ORIGINAL

0000131011

BEFORE THE ARIZONA CORPORATION COMMISSION

COMMISSIONERS
GARY PIERCE, CHAIRMAN
PAUL NEWMAN
BRENDA BURNS
BOB STUMP
SANDRA D. KENNEDY

IN THE MATTER OF THE APPLICATION OF MOHAVE ELECTRIC COOPERATIVE, INC. FOR APPROVAL OF A WASTE-TO-ENERGY FACILITY AS A PILOT PROGRAM UNDER THE RENEWABLE ENERGY RULES OR, IN THE ALTERNATIVE, FOR A LIMITED WAIVER	DOCKET NO. E-01750A-10-0453 MOHAVE ELECTRIC COOPERATIVE, INC.'S NOTICE OF FILING REBUTTAL TESTIMONY

Mohave Electric Cooperative, Inc. ("MEC"), by and through its undersigned counsel, hereby files the rebuttal testimony of Michael A. Curtis, Ron Blendu, Robert Estes and joint testimony of Prof. Nickolas Themelis and Prof. Marco Castaldi.

DATED this 7th day of November, 2011.

CURTIS, GOODWIN, SULLIVAN, UDALL & SCHWAB, P.L.C.

By: [signature]
William P. Sullivan
501 East Thomas Road
Phoenix, Arizona 85012-3205
Attorneys for Mohave Electric Cooperative, Inc.

Arizona Corporation Commission
DOCKETED
NOV 7 2011
DOCKETED BY [signature]

RECEIVED
2011 NOV -7 P 4: 10
AZ CORP COMMISSION
DOCKET CONTROL

File: 1902-000-0000-0000; Desc: Notice of Filing - Rebuttal Testimonies 11-7-11; Doc#: 109178v1

PROOF OF AND CERTIFICATE OF MAILING

I hereby certify that on this 7th day of November, 2011, I caused the foregoing document to be served on the Arizona Corporation Commission by delivering the original and thirteen (13) copies of the above to:

Docket Control
Arizona Corporation Commission
1200 West Washington
Phoenix, Arizona 85007

Copies of the foregoing emailed
this 7th day of November, 2011 to:

Steve Olea
solea@azcc.gov

Janice Alward, Esq.
jalward@azcc.gov

Lyn Farmer
dbroyles@azcc.gov
dperson@azcc.gov

Timothy M. Hogan, Esq.
thogan@aclpi.org

Sandra Bahr
Sandy.bahr@sierraclub.org

Douglas V. Fant, Esq.
dfantlaw@earthlink.net

Copy of the foregoing mailed
this 7th day of November, 2011 to:

Timothy M. Hogan, Esq.
Arizona Center for Law in the Public Interest
202 E. McDowell Rd., Suite 153
Phoenix, Arizona 85004

Douglas V. Fant, Esq.
Law Offices of Douglas V. Fant
3655 West Anthem Way
Suite A-109, PMB 411
Anthem, Arizona 85086

Jason Solomon
SOLOMON INDUSTRIES LLC
3365 Peebles Road
Troy, OH 45373

BEFORE THE ARIZONA CORPORATION COMMISSION

IN THE MATTER OF THE APPLICATION OF MOHAVE ELECTRIC COOPERATIVE, INC. FOR APPROVAL OF A WASTE-TO-ENERGY FACILITY AS A PILOT PROGRAM UNDER THE RENEWABLE ENERGY RULES OR, IN THE ALTERNATIVE, FOR A LIMITED WAIVER	DOCKET NO. E-01750A-10-0453

REBUTTAL TESTIMONY OF MICHAEL A. CURTIS

ON BEHALF OF MOHAVE ELECTRIC COOPERATIVE, INCORPORATED

November 7, 2011

TABLE OF CONTENTS

I. INTRODUCTION AND SUMMARY OF TESTIMONY

Q: Please state your name and business address.

A: My name is Michael A. Curtis, 501 East Thomas, Phoenix, Arizona 85012.

Q: By whom are you employed and in what capacity?

A: I'm a member of Curtis, Goodwin, Sullivan, Udall & Schwab, PLC. I also serve as an officer of Mohave Electric Cooperative, Incorporated ("Mohave"), as its general counsel.

Q: What is your professional background?

A: I was admitted to practice law by the State Bar of Arizona in 1966. Since then, I have advised utilities, political subdivisions, agencies, special taxing districts, individuals, corporations and associations on utility matters. I have served as general counsel to Mohave for many years.

Q: On whose behalf are you testifying?

A: I am testifying on behalf of Mohave.

Q: What is the purpose of your testimony?

A: My testimony expresses Mohave's support for Commission Decision No. 72500 and discusses the relationship between the RPG W-T-E facility and Mohave's Renewable Energy Standard Tariff ("REST") program.

Q: Have you read the testimony of Ms. Sandy Bahr, Ms. Doris Cellarois and Dr. Jeffrey Morris submitted in this proceeding on behalf of the Grand Canyon Chapter of the Sierra Club ("Sierra Club" or "Intervenor")?

A: Yes I have.

II. DECISION NO. 72500 SHOULD NOT BE ALTERED

Q: Has the Sierra Club justified amending, revising or overturning its Decision No. 72500?

A: No. The Commission has already considered and rejected the issues raised by the Sierra Club witnesses. Under this A.R.S. §40-253 proceeding, the Sierra Club must demonstrate that Decision No. 72500 is "unjust or unwarranted, or should be changed." In applying the foregoing, the Commission can and should recognize that its decision can only be overturned by a Court if shown to be unlawful by clear and convincing evidence. Since the Sierra Club's prefiled testimony fails to satisfy these requirements, the Commission can and should summarily affirm Decision No. 72500.

Q: Does Arizona Administrative Code R14-2-1805 require Mohave *to demonstrate it* would not be able to comply with renewable energy waiver requirements before a waiver can be granted, as contended by Ms. Bahr at page 4, line 10?

A: No. The rule sets forth no definition of "good cause" leaving the Commission with broad discretion in making the determination. It is totally consistent with the rules that the Commission consider whether the application provides an opportunity to evaluate technologies or renewable energy resources not otherwise recognized by the existing REST rules. It is also appropriate for the Commission to weigh the benefits of W-T-E over continued use of landfills. That is precisely what the Commission did in issuing Decision No. 72500.

Q. Does Mohave believe the waste-to-energy facility proposed by Reclamation Power Group, LLC ("RPG") satisfies the definition of a pilot program pursuant to Arizona Administrative Code R14-2-1802.D?

A: Yes. As explained by Mr. Blendu in his testimony, the technology RPG will be utilizing, although not new, has not previously been used in Arizona for refuse derived fuel ("RDF"). Municipal solid waste ("MSW") is a natural and inevitable consequence of living, especially in an urban setting. The record demonstrates that MSW will be placed in landfills for the indefinite future and that W-T-E is a superior use of such MSW.

Q: Will the output of the RPG W-T-E facility replace energy produced with fossil fuels or nuclear?

A: Certainly. The 13 MW's to be produced by the RPG W-T-E facility is insignificant as compared to the overall energy demands within the State. As planned, the plant's energy will be placed into the electric grid and displace energy produced by fossil fuels or nuclear.

III. THE COMMISSION WILL LATER DETERMINE WHETHER RPG W-T-E ENERGY IS INCLUDED IN MOHAVE'S REST PLAN

Q: Will the Commission have an opportunity to review Mohave's REST portfolio in the future?

A: Yes. Mohave must annually file and secure Commission approval of its REST plan. Currently the output from the RPG W-T-E is not included in Mohave's REST plan. Mohave will only propose including it when and if Mohave determines the resource provides a competitively priced and reliable energy source, compatible with the energy demands of Mohave's customers. It is still premature for RPG to make a firm proposal relating to selling the energy output and reclaimed energy credits ("RECs") of the W-T-E facility. RPG must first know whether and under what conditions it will have RECs for sale before it can begin to firm up the other contingencies that will impact its offer to Mohave. The current decision, while critical to RPG's ability to move forward, only provides RPG an opportunity to compete with solar, wind and other renewable resources for a place in Mohave's renewable portfolio.

Q: **Does Mohave have a contract to purchase the output of the RPG W-T-E plant?**

A: No. As I explained to the Commission during the earlier evidentiary proceeding on this matter, Mohave is committed to securing renewable energy resources that are competitively priced and meet its load profiles. The energy and RECs produced by the RPG W-T-E plant will be evaluated against all other resources available to Mohave.

Q: **Does Mohave intend to apply REC's from the RPG W-T-E facility towards satisfying its distributive generation requirement?**

A: No. Mohave's distributive generation requirements under the REST rules will be satisfied by other eligible renewable energy resources.

Q: **Will Mohave continue to evaluate other forms of renewable energy such as solar, wind and geothermal to satisfy the renewable energy standard?**

A: As noted, Mohave evaluates all available renewable energy resources with the goal of creating a renewable energy portfolio that is cost competitive and provides a reliable resource compatible with the actual power needs of the Cooperative. On the distributive generation side, those decisions are largely left up to Mohave's customers as impacted by the incentives the Commission approves for the Cooperative as part of its REST program.

Q: **Is Mohave offering any preconstruction or construction incentive of any kind to RPG in connection with the W-T-E facility?**

A: No. RPG has not requested and Mohave has not offered any construction incentive of any kind to RPG.

Q: Does that conclude your testimony?

A: Yes.

BEFORE THE ARIZONA CORPORATION COMMISSION

IN THE MATTER OF THE APPLICATION OF MOHAVE ELECTRIC COOPERATIVE, INC. FOR APPROVAL OF A WASTE-TO-ENERGY FACILITY AS A PILOT PROGRAM UNDER THE RENEWABLE ENERGY RULES OR, IN THE ALTERNATIVE, FOR A LIMITED WAIVER	DOCKET NO. E-01750A-10-0453

REBUTTAL TESTIMONY OF RONALD D. BLENDU

ON BEHALF OF MOHAVE ELECTRIC COOPERATIVE, INCORPORATED

NOVEMBER 7, 2011

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Ronald D. Blendu has over 35 years' experience in power plant operation, design, construction, development and start-up. He holds a B.S. in Engineering. He explains that the Resource Power Group, LLC ("RPG") will be only the second company in the U.S. to use bubbling bed technology for refuse derived fuel ("RDF") and that the Commission properly designated the RPG W-T-E facility a pilot program under A.A.C. R14-2-1802.D and that waiver under A.A.C. R14-2-1816 was also a viable alternative to classify the energy produced by the RPG W-T-E facility eligible for renewable credits. Mr. Blendu discusses the testimony presented by the Grand Canyon Chapter of the Sierra Club and explains that municipal solid waste ("MSW") is a renewable energy resource, that the RPG W-T-E will enhance curbside recycling by removing recyclable material that would otherwise be placed in landfills, and that the Sierra Club's air quality and other pollution concerns are overstated, based upon outdated data, and ignore the regulatory constraints applicable to the RPG W-T-E facility. The testimony taken as a whole supports the Commission Decision No. 72500 and the Commission should affirm it.

I. INTRODUCTION AND PURPOSE OF TESTIMONY

Q: Please state your name and business address.

A: My name is Ronald D. Blendu, 1015 W. 6th Street, Weiser, ID 83672.

Q: By whom are you employed and in what capacity?

A: I am self-employed and own a small Consulting Engineering Company, Anchor Enterprises. I am also a Managing Member of Reclamation Power Group, LLC ("RPG").

Q: What is your professional background?

A: I have a Bachelor of Science Degree in Engineering from the U.S. Coast Guard Academy. I have over 35 years' experience in power plant operation, design, construction, development and start-up. Exhibit RB-1 attached to my testimony is a written summary of my experience. Exhibit RB-1 has previously been admitted as part of A-1 in this proceeding.

Q. On whose behalf are you testifying?

A. I am testifying on behalf of Mohave Electric Cooperative, Incorporated ("Mohave") in support of Arizona Corporation Commission ("Commission" or "ACC") Decision No. 72500, dated July 25, 2011 granting Mohave's Application filed in this matter.

Q: Please describe RPG and its proposed waste-to-energy ("W-T-E") project.

