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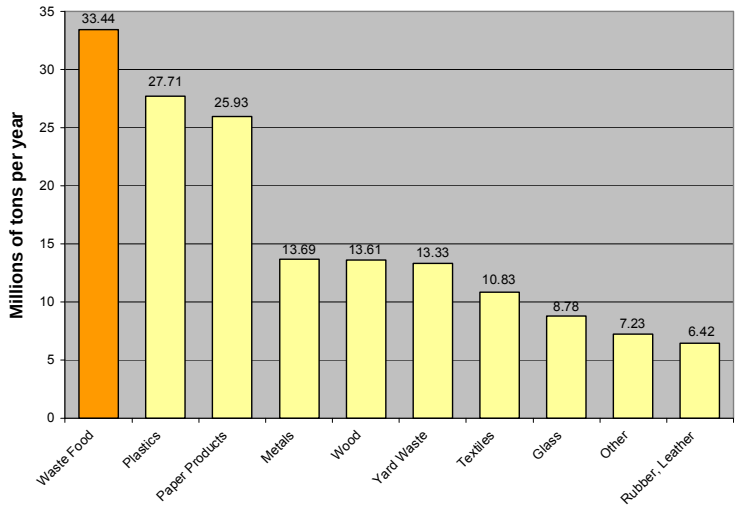
So You Think You Are Green?

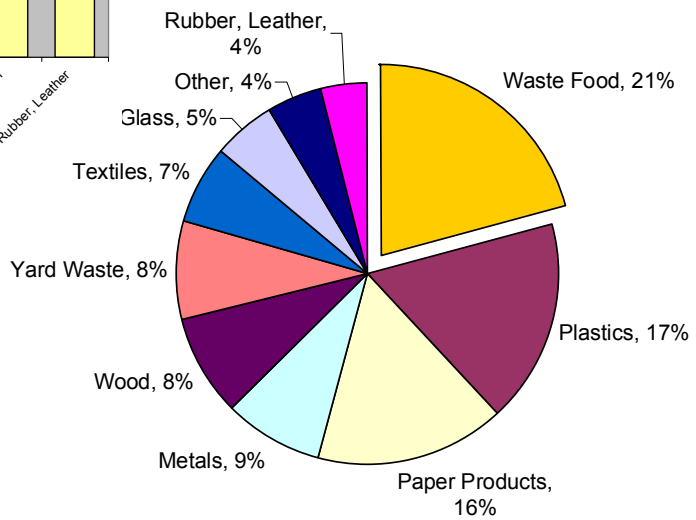
What do you do with your waste food?

1 The Problem

Waste food creates much pollution. A restaurant that sends waste food to a landfill causes the pollution of our atmosphere about ten times more than all the electricity it consumes. Put another way, if the restaurant turned off all the lights in the restaurant forever, but still discarded waste food in the general garbage, it cannot be considered green. This paper discusses the theory behind this claim.

According to the EPA, waste food represents about 21% of all waste sent to landfills. In 2009, it amounted to 33.44 million tonnes (33.44×10^9 kg).[1]





1. The United States Environmental Protection Agency (U.S. EPA). http://www.epa.gov/osw/conserve/materials/organics/food/fd-basic.htm

This waste food degrades into methane, CH_4.[1] CH_4 is 25 times worse for the environment than CO_2.[2] In addition, the EPA states:

> *Food wastes dumped in standard trash cans and dumpsters in the back ally of a home, store, or restaurant can attract rodents and insects – as well as generate bad odors.*

The costs involved by the current methods to dispose of this waste food are huge:

- our planet degrades faster because of the methane
- we have more trucks on the roads to haul away the waste food with resultant congestion and pollution
- organizations spend more money than is necessary to dispose of their trash

2 What Have You Done to Call Your Establishment Green?

You insulated your building, you had window film installed, you got the variable speed hoods, and you got LED lights. You may even have solar panels to generate electricity. You're all set, right?

2.1 LED Lights

Let's look at those LED lights and assume you swapped 100 lights from T8s (which consume 40 W) to LEDs (which consume 17 W), a saving of 23 W per tube. If you have your lights on 10 hours a day, you have saved 23 x 100 x 10 = 23 kWh per day.

The EPA states that:[3]

$$1\ \text{kWh} \approx 0.68956\ \text{kg}\ CO_2 \qquad \text{(EQ 1)}$$

So, you have saved 15.8 kg of CO_2 per day or 5.8 tonne of CO_2 per year.[4]

1. When waste food decomposes in the absence of oxygen, the process is referred to as anaerobic and produces methane. When waste food decomposes in the presence of oxygen, the process is referred to as aerobic and produces carbon dioxide and water. For a discussion, see Wikipedia, http://en.wikipedia.org/wiki/Aerobic_decomposition and http://en.wikipedia.org/wiki/Anaerobic_digestion.
2. See Appendix I on page 6.
3. The United States Environmental Protection Agency (U.S. EPA). http://www.epa.gov/cleanenergy/energy-resources/refs.html.
4. All references to tonne are metric ton (1000 kg). These are the measurements used by the EPA. One tonne = 2205 lb (1.1 US ton (a short ton)).

