

**CARBON FOOTPRINT EVALUATION OF
MUNICIPAL SOLID WASTE DISPOSAL OPTIONS
CHARLESTON COUNTY, SOUTH CAROLINA**

Montenay Resource Recovery, Inc.
1801 Shipyard Creek Road
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December 2008

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EXECUTIVE SUMMARY

As a part of the Charleston County (County) comprehensive solid waste management and recycling program, Montenay Resource Recovery, Inc. (Montenay) receives municipal solid waste (MSW), reduces its volume by 90 percent, and recovers energy from the MSW. In the process, the Montenay facility creates a net reduction in greenhouse gases (GHG) that would otherwise be emitted into the atmosphere if the MSW were sent to the Bees Ferry Landfill.

This evaluation looks at four scenarios: (A) historic system-wide emissions and offsets from 2007 (the last year for which complete data is available), showing net GHG emissions from Montenay and from the Bees Ferry Landfill; (B) projected system-wide emissions and offsets that would occur in 2012 if Montenay implements its planned upgrades and continues to process the County's MSW and the Bees Ferry Landfill processes MSW beyond Montenay's capacity; (C) projected emissions that will result in 2012 if the County elects not to contract with Montenay and instead disposes of all of its MSW at the Bees Ferry Landfill; and (D) projected emissions and offsets that would result if Montenay were to implement its planned upgrades, expand, and process all of the County's MSW. Analysis of these scenarios demonstrates that system-wide net GHG emissions decrease as the percentage of the County's MSW processed by Montenay increases.

Specific conclusions that can be drawn from the data generated by this evaluation are as follows. For every ton of MSW processed at Montenay, there is a net reduction in GHG emissions of 0.8 metric tons (including offsets). If the same ton of MSW were sent to the Bees Ferry Landfill, there would be a positive 1.06 metric tons of GHG emitted. On a per ton basis, GHG emissions from combusting MSW at Montenay are 2.5 times lower than landfilling the waste at Bees Ferry, even when emission offsets are not included. If in 2007 all waste that was processed by Montenay had instead been sent to the Bees Ferry Landfill, there would have been a net increase in GHG emissions of approximately 170,000 metric tons.

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1.0 OVERVIEW

Charleston County (County) is in the midst of deliberations regarding the future of the municipal solid waste (MSW) waste-to-energy (WTE) facility operated by Montenay Resource Recovery, Inc. (Montenay). Montenay is negotiating with the County to obtain a 20-year extension to the contract for operating the WTE facility. The Montenay facility currently processes up to 700 tons of MSW per day. The MSW is generated within Charleston County, and is collected by municipal and private collectors. Heat from combusting the MSW is used to produce steam. The steam is then used to generate electricity for sale to the grid. Montenay also provides steam to a customer adjacent to the facility. MSW that is not processed by Montenay is diverted to the County's Bees Ferry Landfill.

For the potential contract extension, a significant issue the County must consider is the environmental impacts and benefits of WTE weighed against those of landfilling MSW. Some stakeholders maintain that landfilling MSW in the Bees Ferry Landfill has less environmental impacts than the WTE facility operated by Montenay, and that Montenay's contract with the County should not be renewed. Conversely, Montenay and other stakeholders believe that the WTE facility provides net environmental benefits and should remain in operation as an integral part of the County's comprehensive solid waste management strategy.

The objective of this project is to calculate greenhouse gas (GHG) emissions for sources related to the disposal of MSW in Charleston County. GHG emissions produced by these sources include the pollutants carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O). The global warming potential of each GHG is used to calculate the CO₂ equivalence (CO₂e) of the individual gases.

2.0 DESCRIPTION OF EMISSION SOURCES

MSW generated in the County is currently transported to Montenay for processing in two WTE boilers. During periods when Montenay is down for maintenance, MSW is diverted to the Bees Ferry Landfill. GHG emissions occur from transportation and processing of MSW at Montenay, as well as from transportation and disposal of MSW in the Bees Ferry Landfill.

MSW is collected by municipal and private collectors throughout the County. Both municipal and commercial trucks are used to transport MSW to Montenay and the Bees Ferry Landfill. Trucks also transport ash from Montenay to the Landfill, where it is used for daily cover. CO₂, CH₄ and N₂O are emitted from the combustion of fuel in the trucks.

MSW is combusted in the WTE boilers at Montenay to produce steam which is then used to produce electricity for sale to the grid. The boilers use No. 2 fuel oil for ignition and supplemental firing purposes. CO₂, CH₄, and N₂O are emitted at Montenay from the combustion of MSW and fuel oil in the WTE boilers. Operation of the Montenay facility also results in GHG offsets. Montenay recovers ferrous metals from the ash after combustion. Thus, GHG emissions from the production of ferrous metals from raw materials are offset by the operation of the Montenay facility. By producing electricity that is placed on the grid, Montenay reduces the electricity generation required of utilities like SCE&G and Santee Cooper. This offsets GHG emissions that would result from the generation of electricity at other power plants (these calculated offsets are based on the regional power mix for SERC Virginia/Carolina).

Another significant benefit of the Montenay facility is the reduction in CH₄ emissions at the Bees Ferry Landfill. Every ton of MSW that is converted to energy at Montenay is a ton of MSW that is not placed in the Bees Ferry Landfill. CH₄ is emitted from landfills by the anaerobic bioreaction of organic matter (food and yard wastes, paper, wood, organic textiles, and leather). Landfills accounted for approximately 23 percent of total U.S. anthropogenic CH₄ emissions in 2006, the second largest contribution of CH₄ in the U.S.¹ CH₄ is an aggressive GHG, with a global warming potential 21 times greater than CO₂.²

¹ Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006, April 15, 2008, U.S. Environmental Protection Agency EPA 430-R-08-005, Section 8.

http://www.epa.gov/climatechange/emissions/downloads/08_CR.pdf

² The Climate Registry General Reporting Protocol, Version 1.1, Appendix B.

<http://www.theclimateregistry.org/downloads/GRP.pdf>

3.0 FINDINGS

Four MSW scenarios were evaluated. The first scenario uses actual data for Montenay and the Bees Ferry Landfill for 2007, the last year for which complete data is available. The next three scenarios use projected data for 2012. If the County elects to renew its contract with Montenay, 2012 will be Montenay's first full calendar year of operation with new environmental and plant upgrades installed. GHG emissions data for each scenario is summarized in Table 1. A graphical representation of the net GHG emissions for each scenario is provided as Figure 1. Detailed documentation on the GHG emission calculations for each scenario is provided in Assumptions and Calculations I through VI. Information from Assumptions and Calculations I through VI is condensed and summarized in Appendix I. The following is a description of each scenario evaluated in this report.

3.1 Scenario A – Actual 2007 Data (Montenay and Bees Ferry Landfill)

In Scenario A, net GHG emissions were evaluated using actual MSW data for calendar year 2007. Based on information provided by Montenay for 2007, 215,290 tons of MSW were combusted in the WTE boilers and 71,857 tons of MSW were diverted to the Bees Ferry Landfill. As shown in Table 1 and Figure 1, operation of the Montenay facility resulted in a net CO₂e emissions reduction of 94,457 metric tons in 2007.

3.2 Scenario B – Projected 2012 Data (Montenay and Bees Ferry Landfill)

In Scenario B, net GHG emissions were evaluated for projected MSW generated in calendar year 2012 (307,818 tons) and operation of both Montenay and the Bees Ferry Landfill. MSW generated in 2012 was calculated assuming a 1.4 percent increase annually from base year 2007.³ For Scenario B, it is assumed that Montenay will process 225,000 tons of MSW (the value used in the economic model for the draft contract with the County). The remaining 82,818 tons of MSW will be diverted to the Bees Ferry Landfill. As shown in Table 1 and Figure 1, operation of the Montenay facility in 2012 will result in a net CO₂e emissions reduction of 103,709 metric tons.

³ Long Range Facilities and Systems Plan, Volume II, Section 7.4; Alternative Resources, Inc. and Griffin Engineering, LLC, May 2003. <http://www.charlestoncounty.org/departments/SolidWaste/SWCommittee.htm>

3.3 Scenario C – Projected 2012 Data (Montenay Closed, All MSW to Landfill)

In Scenario C, net GHG emissions were evaluated for projected MSW generated in calendar year 2012 (307,818 tons) assuming that the Montenay facility is no longer in operation and all MSW is landfilled at Bees Ferry. Because the Montenay facility is not operating in this scenario, there are no GHG emission offsets from electricity placed on the grid and avoided methane emissions at the Landfill. As shown in Table 1 and Figure 1, total CO_{2e} emissions from disposal of all MSW in the Bees Ferry Landfill in 2012 are projected to be 325,980 metric tons.

3.4 Scenario D – Projected 2012 Data (Expanded Montenay Operations, Minimal MSW to Bees Ferry Landfill)

Scenario D is a hypothetical scenario assuming that the WTE facility is expanded at some point in the future so that it can process all MSW generated in the County. Using the projected MSW generated in calendar year 2012 (307,818 tons), net GHG emissions were calculated assuming that all MSW is processed at Montenay. In this scenario, the Bees Ferry Landfill would be used for the disposal of ash and white goods only. As shown in Table 1 and Figure 1, the net CO_{2e} emissions reduction from processing of all MSW at Montenay would be 261,869 metric tons per year.

4.0 CONCLUSIONS

The findings of this evaluation are that operation of the Montenay WTE facility produces a significant net reduction of GHG emissions versus disposal of MSW in the Bees Ferry Landfill. Every ton of MSW combusted at Montenay yields a net CO_{2e} emissions benefit (reduction) of approximately 0.8 metric tons. Conversely, every ton of MSW placed in the Bees Ferry Landfill results in approximately 1.06 metric tons of CO_{2e} positive emissions. Operation of the Montenay facility also substantially reduces the volume of waste that needs to be landfilled, thus prolonging the useful life of Bees Ferry Landfill.

The findings of this study mirror those of the Environmental Protection Agency's Life Cycle Assessment of Solid Waste Management and GHGs – net emissions from the combustion of MSW are lower than net emissions from landfilling MSW⁴. The net GHG benefit of WTE is due to multiple factors. The electricity Montenay supplies to the grid

⁴ Solid Waste Management and Greenhouse Gases, A Life-Cycle Assessment of Emissions and Sinks, 3rd Edition, September 2006, U.S. Environmental Protection Agency, Executive Summary, Page ES-13.
<http://www.epa.gov/climatechange/wycd/waste/downloads/fullreport.pdf>

reduces power generation requirements and associated GHG emissions that would result from generation of the same quantity of power from other sources. Recovery and recycling of ferrous metals at Montenay avoids GHG emissions that would result from producing these metals from raw materials. Additionally, the primary GHG emitted from the combustion of MSW is CO₂. The primary GHG produced by landfilling MSW is CH₄. CH₄ emissions have a global warming factor 21 times that of CO₂.

