Weighing Organic Waste Management Options

Solid waste facility operators and municipalities looking to invest in organic waste management strategies have plenty to consider to pinpoint the option with the greatest payoffs. And now is the time to better manage organics, with methane becoming front and center in climate change discussions and states enacting organics diversion requirements.

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There is a robust menu, then submenus, of methods and technologies to explore when evaluating organics waste management.

The one which makes the most sense will bevery site- and or location-specific. It depends on how you manage waste now and its impact on your current environmental footprint. It hinges on each management system's capabilities, from controlling different emission types to energy generation (or avoiding energy consumption), depending on which capabilities are most relevant to your goals. While these are core considerations, there are more layers to dig through in each situation.

Let's look at several well-established organics management options and analyze them side by side: composting, anaerobic digestion (AD), and direct combustion, aka biomass-to-energy, looking at outcomes an SCS Engineers team evaluated using computer models and various analytical tools.

As we begin the vetting process, be prepared to think about tradeoffs. For instance, the approach with the best greenhouse gas (GHG) profile may not perform as well withair pollutants like nitrogen oxides (NOx) or volatile organic compounds (VOCs). Suppose you are recovering landfill gas (LFG) for energy. There will be considerations here too, with regard to gains and losses, as diverting organic waste away from a LFG to energy project can reduce benefits you already enjoy.

The first question to ask is whether to divert organics from landfills at all. This is where we narrow in on GHGs. How you currently collect LFG and whether you convert it into energy will result in a huge differential.
So, it's important to know your baseline emission numbers when considering your options to understand better your current carbon footprint and your baseline emissions of other pollutants. Both will significantly affect your analysis and help inform your decision.

Let's look at three different landfill scenarios, considering both GHG emissions and whether energy is recovered or avoided. These each involve the management of one million tons of organic waste. One landfill has no gas collection and control system, with very high GHG emissions—1.5 million metric tons of carbon dioxide equivalent emissions (MTCO2e) and 640tons of VOC emissions.

The second landfill has 75 percent gas capture with a fl are used for emissions controls. Your GHG emissions go down to 370,000 MTCO2e and 170 tons of VOCs, but the NOxemissions increase to 80 tons.
There's 90 percent gas capture in scenario three, with the gas being sent to engines to generate renewable electricity. Here the gap widens further in outcomes. By converting methane to renewable

energy, you get more than direct GHG reductions. You also get GHG reductions from energy offsets. So now you're down to -100,000 CO2equivalents. And your VOCs are only 76 tons. However, NOx emissions increase to 96 tons with the engines.

How does knowing these metrics affect your investment decision?

First, let's revisit the third landfill scenario – the operation with extremely well-controlled emissions that converts methane from organics using LFG to energy technology.

Diverting organics over landfilling, in this case, will gain much smaller emissions benefi ts compared to uncontrolled landfill or landfills with LFG capture systems that arenot as robust. Plus, when you divert the organic waste, depending on the system, you lose a portion of that energy source to make power or fuel in the future. The landfill will generate less methane, eliminating some of the existing benefits you realize while decreasing the value of your energy recovery plant. Spending $10 million to $30 million on a plant to compost or anaerobically digest organic materials, a reasonable estimate depending on facility type and size, may not provide sufficient benefit to justify adopting either technology when you consider the loss in LFG to energy value and investment.

Conversely, if waste goes to a site with no gas collection system, organics diversion of any kind will perform exceedingly better in terms of emissions. At the top of the list of payouts: organics diversion methods can create a huge amount of GHG benefits.

Let's analyze the options, beginning with composting (there are several possibilities within this one space).

Sizing up composting options

One commonality among all compost options differentiating them from other diversion methods is the benefi t of carbon sequestration. Capturing carbon and storing it inthe soil drives additional GHG benefi ts beyond the reduced energy consumption (less irrigation and avoided commercial fertilizer manufacturing). At the same time, AD has limited sequestration benefits, and biomass-to-energy has none. Keep this in mind if you need to improve your GHG profile.

There are three main composting methods, each with different emissions outcomes:
Open windrow composting

Forced aeration

Covered aerated static pile (CASP)

Open windrow composting involves mechanically turning piles to aerate them and break down the feedstock. But without an enclosure or controls, it provides no means toprevent VOC, ammonia, and other emissions.

Comparing the landfi ll scenarios detailed above, an open windrow composting facility without controls can emit 2,125 (green waste) tons of VOCs to 5,000 (green plus food waste) tons of VOCs for every 1,000,000 tons of throughput.

