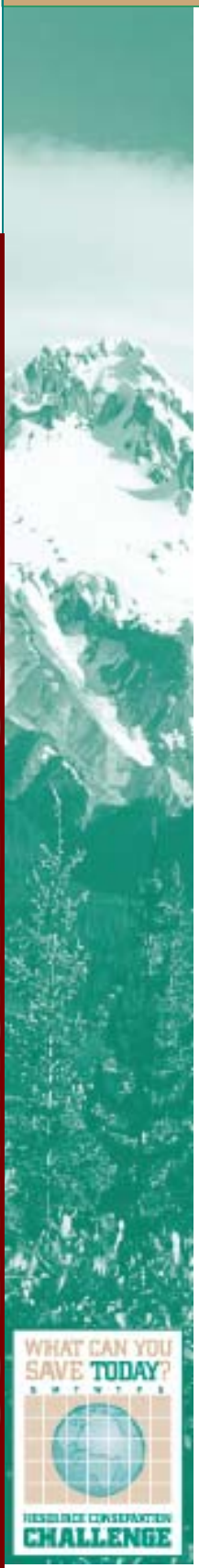
United States
Environmental Protection
Agency
Region 4

Source Reduction and Recycling:

A Role in Preventing Global Climate Change



Recycling has many direct benefits (e.g., resource conservation); however, the indirect benefits of recycling, while often overlooked, are also significant. Indirect benefits of recycling can range from creating jobs and tax revenues to making communities stronger and more appealing to residents to reducing greenhouse gas emissions. The production, transport, and disposal of municipal solid waste leads to greenhouse gas (GHG) emissions. GHG emissions trap heat in the Earth's atmosphere and the release of these gases occurs at every stage of a product's life-cycle, thus contributing to climate change. However, certain measures can be taken to reduce the potentially negative effects on human health and the environment due to changes in the Earth's atmosphere.

The U.S. Environmental Protection Agency (EPA) estimates that reducing waste generation in the United States to 1990 levels could cut GHG emissions by 11.6 million metric tons of carbon equivalent ($MMCO_2e$). Increasing the national recycling rate from the current level of 28 percent to 35 percent would reduce GHG emissions by 9.8 $MMCO_2e$, compared to landfilling the same material. Together, these levels of waste reduction and recycling would slash emissions by more than 21.4 $MMCO_2e$ – an amount equal to the average annual emissions due to electricity consumption that are produced by roughly 11 million households.

Carbon Equivalents:

GHG emissions in the U.S. are most commonly expressed as "million metric tons of carbon equivalents" (MMCO2e). Global warming potentials are used to convert GHG to carbon dioxide equivalents. Carbon dioxide equivalents can then be converted to carbon equivalents by multiplying the carbon dioxide equivalents by 12/44 (the ratio of the molecular weight of carbon to carbon dioxide).

Reducing GHG emissions is becoming an increasingly important issue for local government. As of June 2008, 850 mayors representing nearly 80 million Americans signed The U.S. Conference of Mayors' Climate Protection Agreement, an agreement in which supporting mayors pledge to reduce carbon dioxide emissions by 7 percent below 1990 levels by 2012.[1] This agreement is the only climate protection agreement of its kind among U.S. elected officials. Participating cities commit to:

