National Parks might be permanently altered. Most of the United States is expected to warm, although sulfates might limit warming in some areas. Scientists currently are unable to determine which parts of the United States will become wetter or drier, but there is likely to be an overall trend toward increased precipitation and evaporation, more intense rainstorms, and drier soils. Unfortunately, many of the potentially most important impacts depend upon whether rainfall increases or decreases, which cannot be reliably projected for specific areas.

NAS also found new and stronger evidence that most of the warming during the last 50 years is attributable to human activities that have altered the chemical composition of the atmosphere through the buildup of GHGs, primarily carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O). CO<sub>2</sub> is released to the atmosphere by the burning of fossil fuels, wood and wood products, and solid waste. CH<sub>4</sub> is emitted from the decomposition of organic wastes in landfills, the raising of livestock, and the production and transport of coal, natural gas, and oil. N<sub>2</sub>O is emitted during agricultural and industrial activities, as well as during

## INSIDE THE GREENHOUSE

Understanding the atmospheric phenomenon known as the greenhouse effect is critical to understanding global climate change. The atmosphere that surrounds the Earth contains many types of gases, including those known as “greenhouse gases”—water vapor, CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O. GHGs regulate the Earth’s climate by absorbing and holding heat from the sun in an atmospheric blanket around the planet’s surface.

In the first step of the process, shortwave energy from the sun, or solar radiation, passes through the atmosphere. Most of the radiation is absorbed by the Earth’s surface and serves the life-sustaining functions of heating the ground, melting ice and snow, evaporating water, and powering plant photosynthesis. Some of the energy, however, reflects off the Earth’s surface back into space in the form of long-wave, or infrared, radiation. Atmospheric GHGs trap some of the outgoing energy, retaining heat somewhat like the glass panels of a greenhouse. For more information on how the greenhouse effect works, visit <[www.epa.gov/globalwarming/climate/index.html](http://www.epa.gov/globalwarming/climate/index.html)> on EPA’s Global Warming Site.

combustion of solid waste and fossil fuels. In 1997, the United States emitted about one-fifth of total global GHGs.<sup>1</sup>

Climate change poses real risks. The exact nature of these risks remains uncertain. Ultimately, this is why we have to use our best judgement—guided by the current state of science—to determine what the most appropriate response to climate change should be. Fortunately, many of the activities that can be taken to mitigate climate change, such as reducing waste, increasing energy efficiency, or conserving forests, are beneficial for other reasons.

## From MSW to GHGs

Every stage of a product’s life cycle—extraction, manufacturing, distribution, use, and disposal—indirectly or directly contributes to the concentration of GHGs in the atmosphere and affects global climate. At most stages, the energy expended during the transport and production processes is the main source of GHG emissions. Disposing of organic materials like food, paper, and yard waste in landfills can also lead to CH<sub>4</sub> emissions from decomposition. In addition, cutting down trees to extract wood or other raw materials decreases carbon storage, the ability of plants to absorb

and store carbon from CO<sub>2</sub>.

Whether you are the manufacturer or user of a product, you can analyze the entire product life cycle to determine where your organization can make changes, such as preventing waste, recycling, or buying or manufacturing recycled-content products, to reduce its impact.

For manufacturers, life cycle analysis might uncover opportunities for producing goods using less material, which means that less energy is needed for extracting, transporting, and processing raw materials and for transporting end products. Manufacturing goods from recycled materials is also beneficial because it typically requires less energy than producing goods from virgin materials. If energy demand decreases, so does the burning of fossil fuels and the emission of GHGs to the atmosphere. At the same time, energy and raw materials savings usually produce cost savings.

To produce high-grade office paper, for example, a paper manufacturer uses gasoline-powered machinery to cut down trees (which store carbon), diesel trucks to carry the lumber to the paper mill, fossil fuels or wood products to power the mill, and more diesel trucks to distribute the product to customers. By increasing the amount of recycled-content in the paper, the manufacturer can eliminate GHG emissions

<sup>1</sup> Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2000, U.S. EPA, Office of Atmospheric Programs, April 2002. EPA236-R-02-003.

associated with extraction and transport of wood needed to make the paper. The manufacturer can similarly reduce emissions by improving resource efficiency in its production process to make the same amount of paper with less raw material.

