VORS 2013 – Sally Brown, Ph.D. Workshop Questions and Worksheets

How bad is it to send food scraps to a landfill?

Gas collection efficiency
Gas generation efficiency
Fugitive emissions

If we send our food scraps to a digester would we get a lot of energy?

Use EBM values- calculate quantity of electricity f

What about compost?

I hear that you have GHG emissions during composting?

Aren't there benefits from using compost

Will we make too much compost to use?

Soil C sequestration
Fertilizer
    Done per ton compost/ per ha soil

Is landfill gas collection really green energy?

In perfect digestion conditions 1 dry ton of food waste produces between 660 and 1200 kWh of electricity. We can easily just say that:

1 dry ton of food waste gives you 1000 kWh of electricity

In VT the normal emissions associated with 1 MWh (1000 kWh) is 0.47 tons of CO2

1 dry ton of food waste gives you 65 kg of methane

Let's say the landfill isn't as efficient at turning food waste into methane as a dedicated digester.

How much CO2 offset would you get if the landfill was 75% as efficient as the digester?

How about 50% as efficient?

Let's say that the part that didn't get made into electricity was released to the atmosphere. What is the CO2 equivalent of what was released?

Remember that CH4 is 23 x as potent as CO2

Scale this up to VT

Say that there are 630,000 people in VT and that each person makes 40 kg dry food waste per year

Will there be any place to put compost?

There are 627,000 people in VT

Or a population density of 26.1 people per hectare

Each hectare (ha) his 100 x 100 meters or 10 000 m2

How much land is that per person in m2?

Soil weighs more than you think

The top 15 cm (6") of soil in a hectare weighs about 2000 metric tons

How much soil is that per person?

Every year a person makes about 100 dry kg of food and yard waste- mixed together this makes great compost. Composting makes a stable, rich, high organic matter product out of rotten leaves and moldy leftovers. In the process, some of that mold is converted to CO2

Say that each person's 100 kg of yard and food waste turns into 50 kg of compost

Will there be too much compost for the soil?

What are the soil benefits associated with using compost?

Compost is excellent for the soil. It helps increase soil organic matter, reduces soil bulk density and increases soil water holding capacity. It also reduces the need for synthetic fertilizer

Say that the 627,000 people in VT all participate in the diversion program and each person ends up producing the equivalent of 50 kg of compost each year

How much total compost would that be?

Let's make the multiplication easier- say that each person made 100 kg of compost. You need 1000 kg of compost to equal 1 ton of compost.

Compost can add to soil organic matter. Different papers have found that each ton of compost added to soil sequesters between 0.1 and 1 ton of CO_2 in the soil

How much carbon will you add to the soil if each ton of compost sequesters 0.5 tons of CO_2?

Using compost also means that you don't need to use fertilizer. Compost typically contains about 1-2% nitrogen and 1% phosphorus. These fertilizers require fossil fuels to make; 4 kg CO_2 for each kg N and 2 kg CO_2 for each kg P

If you have 1 ton of compost that contains 2% N and 1%P- how much CO_2 do you save by using that instead of fertilizer?

Scale this up- How much GHG do you save for all compost produced in VT?

How much manure is there in VT?

Vermont has a lot of cows. There are 134,000 dairy cows in the state. Cows not only make milk for cheddar, they make a lot of manure. Each dairy cow makes about 2.4 tons of dry manure each year

How much manure is that each year in the state?

The manure typically has a total nitrogen content of 6%

How many kg of nitrogen are there in each dry ton (1000 kg) of manure?

If a typical agricultural application rate of nitrogen is 150 kg per hectare- how many hectares would you need to use up all of the diary manure each year?

Vermont has about 500,000 hectares in farming. Is there enough, too little or too much manure?

Cow power versus Food power

Vermont has a lot of cows. There are 134,000 dairy cows in the state. Cows not only make milk for cheddar, they make a lot of manure. Each dairy cow makes about 2.4 tons of dry manure each year.

Vermont has been very aggressive in building digesters to produce methane from animal waste. This was even on the cover of Biocycle magazine! In the article it was pointed out that many of the digesters are not making as much power as they had hoped. This makes sense because cows are ruminants and the manure coming out the rear has been digested in 4 chambers.

The manure from each cow produces about 180 kg methane each year

The energy density of methane is 50-55 Mj/kg

First how many Mj do you get per cow per year?

50MJ= 13.9 kWh
55 MJ = 15.3 kWh

Say 50 MJ= 14 kWh

How many kWh do you get per cow per year?

That gives you the amount of kWh for each 2.4 dry tons of manure

How much manure and how much energy do the cows make each year?

In contrast food waste hasn't even been digested once.

You get about 900 kWh of energy for each dry ton of food waste

Say each person makes about 20 dry kg of food waste each year

What part of a ton is 20 kg?

How much energy potential energy is there in each person's annual food waste?

Vermont has about 627,000 people. How much food waste and how much energy do the people make each year?

Transport versus fugitive emissions

It is true that driving cars and trucks release a lot of CO2. I'm going to switch units on this one, so be warned

Every year the people in VT make about 50 kg wet food waste per person. There are 627,000 people.

How much wet food waste is made every year in the state?

A long haul truck can carry 25 wet tons of waste. For food waste that is about 5 dry tons.

How many long haul trucks do you need to carry the food waste for the state for 1 year?

There are two landfills in VT and they are pretty close to each other

Let's say that each truck drove 160 miles round trip to bring food waste to the landfill. Average truck mileage is 5 miles per gallon. Trucks typically use diesel fuel.

How many gallons of fuel does it take to get to the landfill and back for each truck?

Diesel emits about 10 kg CO2 per gallon.

How much CO2 is released by each truck?

How much CO2 is released each year by taking food waste to the landfills?

The 50 kg of wet food waste is really about 20 kg dry food waste.

So how much dry food waste do you get from 627,000 people?

Most of the food waste decomposes within the first few years that waste is in a landfill.

Every thousand kg of food waste produces 65 kg methane. How much total methane would you get from all of the food waste?

If all of that is released to the atmosphere what would the CO2 value be (23 x the methane weight)?

How to collect the food waste

Let's say that a typical town has 20,000 people. Let's say that these people live in single family homes with 3 people per household. Let's say that their garbage collected once per week. Let's say that they drive 4 miles round trip to the supermarket once a week. And let's say that there is a recycling center behind the supermarket

If each person makes 50 (you can say 52) wet kg of food waste per year, how much would each household make per week?

If they each make 26 kg of other recycle able material a year- how much would each household make per week?

If they each make 10 kg waste a year- how much would each household make per week?

If a garbage truck can hold 5000 kg of material- how many garbage trucks would you need to collect wastes each week?

If the garbage truck drives 50 miles per route, gets 5 miles to the gallon and burns 10 kg CO_2 per gallon- how much CO_2 is emitted per garbage truck per route?

If people carry the food waste to a drop off point by the supermarket how many fewer garbage trucks would you need each week?

How many fewer kg of CO_2 would be emitted with fewer garbage trucks?

If VT has 630,000 people- that is the same as about 30 of these towns. What would the differences be if you scale it up?