White Paper:
Greenhouse Gas Offsets from Recycling

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Executive Summary

Greenhouse gas (GHG) emissions offsets trading is receiving increased attention with a number of regional and state programs under development, as well as Congressional consideration of the Lieberman-Warner bill that would establish a national GHG cap and trade program. While recycling is widely viewed as an important means of reducing GHG emissions, recycling activities are not being considered as a source of tradable offsets in any of the developing or proposed trading programs. In fact, recycling faces some unique challenges from an offsets perspective including: difficulty in proving "additionality;" difficulty in avoiding double-counting of GHG reduction benefits; and difficulty in measuring reductions and assigning offset credits among all the recycling parties.

Policymakers widely agree that recycling is an important tool for reducing GHG emissions. Life-cycle analysis shows that increased recycling provides greenhouse gas benefits in several ways. Paper recycling reduces harvesting of trees for virgin paper production, and so provides carbon sequestration benefits. Recycling and remanufacturing of aluminum, steel, glass, and plastics reduces energy consumption (both direct fossil fuel combustion and electricity use), as energy needs are lower for remanufacturing with recycled materials versus virgin inputs. Recycling can also reduce non-energy CO_2 emissions from industrial processes. Of the recyclable waste streams, aluminum cans have the highest GHG benefits followed by paper, and then by plastics, steel cans, and personal computers. Translating these recognized benefits into a protocol for awarding credits to recycling activities or projects, however, can pose difficult policy and accounting problems.

Protocols for offsets used for compliance purposes under a regulatory cap and trade program tend to be more stringent in terms of project eligibility criteria, and verification, registration and tracking requirements than the offsets requirements for voluntary trading programs. Three, key issues that will arise in developing a protocol for measuring emissions reductions from recycling are:

- **Determining additionality**—Emission reductions must be demonstrated to be additional, i.e., represent recycling actions that would not have otherwise taken place, had it not been for the financial incentive provided by selling the offset. Meeting additionality requirements can be a difficult hurdle for existing recycling mills, recycled steel or aluminum plants, as they've been operational prior to the existence of GHG offsets, or for recycling programs that are operating under state or local recycling mandates or requirements.
- **Measurement**—Some aspects of the life cycle GHG emissions for recycling are difficult to measure. There is, for example, scientific uncertainty about measuring the GHG benefits associated with soil carbon from application of compost, which is part of the life cycle benefits of composting food wastes. Other aspects, such as the portions of emissions that occur within US boundaries (due to imports and exports of raw and recycled materials), can also be difficult to determine. Equally complicated from an accounting and political standpoint, is apportioning offset credits among all the parties associated with recycling, from generators, collectors and processors to final remanufacturers.
- **Double counting**— In a regulatory, emissions cap and trading system, eligibility criteria for offsets are more stringent to ensure offsets do not erode the GHG benefits of the trading system, i.e., undermine the integrity of the emissions cap. If the actions to reduce emissions, which are undertaken as part of the offsetting activity, actually reduce emissions from a source(s) covered by the regulatory cap and trading system, then offsets that are generated and sold will effectively increase the allowance cap of the system. This is sometimes referred to as the problem of "double counting." This problem affects recycling activities when the regulatory cap system covers electricity generation. In that case, double counting will be an issue for recycled materials for which the primary greenhouse gas reduction benefit occurs due to reduced

consumption of electricity purchased from the grid. Many of the GHG benefits of recycling—particularly for metals, paper, plastics and glass—represent savings due to reduced electricity consumption. If power plants are included in cap and trade systems, this reduced electricity consumption will already have been accounted for within the regulatory cap, and offsets will not be able to be awarded or sold without double counting of reductions from occurring. **Because the state, regional and federal cap & trade programs under development all envision capping electric utilities, this is the one of the most significant barriers to the development of a recycling offsets market**.

It is important to note that production of renewable energy, either at waste-to-energy plants or landfill gas-to-energy projects, faces the same double counting issue under a mandatory system that caps electric utility emissions. Because the GHG benefits associated with renewable energy production represent the replacement of fossil fuel generated electricity with renewable electricity generation, power plants under a capped system would have already accounted for this reduced electricity consumption. Therefore, renewable energy projects will in all likelihood not be eligible to receive GHG emission offsets. **Such projects will still be able to sell renewable energy certificates (RECs) under state renewable portfolio standards (RPS) programs, as these regulations operate apart from the GHG cap and trade systems.**

While recycling offsets do not appear to be viable, particularly under a mandatory cap system that includes electric utilities, other public policies that promote recycling are viable and should be encouraged. For example, the current version of the Lieberman-Warner bill includes a provision that allows states to use a portion of the revenues generated through the sale of emissions allowances to be used to promote and enhance recycling programs. Additionally, capped utilities will be seeking to encourage downstream power consumers to reduce their electricity consumption, offering potential opportunities to partner with recycling and renewable energy businesses.

1 Introduction

Greenhouse gas (GHG) emissions trading is gaining traction in the US, with a number of regional and state programs being developed, and the Lieberman-Warner bill in Congress representing efforts to develop a national program. Increased recycling can make important contributions to reducing GHG emissions, but is not being considered as an offset in any of the developing or proposed trading programs.

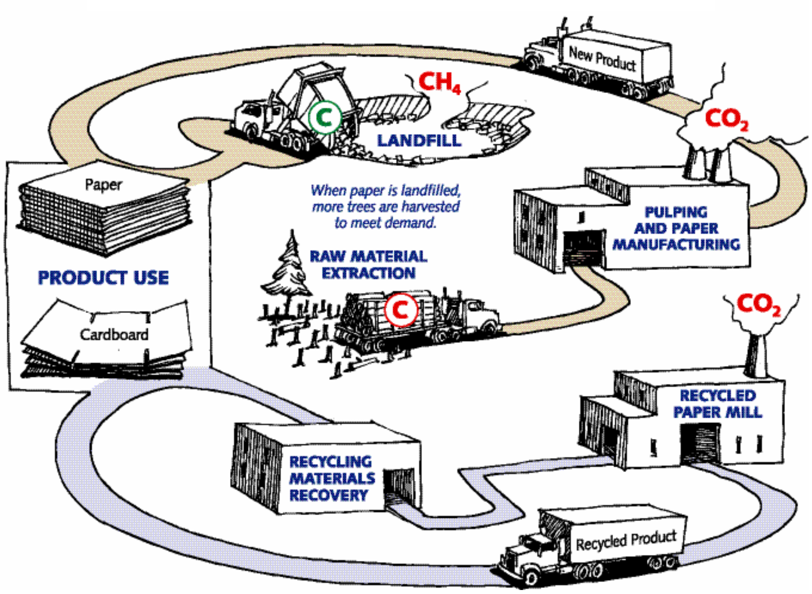
Incorporating recycling into an emissions trading program—potentially via offsets—would provide incentives for additional recycling and GHG emission reductions. However, incorporating recycling offsets or credits into a trading system faces a number of challenges. These challenges arise largely from the complexity of the life cycle emissions pathways and the linkages between the solid waste stream and a variety of product markets. Federal and state regulations that mandate some of the emissions reductions associated with recycling further complicate the issue. This white paper lays out the basic issues in developing an offset system for recycling.

2 The Potential for Emission Reductions from Solid Waste Management

Diverting solid waste from disposal has the potential to measurably reduce US greenhouse gas emissions. In its 2006 report, *Solid Waste Management and Greenhouse Gases*, EPA estimated that if the United States attains a 35 percent recycling rate in 2008, emissions would be nearly 59 million metric tons of carbon equivalent (MTCE) per year lower than if <u>no</u> recycling took place. This amount is roughly 3 percent of US estimated net emissions reported in the most recent US greenhouse gas inventory,[1] and equivalent to about half of the total estimated greenhouse emissions from all sources of methane emissions. National recycling/composting rates for 2006 were estimated at about 33 percent,[2] and considerable potential exists to increase recycling and reduce GHG emissions.