A: RPG is a small development group seeking to permit, construct, and operate a 500 ton per day ("TPD"), 13 Megawatt ("MW") Waste to Energy ("W-T-E") plant. Residential and Commercial municipal solid waste ("MSW"), after curbside recycle, will be transported to the proposed facility. Sampling indicates that, even after curbside recycling, up to 25% of the MSW the facility will receive is recyclable. The MSW will be unloaded, stored and transported to an onsite Material Recycle Facility ("MRF") where additional recycling will occur and result in an increase in recycle rates above current levels. Residual MSW will be ground and processed to a size of 3" minus and stored. A bubbling bed fluidized combustion will be used to generate steam that will drive a turbine to produce electricity. Exiting flue gases will be scrubbed, pass through a baghouse and exit the stack. Continuous emissions monitoring will be required. NOx abatement and other pollution control may be required. Ash will be disposed of either at a landfill or used in concrete products.

Q: Have you reviewed the testimony of Ms. Sandy Bahr, Ms. Doris Cellarius and Dr. Jeffrey Morris submitted in this proceeding on behalf of the Sierra Club?

A: Yes, I have.

Q. What is the purpose of your testimony?

A. My testimony supports the Commission's Decision No. 72500 and responds to the pre-filed testimony of Ms. Bahr, Ms. Cellarius and Dr. Morris submitted on behalf of the Grand Canyon Chapter of the Sierra Club ("Sierra Club" or "Intervenor"). I will discuss the Commission's designation of the RPG W-T-E facility as a pilot program under Arizona Administrative Code ("A.A.C.") R14-2-1802.D, and recognition that waiver pursuant to A.A.C. R14-2-1816 was also a viable alternative, thereby making the energy to be produced by the RPG W-T-E facility eligible for renewable credits. I also address various contentions made by the Intervenor's witnesses, by demonstrating: (i) the RPG W-T-E facility is an "additional" technology; (ii) MSW is a renewable energy resource; (iii) Staff's assumptions regarding the biogenic and nonbiogenic content of the MSW are reasonably based; (iv) the RPG W-T-E positively impacts recycling; (v) the Intervenor submits, outdated, incorrect, misleading and irrelevant air quality and emissions data; and (vi) "good cause" for a waiver has been demonstrated.

Q: In your opinion, has the Sierra Club presented evidence justifying the Arizona Corporation Commission ("ACC" or "Commission") amending, revising or overturning its Decision No. 72500, dated July 25, 2011?

A. Absolutely not. The pre-filed testimonies of the Sierra Club's three witnesses discuss the same issues raised in the Sierra Club's Exceptions docketed on May 27, 2011. These issues were considered and properly rejected after approximately 10 hours of deliberation by the full Commission during an Open Meeting, and evidentiary hearing held in conjunction therewith, over the three day period of July 12, 13 and 14, 2011. The Commission acted after its Staff had submitted a detailed report and proposed order recommending approval of Mohave's Application, both Mohave and the Sierra Club had filed exceptions to the Staff's recommendation and the matter had been noticed a total of three times for consideration at Open Meetings in May, June and July 2011. From the discussion held during the July Open Meeting, I understand the Commission had no duty to conduct any evidentiary hearing on Mohave's Application, but as an accommodation, provided the Sierra Club an opportunity to present evidence and cross examine witnesses on July 13 and 14 in response to the Sierra Club's request for hearing. The Sierra Club had never requested a hearing prior to the Commission's consideration of the matter at its July 12, 2011 Open Meeting. In its Application for Rehearing the Sierra Club asserted that, if given the opportunity, that in addition to Ms. Bahr's testimony presented during the evidentiary hearing on the 12^{th} and 13^{th}, it "would have" presented seven different experts or at least expert testimony on seven different topics. However, after being granted the opportunity it requested, the Sierra Club presents testimony of Ms. Bahr and two additional witnesses. They discuss concerns based upon an old technology RPG will not use. The issues raised by these witnesses are the same issues as previously considered and rejected by the Commission. The Commission should summarily affirm Decision No. 72500.

II. RPG'S W-T-E FACILITY USES AN "ADDITIONAL" TECHNOLOGY

Q: How do you respond to allegations of Ms. Bahr at page 2, lines 30-33 of her testimony that the RPG W-T-E facility "does not represent a new technology"?

A: A.A.C. R14-2-1802.D allows the adoption of pilot programs with "additional technologies" and is not restricted to "new" technologies. While at least 62 U.S. plants use bubbling bed technology in the U.S. to dispose of a variety of waste from sewage sludge to biomass[1], only one plant in the U.S. uses this technology for refuse derived fuel (RDF).[2] It is wrong to imply RDF bubbling bed technology is similar to the mass burn technology currently in use in the U.S. or to assume emissions and performance will be the same as mass burn technology. Bubbling bed technology is "in addition" to the mass burn technology and different than the technology the ACC considered when it adopted its Renewable Energy Standard and Tariff rules in 2007. The ACC acted prudently, and in accordance with the evidence during the July Open Meeting by approving Decision No. 72500 and affording the Commission the opportunity to evaluate a pilot program using an alternate form of renewable energy (MSW) based upon a technology (bubbling bed) that has rarely been used to produce energy from MSW in the United States. The Decision also includes monitoring and reporting requirements, allowing the Commission to continue to evaluate the pilot program.

---

[1] See, www.energyproducts.com.

[2] A retrofit of a 50MW plant owned by the City of Tacoma Department of Utilities. *Id.*; The technology is being used by several European and Japanese companies outside of the United States for RDF. *Id.*

Q: On page 2 of his testimony, Dr. Morris gives the purpose of his testimony. Do you have comments on it?

A: Yes. Dr. Morris makes it clear that his testimony is based on what are called "mass burn" facilities. In a "mass burn" facility all incoming MSW is dumped into a furnace and burned on a grate. There is no attempt to remove recyclable material prior to combustion. Steel scrap is removed from the ash using magnets. Most of the existing W-T-E facilities in the US are of the "mass burn" type and are 20 to 40 years old. RPG will be using a totally different type of technology, and waste management practices have improved in the past 30 years. In the years since the existing W-T-E plants were constructed the Clean Air Act has been passed and amended. As discussed in the testimony of Mr. Estes, today there are regulations that specifically address W-T-E plants. Existing W-T-E plants were "grandfathered-in" for some of these regulations. However, the RPG W-T-E plant will be a new plant and it will have to meet EPA standards that are higher than those that apply to existing W-T-E plants, and significantly higher than the standards in place when old W-T-E plants were built. It is an evaluation of these older "mass burn" facilities that Dr. Morris bases much of his testimony.

In the Phoenix metropolitan area, like most other areas in the US, local governments now encourage residents to put recyclable material in a separate bin from garbage. The recyclable material residents place in the "blue" or "yellow" cans is picked up separately and delivered to a Material Recovery Facility (MRF) where material is put on conveyor lines and separated into different types of plastic, aluminum, paper, cardboard, and glass.

The MSW that will come into the RPG plant will be material that has been placed in the "black bins" which now goes to landfills. In spite of the programs that encourage residents to place recyclable waste into their "blue" or "yellow" recycle bins, a significant amount of recyclable material gets placed in the "black" trash bins. When the MSW arrives at the RPG facility there will be a front end MRF. Plastics, paper, aluminum, metal, paper, cardboard, and glass will be removed and sold for reuse. The remaining material which cannot be recycled will be ground into "Refuse Derived Fuel" ("RDF") for use in a fluidized bed boiler. The older style mass burn boilers have grates on which material of all sizes is combusted. In a fluidized bed boiler combustion air is introduced under a bed of sand. The RDF is introduced on the top of the bed and the air fluidizes the combination of sand and fuel. In addition, limestone will be added to the bed which removes any acids that might be in the fuel. This considerably reduces acid gases as compared to a mass burn boiler. The RDF starts out on the top of the fluidized bed which heats and dries the fuel. It then gets mixed into the bed of sand. Near the top the volatile material is vaporized. As it passes on through the bed the non-volatile material is combusted. At the bottom a mixture of ash and sand is withdrawn from the furnace. Large pieces of ash are withdrawn and the remainder of the bottom material is moved by a closed system back to the top of the bed.

RPG specifically decided to use this technology because it is superior to the old mass burn furnaces in controlling pollution. Newer waste-to-energy plants in Europe use this technology. The fluidized bed allows waste to be combusted at a lower temperature, which minimizes the formation of NOx. The material circulating in the fluidized bed provides a heat mass that keeps the temperature stable so as to avoid upset conditions that could cause pollution. The limestone circulating in the fluidized bed converts acid gases into stable material such as gypsum.

Q: At page 14, starting at line 24, Dr. Morris contends the RPG W-T-E project does not fit the definition of a pilot project. Please comment on that.

A: Dr. Morris makes his own definition of "pilot program" and then says the project does not meet his definition and therefore it isn't a pilot program. He says that a "pilot program" can only last "a limited period of time" but does not specify what he means by that. He also infers that a community will be building the facility. This is incorrect. Private investors will fund the project. As previously stated, the ACC rules provide for pilot plant programs with additional technologies. As recognized by Decision No. 72500 a pilot program is not required to be time limited.

III. <u>MSW IS A RENEWABLE ENERGY RESOURCE</u>

Q: How do you respond to the allegations of Ms. Bahr at page 3, line12, Ms. Cellarius at page 4, line 8 that MSW is not or should not be considered "an eligible renewable energy resource"?

A: A.A.C. R14-2-1802.D permits the Commission to "adopt pilot programs in which 'additional technologies' are established as Eligible Renewable Energy Resources." Thus, a pilot program does not have to meet the current definition of an eligible renewable energy resource, but instead becomes an addition to it. The rule further provides that the additional technology is to be a "Renewable Energy Resource". The Commission defines a "Renewable Energy Resource" as an energy resource that is replaced rapidly by a natural, ongoing process and that is not nuclear or fossil fuel." There is nothing more natural than creation and discarding of waste material. Certainly MSW is produced rapidly by normal everyday societal activity. Exhibit RB-2 includes several articles from Waste to Energy News and the Energy Recovery

Council that discuss, among other things, the renewable character of MSW[3]. Currently at least seven federal laws (including the 2009 Stimulus Act), the Internal Revenue Service and 25 states consider W-T-E a renewable resource because "it meets the criteria for establishing what a renewable energy resource is – its fuel source (trash) is sustainable and indigenous." . Exhibit RB-2 also reflects that on Oct. 6, 2011, Capitol Hill will begin disposing of its trash to a W-T-E facility to show its support for this form of renewable energy[4].

Q: On page 5 of his testimony Dr. Morris indicates that trash is not renewable. Can you comment on that?

A: The premise in his response is that there are only two choices. One is to reuse all the trash and the other is to use it to make electricity. The problem with this premise is that all the trash in the Phoenix area is not reused. Some of it is recycled, and the rest goes to a landfill. Our plant will divert some of what would have gone to a landfill to recycling and make electricity from the rest. Whether the trash goes into a landfill or is used to make electricity, the material is gone. The difference is that using the trash to make electricity offsets the use of fossil fuels. Residents in the Phoenix area will continue to generate trash no matter whether this plant is built or not. The source of trash is continually renewed and the question is whether to throw the non-recyclable and some of the recyclable portion in the ground or make use of it to make electricity and increase recycle rates.

---

[3] *See also,* Exhibit A-3 (previously admitted) 'America's Need for Clean Renewable Energy - The Case for Waste-to-Energy,' Government Coalition for Renewable Energy; and Exhibit A-6 (previously admitted) Energy Resource Council, 'Waste Not Want Not – The Facts Behind Waste-To-Energy (2009).

[4] These and additional references are readily available from the Energy Recovery Council webpage www.wte.org.

Q: On page 10 of her testimony, Ms. Bahr contends that the RPG W-T-E facility will not comply with the Green–E Energy National Standard for Renewable Energy Products. Does it?

A: The Commission rules do not require the facility to meet the Green-E Energy National Standard for Renewable Energy Products. However, I can see no reason why the facility would not meet this standard. MSW would be received, (after having been previously exposed to curbside recycling), unloaded and stored. It would then pass through automatic and manual sorting for recycle and the remaining material would then be ground and converted to RDF for use in a bubbling bed boiler. No discharges would occur from the RDF conversion process.

Q: In her testimony at page 6, line 26, Ms. Bahr indicates "it is not a question of whether it is better to landfill or incinerate trash". Is it a question of which is better?