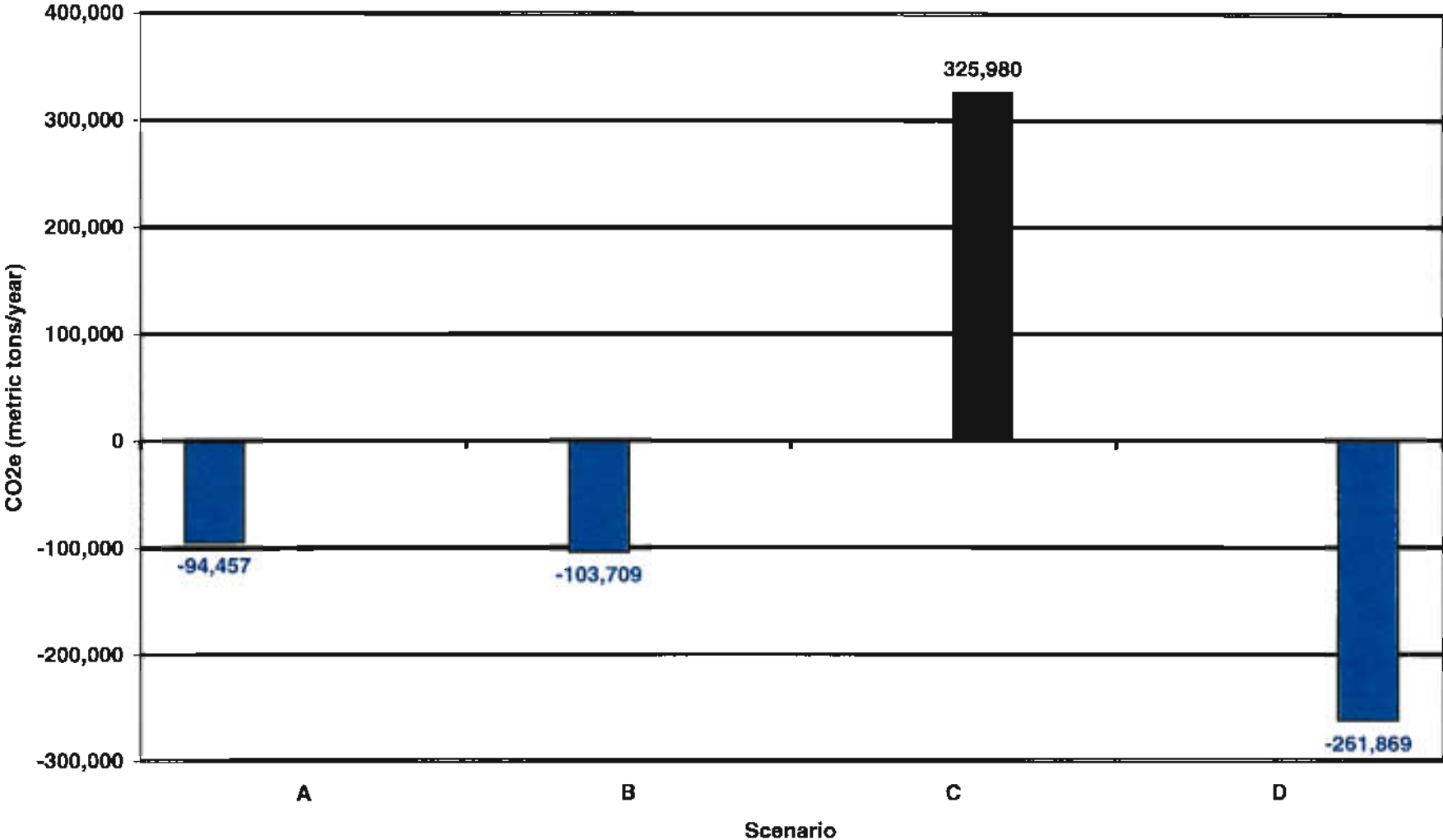
To put the GHG benefits of the Montenay WTE facility in a state-wide perspective, the South Carolina Climate, Energy, and Commerce Advisory Committee (CECAC) established a target of reducing annual GHG emissions in South Carolina by 55 million metric tons CO_{2e} by 2020.⁵ Comparing projected 2012 data from Scenarios B and C, an annual emissions difference of 429,689 tons CO_{2e} would be achieved if the County elects to renew Montenay's contract per the conditions in the current draft document. This difference represents 0.8 percent of CECAC's targeted annual GHG emissions reductions in South Carolina. Comparing 2012 data from Scenarios D and C, an annual emissions difference of 587,849 tons CO_{2e} would be achieved if the County were to elect at some point in the future to expand the Montenay facility to process all MSW generated in Charleston County. Standing alone, an expanded Montenay facility would represent 1.1 percent of CECAC's targeted annual GHG emissions reductions in South Carolina.

⁵ South Carolina Climate, Energy, and Commerce Committee Final Report, July 2008, Executive Summary, Page EX-2.

**Table 1
Carbon Footprint Summary - Charleston County MSW Scenarios**

Source/Activity	Scenario A Actual 2007 Data Montenay and Bees Ferry LF		Scenario B Projected 2012 Data Montenay and Bees Ferry LF		Scenario C Projected 2012 Data Montenay Closed, All MSW to Bees Ferry LF		Scenario D Projected 2012 Data Expanded Montenay Operations, Minimal MSW to Bees Ferry LF	
	MSW Combusted / Landfilled (us Tons)	GHG Emissions Metric Tons CO2e/yr	MSW Combusted / Landfilled (us Tons)	GHG Emissions Metric Tons CO2e/year	MSW Combusted / Landfilled (us Tons)	GHG Emissions Metric Tons CO2e/year	MSW Combusted / Landfilled (us Tons)	GHG Emissions Metric Tons CO2e/year
Montenay								
MSW Combusted in Boilers	215,290 tons		225,000 tons		0 tons		307,818 tons	
MSW Combustion Emissions from Boilers		88,269		92,250		0		126,205
Fuel Oil Combustion Emissions from Boilers		1,605		1,678		0		2,295
Transportation Emissions MSW to Montenay		988		1,032		0		1,735
Total Emissions @ Montenay		90,862		94,960		0		130,235
Waste-to-Energy Offsets/Avoided Emissions								
Avoided Landfill Emissions		-226,055		-236,250		0		-323,209
Avoided Emissions Ferrous Metal Recovery from Ash		-908.3		-949.3		0		-1,298.7
Avoided Emissions Power Generation		-34,678		-49,410		0		-67,596
Total Waste-to-Energy Offsets		-261,641		-286,609		0		-392,104
Total Emissions @ Montenay and Offsets		-170,780		-191,649		0		-261,869
Emissions per Ton MSW Combusted		-0.79		-0.85		-		-0.85
Landfill								
MSW Landfilled	71,857 tons		82,818 tons		307,818 tons		0 tons	
Emissions from Landfilled MSW		75,450		86,959		323,209		0
Transportation Emissions MSW to Landfill		873		981		2,771		0
Total Emissions @ Landfill		76,323		87,940		325,980		0
Emissions per Ton MSW Landfilled		1.06		1.06		1.06		-
Net Carbon Footprint of Scenario		-94,457		-103,709		325,980		-261,869

Figure 1
Carbon Footprint Evaluation - Charleston County MSW Disposal Scenarios



ASSUMPTIONS AND CALCULATIONS I

GREENHOUSE GAS EMISSIONS – TRANSPORTATION OF MSW

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

The following assumptions and calculations are presented for greenhouse gas (GHG) emissions associated with the transportation of municipal solid waste (MSW) in Charleston County, South Carolina.

1.0 Emission Assumptions

- Distances traveled from each municipality to the Montenay Resource Recovery Facility, Inc. (Montenay) and Bees Ferry Landfill (BFLF) were calculated using data referenced from the Long Range Facilities and Systems Plan Volume II – Inventory, Analysis, and System Alternatives (May 2003) (LRFSP).
<http://www.charlestoncounty.org/departments/SolidWaste/SWCommittee.htm>
- MSW data for calendar year 2000 was referenced from Table 7-5 of the LRFSP. Distances from each municipality to Montenay and BFLF were calculated using calendar year 2000 MSW data and a municipality site specific factor referenced from Table 7-8 of the LRFSP.
- MSW is hauled in two types of refuse trucks, commercial and municipal. Based on Montenay scale records for 2007, the average commercial truck hauled 11 tons of MSW per load, and the average municipal truck hauled 8.25 tons per load. In 2007, 68% of MSW was delivered to Montenay in commercial trucks and 32% of MSW was delivered to Montenay in municipal trucks. By dividing the total amount of MSW delivered to Montenay in 2007 (215,290 tons) and the estimated total number of loads as shown below (21,660) the average truck capacity was calculated of 9.94 tons.

A	B	C=B*215,290	D	E=C/D
Truck Type	% of total	Waste by Truck Type (tons)	Truck Capacity (tons)	No. of Loads
Commercial	68%	146,397	11	13,309
Municipal	32%	68,893	8.25	8,351
			Total	21,660

- Based on information provided by Montenay for calendar year 2007, 215,290 tons of MSW were delivered to Montenay and 71,857 tons of MSW were diverted to BFLF. Additionally, 52,563 tons of ash from Montenay was transported to BFLF where it is used as daily cover.

- The amount of MSW that will be generated in Charleston County in 2012 (307,818 tons) was estimated from 2007 actual data using an increase rate of 1.4% per year. This high end projection annual rate of increase was taken from the LRFSP.
- The amount of ash produced at Montenay in Scenarios B and D was calculated by using the ash/MSW combustion ratio from 2007 (52,563 tons ash/215,290 tons MSW).
- Based on Montenay scale records for 2007, the average truck transporting ash to BFLF hauled 20.25 tons of ash per load.
- As discussed in the Summary Section of this report, four scenarios were included in this evaluation. The following table provides a summary of MSW combusted, landfilled, and ash generated in each scenario:

Scenario	MSW Combusted (tons/year)	MSW Landfilled (tons/year)	Ash to BFLF (tons/year)
A	215,290	71,857	52,563
B	225,000	82,818	54,934
C	0	307,818	0
D	307,818	0	75,154

- The average fuel economy (2.8 miles per gallon) for a typical MSW truck was referenced from the Diesel Progress North American Edition, “New Study Makes Strong Case for Natural Gas Garbage Trucks – Alternative Fuels,” November 2003.
http://findarticles.com/p/articles/mi_m0FZX/is_11_69/ai_111463795
- The CO₂ emission factor was referenced from The Climate Registry General Reporting Protocol Version 1.1 (CRGRP), Chapter 13, Table 13.1. The N₂O and CH₄ emission factors were referenced from CRGRP, Chapter 13, Table 13.4. To convert N₂O and CH₄ emissions to CO₂ equivalents (CO₂e), the global warming potentials found in Appendix B of the CRGRP were used (310 for N₂O, 21 for CH₄).
<http://www.theclimateregistry.org/downloads/GRP.pdf>

2.0 Transportation Calculations

2.1 Distance Traveled to MSW Disposal Destination (Table 1)

Using the above assumptions, the distance traveled from each municipality to Montenay or BFLF is calculated below. The boxed alpha codes in the equations refer to the appropriate columns in Table 1.