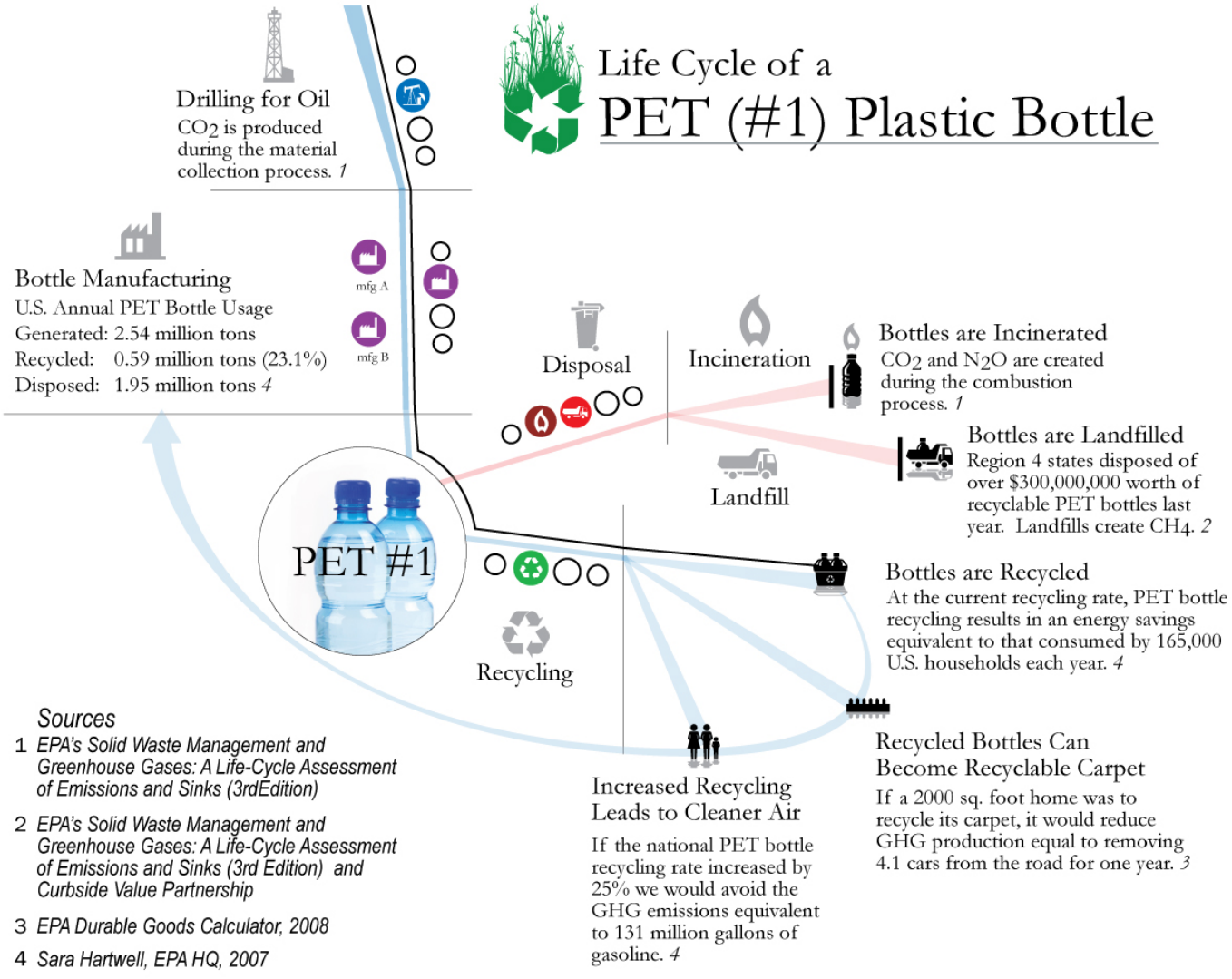
- Strive to meet or beat the Kyoto Protocol targets in their own communities
- Urge their state governments, and the Federal government, to enact policies and programs to meet or beat the greenhouse gas emission reduction target
- Urge the U.S. Congress to pass the bipartisan GHG reduction legislation

Recycling programs can play a role in helping meet GHG emission reduction goals by reducing emissions generated due to waste disposal, extraction of raw materials, and manufacturing of new products.

The Link Between Solid Waste and GHG Emissions

The disposal of solid waste produces GHG emissions in a number of ways.

- The anaerobic decomposition of waste in landfills produces **methane (CH4)**, a GHG *21 times more potent* than carbon dioxide. Landfills are the top human-caused source of methane.[2]
- The incineration of waste that could be recycled produces **carbon dioxide (CO2)** as a by-product.
- Materials that are disposed in landfills must be replaced by new products manufactured from raw materials. Extraction of raw materials and manufacturing activities to new products requires **fossil fuel combustion**. According to a State of Oregon evaluation of GHG emissions from solid waste, landfills and incinerators contribute approximately one percent of Oregon's GHG emissions; however, "upstream" or production-related emissions are approximately 10 times higher, due to transportation of materials and industrial energy use.[3]



The diagram above illustrates the stages of product life cycles, all of which provide opportunities for GHG emissions and/or offsets. These stages are raw material acquisition, manufacturing, recycling, and waste management.