Increased recycling of products, such as paper, metals, and plastics provides greenhouse gas benefits in several ways. As illustrated in Figure 1, recycling paper reduces the amount of organic material placed in landfills, and thus reduces the amount of methane that is generated from the decomposition of waste. Paper recycling also reduces forest harvest for virgin paper production, and so increases the average age (and tree size) of the forested land, providing carbon sequestration benefits. Recycling and remanufacturing of aluminum, steel, and plastics reduces energy consumption (and associated emissions from fossil fuel combustion), which is lower for recycled material acquisition and manufacturing than corresponding processes with virgin inputs. Finally, recycling can reduce non-energy CO_2 emissions from industrial processes.[3] Figure 2 illustrates the

Figure 1. GHG Emissions and Sinks for Paper: Life Cycles for Landfilling vs. Recycling

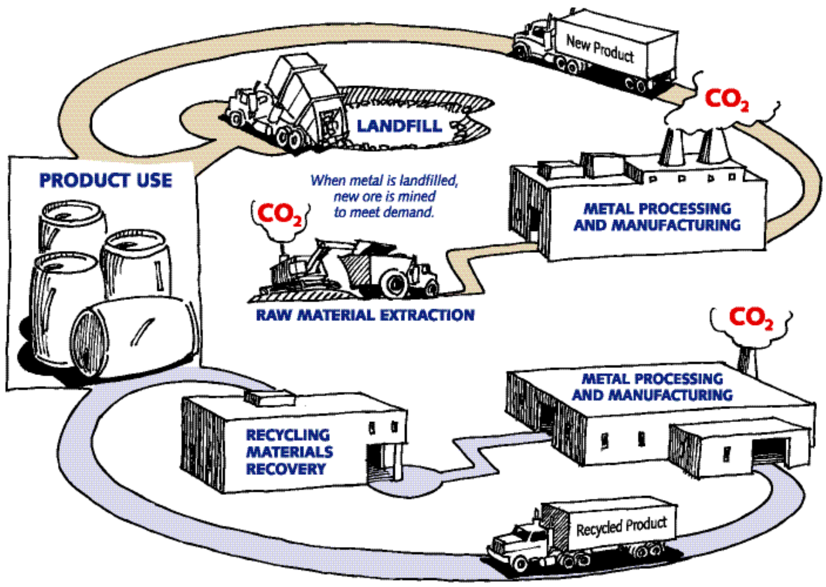


Source: Environment Canada

life cycle emissions associated with metals.

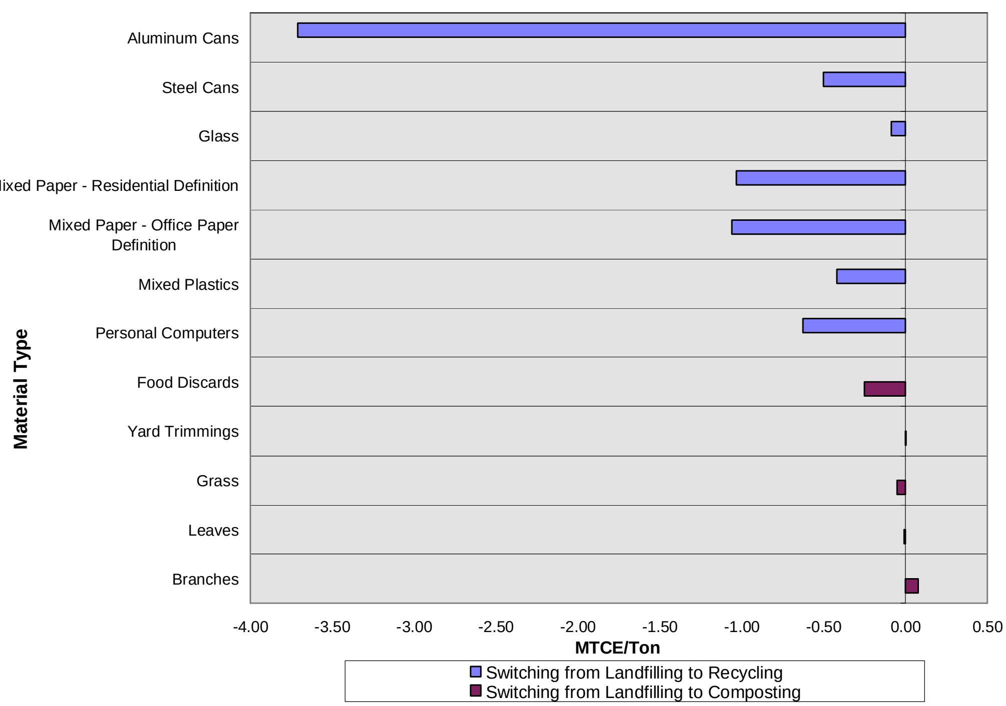
For all recyclable materials, relative to landfilling, recycling reduces GHG emissions, as indicated in Figure 3, which presents the net life cycle GHG reductions per ton of selected materials that are recycled or composted rather than landfilled.[4] On a per ton basis, savings from aluminum and mixed paper are greatest, reducing well over 1 MTCE per ton of material that is diverted from a baseline practice of landfilling.[5] In turn, the GHG reductions that result from increased recycling of aluminum and paper arise primarily from reduced CO_2 emissions associated with lower energy consumption and increased carbon sequestration in forests.

Figure 2. GHG Emissions for Metals Life Cycles for Landfilling vs. Recycling



Source: Environment Canada

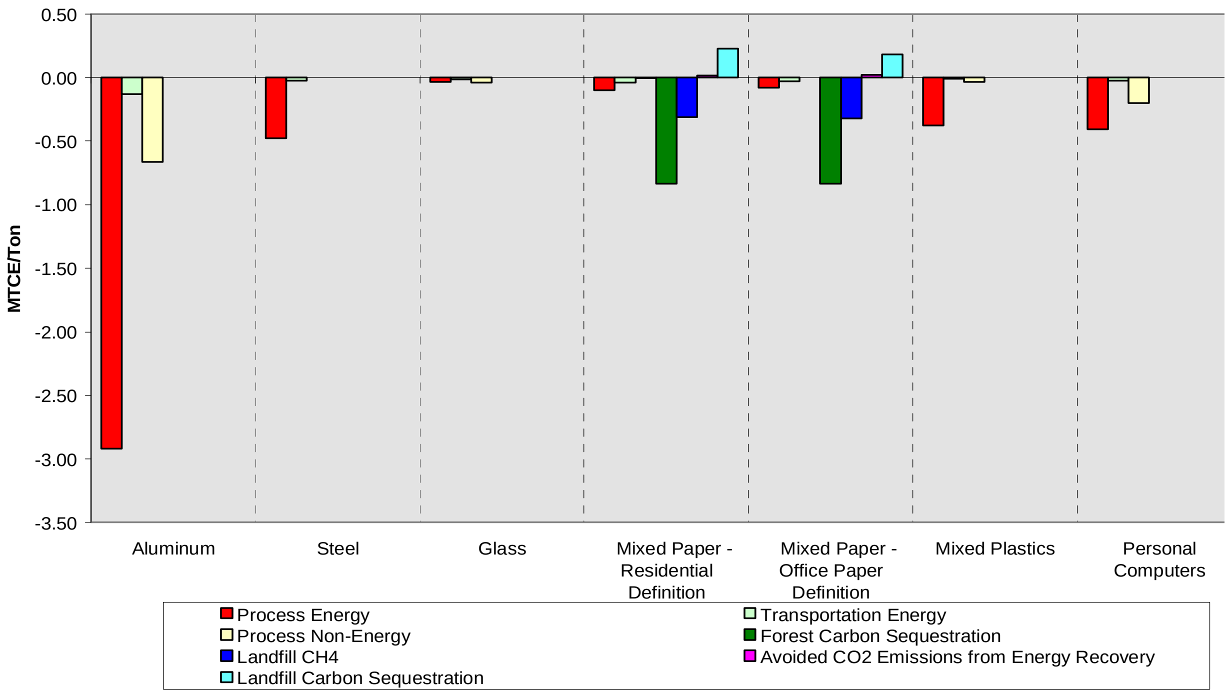
Figure 3. Net Changes in Emissions Factors from Changing from Landfilling to Recycling or Composting (MTCE/ton)



Source for data in figure: *Solid Waste Management and Greenhouse Gases: A Life Cycle Assessment of Emissions and Sinks*. Report developed by ICF International for EPA.

