Comparison of Organic Waste Management Options in Terms of Air Quality and GHG Impacts

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Comparison of Organic Waste Management Options in Terms of Air Quality and GHG Impacts

Goal is to quantitatively compare different organic waste management options based on emissions

Landfilling
- With and Without Control and Energy Recovery
- Organic Waste as Alternative Daily Cover (ADC)

Composting of Green and Food Waste
- Open Windrows
- Aerated Static Piles (ASP) with Controls

Anaerobic Digestion

Biomass to Energy

Quantitative Comparison

Quantitative Comparison - Inputs

- 1,000,000 tons of organic waste managed by each technology
- Biogenic CO_2 not included for any strategy

- All calculations assume a mixture of 90% green, 10% food waste, except:
  - Food waste composting: 55% green/45% food

- Lifecycle emissions for 1,000,000 tons, <u>not annual</u>
- Direct benefit for energy generation from LFG/biogas (AD) and biomass to energy

Quantitative Comparison - Inputs

- Indirect energy benefit from compost use per CARB compost methodology
- Biogas to energy emissions based on typical engine specifications

- Composting emissions taken from CARB emission factors actual source test data

- Anaerobic digestion leaves residual for land application
- **No credit for displaced methane emissions for diversion**

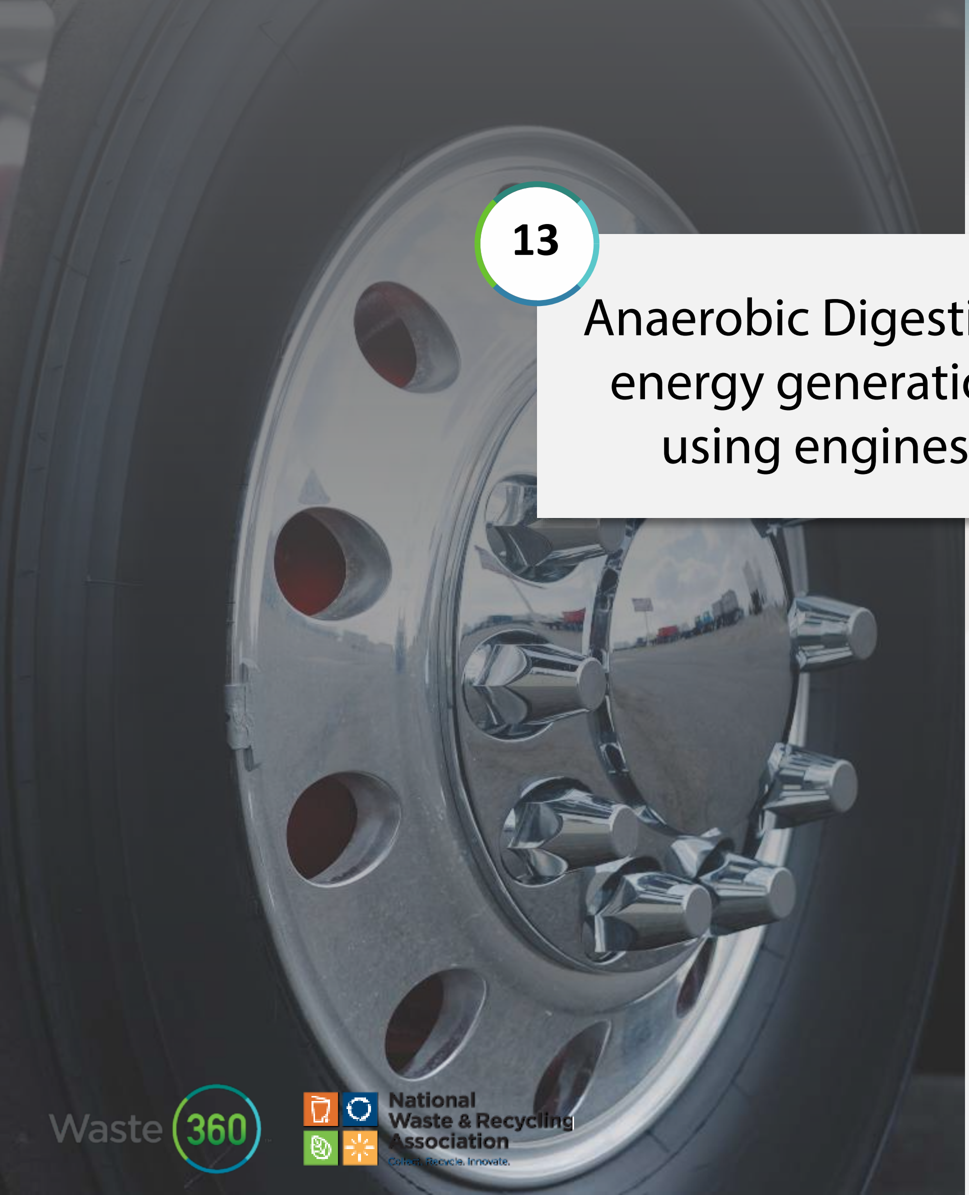
Landfill Scenarios

1. Landfill without a GCCS
2. Landfill with GCCS, flare and 75% capture
3. Landfill with GCCS, energy recovery using engines, 75% capture
4. Landfill with GCCS, flare, 90% capture
5. Landfill with GCCS, energy recovery using engines, 90% capture
6. Use of Organic Waste as Biocover (comparison to #2)