Energy & GHG Emission Facts:

- Producing forty aluminum cans requires the energy equivalent of a gallon of gasoline.[4] Making aluminum from recycled sources requires 95% less energy than virgin production.
- Manufacturing each ton of virgin glass emits a half-ton of carbon dioxide, nearly two tons of nitrogen and smaller quantities of the greenhouse gases nitrogen oxide and sulfur dioxide. Using recycled glass reduces all of these emissions significantly.[4]
- Producing 40,000 tons of plastic bottles requires energy equivalent to 13 million gallons of gasoline. Recycling a ton of plastic bottles saves approximately 74 gallons of gas.[4]

Carbon Dioxide & Discarded Packaging:

In 2005, EPA's Waste Reduction Model (WARM) showed that GHGs equivalent to 99 million metric tons of carbon dioxide were released as a consequence of discarded packaging alone. It would take almost 83 million acres of pine or fir forest one year to store that much carbon.

The Role of Recycling:

How Can My Community Reduce GHG Through Recycling?

When a material is *recycled*, it is used in place of virgin inputs in the manufacturing process, rather than being disposed and managed as waste. Collecting and processing secondary materials, manufacturing recycled-content products, and then purchasing recycled products creates a closed loop that ensures the overall success and value of recycling. This leads to an overall benefit of reducing GHG emissions. Here are some ways to make a difference in your community through recycling:

- ***Collect and Process Recyclables***
  Once collected, recyclables are sent to a materials recovery facility to be sorted and prepared into marketable commodities for manufacturing. Recyclables are bought and sold just like any other commodity, and prices for the materials change and fluctuate with the market.

  In Action: South Carolina has a 35 percent recycling goal. If just one county meets this goal, the County could help meet the demands of several recycling markets. For example, Anderson County is conveniently located on I-85 with easy access to Atlanta-based and Charlotte-based businesses that demand recycled materials.

- ***Support the Manufacturing of Recyclables***
  Contrary to popular belief, there *is* a lucrative market for recycled goods. More and more of today's products are being manufactured with total or partial recycled content. Recycled materials are being used in innovative applications, such as recovered glass in roadway asphalt (glassphalt) or recovered plastic in carpeting, park benches, and pedestrian bridges. In the southeast, there is great demand for recycled materials.

  In 2004, Georgians discarded an amount equivalent to 74 percent of the paper (office, mixed, and newspaper) needed each year by Georgia-based SP Newsprint to produce recycled newspaper.[5] By relying on 100 percent recycled fiber in their mills, SP Newsprint is able to reduce air pollution by 74 percent.[6] The Business Council of Georgia and Georgia Department of Natural Resources recently awarded SP Newsprint with an Air Protection Achievement Award for their outstanding commitment to air quality and environmental integrity. In addition to using recycled content in their newsprint, the mill also uses 80 tons of recycled tire scrap per day for fuel, which burns hotter and cleaner than coal.[7]

The link between recycled content and energy use:

According to EPA's ReCon Tool, increasing the recycled content of polyethylene terephthalate (PET) bottles from 10 percent to 50 percent creates more than a 40 percent savings in energy during manufacturing.

In Action: In 2005, Mississippi reused 480,000 tons of coal combustion by-products (CCBs) in the state in various construction projects as a replacement material for limestone and other similar products. Using CCBs in this manner saved transportation and raw material costs for various industries, local governments, and construction contractors in the state. When CCBs are reused, mining for raw materials is no longer necessary.[8]

- ***Purchase Recycled Products***
  By "buying recycled," governments play an important role in making the recycling process a success. In January 2007, the President signed Executive Order 13423 requiring Federal agencies to use sustainable environmental practices when acquiring goods and services, including acquisition of biobased, environmentally preferable, energy-efficient, water-efficient, and recycled-content products. Although this Order only applies to Federal agencies, similar policies can be established at the local level to support efforts to reduce GHGs, promote energy conservation, and encourage broader participation in recycling programs.