Figures 4 and 5 break down the life cycle emissions impacts of diverting waste from landfills into several categories, including the energy-related emissions associated with transportation and processing, the methane emissions associated with landfilling, and the forest carbon sequestration benefits. As illustrated in Figure 4, for aluminum and steel, the primary source of GHG reductions is the emissions avoided due to reduced process energy, in the form of electricity. For recycled paper, the primary GHG reductions come from increased storage of carbon in forests, due to reduced harvesting as a result of lower demand for primary paper.[6] As illustrated in Figures 3 and 5, composting yard trimmings results in no net change or a very small net increase in GHG emissions overall, although the net effect of composting two components—grass and leaves—is to reduce emissions.[7] While, the primary GHG benefit of composting yard trimmings is decreased landfill methane emissions and increased soil carbon sequestration; these are largely (or in some cases more than) offset by reduced long-term carbon sequestration in landfills.

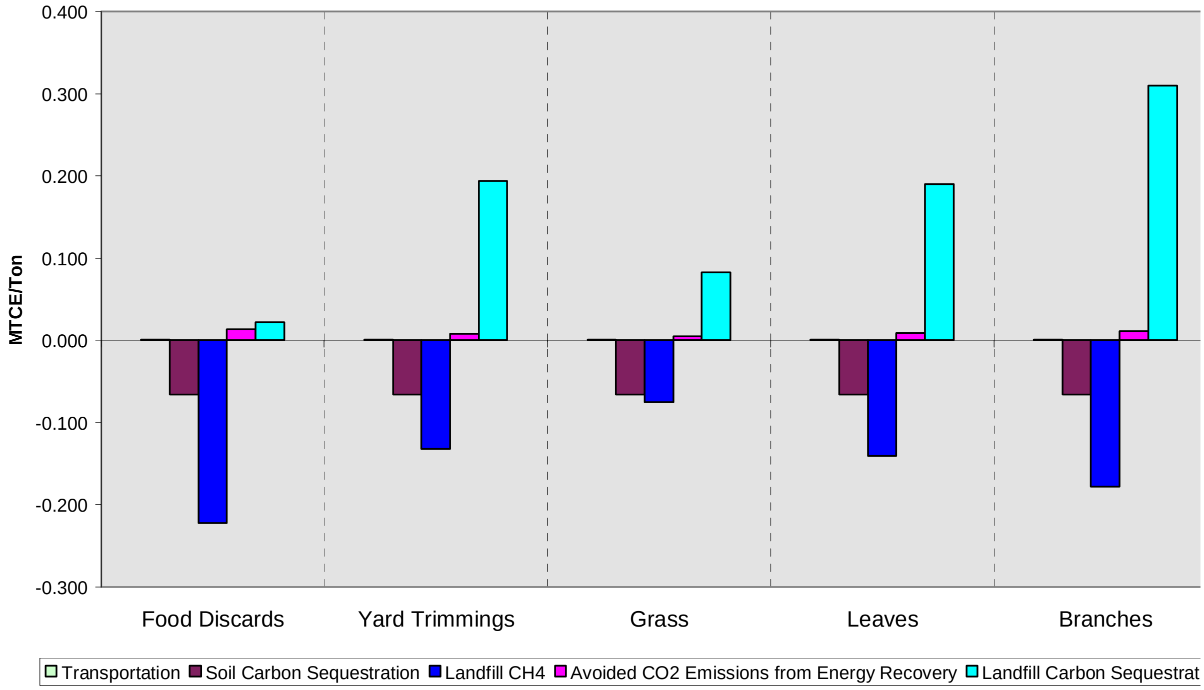
Figure 4. Life Cycle Emission Factor Components (MTCE/Ton)
(Switch from Landfilling to Recycling)



Source for data in figure: *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*. Report developed by ICF for US EPA.

While recycling and composting are occurring throughout the US, not all potential opportunities have been exploited. Expanding these activities would generate both greenhouse gas and other environmental benefits. Given the potential significance of improved waste management as a GHG mitigation option, and the growth in emissions trading as a vehicle for reducing emissions in the US, it is important to assess the viability of including waste management as offsets in the mandatory trading systems being developed, as well as in the existing and expanding voluntary markets for emissions reductions.

**Figure 5: Life Cycle Emission Factor Components (MTCE/Ton)
(Switch from Landfilling to Composting)**



Source for data in figure: *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*. Report developed by ICF for US EPA.

3 Compliance and Voluntary Markets for Offsets

An offset is a set of activities[8] that reduces greenhouse gases and is undertaken voluntarily, i.e., is not required for compliance with existing federal, state, or local regulations. Thus, all offset programs are voluntary, in the sense that emission reductions undertaken by participating entities are discretionary. There are two types of markets in which offsets can be bought and sold—the compliance market and the voluntary market. The compliance market serves buyers that must meet regulatory requirements implemented through existing GHG trading systems. The voluntary market serves buyers that are purchasing offsets either to meet voluntary targets or to enhance their reputation and standing with the general public, investors, customers, and employees.

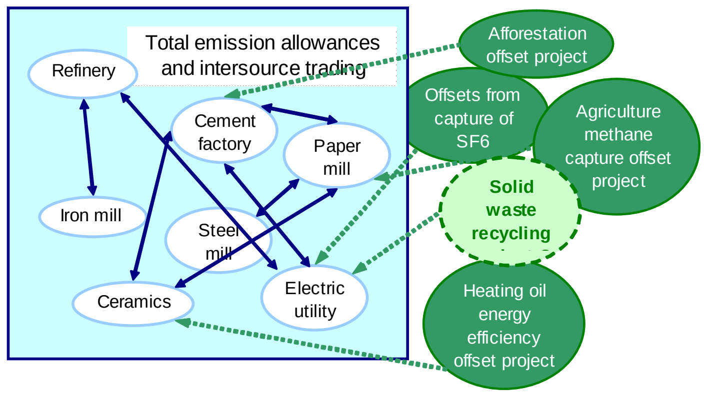
Purchases of offsets allow business, governments, NGOs, and individuals to offset—counteract the effects of—their emissions. An offset project can participate in either the compliance market or the voluntary market (although compliance offsets tend to be more expensive than those sold in the voluntary market). However the standards and protocols that the project must meet, and the requirements for verifying, registering, and tracking the offset will be different depending on the purpose for which it is being purchased. In general, the standards for offsets intended to be used for compliance purposes are stricter than those for the voluntary market. This is because offsets under compliance markets must generate the same degree of confidence that "a ton is a ton" that measured emissions from smokestacks have. Increasingly, many of the certifying authorities participating in the voluntary market require high standards as well.

Existing carbon offsetting programs range from those connected to compliance schemes, such as the Clean Development Mechanism of the Kyoto Protocol, to voluntary programs, such as the Chicago

Climate Exchange. The regional and state emissions trading programs being developed in the US, such as the Regional Greenhouse Gas Initiative (RGGI), the Western Climate Initiative (WCI), and California's AB-32, are either developing or considering including provisions for offsets. Similarly, S. 2191, introduced by Senators Lieberman and Warner as *America's Climate Security Act of 2007*, includes provisions for offset allowances that can be used for compliance purposes. These emissions trading systems differ in the types of offsets projects that will be eligible, and in the types of requirements they plan to impose on offsets.[9] Voluntary offset markets, in contrast, operate outside the compliance market.

Under a cap-and-trade system, aggregate emissions from covered sources are "capped" by limiting the total number of allowances that are created by the system. Individual sources that are included in the system have the choice of reducing emissions or purchasing allowances equal to their emissions. Cap-and-trade systems also generally allow for covered sources to offset their emissions using credits, or *offsets*, generated by emission reductions from a project implemented outside the umbrella of the cap-and-trade, i.e., by a source that is not covered by the cap (see Figure 6, which depicts interactions between emissions trading and offsets).

Figure 6. Illustration of potential trading paths inside and outside an emissions trading system



Note: Blue solid arrows represent trading within the system, i.e., among emissions sources covered by emissions trading.
Green dotted arrows represent trading between offset owners/sellers and purchasers within the trading system.

Including offsets in a cap and trade system is a way of providing covered entities with lower cost emission reductions thereby lowering the cost of complying with the emissions cap. The use of offsets allows capped entities to emit above the level of the cap, but then offset those relatively increased emissions with purchased offsets. Consequently, the offsets generated and sold into an emissions trading system do not themselves reduce total (i.e., including emissions both inside and outside the capped system) emissions. In contrast, when emission offsets are part of a purely voluntary program (i.e., are not undertaken for compliance purposes), the availability of offsets in the voluntary market is more likely to lead to additional emissions reductions that would not have happened without the availability of the offsets.