2.2 Solar Panels

If you install 40 m² (48 yd²) of photo-voltaic (PV) solar panels, these will be rated at about 6.0 kW.[1] If these panels are located in the heart of Silicon Valley (San Francisco Bay Area) where Power Knot is located, they will produce about 8700 kWh per year.[2]

Based on equation 1, this will save 6.0 tonne of CO_2 per year.

3 But What About Your Waste Food?

3.1 Is my Waste Food Bad for the Environment?

You bet! Using values derived from the EPA:[3]

1 tonne of waste food on a landfill generates 4.2 tonne equivalent CO_2

If you dump 100 kg (220 lb) of waste food per day, you cause the creation of 420 kg equivalent of CO_2 per day or 153 tonne per year. This does not include the pollution from the truck that comes to haul it away.

3.2 Shouldn't we Compost our Waste Food?

Yes! Composting is the most beneficial way of disposing of your waste food if you can do it on your site. However, it is not completely beneficial if you have the compost removed to a remote facility where it is composted.

Composting the waste food on site requires either a large dedicated machine to process it or it requires much labor and attention to successfully do it. The problem with composting is that the compost needs to be turned frequently so that the fermentation process is aerobic and not anaerobic. A machine can do this and so can a person. But it takes many weeks to decompose waste food naturally so if you generate 100 kg (220 lb) of waste food per day you need to accommodate 10 tonnes at any time. If you don't have a machine, you need to take care to keep rodents away from the compost heaps.

The other alternative is to have the waste food hauled away for composting by the municipality or other company. Let's consider the cost to the environment by doing that.

A typical garbage truck that collects 40 yd³ (30 m³) in the US does 2.8 miles per gallon (84 l/100km).[4] If you generate 100 kg (220 lb) of waste food per day that will occupy about one cubic yard (one cubic

1. Wikipedia, http://en.wikipedia.org/wiki/Photovoltaic_system
2. National Renewable Energy Laboratory, http://www.nrel.gov/rredc/pvwatts.
3. See Appendix II on page 7.
4. INFORM, Inc. the national environmental research organization. http://www.informinc.org/pr_ggt.php

metre) and you will need to have a waste container of 2 cubic yard. You will have that container collected at least three times a week.[1]

If the truck drives 150 miles to collect your waste food and that of others and take it to a composting facility, your contribution is 1/20 of the load (2 yd³/40 yd³) three times a week. So the diesel consumed to haul your garbage is:

$$\frac{1}{20} \times \frac{150 \text{ miles}}{2.8 \text{ mpg}} \times 3 \text{ times/week} = 8 \text{ gallons of diesel per week} \quad \text{(EQ 2)}$$

The EPA states that:[2]

1 US gallon of diesel creates 10.493 kg of CO_2

Therefore, the weekly CO_2 is 84 kg or 4.4 tonnes per year. That's about the carbon you saved by changing out 100 lights![3]

3.3 What's the Alternative?

The Liquid Food Composter from Power Knot will decompose your waste food where it is created. It fits in your kitchen and plumbs in like a dishwasher. Machines are available to process as little as 50 kg (110 lb) per day to as much as 900 kg (2000 lbs, or one US ton) per day.[4]

Waste food is decomposed in the LFC and sent down the drain. The LFC uses a special environment and a special blend of microorganisms so that most waste food is decomposed in 24 hours or less.

The LFC uses electricity to drive the machine. A machine that will process 100 kg (220 lb) of waste food per day uses about 4.8 kWh per day. Using equation 1, this will cause the generation of 1.2 tonne of CO_2 per year. The net effect (section 3.1 less this section 3.3) is 151.8 tonne of CO_2 saved per year.

3.4 But Isn't it Better to Compost than Send Down the Drain?

Sure, if you can do it locally and if the subsequent fertilizer is used locally. If your waste food is hauled some distance to be processed, or if the fertilizer is sent long distances to be used, you need to weigh the benefits from the standpoint of your carbon footprint.

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1. In the US, garbage containers are typically 2 cubic yard or 4 cubic yard. You can have these picked up six days a week (not on Sunday). Some municipalities mandate that waste food does not sit outside longer than two days.
2. U.S. EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009 (published April 2011). http://epa.gov/climatechange/emissions/usinventoryreport.html.
3. This is not the full story! If the waste food that is hauled off is indeed turned into valuable compost or is used to create methane which is subsequently used for cooking and heating, then that waste food has been put to good use.
4. Power Knot LLC, http://www.powerknot.com/liquid_food_composter.html

The material that exits the LFC and goes to the drain is rich in nutrients and also has those microorganisms. These microorganisms continue to live on any waste food that was not composted before it exited the machine through the fine mesh screen. They also help to digest other material in the sewage system and will help to keep your local drain clean.