  In Action: Salisbury, North Carolina is the first city in the country to use locally manufactured 100 percent recycled bricks and brick pavers in citywide improvements. The bricks and pavers, called "Green Leaf Brick," are composed of 100-percent recycled materials, which are specifically designed and engineered for sustainable building projects.[9]

Florida Governor Signs Executive Order on Climate Change: According to the Governor's Action Team on Energy and Climate Change, in 2005, approximately 15 $MMCO_2e$ was released from Florida's municipal solid waste (MSW) landfills. By recycling common MSW materials, the amount of gases released from landfills can be greatly reduced. On July 12 and 13, 2007, Governor Charlie Crist hosted "*Serve to Preserve: A Florida Summit on Global Climate Change*." The summit brought together leaders of business, government, science and advocacy to examine the risks of global climate change to Florida, and the nation, and to explore the business opportunities that can come from an aggressive response to climate change. At the conclusion of the summit, Governor Crist signed three Executive Orders and two international partnership agreements, adding Florida to the states actively working to address global climate change. For more, visit www.flclimatechange.us

The Role of Source Reduction:
How Can My Community Reduce GHGs Through Source Reduction?

Source reduction is the most effective way to prevent waste. When a material is *source reduced*, GHG emissions associated with producing the material and the management of post-consumer waste is avoided completely. Source reduction can be achieved using various practices, such as:

- Lightweighting (using less material)
- Use of recycled materials in production
- Substituting one material with another more environmentally preferable material
- By-product synergy.

By educating the community about the opportunities for avoiding unnecessary material waste, great energy and environmental benefits can occur. One way to do this is through the development of by-product synergy partnerships. By-product synergy occurs when one entity utilizes certain waste materials in their production practices that another entity typically discards. Therefore, a loop is formed and excess materials are prevented from entering the waste stream.

What about composting yard debris and food residuals? Another form of recycling is composting. Composting is the controlled biological decomposition of organic matter, such as food and yard wastes, into humus, a soil-like material. Composting is nature's way of recycling organic waste into new soil, which can be used in vegetable and flower gardens, landscaping, and many other applications. In 2006, data on U.S. Municipal Solid Waste generation indicate that of the 251 million tons of solid waste generated, 12.9% is yard waste and 12.4% is food residuals. A large portion of food waste is generated from food processing, pre- and post-consumer utilization, and institutional locations (i.e., hospitals, universities, etc.).

When yard waste and food residuals are composted rather than landfilled the amount of GHG emissions are reduced since composting is a biological process of decomposition which produces CO_2 both during the composting process and after the compost is added to the soil. Because this CO_2 is naturally-occurring and returns to the atmosphere through photosynthesis, it is not counted as a GHG in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks*.

EPA. 2005. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2003*, Environmental Protection Agency, Office of Policy, Planning and Evaluation, Washington, DC. EPA 430-R-05-003.

What Are Other Communities Doing to Curb Their Impact on Climate Change?

Data from **Georgia** shows that during 2004, 526,000 metric tons carbon dioxide equivalent (MCO_2e) were emitted as a consequence of landfilling, while 7.2 $MMCO_2e$ were prevented due to recycling activities.[5]

In **Florida**, two million British Thermal Units (BTUs) of energy were wasted in 2000 due to discarded packaging that could have been recycled. This amount of energy is equivalent to the gasoline required to keep over 446,000 cars on the road for a year.[10]

In **Kentucky**, the first recycling grant was awarded in June 2007 for a total of $2.3 million. With the influx of the recycling grants, rural areas in Kentucky that do not have recycling opportunities will have access to the funding needed to develop a recycling program to educate their citizens on the importance of recycling. Increased participation in recycling will inevitably serve to conserve energy and further reduce GHG emissions.[11]

In January 2008, the State of **North Carolina** banned the disposal of beverage containers by certain permit holders. Due to high demand for products made from recycled glass and ready markets both in the state and nearby, certain restaurant and bar establishments must ensure that valuable containers are not discarded. The ban will benefit glass, aluminum, and plastic suppliers. Not only will energy be saved by avoiding the extraction of raw materials for production, but the reduction of valuable commodities from the waste stream will prevent the release of GHGs into the atmosphere.[12]

In 2006, **Mississippi** recycled over nine million waste tires, representing the largest amount of tires ever processed in the state. All 82 counties in Mississippi offer waste tire collection centers for residents. The Rubber Manufacturers Association (RMA) ranked Mississippi 5th nationally in state performance for scrap tire programs in the 2005 Edition of *Scrap Tire Markets in the United States*.[13]

According to the Rubber Manufacturer's Association in their report, *US Scrap Tire Markets 2005*, **South Carolina is the No. 1 state for tire recycling in the country**. The 8 million tires that the state annually sends to recycling markets result in a GHG savings equivalent to removing 71,080 cars from the road. In addition to this accomplishment, the State set up *The Waste Tire Grant Program*. The program is funded by a $2 fee placed on new tires. Fifty cents of that fee goes to the DHEC (Department of Health, and Environmental Control) and is used for waste tire recycling grants for counties or local governments.