Transporting MSW to Montenay

$$\boxed{\text{C}} \frac{\text{Municipality to Montenay mile-tons}}{\text{year}} \times \frac{\text{year}}{\boxed{\text{A}} \text{ Municipality tons of MSW}} \times 2$$

$$= \boxed{\text{D}} \text{ Travel Distance Round Trip (miles)}$$

Transporting MSW to BFLF

$$\boxed{\text{E}} \frac{\text{Municipality to BFLF mile-tons}}{\text{year}} \times \frac{\text{year}}{\boxed{\text{A}} \text{ Municipality tons of MSW}} \times 2$$

$$= \boxed{\text{F}} \text{ Travel Distance Round Trip (miles)}$$

2.2 Total Distance Traveled (Tables 1-A, 1-B, 1-C, and 1-D)

Using the above assumptions, the total miles driven per year to haul MSW from each municipality to Montenay and/or BFLF is calculated below. The boxed alpha codes in the equations refer to the appropriate columns in Table 1-A, 1-B, 1-C, and 1-D.

Transporting MSW to Montenay

$$\boxed{\text{A}} \text{ Percentage from each municipality} \times \boxed{\text{X}} \frac{\text{Total tons of MSW to Montenay}}{\text{year}}$$

$$\times \frac{\text{trip}}{\boxed{\text{B}} \text{ tons of MSW}} \times \boxed{\text{C}} \frac{\text{miles}}{\text{trip}} = \boxed{\text{D}} \frac{\text{miles driven to Montenay}}{\text{year}}$$

Transporting MSW to BFLF

$$\boxed{\text{A}} \text{ Percentage from each municipality} \times \boxed{\text{Y}} \frac{\text{Total tons of MSW to BFLF}}{\text{year}} \times$$

$$\frac{\text{trip}}{\boxed{\text{B}} \text{ tons of MSW}} \times \boxed{\text{E}} \frac{\text{miles}}{\text{trip}} = \boxed{\text{F}} \frac{\text{miles driven to BFLF}}{\text{year}}$$

Transporting Montenay Ash to BFLF

$$\boxed{Z} \frac{\text{tons of ash}}{\text{year}} \times \frac{\text{trip}}{\boxed{B} \text{ tons of ash}} \times \boxed{E} \frac{\text{miles}}{\text{trip}} = \boxed{F} \frac{\text{miles driven to BFLF}}{\text{year}}$$

3.0 Emissions Calculations

3.1 CO₂ Emissions (Tables 2-A, 2-B, 2-C, and 2-D)

Using the above assumptions and the following equations, total CO₂ emissions from mobile combustion of fuels used in the transportation of MSW are calculated below. The boxed alpha codes in the equations refer to the appropriate columns in Table 2-A, 2-B, 2-C, and 2-D.

$$\boxed{A} \frac{\text{miles driven}}{\text{year}} \times \frac{\text{gallon}}{\boxed{B} \text{ average miles}} = \boxed{C} \frac{\text{gallons of fuel consumed}}{\text{year}}$$

$$\boxed{C} \frac{\text{gallons of fuel consumed}}{\text{year}} \times \boxed{D} \frac{\text{kg CO}_2}{\text{gallon}} = \boxed{E} \frac{\text{kg CO}_2 \text{ Emissions}}{\text{year}}$$

$$\boxed{E} \frac{\text{kg CO}_2 \text{ Emissions}}{\text{year}} \times \frac{1 \text{ metric ton}}{1000 \text{ kg}} = \boxed{F} \frac{\text{metric ton CO}_2 \text{ emissions}}{\text{year}}$$

$$\boxed{F} \frac{\text{metric ton CO}_2 \text{ emissions}}{\text{year}} \times \frac{1 \text{ metric ton CO}_2\text{e}}{1 \text{ metric ton CO}_2} = \boxed{G} \frac{\text{metric ton CO}_2\text{e emissions}}{\text{year}}$$

3.2 N₂O Emissions (Tables 3-A, 3-B, 3-C and 3-D)

Using the above assumptions and the following equations, total N₂O emissions from mobile combustion of fuels used in the transportation of MSW are calculated below and converted to CO₂e. The boxed alpha codes in the equations refer to the appropriate columns in Table 3-A, 3-B, 3-C, and 3-D.

$$\boxed{A} \frac{\text{miles driven}}{\text{year}} \times \boxed{B} \frac{\text{g N}_2\text{O}}{\text{mile}} \times \frac{1 \text{ kg}}{1000 \text{ g}} = \boxed{C} \frac{\text{kg N}_2\text{O Emissions}}{\text{year}}$$

$$\boxed{C} \frac{\text{kg N}_2\text{O emissions}}{\text{year}} \times \frac{1 \text{ metric ton}}{1000 \text{ kg}} = \boxed{D} \frac{\text{metric ton N}_2\text{O emissions}}{\text{year}}$$

$$\boxed{D} \frac{\text{metric ton N}_2\text{O emissions}}{\text{year}} \times \frac{310 \text{ metric ton CO}_2\text{e}}{1 \text{ metric ton N}_2\text{O}} = \boxed{E} \frac{\text{metric ton CO}_2\text{e emissions}}{\text{year}}$$

3.3 CH₄ Emissions (Tables 4-A, 4-B, 4-C, and 4-D)

Using the above assumptions and the following equations, total CH₄ emissions from mobile combustion of fuels used in the transportation of MSW are calculated below and converted to CO₂e. The boxed alpha codes in the equations refer to the appropriate columns in Table 4-A, 4-B, 4-C, and 4-D.

$$\boxed{\text{A}} \frac{\text{miles driven}}{\text{year}} \times \boxed{\text{B}} \frac{\text{g CH}_4}{\text{mile}} \times \frac{1 \text{ kg}}{1000 \text{ g}} = \boxed{\text{C}} \frac{\text{kg CH}_4 \text{ Emissions}}{\text{year}}$$

$$\boxed{\text{C}} \frac{\text{kg CH}_4 \text{ emissions}}{\text{year}} \times \frac{1 \text{ metric ton}}{1000 \text{ kg}} = \boxed{\text{D}} \frac{\text{metric ton CH}_4 \text{ emissions}}{\text{year}}$$

$$\boxed{\text{D}} \frac{\text{metric ton CH}_4 \text{ emissions}}{\text{year}} \times \frac{21 \text{ metric ton CO}_2\text{e}}{1 \text{ metric ton CH}_4} = \boxed{\text{E}} \frac{\text{metric ton CO}_2\text{e emissions}}{\text{year}}$$

TABLE 1

Distance Traveled to MSW Disposal Destination

Municipalities	A	B	C		E		F
	MSW - 2000 (tons/year)	Percentage from each Municipality	Transporting MSW to Montenay		Transporting MSW to Bees Ferry Landfill		Travel Distance - round trip (miles)
			Distance to Montenay (Mile-tons/year)	Travel Distance - round trip (miles)	Distance to Bees Ferry LF (Mile-tons/year)	Travel Distance - round trip (miles)	
Awendaw	981	0.49%	30,325	62	37,195	76	
City of Charleston	79,374	39.46%	404,806	10	873,112	22	
Folly Beach	1,738	0.86%	26,066	30	30,063	35	
Hollywood	3,241	1.61%	66,433	41	31,434	19	
Isle of Palms	3,764	1.87%	53,446	28	79,416	42	
Kiawah Island	955	0.47%	28,558	60	21,490	45	
Lincolnton	742	0.37%	13,363	36	18,263	49	
McClellanville	407	0.20%	16,586	82	19,432	95	
Meggett	1,010	0.50%	22,122	44	11,213	22	
Mt. Pleasant	39,099	19.44%	336,250	17	606,033	31	
N. Charleston	65,405	32.52%	183,134	6	686,754	21	
Ravenel	1,818	0.90%	37,820	42	18,182	20	
Seabrook Island	1,027	0.51%	27,820	54	20,223	39	
Sullivan's Island	1,569	0.78%	17,734	23	28,720	37	
TOTAL TONS	201,130						

TABLE 1-A

Total Distance Traveled - 2007 Actual Data - Scenario A

Municipalities	A	B	C	D	E	F
	Percentage from each Municipality	Truck Capacity tons/trip	Transporting MSW to Montenay		Transporting MSW to Bees Ferry LF	
			miles (round trip)	miles driven/year	miles (round trip)	miles driven/year
Awendaw	0.49%	9.94	62	6,531	76	2,674
City of Charleston	39.46%	9.94	10	87,184	22	62,763
Folly Beach	0.86%	9.94	30	5,614	35	2,161
Hollywood	1.61%	9.94	41	14,308	19	2,260
Isle of Palms	1.87%	9.94	28	11,511	42	5,709
Kiawah Island	0.47%	9.94	60	6,151	45	1,545
Lincolnton	0.37%	9.94	36	2,878	49	1,313
McClellanville	0.20%	9.94	82	3,572	95	1,397
Meggett	0.50%	9.94	44	4,764	22	806
Mt. Pleasant	19.44%	9.94	17	72,419	31	43,564
N. Charleston	32.52%	9.94	6	39,442	21	49,367
Ravenel	0.90%	9.94	42	8,145	20	1,307
Seabrook Island	0.51%	9.94	54	5,992	39	1,454
Sullivan's Island	0.78%	9.94	23	3,819	37	2,065
Montenay Ash		20.25	-	-	24	62,297
Totals				272,331		240,681

X	Y	Z
MSW to Montenay (tons/year)	MSW to Bees Ferry LF (tons/year)	Ash to Bees Ferry LF (tons/year)
215,290	71,857	52,563

TABLE 2-A**Total CO₂ Emissions from Mobile Combustion - Scenario A**

		A	B	C	D	E	F	G
Facility Options	Average Refuse Truck	2007 Total Miles Per Year	Average Miles Per Gallon	Fuel Consumed (gallons / year)	CO ₂ Emission Factor (kg CO ₂ /gallon)	CO ₂ Emissions (kg/year)	CO ₂ Emissions (metric tons)	CO ₂ e Equivalent for CO ₂ (metric tons)
Montenay	Heavy Duty Truck	272,331	2.8	97,261	10.15	987,199	987.2	987.2
Bees Ferry LF	Heavy Duty Truck	240,681	2.8	85,957	10.15	872,467	872.5	872.5

TABLE 3-A**Total N₂O Emissions from Mobile Combustion - Scenario A**

		A	B	C	D	E
Facility Options	Average Refuse Truck	2007 Total Miles Per Year	N ₂ O Emission Factor (g/mile)	N ₂ O Emissions (kg/year)	N ₂ O Emissions (metric tons)	CO ₂ e Equivalent for N ₂ O (metric tons)
Montenay	Heavy Duty Truck	272,331	0.0048	1.31	0.0013	0.41
Bees Ferry LF	Heavy Duty Truck	240,681	0.0048	1.16	0.00116	0.36

TABLE 4-A**Total CH₄ Emissions from Mobile Combustion - Scenario A**

		A	B	C	D	E
Facility Options	Average Refuse Truck	2007 Total Miles Per Year	CH ₄ Emission Factor (g/mile)	CH ₄ Emissions (kg/year)	CH ₄ Emissions (metric tons)	CO ₂ e Equivalent for CH ₄ (metric tons)
Montenay	Heavy Duty Truck	272,331	0.0051	1.39	0.0014	0.029
Bees Ferry LF	Heavy Duty Truck	240,681	0.0051	1.23	0.00123	0.026

