Island Composting and the Carbon Footprint of Food Waste Disposal Alternatives

Presented by Michael Bryan-Brown

Green Mountain Technologies

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GMT Company History

- Founded in Vermont in1992
- Moved to Bainbridge in 2001
- Donated the compost system to Islandwood in 2002
- Local facilities include los Ranch, Heyday Farm Bloedel Reserve
- Approximately 400 sites worldwide

Islandwood Earth Flow System

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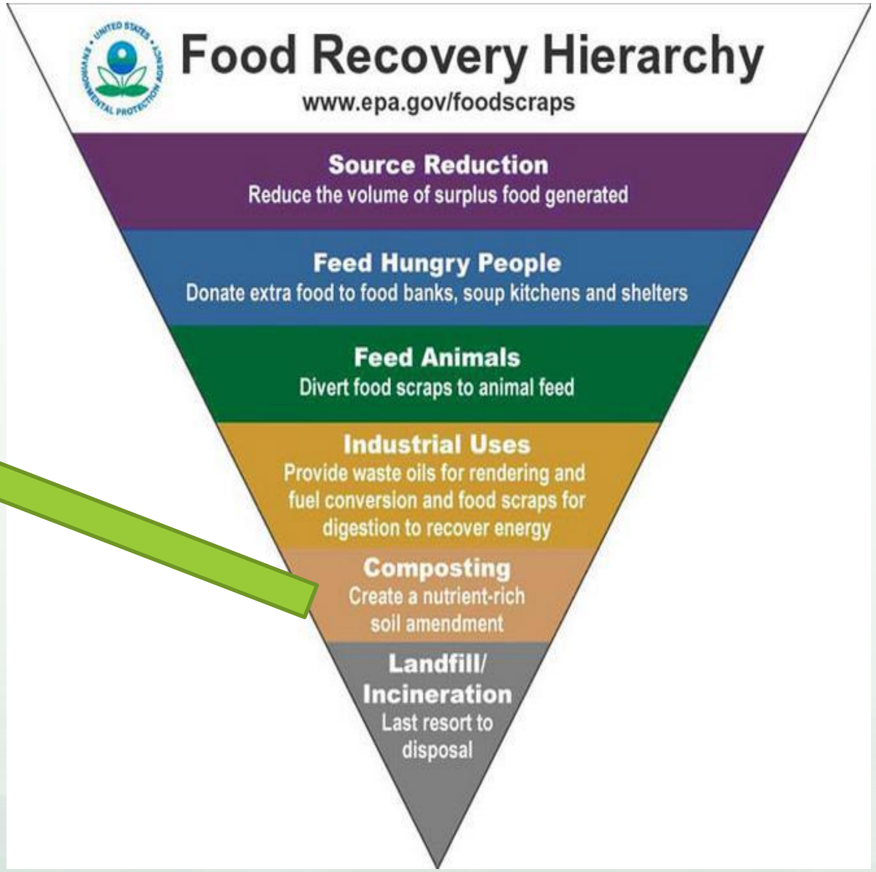
The Best or Highest Use for Food Scraps

Composting Options

- Residential backyard composting
- Curbside collection
- Trucking to centralized compost facilities
- One alternative for Islands is to encourage community composting



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GMT On-Site Composting Systems

The Earth Cube ™

for Smaller on-site waste generators

The Earth Flow ™

for Mid-sized waste generators

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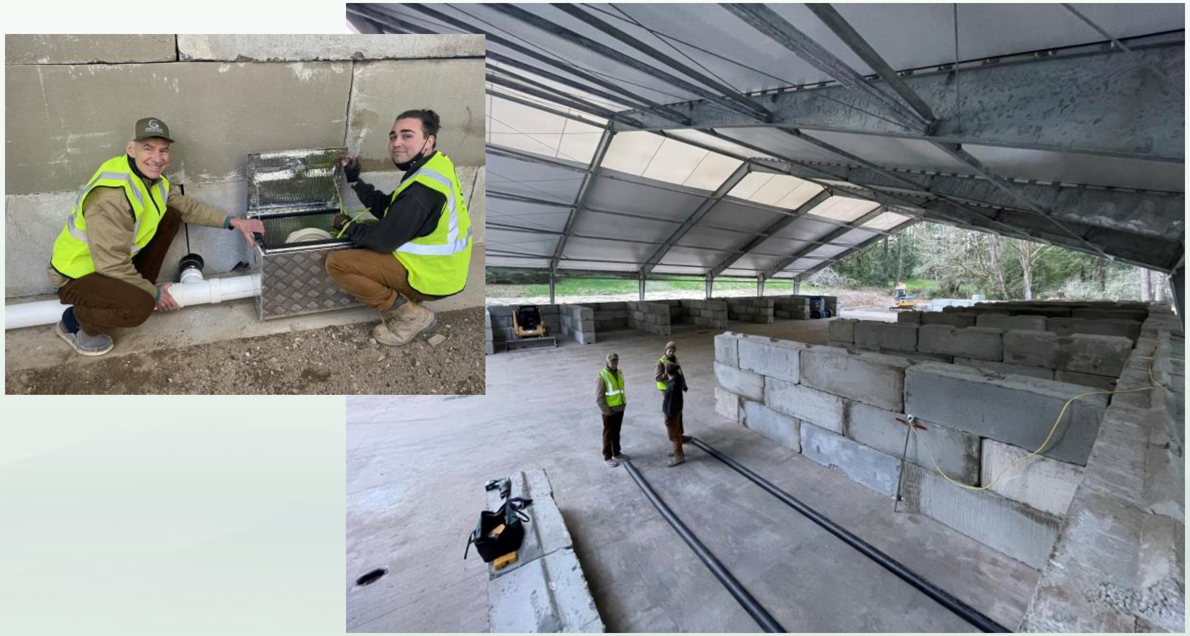
GMT Composting on Bainbridge

Bloedel Reserve



Heyday Farm Earth Flow

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Olympic Organics, ASP System Design
Kingston, WA

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Thurston County Purdy Topsoil