A: Of course it is. Ms. Bahr went on to quote "Stop Trashing the Climate" a special interest document, and to basically re-state the philosophy of Zero-Waste Communities. RPG supports the concept of zero waste and working towards zero waste. At 10,000 tons per day of waste generated in the Phoenix area it is unlikely to go to anywhere near zero in the expected lifetime of this project.

Attached to my testimony as Exhibit RB-3 is an Article by an investigative reporter, Allyssa A. Lappen, titled "Harnessing the Energy of Trash." In it she quotes Columbia University's Jack Lauber (deceased) that zero waste "is an idealistic impossibility". She further quotes Ward Stone, who is a recipient of a Sierra Club lifetime achievement award, that "WTE is a smart way to go". Regardless of whether

Mr. Lauber was correct, failure to make a significant improvement as an interim step on the way to zero waste objectives is not rational.

Also included in Exhibit RB-3 is an article from March-April MSW Management titled "The Landfill Disposal Rates of Waste-to-Energy and Zero-Waste Communities" that compares landfill disposal rates for communities dedicated to zero-waste initiatives as compared to communities that combine W-T-E with recycle programs. In this study the two cities known for aggressive zero, waste and recycling programs, San Francisco and Seattle, landfilled 0.58 – 0.68 tons per person as compared to 0.35 tons per person landfilled from communities that have active W-T-E and recycling programs[5].

Q: How do you respond to the comment "cities" such as San Francisco have greatly reduced the need for waste disposal"?

A: San Francisco and Seattle are committed to Zero-Waste, a philosophy championed by Sierra Club. I provided data in Exhibit RB-3 that both these communities have per capita landfill disposal rates 80% higher than communities with complementary recycling programs and W-T-E facilities.

Q: At pages 9-10 of her testimony, Ms. Bahr questions the assumptions regarding biogenic vs. non-biogenic (anthropogenic added) content of the MSW. Why didn't RPG use the 2003 characterization of Waste prepared by Cascadia Consulting Group for the City of Phoenix, the Executive Summary thereto is attached as Exhibit 2 to Ms. Bahr's testimony, for its waste characterization?

---

[5] *Id.* at p.4 ('Conclusions')

A: There are three basic reasons. One, as the Executive Summary clearly states, this report was conducted to determine relative amounts of recyclable material available in the Phoenix waste and it sorted 283 samples of indeterminate size. The actual report is over 60 pages long and Ms. Bahr only attached the Executive Summary, which provides a city wide average. RPG's MSW is to come from Commercial and Residential sources only after the existing recycle programs are implemented. Second, recycle efforts changed dramatically from 2003 thru 2008 and no data was provided on the make-up of the "after recycle MSW." Further questions arose regarding accuracy of recycle rates. In discussions with Mr. Al Gomez, then Supervisor of the Glendale Recycling facility, it was indicated up to 25% of material contained in the "recycle bins" was non-recyclable. Thirdly, boiler emission guarantees and permit emissions estimates are made based upon determinations of chemical composition of the fuel.

There are literally hundreds of "trash analyses" to choose from. The generic and locally available data are simply not precise enough to make the technical and economic decisions required for a project of this type. In counsel with URS, its environmental consultant, RPG chose to have URS conduct an independent analysis of approximately 7 ½ tons of waste of the type of material expected to be received (construction debris was excluded as non-acceptable). A representative sample was then sent to a materials testing lab for chemical analysis. Subsequently RPG conducted its own sampling to verify the URS result. While there is insufficient data to confirm, one could conclude that an effective curbside recycle program accounts for much of the difference in the biogenic make-up of the MSW in the two studies.

Q: On page 3 starting with line 11, Dr. Morris also discusses the 2003 Cascadia report. Can you comment on his testimony?

A: As noted above, the composition of waste in the Phoenix metropolitan area studied in the 2003 Cascadia report varied substantially depending on the area. Dr. Morris further notes that disposal studies done in the Vancouver, Canada and Seattle areas are based on more comprehensive and robust sampling of waste composition than available for Phoenix MSW. Yet, Dr. Morris contends the Phoenix MSW disposal stream is not significantly different than these other disposal streams. The Phoenix study itself reflects significant variation within the Phoenix area. I don't understand how he can make that statement.

Also, it has been over eight years since the sampling work for the 2003 Cascadia study was done. In the interim there has been more emphasis by local governments encouraging residents to put recyclable material in the recycle bin. In addition, some new MRFs have come on line. If the Cascadia study were done again, there likely would be a change in the composition. Since his conclusion at page 4, lines 2-4, and his response to the question that follows, are based on old data and data from Vancouver, Seattle, and Massachusetts, the Commission should give little weight to them.

Q: On page 9 Ms. Bahr again expresses concern over the fuel sample as compared to the 2003 City of Phoenix study. Do you have any additional comments?

A: The Phoenix sample did not represent incoming waste after recycle and had "14% other material". That data may be sufficient for estimating anticipated recycle rates and landfill operation. It may even be sufficient for a mass burn facility. It was not detailed and accurate enough for RPG's purposes, so we undertook our own evaluation. Since it is more recent and more localized, the results are more reliable for evaluating the RPG W-T-E project than the 2003 Cascadia Study.

Q: On page 4 at line 14 of his testimony, Dr. Morris indicates that 45% of the electricity generated by burning Phoenix residential MSW would come from fossil fuel. Is that correct?

A: Dr. Morris does not explain how he derived the 45% figure, but it is clear that he made three fundamental errors. First, he assumes that the RPG W-T-E facility will be burning fossil fuel during normal operation. That is incorrect. It is only during startup when the fluidized bed needs to be heated that fossil fuel will be used. Second, within MSW the primary contributor to fossil content is plastic. He uses the 8-year old Cascadia report but fails to mention that today plastics are picked up separately and sent to a MRF. And third, he erroneously claims that the plant will be a "mass burn" facility and ignores the front-end MRF that will remove recyclable plastic that has been placed in the "black" bin.

Q: Ms. Bahr at page 3, lines 33-35 testifies "Municipal solid waste is not clean energy and would take away from progress towards clean, renewable energy sources like solar and wind power." Is this accurate?

A: Exhibit RB-4 attached to my testimony is a copy of a February 14, 2003 letter EPA wrote to Integrated Waste Services Association (IWSA) in which EPA congratulates IWSA on its accomplishments in complying with the Clean Air Act. In the letter EPA acknowledges MSW as "a clean reliable, renewable source of energy." EPA goes on to say "these plants produce 2800 megawatts of electricity with less environmental impact than almost any other source of electricity."

Additionally Ms. Bahr seems to have drawn the rather bizarre conclusion that renewable energy is a "zero sum game". That every kW of renewable energy from sources other than solar or wind reduces the amount of wind and solar power that can be built. Taking Ms. Bahr's logic to its conclusion, wind and solar technologies also compete against each other and supporting either takes away progress toward the other. In reality, promoting a diversity of resources, including a variety of renewable resources, has the best chance of providing a reliable power supply at an economic cost for the utility and its customers.

Q: On page 1 Ms. Cellarius suggests Mohave's application should be rejected because it contains no evidence of any efforts to obtain wind, solar, or other categories of renewable energy. What is RPG's position on this?

A: Arizona's efforts to encourage renewable energy do not require a certain percentage of varying technologies. Pursuit of alternate and innovative technologies are encouraged. A utility may obtain any combination of resources it chooses. The ultimate composition of a utility's renewable portfolio is subject to Commission review and approval as part of the annual REST filings required under the REST rules. Mohave has a solar energy program called SunWatts. Mohave provides financial subsidies for installing solar and wind generation. Information on Mohave's renewable programs is available on Mohave's website and the applicable Commission dockets and decisions. In contrast, RPG is not requesting, and will not receive, any incentive payments from Mohave toward the cost of installing its W-T-E facility.

IV. THE RPG W-T-E FACILITY WILL POSITIVELY IMPACT RECYCLING

Q: How do you respond to the assertions of Ms. Bahr at page 7 starting at line 23 of her testimony, and Dr. Morris at page 14, starting at line 7 of his testimony that the W-T-E plants will have a negative impact on recycling in the Phoenix area?

A: Those statements are wrong and misleading. Exhibit RB-5 is a report written by Dr. Eileen Berenyi titled "Recycling and Waste-to-Energy: Are They Compatible? 2009 Update" that confirms the EPA conclusion that W-T-E communities are above the national average in recycle rates.

One of the misleading fallacies is to look at the percent of trash that is recycled rather than the actual per capita amounts of trash dumped in a landfill. For example, if Community A has a recycle rate of 50% and Community B has a recycle rate of 25%, then you might say that Community A is doing much better than Community B. However, you need to look at the actual per capita tonnages. If Community A generates 2 tons of trash per capita and Community B generates 1 ton per capita, then Community A sends 1 ton per capita to the landfill, but Community B only sends 0.75 tons per capita to the landfill. Everyone might be congratulating Community A for their 50% recycle rate, but it is Community B that is actually doing much better by not generating so much trash to begin with.

The Sierra Club uses San Francisco as an example of a community that is doing a really good job of recycling because they are diverting 70% of their waste from landfills. The City of San Francisco reported generating 2.43 tons of trash per resident in 2008[6]. For California it was 1.67 tons per capita and in Arizona it was 1.04 tons per

[6] *See* "The Landfill Disposal Index: How To Measure Progress Toward Zero Waste", Jeremy O'Brien, http://www.mwcog.org/committee/committee/documents.asp?COMMITTEE_ID=24

capita[7]. So while the Sierra Club is congratulating San Francisco for increasing their diversion rate, on a per capita rate San Francisco generates more trash on a per capita basis than either California or Arizona as a whole.

The other thing that is wrong with that part of the testimony is that it ignores the high correlation between W-T-E and recycling.[8] For example, in Denmark 50% of the trash is used for generating heat and electricity, 40% is recycled, and less than 10% goes into a landfill. In the same region is Lithuania, which has no W-T-E, recycles only 10% and landfills the rest. European countries with higher percentages of thermal treatment of trash have higher rates of recycling[9]. In New England which does have W-T-E facilities, 29% percent of the trash is recycled. The Midwest and Rocky Mountain states do not have W-T-E facilities and their recycling rates are only 14% and 22% respectively[10].

Q: Ms. Bahr at page 8, lines 1-7 indicates the "put or pay" contracts used by W-T-E facilities create a disincentive for recycling. Will the RPG facility use "put or pay" contracts?

A: No.

Q: On page 8 lines 12 – 16 Ms. Bahr again expresses concern the facility may not recycle. How do you respond?

---

[7] "The State of Garbage in America, 17th Nationwide Survey of MSW Management in the U.S.," Rob van Haaren, Nickolas Themelis and Nora Goldstein, BioCycle Journal, Oct. 2010, www.wtert.org/sofos/sog2010.pdf

[8] *See* "Materials and Energy Recovery in the U.S., New York and California", Dr. Nickolas Themelis (2009); http://www.seas.columbia.edu/earth/wtert/globalwte_US.html.

[9] *Id.*

[10] *Id.*

A: To suggest the project would incur several million dollars in capital cost for a MRF, include recycle personnel in its job forecasts, and then bypass anthropogenic material through the MRF, thereby reducing the biogenic fuel content it must report, likely resulting in a reduction in allowed REC's, is absurd.

Q: On page 8 Mr. Morris discusses the benefits about recycling. Can you comment on that?

A: The Phoenix area already has recycling programs in place. Material that residents place in the "blue" or "yellow" recycle bin goes to one of the existing MRFs. The RPG W-T-E Plant will receive trash that residents place in the "black" bin. The RPG W-T-E Plant will have a MRF on the front end that removes recyclable material from what would have gone to a landfill. It supplements recycling done by the residents.

Q: On page 13 starting at line 22, Dr. Morris indicates the plant will only recycle metals and that you claim the incoming MSW will contain 25% metals. Is that correct?

A: No, it is not correct. The idea that the incoming MSW will have 25% metals is ridiculous. The premise of this testimony is that the plant will not have a front end MRF and that it will be a mass burn facility. That premise is wrong which is why so much of his testimony is irrelevant. We did an analysis of the trash that was destined for landfill. From that analysis we estimated up to 25% could be recycled. That is why we are basing the design of the plant on 500 tons per day of incoming trash with a front-end MRF that removes the material as recyclable.

