The Landfill Disposal Rates of Waste-to-Energy Communities

Photo Courtesy of Miami-Dade County Resource Recovery Facility - Ash Disposal

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APPLIED RESEARCH FOUNDATION

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Ash Disposal – Miami-Dade County Resource Recovery Facility

Prepared for:

SWANA Applied Research Foundation
FY2010 Waste-to-Energy Group Subscribers

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1.0 INTRODUCTION

In Fiscal Year (FY) 2010, the SWANA Applied Research Foundation's (ARF) Waste-to-Energy (WTE) Group identified the issue of documenting the landfill disposal rates of communities with waste-to-energy systems for comparison with other solid waste systems as one of high importance to the group.

In this regard, a new municipal solid waste (MSW) management strategy that is growing in popularity is the "Zero Waste" option. According to the Grass Roots Recycling Network,

> *"Zero Waste is a philosophy and a design principle for the 21st Century. It includes 'recycling' but goes beyond recycling by taking a 'whole system' approach to the vast flow of resources and waste through human society. Zero Waste maximizes recycling, minimizes waste, reduces consumption, and ensures that products are made to be reused, repaired, or recycled back into nature or the marketplace."*[1]

MSW management systems that embrace the zero waste philosophy typically rely on materials recycling, food and yard waste composting, and composting or anaerobic digestion of mixed waste to achieve high recycling and waste diversion rates. A key aspect of the zero waste philosophy appears to be the outright rejection of WTE as a possible system component.

One city that has embraced the zero waste philosophy is San Francisco, California. As stated on its web site,

> *"Imagine a world in which nothing goes to the landfills or incinerators. We think it's achievable, and SF Environment is doing everything we can to make it happen in the residential, business and city government sectors, and at special events held throughout the city. Today, San Francisco recovers 72 percent of the materials it discards, bringing the city ever closer to its twin goals of 75 percent landfill diversion by 2010, and bringing the city to zero waste by 2020."*[2]

In the past, the WTE industry has conducted numerous studies to document the fact that WTE communities achieve recycling rates that are comparable to or higher than those achieved by communities with robust recycling programs. However, the landfill disposal rates of WTE communities and communities with zero waste and/or aggressive recycling programs have not been documented for comparative purposes.

[1] http://www.grrn.org/zerowaste/zerowaste_faq.html.
[2] http://www.sfenvironment.org/our_programs/overview.html?ssi=3.

The purpose of this report is to introduce a new metric – the "Landfill Disposal Index" – that can be used as a performance measure for communities that have WTE-based systems and to compare the landfill disposal indices of WTE communities to those of other solid waste management systems such as zero waste systems.

Five organizations subscribed to the SWANA ARF's WTE group in FY2010, each of which made a funding commitment to the conduct of collective applied research in the WTE area.[3] A listing of the five WTE Group subscribers and their contacts are provided in Table 1.

TABLE 1
SWANA ARF FY2010 WTE Group

Organization	Contact	Title
HDR Engineering, Inc.	John Williams	Senior Vice President
I-95 Landfill Owners Group	Carl Newby	Arlington County WTE Contract Manager
	John Snarr	Metro Washington COG Project Manager
Lancaster County Solid Waste Authority	Gary Forster, P.E.	Senior Manager, RRF Contract Administration
Wheelabrator Technologies, Inc.	David Tooley	Vice President, Government and Public Affairs
Three Rivers Solid Waste Authority	Colin Covington	General Manager

2.0 THE LANDFILL DISPOSAL INDEX (LDI)

In a presentation given at the "Cispel Conservizi Toscana Symposium" in Florence, Italy, in 2009, Dr. Nicholas Themelis of Columbia University's "WTE Research and Technology Council" stated that,

> *"Waste management performance should be based on "tons landfilled" per capita (i.e. the fewer tons landfilled per capita the more sustainable the solid waste system."*[4]

Based on this recommendation, as well as research conducted during this project, the new LDI metric is proposed by the ARF's WTE Group for adoption and endorsement by SWANA and the solid waste industry. The following definition is proposed for the "Landfill Disposal Index":

> *The Landfill Disposal Index, or LDI, is defined as the tons of solid waste generated by a community that are disposed in landfills. The LDI should be reported on an annual weight per capita basis such as "tons of waste landfilled per person per year."*

[3] If the jurisdiction or organization was already an ARF subscriber and had made a penny per ton funding commitment to another group, the funding rate for the WTE group was reduced to $0.005 per ton.

[4] Themilis, N. "Materials and Energy Recovery in the U.S., New York and California," CISPEL CONFSERVIZI TOSCANA Symposium, Florence, Italy. April 24, 2009.