TABLE 1-B

Total Distance Traveled - 2012 Data - Scenario B

Municipalities	A	B	C	D	E	F
	Percentage	Truck Capacity	Transporting MSW to Montenay		Transporting MSW to Bees Ferry LF	
	from each Municipality	tons/trip	miles (round trip)	miles driven/year	miles (round trip)	miles driven/year
Awendaw	0.49%	9.94	62	6,826	76	3,082
City of Charleston	39.46%	9.94	10	91,116	22	72,337
Folly Beach	0.86%	9.94	30	5,867	35	2,491
Hollywood	1.61%	9.94	41	14,953	19	2,604
Isle of Palms	1.87%	9.94	28	12,030	42	6,580
Kiawah Island	0.47%	9.94	60	6,428	45	1,780
Lincolnton	0.37%	9.94	36	3,008	49	1,513
McClellanville	0.20%	9.94	82	3,733	95	1,610
Meggett	0.50%	9.94	44	4,979	22	929
Mt. Pleasant	19.44%	9.94	17	75,685	31	50,210
N. Charleston	32.52%	9.94	6	41,221	21	56,897
Ravenel	0.90%	9.94	42	8,513	20	1,506
Seabrook Island	0.51%	9.94	54	6,262	39	1,675
Sullivan's Island	0.78%	9.94	23	3,992	37	2,379
Montenay Ash		20.25	-	-	24	65,107
Totals				284,613		270,701

X	Y	Z
MSW to Montenay (tons/year)	MSW to Bees Ferry LF (tons/year)	Ash to Bees Ferry LF (tons/year)
225,000	82,818	54,934

TABLE 2-B**Total CO₂ Emissions from Mobile Combustion - Scenario B**

		A	B	C	D	E	F	G
Facility	Average Refuse Truck	2012 Total Miles Per Year	Average Miles Per Gallon	Fuel Consumed (gallons / year)	CO ₂ Emission Factor (kg CO ₂ /gallon)	CO ₂ Emissions (kg/year)	CO ₂ Emissions (metric tons)	CO ₂ e Equivalent for CO ₂ (metric tons)
Montenay	Heavy Duty Truck	284,613	2.8	101,648	10.15	1,031,724	1031.7	1031.7
Bees Ferry LF	Heavy Duty Truck	270,701	2.8	96,679	10.15	981,292	981	981

TABLE 3-B**Total N₂O Emissions from Mobile Combustion - Scenario B**

		A	B	C	D	E
Facility	Average Refuse Truck	2007 Total Miles Per Year	N ₂ O Emission Factor (g/mile)	N ₂ O Emissions (kg/year)	N ₂ O Emissions (metric tons)	CO ₂ e Equivalent for N ₂ O (metric tons)
Montenay	Heavy Duty Truck	284,613	0.0048	1.37	0.0014	0.42
Bees Ferry LF	Heavy Duty Truck	270,701	0.0048	1.30	0.00130	0.40

TABLE 4-B**Total CH₄ Emissions from Mobile Combustion - Scenario B**

		A	B	C	D	E
Facility	Average Refuse Truck	2012 Total Miles Per Year	CH ₄ Emission Factor (g/mile)	CH ₄ Emissions (kg/year)	CH ₄ Emissions (metric tons)	CO ₂ e Equivalent for CH ₄ (metric tons)
Montenay	Heavy Duty Truck	284,613	0.0051	1.45	0.0015	0.030
Bees Ferry LF	Heavy Duty Truck	270,701	0.0051	1.38	0.00138	0.029

TABLE 1-C

Total Distance Traveled - 2012 Data - Scenario C

Municipalities	A	B	C		D		E	F
	Percentage from each Municipality	Truck Capacity tons/trip	Transporting MSW to Montenay		Transporting MSW to Bees Ferry LF		miles (round trip)	miles driven/year
			miles (round trip)	miles driven/year	miles (round trip)	miles driven/year		
Awendaw	0.49%	9.94	62	0	76	11,454		
City of Charleston	39.46%	9.94	10	0	22	268,863		
Folly Beach	0.86%	9.94	30	0	35	9,257		
Hollywood	1.61%	9.94	41	0	19	9,680		
Isle of Palms	1.87%	9.94	28	0	42	24,455		
Kiawah Island	0.47%	9.94	60	0	45	6,618		
Lincolnville	0.37%	9.94	36	0	49	5,624		
McClellanville	0.20%	9.94	82	0	95	5,984		
Meggett	0.50%	9.94	44	0	22	3,453		
Mt. Pleasant	19.44%	9.94	17	0	31	186,620		
N. Charleston	32.52%	9.94	6	0	21	211,476		
Ravenel	0.90%	9.94	42	0	20	5,599		
Seabrook Island	0.51%	9.94	54	0	39	6,227		
Sullivan's Island	0.78%	9.94	23	0	37	8,844		
Montenay Ash		20.25	-	-	24	0		
Totals				0				764,153

X	Y	Z
MSW to Montenay (tons/year)	MSW to Bees Ferry LF (tons/year)	Ash to Bees Ferry LF (tons/year)
0	307,818	0

TABLE 2-C**Total CO₂ Emissions from Mobile Combustion - Scenario C**

		A	B	C	D	E	F	G
Facility	Average Refuse Truck	2012 Total Miles Per Year	Average Miles Per Gallon	Fuel Consumed (gallons / year)	CO ₂ Emission Factor (kg CO ₂ /gallon)	CO ₂ Emissions (kg/year)	CO ₂ Emissions (metric tons)	CO ₂ e Equivalent for CO ₂ (metric tons)
Montenay	Heavy Duty Truck	0	2.8	0	10.15	0	0.0	0.0
Bees Ferry LF	Heavy Duty Truck	764,153	2.8	272,912	10.15	2,770,054	2,770	2,770

TABLE 3-C**Total N₂O Emissions from Mobile Combustion - Scenario C**

		A	B	C	D	E
Facility	Average Refuse Truck	2007 Total Miles Per Year	N ₂ O Emission Factor (g/mile)	N ₂ O Emissions (kg/year)	N ₂ O Emissions (metric tons)	CO ₂ e Equivalent for N ₂ O (metric tons)
Montenay	Heavy Duty Truck	0	0.0048	0.00	0.0000	0.00
Bees Ferry LF	Heavy Duty Truck	764,153	0.0048	3.67	0.00367	1.14

TABLE 4-C**Total CH₄ Emissions from Mobile Combustion - Scenario C**

		A	B	C	D	E
Facility	Average Refuse Truck	2012 Total Miles Per Year	CH ₄ Emission Factor (g/mile)	CH ₄ Emissions (kg/year)	CH ₄ Emissions (metric tons)	CO ₂ e Equivalent for CH ₄ (metric tons)
Montenay	Heavy Duty Truck	0	0.0051	0.00	0.0000	0.000
Sees Ferry LF	Heavy Duty Truck	764,153	0.0051	3.90	0.00390	0.082

TABLE 1-D

Total Distance Traveled - 2012 Data - Scenario D

Municipalities	A	B	C	D	E	F
	Percentage	Truck Capacity	Transporting MSW to Montenay		Transporting MSW to Bees Ferry LF	
	from each Municipality	tons/trip	miles (round trip)	miles driven/year	miles (round trip)	miles driven/year
Awendaw	0.49%	9.94	62	9,338	76	0
City of Charleston	39.46%	9.94	10	124,654	22	0
Folly Beach	0.86%	9.94	30	8,027	35	0
Hollywood	1.61%	9.94	41	20,457	19	0
Isle of Palms	1.87%	9.94	28	16,458	42	0
Kiawah Island	0.47%	9.94	60	8,794	45	0
Lincolnton	0.37%	9.94	36	4,115	49	0
McClellanville	0.20%	9.94	82	5,107	95	0
Meggett	0.50%	9.94	44	6,812	22	0
Mt. Pleasant	19.44%	9.94	17	103,544	31	0
N. Charleston	32.52%	9.94	6	56,394	21	0
Ravenel	0.90%	9.94	42	11,646	20	0
Seabrook Island	0.51%	9.94	54	8,567	39	0
Sullivan's Island	0.78%	9.94	23	5,461	37	0
Montenay Ash		20.25	-	-	24	89,071
Totals				389,374		89,071

X	Y	Z
MSW to Montenay (tons/year)	MSW to Bees Ferry LF (tons/year)	Ash to Bees Ferry LF (tons/year)
307,818	0	75,154

TABLE 2-D**Total CO₂ Emissions from Mobile Combustion - Scenario D**

		A	B	C	D	E	F	G
Facility	Average Refuse Truck	2012 Total Miles Per Year	Average Miles Per Gallon	Fuel Consumed (gallons / year)	CO ₂ Emission Factor (kg CO ₂ /gallon)	CO ₂ Emissions (kg/year)	CO ₂ Emissions (metric tons)	CO ₂ e Equivalent for CO ₂ (metric tons)
Montenay	Heavy Duty Truck	389,374	2.8	139,062	10.15	1,411,481	1411.5	1411.5
Gees Ferry LF	Heavy Duty Truck	89,071	2.8	31,811	10.15	322,883	323	323

TABLE 3-D**Total N₂O Emissions from Mobile Combustion - Scenario D**

		A	B	C	D	E
Facility	Average Refuse Truck	2007 Total Miles Per Year	N ₂ O Emission Factor (g/mile)	N ₂ O Emissions (kg/year)	N ₂ O Emissions (metric tons)	CO ₂ e Equivalent for N ₂ O (metric tons)
Montenay	Heavy Duty Truck	389,374	0.0048	1.87	0.0019	0.58
Bees Ferry LF	Heavy Duty Truck	89,071	0.0048	0.43	0.00043	0.13

TABLE 4-D**Total CH₄ Emissions from Mobile Combustion - Scenario D**

		A	B	C	D	E
Facility	Average Refuse Truck	2012 Total Miles Per Year	CH ₄ Emission Factor (g/mile)	CH ₄ Emissions (kg/year)	CH ₄ Emissions (metric tons)	CO ₂ e Equivalent for CH ₄ (metric tons)
Montenay	Heavy Duty Truck	389,374	0.0051	1.99	0.0020	0.042
Bees Ferry LF	Heavy Duty Truck	89,071	0.0051	0.45	0.00045	0.010

ASSUMPTIONS AND CALCULATIONS II

GREENHOUSE GAS EMISSIONS BOILERS - COMBUSTION OF MSW

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

The following assumptions and calculations are presented for the greenhouse gas (GHG) emissions of carbon dioxide (CO₂) and nitrous oxides (N₂O) generated from the two municipal solid waste (MSW) waste-to-energy boilers at the Montenay Resource Recovery, Inc. (Montenay) facility located in North Charleston, South Carolina. GHG emission assumptions and calculations from MSW combustion are based on emission factors available in the Environmental Protection Agency (EPA) document "Solid Waste Management and Greenhouse Gases – A Life Cycle Assessment of Emissions and Sinks."

<http://www.epa.gov/climatechange/wycd/waste/downloads/fullreport.pdf>

I. Emission Assumptions

- The rated heat input of each boiler is 130 million Btu per hour.
- Each boiler can also be fired with No. 2 fuel oil for ignition and supplemental heat purposes.
- The emission factor for CO₂ used in the calculations is 0.37 metric tons per ton of mixed MSW burned. The emission factor of N₂O used in the calculations is 0.04 metric tons of CO₂ equivalents per ton of mixed MSW burned. The emission factors were referenced from the EPA document "Solid Waste Management and Greenhouse Gases – A Life Cycle Assessment of Emissions and Sinks," Exhibit 8-8 (a link to this document is provided above).
- According to Montenay records, 215,290 tons of MSW was combusted in calendar year 2007.
- The amount of MSW that will be generated in Charleston County in 2012 (307,818 tons) was estimated from 2007 actual data using an increase rate of 1.4% per year. This high end projection annual rate of increase was taken from the study entitled "Long Range Facilities and Systems Plan – Volume II – Inventory, Analysis, and System Alternatives" completed in May 2003 by Alternative Resources, Inc. and Griffin Engineering, LLC.