Dr. Morris is wrong to say that we will only remove metals. The front-end MRF will be designed to remove recyclable plastics, paper, cardboard, glass, aluminum, ferrous metals, and non-ferrous metals. The MRF will also be able to safeguard against material that should not have been put in the trash to begin with such as batteries or tires.

Q: At the top of page 4 of her testimony, Ms. Cellarius suggests that there is much "green waste" currently landfilled that could instead be composted. Dr. Morris also discussed recycling of green waste. Have you considered composting of "green waste"?

A: I am not opposed to composting. Also, as reflected on Exhibit RB-6, on October 12, 2011, two young men, brothers and employees of the composting facility in Lamont, California, were overcome by hydrogen sulfide gas produced by the process and lost their lives while attempting routine cleaning of a confined space. However, composting waste is acted upon by few. Therefore, practical problems and pollution control issues still must be addressed to build and operate such a facility.

To begin with, if an entity in the Phoenix area was interested in going into the composting business, the first thing that would need to be done would be to add a third collection bin and system so that green waste could be segregated and picked up separately. Some areas elsewhere do this, but I am unaware of such efforts in the Phoenix area. The second thing that needs to be considered piling up huge quantities of organic matter for composting or accelerated decay is not the same as leaving grass clippings on the lawn. Composting produces methane, nitrous oxide, hydrogen sulfide, ammonia, other gases and leachate. The composting facility would have to be built such that compost is enclosed and methane captured and that adds costs which is one of the impediments to large scale composting. Third, it would be necessary to deal with the concern for contaminates that make the compost unsuitable for use.

I visited state of the art composting facilities in Germany that accelerate composting, collect and burn the gas for power. These facilities are still required to landfill non-compostable material. In Payette, Idaho, the county runs a green waste composting operation. It receives brush, shrubs, tree limbs, etc. grinds the material and layers it. Agricultural juices from onion and potato producers are added to increase moisture and speed decomposition. However, in spite of all this work, the compost can't be given away due to contaminants that invariably get included.

The staff writer from the Bakersfield Californian observes that because of the passionate support from certain groups, the realities of endeavors like composting get glossed over and tend to get a "free pass" from regulatory groups. Exhibit RB-6. If the Lamont facility had been subjected to the same scrutiny and regulatory controls as a landfill or W-T-E facility those two young California men may still be alive.

Q: Do you have any other comments regarding this portion of Dr. Morris' testimony?

A: Dr. Morris' testimony is largely a discussion about how we should do more to conserve resources and recycle waste. We agree with that premise. The RPG W-T-E Plant is not intended to and will not address the issue about <u>how much</u> resources residents will use. Instead it will address the recycling issue by overlaying a level of recycling of waste that would otherwise be dumped in a landfill, as well as generate energy from non-recyclable waste that otherwise would be placed in a landfill today.

Q: On page 14, starting at line 39, Dr. Morris suggests W-T-E is not a good alternative to landfilling. Please comment on that.

A: Again, his argument is based on the premise that if the W-T-E plant is not built, then magically Phoenix area waste generation will decrease and what would have gone to the plant will instead be composted or otherwise recycled. If the Sierra Club or any other organization wishes to build a composting facility, we see no conflict or competition with the plant we propose. There is far more waste going to the landfill than the W-T-E facility could handle and anything that can be done to use that waste as a resource is a good idea. As far as it being in conflict or competition with solar, again this is a false claim. There is far more electricity used in Arizona than can be produced by the RPG 13 MW W-T-E Plant, plus solar and wind.

V. AIR QUALITY AND OTHER POLLUTION CONCERNS ARE OVERSTATED AND BASED ON OUTDATED AND MISAPPLIED DATA

Q: On page 5 line 23 – 26, Ms. Bahr says MSW produces significant amounts of various emissions. What is your response?

A: Attached to my testimony as Exhibit RB-8 is EPA's Air Emissions from MSW Combustion Facilities, as updated 7/27/2011. The document also compares MSW emissions to other sources. The question is "what is significant". Example, dioxin emissions from all US W-T-E facilities was 15 grams, or less than ½ oz. in 2005. In comparison to other sources MSW emissions overall do not appear significant. Further, the report contradicts Ms. Bahr on quantities of CO_2 emissions produced. It also should be kept in mind current data are derived from mass-burn technology which will generally be higher than a bubbling bed unit. Additionally the RPG W-T-E facility, as a new plant, will be subject to more stringent environmental regulations.

Q: Ms. Cellarius alludes at page 2 lines 6 -7 that EPA has documented incinerators emit more carbon dioxide per MWH than coal fired, natural gas, or oil fired units. Is this correct?

A: Exhibit RB-8 to my testimony includes EPA's air emission from MSW combustion facilities. This data indicates carbon dioxide per megawatt hour for W-T-E facilities are less than coal and oil fired facilities and slightly less than gas fired units (1016 vs. 1035 lbs. per MWH).

Q: On page 2 lines 7– 9 Ms. Cellarius contends W-T-E plants also emit nitrous oxides a substance 300 times more effective than carbon dioxide at trapping heat in the atmosphere. Is this accurate?

A: I am surprised this claim has come up again. Nitrous oxide is not a classified pollutant or environmentally controlled substance. It receives attention because it is more potent than CO_2 as a greenhouse gas. Exhibit RB-9 contains an EPA report on Nitrous Oxide sources and emissions. From that exhibit one can calculate approximately 4130 Tg CO_2 eq. are produced naturally annually and that in 2008, 318.2 Tg CO_2 were manmade in the U. S., of that only 0.4 Tg CO_2 came from Incineration of Waste (the lowest source of manmade N_2O listed) while composting was 4½ times that. Using the EPA information referenced by Dr. Morris which is based on a U. N. report one ton of MSW will produce .01 tons CO_2 eq. from N_2O (page 170) or approximately 20 pounds. Assuming at least that much N_2O (if not 4 ½ times that through material composting) would have been generated in landfill had the MSW not been combusted the issue hardly seems relevant.

Q: Have you reviewed the "Risks of Municipal Solid Waste Incineration: an Environmental Perspective" referenced by Ms. Cellarius on page 2 of her testimony?

A: Yes. It was written 23 years ago, long before the Clean Air Act implementation. It precedes many/most recycling programs, and focuses on mass burn facilities that made no attempt at recovering metals, glass etc. before combustion. Additionally household availability of lead, mercury and other heavy metals has been reduced substantially by regulation since then. The report has no relevance to the RPG W-T-E project.

Q: How do you respond to Ms. Cellarius' comment at the top of page 3 of her testimony that "US EPA" inventory of sources of dioxins find incinerators to be one of the largest source of dioxins in the home.

A: Exhibit RB-8 includes EPA air emissions data from waste incinerators and reports at page 4 of 8, dioxin emission from waste incineration facilities, in total for the U.S. have dropped to 15 grams or less than ½ oz. Frankly, EPA considers W-T-E facilities an insignificant source of dioxins emissions. Germany reported dioxins from home fireplaces were 1000 times that of its W-T-E facilities. Exhibit RB-7 contains three articles describing dioxins.

Q: At pages 11 and 12, Dr. Morris discusses pollutants. Please comment on that.

A: Much of it is generalized opinions. For example, a statement is made that "solid waste combustion, sewage treatment, stone quarrying, marinas, and oil and coal-fired power plants have air pollution damages larger than their value added." If you took that statement to its logical conclusion, then we should not only shut down all power plants that use fossil fuels, but also stop using stone for construction and shut down sewage treatment plants. It sounds as though what is being proposed is to go back to living in the dark ages.

The other problem with that section of his testimony is that its assumption that the RPG W-T-E plant will be using the technology of 30 to 40 years ago. For example, the Saugus plant, cited as an example, was built 35 years ago. In the intervening years the Clean Air Act has been put into place and amended many times. It is not valid to compare the technology used 35 years ago with what will be used in the RPG W-T-E plant.

Q: On page 6 starting on line 28, Dr. Morris indicates W-T-E emits 275% more climate changing carbon per kilowatt-hour of generated electricity than natural gas and 69% more than coal-fired power. Is that correct?

A: No, it is not correct. He does not show how he arrived at those calculations, but as mentioned above he uses old data and makes the erroneous assumptions that the plant will be a "mass burn" facility. See Exhibit RB-8 for the EPA's figures which show greenhouse gases per megawatt of electricity from MSW to the slightly less than natural gas and less than half of coal.

Q: On page 12, line 12 Dr. Morris infers the plant will "produce large quantities of dioxin." Is that correct?

A: No, it is not correct. The EPA reports annual dioxin emissions from W-T-E facilities have dropped dramatically. For all W-T-E facilities in the US combined the total dioxin toxic equivalents has gone from 18 pounds per year in 1987 to less than ½ oz. under the current EPA regulations.[11]

Q: Will ash from this facility be hazardous as claimed by Ms. Cellarius at page 3, lines 25-33?

A: Residential MSW is classified as non-hazardous. The project will only reduce the volume and weight substantially. I have visited several W-T-E facilities and none have had their ash classified as hazardous. In many facilities ash is used as cover material at landfills.

Q: Did you investigate Ms. Cellarius claim regarding ash disposal sites having leachable problem?

A: Yes, I have attached an EPA summary as Exhibit RB-10.

Q: What is your assessment of those sites?

A: It appears a former incinerator ash disposal site, a landfill, a former pole preservative treatment site, and the former site of a fertilizer/pesticide manufacture have all had high levels of metals and other contaminants detected in soil and in some cases groundwater. I cannot say this is surprising considering waste management practices of the times. As indicated in the Pickettville Road landfill summary, lead, acid,

---

[11] *See,* "Air Emissions from MSW Combustion Facilities", at RB-8 http://www.epa.gov/wastes/nonhaz/municipal/wte/airem.htm and "Questions and Answers about Dioxins", U.S. Government Interagency Work Group, May 2010, http://www.fda.gov/Food/FoodSafety/FoodContaminantsAdulteration/ChemicalContaminants/DioxinsPCBs/ucm077524.htm

batteries, oil, tires, PCB's, paints, etc. were all indiscriminately landfilled, generally on bare ground. I have never seen a 1940's vintage incinerator operate on MSW, but I have seen similar versions in saw mills. Frankly, if one throws batteries, arsenic, lead, PCB's, etc. into one of those low temperature incinerators you would expect elevated levels of pollutants in residual ash. Today, with dry scrubbers which not only remove this material from the flue gas stream but chemically binds it so it will not leach from the ash, these pollutants are not detected by ongoing monitoring in modern facilities. With this type of material it makes little difference whether it was incinerated or not as to whether it pollutes the environment. It has been nearly 50 years since the Jacksonville ash site closed. Had that same material simply been deposited there as was the practice then, there would have 50 years of decomposition and methane generation and the material would have largely decomposed to ash anyway.

Q: Dr. Morris, at page 15, line 2, claims 25% of the material going into the W-T-E plant will be ash. Is that correct?

A: No. Ash content from trash combustion is typically 5% by volume and 10% by weight of the trash fed to the combustor. Because of the front-end MRF, the ash content at our facility will be even lower when measured as a percentage of the trash coming into the facility.

Q: On page 15, line 10 Dr. Morris states the "dangers of incineration are widely known and have greatly influenced the public's assessment." Please comment on this.

A: This is a circular argument. In recent years some organizations have been making inaccurate claims about W-T-E plants and have been trying to scare the public. In particular they like to cherry-pick items from old plants built before the Clean Air Act. The EPA now has very strict and specific rules for W-T-E plants which addresses the concerns as more fully discussed in Mr. Estes' testimony. However, that has not stopped these organizations from continuing to try to scare the public. Thus after scaring the public, they say that the public is against W-T-E plants and they should be banned. It is circular logic.

Q: On page 15, starting at line 23 Dr. Morris indicates Europe's W-T-E experience is irrelevant to Arizona. How do you respond?

A: Dr. Morris suggests that W-T-E is appropriate only where there is less reliance on landfills and stricter policies on disposing of biodegradable waste in landfills and ensuring more recycling. I struggled with the logic. First, the ban on landfilling biodegradable waste undercuts his previous arguments that it is better to dump biodegradable waste into a landfill than to use it to make electricity in a W-T-E plant. Additionally, it is the extensive use of landfilling in the United States that creates the need for W-T-E plants.