GMT Centralized Facilities

Dirt Hugger Dallesport, WA

Recology Tracy, CA

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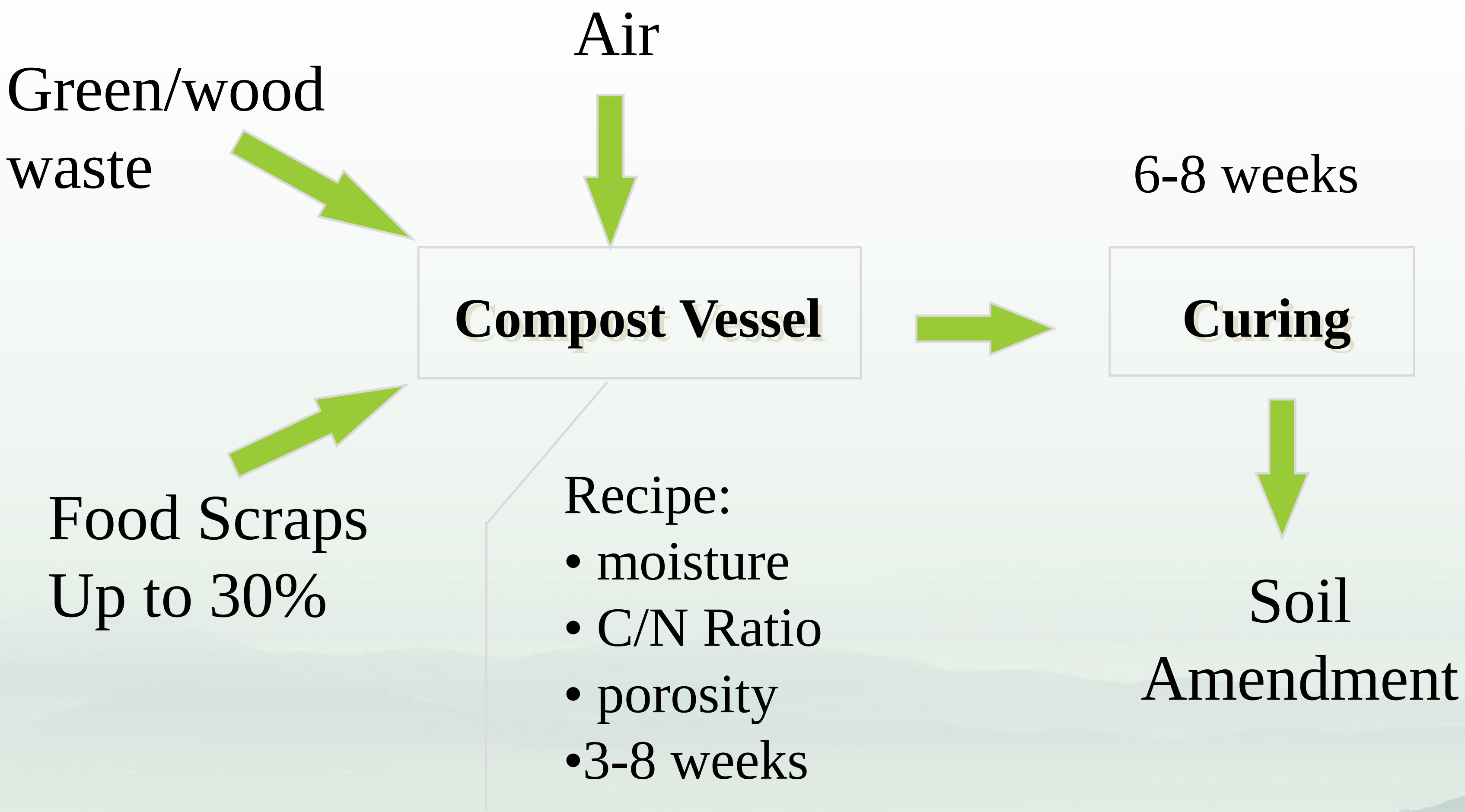
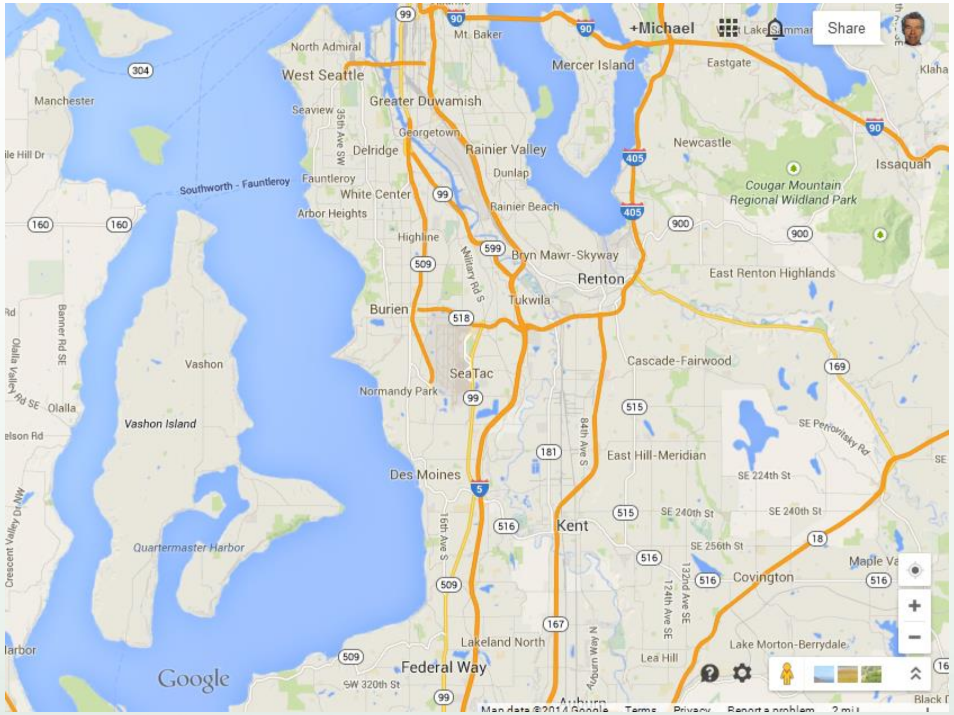
Aerobic Food Scrap Composting Process



BGI Case Study for Vashon Island



Vashon Zero waste field trip to Harvest Power

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Vashon Island Recycling Rate

- Seattle and Vashon are both in King County and has a diversion goal of 60% by 2015
- Seattle has a recycling rate of 57% and has curbside collection of organics
- Environmentally aware population of 11,000 on Vashon Island
- Vashon has a recycling rate of 9% due to lack of recycling services and options

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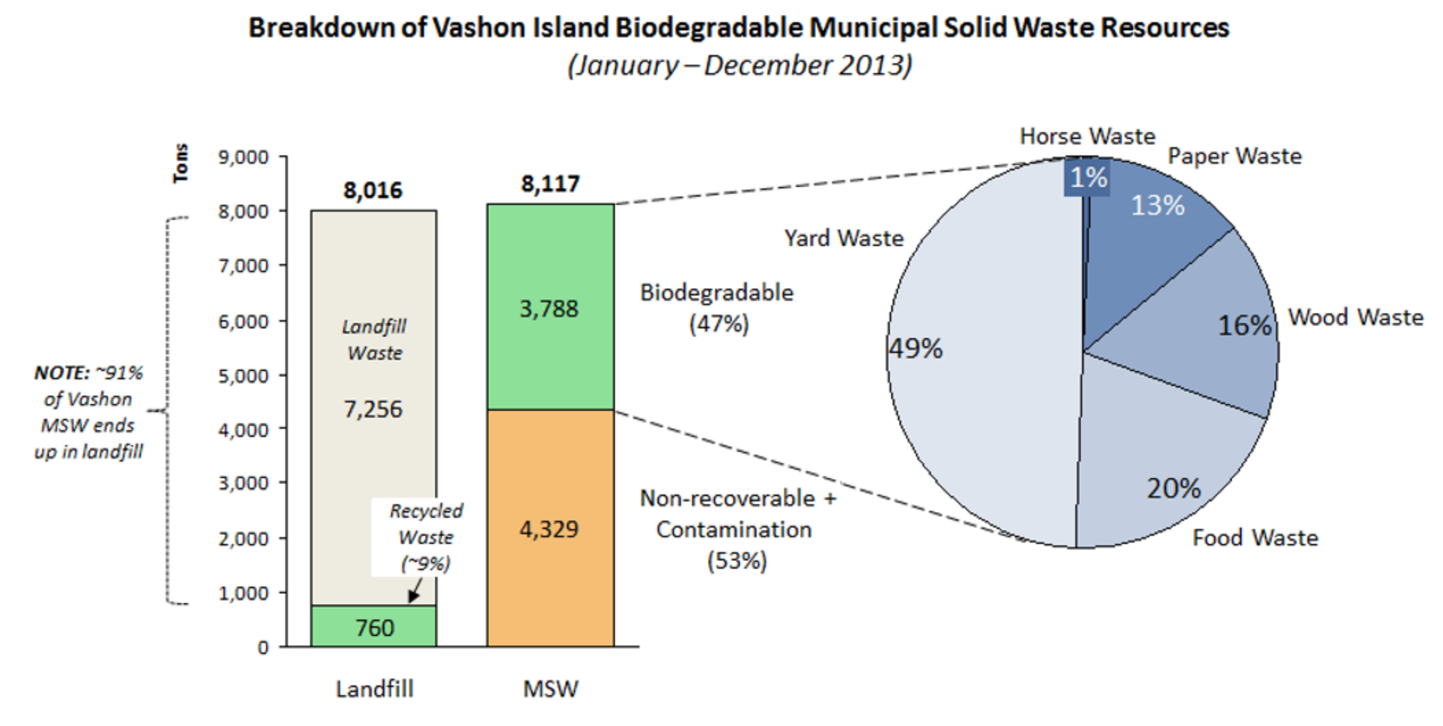
Organic Fraction on Vashon