A product user also has many opportunities to reduce waste. If an organization is a buyer of high-grade paper it can practice waste reduction techniques like purchasing recycled-content paper or instituting a double-sided copying policy. Purchasing recycled-content paper would eliminate the extraction and transport of some of the raw materials needed to make the paper, and double-sided copying would half the amount of paper used along with its associated energy consumption.

Overall, waste reduction has significant potential for decreasing GHG emissions. EPA estimates that simply increasing our national recycling rate from its current level of 30 percent to 35 percent would reduce GHG emissions by another 10 million tons of carbon equivalent (MTCE). That amount is equal to the average annual emissions from the electricity consumed by roughly 4.6 million households. By recycling all of its paper, plastic, and corrugated cardboard waste generated in one year, an office building of 7,000 workers could reduce GHG emissions by 2,287 MTCE. This amount is equivalent to taking about 1,677 cars off the road that year. If just one household generated 5 percent less waste—including newspapers, aluminum, steel cans, and plastic containers—and then recycled what remained, it could reduce 367 pounds of carbon equivalent.<sup>2</sup>

## Data Made Easy: GHG Inventories

The federal government and an increasing number of states are developing reports known as “GHG Inventories.” These inventories provide annual GHG emissions data by sector (e.g., energy, agriculture, waste), source (e.g., transportation emissions, manure management), and gas (e.g., CO<sub>2</sub>, CH<sub>4</sub>). The official U.S. government GHG inventory is currently available on the Web at <[www.epa.gov/globalwarming/emissions/national/index.html](http://www.epa.gov/globalwarming/emissions/national/index.html)>. Thirty-eight states and Puerto Rico have completed inventories in partnership with EPA’s State and Local Outreach Program, and another two states have inventories in progress. Summaries of all these inventories are available on the Web at <<http://yosemite.epa.gov/globalwarming/ghg.nsf/emissions/StateAuthoredInventories>>.

## WASTEWISE PARTNERS REDUCE GREENHOUSE GASES

Across the country, WasteWise partners are reducing, reusing, and recycling waste, and reducing GHGs at the same time. Highlights include the following:

### By Preventing

The **Seydel Companies**, Georgia-based chemical manufacturers, work hard to prevent plastic waste. Through packaging waste reductions and changes to their manufacturing processes, Seydel prevented the disposal of 813 tons of high density polyethylene (HDPE), reducing GHG emissions by approximately 400 MTCE.

### By Recycling

In 2001, the **Public Service Enterprise Group (PSEG)**, a utility company based in Newark, New Jersey, used 31,000 tons of coal combustion by-products, such as fly ash, as a replacement for virgin materials. PSEG used these by-products as Portland cement replacements, roofing-shingle manufactured components, blasting grits, and surface abrasives. The manufacture of each ton of Portland cement with coal fly ash prevented approximately 1 ton of CO<sub>2</sub> from being emitted into the atmosphere.

### By Educating

To accomplish its waste reduction goals, **Battelle Memorial Institute**, of Columbus, Ohio, implemented a comprehensive employee education campaign that includes an extensive internal Web site, quarterly newsletters, daily bulletins, promotional signs, and helpful reference labels. These outreach activities have helped Battelle report WasteWise emissions reductions of 443 MTCE, and its efforts to encourage employees to reduce waste at home and educate other community members should lead to even greater GHG reductions.

### By Reusing

**Kessler Consulting, Inc.** of Tampa, Florida, maintains an internal reuse system for folders, standard and legal size paper, and files and envelopes, encouraging employees to reuse office materials rather than purchase new ones. In 2000, Kessler reported preventing several tons of mixed paper from being sent to the landfill, where it would decompose and emit GHGs.

<sup>2</sup> Figures based on 1999 EPA WARM emissions factors.

# Solutions: Corporate, Community, and State Actions

**F**rom boardrooms and factories of major corporations to state governments and local communities, real action to reduce climate change is taking place. In many cases, these actions reflect stakeholders' decisions to voluntarily help mitigate the climate change problem. EPA and other federal agencies champion this approach by engaging businesses, states, and localities in voluntary "win-win" partnerships that address the challenge of global climate change while strengthening the economy and improving communities.



