# Zero Waste: A Practical and Effective Approach to Reducing Human Impacts on Climate

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## Introduction

Recycling began in the United States in the early-1970s due to a growing awareness of population and environmental pressures upon our ecosystems. Even though almost 80% of the materials thrown away by Americans is recyclable, our recycling rate in 2007 was just 33.4% (*EPA*). The remaining materials, more than 169 million tons (*EPA*), were primarily hauled to landfills (Picture 1). Landfills pollute our water resources and environment and emit anthropogenic methane ($CH_4$), contributing to climate change. A zero waste program that reduces our volume of waste hauled to landfills is an easy and economical approach to fighting climate change and decreasing our environmental impact.

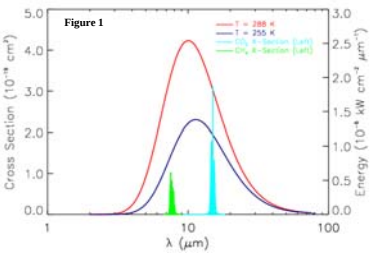
Picture 1

## Conclusion

NOAA's Earth System Research Laboratory's new composting and recycling program shows that very little effort can make a difference in decreasing our greenhouse gas emissions while also conserving resources, protecting ecosystems, and reducing pollution. After only six months with the new program, we have saved 2,000 gallons of gasoline in energy and over $8,000 in environmental harm to our community. Yet there is still plenty of room for improvement – our trash at the DSRC is still almost 60% of the total weight! We need more employee participation and education and we should reduce our trash pickup to 30% of the total by 2010. It is imperative that recycling and composting programs like ours continue to grow across the country. Zero waste is a very practical and effective way to reduce our human impacts on climate.

## Why Focus on Methane Emissions?

Carbon dioxide ($CO_2$) and $CH_4$ strongly absorb thermal infrared radiation (Figure 1). Based on their cross sections, we expect $CO_2$ to trap ~2 times more heat, per molecule, than $CH_4$. This would be true in an atmosphere with low concentrations of both. But, in the modern atmosphere, $CO_2$ absorption bands are saturated so heat trapping increases with the log of $CO_2$ abundance ($1.4 \times 10^{-5}$ W m$^{-2}$ ppb$^{-1}$). $CH_4$ is an intermediate absorber and its heat trapping increases with the square root of its abundance ($3.7 \times 10^{-4}$ W m$^{-2}$ ppb$^{-1}$). In both cases, a radiative transfer model is needed to calculate changes in radiative forcing resulting from increased atmospheric concentrations. To compare the relative climate impacts of reductions in emissions of $CH_4$ and $CO_2$, the global warming potential (GWP) is used. GWP compares climate impacts over specified time periods. Using a 20 year time horizon, reductions of a specified mass of $CH_4$ have a 72 times larger impact than equivalent reductions in $CO_2$ emissions. This makes $CH_4$ an excellent gas to target for short-term relief in the growth of radiative forcing.




## Case Study at the David Skaggs Research Center

Starting October 2008, the David Skaggs Research Center (DSRC) expanded its recycling program to include composting (Figure 2). **Since then, we have diverted almost half of our waste from the landfill through composting and recycling**. All it took was some research and minimal setup time to get this program going. We added some color coded bins and labels, started sorting our organics, and it has made a huge difference. Based on model calculations (Morris, J.), from October 2008 to April 2009 we have saved:

- **2,000** gallons of gasoline in energy equivalent
- **110** tons greenhouse gas emissions ($CO_2$ equivalent) equal to 20 cars off the road for one year
- **405** lbs of air pollutants ($SO_2$ equivalent)
- **165** lbs of water pollution (N equivalent)
- **210** lbs of toxic herbicides that threaten plants, wildlife, humans, and our food systems (herbicide 2,4-D equivalent)
- **47,800** lbs of substances that threaten human health, including carcinogens, particulate matter (PM) and toxics (benzene equivalents, PM less than 2.5 microns equivalent, toluene equivalents)