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Community Composting got highest ranking
Their biggest issue was scalability

Figure 4.1.2 – Final Scoring of Approaches

Approach	Criteria						
	Reliability	Readiness	Scale	Social	Environ	Financial	TOTAL
	20%	*15%*	*10%*	*15%*	*20%*	20%	100%
(1) Fertilizer-Feedstock Facility	4	4	2	2	2	3	2.9
(2) Community Composting	5	4	2	4	3	4	3.8
(3) Organic Waste-to-Energy	2	3	4	4	4	4	3.5
(4) Organic Waste-to-Energy + Gasification	2	3	5	5	5	3	3.7

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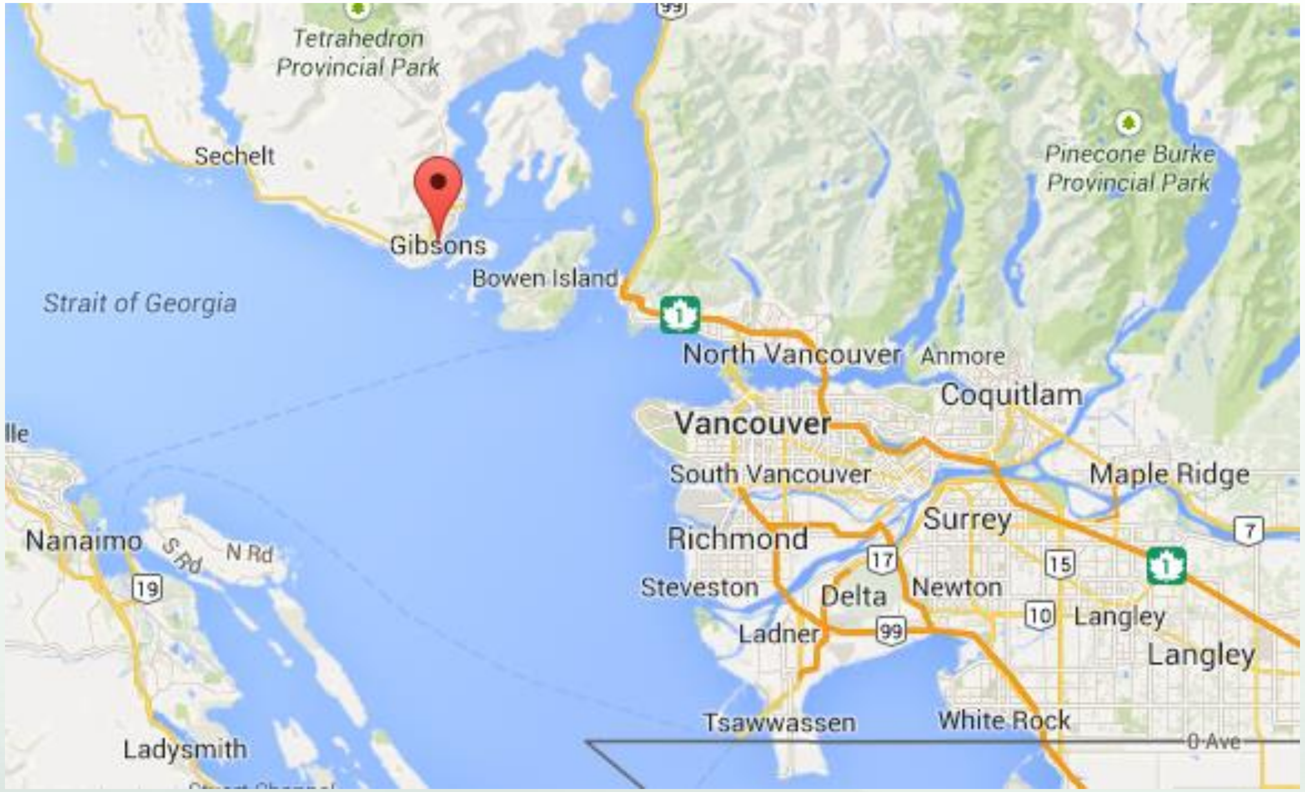
Gibson's Landing Case Study



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Gibson's Recycling

- Operator is president of Zero Waste Canada
- Provides curbside collection with electric vehicles
- Crushes glass and extrudes Styrofoam with on-site equipment
- Successfully diverting 55% of solid waste without composting

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Gibson's Drop-off Center

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Gibson's adds Composting

22' long Earth Flow Composter

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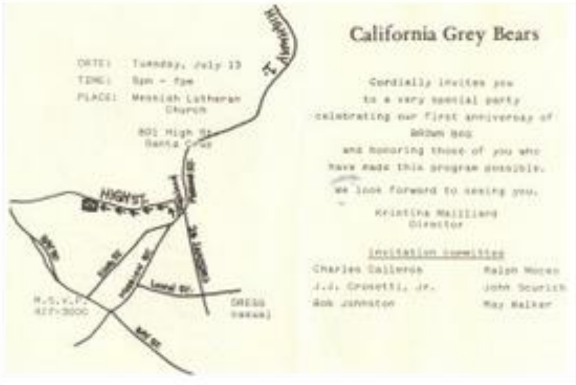
Grey Bears History

Benchmarks over four decades of service

1973 – Grey Bears is conceived by Kristina Mailliard, 23, and her boyfriend, Gary Denny, 32, when they share fruits and vegetables from their garden with local seniors. Surprised at the undernourishment of the elderly poor, they held a harvest festival for the senior community. First year membership is 100.

1975 – Working out of local grower Ralph Moceo's warehouse on Fair Avenue on the westside of Santa Cruz, Grey Bears balloons to 1,400 members paying $1 per year. Fifteen farms are now open to volunteer gleaners to secure produce that would otherwise go to waste. Stories in the *Wall Street Journal*, People Magazine and network television coverage catapults the organization and senior volunteerism into the national spotlight.