<http://www.charlestoncounty.org/departments/SolidWaste/SWCommittee.htm>

- As discussed in the Summary Section of this report, four scenarios were included in this evaluation. The following table provides a summary of MSW combusted and/or landfilled in each scenario:

Scenario	MSW Combusted (tons/year)	MSW Landfilled (tons/year)
A	215,290	71,857
B	225,000	82,818
C	0	307,818
D	307,818	0

II. Emission Calculations

Using the above assumptions, annual emissions for GHG pollutants are calculated for Scenarios A, B, C and D. The boxed alpha codes in the equations refer to the appropriate columns in Tables 1-4.

Annual Combustion Emissions of Carbon Dioxide, Nitrous Oxide & Methane

$$\boxed{A} \frac{\text{MSW Combusted tons}}{\text{year}} \times \boxed{B} \frac{\text{GHG Emission Factor Metric ton CO}_2 \text{ Equivalent}}{\text{tons of MSW}}$$

$$\boxed{C} = \frac{\text{GHG Metric ton CO}_2 \text{ Equivalent}}{\text{year}}$$

**TABLE 1 - SCENARIO A
GREENHOUSE GAS EMISSIONS
COMBUSTION OF MSW - 2007 Data**

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

A		B	C
CY 2007			
MSW Combusted (tons/year)	GHG Pollutants	Emission Factors (Metric ton CO2e/ ton MSW)	Emissions (Metric ton CO2e/year)
215,290	CO2	0.37	79,657
	N2O	0.04	8,612
TOTAL			88,269

**TABLE 2 - SCENARIO B
GREENHOUSE GAS EMISSIONS
COMBUSTION OF MSW - 2012**

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

A		B	C
CY 2012			
MSW Combusted (tons/year)	GHG Pollutants	Emission Factors (Metric ton CO2e/ ton MSW)	Emissions (Metric ton CO2e/year)
225,000	CO2	0.37	83,250
	N2O	0.04	9,000
		TOTAL	92,250

**TABLE 3 - SCENARIO C
GREENHOUSE GAS EMISSIONS
COMBUSTION OF MSW - 2012**

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

A		B	C
CY 2012			
MSW Combusted (tons/year)	GHG Pollutants	Emission Factors (Metric ton CO2e/ ton MSW)	Emissions (Metric ton CO2e/year)
0	CO2	0.37	0
	N2O	0.04	0
		TOTAL	0

**TABLE 4 - SCENARIO D
GREENHOUSE GAS EMISSIONS
COMBUSTION OF MSW - 2012**

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

A		B	C
CY 2012			
MSW Combusted (tons/year)	GHG Pollutants	Emission Factors (Metric ton CO2e/ ton MSW)	Emissions (Metric ton CO2e/year)
307,818	CO2	0.37	113,893
	N2O	0.04	12,313
		TOTAL	126,205

ASSUMPTIONS AND CALCULATIONS III

GREENHOUSE GAS EMISSIONS - BOILERS - COMBUSTION OF NO. 2 FUEL OIL

Montenay Resource Recovery, Inc.
North Charleston, South Carolina

The following assumptions and calculations are presented for the greenhouse gas (GHG) emissions of carbon dioxide (CO₂), nitrous oxides (N₂O), and methane (CH₄) generated from the two municipal solid waste (MSW) waste-to-energy boilers at the Montenay Resource Recovery, Inc. (Montenay) facility located in North Charleston, South Carolina.

I. Emission Assumptions

- The rated heat input of each boiler is 130 million Btu per hour.
- Each boiler can be fired with No. 2 fuel oil for ignition and supplemental heating purposes.
- The Btu content of No. 2 fuel oil is 0.14 MMBtu/gallon based on EPA's Compilation of Air Pollutant Emission Factors, AP-42, Volume I, Appendix A, September 1985, entitled "Typical Parameters of Various Fuels."
<http://www.epa.gov/ttn/chief/ap42/appendix/appa.pdf>
- GHG emission factors for the combustion of No. 2 fuel oil were referenced from The Climate Registry's General Reporting Protocol document, Chapter 12 (<http://www.theclimateregistry.org/downloads/GRP.pdf>). The emission factor for CO₂ from the combustion of No. 2 fuel oil (listed as distillate fuel oil) is found in Table 12.1 (page 74) and is 10.15 kg/gallon. The emission factors for CH₄ and N₂O are listed in a table on page 72 of the General Reporting Protocol as 11 grams/MMBtu and 0.6 grams/MMBtu, respectively. Each emission factor was converted to pounds/1,000 gallons of No. 2 fuel oil as follows:

$$\frac{10.15 \text{ kg CO}_2}{\text{gallon}} \times \frac{1000 \text{ g}}{\text{kg}} \times \frac{1 \text{ lb}}{453.6 \text{ g}} \times 1000 = \boxed{22377} \frac{\text{lbs CO}_2}{1000 \text{ gal}}$$

$$\frac{11 \text{ g CH}_4}{\text{MMBtu}} \times \frac{0.14 \text{ MMBtu}}{\text{gal}} \times \frac{1 \text{ lb}}{453.6 \text{ g}} \times 1000 = \boxed{3.40} \frac{\text{lbs CH}_4}{1000 \text{ gal}}$$

$$\frac{0.6 \text{ g N}_2\text{O}}{\text{MMBtu}} \times \frac{0.14 \text{ MMBtu}}{\text{gal}} \times \frac{1 \text{ lb}}{453.6 \text{ g}} \times 1000 = \boxed{0.19} \frac{\text{lbs N}_2\text{O}}{1000 \text{ gal}}$$

- Emissions of GHG were converted to metric tons by dividing by 2,205. The metric tons of the GHG pollutants were then converted to CO₂ equivalents by multiplying the emissions of N₂O by 310 and multiplying CH₄ emissions by 21. These conversion factors were taken from The Climate Registry General Reporting Protocol, Equation 12j, page 69.
- The amount of No. 2 fuel oil projected to be combusted at Montenay in 2012 for Scenarios B and D was calculated by using the 2007 ratio of fuel oil/MSW combustion (157,298 gallons/215,290 tons).
- As discussed in the Summary Section of this report, four scenarios were evaluated in this project. The following table provides a summary of Number 2 fuel oil combusted in each scenario:

Scenario	MSW Combusted (tons/year)	No. 2 Fuel Oil Combusted (tons/year)
A	215,290	157,298
B	225,000	164,392
C	0	0
D	307,818	224,902

II. Emission Calculations

Using the above assumptions, annual emissions for GHG pollutants are calculated for Scenarios A, B, C and D. The boxed alpha codes in the equations refer to the appropriate columns in Tables 1-4.

Annual Combustion Emissions of Carbon Dioxide, Nitrous Oxide & Methane

$$\boxed{A} \frac{\text{No. 2 Fuel Oil Combusted gals}}{\text{year}} \times \boxed{B} \frac{\text{GHG Emission Factor lbs}}{1,000 \text{ gals}} \times \frac{1 \text{ metric ton}}{2,205 \text{ lbs}}$$

$$\times \text{CO}_2 \text{ Equivalent Factor} = \boxed{C} \frac{\text{GHG Metric ton CO}_2 \text{ Equivalent}}{\text{year}}$$

**TABLE 1 - SCENARIO A
GREENHOUSE GAS EMISSIONS
COMBUSTION OF NO. 2 FUEL OIL - 2007 Data**

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

A		B			C
CY 2007 Fuel Oil Combusted (gals/year)	GHG Pollutants	Emission Factors (lbs GHG/1,000 gal)	(lbs/metric ton)	CO2e Factor	Emissions (Metric ton CO2e/year)
157,298	CO2	22,377		1	1,596
	N2O	0.19	2,205	310	4.10
	CH4	3.40		21	5.09
				TOTAL	1,605

**TABLE 2 - SCENARIO B
GREENHOUSE GAS EMISSIONS
COMBUSTION OF NO. 2 FUEL OIL - 2012 Data**

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

A		B			C
CY 2012 Fuel Oil Combusted (gals/year)	GHG Pollutants	Emission Factors (lbs GHG/1,000 gal)	(lbs/metric ton)	CO2e Factor	Emissions (Metric ton CO2e/year)
164,392	CO2	22,377		1	1,668
	N2O	0.19	2,205	310	4.28
	CH4	3.40		21	5.32
				TOTAL	1,678

**TABLE 3 - SCENARIO C
GREENHOUSE GAS EMISSIONS
COMBUSTION OF NO. 2 FUEL OIL - 2012 Data**

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

A		B			C
CY 2012 Fuel Oil Combusted (gals/year)	GHG Pollutants	Emission Factors (lbs GHG/1,000 gal)	(lbs/metric ton)	CO2e Factor	Emissions (Metric ton CO2e/year)
0	CO2	22,377		1	0
	N2O	0.19	2,205	310	0
	CH4	3.40		21	0
				TOTAL	0

**TABLE 4 - SCENARIO D
GREENHOUSE GAS EMISSIONS
COMBUSTION OF NO. 2 FUEL OIL - 2012 Data**

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

A		B			C
CY 2012 Fuel Oil Combusted (gals/year)	GHG Pollutants	Emission Factors (lbs GHG/1,000 gal)	(lbs/metric ton)	CO2e Factor	Emissions (Metric ton CO2e/year)
224,902	CO2	22,377		1	2,282
	N2O	0.19	2,205	310	5.86
	CH4	3.40		21	7.27
				TOTAL	2,295

ASSUMPTIONS AND CALCULATIONS IV

GREENHOUSE GAS EMISSIONS - LANDFILLING MSW

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

The following assumptions and calculations are presented for the greenhouse gas (GHG) emissions generated from the disposal of municipal solid waste (MSW) at the Bees Ferry Landfill operated by Charleston County and located in Charleston, South Carolina.

I. Emission Assumptions

- The amount of MSW diverted from the Montenay Resource Recovery, Inc. (Montenay) facility to the Bees Ferry Landfill was 71,857 tons in calendar year 2007. This was used in the calculations detailed in Scenario A.
- GHG emissions from landfill disposal of MSW are based on emission factors available in the Environmental Protection Agency's (EPA) document "Solid Waste Management and Greenhouse Gases - A Life Cycle Assessment of Emissions and Sinks."
<http://www.epa.gov/climatechange/wycd/waste/downloads/fullreport.pdf>
- Emission factors of GHG pollutants from landfills is dependant on the type of material disposed in the landfill. The Bees Ferry Landfill waste material was classified as mixed MSW to account for the variety of wastes disposed at this site. The emission factor for mixed MSW in Exhibit 7-2, Methane Yield for Solid Waste Components, (page 106) of the EPA document is listed as:

Selected Methane Yield = 0.286 metric tons of carbon equivalents per wet ton of mixed MSW.
- This emission factor was converted to metric tons of CO₂ equivalents by multiplying the above emission factor by the ratio of the molecular weight of CO₂ to the molecular weight of carbon ($44 / 12 = 3.67$). This resulted in the emission factor of 1.05 metric tons of CO₂ equivalent/wet ton of mixed MSW ($0.286 \times 3.67 = 1.05$).
- The amount of MSW that will be generated in Charleston County in 2012 (307,818 tons) was estimated from 2007 actual data using an increase rate of 1.4% per year. This high end projection annual rate of increase was taken

from the study entitled “Long Range Facilities and Systems Plan – Volume II – Inventory, Analysis, and System Alternatives” completed in May 2003 by Alternative Resources, Inc. and Griffin Engineering, LLC.