In 2006, **Americans** recycled 82 million tons of solid waste (32.5 percent of waste generated), providing an annual benefit of 49.7 $MMCO_2e$ of reduced emissions, or the equivalent to taking 39.4 million passenger cars off the road.[14]

Life Cycle Inventory: A study conducted by Oregon's DEQ to assess packaging options for shipping soft goods in e-commerce and catalog sales utilized a Life Cycle Inventory Analysis to evaluate natural resource use and environmental burdens from production to disposal for 26 different packaging options for non-breakable items. The study found that minimizing box size and total fiber content results in significant environmental savings.

How Can State and Local Governments Get Started With Waste Reduction?

States are developing and implementing a range of programs and strategies that are cost-effectively reducing GHGs, improving air quality, enhancing economic development, and creating jobs. Local governments across the United States are implementing energy efficiency and renewable energy actions that can have multiple benefits including saving money, creating jobs, promoting sustainable growth and reducing GHGs and air pollution. So, how do you get started?

- **Take an inventory of your waste.** To do this, reach out to representatives from EPA's numerous voluntary programs. One program, WasteWise, is a voluntary partnership between EPA and U.S. businesses, Federal, tribal, state and local governments, and institutions to prevent waste, recycle, and buy and manufacture products made with recycled materials. Presently, more than 1,900 partners are participating in the Waste Wise program. Visit www.epa.gov/wastewise/.

- **Identify potential waste prevention opportunities**. EPA and its partners have developed several tools to help individuals and organizations determine the GHG impact of their purchasing, manufacturing, and waste management actions and find opportunities for waste prevention. Several of these tools are based on EPA research on emission factors, as reported in *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks (3rd Edition)* and associated reports.[15]

  - *The ReCon Tool* calculates GHG emissions and energy consumption related to purchasing and/or manufacturing activities using analyses of baseline and alternative recycled-content scenarios. For example, the tool will allow the user to estimate the GHG emissions and energy benefits of purchasing office paper with 35 percent recycled content instead of 25 percent recycled content. Emissions and energy impacts are calculated using a life-cycle perspective (i.e., what impacts will this purchasing or manufacturing decision have on emissions and energy use associated with the manufacture and disposal of a given material).[16]

  - *The Waste Reduction Model (WARM)* is a user-friendly software tool that enables waste managers to compare GHG emissions from business-as-usual waste management practices with emissions from alternative strategies. WARM covers 17 types of materials and five waste management options: source reduction, recycling, combustion, composting, and landfilling. WARM also accounts for transportation distances to disposal and recycling facilities, carbon sequestration, and utility offsets that result from landfill gas collection and combustion. [17]

  - *The Durable Goods Calculator* estimates GHG emission and energy requirements in order to support voluntary GHG measurement and reporting initiatives, as well as to provide information regarding the GHG emission implications of waste management decisions. The Calculator estimates GHG emissions benefits in MCO_2e and energy savings in MMBtu for recycling, landfilling, and combustion of 14 typical durable goods.[18]

Every other week collection:

Although you may think that every other week collection of recycling saves energy by reducing fossil fuel combustion from trucks by 50 percent, the Oregon Department of Environmental Quality found that the consequences of this collection method actually outweighs the benefits. Less frequent collection leads to 9 to 20 percent fewer participants, fewer recyclables, and greater time for contamination of recycled materials.

