



**US** Composting  
Council

# USCC factsheet: Composting, Global Climate Change and Carbon Trading

As the debate over Global Climate Change shifts from “is it happening” to “what do we do about it”, composting, like all other waste management activities, is being reviewed through the greenhouse gas lens. However, in order to make fair comparisons, you have to compare different activities as both possible sources of greenhouse gases and as possible sinks. Composting would be beneficial if, when compared to alternatives, it either puts less greenhouse gases into the atmosphere (avoidance) or takes more CO<sub>2</sub> out of the atmosphere (sequestration). The net benefit can be turned in to cash through the sale of “carbon credits” on the emerging carbon trading market.

## How does composting impact greenhouse gas emissions?

Composting is predominately an aerobic process. During composting the natural breakdown of organic materials produces carbon dioxide and water. In some cases anaerobic conditions can develop in a compost pile. Without oxygen methane may be produced instead, along with a host of often odiferous compounds. In some situations with high nitrogen availability, nitrous oxide may also be produced instead of CO<sub>2</sub>. Both methane and nitrous oxide are potent greenhouse gases: compared to carbon dioxide, the “global warming potential” of methane is 23 times and nitrous oxide is 296 times worse. According to the US EPA, landfills emit about 6.3 million metric tons of methane (equivalent to 132 million metric tons of carbon dioxide) into the atmosphere. This represents 34% of all methane released and about 1.8% of the U.S. total annual anthropogenic<sup>1</sup> greenhouse gas emissions (EPA, 2007). Waste prevention and recycling (including composting) divert organic wastes from landfills, thereby reducing the methane released when these materials decompose. Estimates of landfill gas emissions are much higher in Europe, suggesting that controlling these emissions may lead to even greater GHG reductions.

Well-managed composting operations themselves produce very little methane or nitrous oxide but can emit greenhouse gases through the combustion of fossil fuel for vehicles and equipment and indirectly through the consumption of electricity generated at fossil fuel-burning power plants (EPA,

<sup>1</sup> Anthropogenic emissions are those greenhouse gases that come about through human activities, as opposed to biogenic emissions, that are part of the natural carbon cycle.

2006). Increased fuel use efficiency and the use of renewable fuels and energy can reduce these emissions.

To do a thorough job of examining composting, you have to take into account the different feedstocks (inputs) that might be composted and the use of the products (outputs) and compare them to the alternatives on a site-specific basis. New regulatory frameworks are developing that will provide comprehensive accounting of GHG sources and sinks; the most commonly proposed systems are called the carbon “cap-and-trade” programs.

## How does a cap-and-trade program work?

Cap-and-trade regulations limit the quantities of pollutants, in this case greenhouse gases, that entities can emit into the atmosphere, and can provide economic incentives for reducing emissions even further (below the cap). Regulated entities (for example, a coal burning power plant) can either reduce emissions from their own facilities, or can purchase “emission reductions” from other regulated entities that have reduced their emissions below their cap (and therefore have some left over). Emission reductions can also be created voluntarily by non-regulated entities (such as a compost facility) to be used by regulated entities to offset their own emissions (such as a power company).

The 1992 UN Framework Convention on Climate Change created the Kyoto Protocol, the basis for initial carbon cap-and-trade programs. While the US was not a signatory to Kyoto, the political climate is shifting dramatically. As of Mid 2007, there were 165 pieces of legislation introduced to the 110<sup>th</sup> Congress, of which at least were related to cap-and-trade programs (Pew, 2007). The primary instrument being traded in these programs are “carbon credits”

## What are carbon credits?

The terms “carbon credits” or “carbon offsets” can mean different things to different people, but usually they refer to certified, tradable greenhouse gas emission reductions used within a cap-and-trade program. Reducing emissions doesn’t automatically create carbon credits – they result from a formal process or “protocol” that quantifies, verifies, and certifies qualifying emission reductions from eligible projects. Credible carbon credits represent real, permanent, quantifiable, verifiable, and enforceable emission reductions. Often carbon credits are formally issued or registered by a carbon “registry” or exchange to facilitate market trading and ensure that the same credits are not sold more than once. Carbon credits are usually quantified in units of metric tons of carbon dioxide equivalents.