<http://www.charlestoncounty.org/departments/SolidWaste/SWCommittee.htm>

- Methane emissions from the Bees Ferry Landfill are not currently captured or recovered.
- As discussed in the Summary Section of this report, four scenarios were included in this evaluation. The following table provides a summary of MSW combusted and/or landfilled in each scenario:

Scenario	MSW Combusted (tons/year)	MSW Landfilled (tons/year)
A	215,290	71,857
B	225,000	82,818
C	0	307,818
D	307,818	0

- The same assumptions and emission factors discussed above are also used to calculate avoided GHG emissions at the Bees Ferry Landfill. Each ton of MSW combusted at Montenay is a ton of MSW that is not landfilled, thus avoiding GHG emissions from the MSW decomposing in the landfill.

II. Emission Calculations

Using the above assumptions, annual emissions for GHG pollutants are calculated for Scenarios A, B, C and D. The boxed alpha codes in the equations refer to the appropriate columns in Tables 1-4.

Annual Emissions of Carbon Dioxide Equivalents from the Bees Ferry Landfill

$$\boxed{A} \frac{\text{MSW disposed tons}}{\text{year}} \times \boxed{B} \frac{\text{Metric ton CO}_2 \text{ Equivalent}}{\text{MSW tons}}$$

$$= \boxed{C} \frac{\text{Metric ton CO}_2 \text{ Equivalent}}{\text{year}}$$

**TABLE 1 - SCENARIO A
GREENHOUSE GAS EMISSIONS
MSW LANDFILL - 2007 Data**

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

A		B	C
CY 2007 MSW to Landfill (tons/year)	GHG Pollutants	Emission Factor (Metric ton CO2e/ton MSW)	Emissions (Metric ton CO2e/year)
71,857	CH4	1.05	75,450

Landfill GHG Emissions Avoided by Combustion of MSW

A		B	C
CY 2007 MSW Combusted (tons/year)	GHG Pollutants	Emission Factor (Metric ton CO2e/ton MSW)	Emissions (Metric ton CO2e/year)
215,290	CH4	1.05	226,055

**TABLE 2 - SCENARIO B
GREENHOUSE GAS EMISSIONS
MSW LANDFILL - 2012 Data**

Montenay Resource Recovery, Inc.
North Charleston, South Carolina

A		B	C
CY 2012 MSW to Landfill (tons/year)	GHG Pollutants	Emission Factor (Metric ton CO2e/ton MSW)	Emissions (Metric ton CO2e/year)
82,818	CH4	1.05	86,959

Landfill GHG Emissions Avoided by Combustion of MSW

A		B	C
CY 2012 MSW Combusted (tons/year)	GHG Pollutants	Emission Factor (Metric ton CO2e/ton MSW)	Emissions (Metric ton CO2e/year)
225,000	CH4	1.05	236,250

**TABLE 3 - SCENARIO C
GREENHOUSE GAS EMISSIONS
MSW LANDFILL - 2012 Data**

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

A		B	C
CY 2012 MSW to Landfill (tons/year)	GHG Pollutants	Emission Factor (Metric ton CO2e/ton MSW)	Emissions (Metric ton CO2e/year)
307,818	CH4	1.05	323,209

Landfill GHG Emissions Avoided by Combustion of MSW

A		B	C
CY 2012 MSW Combusted (tons/year)	GHG Pollutants	Emission Factor (Metric ton CO2e/ton MSW)	Emissions (Metric ton CO2e/year)
0	CH4	1.05	0

**TABLE 4 - SCENARIO D
GREENHOUSE GAS EMISSIONS
MSW LANDFILL - 2012 Data**

Montenay Resource Recovery, Inc.
North Charleston, South Carolina

A		B	C
CY 2012 MSW to Landfill (tons/year)	GHG Pollutants	Emission Factor (Metric ton CO2e/ton MSW)	Emissions (Metric ton CO2e/year)
0	CH4	1.05	0

Landfill GHG Emissions Avoided by Combustion of MSW

A		B	C
CY 2012 MSW Combusted (tons/year)	GHG Pollutants	Emission Factor (Metric ton CO2e/ton MSW)	Emissions (Metric ton CO2e/year)
307,818	CH4	1.05	323,209

ASSUMPTIONS AND CALCULATIONS V

GREENHOUSE GAS EMISSIONS - OFFSETS FROM FERROUS RECOVERY FROM ASH

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

The combustion of municipal solid waste (MSW) at the Montenay Resource Recovery, Inc. (Montenay) facility generates ash. Ferrous metal is recovered from the ash and sold as scrap metal for recycling. The recycling of the metal offsets the greenhouse gas (GHG) emissions from producing metal from raw materials.

I. Emission Assumptions

- Based on facility operating records, the amount of ferrous material recovered from the ash generated at Montenay in calendar year 2007 was 504.6 tons.
- An emission factor to calculate avoided GHG emissions from ferrous recovery is provided in Exhibit 6-5 of the Environmental Protection Agency's document "Solid Waste Management and Greenhouse Gases - A Life Cycle Assessment of Emissions and Sinks." The emission factor is expressed as 0.49 metric tons of carbon equivalents per ton of mixed MSW.
<http://www.epa.gov/climatechange/wycd/waste/downloads/fullreport.pdf>
- This emission factor was converted to metric tons of CO₂ equivalents by multiplying the above emission factor by the ratio of the molecular weight of CO₂ to the molecular weight of carbon ($44 / 12 = 3.67$). This resulted in the emission factor of 1.80 metric tons of CO₂ equivalents per ton of mixed MSW ($0.49 \times 3.67 = 1.80$).
- The projected amount of ferrous material recovered from ash in 2012 for Scenarios B and D was calculated by using the 2007 ratio of ferrous recovery/MSW combustion (504.6 tons/215,290 tons).

- As discussed in the Summary Section of this report, four scenarios were included in this evaluation. The following table provides a summary of ferrous material recovered in each scenario:

Scenario	MSW Combusted (tons/year)	Ferrous Material Recovered (tons/year)
A	215,290	504.6
B	225,000	527.4
C	0	0
D	307,818	721.5

II. Emission Calculations

Using the above assumptions, annual emissions for GHG pollutants are calculated for Scenarios A, B, C and D. The boxed alpha codes in the equations refer to the appropriate columns in Tables 1-4.

Annual Emissions of Carbon Dioxide Equivalents from Ferrous Recovery

$$\boxed{\text{A}} \frac{\text{Ferrous Material Recovered tons}}{\text{year}} \times \boxed{\text{B}} \frac{\text{Metric ton CO}_2 \text{ Equivalent}}{\text{Ferrous Material Recovered tons}}$$

$$= \boxed{\text{C}} \frac{\text{Metric ton CO}_2 \text{ Equivalent}}{\text{year}}$$

**TABLE 4 - SCENARIO D
GREENHOUSE GAS EMISSIONS
FERROUS RECOVERY - 2012 Data**

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

A		B	C
CY 2012 Ferrous Material Recovered (tons/year)	GHG Pollutants	Emission Factor (Metric ton CO ₂ e/ ton Ferrous Material Recovered)	Emissions (Metric ton CO ₂ e/year)
721.5	CO ₂	1.80	1,298.7

**TABLE 3 - SCENARIO C
GREENHOUSE GAS EMISSIONS
FERROUS RECOVERY - 2012 Data**

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

A		B	C
CY 2012 Ferrous Material Recovered (tons/year)	GHG Pollutants	Emission Factor (Metric ton CO ₂ e/ ton Ferrous Material Recovered)	Emissions (Metric ton CO ₂ e/year)
0	CO ₂	1.80	0

**TABLE 2 - SCENARIO B
GREENHOUSE GAS EMISSIONS
FERROUS RECOVERY - 2012 Data**

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

A		B	C
CY 2012 Ferrous Material Recovered (tons/year)	GHG Pollutants	Emission Factor (Metric ton CO ₂ e/ ton Ferrous Material Recovered)	Emissions (Metric ton CO ₂ e/year)
527.4	CO ₂	1.80	949.3

**TABLE 1 - SCENARIO A
GREENHOUSE GAS EMISSIONS
FERROUS RECOVERY - 2007 Data**

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

A		B	C
CY 2007 Ferrous Material Recovered (tons/year)	GHG Pollutants	Emission Factor (Metric ton CO ₂ e/ ton Ferrous Material Recovered)	Emissions (Metric ton CO ₂ e/year)
504.6	CO ₂	1.80	908.3

ASSUMPTIONS AND CALCULATIONS VI

GREENHOUSE GAS EMISSIONS - OFFSETS FROM POWER GENERATION

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

The Montenay Resource Recovery, Inc. (Montenay) facility located in North Charleston, South Carolina generates electricity using steam produced by the combustion of municipal solid waste (MSW) in two waste-to-energy boilers. This electricity is placed on the grid. The following assumptions and calculations are presented for avoided greenhouse gas (GHG) emissions of carbon dioxide (CO₂), nitrous oxides (N₂O), and methane (CH₄) due to the electricity placed on the grid by Montenay.

I. Emission Assumptions

- By placing electricity on the grid, Montenay offsets the need for a fossil fuel fired utility to provide this same amount of electricity to the grid.
- Montenay combusted 215,290 tons of MSW and placed 66,324 megawatt hours (MWh) of electricity on the grid in calendar year 2007. This data is used for the Scenario A calculations.
- Should Charleston County elect to renew Montenay's contract, the facility will invest in upgrades to the boilers and steam generators that will increase the amount of electricity that can be generated per ton of MSW combusted. Also, the facility's contract to supply steam to the Navy Base will expire in 2010. Thus, steam currently being sent to the Navy Base will be available for electricity production. For the 2012 scenarios, the amount of electricity placed on the grid was calculated based on the net grid heat rate factor used in Montenay's economic model for the draft contract renewal: 0.42 MWh per ton of MSW combusted.
- Based on the above, the following table provides a summary of the electricity placed on the grid in each scenario:

Scenario	MSW Combusted (tons/year)	Electricity to Grid (MWh per year)
A	215,290	66,324
B	225,000	94,500
C	0	0
D	307,818	129,284

- GHG emission factors from utility operations were taken from The Climate Registry's General Reporting Protocol, Table 14.1, U.S. Emission Factors for Grid Electricity by eGRID Subregion. The eGRID Subregion for facilities located in South Carolina is denoted as SERC Virginia/Carolina in Table 14.1 (page 104) of the General Reporting Protocol.