It is further recommended that the LDI be calculated for each type of solid waste generated by a community. For example, a community will have a "Municipal Solid Waste LDI (MSW-LDI), a "Construction and Demolition Waste LDI (C&D-LDI) etc.

The MSW LDI can be further characterized as to whether or not the waste has been stabilized or biodegraded prior to landfill disposal, as is required in the European Union's 1999 Landfill Directive.[5] In this regard, a community can have a "Biodegradable MSW-LDI" and a "Stabilized MSW-LDI".

The SWANA ARF's WTE Group recommends that SWANA and the solid waste industry adopt the LDI as a meaningful solid waste management metric and endorse a policy that a primary goal of local solid waste management systems should be to minimize the LDI of the community.

3.0 THE LANDFILL DISPOSAL INDICES OF WTE COMMUNITIES

In June 2009, Dr. Eileen Berenyi published a report entitled *Recycling and Waste-to-Energy: Are They Compatible? 2009 Update*. This report provides solid waste data for communities with WTE facilities, including populations served, tons recycled, and tons disposed in landfills or at WTE facilities.

Dr. Berenyi's firm (Governmental Advisory Associates, Inc.) also publishes a *Waste-to-Energy* yearbook. In response to a request from the ARF's WTE Group, Dr. Berenyi provided unpublished data on the actual MSW tonnages processed at United States WTE facilities. Data from these two sources were used to calculate the LDIs for 65 WTE communities with the results presented in Table 2.

As shown, on a national basis, communities with WTE facilities on average dispose of 25 percent of the MSW generated by their communities in landfills. Of the remaining 75 percent of the MSW generated, 34 percent is recycled and 41 percent is combusted to generate electricity or produce other useful energy products. The average LDI for the 36.2 million people served by these WTE facilities is 0.35 tons per person per year.

[5] This Directive requires, for example, that "not later than five years after the date laid down in Article 18(1), biodegradable municipal waste going to landfills must be reduced to 75 percent of the total amount (by weight) of biodegradable municipal waste produced in 1995 or the latest year before 1995 for which standardized Eurostat data is available." The directive increases the amount of target reduction for the landfilling of biodegradable waste to 35 percent of the amount produced in 1995 by no later than 15 years after the adoption of the Directive by each Member State of the European Union.

Table 2. Landfill Disposal Indices For Communities With Waste-to-Energy Facilities

Column		A	B	C	D	E	F	G	H	I	J	K
State	No. of WTE Facilities[1]	Population Served by WTE Facilities[2]	Tons Recycled[3]	MSW To WTE Facilities[4]	Bypass MSW to Landfill Disposal[5]	Total MSW Combusted/ Disposed[6]	MSW Generated[7]		Ash Generated[8]	Ash/Bypass Waste Disposed		Landfill Disposal Index[11]
		Persons	Tons/Year	Tons/Year	Tons/Year	Tons/Year	Tons/Year	Per Capita	Tons/Year	Tons/Year[9]	%[10]	Tons/Person/Yr
California	3	2,082,069	1,694,873	858,112	1,249,332	2,107,444	3,802,317	1.83	162,183	1,411,515	37%	0.68
Connecticut	6	3,081,621	907,213	2,181,010	241,698	2,422,708	3,329,921	1.08	412,211	653,909	20%	0.21
Florida	11	8,494,222	3,184,586	5,736,740	3,241,367	8,978,107	12,162,693	1.43	1,084,244	4,325,611	36%	0.51
Maryland	3	1,952,955	1,614,668	1,392,238	747,729	2,139,967	3,754,635	1.92	263,133	1,010,862	27%	0.52
Massachusetts	7	3,239,216	1,607,923	3,296,431	-	3,296,431	4,904,354	1.51	623,025	623,025	13%	0.19
Minnesota	9	3,376,057	1,685,268	1,501,753	719,051	2,220,804	3,906,072	1.16	283,831	1,002,882	26%	0.30
New Jersey	5	2,182,216	922,143	2,177,208	-	2,177,208	3,099,351	1.42	411,492	411,492	13%	0.19
New York	10	4,275,024	1,874,923	3,890,383	-	3,890,383	5,765,306	1.35	735,282	735,282	13%	0.17
Pennsylvania	6	4,869,512	1,863,423	3,110,530	1,237,836	4,348,366	6,211,789	1.28	587,890	1,825,726	29%	0.37
Virginia	5	2,659,944	1,119,532	2,028,993	121,038	2,150,031	3,269,563	1.23	383,480	504,518	15%	0.19
Totals	65	36,212,836	16,474,552	26,173,398	7,558,051	33,731,449	50,206,001	1.39	4,946,772	12,504,823	25%	0.35
Percent			33%	42%			100%				25%	

