

Comparison of Environmental Burdens

**Recycling, Disposal with Energy Recovery from Landfill Gases,
and Disposal via Hypothetical Waste-to-Energy Incineration**

San Luis Obispo County 2002

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February 2004

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The San Luis Obispo County Integrated Waste Management Authority (IWMA) contracted with Sound Resource Management (SRMG) to conduct a life cycle analysis of important and quantifiable environmental impacts associated with the County's curbside/on site refuse collection and disposal, and curbside recycling systems. The IWMA also asked SRMG to evaluate those same environmental impacts that would be associated with disposal of collected refuse in a waste-to-energy incineration facility rather than the County's current landfill where landfill gas (LFG) is collected and used for energy generation. The following report provides the results of SRMG's analysis.

1. Background and Summary Conclusions

A. Background

SRMG used life cycle assessment (LCA) techniques to enumerate and evaluate important and quantifiable environmental burdens associated with collection and management of municipal solid waste in SLO County during 2002. The particular environmental burdens we evaluated were:

- Energy usage,
- Increases in global warming, acidification and eutrophication potentials associated with emissions of certain pollutants to the atmosphere and to waterways,
- Increases in potential adverse impacts on human health associated with criteria air pollutant emissions and with releases of toxic substances to the atmosphere and to waterways, and
- Increases in potential adverse impacts on ecological systems associated with releases of toxic substances to the atmosphere and to waterways.

We compared these environmental burdens caused by curbside collection for recycling, processing, and market shipment of recyclable materials picked up from households and businesses against those same type of environmental burdens caused by curbside collection and disposal of mixed solid waste in the Cold Canyon landfill where landfill gas is collected and used for energy generation. We also evaluated the likely extent of these environmental burdens from disposal of refuse in a hypothetical waste-to-energy (WTE) incineration facility rather than disposal in the current landfill with LFG energy recovery.

For this project SRMG used life cycle inventory (LCI) techniques to estimate atmospheric emissions of ten pollutants, waterborne emissions of seventeen pollutants, and emissions of industrial solid waste associated with curbside recycling, as well as refuse collection and disposal methods for managing municipal solid waste. We also estimated total energy consumption for the recycling versus disposal methods of managing SLO County's municipal solid wastes.

Emissions estimates came from the Decision Support Tool (DST) developed for assessing the cost and environmental burdens of integrated solid waste management strategies by North Carolina State University (NCSU) in conjunction with Research Triangle Institute (RTI) and the US Environmental Protection Agency (US EPA),¹ as well as from the Municipal Solid Waste Life-Cycle Database (Database), prepared by RTI with the support of US EPA during DST model development, to estimate environmental emissions from solid waste management practices.²

Once we developed the LCI estimates, SRMG then prepared a life cycle environmental impacts assessment of the environmental burdens associated with these emissions. To do this we used the Envi-

¹ (RTI 1999a), (RTI 1999b), (Barlaz 2003a), and (Barlaz 2003b).

² Both the DST and its Database are intended to be available for sale to the public by RTI. Contact Keith Weitz at kaw@rti.org for further information on public release dates for the DST and the Database.

ronmental Problems approach discussed in the methodology section of this report. This approach combines the LCI detail on emissions estimates for individual pollutants into aggregate measures of potential impacts caused by certain categories of pollutant emissions. For example, emissions of carbon dioxide, methane, nitrous oxide and CFC/HFCs are weighted according to each pollutant's potency for trapping heat in the atmosphere (the greenhouse effect) relative to the heat trapping potency of carbon dioxide. This calculation yields an index of global warming potential that is expressed as pounds (or tons) of carbon dioxide releases which have the same global warming potential as the combined releases of the individual greenhouse gases.

B. Summary Conclusions

Recycling of newspaper, cardboard, mixed paper, glass bottles and jars, aluminum cans, tin-plated steel cans, plastic bottles, and other conventionally recoverable materials found in household and business municipal solid wastes in general consumes less energy and imposes lower environmental burdens than disposal of solid waste materials via landfilling or incineration, even after accounting for energy that may be recovered from waste materials at either type disposal facility. This result holds for all environmental impacts evaluated in this study:

- Global warming,
- Acidification,
- Eutrophication,
- Disability adjusted life year (DALY) losses from emissions of criteria air pollutants,
- Human toxicity, and
- Ecological toxicity.

The basic reason for the general conclusion that recycling uses less energy and causes lower environmental burdens than either disposal method is that there is a substantial amount of energy conservation and pollution prevention engendered by using recycled rather than virgin materials as feedstocks for manufacturing new products. These energy conservation and pollution reductions from recycled-content manufacturing tend to be an order of magnitude greater than the additional energy and environmental burdens imposed by curbside collection trucks, recycled material processing facilities, and transportation of processed recyclables to end-use markets.