<http://www.theclimateregistry.org/downloads/GRP.pdf>

- The utilities emission factors for the SERC Virginia/Carolina classified facilities is provided in pounds per megawatt hour for GHG pollutants. The emission factors are listed in Table 14.1 of the General Reporting Protocol as:

$$\text{CO}_2 = 1,146.39 \text{ lbs/MWh}$$

$$\text{N}_2\text{O} = 0.019 \text{ lbs/MWh}$$

$$\text{CH}_4 = 0.029 \text{ lbs/MWh}$$

- As shown on the attached page, the SERC Virginia/Carolina emission factors are weighted for the electricity generation mix in South, Carolina, North Carolina, and eastern Virginia – 51% coal, 39.5% nuclear, and various other sources the remaining 9.5%. If the emission offsets were calculated for coal-fired generation only, they would be larger than those calculated using the SERC Virginia/Carolina emission factors.

http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2006V2_1_Summary_Tables.pdf

- Emissions of the GHG pollutants were converted from pounds to metric tons by dividing by 2,205 pounds per metric ton. The metric tons of the GHG pollutants were then converted to CO₂ equivalents by multiplying the emissions of N₂O by 310 and multiplying CH₄ emissions by 21. These conversion factors were taken from The Climate Registry General Reporting Protocol, Equation 12j, page 69.

II. Emission Calculations

Using the above assumptions, annual emissions for GHG pollutants are calculated for Scenarios A, B, C and D. The boxed alpha codes in the equations refer to the appropriate columns in Tables 1 through 4.

Annual Combustion Emissions of Carbon Dioxide, Nitrous Oxide & Methane

$$\boxed{A} \frac{\text{Megawatt hours}}{\text{year}} \quad \times \quad \boxed{B} \frac{\text{GHG Emission Factor lbs}}{\text{Megawatt hours}} \quad \times \quad \frac{1 \text{ metric ton}}{2,205 \text{ lbs}}$$

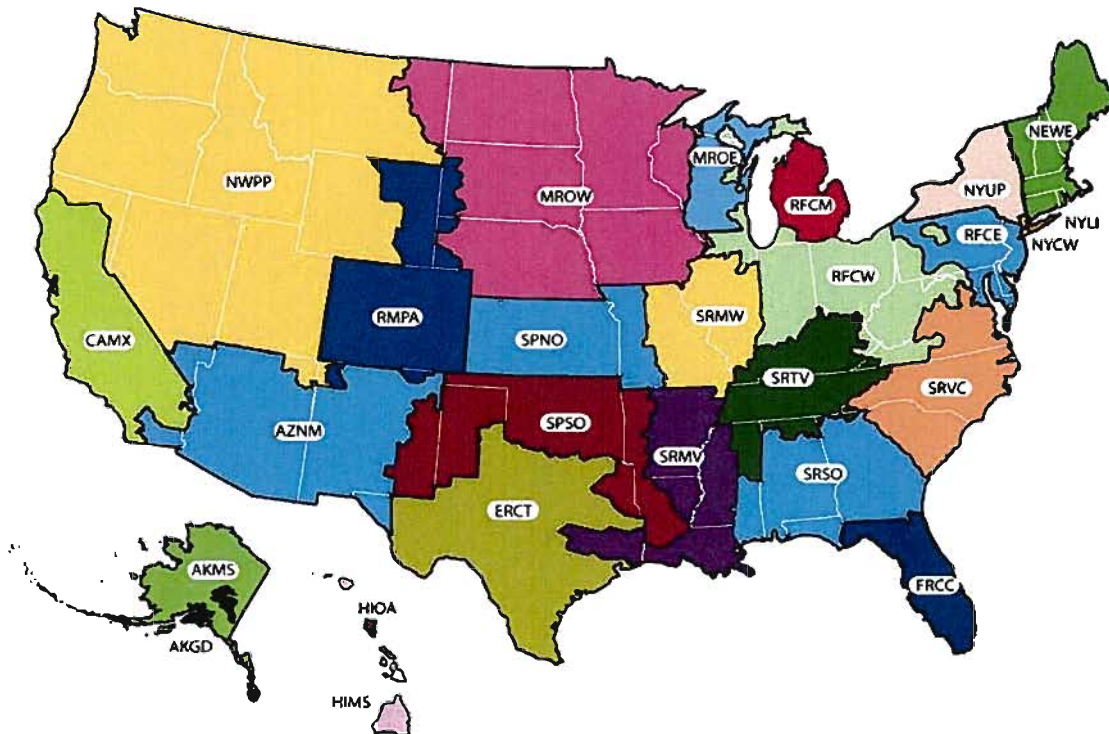
x CO2 Equivalent Factor

$$= \boxed{C} \frac{\text{GHG Metric ton}}{\text{year}}$$

Year 2004 eGRID Subregion Resource Mix

(Source: eGRID2006 Version 2.1, April 2007)

eGRID subregion acronym	eGRID subregion name	Nameplate capacity (MW)	Net generation (MWh)	Generation resource mix (percent)									
				Coal	Oil	Gas	Other fossil	Biomass	Hydro	Nuclear	Wind	Solar	Geo-thermal
AKGD	ASCC Alaska Grid	1,428	5,280,954	12.3	7.3	68.0	0.0	0.0	12.4	0.0	0.00	0.00	0.0
AKMS	ASCC Miscellaneous	635	1,265,757	0.0	28.8	3.6	0.0	0.7	66.9	0.0	0.00	0.00	0.0
AZNM	WECC Southwest	37,712	132,753,033	40.4	0.0	31.5	0.0	0.0	4.5	21.2	0.39	0.003	2.0
CAMX	WECC California	67,186	213,779,426	12.6	1.1	46.4	0.9	2.8	15.1	14.2	2.01	0.267	4.7
ERCT	ERCOT All	88,542	306,488,130	37.7	0.5	45.9	1.3	0.1	0.3	13.2	0.94	0.000	0.0
FRCC	FRCC All	56,126	201,982,118	25.4	18.3	36.5	0.3	2.0	0.0	15.5	0.00	0.000	0.0
HIMS	HICC Miscellaneous	841	3,079,854	3.6	77.2	4.1	0.0	4.9	3.0	0.0	0.24	0.000	6.9
HIOA	HICC Oahu	1,784	8,333,611	18.0	77.4	0.0	1.9	2.7	0.0	0.0	0.00	0.000	0.0
MROE	MRO East	7,646	29,431,172	71.3	2.4	5.2	0.1	3.7	3.9	13.2	0.14	0.000	0.0
MROW	MRO West	42,534	177,494,568	74.6	0.6	1.8	0.1	0.8	4.7	16.0	1.28	0.000	0.0
NEWE	NPCC New England	36,783	132,524,397	14.5	9.4	36.7	1.0	5.7	5.1	27.8	0.01	0.000	0.0
NWPP	WECC Northwest	59,994	250,231,026	34.4	0.3	10.6	0.1	1.2	49.0	3.6	0.49	0.000	0.3
NYCW	NPCC NYC/Westchester	11,749	33,470,521	0.0	20.4	29.8	0.3	0.8	0.0	48.8	0.00	0.000	0.0
NYLI	NPCC Long Island	5,505	14,321,157	0.0	58.2	35.5	1.8	4.5	0.0	0.0	0.00	0.000	0.0
NYUP	NPCC Upstate NY	24,158	89,924,573	25.4	6.8	13.2	0.3	1.3	26.0	27.1	0.11	0.000	0.0
RFCE	RFC East	78,512	273,924,233	44.9	3.5	9.6	0.7	1.3	1.6	38.4	0.10	0.000	0.0
RFCM	RFC Michigan	29,765	95,781,410	67.0	0.9	15.5	0.3	2.0	0.0	14.3	0.00	0.000	0.0
RFCW	RFC West	144,922	597,514,474	72.8	0.5	1.5	0.7	0.3	0.7	23.2	0.06	0.000	0.0
RMPA	WECC Rockies	18,408	81,742,789	80.6	0.0	13.5	0.0	0.0	5.3	0.0	0.46	0.000	0.0
SPNO	SPP North	18,363	66,514,000	78.1	1.3	4.6	0.1	0.0	0.1	15.2	0.54	0.000	0.0
SPSO	SPP South	41,190	137,772,165	58.8	0.2	34.1	0.3	1.7	4.2	0.0	0.81	0.000	0.0
SRMV	SERC Mississippi Valley	48,864	160,765,508	23.4	5.0	39.3	1.1	2.4	1.8	26.6	0.00	0.000	0.0
SRMW	SERC Midwest	31,186	135,519,573	84.7	0.3	2.0	0.1	0.1	1.2	11.7	0.00	0.000	0.0
SRSO	SERC South	88,200	251,944,380	64.0	0.6	10.1	0.1	3.5	3.1	18.6	0.00	0.000	0.0
SRTV	SERC Tennessee Valley	57,181	230,695,467	65.8	1.7	2.4	0.0	0.9	8.8	20.4	0.00	0.000	0.0
SRVC	SERC Virginia/Carolina	75,784	302,557,474	51.0	1.7	3.8	0.2	2.0	1.7	39.5	0.00	0.000	0.0
U.S.		1,052,996	3,835,071,768	50.2	3.0	17.4	0.5	1.4	6.6	20.0	0.34	0.015	0.3



**TABLE 1 - SCENARIO A
GREENHOUSE GAS EMISSION OFFSETS
AVOIDED POWER GENERATION**

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

A		B			C
CY 2007 Electricity to Grid (Megawatt hours/year)	GHG Pollutants	Emission Factors (lbs/Megawatt hour)	(lbs/metric ton)	CO2 Equivalent Factor	Emission Offsets (Metric ton CO2 Equivalent/year)
66,324	CO2	1,146.39		1	34,482
	N2O	0.019	2,205	310	177
	CH4	0.029		21	18.32
TOTAL					34,678

**TABLE 2 - SCENARIO B
GREENHOUSE GAS EMISSION OFFSETS
AVOIDED POWER GENERATION**

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

A		B			C
CY 2012 Electricity to Grid (Megawatt hours/year)	GHG Pollutants	Emission Factors (lbs/Megawatt hour)	(lbs/metric ton)	CO2 Equivalent Factor	Emission Offsets (Metric ton CO2 Equivalent/year)
94,500	CO2	1,146.39		1	49,131
	N2O	0.019	2,205	310	252
	CH4	0.029		21	26.10
TOTAL					49,410

**TABLE 3 - SCENARIO C
GREENHOUSE GAS EMISSION OFFSETS
AVOIDED POWER GENERATION**

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

A		B			C
CY 2012 Electricity to Grid (Megawatt hours/year)	GHG Pollutants	Emission Factors (lbs/Megawatt hour)	(lbs/metric ton)	CO2 Equivalent Factor	Emission Offsets (Metric ton CO2 Equivalent/year)
0	CO2	1,146.39		1	0
	N2O	0.019	2,205	310	0
	CH4	0.029		21	0
TOTAL					0

**TABLE 4 - SCENARIO D
GREENHOUSE GAS EMISSION OFFSETS
AVOIDED POWER GENERATION**

**Montenay Resource Recovery, Inc.
North Charleston, South Carolina**

A		B			C
CY 2012 Electricity to Grid (Megawatt hours/year)	GHG Pollutants	Emission Factors (lbs/Megawatt hour)	(lbs/metric ton)	CO2 Equivalent Factor	Emission Offsets (Metric ton CO2 Equivalent/year)
129,284	CO2	1,146.39		1	67,215
	N2O	0.019	2,205	310	345
	CH4	0.029		21	35.71
TOTAL					67,596