We believe that Europe has better policies regarding waste management than many localities in the USA. Consequently we can learn from those policies and improve our own practices. The overall waste management policies in Europe are similar to those advocating the EPA. The RPG W-T-E facility will help Arizona in efforts to both improve waste management practices and achieve low cost renewable energy goals in the process.

VI. GOOD CAUSE HAS BEEN DEMONSTRATED FOR A WAIVER

Q: How do you respond to Sierra Club's contention that MEC has not shown "good cause" for a waiver of the REST Rules?

A: Arizona's Renewable Energy program is intended to reduce reliance on fossil fuels to meet energy demands and make sound environmental decisions such as reducing greenhouse gas emissions. It is not intended to be a mandate to rely only on wind and Solar power generation which is Sierra Club's basic intent. The proposed W-T-E project meets the two basic objectives of reducing use of fossil fuels and improving environmental emissions but has added benefits of increasing recycle rates, reducing emissions, reduction of landfill dependency and is less costly than other forms of renewable power. In addition, the construction and operation of the RPG W-T-E plant will create jobs and be a boost to the economy at a time when such activity is desperately needed. The Application, the Staff Report and the testimony presented to the Commission, including without limitation, the articles included as Exhibits A-3, A-6 (previously admitted) and RB-11cumulatively demonstrate that there is good cause to allow the energy from the RPG W-T-E facility to receive renewable energy credits.

Q: On page 13, starting at line 30, Dr. Morris asserts that your job creation estimates are misleading because the plant will not employ workers to do sorting. Is that correct?

A: Those statements are wrong. Dr. Morris again disregards the personnel in the MRF. I have over 30 years' experience in power plant operation. Dr. Morris does not.

VII. CONCLUSION

Q: The Sierra Club has leveled numerous objections to the RPG plant. Do you have any closing thoughts?

A: Yes. The Sierra Club was founded more than a hundred years ago in the last part of the 19th century. John Muir was the president until his death in 1914. The work of John Muir and the Sierra Club are the principle reason why the Sierra Nevadas in California are one of the premier destinations for people who want to enjoy nature as it has been from time immoral. It was in large part due to the work of John Muir and the Sierra Club that Teddy Roosevelt created the National Park system that is enjoyed by millions of people today. I, and the rest of our group, appreciate the work of people who strive to preserve and protect the public well-being. However, sometimes in their zeal to achieve the overall objectives, the practicalities and realities of the current situation become lost or ignored. I think this is one of those times.

RPG supports many of the concepts advocated by the Sierra Club, such as recycling, reuse, composting and its potential for use as a renewable resource. However, the rather indiscriminate accumulation of organic material for enhanced decay is not superior to either landfill or W-T-E as tragically demonstrated at Lamont, CA.

RPG is not against generating electricity from solar power. In fact, the engineering consulting company that RPG has engaged spent considerable pro-bono time trying to find a way to economically use solar to generate electricity in Guam. At present Guam depends entirely on oil to generate electricity.

On the other hand, the realities of today cannot be ignored. Developing countries are seeing a marked increase in solid waste generation per capita. Wind and solar power alone are not going to meet all of Arizona's need for power. We are digging holes in remote locations and extracting fossil fuels while digging holes locally and burying an alternate source of energy. The definition of renewable is defined in varying manners by different governing agencies. Despite the rhetoric and often-times contradictory estimates of environmental impacts, MSW is going to be produced, disposed of, and replaced for the foreseeable future, especially in areas where land is still available for landfilling in large quantities and at reasonable prices. The majority of the world community has concluded W-T-E is a safe, effective, and proven way to dispose of an ongoing waster generation problem while at the same time making incremental improvements to our environment and reducing the dependence on fossil fuels. The Commission was correct in issuing Decision No. 72500 dated July 25, 2011. The prefiled testimony is merely a restatement of the same arguments the Commission has duly considered and rejected. The record supported that Decision when issued. There was no violation of due process, since the Sierra Club had no right to hearing in the first instance. The record now contains even more support for Decision No. 72500 now. I respectfully ask the Commission affirm the Decision.

Q: Does this conclude your testimony?

A: Yes.

EXHIBIT RB-1

RONALD D. BLENDU

1015 W. 6^{th} Street
Weiser, Idaho 83672

Ronald Blendu is the owner and Chief Executive Officer of Anchor Enterprises, Inc. a project development and technical support company formed in 1995. His experience includes permitting, plant design, economic modeling, project finance, plant assessments, plant operations and fuel procurement. He has developed power sales and construction contracts and provided oversight of design and implementation of electrical interconnection and transmission lines.

From 1989 until 1997 Mr. Blendu was a partner in Rosebud Enterprises Inc. and its affiliates. Mr. Blendu served as President of Rosebud Operating Services that had oversight of a 35 MW waste coal project with Bechtel and Pacific Gas and Electric as Limited Partners and operated a 55MW waste petroleum coke plant with Exxon as Limited Partner. Both projects used fluidized bed combustor technology and Mr. Blendu was instrumental in getting both fuels classified as wastes for purposes of tax exempt Bond financing. He served as the technical representative for marketing $120million dollars worth of tax-exempt bonds by Morgan Stanley. During this time he appeared before several State Public Utilities Commissions and obtained permits for the operation and disposal of solid and waste water streams for both projects.

During the period 1983 until 1989 Mr. Blendu was employed by Ultrasystems Inc. a 500 employee, engineering and project development company. He was part of a core group that developed a plant operations company. He also served as owner's representative as projects were developed and became joint ventures. Partner companies included Pacific Lighting, Combustion Engineering, and Baltimore Gas and Electric. Mr. Blendu had oversight of up to 12 projects in the 10 – 35 MW range. Technologies included stoker boilers, bubbling bed and circulating fluidized beds. Fuels included coal, waste coal, agricultural waste, forest residue, and sawmill waste.

> During this period Mr. Blendu served as General Manager in starting up Maine Power Services a joint Venture operating company owned by Ultrapower and Babcox and Wilcox.

Mr. Blendu was employed by Proctor and Gamble from 1970 until 1983. He had various plant and project management assignments. He became Steam, Power, and Utilities Manager for a 3 mill, 2000 employee paper mill complex.

Mr. Blendu served with distinction in the United States Coast Guard from 1966 through 1970. He was given command of two separate patrol boats in the 90 foot range and earned 12 medals and citations.

EXHIBIT RB-2

ENERGY RECOVERY COUNCIL

Waste-To-Energy is a Climate-Friendly, Renewable Energy Source

In determining the sources to include under a greenhouse gas emissions cap, policymakers should evaluate the complete lifecycle of the source. Sources that reduce greenhouse gases over their lifecycle should be encouraged rather than regulated. Applying a lifecycle analysis to waste-to-energy facilities demonstrates that they are net reducers of greenhouse gases and should be treated accordingly under any policy to regulate greenhouse gas emissions. Crafting a climate policy that recognizes the benefits of waste-to-energy will have the desired effect of providing incentives to renewable energy sources that minimize greenhouse gases and promote energy independence and fuel diversity. Waste-to-energy facilities should qualify as sources of offsets in any climate change program and be excluded as a source regulated under a cap.

Waste-to-Energy Basics

Waste-to-energy facilities generate electricity and steam using municipal solid waste as the primary fuel source. The facilities burn waste in specially designed boilers to ensure complete combustion and employ modern pollution control equipment to scrub emissions.

The result is clean, renewable energy. Nationwide, 87 waste-to-energy plants supply about 2,500 megawatts of generating capacity to the grid. These plants divert approximately 90,000 tons of waste each day from landfills, generating nearly 17 billion kilowatt hours of electricity per year. This is enough to meet the electricity needs of almost two million homes and represents nearly 20 percent of all non-hydro renewable electricity generation in the U.S. To put this in context, it would take 7.8 million tons of coal to produce the same amount of electricity from a coal-fired power plant. Additionally, waste-to-energy plants generally operate in or near metropolitan areas, increasing transmission efficiency and improving distribution bottlenecks.

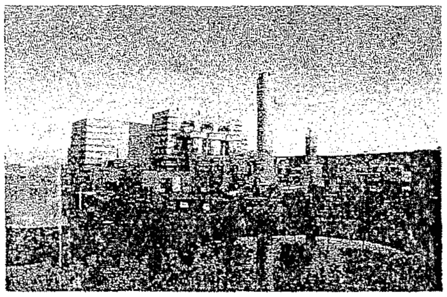
Currently, waste-to-energy facilities process only 8 percent of the municipal solid waste produced in the U.S. each year. This largely untapped resource of readily-available biomass does not require large-scale conversion of arable land or diversion of compostable materials.

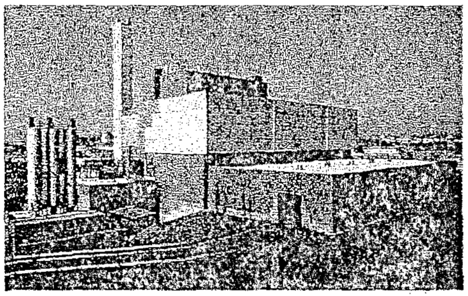
Waste-to-Energy Reduces Greenhouse Gases and Should be Encouraged

Although waste-to-energy facilities emit CO_2 as part of their process, they achieve a net reduction of greenhouse gas emissions over their lifecycle and should not be covered under an emissions cap.

Waste-to-energy emits two types of CO_2: biogenic and anthropogenic. Most of the emissions (67%) are biogenic. These emissions result from the combustion of biomass, which is already part of the Earth's natural carbon cycle – the plants and trees that make up the paper, food, and other biogenic waste remove CO_2 from the air while they are growing, which is returned to the air when this material is burned at a waste-to-energy facility. Because they are part of the natural carbon cycle, greenhouse gas policies should not seek to regulate these emissions.

The remaining CO_2 emissions are anthropogenic. They come from man-made substances in the waste that is combusted, such as unrecyclable plastics and synthetic rubbers. Despite these emissions, waste-to-energy facilities more than offset these emissions through three separate mechanisms.





Energy Recovery Council
1730 Rhode Island Ave., NW
Suite 700
Washington, DC 20036
202-467-6240
www.energyrecoverycouncil.org

Waste-To-Energy is a Climate-Friendly, Renewable Energy Source

Waste-to-energy facilities reduce greenhouse gas emissions in each of the following ways:

- by generating electrical power or steam, waste-to-energy avoids CO_2 emissions from fossil fuel-based electrical generation;
- the waste-to-energy combustion process eliminates the methane emissions that would have occurred if the waste was placed in a landfill; and
- the recovery of metals from municipal solid waste by waste-to-energy facilities is more energy efficient than the production of metals from raw materials.

As a result of these mechanisms, waste-to-energy produces electricity at a net emission rate of ***negative*** 3,636 lbs of CO_2/ MWh. In other words, on a lifecycle basis, for every ton of trash burned at a waste-to-energy plant, approximately one ton of CO_2 equivalents is reduced.

Climate change policies that only look at the end of the stack may inadvertently include net reducers like waste-to-energy facilities. This would unnecessarily penalize facilities that provide climate change benefits and would be inconsistent with state and regional greenhouse gas programs like the Regional Greenhouse Gas Initiative (RGGI), which exclude waste-to-energy facilities from the definition of covered sources. It would also be inconsistent with international carbon regimes. For example, the Clean Development Mechanism established under the Kyoto Protocol accords waste-to-energy projects offset status for displacing fossil fuel-fired electricity generation and eliminating methane production from landfills. Any federal climate change program should similarly recognize waste-to-energy as an important tool to meet greenhouse gas reduction goals and should treat waste-to-energy as a renewable energy source and an eligible offset project category.

Renewable Energy Policies Should Promote Waste-to-Energy Facilities

Federal, state, and local governments have enacted a variety of laws that recognize waste-to-energy as a renewable energy source. At the federal level, waste-to-energy has been recognized as an important source of renewable energy since the inception of the industry over 30 years ago. The Federal Power Act, the Public Utility Regulatory Policy Act (PURPA), the Biomass Research and Development Act of 2000, the Pacific Northwest Power Planning and Conservation Act, the Internal Revenue Code, the Energy Policy Act of 2005, Executive Order 13123, and Federal Energy Regulatory Commission regulations all recognize waste-to-energy as a renewable source of energy. Most recently, the Emergency Economic Stabilization Act, also recognized waste-to-energy as a renewable energy source by providing a two-year extension of the renewable energy production tax credit for waste-to-energy facilities and other renewable sources.