1. Berenyi. E. *Recycling and Waste-to-Energy: Are They Compatible? 2009 Update* . Westport, CT: Governmental Advisory Associates, Inc., June 2009. Table 2.
2. Ibid., Table 2.
3. Berenyi. E. *Recycling and Waste-to-Energy: Are They Compatible? 2009 Update* . Westport, CT: Governmental Advisory Associates, Inc., June 2009. Table 2.
4. Berenyi. E. *Tonnage Data - Waste-to-Energy Yearbook. (Unpublished data)* . Westport, CT: Governmental Advisory Associates, Inc.
5. Calculated. Column D = Column E - Column C.
6. Berenyi. E. *Recycling and Waste-to-Energy: Are They Compatible? 2009 Update* . Table 2. Total MSW Disposed = MSW Landfilled + MSW Combusted in WTE Facilities.
   For MA, NJ, and NY, Column E was assumed to equal Column C.
7. Calculated. Column F = Column B + Column E. Column G = Column F/Column A.
8. Calculated. Column H = Column C * 0.27 (wet weight of ash) * 0.70 (1.0 - moisture content of ash (0.30)).
9. Calculated. Column I = Column D + Column H.
10. Calculated. Column J = Column I / Column F.
11. Calculated. Column K = Column I/ Column A.

For communities in the state of Massachusetts that are served by WTE systems, the LDI is even lower – 0.19 tons per person per year. In addition, only 13 percent of the MSW generated by these communities is disposed in landfills.

4.0 LANDFILL DISPOSAL INDICES FOR ZERO WASTE COMMUNITIES

Due to the newness of the zero waste approach, the calculation of LDIs for communities that have embraced the zero waste philosophy may be premature. However, data for two cities that are nationally known for their aggressive recycling programs and zero waste plans (San Francisco and Seattle) are presented in Table 3.

TABLE 3
Per Capita Disposal Rates for Selected Zero Waste Communities

Jurisdiction	Year	Tons Disposed	Population	LDIs (Tons/Person/Year)
San Francisco, CA[1]	2008	594,660	808,976	0.74
Seattle, WA[2]	2009	351,688	602,000	0.58

[1]California Department of Resources Recycling and Recovery (CalRecycle) Disposal Reporting System. California Waste Stream Profiles: Jurisdictions. (http://www.calrecycle.ca.gov/Profiles/Juris/)
[2]Seattle Public Utilities. Annual Garbage Report. http://www.seattle.gov/util/groups/public/@spu/@usm/documents/webcontent/spu01_006649.pdf

As shown, in 2008, the city of San Francisco disposed of 594,600 tons of MSW that was generated within its jurisdictional limits. Given its 2008 population of 808,976, this disposal amount equates to an LDI of 0.74 tons per person per year. This LDI is more than double the average LDI documented for communities with WTE systems in Table 2.

Similarly, in 2009, 351,688 tons of MSW from the city of Seattle were disposed in landfills. This amount was substantially lower than the 439,542 tons disposed in 2007, with the decrease in tonnage presumably due to the economic recession. Even at the low 2009 disposal rate, the city of Seattle had an LDI of 0.58 tons per person per year, which is 66 percent higher than the average LDI for WTE system communities.

5.0 SHORTCOMINGS OF THE MSW DIVERSION RATE METRIC

With the promulgation of new landfill disposal regulations by the United States EPA (USEPA) in 1991, many states adopted voluntary or mandatory recycling and waste reduction goals. Typically, these goals involve the achievement of a percentage reduction in amount of waste disposed.

In this regard, based on information presented on its web site, the City of San Francisco is currently diverting 72 percent of the waste generated within the city from landfill disposal through recycling and waste reduction programs.

As presented in Table 3, the City's per capita disposal rate (i.e., LDI) is 0.74 tons per person per year. Using this data, the City of San Francisco's MSW generation rate can be calculated as follows:

MSW Generation Rate = LDI / (1 - Per Capita Diversion Rate)
= 0.74/(1-0.72)
= 2.64 tons/person/year.
= 14.5 pounds per person per day.

The MSW generation rate calculated for the City of San Francisco is compared to other published rates in Table 4. As shown, the San Francisco MSW generation rate is more than twice the rate published for the State of California and the national rate published by Columbia University/Biocycle magazine. It is more than three times the national rate published by the USEPA.