## What Are Stakeholders Doing?

Many different types of organizations are working to better understand and respond to the challenge of climate change. Actions include increasing energy efficiency, pursuing renewable energy sources, decreasing transportation emissions, and conserving forests and planting trees to increase carbon storage. Many stakeholders are also exploring ways to mitigate climate change by reducing waste, and they are finding that their efforts pay multiple dividends.

Large corporations are conducting environmental audits and product life-cycle assessments to learn how to reduce GHGs through better product design, resource management, and manufacturing processes. As a result they are discovering operational efficiencies, reduced energy costs, and increased market share—all things that contribute to a healthier bottom line. Small businesses are assessing the impacts of their waste disposal and purchasing habits and are finding easy ways to simultaneously reduce emissions and save money.

Cities and states across the country are preparing GHG inventories and developing programs that tackle GHG emissions by increasing recycling, capturing landfill gas, and educating community members. The outcome is cleaner air, less waste, and new energy sources. Overall, these cities and states are providing smarter growth, making their communities more attractive and their economies more competitive.

These examples prove that stakeholders can achieve impressive results when they are given the flexibility and opportunity to explore and implement solutions that fit their unique needs and capabilities.

## Innovative Partnerships Produce "Win-Win" Results

EPA and other federal agencies support the types of activities mentioned above by engaging stakeholders in voluntary partnership programs. By providing flexibility, technical assistance, and recognition, partnership programs leverage innovation and outstanding environmental performance while preserving economic health. In addition to WasteWise, several other partnership programs facilitate waste-related emissions reductions:

- In communities with **Pay-As-You-Throw (PAYT)** programs (also known as unit pricing or variable-rate pricing), residents pay for MSW collection based on the amount they throw away. Communities with PAYT programs have reported significant increases in recycling and reductions in waste due primarily to the direct economic incentive to recycle more and generate less waste. The **City of Gainesville, Florida**, a WasteWise partner, saw an 18 percent decrease in solid waste collected and a 25 percent increase in recyclables recovered after switching to a PAYT program. Another WasteWise partner, the **City of Dover, New Hampshire**,

reduced total annual residential solid waste by a remarkable 65 percent, while simultaneously cutting its annual solid waste budget from \$1.2 million to \$878,000. In addition to lowering waste management costs, the increased recycling and waste prevention activities that PAYT encourages results in reduced GHG emissions associated with the manufacture, distribution, use, and subsequent disposal of products. See <[www.epa.gov/payt](http://www.epa.gov/payt)> for more information on the PAYT program.

- **EPA's Landfill Methane Outreach Program (LMOP)** is a voluntary assistance and partnership program that helps facilitate and promote the use of landfill gas as a renewable energy source. Landfill gas emitted from decomposing garbage is a reliable and renewable fuel option that remains untapped at many landfills in the United States, despite its significant value. By controlling landfill gas instead of allowing it to migrate into the atmosphere where it is a powerful GHG, LMOP helps businesses, states, and communities protect the environment and build a sustainable future. Participation also leads to cost savings and helps meet energy demand. Several WasteWise partners also participate in LMOP. The **Tennessee Valley Authority (TVA)** makes landfill gas a key component, along with solar and wind power, of its Green Power Switch program, which produces electricity from cleaner, renewable sources. TVA's Middle Point Landfill in Murfreesboro, Tennessee, currently produces 2.6 megawatts of generating capacity and expects to increase

capacity in the future. Other WasteWise partners that participate in LMOP include **Detroit Edison Company**, **General Motors**, **International Truck & Engine**, the **Los Angeles Department of Water and Power**, the **Massachusetts Department of Environmental Protection**, and **Northeast Utilities**. See <[www.epa.gov/lmop](http://www.epa.gov/lmop)> for more information on the LMOP program.