The emission reductions associated with offsets are generally more difficult to measure than emission reductions made as part of a regulatory program, such as cap and trade. Offsets are, thus, generally viewed as less certain than emissions reductions those associated with the cap and trade system. Consequently, some cap and trade systems, such as those of countries participating in the Emissions Trading System of the European Union (EU ETS), limit the portion of emission offsets that can be used to comply with regulatory limits, and most systems limit the types of projects or source categories from which offsets can be generated. Some also "discount" the offsets to account for potential leakage or uncertainty (these issues are all discussed in more detail below).

4 The Requirements of Offset Protocols

Whether part of a compliance market or a voluntary market, offset systems are designed to meet certain quality standards. Each system, to a greater or lesser extent, includes protocols and requirements designed to promote "high quality" offsets and that the emissions reductions being sold have actually been generated. Three types of standards are generally identified as critical to ensuring the quality of an offset.[10]

- Accounting standards—to ensure that offsets are "real, additional, and permanent"
- Monitoring, verification, and certification standards—to ensure that offsets projects perform as predicted during project design
- Registration and enforcement systems—to ensure that offsets are sold only once, and clarify ownership and enable trading of offsets

The existing mandatory and voluntary systems differ in how they have addressed these standards and, hence, the stringency of the system. Thus, there is considerable uncertainty regarding the types of standards that a recycling offset might be expected to meet—not only across the existing voluntary and compliance markets, but also over time, as systems such as RGGI evolve and develop standards and protocols. However, although stringency differs, nearly all the various systems include elements that address all three of these types of standards. They do this by including methodologies for estimating emissions and protocols for determining criteria such as "additionality" (see below), by defining the types of projects that are eligible to be offsets, by specifying requirements for third party verification, and by developing registration systems and other features of the system.

From the perspective of whether and how waste diversion actions/projects could participate in a compliance or voluntary market, the accounting standards are most important. Accounting standards are designed to ensure that the emission reductions being generated and sold are "real, additional, and permanent."[11] In particular, the reductions must be "real"—i.e., representing identifiable and measurable changes in emissions. Offsets must also demonstrate that the project actions would not have otherwise occurred (i.e., are additional) so that credits are not being given for actions that would have occurred anyway. Finally, the emission reductions must be permanent (i.e., actions other than those in the project do not erode the environmental benefits of the actions).

Standards designed to ensure the quality of offsets are necessary because the total number of offsets or credits generated is not capped in the way that the number of allowances (and therefore total emissions) is limited in a cap and trade system.[12] Thus, if an entity that is covered by an allowance cap is allowed to purchase credits that do not meet adequate standards, the credits will not represent legitimate reductions, but will nonetheless allow the purchaser to increase emissions. Consequently, aggregate emissions will rise, despite the presence of the cap in the allowance trading system. Table 1 summarizes the discussion in Section 4 of the issues for each material that are imposed by the requirements of accounting standards.

Table 1. Key Accounting Issues in Offsets for Recycling or Composting

	Primary **sources of GHG effects of recycling or composting**	**Key Accounting Challenges**
Metals—Aluminum	Reduced energy consumption & CO_2 emissions Reduced emissions of other GHGs during manufacturing	Double-counting if trading system covers electricity generation Determination of additionality of recycling activities National vs. site-specific emission factors for electricity
Metals—Steel	Reduced energy consumption & CO_2 emissions	Double-counting if trading system covers electricity generation Determination of additionality of recycling activities National vs. site-specific emission factors for electricity
Plastic	Reduced energy consumption & CO_2 emissions	Double-counting if trading system covers electricity generation Determination of additionality of recycling activities National vs. site-specific emission factors for electricity
Glass	Reduced energy consumption & CO_2 emissions[†] Avoided emissions of other GHGs during manufacturing[†]	Double-counting if trading system covers electricity generation Determination of additionality of recycling activities National vs. site-specific emission factors for electricity
Paper	Reduced landfill CH_4 emissions Increased forest carbon Losses due to reduce landfill carbon storage	Methane recovery systems reduce benefits Regulations governing landfills Uncertainty in measuring landfill carbon storage Determination of additionality of recycling activities Timing of emissions & storage National vs. site-specific emission factors for landfills & forests
Yard trimmings	Reduced landfill CH_4 emissions *Losses* due to reduce landfill carbon storage	Methane recovery systems reduce benefits Uncertainty in measuring landfill carbon storage Timing of emissions & storage National vs. site-specific emission factors for landfills Determining additionality of composting
Food waste	Reduced landfill CH_4 emissions *Losses* due to reduce landfill carbon storage	Methane recovery systems reduce benefits Uncertainty in measuring landfill carbon storage Timing of emissions & storage National vs. site-specific emission factors for landfills Determining additionality of composting
Electronics	Reduced energy consumption & CO_2 emissions Reduced emissions of other GHGs during manufacturing	Double-counting if trading system covers electricity generation Determination of additionality of recycling activities National vs. site-specific emission factors for electricity

4.1 Additionality Determinations and Baselines

The topic of additionality is the most contentious—and arguably even the most important—in discussions of the integrity of an offsets or credit scheme. A project is deemed "additional" if the actions that occur as part of the project are undertaken *because* of the project and the potential to sell the emissions reductions. If these actions are not truly additional, then offsets will be bought from a project owner who would have reduced emissions anyway, even in the absence of the payment for credits. In such a case, emissions will not be reduced by the offset sale, but the sale merely subsidizes actions that would have occurred anyway.

The two approaches to additionality testing that are commonly used are project-based additionality testing and performance standards. Project-based additionality testing evaluates each individual project on a case-by-case basis, using a number of tests:

- *Regulatory test*—whether the actions undertaken as part of the project are required by regulations or industry standards, implying that the project is not additional.
- *Investment or financial test*—whether the project is "profitable" and so would have been undertaken without the additional financial incentive provided by the sale of the offset (implying that the project is not additional)
- *Barriers test*—whether there are barriers to reducing emissions that are overcome by the project and so the project is considered additional
- *Common practice test*—whether the project employs technologies that are commonly used and so might not be additional or, alternatively, goes beyond those practices and so would be considered additional.[13]

The determination of project-based additionality not only is resource intensive in its application (requiring a review of each individual project), but also can be quite subjective in outcome. For example, financial additionality may not be a simple test of profitability, since projects that are profitable may not be undertaken for other reasons, including information failures or other market barriers. Further, financial viability is difficult to determine and will be unique to each company, since acceptable internal rates of return will vary.

Because of the difficulty with project-based additionality tests, some systems also use a standardized approach, sometimes referred to as a performance standard or benchmarking approach. The standardized approach does not rely on examining each individual project, but establishes a threshold for technologies or processes to determine additionality. The typical application of this approach is to technologies rather than project activities. Once a standard has been determined, any project that exceeds the standard is deemed additional. The RGGI program is pursuing a benchmark/performance standard approach to additionality. [14] For example, performance standards might require that a project exceed a technology standard expressed in terms of emission rates, energy efficiency criteria, or even market penetration rates. The Australian Greenhouse Friendly™ initiative actually allows a financial benchmark test; demonstration of additionality in this case requires comparing an appropriate financial indicator (such as NPV, IRR, etc.) against an objective benchmark (such as government bond rates, or commercial lending rates) that represents a threshold below which a project of the type proposed ceases to be financial attractive.[15]

Implementing the standardized approach for technology requires conducting a detailed review of industry practices to determine appropriate standards and updating them over time to reflect changing conditions. It works best when technologies are associated with relatively well-known emission rates, and where common practice can be determined reliability. It works poorly when standards are so broad and simplified that an unacceptably large number of projects that are non-additional may fall within the standard.[16] In general, no single approach is thought to be appropriate for all project-types or circumstances. Consequently, currently proposed legislation and programs are dealing with additionality in different ways.

The concepts of additionality and baseline are strongly interrelated. Determining the extent of additionality requires devising a baseline of activities and emissions. The emissions baseline, which is sometimes referred to as a reference case, represents a projection of emissions activity in the absence of the project activity for which credits or offsets are being awarded. The amount of credit that is awarded the project is calculated as the difference between actual emissions and baseline emissions. Developing a baseline is difficult because it requires resolving a counterfactual question: What would have happened in the absence of a specific project? Moreover, because it is hypothetical, the baseline can never be established with certainty. Like additionality, baselines can be defined using project-based or performance-based approaches. The method for calculating baselines will be a critical piece of determining which projects show positive emission reductions, i.e., which projects are considered to be additional.