A sewage treatment plant typically receives 99.94% water, with only 0.06% percent of the waste water being dissolved and suspended solid material.[1] The water is eventually treated and sent to rivers and then most sewer treatment plants create methane and fertilizer from the solid waste.[2] The nutrients you have put into the drain are not lost to the environment. So, your waste food that might be valuable for composting is not completely wasted.

4 Conclusion

The numbers speak for themselves:

Action	Result
Switch 100 T8 fluorescent lights to LED lights	Save 5.8 tonne CO_2 per year
Install 6 kW of solar panels	Save 6.0 tonne CO_2 per year
Have my waste food composted by an outside company	Add 4.4 tonne CO_2 per year
Use an LFC to decompose my waste food	Save 152 tonne CO_2 per year

For a perspective, 152 tonne of CO2 also comes from 64,500 litres (17,040 US gallons) of gasoline. This equates to driving nearly 350,000 miles per year![3]

To be a truly green establishment, you must stop polluting the earth with waste food. Sure, you can save a few kW by changing those lights or buying solar panels, and those measures are to be applauded. But you need to focus on the bigger problem: how to dispose of your waste food properly.

Power Knot provides safe and economically sound solutions for commercial, industrial, and military customers globally seeking to reduce their carbon footprint. The Liquid Food Composter (LFC) allows customers to reduce the expense, inconvenience, and mess of disposing of waste food that would otherwise be hauled to a landfill. Models are available that process from 100 lb per day to 2000 lb per day of waste food. Our technologies are proven, available today, have been in reliable use for many years, and offer a payback period typically of less than four years. Power Knot has its headquarters in Milpitas California. For more information, access www.powerknot.com.

1. South Carolina Office of Regulatory Staff (ORS). http://www.regulatorystaff.sc.gov/orscontent.asp?pageid=654.
2. Wikipedia, http://en.wikipedia.org/wiki/Sewerage_treatment
3. U.S. EPA. http://www.epa.gov/cleanenergy/energy-resources/refs.html#vehicles

5 Appendix I

The source is from *The Intergovernmental Panel on Climate Change (IPCC)*.[1] The data is from the *Fourth Assessment Report (AR4)* available here:

https://www.ipcc-wg1.unibe.ch/publications/wg1-ar4/wg1-ar4.html

The data is found in chapter 2, *Changes in Atmospheric Constituents and in Radiative Forcing*, which you can download directly from this link:

https://www.ipcc-wg1.unibe.ch/publications/wg1-ar4/ar4-wg1-chapter2.pdf

Part of table 2.14 on page 212 is reproduced here:

Gas	Global Warming Potential (GWP) for Given Time Horizon			
	SAR (100 yr)	20 yr	100 yr	500 yr
Carbon dioxide, CO_2	1	1	1	1
Methane, CH_4	21	72	25	7.6

The column headed SAR shows the data taken from the Second Assessment Report (SAR) of the IPCC which considered the effects on the climate up to 1993. The number 21 is still commonly used to describe the relative GWP effects of methane and is the number used by the U.S. EPA.[2]

1. The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change. It was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts. The UN General Assembly endorsed the action by WMO and UNEP in jointly establishing the IPCC.
2. U.S.EPA, http://www.epa.gov/methane/

6 Appendix II

The source is from the *U.S. EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009* (published April 2011), Annex 3.14, available here:

http://epa.gov/climatechange/emissions/usinventoryreport.html.

Table A-247 on page A-310 indicates that in 2009 the net amount of CH_4 emissions from landfills is 5.593×10^9 kg.

Using the data from section 1 on page 1 of this document, 33.44×10^9 kg of waste food is discarded annually. So,

$$33.44 \times 10^9 \text{ kg of waste food generates } 5.593 \times 10^9 \text{ kg of } CH_4 \text{[1]} \quad \text{(EQ 3)}$$

or,

$$1 \text{ kg of waste food generates } 0.1673 \text{ kg of } CH_4 \quad \text{(EQ 4)}$$

Using a multiplier of 25 for the effect of CH_4 on the GWP,

$$1 \text{ kg of waste food generates the equivalent of } 4.2 \text{ kg of } CO_2 \quad \text{(EQ 5)}$$

The units are dimensionless, so, for example, 1 lb of waste food generates the equivalent of 4.2 lb of CO_2.[2]

1. This analysis is not strictly accurate. Some of the methane discharged into the atmosphere in any one year has come from waste food discarded on the landfill in previous years. However, the author believes that second order effect to be negligible to the current argument.
2. This number can alternatively be derived from the EPA web site: http://www.epa.gov/outreach/sources.html. It states that landfills produce methane that is the equivalent CO_2 of 117.5×10^9 kg. Dividing this by 33.44×10^9 kg gives a factor of 3.5. This is because the EPA uses a multiplier of 21 not 25 as discussed in Appendix I on page 6. Multiplying 3.5 by 25/21 gives 4.2 as the multiplier derived in equation 5.