California Grey Bears

DATE: Tuesday, July 13
TIME: 5pm - 7pm
PLACE: Messiah Lutheran Church
801 High St
Santa Cruz

Cordially invites you
to a very special party
celebrating our first anniversary of
BROWN BAG
and honoring those of you who
have made this program possible.
We look forward to seeing you.

Kristina Mailliard
Director

Invitation committee

Charles Calleros
J.J. Crosetti, Jr.
Bob Johnston
Ralph Moceo
John Scurich
May Walker

1976 – Grey Bears was incorporated as a nonprofit 501(c)(3) membership organization. The first anniversary celebrating Brown Bag program volunteers takes place on July 13th at Messiah Lutheran Church on High Street in Santa Cruz.

1984 – Grey Bears moves to the Brown Bulb Ranch. Membership has been steadily increasing to about 2,000 seniors.

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Grey Bears Adds Recycling

are used, and the rolled paper is sold to local nurseries.

1992 – The Santa Cruz Recycling Alliance Program (SCRAP) is incorporated. Formerly a group of four recycling partners, SCRAP is consolidated to deter Waste Management Inc. from putting small recyclers out of business.

Grey Bears is a founding member of F.O.O.D. Crops (food organizations organizing and distributing crops) which later becomes Ag Against Hunger. Ag AgainstHunger supplies Grey Bears with 750,000 pounds of produce per year. They become a central organizing component for the ag community.

Board approves purchase of the property adjacent to Chanticleer and opens a full time thrift store and discontinues quarterly rummage sales.

1996 –Grey Bears purchases the recycling property (lot #3), creating space to separate the brown bag program from the recycling center. The first contract with the County is signed to run the recycling center at the Buena Vista Landfill.

2000 – Grey Bears board of directors collaborates with the County Board of Supervisors to operate the Chanticleer Avenue public recycling center.

2002 – E-waste recycling begins, accepting computers, printers, televisions, appliances and other electronics.

Grey Bears Adds Composting

- Senior volunteer labor
- Composting rejects from food bank
- Offers compost to members to use in their gardens

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Two Primary GHGs Generated by Organic Waste are Methane and Nitrous Oxide

- Biogenic CO2 emissions are generally excluded from the LCA models
- Methane is approx. 30x more potent GHG than CO2 or 80x over 20 yrs
- Nitrous Oxide is 264x more potent than CO2 and is produced during composting or by ammonium Nitrate fertilizers and manure when applied to ag land.
- Both gases are produced anaerobically or facultatively at O2 levels less that 2% or are intrinsic in the organic waste when it arrives at the facility
- Methane and N2O can be oxidized by biofiltration or a well oxygenated biocover layer on the surface of the compost pile

Nitrous Oxide (N_2O): **Nitrous oxide** occupies a relatively small share of global greenhouse gas emissions—about six percent—but it is 264 times **more powerful than carbon dioxide** over 20 years, and its lifetime in the atmosphere exceeds a century, according to the IPCC.

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Real Time Data of Methane Emissions in California by Aerial Survey

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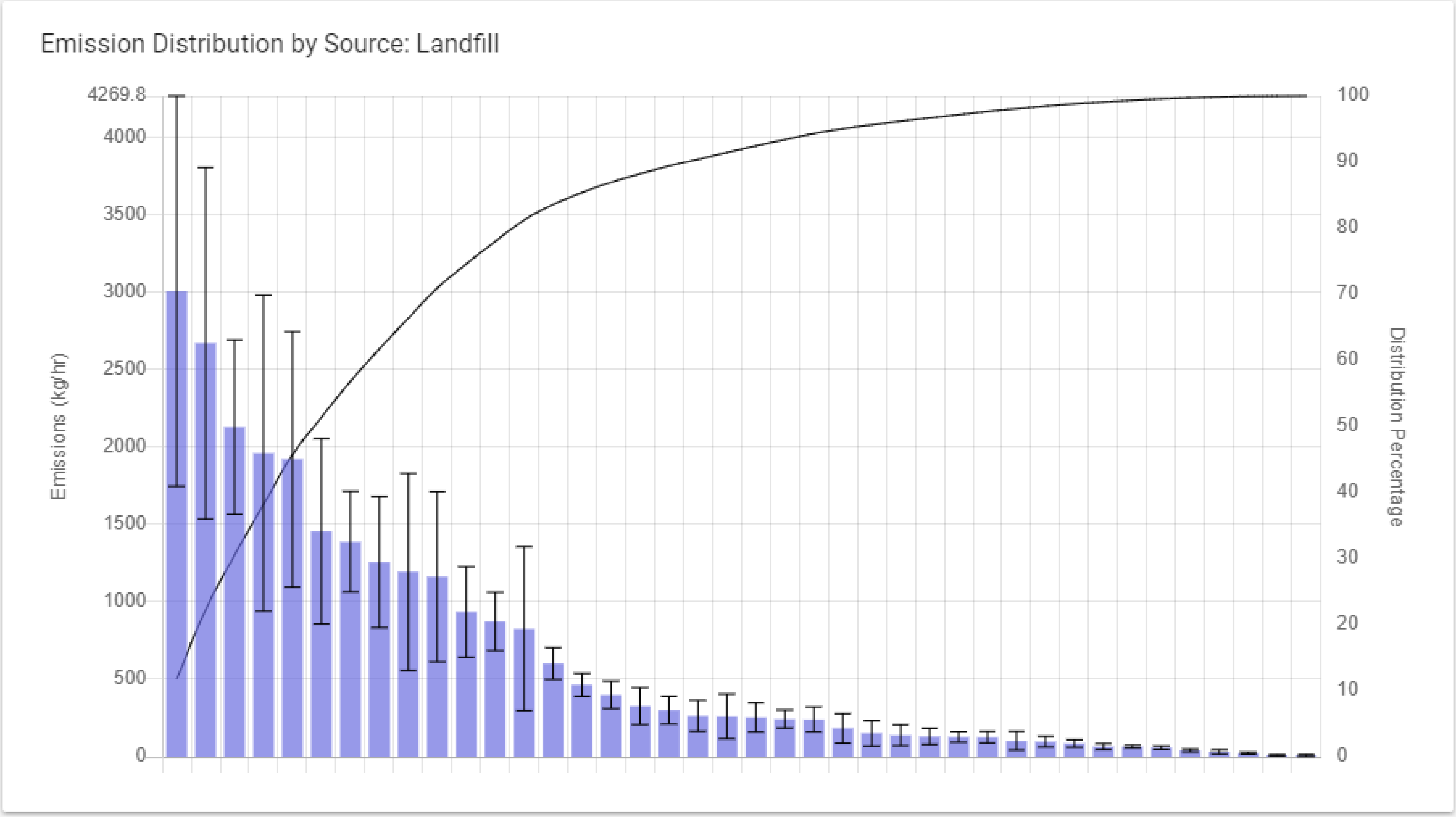
Methane Plume Detection Rates by Subsector