- **Cities for Climate Protection (CCP)** is a global campaign of the International Council for Local Environmental Initiatives (ICLEI). More than 475 local governments worldwide participate in the campaign, including more than 100 cities and counties in the United States. The CCP campaign goal is to reduce GHG emissions from fossil fuel burning and other human activities that contribute to air pollution. Emissions reduction efforts focus on two primary GHGs—CO<sub>2</sub> and CH<sub>4</sub>. Local governments can play a key role because they directly influence and control many of the activities that produce these emissions, such as burning fossil fuels and managing landfill methane emissions. Local decisions regarding land use and development, investments in public transit, energy-efficient building codes, waste reduction, and recycling programs affect local air quality and living standards as well as global climate.

CCP recently initiated a *Waste Challenge and Peer Match Project* that promotes innovative waste management projects that reduce GHGs. Nine cities, including WasteWise partner the **City of San Francisco**, were selected for this special

## Packaging Changes Decrease GHGs

There is a reason why **Allergan, Inc.** has been named a WasteWise Large Business Program Champion 3 years in a row. In 2000, not only did the pharmaceutical company prevent 760 tons of boxboard waste and 400 MTCE of GHGs, but it incorporated an innovative new waste reduction process into the design of all products.

Allergan performs a full assessment of potential waste during new product development, evaluating the environmental impact of each step in a product's life cycle. To assess all potential waste, Allergan includes the impact of product packaging in each product's overall environmental profile. The company also evaluates existing products for opportunities to minimize packaging. During each assessment, Allergan focuses on:

- **Reducing**—Minimizing product packaging by reducing the layers or weight of packaging materials
- **Reusing**—Creating reusable packaging
- **Recycling**—Increasing the recycled content in packaging material and ensuring the packaging itself can be recycled

Mike Whaley, Allergan's director of environmental health and safety, attributes much of his knowledge about the relationship between MSW and global warming to WasteWise. "Allergan was aware indirectly through various EPA reports and other published articles that reducing waste also reduces GHGs. The WasteWise estimates of GHG emissions reductions were the first quantifications we received directly attributable to our actions," he said.

To reduce GHG emissions through packaging:

- Prevent waste before it is created
- Purchase products with the least amount of packaging
- Purchase products with packaging containing recycled material
- Purchase products that can be recycled or whose packaging can be recycled
- Ship and purchase products in bulk to prevent packaging waste



project and will receive targeted assistance from ICLEI and EPA staff to design, implement, and quantify advanced waste and GHG reduction projects. The CCP campaign is an excellent opportunity for cities and counties to take practical steps to reduce GHG emissions and generate multiple benefits for their communities. Other CCP partners that are also active WasteWise partners include **Alachua County, Florida**; the **City of Chicago, Illinois**; the **City of Durham, North Carolina** (2001 Program Champion); **King County, Washington** (2001 Program Champion); **Los Angeles Department of Water and Power** (2001 Program Champion); the **City of Meza, Arizona**; and the **City of San Diego, California**. See <[www.iclei.org/co2](http://www.iclei.org/co2)> for more information on ICLEI and the CCP program.

- **Climate Leaders** is a voluntary EPA-industry partnership that encourages partners to develop long-term, comprehensive greenhouse gas reduction. Climate Leaders establish GHG reduction goals and report to EPA annually on their progress. To set a GHG reduction goal, an organization first determines its GHG emissions using either the Department of Energy 1605b Voluntary GHG Emissions Reporting Protocol or the GHG Emissions Inventory Protocol developed by the World Resources Institute and World Business Council for Sustainable Development. Because each company has a unique mix of GHG emissions and potential reduction opportunities, each partner might use a slightly different approach to mitigating its greenhouse gas emissions footprint. All partners report their direct emissions from onsite fuel consumption and waste incineration, process-related emissions, and indirect emissions from electricity use. Additionally, companies can broaden their initiatives to include optional activities, such as reduction and recycling, product transports, employee commuting, business travel, or investments that offset emissions. WasteWise partners **Bethlehem Steel**, **General Motors**, and **PSEG** are charter Climate Leaders. For more information about the Climate Leaders program, visit <[www.epa.gov/climateleaders](http://www.epa.gov/climateleaders)>.