## Is there a market for carbon credits?

From 2005 to 2006 the value of the total world market of carbon credits tripled (figure 1). In 2006, over one billion tons of credits, with a market value of about \$20 billion, were traded through the European Trading System (by countries that have adopted the Kyoto Protocol) (Capoor and Ambrosi, 2007). In the U.S., which is not participating in the Kyoto cap-and-trade system, the market is much smaller, but still significant: in 2006 over 10 million tons of carbon traded on the Chicago

Climate Exchange (CCX) with a value of over \$40 million. Since 2003 CCX prices have ranged from less than a dollar per metric ton to almost \$5. In 2007 the U.S. carbon credit market is expected to surpass \$100 million. Due to international agreements and action on climate change, the carbon market is one of the fastest growing markets for financial commodities.

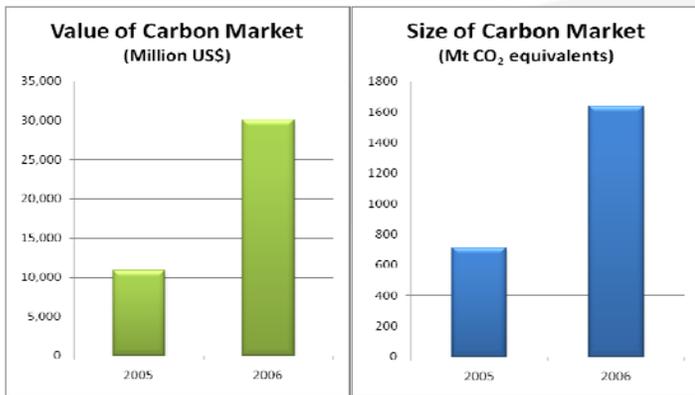


Figure 1. Growth of carbon market (Source: Capoor and Ambrosi 2007)

## Could I get carbon credits for composting?

Carbon credits are intended to provide financial incentives to reduce emissions over and above “business as usual”. New facilities, facility expansions, and new programs designed to accept new or increased volumes of certain feedstocks may be eligible. The types of feedstocks, and where they were going before the new composting project, are also important since credits are only valid where real emission reductions (relative to a baseline scenario) occur. In other words, you don’t get credit just for composting, but for composting those feedstocks that would otherwise be emitting methane or nitrous oxide into the atmosphere. Formal protocols for quantifying compost-related emission reductions have been developed by the Intergovernmental Panel on Climate Change (IPCC) and are already being used for offset projects within the Kyoto Protocol framework. In the U.S., protocols for the Chicago Climate Exchange and other programs are being developed.

## How would it work?

A recent study by the City of Portland, Oregon’s Office of Sustainable Development can provide data to illustrate how a facility might gain carbon credits through composting (Visse, 2004). The City would like to divert 40-60% of the 37,000 tons of food waste that it sends to a landfill each year. The landfill is 151 miles away, and the compost facility is 8 miles further.

Let’s assume that the compost facility is already processing 100,000 tons per year and has sufficient bulking agents (brush and crop residues) to accept whatever tonnage of food waste gets diverted. To figure out what their credits would be we add up their emissions reductions and emission increases and if the reductions exceed the increases they could earn or sell the credit for that emission reductions. Since the bulking agents were already being composted, they can get no credits for that. Also, the carbon released in composting is part of the

short-term carbon cycle, so not considered in greenhouse gas computations.

## Emission reductions:

The source of the reduction in this situation is the methane avoidance that will be achieved by NOT sending those food scraps to the landfill. Of course, not all the methane that those food scraps might produce would escape into the atmosphere; some of it will be captured by the landfill’s gas collection system. Portland’s report noted that while the manufacturers and operators of the landfill gas collection system claimed a 70-75% methane recovery, actual measurements at the landfill yielded collection rates of only 23-26%. At a 75% capture rate the GHG reduction was calculated to be 1 ton CO<sub>2</sub>E (carbon dioxide equivalents) per ton of food waste, whereas at 26% the reduction was only .45 tons CO<sub>2</sub>E.

In a landfill, food can produce the equivalent of 12 metric tons (mT) of CO<sub>2</sub> for every dry metric ton of waste (Eleazer et al, 1997). Since food scraps are roughly 80% moisture, that equals about 2.6 tons on a wet weight basis. In addition, not all the carbon gets converted to methane, since a significant portion stays buried and is counted as sequestration, reducing the net emissions.

If the protocol that was being used to calculate carbon credits averaged those collection efficiencies, that would mean .72 tons CO<sub>2</sub>E per ton of food waste diverted. If Portland achieved the low end of their diversion goal, 40%, that would divert 14,800 wet tons of food waste which would equal 10,656 tons of carbon. At the 2008 rate of \$3.50/carbon credit, that could be worth \$37,296 for the methane avoidance.