Sector	Facilities	Facility Flyovers	Unique Facilities Flown Over	Unique Facilities with > 0 Plume Detections
Fuel Combustion Activities	459	422	175 (38%)	21 (4%)
Fugitive Emissions from Fuels	227884	806	173479 (76%)	85 (0%)
Livestock	1810	245	900 (49%)	131 (7%)
Solid Waste Disposal	712	517	189 (26%)	31 (4%)
Biological Treatment of Solid Waste	418	277	90 (21%)	1 (0%)
Wastewater Treatment & Discharge	149	159	35 (23%)	6 (4%)

Composting=biological treatment of solid waste

31 landfills had a wide range of emissions



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There are 409 static pile facilities that likely have high methane emissions

State	Windrow	SP[1]	ASP[2]	I-V[3]
Alaska	0	0	4	1
Arizona	5		1	
Arkansas	8	10		
California	151	0	12	13
Colorado	23	8	1	1
Delaware	1	1	3	0
Georgia	11	10	1	5
Idaho	3		2	
Iowa	25	6	48	1
Kansas	165	21		
Kentucky	33			
Louisiana	150	15	25	25
Maine	25	80	11	3
Maryland	16		2	
Minnesota	5	0	4	2
Mississippi	3	8		
Montana	13	27	1	1
Nebraska	8			
Nevada	5		1	
New Mexico	20	19	1	1
N. Carolina	14	2	4	2
N. Dakota	23	57	0	0
Ohio				10
Oklahoma	13		1	1
Oregon	32	13	8	0
Rhode Island	22	1		1
S. Carolina	7		1	
S. Dakota	16	126	0	1
Tennessee	7	0	1	
Texas	15	1	2	
Vermont	9	0	1	0
Virginia	18	0	4	5
Washington	24	4	30	8
Wisconsin	265	0	1	
Total	**1,135**	**409**	**170**	**81**

Gas meter shows almost 5% methane from static pile

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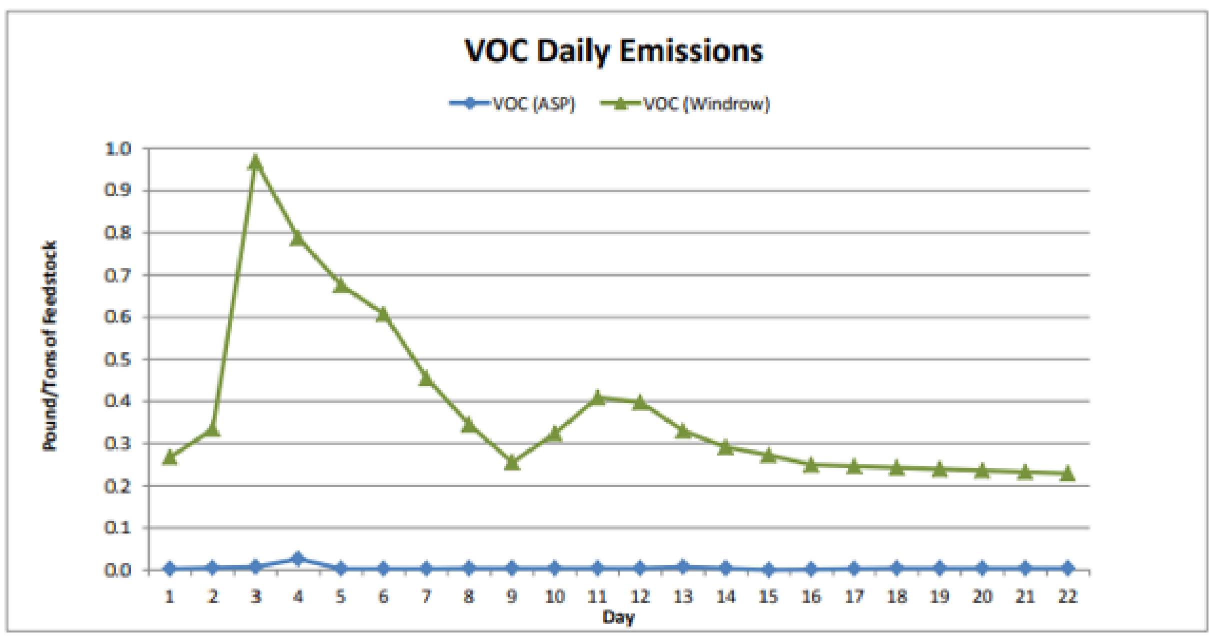
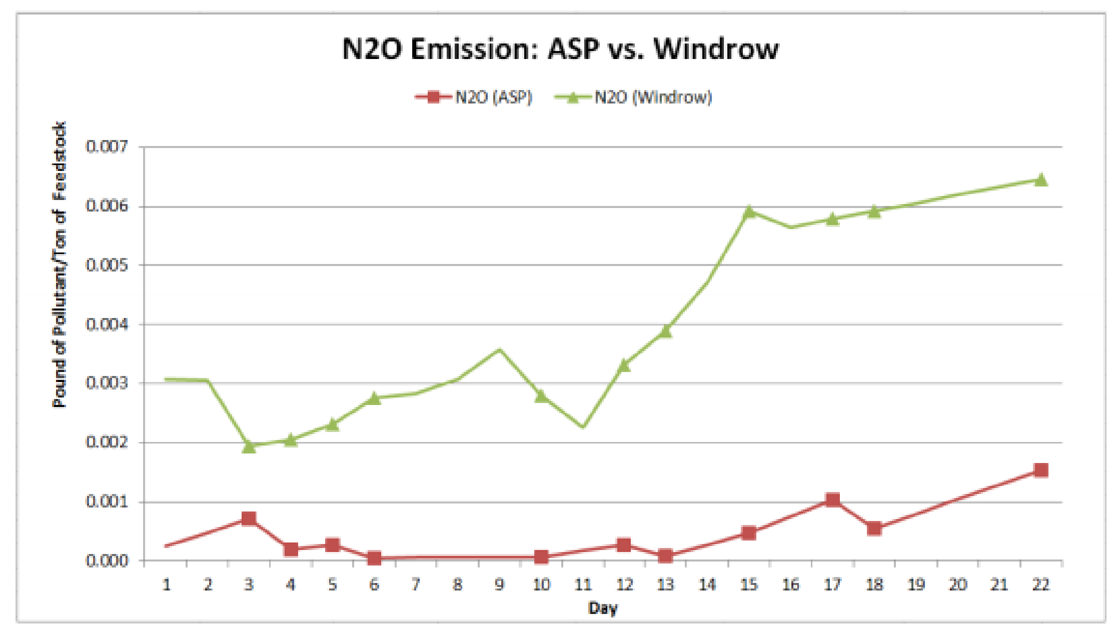
VOC's and N2O Emissions Reductions ASP vs Windrow*





Aeration can greatly reduce emissions compared to static piles or windrows

*Green waste Compost Site Emissions Reductions
from Solar-powered Aeration and Biofilter Layer 2013