States Defining Waste-to-Energy as Renewable in State Law (as of 1/1/09)

Alaska	Maine	New York
Arkansas	Maryland	Oregon
California	Massachusetts	Pennsylvania
Connecticut	Michigan	South Dakota
District of Columbia	Minnesota	Virginia
Florida	Montana	Washington
Hawaii	Nevada	Wisconsin
Iowa	New Hampshire	
Indiana	New Jersey	

Policies aiming to increase renewable energy production (production tax credit or renewable energy standard) and reduce greenhouse gas emissions (cap-and-trade) should rely on waste-to-energy to assist in these efforts. Increased use of waste-to-energy will help promote energy independence, reduce dependence on fossil fuels, and reduce greenhouse gas emissions. In conclusion, it is essential that any future climate and renewable policies continue to encourage the development and operation of waste-to-energy facilities.

For more information, please contact Ted Michaels, President of the Energy Recovery Council, at 202-467-6240 or tmichaels@energyrecoverycouncil.org.

WHY WASTE -TO- ENERGY?

FAQ

FREQUENTLY ASKED QUESTIONS AND ANSWERS EXPLAINING THE RENEWABLE, CLEAN, SAFE – AND UNDERDEVELOPED ENERGY RESOURCE

GOT QUESTIONS? GET ANSWERS! GO

NEWS

NAWTEC Call For Papers is Available

Congress Chooses Waste-to-Energy

ERC Submits Comments to EPA on Measuring MSW Trends

Minneapolis WTE Facility Earns SWANA Award

Grenada Considering Waste-to-Energy

Arizona Takes Steps to Make WTE Renewable

Durham WTE Facility Given Green Light by Ontario Ministry of Environment

Green Conversion Systems Makes Strides in Los Angeles

Portland, Maine to Host 20th Annual NAWTEC

Maryland Gov. O'Malley Signs Landmark WTE Legislation

PARTNERS

WASTE-TO-ENERGY NEWS

NAWTEC Call For Papers is Available

Friday, October 7, 2011 12:00 pm

The Call For Papers for the 20th Annual North American Waste-to-Energy Conference is out. NAWTEC 20 will take place April 23-25, 2012 in Portland, ME. Don't miss this opportunity to reach the largest specialty group of professionals in North America dealing with municipal waste-to-energy, combustion engineering science, and emerging waste conversion & processing technologies. Abstracts are being sought on the following overarching topics: Advancing Waste-to-Energy through Research and Technology, Waste-to-Energy Contracts and Development Initiatives, Waste-to-Energy as Part of Sustainable Waste Management, and Improving Waste-to-Energy Plant Operations. All abstracts must be submitted online by November 7, 2011. The abstract submittal website is currently being developed and will be open soon to accept your submittal. Please visit http://www.nawtec.org for updates on the opening of the website.

Read More » Permalink » Print » Email »

Congress Chooses Waste-to-Energy

Thursday, October 6, 2011 5:00 pm

Capitol Hill will begin sending its trash to local waste-to-energy facilities that will turn trash into electricity, according to an announcement today by the Architect of the Capitol (AoC). The chairman of the Committee on House Administration, Rep. Dan Lungren (R-Calif.), praised the AoC's waste-to-energy initiative. "Waste-to-energy facilities, woefully underutilized here in the U.S., are an environmentally efficient, cost-effective means to reduce greenhouse emissions and divert waste from landfills" wrote Lungren in a statement Thursday. Rep. Connie Mack (R-Fla.) said in a statement, "Waste-to-energy is one of the steps we need to take to end our dependence on foreign energy sources and dictators like Hugo Chavez."

The support for sending trash from the Capitol and House and Senate office buildings was bipartisan. Rep. Jim Moran (D-Va.), the ranking member of the Appropriations Subcommittee on the Interior and Environment, praised the news of the waste-to-energy program, saying ""It's the appropriate thing to do, burning our waste and getting energy from it," he said. Rep. Peter Welch (D-Vt.), who pays a carbon-offset provider to offset the greenhouse gas emissions related to his Washington and district offices, said, "I'm totally open to it [WTE], if it's done right."

Statement of Ted Michaels, President, Energy Recovery Council:

"The Energy Recovery Council applauds the decision of the Architect of the Capitol and the Committee on House Administration to send Congress' non-recyclable waste to waste-to-energy facilities. By relying on waste-to-energy, Congress will save taxpayers tens of thousands of dollars, reduce the Capitol's greenhouse gas emissions, increase the region's supply of renewable energy and reduce dependence on landfilling. Waste-to-energy is recognized around the world as a renewable, low-emission power source and a sustainable waste management tool. It also provides thousands of well-paying, clean energy jobs that can't be exported. It is extremely encouraging to see Congress stand behind this technology in a bipartisan way. Our industry looks forward to continuing to support local jobs while providing clean, affordable power for the region."

Read More » Permalink » Print » Email »

ERC Submits Comments to EPA on Measuring MSW Trends

Friday, September 30, 2011 5:00 pm

The Energy Recovery Council filed comments this week on EPA's notice seeking input on measuring waste generation, recovery, and disposal in the United States. EPA has for years relied upon data generated by the Franklin Institute which estimated the amount of waste generated in the United States based on manufacturing data. Due to inherent flaws in this process which leads to the gross underestimation of waste generation, the ERC has relied upon the data published by BioCycle/Columbia University in its biannual State of the Garbage in America, which relies on data reported by state agencies. ERC's comments are intended to drive EPA to reporting-based data. In addition, ERC recommends that they begin to track all types of waste, not just traditional municipal solid waste.

Read More » Permalink » Print » Email »

87 599 640

Minneapolis WTE Facility Earns SWANA Award

Friday, September 9, 2011 12:00 pm

The Hennepin Energy Recovery Center (HERC) has received a Waste-to-Energy Excellence Award at the Gold level from the Solid Waste Association of North America (SWANA). SWANA's Excellence Awards Program recognizes outstanding solid waste programs and facilities that advance the practice of environmentally and economically sound solid waste management. HERC, located in downtown Minneapolis, provides reliable, renewable electricity that is sold to Xcel Energy and steam that supplies the downtown district energy system and Target Field. HERC is owned by Hennepin County and operated by Covanta Energy. To earn the award, HERC was judged on a wide variety of criteria, including engineering and technology, operational performance and efficiency, environmental compliance, aesthetics, other recycling and solid waste management programs in the county, public relations and education, and innovation and creativity. HERC is situated in a unique and highly visible urban location. With the construction of Target Field, new light rail, commuter rail and other mass transit projects, and residential and commercial redevelopment efforts, the neighborhood around the HERC has changed significantly since operations began more than 20 years ago. The county has also worked with community partners to ensure that HERC continues to be a good neighbor and an integral part of downtown redevelopment.

Read More » Permalink » Print » Email »

Grenada Considering Waste-to-Energy

Wednesday, August 17, 2011 8:00 am

The Government of Grenada (GoG) through the Grenada Solid Waste Management Authority (GSWMA) invites submissions of expression of interest to establish a waste-to-energy facility on the island of Grenada. GSWMA is responsible for the collection of domestic solid waste throughout Grenada. A 2009 study that examined options for waste disposal, among other things in Grenada, gave support to a waste-to-energy thrust. Interested parties may consider and submit any appropriate technology and any commercial arrangement within the confines of existing policy and legislation. The venture will include researching, sourcing, construction, installation and commissioning of a suitable and appropriate waste to energy technology in Grenada as a means of effectively dealing with applicable fractions of the municipal solid waste stream. The GoG wishes to have an operational waste to energy facility by the fourth quarter of 2015 and intends to choose a suitable waste to energy partner by the third quarter of 2012. For more information on how to submit an expression of interest, please visit: http://www.gswma.com/download/EOI_Grenada.pdf.

Read More » Permalink » Print » Email »

CONTACT

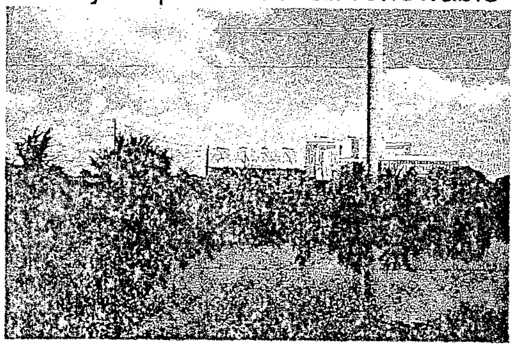
1730 Rhode Island Ave, NW
Suite 700
Washington DC 20036

Tel. 202.467.6240

Email Us
energyrecoverycouncil.org

Waste-to-Energy Produces Clean, Renewable Energy

With the majority of America's energy currently being produced by fossil fuel-fired power plants, the steam and renewable electricity generated by the nation's 87 waste-to-energy plants are valuable commodities. These waste-to-energy facilities have a power generating capacity of nearly 2,700 megawatts of clean electricity. Unlike other types of renewable resources, waste-to-energy is considered base load power that operates 24 hours per day, 365 days per year. As a result, these facilities reliably generate approximately 17 billion kilowatt hours of electricity per year—enough power approximately 2 million American homes. This accounts for nearly 20 percent of all renewable electricity generation in the United States.



Today's waste-to-energy plants are highly efficient power plants that utilize municipal solid waste as their fuel rather than coal, oil or natural gas. Far better than expending energy to explore, recover, process and transport the fuel from some distant source, waste-to-energy plants find value in what others consider garbage. Waste-to-energy plants recover the thermal energy contained in the trash in highly efficient boilers that generate steam that can then be sold directly to industrial customers, or used on-site to drive turbines for electricity production.

Waste-to-energy meets the two basic criteria for establishing what a renewable energy resource is—ts fuel source (trash) is sustainable and indigenous. Waste-to-energy facilities recover valuable energy from trash after efforts to "reduce, reuse, and recycle" have been implemented by households and local governments.

The renewable electricity produced at these facilities is so valuable that Congress included waste-to-energy in the Section 45 Production Tax Credit to encourage development of waste-to-energy and other renewable technologies.

Furthermore, waste-to-energy has been recognized as renewable in federal law more than 30 years. Statutes that define waste-to-energy as renewable include:

- AmeBrican Recovery and Reinvestment Act (Stimulus Bill)
- Energy Policy Act of 2005
- Public Utility Regulatory Policy Act (PURPA) of 1978
- Biomass Research and Development Act of 2000
- Pacific Northwest Power Planning and Conservation Act
- Federal Power Act
- Internal Revenue Code
- Laws of 25 States, the District of Columbia, and Puerto Rico

howing that waste-to-energy can help lead the way to a cleaner, more energy independent future, ie Davos Report, produced by the World Economic Forum in 2009, cited waste-to-energy among ght emerging "green" technologies that can help reduce greenhouse gases and change the world's nergy consumption patterns.

IRS

Energy Provisions of the American Recovery and Reinvestment Act of 2009

FS-2009-10, April 2009
(Clarified statutory language in Section 1142, 5/13/09)

The American Recovery and Reinvestment Act of 2009 (ARRA) provides energy incentives for both individuals and businesses.

Here are some of the key energy provisions in ARRA that may impact taxpayers:

Residential Energy Property Credit (Section 1121): The new law increases the energy tax credit for homeowners who make energy efficient improvements to their existing homes. The new law increases the credit rate to 30 percent of the cost of all qualifying improvements and raises the maximum credit limit to $1,500 for improvements placed in service in 2009 and 2010.

The credit applies to improvements such as adding insulation, energy efficient exterior windows and energy-efficient heating and air conditioning systems.

A similar credit was available for 2007, but was not available in 2008. Homeowners should be aware that the standards in the new law are higher than the standards for the credit that was available in 2007 for products that qualify as "energy efficient" for purposes of this tax credit. The IRS has issued guidance that will allow manufacturers to certify that their products meet these new standards.

Until the guidance is released, homeowners generally may continue to rely on manufacturers' certifications that were provided under the old guidance. For exterior windows and skylights, homeowners may continue to rely on Energy Star labels in determining whether property purchased before June 1, 2009, qualifies for the credit. Manufacturers should not continue to provide certifications for property that fails to meet the new standards.