In all of the above programs, participants have received targeted technical assistance and the flexibility to develop custom-tailored goals and activities. As a result, participants achieve meaningful and quantifiable results that are good for the environment and the economy. As part of high-profile, nationally recognized partnership programs, participants also benefit by being recognized as environmental stewards that have voluntarily undertaken special actions to improve their environmental performance. See the resources list on page 15 to learn where to find more information on these exciting programs.

## CCP Program Participant Gets WasteWise Value

Recently, the **Los Angeles Department of Water and Power (LADWP)**, a member of CCP, noted that many of its ideas for waste reduction activities came from its involvement in WasteWise. In 2000, LADWP prevented approximately 16,000 tons of CO<sub>2</sub> emissions through its recycling program! The department recycles materials such as office paper, yard trimmings, plastics, and wood, and boasts a recycling rate of 76 percent. The organization also promotes waste prevention activities such as donation programs, office supply swaps, and double-sided copying.

Several of LADWP's waste reduction activities reduce GHG emissions. LADWP tracks estimated GHG emissions reductions using the formulas provided by the WasteWise program and is currently working with recycling vendors to obtain accurate information about the types of materials being diverted from the landfill. The department uses the information gathered from its WasteWise activities to constantly assess and improve its waste reduction activities. To decrease future CO<sub>2</sub> emissions, LADWP plans to expand its recycling program to ensure that even the smallest of the department's 300 sites recycles.

"WasteWise reminds us that we are not just recycling for the department, but also for the community at large," says Recycling Manager Karen Higgins. "Tracking the data helps us determine if we are in line with the recycling program goals and are actually increasing diversions, as well as reducing GHG emissions."

# Calculating the Cooling Effects of Waste Reduction

**I**n the mid 1990s, EPA created WARM—the Waste Reduction Model—to calculate the climatic benefits of preventing waste, recycling, and composting along with the impacts of landfilling and combustion. WARM estimates GHG emissions associated with producing and managing 27 different materials and mixed material categories.

Communities and organizations across the United States have been using WARM to quantify waste reduction benefits and plan for the future. This section:

- Explains how EPA developed WARM
- Describes WARM measurement units and calculations
- Introduces the online and Microsoft Excel© versions of the tool
- Provides examples of how WasteWise partners use WARM results



## WARM GHG Emission Factors

In 1994, EPA recognized the connection between solid waste and climate change and called for accelerated source reduction and recycling. The Agency then realized that quantifying GHG emissions reductions associated with these activities would be extremely valuable and began to develop emission factors for 11 different types of materials and wastes including aluminum cans, HDPE plastic, and corrugated cardboard.

### **EMISSION FACTOR = GHGs EMITTED IN PRODUCING AND MANAGING 1 TON OF A SPECIFIC MATERIAL**

Using life cycle assessment methodology, EPA examined each material from cradle to grave to determine all the GHG emissions and sinks associated with each commodity. For example, analysts determined the GHG emissions and the energy required to produce and dispose of 1 ton of aluminum cans. They evaluated each step in the production process, beginning with aluminum ore extraction, and examined each waste management option—waste prevention, recycling, landfilling, and combustion. Finally, they

converted energy use into GHG emissions. The cradle-to-grave emission factors for aluminum waste prevention and recycling are -2.49 and -4.11 MTCE per ton. The GHG emission factors for landfilling and combustion are 0.01 and 0.02 MTCE per ton. These numbers indicate that waste prevention and recycling reduce GHG emissions while landfilling and combusting release GHGs.

After extensive peer review and public comment, the original GHG emission factors and project methodology appeared in EPA's *Greenhouse Gas Emissions From Management of Selected Materials in Municipal Solid Waste (EPA530-R-98-013)*. EPA then released emission factors for additional materials, and, in 2002, the Agency published *Solid Waste Management and Greenhouse Gases: A Life-Cycle Analysis of Emissions and Sinks (EPA530-R-02-006)* to explain the emission factors for all 27 materials and mixed material categories. For a free copy of this report, visit [www.epa.gov/mswclimate](http://www.epa.gov/mswclimate) or contact EPA's RCRA Call Center at 800 424-9346.