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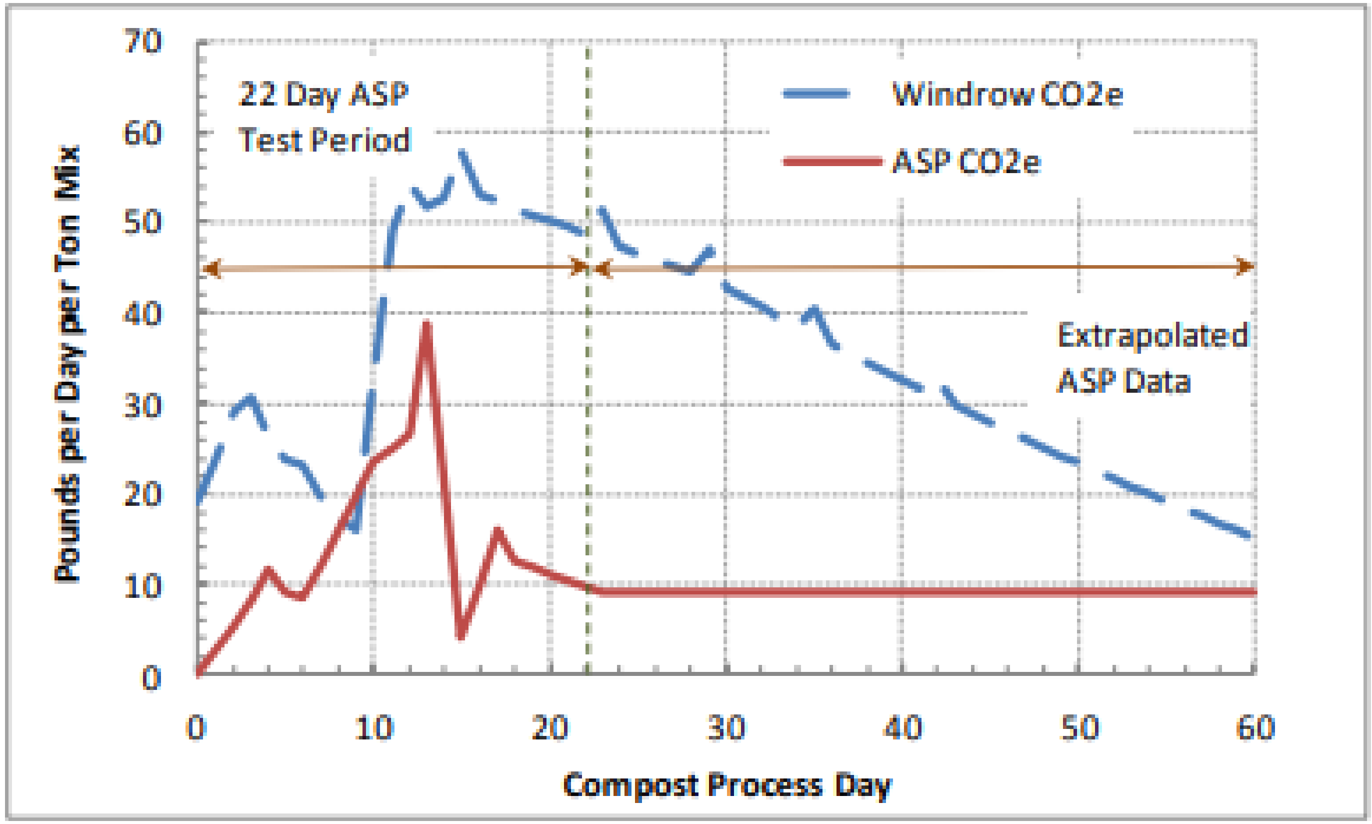
CO2e Emissions Comparison Windrow vs ASP*

Figure 6.6 CO2 Equivalent Emissions (#/ton mix) for Each Process Day.



*Green waste Compost Site Emissions Reductions from Solar-powered Aeration and Biofilter Layer 2013

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What is Life Cycle Assessment (LCA)

- LCA is a method of assessing environmental impacts associated with all the stages of a product's life from raw material extraction (through materials processing, manufacture, distribution, use, repair and maintenance) to disposal or recycling.
- For Composting, LCA is a Cradle to Grave analysis of environmental impacts from the point at which waste is collected to utilization of the final product
- LCA used to evaluate alternative methods of management such as landfilling vs composting or anaerobic digestion.
- Life cycle impact assessment (LCIA) includes more environmental impacts than GHG such as VOCs, water and human health.

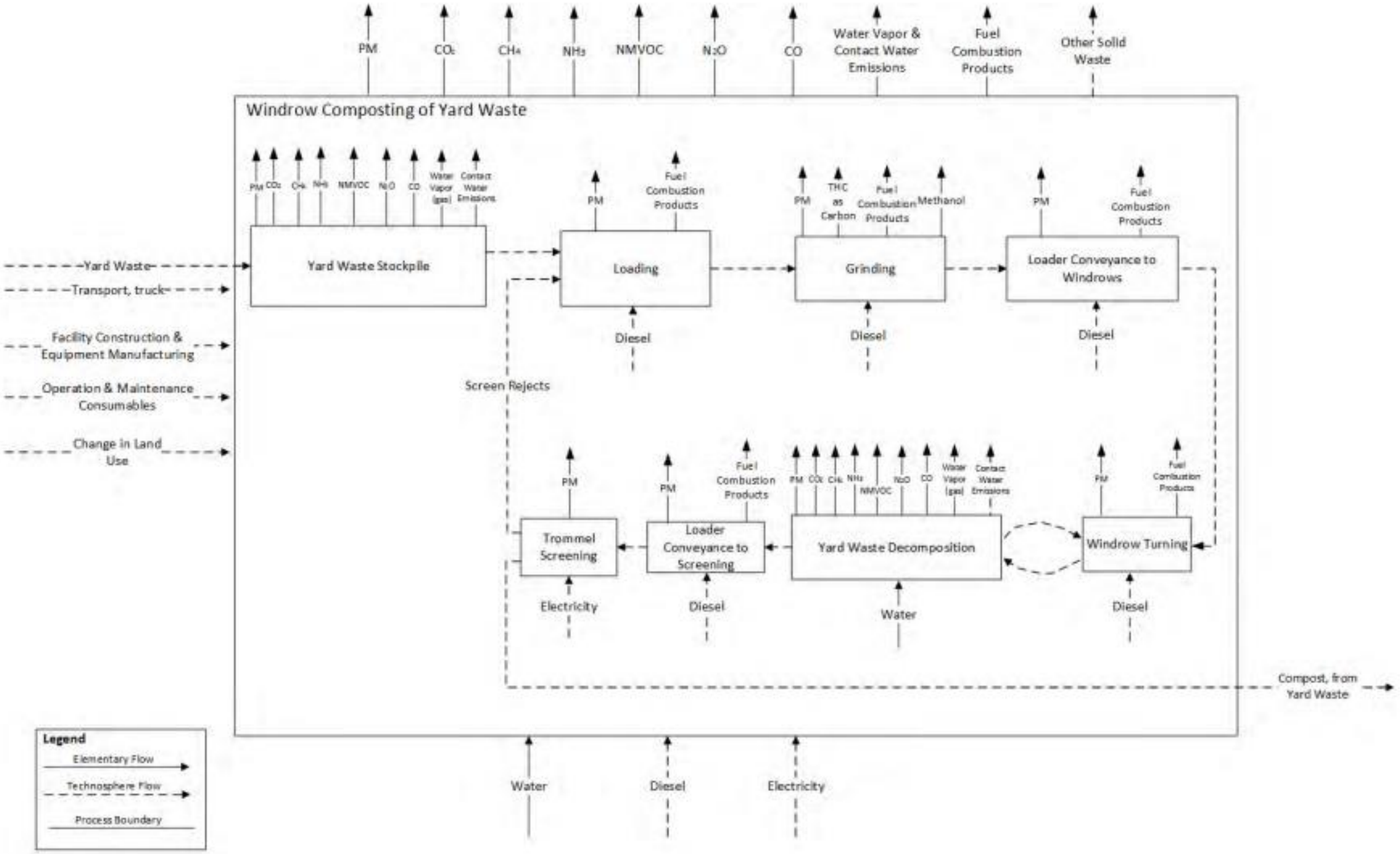

Figure 3-4. Example of Materials and Energy Inputs and Emissions Associated with Composting of Yard Waste