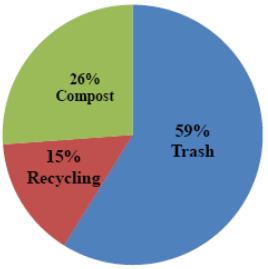



Figure 2

**The value of these benefits to our local and global community is $8, 229.**

## Composting As a Climate Mitigation Strategy

Biodegradable materials in landfills decompose anaerobically, without oxygen, and release $CH_4$. When soiled paper, yard debris, and food discards are properly sorted and composted instead, these potent $CH_4$ emissions are avoided. We also reap huge environmental and climate gains by returning these materials back to the earth as soil amendments (Pictures 2 and 3). Soil organic matter enhances water and nutrient holding capacity, improves soil structure, stores carbon, can enhance productivity and environmental quality, and can reduce the severity and costs of natural phenomena such as drought, flood, and disease. Over approximately 20 years, most agricultural soils will have lost about 50% of their organic carbon because of the reliance of industrial agriculture on inorganic fertilizers and the extensive use of tillage (Smith, Alison et al.). A primary solution to this problem is the application of compost as a soil additive in place of synthetic fertilizers.

Picture 2

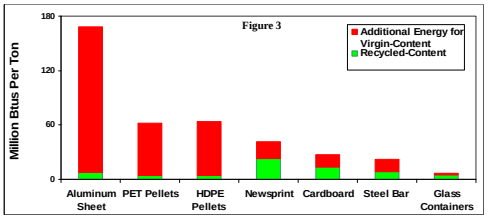
Picture 3

## Energy Savings from Recycling

- On average, Americans recycle and compost 1.5 lbs of our individual waste generation of 4.6 lbs per person per day *(EPA)*.
- Every ton of mixed paper recycled can save the energy equivalent of 185 gallons of gasoline *(EPA)*.
- Recycling just 1 ton of aluminum cans conserves more than 207 million Btu, the equivalent of 36 barrels of oil, or 1,665 gallons of gasoline *(EPA)*.

Figure 3 shows the energy benefits for using recycled materials instead of virgin materials (*Morris, J.)*

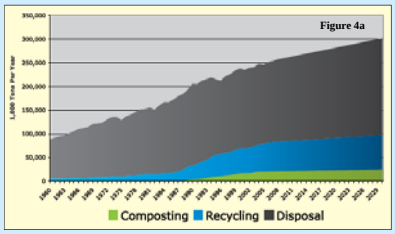
- **Aluminum: ~95%**
- **Paper: 25-45%**
- **Glass: ~30%**
- **Steel: ~60%**
- **Plastics: 50-75%** (*NRDC)*

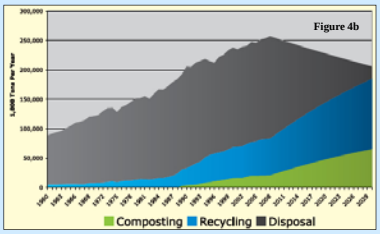



## National Impacts of a Zero Waste Approach

The U.S. has the potential to decrease our greenhouse gas emissions by 406 million tons $CO_2$ equivalent per year by 2030 by dramatically reducing our waste stream to landfills. A new zero waste program in the U.S. "would reduce greenhouse gas emissions the equivalent of closing one-fifth of the existing 417 coal-fired power plants" (Platt, B., et al.).

Figures 4a and b show the Business As Usual scenario and the Zero Waste Approach to disposing of waste in the U.S. By 2030, 90% of domestic waste could be diverted from landfills to recycling and composting. This would achieve 7% of the cuts in equivalent $CO_2$ emissions needed to reduce total U.S. emissions 80% below 1990 levels by 2050.




## Acknowledgements

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## References

**EPA**, *Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2007.*

**Morris, Jeffrey,** Sound Resource Management, *Valuation of Environmental Benefits of Recycling and Composting Model*. Calculation performed by Eco-Cycle with consent, 2009.

**National Resources Defense Council**, *Too Good to Throw Away: Recycling's Proven Record.*

**Platt, Brenda et al.**, Institute for Local Self-Reliance, *Stop Trashing the Climate.*

**Smith, Alison et al.**, AEA Technology, 2001. *Waste Management and Climate Change: Final Report to the European Commission.*