Residential Energy Efficient Property Credit (Section 1122): This nonrefundable energy tax credit will help individual taxpayers pay for qualified residential alternative energy equipment, such as solar hot water heaters, geothermal heat pumps and wind turbines. The new law removes some of the previously imposed maximum amounts and allows for a credit equal to 30 percent of the cost of qualified property. See Notice 09-41.

Plug-in Electric Drive Vehicle Credit (Section 1141): The new law modifies the credit for qualified plug-in electric drive vehicles purchased after Dec. 31, 2009. To qualify, vehicles must be newly purchased, have four or more wheels, have a gross vehicle weight rating of less than 14,000 pounds, and draw propulsion using a battery with at least four kilowatt hours that can be recharged from an external source of electricity. The minimum amount of the credit for qualified plug-in electric drive vehicles is $2,500 and the credit tops out at $7,500, depending on the battery capacity. The full amount of the credit will be reduced with respect to a manufacturer's vehicles after the manufacturer has sold at least 200,000 vehicles.

Plug-In Electric Vehicle Credit (Section 1142): The new law also creates a special tax credit for two types of plug-in vehicles — certain low-speed electric vehicles and two- or three-wheeled vehicles. The amount of the credit is 10 percent of the cost of the vehicle, up to a maximum credit of $2,500 for purchases made after Feb. 17, 2009, and before Jan. 1, 2012. To qualify, a vehicle must be either a low speed vehicle propelled by an electric motor that draws electricity from a battery with a capacity of 4 kilowatt hours or more or be a two- or three-wheeled vehicle propelled by an electric motor that draws electricity from a battery with the capacity of 2.5 kilowatt hours. A taxpayer may not claim this credit if the plug-in electric drive vehicle credit is allowable.

Conversion Kits (Section 1143): The new law also provided a tax credit for plug-in electric drive conversion kits. The credit is equal to 10 percent of the cost of converting a vehicle to a qualified plug-in electric drive motor vehicle and placed in service after Feb. 17, 2009. The maximum amount of the credit is $4,000. The credit does not apply to conversions made after Dec. 31, 2011. A taxpayer may claim this credit even if the taxpayer claimed a hybrid vehicle credit for the same vehicle in an earlier year.

Treatment of Alternative Motor Vehicle Credit as a Personal Credit Allowed Against AMT (Section 1144): Starting in 2009, the new law allows the Alternative Motor Vehicle Credit, including the tax credit for purchasing hybrid vehicles, to be applied against the Alternative Minimum Tax. Prior to the new law, the Alternative Motor Vehicle Credit could not be used to offset the AMT. This means the credit could not be taken if a taxpayer owed AMT or was reduced for some taxpayers who did not owe AMT.

New Clean Renewable Energy Bonds (Section 1111): The new law increases the amount of funds available to issue new clean renewable energy bonds from the one-time national limit of $800 million to $2.4 billion. These qualified tax credit bonds can be issued to finance certain types of facilities that generate electricity from renewable sources (for example, wind and solar).

Qualified Energy Conservation Bonds (Section 1112): The new law increases the amount of funds available to issue qualified energy conservation bonds from the one-time national limit of $800 million to $3.2 billion. These qualified tax credit bonds can be issued to finance governmental programs to reduce greenhouse gas emissions and other conservation purposes.

Extension of Renewable Energy Production Tax Credit (Section 1101): The new law generally extends the "eligibility dates" of a tax credit for facilities producing electricity from wind, closed-loop biomass, open-loop biomass, geothermal energy, municipal solid waste, qualified hydropower and marine and hydrokinetic renewable energy. The new law extends the "placed in service date" for wind facilities to Dec. 31, 2012. For the other facilities, the placed-in-service date was extended from December 31, 2010 (December 31, 2011 in the case of marine and hydrokinetic renewable energy facilities) to Dec. 31, 2013.

Election of Investment Credit in Lieu of Production Credit (Section 1102): Businesses who place in service facilities that produce electricity from wind and some other renewable resources after Dec 31, 2008 can choose *either the energy investment tax credit, which generally* provides a 30 percent tax credit for investments in energy projects or the production tax credit, which can provide a credit of up to 2.1 cents per kilowatt-hour for electricity produced from renewable sources. A business may not claim both credits for the same facility.

Repeal of Certain Limits on Business Credits for Renewable Energy Property (Section 1103): The new law repeals the $4,000 limit on the 30 percent tax credit for small wind energy property and the limitation on property financed by subsidized energy financing. The repeal applies to property placed in service after Dec. 31, 2008.

Coordination With Renewable Energy Grants (Section 1104): Business taxpayers also can apply for a grant instead of claiming either the energy investment tax credit or the renewable energy production tax credit for property placed in service in 2009 or 2010. In some cases, if construction begins in 2009 or 2010, the grant can be claimed for energy investment credit property placed in service through 2016, and for qualified renewable energy facilities, the grant is 30 percent of the investment in the facility and the property must be placed in service before 2014 (2013 for wind facilities).

Temporary Increase in Credit for Alternative Fuel Vehicle Refueling Property (Section 1123): The new law modifies the credit rate and limit amounts for property placed in service in 2009 and 2010. Qualified property (other

EXHIBIT RB-3

HARNESSING THE ENERGY OF TRASH
MSW MANAGEMENT MARCH-APRIL 2011
THE LANDFILL DISPOSAL RATES OF WASTE-TO-ENERGY
AND ZERO-WASTE COMMUNITIES

HARNESSING THE ENERGY OF TRASH

by Alyssa A. Lappen
inFocus
Fall 2009

Among the greatest ironies of President Barack Obama's environmental policies is his federal budget proposal to "cap-and-trade" greenhouse gas emissions. The plan would roughly double electricity rates nationwide. It would weigh heavily on businesses during the worst recession since World War II. The irony stems from Obama's oft-repeated promise on the campaign trail not to raise taxes on American families earning less than $250,000 annually. Indeed, "cap-and-trade" might be better termed "cap-and-tax" for the crushing tax impact it will have on Americans.

The American Recovery and Reinvestment Act (ARRA) and the proposed 2010 federal budget promote many potential "clean" and "renewable energy" projects. However, they ignore one of the most economical and environmentally friendly ways of improving energy efficiency and cutting carbon emissions: harnessing the potential energy of trash.

Waste-to-Energy

In 2006, the state of California enacted a "Roadmap for the Development of Biomass" to increase wind, solar, and biomass projects—and to eventually extract 22 percent of its energy feeds from urban waste. The same year, the Los Angeles City Council unanimously voted to replace citywide garbage disposal with waste-to-energy (WTE) by 2016. The goal is to improve energy efficiency and eliminate the high costs and pollution from trash transports.

The federal government, the District of Columbia, and at least 11 states now include waste-to-energy on their lists of viable, renewable energy resources, according to Ted Michaels of Washington, D.C.'s Energy Resource Council. Yet, the United States lags the rest of the world in WTE development. Of more than 600 state-of-the-art WTE plants worldwide, only 90 operate in the U.S. Waste-to-energy plants like those in Cape Cod, MA, Palm Beach, FL, and Hempstead and Onondaga County, NY, prove that municipal and solid wastes can serve as significant and effective biomass energy sources, generating clean electrical energy.

In total, American WTE plants generate 2,800 megawatts of electricity annually, saving 1.4 billion gallons of fuel oil. That's equivalent to current U.S. geothermal energy production, and far more than wind and solar energy, according to Columbia University Professor Nicholas Themelis.

Untapped Potential

The U.S. could recover much more energy from trash. Some 300 million Americans generate nearly 1.4 billion pounds of municipal solid waste daily, more than 500 billion pounds annually. From that supply of residential waste alone, the U.S. could more than septuple its waste-produced energy to 21,000 megawatts of electricity per year. That could save nearly 14 billion gallons of fuel oil. Add industrial and agricultural wastes, and total U.S. energy gains could skyrocket.

So far, Europe is far ahead. By late 2005, European WTE plants generated sufficient energy to supply 27 million people a year with electricity —or to heat 13 million homes, reports Dr. Ella Stengler, Managing Director of the Brussels-based Confederation of European Waste-to-Energy Plants.

By 2006, Holland generated 14.3 percent of its renewable energy from waste, Belgium 13.3 percent, Denmark 12.5 percent, and Germany 7.5 percent. Germany has since further enhanced its WTE program to include agricultural and industrial waste. In fact, Germany now recycles 60 percent of its municipal solid waste at 72 plants despite having cut overall waste production by more than one fifth since 2002.

Unexpected Enemies

Surprisingly, a huge roadblock to WTE in the U.S. stems from opposition from local, state, national, and global environmental organizations like the New York Public Interest Research Group (NYPIRG), the Sierra Club, and the Global Alliance for Incinerator Alternatives (GAIA). Even some government officials reportedly oppose WTE, including New York deputy environmental secretary Judith Enck, a former NYPIRG activist and a potential presidential pick to serve as a regional administrator for the Environmental Protection Agency (EPA).

These and other opponents believe that WTE plants could eliminate incentives to recycle. Citing obsolete data, they also erroneously assert that WTE can cause harmful emissions. Ultimately, their opposition may stem from an unrealistic goal of creating a utopian society that generates zero waste.

This, according to Columbia University's Jack D. Lauber, is an idealistic impossibility. While zero waste is a pipe dream, working toward zero waste disposal would significantly increase recycling in the U.S., which would thrive as long as it offers profit potential. It would also substantially cut trash transport expenses nationwide, not to mention the transports' annual release of hundreds of tons of atmospheric gaseous and particulate toxins. Indeed, a 2002 Australian study found that diesel trucks spew five times more atmospheric particulates than municipal waste plants.

Unexpected Allies

While the ideologues try to achieve the unachievable, WTE has attracted allies from some unexpected quarters, including a wildlife pathologist from New York's Department of Environmental Conservatism, Ward Stone, who in September will receive a Sierra Club lifetime achievement award for his scientific work.

"WTE is a smart way to go," Stone says. While "some people have made careers of fighting waste incineration," as a scientist, Stone well understands "we won't have dioxin emissions."

Stone refers to the fact that new-generation, multi-stage WTE plants have virtually eliminated emissions. In fact, according to the EPA, the plants have cut dioxin and other toxic emissions upwards of 99 percent. Total combined waste-to-energy plant emissions in the U.S. are only 12 grams of dioxin annually, less than 0.5 percent of all dioxins produced nationwide. Moreover, the residue produced can be recycled into road building, and construction materials, as well as valuable metals.

There is no getting around the fact that these plants incinerate waste. The very word "incineration" can evoke an image of unregulated back yard burning, sending curls of black smoke into the air. However, modern mechanical and chemical engineers worldwide (U.S., Japan, Germany, and elsewhere) have devised remarkably innovative toxin extraction methods. Multiple-burn technology, for example, re-circulates dioxins into high temperature combustion zones, cutting their concentrations and all but eliminating them. In another extraction technique, introducing lime directly into refuse-derived fuel causes calcium to react with toxins to form removable particulates.

Thus, even though WTE involves incineration, Stone considers it a potential boon to the energy resource and recycling industries. "It is better to eliminate unnecessary use or waste of anything," he says.

Stone also notes that multiple-burn WTE technology allows for technological and economic flexibility. During recessionary periods like the current one—when "trash crashes," and plastic and paper prices decline deeply, rendering recycling costly and unprofitable—WTE plants can burn increased material loads. The high-tech incinerators simply pick up the economic slack, and generate more electricity until raw material prices recover sufficiently to again warrant sales to factories and other recyclers.

Urban Mining

The idea of utilizing WTE technology becomes particularly appealing when considering that the alternative is landfills. One ton of municipal solid waste in a landfill produces 200 normal cubic meters (Nm3) of methane. According to the National Oceanic and Atmospheric Administration, methane is a greenhouse gas that is 25 times more potent than carbon dioxide. Even the operating landfills that reclaim methane emit far more greenhouse gas than WTE plants.

Emissions are not the only problem. New York City, for example, buried over 150 million tons of municipal solid waste in Staten Island —without liners—before closing the Fresh Kills dump in March 2001. Without further intervention, toxins will pollute the adjacent wetlands and air throughout the 21st century. This is why Europe largely bans municipal solid waste landfills.

New York is now spending millions on "remediation" and building public parks on top of Fresh Kills. Instead, it could be mining these landfills, and turning waste to energy.

Other countries have already engaged in "urban mining." Japan's private and government sectors have partnered to mine 20th century "landfill mountains" for their wealth in recyclable and precious metals, as well as plastic, newspaper, combustible materials, and methane.