Other feedstocks might be available to the compost facility that could also earn carbon credits. For example, dairy or swine manure stored in lagoons can produce significant amounts of methane. Table 1 shows some typical feedstocks and the carbon avoidance they may qualify for. Note that these are

Feedstock	Yield		Time
	L CH <sub>4</sub> kg <sup>-1</sup>	Mg CO <sub>2</sub> /Mg waste	Days
Grass	144.4	2.37	50
Leaves	30.6	0.5	100
Branch	62.6	1.03	100
Food	300.7	4.94	120
Coated paper	84.4	1.39	150
Old newsprint	74.33	1.22	300
Corrugated containers	152.3	2.5	400
Office paper	217.3	3.57	500

Table 1. GHG production from selected feedstocks (source: Sally Brown, pers. comm.)

given per dry ton, not wet ton. Ultimately each case will have to be calculated and certified individually.<sup>2</sup>

## Emissions from composting

GHG emissions from the composting facility need to be calculated and subtracted from the emissions avoided calculated above. Emissions may come from the composting process itself and from the equipment used to manage the process. Carbon dioxide released during composting is considered biogenic, so does not count in GHG calculations. While it is theoretically possible for methane to be generated in a poorly managed compost pile, the EPA has concluded that there is little evidence that this actually happens, so considers any releases negligible (EPA 2002)

On the other hand, the fuel and electricity used to operate the equipment and buildings result in anthropogenic releases. The EPA estimated that diesel use at compost facilities result in the release of 35 pounds of CO<sub>2</sub> per wet ton of processed feedstocks. Using this figure, the 14,800 tons of food waste potentially diverted from Portland would therefore result in 259 tons of CO<sub>2</sub> being emitted. This tonnage would be subtracted from the net benefit of the avoided emissions. In reality, the actual use would have to be documented and verified. For example, a study by the Recycled Organics Unit in Australia estimated the release of about 30 pounds of CO<sub>2</sub> per ton of garden residuals windrowed from fuel use, and only an additional .6 pounds per ton from electricity (ROU, 2003). A facility that used an in-vessel system with forced aeration and biofiltration would be a very different picture.

## Compost Use

Additional credits could be available from the compost use. Those 14,800 tons of food scraps might result in 2100 tons of finished compost (wet weight at 30% moisture). The EPA estimated that .05 metric tons of carbon equivalent per wet ton of finished compost is sequestered after 10 years. That would add an additional 105 tons of credit to the methane avoidance credit. The ROU study noted that this is a conservative estimate, as it does not include multiplier effects that might accrue from increased yield due to higher organic matter content.

In the Life Cycle Analysis performed by the Recycled Organics Unit, the reduction in crop inputs such as fertilizer, herbicides and irrigation water coupled with the carbon sequestration more than made up for the emissions stemming from compost production and production transportation. They concluded that there is a net reduction in Global Warming Potential from the windrow composting of yard debris. This was true even if the compost was transported over 400 miles and the trucks returned empty.

<sup>2</sup> A note on transportation: In the Portland study, the difference in hauling the food waste to the landfill (151 miles) and the compost facility (159 miles) made a negligible difference in CO<sub>2</sub> emissions. Often that is not the case, and compost facilities are much closer to the point of collection than the landfill. If that were the situation, than the difference in transportation would no longer be insignificant, though still very small compared to the effect of methane avoidance.

## Getting those credits...

As can be seen in this example, the primary benefit of composting from a climate change perspective is in the avoidance of methane generation. Sending organics to an anaerobic digester for methane production and use as energy would likewise avoid the greenhouse gas release with the additional benefits of replacing non-renewable energy. Some additional credits may come from the use of compost, via carbon sequestration and via reduction of GHGs by displacing other inputs.

The specific benefits of any composting venture will have to be figured on a case-by-case basis. For more help in determining your potential carbon credits, you can contact:

- ④ Chicago Climate Exchange (CCX)  
The CCX provides an integrated trading system to reduce greenhouse gas emissions with worldwide offset projects [www.chicagoclimatex.com](http://www.chicagoclimatex.com), (312) 554-3350
- ④ Environmental Credit Corp (ECC)  
USCC member ECC is a "leading supplier of high quality environmental credits" [www.envcc.com](http://www.envcc.com), (607) 288-4020

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**About the USCC:** The United States Composting Council (USCC) is a national not-for-profit organization dedicated to the development, expansion and promotion of the composting industry. For more information visit [www.compostingcouncil.org](http://www.compostingcouncil.org)

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