Composting Scenarios

7. Open windrow composting, no controls
8. Open windrow composting, operational controls
9. CASP composting
10. Open windrow composting of food, no controls
11. Open windrow composting of food, operational controls
12. CASP composting of food

Other Diversion Scenarios



13 Anaerobic Digestion, energy generation using engines

14 Biomass to Energy

Results

Landfill Scenario		Direct GHG	Energy Offset	Overall GHG Profile (no seq.)	Carbon Storage	(with seq.)	CO	NOx	VOCs
		($MTCO_2e$)					(Tons)		
Landfill	1. No GCCS	1.5 mil	0	**1.5 mil**	-730,000	**770,000**	0	0	640
	2. 75% LFG capture to flare	370,000	0	**370,000**	-730,000	**-360,000**	120	36	170
	3. 75% LFG capture to engines	370,000	-210,000	**160,000**	-730,000	**-570,000**	400	80	170
	4. 90% LFG capture to flare	150,000	0	**150,000**	-730,000	**-580,000**	144	44	76
	5. 90% capture to engines	150,000	-250,000	**-100,000**	-730,000	**-830,000**	480	96	76
6. Landfilling with biocover (compare to #2)		300,000	0	**300,000**	-730,000	**-430,000**	120	36	140

Results

Diversion Scenario		Direct GHG	Energy Offset	Overall GHG Profile (no seq.)	Carbon Storage	(with seq.)	CO	NOx	VOCs
		$MTCO_2e$					Tons		
Compost	7. Windrow, no control	100,000	-400,000	**-300,000**	-730,000	**-1.03 mil**	0	0	2,125
Compost	8. Windrow, 54% operational control	46,000	-400,000	**-354,000**	-730,000	**-1.08 mil**	0	0	978
Compost	9. CASP, 90% control	4,000	-400,000	**-396,000**	-730,000	**-1.13 mil**	0	0	50
Compost	10. Food waste, windrow, no controls	172,000	-400,000	**-228,000**	-730,000	**-958,000**	0	0	5,000
Compost	11. Food waste, 54% operational control	79,000	-400,000	**-321,000**	-730,000	**-1.05 mil**	0	0	2,300
Compost	12. Food Waste with CASP, 90% control	7,000	-400,000	**-393,000**	-730,000	**-1.12 mil**	0	0	75
13. Anaerobic Digestion		25,000	-550,000	**-525,000**	-100,000	**-625,000**	600	120	96
14. Direct Combustion		10,000	-750,000	**-740,000**	0	**-740,000**	2400	880	110

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Conclusions

What did we learn about landfills?

- Highly dependent on presence/level of LFG collection/control
- No LFG capture has worst GHG/VOC profile; 90% capture/energy recovery has best GHG profile
- Without sequestration, landfill GHG emissions are highest
- Energy recovery improves GHG profile but increases other emissions (e.g., NOx, CO) unless RNG created
- ADC does not increase emissions but increases oxidation of methane/VOC in the landfill surface

Conclusions

What did we learn about composting?

- Composting has low GHG emissions even without sequestration
  - Lowest when sequestration considered
- Windrow composting has high emissions
  - Higher with food waste
- VOC/GHG emissions are reduced with controls/aeration
  - Significant with CASP or synthetic covers
- GHG benefit due to indirect energy reductions is significant, but no renewable energy created

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Conclusions

What did we learn about AD?

- Strong GHG profile due to closed loop system and energy recovery
- Limited sequestration benefits
- High criteria pollutant emissions when biogas combusted in engines
- Most projects involve RNG so combustion emissions would be significantly reduced

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Conclusions

What did we learn about Biomass to Energy?

- Strongest GHG profile before sequestration is considered
- No sequestration benefits
- Highest criteria pollutant emission rates due to combustion of solids
- Releases CO_2 from organic components that may be sequestered under other options

Closing Thoughts

- There is no “silver bullet” waste management option for organics from emissions standpoint
  - Each has pros/cons and trade-offs

- Controls are available for all options (with added cost)
  - LFG collection
  - Controls on combustion
  - CASP with biocover, biofilter, synthetic cover

- Reduction of landfill methane can be additional benefit for any diversion options, but very case specific
  - Range: -100,000 to 1.5 million MTCO2e

Closing Thoughts

- Who gets sequestration benefit? Should they?
  - Landfills
  - Composting
  - AD

- Project specific analyses are critical as there are many variables
- RNG production instead of combustion can have improved emissions and GHG profile

- Don't forget about transportation impacts/benefits; can be significant if waste has to travel large distances

Contact Information

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