- *The Office Carbon Calculator,* created for office-based organizations, estimates GHG emissions from a variety of sources including company-owned vehicle transportation, purchased electricity, waste disposal, as well as leased assets, franchises, and outsourced activities. It is not intended to address manufacturing operations or service-oriented businesses that use significant quantities of chemicals (e.g., cleaning services). This tool also includes examples of carbon-cutting actions such as recycling, waste prevention, and green power purchasing.[19]

- **Develop an Action Plan and Implement it**. Set goals and determine the top priorities for your community waste reduction program. Focus on communicating your goals and getting legislators on board.
  - Legislation in Action: When North Carolina identified a strong market demand for recycled plastics and noticed that 96 percent of plastic was recyclable, they passed legislation to ban disposal of beverage containers by businesses that serve alcohol for on-site consumption. NC House Bill 1518 will help ensure that beverage containers are put to good economic and environmental use.
  - Goals in Action: In 2003, Kentucky recycled approximately 6,000 tons of aluminum.[20] By setting goals to increase aluminum recycling to 10 percent more the following year, a total energy savings would occur that is equivalent to removing approximately 1,800 cars from the road. These savings are possible from increasing aluminum recycling alone.
  - Municipalities in Action: More than 160 municipalities in the United States have joined the Cities for Climate Protection (CCP) campaign run by Local Governments for Sustainability.[21] CCP members agree to inventory their GHG emissions, set a reduction target, write an action plan to reduce emissions, and implement the plan.
  - Yard Waste Landfill Bans: Georgia, Florida, South Carolina and North Carolina have all banned yard waste from their landfill operations. By banning yard waste, wood chips and other vegetative feedstock can be reused as mulch, fuel, or compost.

More EPA Region 4 Resources

EPA has developed the Region 4 ***Municipal Government Toolkit*** (MGTK) to help state and local leaders initiate and improve community recycling programs. Several other fact sheets and resources are available online. Addressing climate change is just one positive aspect of adopting efficient recycling programs. Recycling also plays a role in boosting local and state economies and adding jobs to the workforce. In addition to the economic benefits of recycling, recycling is an indicator of strong communities dedicated to sustainable growth. To learn more about how your community can reap the benefits of recycling, check out the MGTK online at:

http://www.epa.gov/region4/recycle

Follow the link to the Toolkit

Check out other EPA fact sheets from the Toolkit

Recycling: A Component of Strong Community Development

The Economics of Recycling in the Southeast: Understanding the Whole Picture

[1] http://usmayors.org/climateprotection/agreement.htm
[2] http://www.grrn.org/zerowaste/climate_change.html
[3] http://www.deq.state.or.us/lq/pubs/docs/sw/MaterialsOptions0601.pdf
[4] http://www.tennessee.gov/environment/swm/pdf/TFBottleBill4.pdf and Earth 911 http://earth911.org/energy/energy-costs-and-conservation-facts/
[5] Georgia Department of Community Affairs, *2005 Georgia Statewide Waste Characterization Study,* http://www.dca.state.ga.us/development/EnvironmentalManagement/publications/GeorgiaMSWCharacterizationStudy.pdf
[6] North Carolina's RE3.org, www.re3.org
[7] SP Newsprint, www.spnewsprint.com
[8] http://www.deq.state.ms.us/mdeq.nsf/pdf/SW_MDEQStatusReport030707/$File/MDEQ%20Status%20Report2.pdf?OpenElement
[9] North Carolina Recycling Business Assistance Center (RBAC), *Recycling Works* Newsletter, Fall 2007
[10] http://www.dep.state.fl.us/waste/categories/solid_waste/default.htm
[11] http://www.waste.ky.gov/
[12] http://www.p2pays.org/
[13] www.rma.org/publications/scrap_tires/index.cfm?PublicationID=11453
[14] http://www.epa.gov/msw/reduce.htm
[15] EPA. 2005. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2003*, Environmental Protection Agency, Office of Policy, Planning and Evaluation, Washington, DC. EPA 430-R-05-003.
[16] EPA's ReCon Tool http://www.epa.gov/climatechange/wycd/waste/calculators/ReCon_home.html
[17] EPA's WARM Model http://www.epa.gov/climatechange/wycd/waste/calculators/Warm_home.html
[18] EPA's Durable Goods Calculator http://www.epa.gov/climatechange/wycd/waste/calculators/DGC_home.html
[19] EPA's Office Carbon Calculator http://www.epa.gov/wastewise/carboncalc.htm
[20] http://www.waste.ky.gov/
[21] http://www.iclei.org