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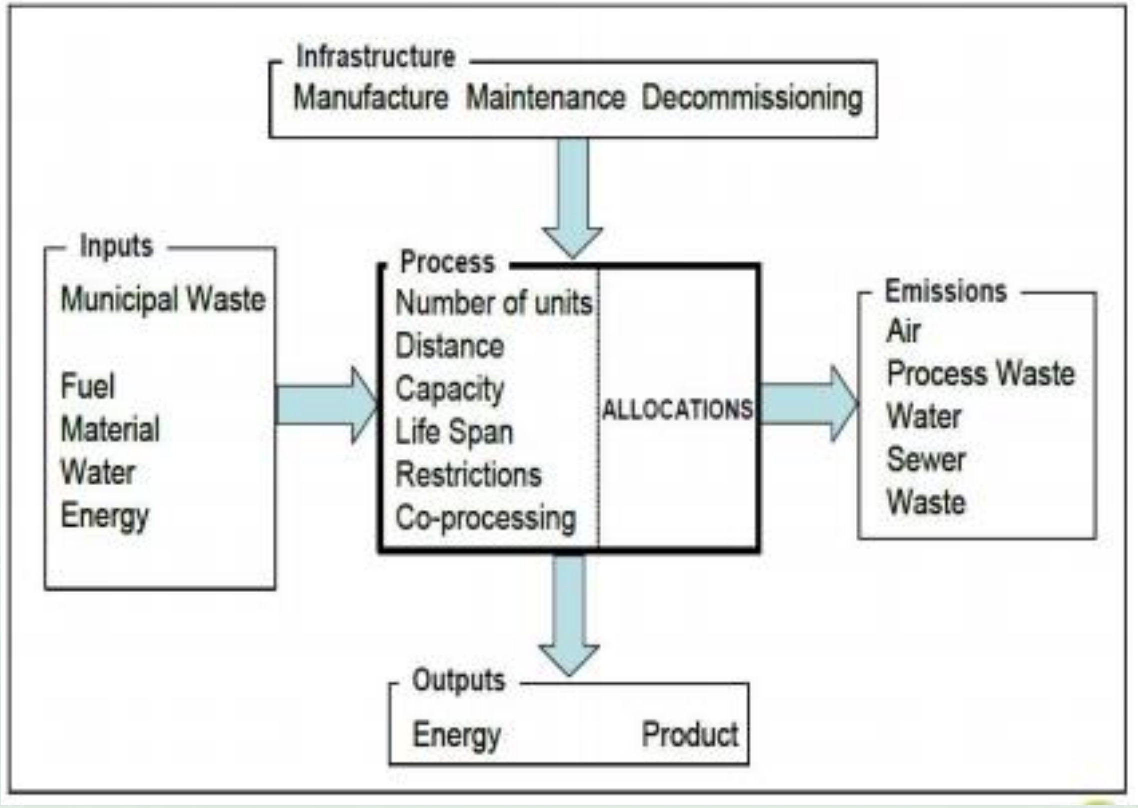
Two LCA Models Designed for Waste Managers

- EPA Warm Model (US) LCA modelling for dummies
- (WRATE) Waste and Resource Assessment Tool for the Environment from UK
- Models have varying functionality and flexibility
- WRATE calculates LCIA impacts such as acidification, water quality and human toxicity in addition to GHG



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300,000 TPY Mixed Organics to Compost

Waste Reduction Model (WARM)

Summary Report (MTCO2E)

GHG Emissions Analysis - Summary Report

GHG Emissions Waste Management Analysis for **Green Mountain Tech**
Prepared by: **Michael Bryan-Brown**
Project Period for this Analysis: to

	Baseline Scenario						Alternative Scenario							
Material	**Tons Recycled**	**Tons Landfilled**	**Tons Combusted**	**Tons Composted**	**Tons Anaerobically Digested**	**Total MTCO2E**	**Tons Source Reduced**	**Tons Recycled**	**Tons Landfilled**	**Tons Combusted**	**Tons Composted**	**Tons Anaerobically Digested**	**Total MTCO2E**	**Change (Alt-Base) MTCO2E**
Food Waste	N/A	100000.00	0.00	0.00	0.00	54216.22	0.00	N/A	0.00	0.00	100000.00	0.00	-17601.20	-71817.42
Yard Trimmings	N/A	200000.00	0.00	0.00	0.00	-35971.44	N/A	N/A	0.00	0.00	200000.00	0.00	-29262.41	6709.03
						18244.78							-46863.61	

a) For explanation of methodology, see the EPA WARM Documentation

b) Emissions estimates provided by this model are intended to support voluntary GHG measurement and reporting initiatives.

c) The GHG emissions results estimated in WARM indicate the full life-cycle benefits waste management alternatives. Due to the timing of the GHG emissions from the waste management pathways, (e.g., avoided landfilling and increased recycling), the actual GHG implications may accrue over the long-term. Therefore, one should not interpret the GHG emissions implications as occurring all in one year, but rather through time.

d) The equivalency values included in the box to the right were developed based on the EPA Greenhouse Gas Equivalencies Calculator and are presented as an example of potential equivalencies. Additional equivalencies can be calculated using WARM results at the Greenhouse Gas Equivalencies Calculator website or using alternative data sources.

Total Change in GHG Emissions (MTCO2E): **-65108.39**

This is equivalent to...
Removing annual emissions from **13823** Passenger Vehicles
Conserving **7326250** Gallons of Gasoline
Conserving **2712849** Cylinders of Propane Used for Home Barbeques
0.00004% Annual CO2 emissions from the U.S. transportation sector
0.00004% Annual CO2 emissions from the U.S. energy sector

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Compost vs AD Food Waste Direct Comparison

Waste Reduction Model (WARM)

Summary Report (MTCO2E)

GHG Emissions Analysis - Summary Report

GHG Emissions Waste Management Analysis for **Green Mtn Tech**
Prepared by: **MBB**
Project Period for this Analysis: to

	Baseline Scenario						Alternative Scenario							
Material	**Tons Recycled**	**Tons Landfilled**	**Tons Combusted**	**Tons Composted**	**Tons Anaerobically Digested**	**Total MTCO2E**	**Tons Source Reduced**	**Tons Recycled**	**Tons Landfilled**	**Tons Combusted**	**Tons Composted**	**Tons Anaerobically Digested**	**Total MTCO2E**	**Change (Alt-Base) MTCO2E**
Food Waste	N/A	0.00	0.00	100000.00	0.00	-17601.20	0.00	N/A	0.00	0.00	0.00	100000.00	-5816.87	11784.33
						-17601.20							-5816.87	