Developing baselines and showing additionality based on financial criteria, or even performance standards, may be difficult for some (but not all) waste diversion projects. Some materials, such as aluminum and steel, have a long history of recycling, indicating that in many circumstances it can profitable to collect and recycle these materials. Further, overall rates of recycling have been rising steadily for municipal solid waste, suggesting that the near term trend is continuing upwards, again making incremental changes difficult to identify as additional.

Demonstrating additionality may require very material-specific and perhaps region specific data indicating the existence of barriers to recycling (and how they may be overcome), citing current trends, calculating subsidies, and otherwise indicating the importance of financial incentives to the project based on market characteristics. For some materials, recycling rates have been constant or even declining in recent years, suggesting that most cost-effective recycling options are being utilized and making a demonstration of additionality more plausible. For aluminum, for example, recycling rates (in both percentage of sales and ton terms) have been relatively constant in recent years (particularly from 2004 through 2006), according to the Container Recycling Institute (CRI).[17] In contrast, CRI reports that PET recycling rates have been rising gradually, suggesting that additionality of incremental recycling for any specific project may be more difficult to prove. However, to the extent that MSW recycling programs are partially subsidized, inducing incremental recycling may require similar incentives (in the form of payments for offsets) to become profitable.

Additionality also requires attention to regulatory requirements and how these influence the baseline. A number of states are considering expanding current bottle bills or have proposed new ones. Legislation that requires a deposit on recyclable bottles will change behavior and so influence the extent of recycling that should be assumed in the baseline, in states implementing new legislation. Federal and state standards governing methane from landfills will also affect baseline emissions from landfilled materials and, thus, the emissions benefits of incremental recycling.

A final issue in determining the baseline is the effect of cap and trade programs themselves. To some extent, any domestic GHG allowance trading system that is developed will provide incentives for increased recovery of energy-intensive materials, and a corresponding reduction in GHG emissions. A trading system focused on energy generated from fossil fuels (e.g., by targeting electric utilities, large industrial energy consumers, transportation fuels, and other fossil fuel uses) will increase the price of energy, both fossil and non-fossil. In turn, higher energy prices will provide incentives for increased recycling of some materials. Developing a robust and defensible baseline regarding the rate of recycling across the material streams that Waste Management is potentially interested in generating offsets from would be crucial next step.

4.2 Double-Counting Emission Reductions: Eroding the Binding Emissions Cap

In a national emissions trading system, offsets can sometimes erode the GHG benefits of the trading system. If the actions to reduce emissions, which are undertaken as part of the offsets product, actually reduce emissions from the sources covered by the parent trading system, then offsets that are generated and sold will effectively increase the allowance cap of the system. This is sometimes referred to as the problem of "double counting." For example, consider that emissions trading systems generally include, at a minimum, electricity generation. In that case, double counting will be an issue for recycled materials for which the primary greenhouse gas reduction benefit occurs due to reduced consumption of electricity purchased from the grid. For example, if the GHG value of a credit claimed for recycled aluminum includes the energy savings of aluminum remanufacturing (as it would), the emission reductions may be counted twice—once when the offset is generated by increased recycling, and again when process electricity consumption falls and an allowance held by an electric utility is thereby freed up and sold.[18]

The issue of double counting is a critical one to address in an offset program that includes recycled materials. In a capped system that includes power plants, covered plants will, in aggregate, emit up to their caps. Any reductions generated by increased recycling will be eroded by increases elsewhere, since the allowance cap will be binding. Consequently there will be no real incremental GHG reduction in the economy as a whole, although compliance with the cap will be made less expensive. Figure 7a illustrates how offsets interact with an emissions trading system. Figure 7b illustrates how double counting can arise for the example of a cap and trade system that includes power plants and an offset for aluminum recycling.

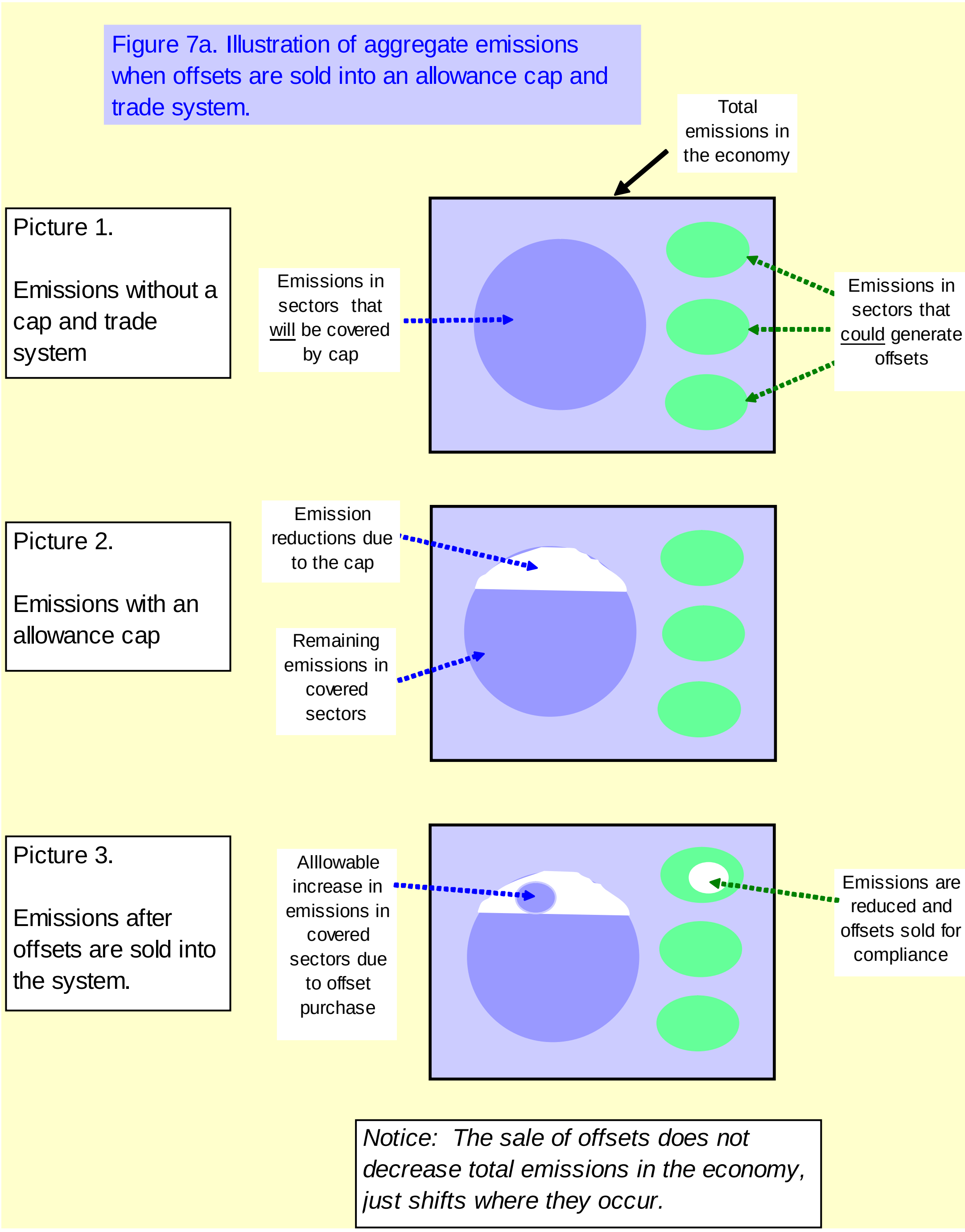
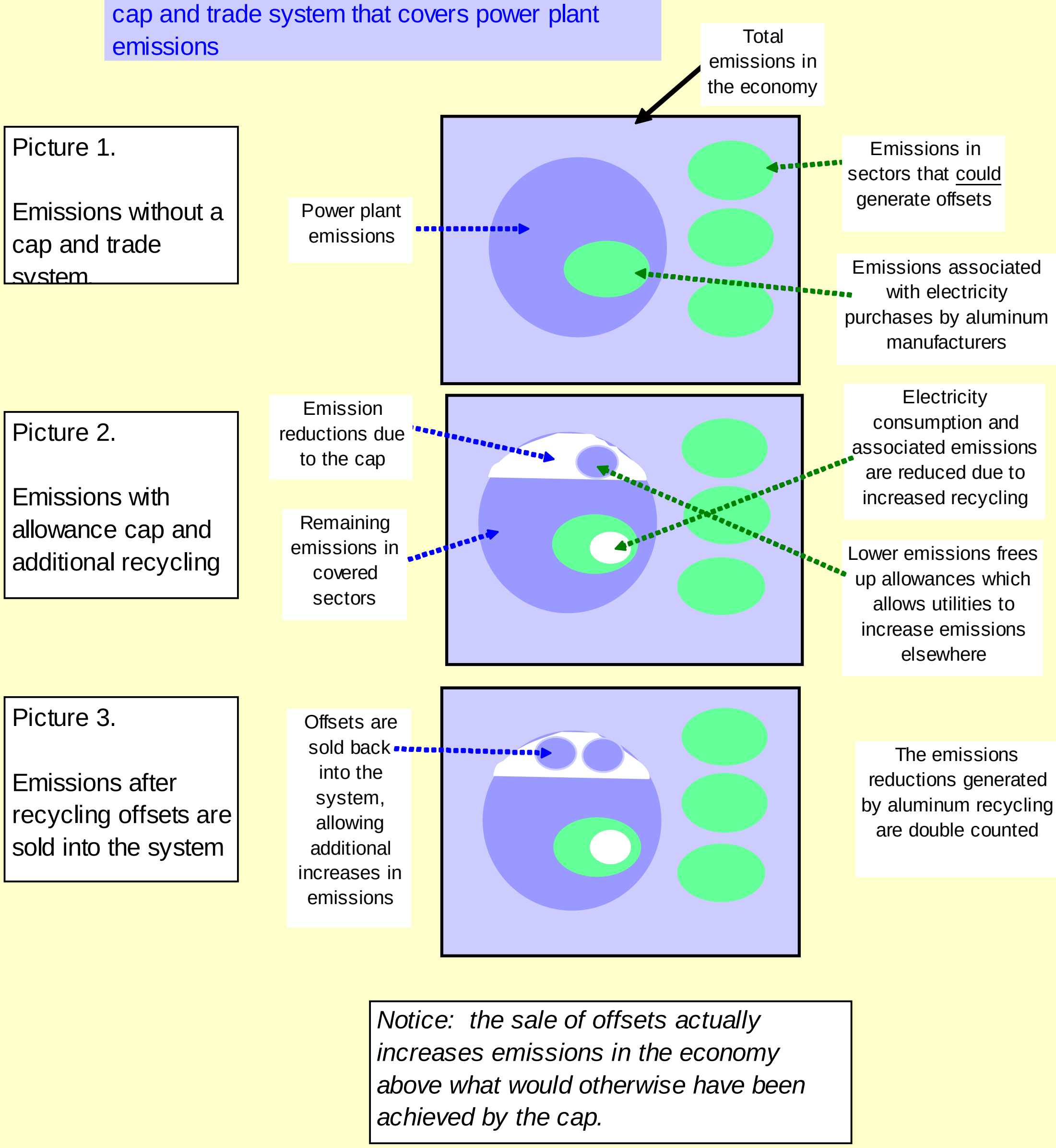