Furthermore, the energy grid offsets and associated reductions in environmental burdens yielded by generation of energy from landfill gas or from mixed solid waste combustion are substantially smaller than the upstream energy and pollution offsets attained by manufacturing products with recycled materials. This is true even after accounting for energy used and pollutants emitted during collection, processing and transportation to end-use markets for recycled materials.

The remaining portions of this Summary Conclusions section of our report review graphical results for our comparative analysis. The graphs show the increases in energy usage and environmental pollution that would result if the County were to abandon its curbside and on-site recycling collections, and instead send all solid waste materials to the Cold Canyon Landfill or to a hypothetical waste-to-energy (WTE) facility.

Details for comparisons between recycling and landfilling are provided in Appendix A, and in Appendix B for recycling versus WTE incineration. These appendices show impacts for each component of the recycling and disposal waste management systems, so that the interested reader can compare impacts of, for example, collection trucks versus recyclables processing or virgin materials offsets versus energy grid offsets.

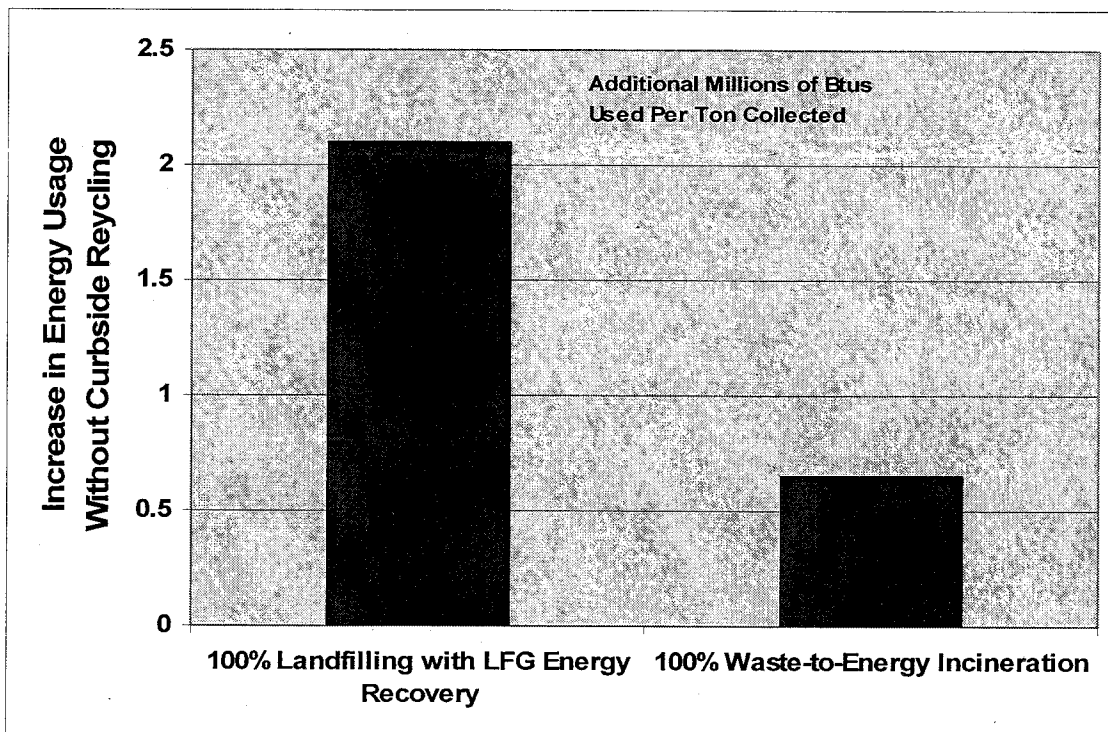
1. Energy Conservation from Curbside/On-Site Recycling

Figure 1, Incremental Energy Usage by 100% Landfilling or 100% WTE System, shows the amount of additional energy that would be used per ton of solid waste material collected if SLO County abandoned its curbside recycling system in favor of 100% landfilling with LFG energy recovery. The chart also shows hypothetical incremental energy usage per ton if all collected refuse and recyclables were delivered to a WTE incineration facility instead of recyclables being delivered, as at present, to the Cold Canyon recyclables processing facility and currently collected refuse being delivered to the hypothetical WTE facility.³

As indicated in Figure 1, the 100% landfilling waste management system would use 2.1 million BTUs more energy per ton collected than the current system which entails curbside/onsite collection of recyclables, along with collection and landfill disposal with LFG energy recovery for refuse. Similarly, 100% WTE incineration likely would use over 0.6 million additional BTUs per ton compared with the mixed system of current curbside/onsite recycling and disposal via WTE incineration instead of landfilling. Thus, while 100% WTE incineration uses less energy than 100% landfilling, curbside recycling still saves more energy on every ton collected for recycling instead of incineration.