Appendix I

Summary of Greenhouse Gas Emission Calculations

**Table 1
Net CO2e Emissions - Scenario A**

CO2 Equivalent Emissions from MSW Combustion

MSW Combusted - CY 2007		215,290 tons/yr		
	Pollutants & Emission Factors (Metric tons CO2e/ton MSW)			
	CO2	N2O	CH4	Total
MSW Combustion	0.37	0.04	NA	
Metric Tons CO2e/year	79,657	8,612	0	88,269

Fuel Oil Combusted - CY 2007		157,298 gals/yr		
	Pollutants & Emission Factors (lbs /1,000 gal)			
	CO2	N2O	CH4	Total
Fuel Oil Combustion	22,377	0.19	3.40	
Metric Tons/year	1,596	0.013	0.24	
Metric Tons CO2e/year	1,596	4.10	5.09	1,605

	Metric tons of CO2e/year		
Transportation of MSW to Montenay	CO2	N2O	CH4
	987.2	0.41	0.029
Total	987.6		

	CO2e (Metric tons/year)
TOTAL EMISSIONS	90,862

CO2 Equivalent Emission Offsets from MSW Combustion

Avoided Landfill Emissions	
MSW to Landfill/No MSW to Montenay	215,290 tons
	CH4 (Metric tons CO2e/ton MSW)
	1.05
	-226,055

Avoided Ferrous Production Emissions	
Montenay Ferrous Recovery - CY 2007	504.6 tons
	CO2 (Metric tons CO2e/ton ferrous)
	1.80
	-908.3

**Table 1
Net CO2e Emissions - Scenario A**

Avoided Utility Emissions			
Montenay Electricity to Grid - CY 2007	66,324 MWh		
	Pollutants & Emission Factors (lbs/Megawatt hour)		
	CO2	N2O	CH4
	1,146.39	0.019	0.029
Metric tons/year	34,482	0.57	0.87
Metric tons CO2e/year	34,482	177	18.32
Total	-34,678		

	Total CO2e Offsets (Metric tons/year)
TOTAL OFFSETS	-261,640

CO2 Equivalent Emissions - MSW to Landfill

MSW to Bees Ferry Landfill - CY 2007	71,857 tons	
	CH4 (Metric tons CO2e/ton MSW)	
	1.05	
MSW to Landfill Emissions - CY 2007	75,450	

Transportation MSW and Ash to Bees Ferry Landfill	Metric tons of CO2e/year		
	CO2	N2O	CH4
	872.5	0.36	0.026
Total	872.9		

	CO2e (Metric tons/year)
TOTAL EMISSIONS	76,323

Net CO2 Equivalent Emissions for Operation of Montenay and Bees Ferry Landfill (2007)

	Net CO2e (Metric tons/year)
Net Difference	-94,456

Notes:
(1) Refer to Assumptions and Calculations for emission factor references and emission calculations

**Table 2
Net CO2e Emissions - Scenario B**

CO2 Equivalent Emissions from MSW Combustion

MSW Combusted - CY 2012	225,000 tons/yr			
	Pollutants & Emission Factors (Metric tons CO2e/ton MSW)			
	CO2	N2O	CH4	Total
MSW Combustion	0.37	0.04	NA	
Metric Tons CO2e/year	83,250	9,000	0	92,250

Fuel Oil Combusted - CY 2012	164,392 gals/yr			
	Pollutants & Emission Factors (lbs /1,000 gal)			
	CO2	N2O	CH4	Total
Fuel Oil Combustion	22,377	0.19	3.40	
Metric Tons/year	1,668	0.014	0.25	
Metric Tons CO2 Eq/year	1,668	4.28	5.32	1,678

	Metric tons of CO2e/year		
Transportation of MSW to Montenay	CO2	N2O	CH4
	1,031.7	0.42	0.030
Total	1,032		

	CO2e (Metric tons/year)
TOTAL EMISSIONS	94,960

CO2 Equivalent Emission Offsets from MSW Combustion

Avoided Landfill Emissions	
MSW to Landfill/No MSW to Montenay	225,000 tons
	CH4 (Metric tons CO2e/ton MSW)
	1.05
	-236,250

Avoided Ferrous Production Emissions	
Montenay Ferrous Recovery - CY 2012	527.4 tons
	CO2 (Metric tons CO2e/ton ferrous)
	1.80
	-949.3

**Table 2
Net CO2e Emissions - Scenario B**

Avoided Utility Emissions			
Montenay Electricity to Grid - CY 2012		94,500 MWh	
	Pollutants & Emission Factors (lbs/Megawatt hour)		
	CO2	N2O	CH4
	1,146.39	0.019	0.029
Metric tons/year	49,131	0.81	1.24
Metric tons CO2e/year	49,131	252	26.10
Total	-49,410		

Total CO2e Offsets (Metric tons/year)	
TOTAL OFFSETS	-286,609

CO2 Equivalent Emissions - MSW to Landfill

MSW to Bees Ferry Landfill - CY 2012	82,818 tons
	CH4 (Metric tons CO2e/ton MSW)
	1.05
MSW to Landfill Emissions - CY 2012	86,959

Transportation MSW and Ash to Bees Ferry Landfill	Metric tons of CO2e/year		
	CO2	N2O	CH4
	981	0.40	0.029
Total	981		

CO2e (Metric tons/year)	
TOTAL EMISSIONS	87,940

Net CO2 Equivalent Emissions for Operation of Montenay and Bees Ferry Landfill (2012)

Net CO2e (Metric tons/year)	
Net Difference	-103,709

Notes:
(1) Refer to Assumptions and Calculations for emission factor references and emission calculations

**Table 3
Net CO2e Emissions - Scenario C**

CO2 Equivalent Emissions from MSW Combustion

MSW Combusted - CY 2012		0 tons/yr		
	Pollutants & Emission Factors (Metric tons CO2e/ton MSW)			
	CO2	N2O	CH4	Total
MSW Combustion	0.37	0.04	NA	
Metric Tons/yr	0	0	0	0

Fuel Oil Combusted - CY 2012		0 gals/yr		
	Pollutants & Emission Factors (lbs /1,000 gal)			
	CO2	N2O	CH4	Total
Fuel Oil Combustion	22,377	0.19	3.40	
Metric Tons/year	0	0	0	
Metric Tons CO2e/year	0	0	0	0

	Metric tons of CO2e/year		
Transportation of MSW to Montenay	CO2	N2O	CH4
	0	0	0
Total	0		

	CO2e (Metric tons/year)
TOTAL EMISSIONS	0

CO2 Equivalent Emission Offsets from MSW Combustion

Avoided Landfill Emissions	
MSW to Landfill/No MSW to Montenay	0 tons
	CH4 (Metric tons CO2e/ton MSW)
	1.05
	0

Avoided Ferrous Production Emissions	
Montenay Ferrous Recovery - CY 2012	0 tons
	CO2 (Metric tons CO2e/ton ferrous)
	0.04
	0

**Table 3
Net CO2e Emissions - Scenario C**

Avoided Utility Emissions			
Montenay Electricity to Grid - CY 2012	0 MWh		
	Pollutants & Emission Factors (lbs/Megawatt hour)		
	CO2	N2O	CH4
Metric tons/year	1,146.39	0.019	0.029
Metric tons CO2e/year	0	0	0
Total	0		

	Total CO2e Offsets (Metric tons/year)
TOTAL OFFSETS	0

CO2 Equivalent Emissions - MSW to Landfill

MSW to Bees Ferry Landfill - CY 2012	307,818 tons
	CH4 (Metric tons CO2e/ton MSW)
	1.05
MSW to Landfill Emissions - CY 2012	323,209

Transportation MSW to Bees Ferry Landfill	Metric tons of CO2e/year		
	CO2	N2O	CH4
	2770	1.14	0.082
Total	2,771		

	CO2e (Metric tons/year)
TOTAL EMISSIONS	325,980

Net CO2 Equivalent Emissions for Operation of Montenay and Bees Ferry Landfill (2012)

	Net CO2e (Metric tons/year)
Net Difference	325,980

Notes:
(1) Refer to Assumptions and Calculations for emission factor references and emission calculations

**Table 4
Net CO2e Emissions - Scenario D**

CO2 Equivalent Emissions from MSW Combustion

MSW Combusted - CY 2012		307,818 tons/yr			
Pollutants & Emission Factors (Metric tons CO2e/ton MSW)					
		CO2	N2O	CH4	Total
MSW Combustion		0.37	0.04	NA	
Metric Tons/year		113,893	12,313	0	126,205

Fuel Oil Combusted - CY 2012		224,902 gals/yr			
Pollutants & Emission Factors (lbs /1,000 gal)					
		CO2	N2O	CH4	Total
Fuel Oil Combustion		22,377	0.19	3.40	
Metric Tons/year		2,282	0.019	0.35	
Metric Tons CO2e/year		2,282	5.86	7.27	2,295

Transportation of MSW to Montenay	Metric tons of CO2e/year		
	CO2	N2O	CH4
	1,411.5	0.58	0.042
Total	1,412.1		
Transportation Ash - Montenay to Bees Ferry Landfill	Metric tons of CO2e/year		
	CO2	N2O	CH4
	323	0.13	0.010
Total	323.0		

**Total
Transportation Emissions
MSW and Ash
1,735
Metric tons CO2e/year**

TOTAL EMISSIONS	CO2e (Metric tons/year) 130,236
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CO2 Equivalent Emission Offsets from MSW Combustion

Avoided Landfill Emissions	
MSW to Landfill/No MSW to Montenay	307,818 tons
	CH4 (Metric tons CO2e/ton MSW)
	1.05
	-323,209

**Table 4
Net CO2e Emissions - Scenario D**

Avoided Ferrous Production Emissions	
Montenay Ferrous Recovery - CY 2012	721.5 tons
	CO2
	(MTCO2e/ton ferrous)
	1.80
	-1,298.7

Avoided Utility Emissions			
Montenay Electricity to Grid - CY 2012	129,284 MWh		
	Pollutants & Emission Factors		
	(lbs/Megawatt hour)		
	CO2	N2O	CH4
	1,146.39	0.019	0.029
Metric tons/year	67,215	1.11	1.70
Metric tons CO2e/year	67,215	345	35.71
Total	-67,596		

	Total CO2e Offsets
	(Metric tons/year)
TOTAL OFFSETS	-392,104

CO2 Equivalent Emissions - MSW to Landfill

MSW to Bees Ferry Landfill - CY 2012	0 tons
	CH4
	(Metric tons CO2e/ton MSW)
	1.05
MSW to Landfill Emissions - CY 2012	0

Transportation	Metric tons of CO2e/year		
MSW to Bees Ferry Landfill	CO2	N2O	CH4
	0	0.00	0.000
Total	0		

	CO2e
	(Metric tons/year)
TOTAL EMISSIONS	0

Net CO2 Equivalent Emissions for Operation of Montenay Only (2012)

	Net CO2e
	(Metric tons/year)
Net Difference	-261,868

Notes:

(1) Refer to Assumptions and Calculations for emission factor references and emission calculations