Figure 7a. Illustration of aggregate emissions when offsets are sold into an allowance cap and trade system.

Figure 7b. Illustration of double counting: Example of offsets that reduce electricity demand sold into cap and trade system that covers power plant emissions



If there is no national emissions trading system, or if offsets are sold only into the voluntary market, then double counting may be less of an issue. Suppose, for example, that primary aluminum producers are located in—and purchase electricity from—electric utilities in states <u>without</u> a greenhouse gas emissions trading system. In this case, offsets that are generated will represent real reductions, and will <u>not</u> be double-counted with allowance reductions from a covered electric utility (i.e., one covered by a cap and trade system).[19] This will be the case even if the purchasers of the offsets use them for compliance purposes. The case is even more clear-cut if the offsets are bought and sold on the voluntary market and so are not used to meet emissions caps in an allowance trading system.[20] Even so, as before, it is critical that the emissions reductions claimed by the offset project be located in a state or region <u>without</u> binding caps. However, such a situation will be viable only as long as regional or state systems do not continue to develop, and until a national emissions trading system comes about.[21]

4.3 Leakage and Permanence

Leakage occurs when a project has unintended consequences—outside of the project—that erode the emission reductions associated with the project. Ideally, leakage should be prevented if possible, and if not, the general recommendation is that it be estimated and the effects of leakage be incorporated into the estimated benefits of the project. Leakage has the potential to reduce the benefits of recycling, in particular. If increased recycling reduces the demand for virgin materials, then the price of these materials may fall; in turn, lower prices of virgin materials may result in increased output and use of virgin materials by manufacturers. Paper recycling presents an additional potential for leakage that is difficult to account for; while recycling may reduce harvesting and so increase forest carbon, in the longer term landowners may respond to the reduced demand for timber by planting less, resulting in reduced forested land over time, and less long-term forest carbon storage.

Permanence is a related problem, but affects primarily paper recycling. Permanence refers to the length of time that carbon will remain stored after being sequestered in vegetation. Forests can easily be destroyed by natural events such as fire, pests, or disease. The benefits of increased forest carbon due to increased paper recycling, therefore, maybe represent only a temporary increase in carbon. This is a problem that is also faced by offsets that involve afforestation or reforestation, both of which are now widely included in offset systems. The Lieberman-Warner Bill includes provisions for standardized methods used to determine and discount for both leakage and uncertainty, which is discussed below.

4.4 Timing

Ideally, credits should be awarded closely to the time that the emissions reductions occur. A number of potential timing issues occur with waste diversion, including the gradual sequestration of carbon in forests and the rate at which carbon is released from landfilled materials. Differences in timing raise questions of the value of the credit and the amount that potential purchasers will be willing to pay; because the benefits occur in the future, they are less certain and so of less value. There is also a temporal issue associated with the implementation of a federal cap and trade program. Reductions in electricity use may be creditable before the implementation of a national climate policy, but may not count after its implementation due to reasons discussed above.

4.5 Uncertainty in Measurement

Two key issues arise with regard to the measurement of emission reductions associated with waste management:

- The uncertainty associated with emissions at different stages of the product life cycle
- The differences between national or regional averages and site-specific emission factors

Methodologies for estimating emissions at each stage of the life cycle of recycled or composted products vary considerably in the level of uncertainty to which they are subject. In some cases, the uncertainty stems from the science; for example, there is widespread debate about the factors that influence soil carbon, and the magnitude of long-term carbon storage in landfills. In contrast, the science and data needed to estimate emissions associated with fossil fuel combustion is reliable and much less uncertain. Uncertainty can stem not only from science and data issues, but also from unknowns regarding market behavior. For example, the extent to which reduced harvesting today results in less planting and lower forested land in the future depends on how large and small landowners respond to price incentives and expectations about the future.

Further, the GHG benefit of a particular ton of recycled material will be difficult to estimate accurately because it depends on factors specific to the project, such as the landfill where disposal would have occurred or the source of electricity. National estimates of the benefits of recycling or composting are developed based on national averages—assumptions of the national rate of landfill methane recovery (which is also changing over time and so should be incorporated into any national estimates) and the composition of avoided emissions from electricity generation (which currently assumes avoided emissions are entirely fossil fuel). These national estimates may not be applicable to a particular project, which further increases the uncertainty associated with estimated benefits of a particular project.

The issue is even more complex because, for many materials, the primary manufacturing and recycling chains are not located entirely within US borders. Much primary steel manufacturing occurs outside the US, and so increased recycling actually increases domestic emissions. Similarly, a significant portion of recycled paper is exported, rather than used domestically. The cross-boundary movements of primary and recycled materials raise multiple questions of how to treat cross-boundary emissions and emission reductions in accounting protocols or standards.

Some systems have proposed including discounting to account for uncertainty. It may also be possible to restrict the use of emission factors to those portions of the life cycle emissions chain that are more certain (e.g., landfill methane but not soil carbon), to those for which national averages are not likely to deviate greatly from site-specific data, or to circumstances in which site specific data are available and can be used.