TABLE 4
Comparison of City of San Francisco's MSW Generation Rate to Other Published Rates

Organization	Application	Year	MSW Generation Rate	
			Tons/Person/Year	Pounds/Person/Day
City of San Francisco	City of San Francisco	2008	2.64	14.5
State of California	State of CA	2005	1.38	7.6
Columbia University - Earth Engineering Center/Biocycle[1]	United States	2008	1.28	7.0
US EPA[2]	United States	2008	0.82	4.5

[1]Van Haaren, Themelis, N. and Goldstein, N. "The State of Garbage in America - 17th Nationwide Survey of MSW Management in the U.S.", Biocycle, October 2010.
[2]US EPA. *Municipal Solid Waste (MSW) in the United States: 2008 Facts and Figures. http://www.epa.gov/osw/nonhaz/municipal/msw99.htm*

The comparison of the calculated MSW generation rate for the City of San Francisco with other published rates indicates that the calculated San Francisco rate may be inaccurate. Since this rate is a calculated rate based on two variables, the inaccuracy is likely caused by the inaccuracy associated with one of these variables.

One of the variables used to calculate the MSW generation rate is the LDI. As discussed above, the LDI is calculated by dividing the tonnages of waste disposed in landfills from a community by the population of the community. Since the waste disposal tonnages are determined by landfill

truck scales and the population of the community is determined by the United States Census, the data used for both of these parameters are considered to be fairly accurate.

The other variable used to calculate the MSW generation rate is the MSW diversion rate. This rate is estimated by local governments based on local recycling and waste diversion activities. To determine the MSW recycling rates of local businesses and industries, local governments typically conduct telephone or mail surveys. The data collected through these efforts is not standardized and is generally considered to be incomplete and inaccurate. As a result, the MSW diversion rates, which are calculated using this data, are also likely to be inaccurate.

The San Francisco example demonstrates the shortcomings of using the MSW diversion rate metric in evaluating MSW management systems. In this example, the city claims to be achieving an extremely high diversion rate – 72 percent while, at the same time, it is landfilling 0.74 tons per person per year – an amount that is twice the amount of waste that is landfilled by WTE communities and 90 percent of the national MSW generation rate published by the USEPA.

In light of the problems associated with accurately accounting for commercial and industrial recycling, it seems more reasonable to focus on the per capita disposal rates as a measure of the sustainable merits of a local solid waste management system. As indicated above, Dr. Themelis of Columbia University agrees with and is promoting this approach.

6.0 THE BIODEGRADABLE MSW-LDI

Waste stabilization has long been recognized as an important process in the treatment of certain wastes such as wastewater treatment plant sludges.

The European Commission recognized the importance of waste stabilization in the promulgation of its 1999 Landfill Directive. This Directive requires Member States to reduce the amount of biodegradable waste landfilled to 35 percent of 1995 levels by 2016. Many Member States are implementing WTE facilities to meet the requirements of the Directive.

An implicit and reasonable assumption in this approach is that the ash generated by the WTE systems in these communities has been stabilized through the combustion process and is, therefore, non-biodegradable.

The Biodegradable MSW-LDI for the 65 WTE communities included in Table 2 can be calculated by dividing the tonnages of "Bypass MSW" by the populations served. The resulting Biodegradable MSW-LDI is 0.21 tons per person per year.

7.0 CONCLUSIONS

This report introduces a new metric for measuring the performance of MSW management systems. This LDI metric indicates the amount of MSW generated in a community that is landfilled each year on a per capita basis and is reported as "tons landfilled per person per year."

The following conclusions are offered with respect to the LDIs of communities with WTE systems:

- Based on published and unpublished data from reliable industry sources, the average LDI for 65 communities that have implemented WTE systems, which serve over 36 million people, is 0.35 tons per person for year.

- The WTE systems that serve these communities have typically been in place for 20 years or more. Therefore, it can be concluded that these communities have been achieving an LDI on the order of 0.35 tons per person per year for many years.

- In comparison, the LDIs for communities such as San Francisco and Seattle that claim high waste diversion rates due to aggressive waste reduction and recycling programs are 0.58 to 0.74 tons per person per year. These LDIs are substantially higher than the LDI of communities with WTE systems and indicate that these cities may not be diverting as much waste from landfill disposal as claimed.

- A significant portion of the waste that is landfilled from communities with WTE systems has been stabilized. In this regard, the Biodegradable LDI for WTE communities has been found to average 0.21 tons per person per year.

- As documented in this report, the 65 communities that utilize WTE systems divert 33 percent of the waste generated in their communities for materials recycling programs and 42 percent for the generation of electricity. In this regard, the United States Department of Energy has concluded that at least 50 percent of the electricity from WTE systems is generated from renewable waste materials.[6]

The WTE Group of the SWANA ARF recommends that the Landfill Disposal Index be adopted by the solid waste industry as a useful metric to evaluate the performance of MSW management systems.

[6] SWANA Applied Research Foundation. *Waste-to-Energy and the Solid Waste Management Hierarchy*. Silver Spring, MD: SWANA, 2008.


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