Figure 1

Incremental Energy Usage by 100% Landfilling or 100% WTE System



2. Reductions in Global Warming Potential from Curbside/On-Site Recycling

Figure 2, Incremental Greenhouse Gas Releases by 100% Landfilling or 100% WTE System, shows the amount of additional greenhouse gases that would be released per ton of solid waste material col-

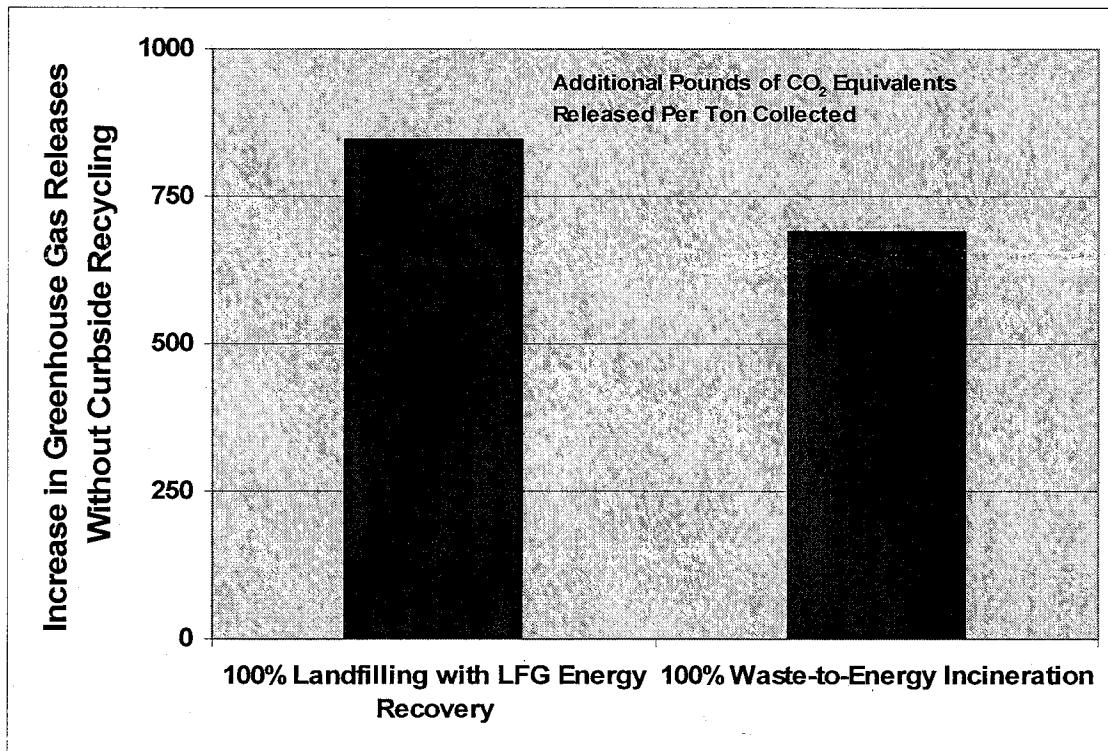
³ The assumption used to calculate incremental energy usage for the 100% WTE System is that the hypothetical WTE facility is located at the same site as the Cold Canyon landfill. This assumption means that travel distance from the end of a refuse collection route to the disposal facility is the same for both landfill and incineration disposal facilities.

lected if SLO County abandoned its curbside recycling system in favor of 100% landfilling with LFG energy recovery. The chart also shows hypothetical incremental greenhouse gas releases per ton if all collected refuse and recyclables were delivered to a WTE incineration facility.

As indicated in Figure 2, the 100% landfilling waste management system would release nearly 850 pounds more greenhouse gases per ton collected than the current system which entails curbside/onsite collection of recyclables, along with collection and landfill disposal with LFG energy recovery for refuse. Similarly, 100% WTE incineration likely would release nearly 700 additional pounds of greenhouse gases per ton collected compared with the hypothetical mixed system of current recycling with disposal via WTE incineration instead of landfilling. Thus, both 100% landfilling and 100% WTE incineration release substantially more greenhouse gases than a system that includes curbside and on-site recycling collections. This is because curbside recycling reduces greenhouse gases on every ton collected for recycling instead of disposal by either landfilling or incineration with energy recovery.