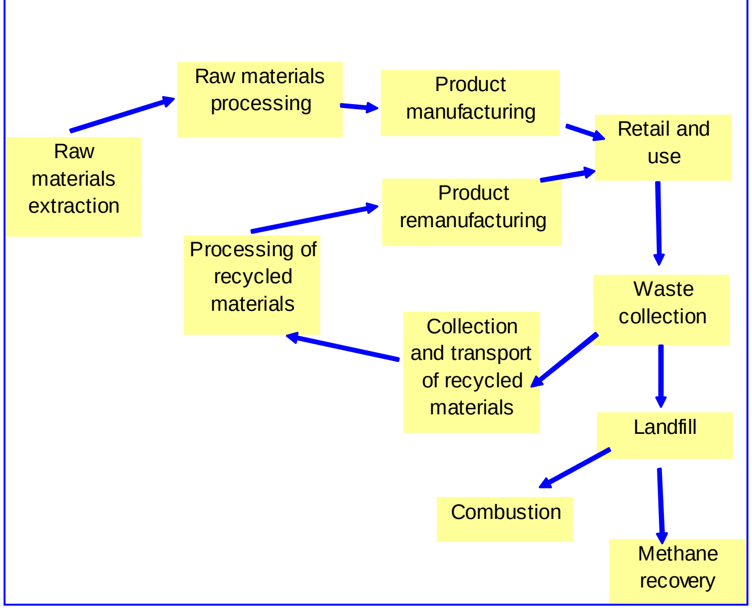
4.6 Where in the Recycling/Composting Chain to Assign Credits?

A critical issue in the design of an offset system is what entities are able to generate—and claim—credits for emission reductions. The process associated with recycling potentially involves a number of different entities—the municipality representing the citizens who separate recyclables, the collector of the recyclables, the material recovery facility (MRF) or other processors of post-consumer material, and the remanufacturers that use the processed recycled material. Figure 8 portrays the generic categories of entities involved in waste management. Many of these entities may have a vested interest in the financial benefits afforded by the sale of recycling offsets.

Ideally, the choice of which entity can generate credits could reflect several different criteria, which may not always be in agreement:

- ***Effectiveness***—the incentive should go to the entity that is best able to take steps to ensure that incremental recycling happens
- ***Equity***—the entity that bears the cost of increasing recycling should also receive the benefits of the offset
- ***Measurement***—the offset should be awarded at the point in the life cycle where measurement is least uncertain, i.e., where the data can be gathered to quantify

Figure 8. Generic Pathways for Product Recycling



emissions and emissions reductions.

These are discussed below.

Effectiveness. In theory, financial incentives provided to one entity in the chain should flow through the marketplace to other entities. This is the logic behind the presumption that an emissions trading system focused on fossil fuel combustion would, by raising energy and electricity prices, provide incentives for additional product recycling. The assumption is that higher electricity prices will raise the value of scrap aluminum and steel, and so additional collection would be profitable and would occur.

In practice, prices effects do not always move smoothly through a trading system, and so other incentives must be targeted at an appropriate economic actor in order to achieve the desired results. Thus, the incentives of higher gasoline prices coupled with fuel economy standards may be more effective than either alone in reducing gasoline consumption. Similarly, the effectiveness of the offset program may depend on identifying the entity in the chain that has most control over how much recycling occurs. For most recycled products, this will be at the point of collection, which may be the municipality or a private collection facility.

New Jersey developed several draft model protocols in the late 1990s in support of its Open Market Emissions Trading Rule. These protocols, which never were finalized and promulgated as regulations, recognized the importance of both incentive and control over recycling in the assignment of credits. In the draft model protocol for recycling plastics, the NJ Department of Environmental Protection identified post-consumer resin processors as the entity capable of earning credits. The rationale was, in part, that the processors have the most control and incentive to increase recycling rates. The rule recognized, however, the important additionality/baseline and measurement concerns associated with choosing a single entity, and considered several alternatives to the PC resin processors, including the plastic collectors, the remanufacturer, and manufacturer. NJ DEP applied a similar rationale when they selected demanufacturers; the parties who demanufacture used personal computers and distribute the components to scrap dealers or recycling of specific materials, in the draft protocol for generation of GHG credits by recycling personal computers.

Equity. Because the offset is a “reward” for increasing recycling rates, ideally it should accrue to the entity that designs the project, undertakes the work, and takes steps to ensure that recycling increases. In most existing offset programs, the principle “follow the money” is applied. In general, the entity financing a project has the right to the offset, a principle that is loosely tied to the financial additionality criterion.

In the case of waste diversion, a range of entities may bear different types of costs. For example, the costs of a public awareness program that encourages consumers to compost food waste rather than discarding it are borne primarily by consumers who must sort and transport their food waste and build and maintain a compost bin. The administrative and other costs of the program itself are not borne by the consumer, however, and the increased composting would not occur without the program. Thus, it might be reasonable to award the offset to the entity that develops the program—which could be a landfill, the hauler, a municipality, or indeed any entity along—or even outside—the recycling chain.

Measurement. As noted repeatedly in this paper, the points at which emission reductions occur may be quite diffuse in terms of life cycle stages, individual facilities, geography, and time. And one of the principal obstacles to including recycling in an offsets system is the measurement of the emission reductions—whether and where they are actually occurring. One way to overcome this obstacle might be to only allow credit where certain measurement thresholds could be met. These thresholds might involve the uncertainty associated with (a) measurement methodologies themselves (i.e., with the science underlying measurement), (b) the potential to identify emissions paths and emissions factors (i.e., to identify site-specific factors), or (c) where the emissions reductions occur (i.e., whether they can be demonstrated to reduce US emissions).

Methodologies for estimating emission reductions generally rely on a combination of activity data—specific data on actions undertaken, such as tons of recycled inputs or electricity consumption—and on emissions factors—emissions per unit of the activity. As discussed in Section 4.5, the uncertainty of these methodologies is quite variable. However, measurement depends not only on the scientific basis of the methodology, but also on access to data. Depending on the activity data used, one entity in the chain would likely have better access to site-specific data than another.

For example, the remanufacturing facility and the entities delivering the materials to the remanufacturer would have the best data on the quantity of recycled materials being used. The remanufacturer would have the best information on the quantity of electricity used in recycling. The landfill where the materials would otherwise have been taken would have the information on both avoided methane emissions and lost carbon sequestration. None of these, however, would have data on avoided emissions—for example, the CO_2 emissions avoided as a result of reduced electricity consumption at the primary manufacturer. Thus, given these measurement issues, deciding which specific entity can generate and sell emission reduction credits may depend on access to site-specific data and the accuracy of using national or regional, rather than site-specific information. It may be that entities share ownership of credits, as they also share access to data or responsibility for the activities leading to increased recycling.

Where in the recycling chain the emission reductions occur is a point of contention, as well as a source of uncertainty. For example, one of the main uncertainties associated with paper recycling is whether the paper stays in the US and reduces the demand for virgin pulp harvested from US forests. To address this issue of transboundary flows, there could be a requirement that paper recycling would only get credit if used in a US mill.

Given the global nature of some scrap markets, if these transboundary issues were regarded as a significant policy design issue (as appears to be the case in the Lieberman-Warner bill, which imposes limits on international offsets), the point of measurement might be at the remanufacturer. This would also allow use of more site-specific information on the effects of increased recycled inputs on the facilities' fuel and energy mix (and GHG emissions).

5 Conclusions

From a life cycle perspective, recycling has the potential to significantly reduce GHG emissions. If the roughly 4.5 million tons of key materials currently recycled by WMRA annually—primarily aluminum, corrugated cardboard, newspaper, office paper, mixed plastics, and glass—were doubled, full life-cycle emissions would be reduced by over 3 million tons of carbon equivalent (MMTCE). The potential for the value of offsets associated value of increased recycling is considerable.