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Every Ton of Diverted Food Waste = .72 MTCO2E

Waste Reduction Model (WARM)

Summary Report (MTCO2E)

GHG Emissions Waste Management Analysis for **Green Mtn Tech**
Prepared by: **MBB**
Project Period for this Analysis: to

	Baseline Scenario						Alternative Scenario							
Material	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Tons Anaerobically Digested	Total MTCO2E	Tons Source Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Tons Anaerobically Digested	Total MTCO2E	Change (Alt-Base) MTCO2E
Food Waste	N/A	1.00	0.00	0.00	0.00	0.54	0.00	N/A	0.00	0.00	1.00	0.00	-0.18	-0.72
						0.54							-0.18	

WARM estimates that landfill will generate .54 MTCO2e (1200lbs) and composting will save .18 MTCO2e for a combined savings of .72 (1584) lbs CO2e per ton which easily offsets the energy inputs of 30lbs of CO2e for energy inputs

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Compost Process Energy Inputs vs GHG Reductions

- Grinding and handling with loader burns about .5 gallons of diesel or 11 lbs of CO_2 per ton processed
- Windrow turning and screening uses .4 gallons diesel or 9 lbs of CO_2 per ton
- ASP aeration uses about 10 kw-hr of electricity per ton or 10 lbs CO_2 per ton for 30 days aeration
- Total process energy inputs around 30 lbs CO_2e

About 19.64 pounds of **carbon dioxide** (**CO2**) are produced from burning a **gallon** of gasoline that does not contain ethanol. About 22.38 pounds of **CO2** are produced by burning a **gallon of diesel** fuel. May 21, 2014

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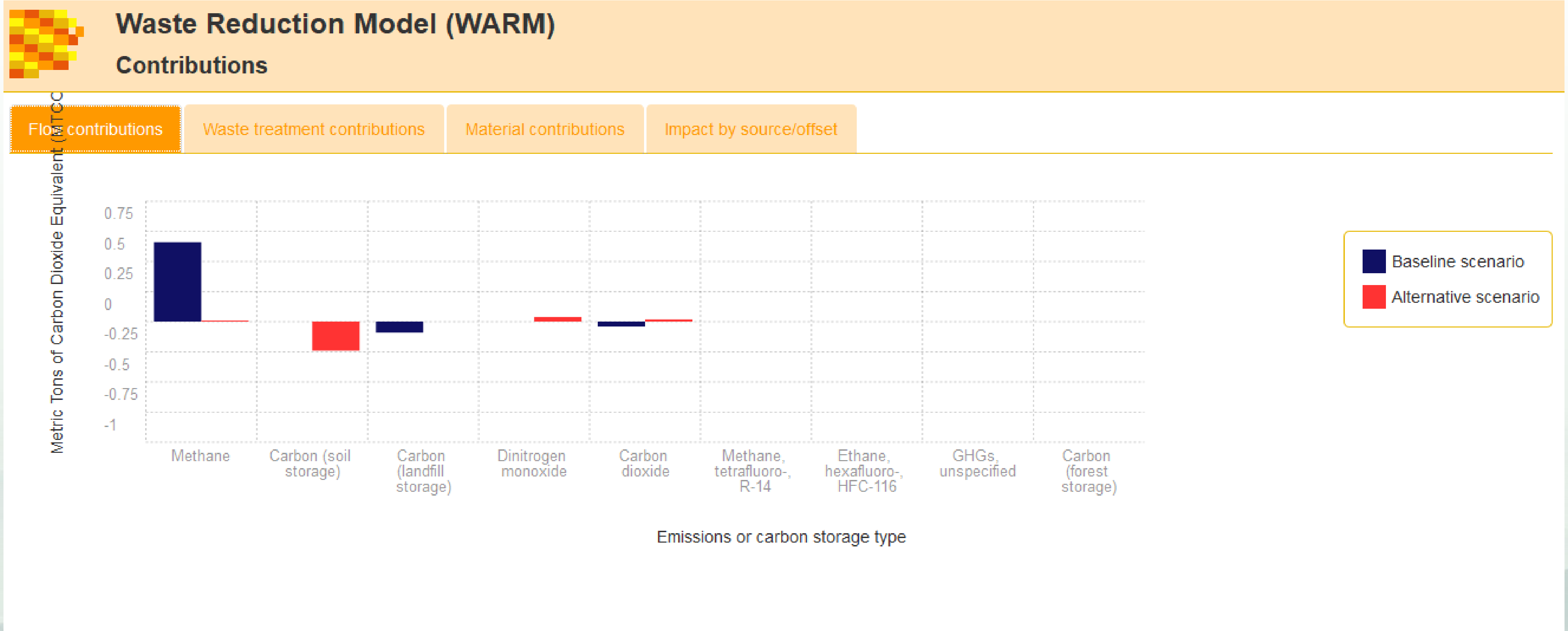
Breakdown of GHG contributions Landfill is Baseline vs Composting Alternate



What Are the Benefits from Composting that Warm and WRATE Models Don't Account For

- The impacts caused by manufacturing products that compost replaces
- Carbon Capture from increased soil fertility and carbon pump from increased root biomass (UC Davis Research & Marin Carbon Project)

Table 2 - Emission factors (EFs) relevant in GHG accounting for composting.

Type of process/emission	Emission factor	Reference
Provision of diesel oil	0.4-0.5 kg CO_2-eq litre^{-1} diesel	Fruergaard et al. (2009)
Combustion of diesel oil	2.7 kg CO_2-eq litre^{-1} diesel	Fruergaard et al. (2009)
Provision of electricity	0.1-0.9 kg CO_2-eq kWh^{-1}	Fruergaard et al. (2009)
Production of N fertilizer	4.7-13.0 kg CO_2-eq kg N^{-1}	Table 10
Production of P fertilizer	0.5-3.1 kg CO_2-eq kg P^{-1}	Table 10
Production of K fertilizer	0.4-1.5 kg CO_2-eq kg K^{-1}	Table 10
Production of peat	550-1197 kg CO_2-eq tonne^{-1} peat	Section 3.3

Lack of Composting Capacity in USA

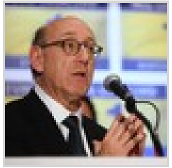
THE WALL STREET JOURNAL. | U.S.

TOP STORIES IN U.S.

1 of 12

Reid Shapes Regulator With an Eye to Hi...

2 of 12



Plaintiffs' Lawyers Take Aim at GM for ...

Sex, Dru

U.S. NEWS

Food-Waste Recycling Faces Hiccups

More States Want to Compost Table Scraps, But Infrastructure to Turn T

By BEN LEUBSDORF CONNECT

June 5, 2014 4:05 p.m. ET

JOHNSTON, R.I.—More states want to recycle their food waste instead of dumping it into landfills, but they have run into a snag: The infrastructure needed to turn huge quantities of table scraps into fertilizer or electricity isn't ready.

In Rhode Island, a landfill in this town outside Providence handles most of the 1.5 million tons of garbage the state generates annually. While the Central Landfill isn't forecast to

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