Figure 2

Incremental Greenhouse Gas Releases by 100% Landfilling or 100% WTE System



3. Reductions in Acidification Potential from Curbside/On-Site Recycling

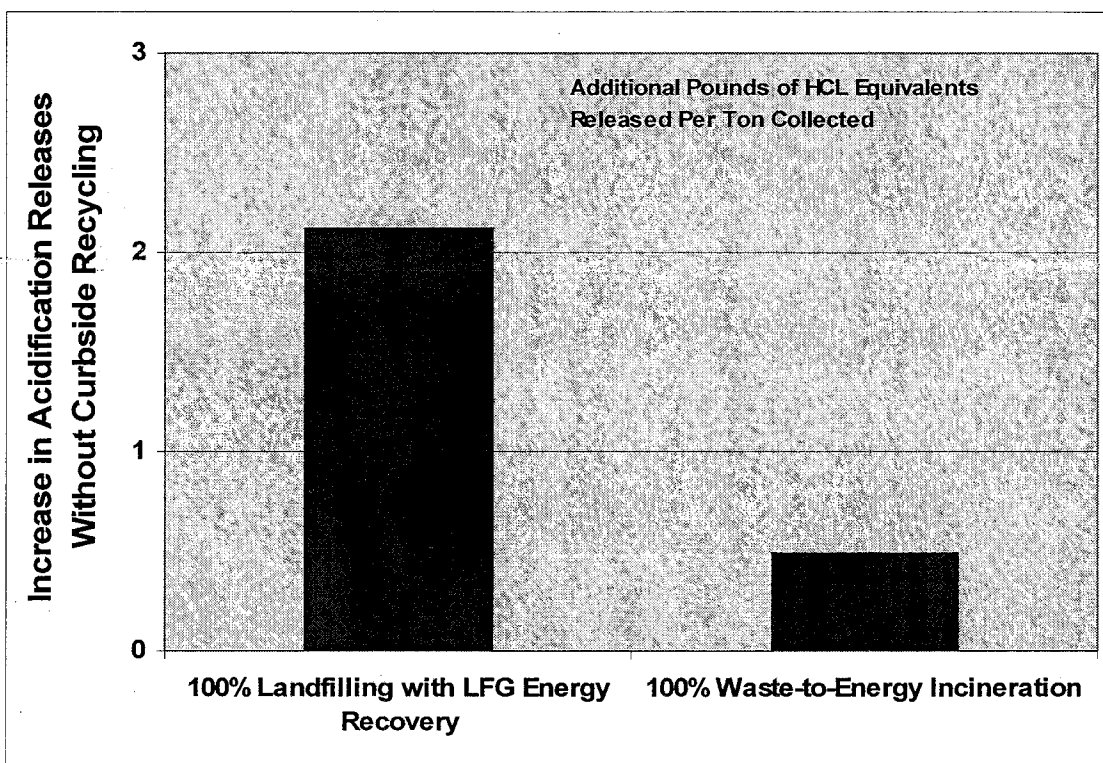
Figure 3, Incremental Acidification Potential Increases by 100% Landfilling or 100% WTE System, shows the amount of additional acidification potential from releases of acidifying compounds per ton of solid waste material collected if SLO County abandoned its curbside recycling system in favor of 100% landfilling with LFG energy recovery. The chart also shows hypothetical incremental acidification potential increases per ton if all collected refuse and recyclables were delivered to a WTE incineration facility.

Release of acidifying compounds from human sources, principally fossil fuel and biomass combustion, affects trees, soil, buildings, animals and humans. The main pollutants involved in acidification are sulfur and nitrogen compounds – e.g., sulfur oxides, sulfuric acid, nitrogen oxides, hydrochloric acid (HCL), and ammonia.

As indicated in Figure 3, the 100% landfilling waste management system would release over two pounds more hydrochloric acid equivalents per ton collected than the current system which entails curbside/onsite collection of recyclables, along with collection and landfill disposal with LFG energy recovery for refuse. Similarly, 100% WTE incineration likely would release an additional half pound of hydrochloric acid equivalents per ton collected compared with the hypothetical mixed system of recycling and WTE disposal. Thus, while 100% WTE incineration releases less acidifying compounds than 100% landfilling, curbside recycling still prevents releases of acidifying compounds on every ton collected for recycling instead of incineration.

Figure 3

Incremental Acidification Potential Increases by 100% Landfilling or 100% WTE System



4. Reductions in Eutrophication Potential from Curbside/On-Site Recycling

Figure 4, Incremental Eutrophication Potential Increases by 100% Landfilling or 100% WTE System, shows the amount of additional eutrophication potential from releases of nutrifying compounds per ton of solid waste material collected if SLO County abandoned its curbside recycling system in favor of 100% landfilling with LFG energy recovery. The chart also shows hypothetical incremental eutrophication potential increases per ton if all collected refuse and recyclables were delivered to a WTE incineration facility instead of recyclables going to the Cold Canyon recycling processing facility and refuse going to the hypothetical WTE incineration facility.