There are formidable obstacles, however, to including recycling within an offsets program. Offsets that are being considered for US programs generally occur at discrete and specific locations, with readily identifiable ownership, and with (mostly) directly measurable emission reductions. In contrast, the emission reductions from recycling occur at a variety of points upstream (in the raw material acquisition and manufacturing stages) and downstream (during the waste management stages). Further, the GHG effects vary significantly from material to material. While recycling aluminum, steel, glass, and plastics results in effects that are essentially all upstream in the raw material acquisition and manufacturing stages, composting food scraps and yard trimmings results in effects that are essentially all downstream, and recycling paper has effects that are both upstream and downstream. The complexity of the solid waste stream makes developing a credible system for offsets from solid waste diversion equally complex. In particular, a number of accounting issues—such as the potential for double counting emission reductions, the uncertainty in some emissions estimates, and additionality—would need to be addressed.

Because no national emissions trading system currently exists in the US, some of these issues are less important than they might otherwise be. Participation of offsets in the voluntary market, but not in compliance markets, would address some of the difficult issues, possibly including the double counting issue, and would make issues related to leakage and permanence less important. It would also allow for the development and testing of measurement methodologies that could, over time, meet the more stringent requirements of the compliance market. Because they are not used for compliance purposes, prices in voluntary markets tend to be lower than those for offsets used for compliance.

There may also be circumstances in which offsets can contribute to the regional and state emissions trading programs that are being developed, depending on the extent of potential double counting or measurement issues. Participation in these compliance markets can also serve as a testing ground for discounting or other methods of addressing uncertainties; leakage or permanence concerns; and possible contractual arrangements for sharing credits that might address double counting issues or address issues of access to site-specific data.

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ENDNOTES

[1] The current draft US Greenhouse Gas inventory (ending in the year 2006) is available at http://www.epa.gov/climatechange/emissions/usinventoryreport.html

[2] EPA estimate. http://www.epa.gov/epaoswer/non-hw/muncpl/facts.htm, accessed on April 3, 2008.

[3] For example, manufacture of recycling aluminum does not emit PFCs, unlike primary aluminum manufacturing.

[4] Additional information for Figures 3, 4, and 5 follows. Note that all emissions factors from landfilling various materials are based on national average statistics on landfill recovery rates.

Definitions of materials categories:

Mixed plastics are composed of HDPE, LDPE, and PET and are estimated by taking a weighted average of the 2003 recovery rates for these three plastic types.

Mixed paper is recycled in large quantities and is an important class of scrap material in many recycling programs. Presenting a single definition of mixed paper is difficult, however, because recovered paper varies considerably, depending on the source. For purposes of this report, EPA identified three categories of mixed paper according to the dominant source—broad (includes most categories of recyclable paper products), office, and residential (see Exhibit 3-2 in the EPA document for definitions of mixed paper categories).

Categories of emissions factors:

Process energy = the amount of emissions avoided (or added) from the combustion of fuels used in the production process due to manufacturing a product from virgin vs. recycled inputs.

Transportation energy = the amount of emissions avoided (or added) from the combustion of fuels used in the transportation component of the life cycle (i.e., virgin materials manufacture transportation, recycled inputs transportation, avoided landfill collection and equipment transportation)

Process non-energy = the amount of emissions avoided (or added) from the non-energy processing in manufacturing a product from virgin vs. recycled inputs. These emissions are not related to the combustion of fuels but rather non-combustion related processes. An example of a process non-energy GHG would be the PFCs that are formed when converting bauxite into alumina (due to anode upsets) for virgin aluminum production.

Forest carbon sequestration = the amount of emissions reductions from producing paper from recycled inputs and thus offsetting the amount of forest that would have been used to produce paper from virgin materials.

Landfill CH_4 = the emissions associated with the decomposition of organic materials in the anaerobic landfill environment that are "avoided" due to the recycling of these materials.

Avoided CO_2 *from Energy Recovery*= the emissions associated with capturing the landfill methane that would have been generated in a landfill and using this to offset electric utility generated emissions.

Landfill Carbon Sequestration = the emissions associated with the sequestering of biogenic carbon that would have otherwise been released to the atmosphere but are credited with being sequestered in a landfill (i.e., a transfer of carbon).

[5] Note that Figure 3 follows the widely used convention of reporting emissions as positive numbers; thus, negative numbers in

ENDNOTES

this and other figures represent emission reductions. ***Also note that we are using the convention, adopted by EPA's Office of Solid Waste, of reporting in units of metric tons of carbon equivalent (MTCE) per short ton of material managed. Trading systems generally are keyed to metric tons of carbon dioxide equivalent (tonnes CO_2e). The conversion factor is 1 MTCE = 3.67 tonnes CO_2e.***

[6] For recycled paper, there is a slight increase in emissions due to both (a) reduced long-term storage of carbon in landfills and (b) a reduction in the avoided emissions associated with landfills that recover methane and substitute for fossil fuel generated electricity (assumed to be the norm). This effect is far outweighed by the forest sequestration effects.

[7] The near zero effect results because reduced landfilling reduces long term carbon storage (landfill carbon sequestration) and so composting increases emissions relative to landfilling. This change in storage is enough to more than offset the benefits of lower methane emissions due to less landfilling. More recent evidence suggests that these emission factors overstate the magnitude of carbon storage, and so the emission factors for landfill carbon sequestration are being revisited. Updating is likely to change the net effect of composting to emission reductions, rather than emissions. Although the actual emissions factor is likely to be small (relative to some other material streams), the large quantity of yard trimmings that is available for composting could in aggregate lead to significant emission reductions.

[8] Offsets can be defined in different ways. In some cases, they may represent a discrete project or, in others, a set of actions taken by an entity or group of entities. In this paper, we follow the convention of referring to offsets as projects, knowing that that may not always be the accounting basis for the offset.

[9] Different certifying authorities have given the emissions reductions associated with offsets different names, such as credits or credit allowances. Emissions reductions generated and certified under the Clean Development Mechanism (CDM), one of the flexibility mechanisms of the Kyoto Protocol, are referred to as CERs, or Certified Emission Reductions.

[10] World Wildlife Federation, "Making Sense of the Voluntary Carbon Market: A Comparison of Carbon Offset Standards. March 2008.

[11] Different systems use different terminology—but the meaning is generally the same. These are the terms used by CDM under the Kyoto Protocol, which is among the most stringent of the standards.

[12] Some systems limit the ability of covered entities to use offsets to meet emissions limitations. Some systems also include safety valves, i.e., allow increased use of offsets when compliance costs appear to be rising too high.

[13] This test has much in common with the performance standard. The difference is that, in this case, it uses information specific to the individual project. In the case of a performance standard, the information has been collected and applied broadly to projects of that type.

[14] See Regional Greenhouse Gas Initiative (RGGI) Offsets Approach. Presentation by Christopher Sherry, New Jersey Department of Environmental Protection, on April 19-20, 2007, before the California Public Utilities Commission.

[15] Guidance on Additionality for the Approval of Abatement Projects under the Greenhouse Friendly™ Initiative, prepared by Australian Greenhouse Office of the Department of the Environment and Water Resources, Australian Government. Version 1.1, Released 08.08.2007.
Available at: http://www.greenhouse.gov.au/greenhousefriendly/publications/pubs/additionality-guidance.pdf

[16] All additionality tests must accept a certain number of "false positives"—i.e., projects that pass the test but are not really additional. The question is what level is acceptable, and how to minimize the incidence of passing projects that are not additional.

[17] http://www.container-recycling.org/alumrate/graphs.htm

[18] If the electricity is generated by the primary producer of the material and used internally, and that entity is not included in the emissions trading system, then there would be no double counting.

[19] The location of the primary producers is important because the reduction in primary production of aluminum provides the greenhouse gas benefit. The increase in electricity consumption by remanufacturers does not create a double-counting problem, at least not one that erodes the greenhouse gas benefits of recycling. Note that the magnitude of the credit for avoided emissions will reflect the difference between electricity consumption by primary producers and remanufacturers, and not the drop in electricity consumption at primary manufacturers.

[20] Following the example in the text, suppose that offsets that represent emissions reductions from an electric utility in a covered system. If these offsets are sold on the voluntary market there are two effects: (a) the electric utility may find it easier to meet its allowance cap (b) emissions in the economy as a whole are not reduced by the amount of the reductions, although the allowance cap is still binding for the trading system. Thus, the important issue in double counting is where the *emission reductions* are located, not where the offsets are *bought and sold*.

[21] Double counting might also occur between the methane reductions associated with less paper recycling and possible offsets for methane recovery at landfills, although this issue has not been examined for this report.