Windrow composting operations can also produce GHG emissions in the form of methane when aeration is not sufficient via mechanical means and some anaerobic degradation occurs. This is a bigger problem for food waste composting because of the faster degradation of organic materials.

You can add operational controls to windrows through forced aeration (aerated static piles). This method involves pumping air through the pile to speed up the composting process, which substantially reduces methane formation, reduces VOCs to a degree, and provides better odor control. Additionally, because throughput moves quicker, the operation requires less space.

Comparing to open windrow composting with no controls, VOC emissions are reduced to 978 (green waste) tons of VOCs to 2,300 (green plus food waste) tons of VOCs for each every 1,000,000 tons of throughput, a reduction of greater than 50 percent.

The next method, CASP, yields better outcomes by adding a control system to an aerated pile system. There are three main CASP options:

Pulling air through the compost piles with a vacuum and sending that air to a biofi lter that treats and removes pollutants.

Blowing air into the pile, which operates under a biocover that acts as a treatment layer, removing pollutants.

Installing a synthetic cover, such as the GORE cover system, with semi-permeable membranes that achieve the same results as the biocover.

Each of these control technologies is similar in terms of VOC emission reductions. And when deployed in the example scenarios just described, VOC emissions are reduced to 50 (green waste) tons to 75 (green plus food waste) tons for every 1,000,000 tons of throughput— a reduction greater than 95% compared to open windows.

GHG benefits from composting range from -228,000 to -396,000 MTCO2e (-958,000 to 1.13 million MTCO2e when including sequestration)—even greater depending on the avoided landfill ll methane scenarios we reviewed.

The main takeaways on composting are:
Both GHGs and VOCs vary substantially, depending on whether you add aeration and controls.
Even without controls, the GHG profi le is strong.
The CASP options achieve the best results. But be prepared to pay for this system's additional benefits—up to two to three times more than windrows, depending on your facility size.

How does anaerobic digestion fare?

With AD, organics break down in enclosed vessels or reactors. Biogas comes out in one direction, and residuals exit through the other. Because AD happens in an enclosure,emissions are easier to control than when composting.
The ability to make renewable natural gas (RNG) is perhaps the greatest benefit that distinguishes this technology from composting. And the gas has higher methane content with fewer impurities than renewable biogas from landfill gas, adding to its value.

The federal government offers good subsidies for RNG-derived transportation fuel in the form of renewable identifi cation numbers (RINs), which are credits used for compliance. California and Oregon issue low-carbon credits for RNG used for transportation fuel at the state level, and other states are exploring implementing similar programs. So, investing in AD can be lucrative now.

Some caveats: the AD systems require more energy to run and are more expensive on a dollar-per-ton basis than composting. There are building costs and reactors. You also have to pre-process material to a greater degree, so it's more involved than composting.

And while producing RNG for transportation fuel reduces emissions significantly, burning the biogas in engines for electricity creates additional combustion emissions.

AD has a better GHG profile than composting when excluding carbon sequestration but not as good when including sequestration. And AD has much lower VOC emissionsthan composting because of its generally closed-loop design.

So, ask yourself if improving GHG emissions while achieving robust energy recovery are your top priorities. This is where you could cash in if you choose to make RNG leveraging AD, and if you are able and willing to make the additional capital and operational investment over composting.

The nitty-gritty of biomass-to-energy (direct combustion)

This option, entailing direct burning of solid organics, has the highest energy value and thus the greatest GHG profi le if excluding sequestration.

While AD yields energy only from a certain portion of organics, and composting creates no direct energy (only energy offsets), you get energy from all of it when you burn organics. That’s because you are using the entire feedstock in the combustion process.

Here’s the drawback: there are more air pollution emissions with biomass-to-energy, especially NOx, as well as other combustion byproducts.

Technologies to control emissions are improving, and burning organics is cleaner than burning municipal solid waste. But biomass-to-energy is only a likely option if there isa strong need for electricity or there is very limited space for disposal or composting. But know that many regulatory jurisdictions frown upon direct combustion and prefer composting or AD.

There are many variables to consider with each organics management method, and there are no silver bullets as each has its pros and cons. It’s important to do a deep dive,site-specific analysis, carefully weighing each of your options. And of course, once the emission and energy impacts and benefits are determined, cost—both capital and operating—must be considered for a truly sustainable solution.
