Solid Waste:
Baseline information to enable cities to reduce GHG emissions and save money
GHG Inventory Project, Sonoma County, California
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Municipal solid waste consists of a variety of solids from operations such as office paper, and refuse collected in park receptacles. Another source is greenwaste – grass, leaves, and wood – from parks and other city landscapes. Solid waste also contributes to a city's GHG emissions. The choice of disposal processes – landfilling vs. recycling – will affect GHGs. And the manufacture of the solid materials cities use also creates GHGs. This results in a complicated relationship between solids and GHGs. Fortunately, the recommended course of action to reduce GHGs related to solid waste are straightforward and follow what we already know are good practices: use less and recycle more.

The ICLEI inventory process for cities only measures the GHG contribution of landfilling the solid waste stream. The landfilling process can result in a positive or negative contribution to a city's inventory, depending primarily on how the landfill is operated. When materials containing carbon such as paper are buried in a landfill, part of the carbon is sequestered. This means it could no longer enter the atmosphere as greenhouse gas. The remainder of the carbon decomposes to methane, a potent greenhouse gas, and carbon dioxide. If the methane were allowed to escape to the atmosphere, the net greenhouse emissions from landfilling would be positive and substantial. However, we estimate 70% of the Sonoma County landfill's methane is captured and burned. The net effect, as determined by the ICLEI software, is that the solid waste sent to the landfill is a reduction, or negative contribution, to each city's GHG emissions inventory.

Solid Waste Estimation

The underlying protocol for converting solid waste to GHG emissions is the most complex of the municipal sectors studied. The data available from the cities is also the most limited. To calculate the amount of GHG produced by cities' solid waste streams, we first estimate the tons of solid waste they each produce. Only the City of Sonoma supplied actual tonnages for city-generated refuse. For Rohnert Park, Pam Davis, Public Education Manager for West Sonoma County Disposal, generously helped obtain information on these cities' present (2003) volume of refuse containers and frequency of collection.

From this information, we estimated refuse weight by assuming that each cubic yard collected contained 0.16 tons of material.[1] Our estimates are imprecise because we didn't know, for example, how full each container was. Because we had data only for 2003, we used it for the two base years for our study, FY 2000-01 and FY 2001-02.

For the remaining cities (Petaluma, Healdsburg, Cotati, Windsor and Sebastopol and Cloverdale) we used Rohnert Park's data to develop ratios of annual tons of refuse per

[1] From the ratio of disposal charges for solid waste at the County landfill for tons vs. cubic yards basis.

building floor area. We tested both employee count and building size as a basis for these solid waste ratios, and the latter showed less variation between buildings.[2] The weighted average ratio for all Rohnert Park city buildings was 2.88 annual tons landfill refuse per thousand square feet. From this ratio, we then could estimate the annual tons of solid waste and recycled materials for each remaining city. The following table summarizes the results:

City	Buildings			GHG Emissions
	Building Sq. Ft.	Estimation Method	Refuse, Tons/ Year	Tons eCO2/year
Cloverdale	16,100	Square Feet	46	-11
Cotati	20,000	Square Feet	58	-13
Healdsburg	74,780	Square Feet	216	-50
Petaluma	479,446	Square Feet	1,382	-321
Rohnert Park	215,879	Collection	622	-145
Sebastopol	34,390	Square Feet	99	-23
Sonoma	79,507	City provided[3]	55	-13
Windsor	43,400	Square Feet	125	-29

We also attempted to estimate the refuse from city parks, but the only data available produced unreasonably large GHG volumes, so parks refuse is not included in this analysis.

Another component of the solid waste stream from City operations is greenwaste (leaves, grass, and wood from maintained landscape). Much of the County's greenwaste is composted at the landfill site. Composting releases more biomass carbon dioxide than landfilling, but it also closely resembles the natural biological cycle. We had hoped to include a GHG estimate for the composting of green waste from parks and City property, but too little data was available to make a credible attempt. We do not believe this is a significant omission compared to the overall inventory[4]. Nor do we believe landfilling all the greenwaste is a practical strategy for GHG reductions, compared to other alternatives.

Greenhouse Gas Emissions

From this method of inventory, it may appear that sending more solid waste to the landfill in the future could reduce greenhouse gas emissions. In fact, this is an artifact of the accounting system ICLEI has chosen for solid materials. Considerably more greenhouse gas is emitted by manufacturing most solid goods than the reduction from landfilling.

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[2] On an employee basis, ratios ranged from 0.34 to 24 annual tons per employee. Public facilities with few employees but many citizen visitors produce the highest ratios. On a square footage basis, the ratios ranged from 0.95 to 15 annual tons per 1000 square feet.

[3] Actual tonnage from the 2002-03 fiscal year.

[4] The only greenwaste data available was for the City of Sonoma, which counted 30 annual tons city-wide for tree maintenance. We estimate composting this might result in 10 tons eCO2 emissions.

For instance, manufacturing a ton of office paper generates 3 tons of CO2 equivalent GHGs (tons eCO2). Landfilling that ton of office paper will only offset about 0.5 tons of the emissions from manufacture, depending again on the landfill operation. However, cities do not count the emissions of manufacture in their inventory; this accrues to the manufacturer. This is done to avoid double counting of the manufacturing emissions when an economy-wide GHG inventory is made. Therefore, the negative values shown above need to be coupled with the emissions of manufacture to provide a complete picture of the impact of solid waste.

Next Steps – Solid Waste Strategies to Reduce GHG Emissions

A city can employ two basic strategies to reduce GHG emissions associated with solid waste: use less and recycle more. The first strategy, also called "source reduction" avoids the GHG emissions of manufacture, and it also saves cities the purchase cost of supplies. One example of source reduction might be promoting double sided photocopying when possible, and saving paper costs as well as solid waste. Or, use electronic documents to replace paper documents. The recycling strategy reduces the overall GHG emissions over landfilling since manufacturing products from recycled materials generally requires substantially less processing and energy.

In the cities' ICLEI inventory, the effect of reducing the GHG emissions of manufacture is accounted for later, when cities take measures to reduce their tons of landfilled solid waste, by either using less, or diverting more to recycling. Either action will then give cities GHG credit for reducing the emissions of manufacture, and reduce their overall GHG emissions accordingly.

However, an accurate solid waste baseline is critical to including solid waste as a GHG reduction strategy. The estimates of this study are intended only to help cities decide whether or not to include solid waste as part of their GHG reduction strategy. Should a city choose to proceed, it should first establish a measurement methodology, and a more precise baseline than determined here, that will allow it to reliably observe expected reductions in use or increases in recycling. The measurements should include both weight and composition of the solid waste streams that will be affected.[5]

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