Using WTE technology, treasure can be found beneath the trash in Fresh Kills—at least $50 per ton via municipal waste-to-energy electricity generation. Multiply that buried treasure times thousands of U.S. municipal and state landfills, and one can understand the vast potential in WTE. This does not include the value to be captured in recovering paper, plastic, metals, combustibles, and gas.

Will Washington Embrace Waste?

Despite its promises to embrace all forms of renewable energy, the Obama Administration may not have a taste for waste. Indeed, for Congress to even consider a switch to WTE technology would likely require the "cap-and-tax" scheme to wither on the vine, as a growing chorus of analysts now suggest might happen.

However, the battle would not end there. The waste disposal industry would then need to navigate around ideologically-charged environmental activists, such as Enck, who put politics before the planet.

In the end, however, if Washington is to embrace WTE, it will likely stem from popular demand. Indeed, when the broader public learns of WTE's multiple benefits, the American people will insist that government put this available technology to work on a broader scale.

Alyssa A, Lappen, a former senior editor at Institutional Investor *magazine and former associate editor at* Forbes, *is a U.S.-based investigative journalist.*

MSW Management
The Journal for Municipal Solid Waste Professionals
March-April 2011

The Landfill Disposal Rates of Waste-to-Energy and Zero-Waste Communities

Photo: istockPhoto/DTBMedia

By Jeremy K. O'Brien

A municipal solid waste (MSW) management strategy that is growing in popularity is that of "zero waste." 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."

Communities that embrace the zero waste philosophy typically rely on materials recycling, food and yardwaste composting, and composting or anaerobic digestion of mixed waste to achieve high rates of recycling and waste diversion. A key aspect of the zero waste philosophy appears to be the outright rejection of waste-to-energy (WTE) as a possible system component. For example, the city of San Francisco—a city that has embraced the zero waste philosophy—states 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% of the materials it discards, bringing the city ever closer to its twin goals of 75% landfill diversion by 2010, and bringing the city to zero waste by 2020."

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 programs have, to date, not been documented.

This article presents highlights from a research report developed with input and guidance provided by the SWANA Applied Research Foundation (ARF) FY 2010 WTE Group Subscribers. A major outcome of the research was the development of a new metric, the landfill disposal index, which can be used as a performance measure for solid waste system options, including WTE-based systems and 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. (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.) 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

The Landfill Disposal Index

In a presentation given at the "Cispel Confservizi 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." (Themelis, N. "Materials and Energy Recovery in the US: New York and California," Cispel Confservizi Toscana Symposium, Florence, Italy. April 24, 2009.)

Based on this recommendation, as well as research conducted during the FY2010 project, a new metric, the landfill disposal index, has been proposed by the ARF's WTE Group for adoption by the solid waste industry.

The landfill disposal index, or LDI, is defined as the quantity of solid waste generated in a community that is disposed in landfills. The LDI should be reported on an annual weight per capita basis, such as tons of solid waste landfilled per person per year.

As shown in Table 2, an LDI can be calculated for each type of solid waste generated by a community. For example, a typical community is likely to have a municipal solid waste LDI (MSW-LDI) and a construction-and-demolition waste LDI (C&D-LDI). LDIs can also be calculated for the residential and commercial MSW substreams.

The LDIs presented in Table 2 are in line with, but more defined than, the waste reduction and recycling goal parameters established in many states. For example, the state of North Carolina has a waste reduction/recycling goal of 40% of the FY1991 per capita disposal rates. This goal, however, does not distinguish between wastestreams (MSW or C&D) or substreams (residential or commercial). If LDI goals were established by state and local governments for each type of wastestream, it would likely result in a better understanding of the effectiveness of waste reduction and recycling programs targeted toward these wastestreams.

Finally, a "Biodegradable MSW-LDI" would indicate the quantity of MSW generated in a community that has been not been stabilized or biodegraded prior to or during landfill disposal.

The LDIs 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 the *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, as well as from the city and the county of Honolulu, were used to calculate the LDIs for 66 WTE communities with the results presented in Table 3.

As shown, communities with WTE facilities dispose of 25%, on average, of the MSW they generate in landfills. Of the remaining 75% of the MSW generated, 33% is recycled and 42% is combusted to generate electricity or produce other useful energy products. The average MSW-LDI for the estimated 37.2 million people served by these WTE facilities is 0.35 of a ton per person per year.

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 (EC) recognized the importance of solid waste stabilization in the promulgation of its 1999 landfill directive, which requires member states to reduce the amount of biodegradable waste landfilled to 35% 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 66 WTE communities included in Table 3 can be calculated by dividing the tonnages of "Bypass MSW" by the populations served. The resulting Biodegradable MSW-LDI is 0.21 of a ton per person per year, which equates to 15% of the waste generated in the WTE communities. Therefore, it appears that these communities would comply with the EC landfill directive if a similar policy was adopted in the US.

MSW-LDIs for Zero Waste Communities

Due to the newness of the zero-waste approach, the calculation of MSW-LDIs for zero-waste

Table 3. Landfill Disposal Indices For Communities With Waste-to-Energy Facilities

Column		A	B	C	D	E	F	G	H	I	J	K
State	Number of WTE Facilities	Population Served by WTE Facilities	Tons Recycled	[illegible]	[illegible]	[illegible]	MSW Generated	[illegible]	[illegible]	[illegible]	[illegible]	Landfill Disposal Index
		Persons	Tons/Year	Tons/Year	Tons/Year	Tons/Year	Tons/Year	Per Capita	Tons/Year	Tons/Year	%	Tons/Person/Yr
California	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Connecticut	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Florida	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hawaii	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Maryland	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Massachusetts	[illegible]	[illegible]	[illegible]	[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Minnesota	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
New Jersey	[illegible]	[illegible]	[illegible]	[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
New York	[illegible]	[illegible]	[illegible]	[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pennsylvania	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Virginia	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Totals	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Percent			[illegible]	[illegible]	[illegible]		[illegible]				[illegible]	

1. [illegible]
2. Ibid, Table 2.
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]
7. [illegible]
8. [illegible]
9. [illegible]
10. [illegible]
11. [illegible]
12. [illegible]

communities is based on very limited data from communities that have not yet implemented all of their planned zero-waste initiatives. With this understanding, data for two cities that are nationally known for their aggressive recycling programs and/or zero waste plans—San Francisco and Seattle—are presented in Table 4 for consideration.

As shown, in 2008, the city of San Francisco disposed of 594,600 tons of waste that were generated within its jurisdictional limits. In light of its 2008 population of 808,976 and assuming (based on the CalRecycle jurisdiction profile for San Francisco) that 93% of the waste disposed in 2008 was MSW, this equates to an MSW-LDI of 0.68 tons per person per year.

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 MSW-LDI of 0.58 tons per person per year.

Discussion

While this preliminary analysis of the MSW-LDIs of zero waste communities is based on only two communities that have not yet implemented all of their planned zero-waste initiatives, it indicates that significantly lower MSW-LDIs have been achieved by communities with WTE systems—0.35 tons per person per year—when compared with those that are currently being achieved by communities implementing zero-waste systems: 0.58–0.68 tons per person per year. Furthermore, as the WTE systems that are included in Table 3 have typically been in place for 20 years or more, it can be concluded that these communities have been achieving these low MSW-LDIs for many years.

The analysis also indicates that zero-waste communities might not be diverting as much waste from

Table 3. 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 (Biodegradable 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	1,382,083	1,554,173	858,112	1,146,332	2,137,444	3,802,217	1.83	182,185	1,411,515	37%	0.68
Connecticut	5	3,381,621	307,213	1,182,024	241,558	2,422,728	3,329,511	1.08	411,211	653,329	20%	0.21
Florida	11	8,484,227	1,384,586	3,735,240	3,181,367	1,978,157	12,162,898	1.43	1,184,244	4,325,611	36%	0.52
Hawaii[12]	1	370,000	543,117	600,300	176,512	735,303	1,329,434	1.17	157,989	336,501	25%	0.35
Maryland	3	1,392,555	1,524,868	1,352,238	797,729	2,138,367	3,754,635	1.52	263,183	1,110,902	27%	0.52
Massachusetts	7	3,239,216	1,507,323	3,236,431	-	3,236,431	4,504,334	1.31	621,325	621,325	13%	0.13
Minnesota	5	3,376,057	1,563,202	1,522,759	715,251	2,221,304	3,306,072	2.15	283,181	1,002,302	26%	0.30
New Jersey	5	2,182,216	321,343	1,177,208	-	2,177,208	3,299,332	1.42	411,452	411,452	13%	0.13
New York	10	4,275,034	1,304,523	3,830,383	-	3,830,383	5,763,306	1.35	735,262	735,262	13%	0.17
Pennsylvania	6	4,883,512	1,863,033	3,112,596	1,130,336	4,348,356	6,211,383	1.23	567,850	1,825,706	29%	0.37
Virginia	5	2,633,544	1,119,537	2,023,953	121,380	2,150,081	3,269,568	1.23	383,480	504,538	15%	0.13
Totals	64	37,382,836	17,318,389	26,730,698	3,796,563	34,507,252	51,515,431	1.39	5,104,381	12,340,304	23%	0.35
Percent			33%[7]	42%	13%		100%				23%	

1. Berenyi, E. Recycling and Waste-to-Energy: Are They Compatible? 2009 Update. Westport, CT: Governmental Advisory Associates, Inc., June 2009. Table 1.
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.
12. Data for the H-power Facility in Honolulu provided in email from Ahmad Sadri, Civil Engineer III, City and County of Honolulu, dated 1/20/11.

Added for Clarity

4a

TABLE 2 Recommended Landfill Disposal Indices for Different Wastestreams		
Waste Stream	LDI	Performance Measurement
Municipal Solid Waste (MSW)	MSW-LDI	Overall effectiveness of MSW Reduction and Recycling Programs
	Biodegradable MSW-LDI	Effectiveness of MSW Stabilization Systems (Composting, Anaerobic WTE, Bioreactor Landfills)
Residential MSW	RSW-LDI	Effectiveness of Residential MSW Reduction and Recycling Programs
Commercial MSW	C&D-LDI	Effectiveness of Residential MSW Reduction and Recycling Programs
Construction and Demolition (C&D) Waste	C&D-LDI	Effectiveness of Residential MSW Reduction and Recycling Programs

landfill disposal as is indicated by their reported diversion rates. For example, the city of San Francisco reports that it is currently diverting 72% of its waste from landfill disposal. This high diversion rate is difficult to understand in light of the city's MSW-LDI of 0.68 tons per person per year. In comparison, the documented average MSW diversion rate for the 65 WTE communities in Table 3 is 75%, while the MSW-LDI for these communities averages 0.35 tons per person per year.

Conclusions

This article describes a new metric—the landfill disposal index (LDI)—that can be used to measure the performance of waste management systems. The LDI indicates the amount of waste generated in a community that is landfilled each year on a per capita basis and is reported as "tons landfilled per person per year."

Based on published and unpublished data from reliable industry sources, the average MSW-LDI for 66 communities that have implemented WTE systems that serve over 37 million people is 0.35 ton per person for year. In addition, the biodegradable MSW-LDI of these communities averages 0.21 ton per person per year, which equates to 15% of the MSW generated.

In

TABLE 4
Per Capita Disposal Rates for Selected Zero Waste Communities

Jurisdiction	Year	Waste Disposed	Population	MSW LDI (Tons/Person/Year)
San Francisco, CA[1]	2008	594,660	808,976	0.68
Seattle, WA2	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/). Waste composition data indicate waste disposed is 93% MSW and 7% C&D.
[2]Seattle Public Utilities. Annual Garbage Report. http://www.seattle.gov/util/groups/public/@spu/@usm/documents/webcontent/spu01_006649.pdf

comparison, the MSW-LDIs for two communities (San Francisco and Seattle) that have implemented aggressive waste reduction and recycling programs range from 0.58 to 0.68 tons per person per year. These MSW-LDIs are substantially higher than the MSW-LDI of communities with WTE systems and indicate that these communities might not be diverting as much waste from landfill disposal as indicated by their reported recycling/diversion rates.

The FY2010 WTE Group of the SWANA ARF recommends that the LDI be adopted by the solid waste industry as a useful metric to evaluate the performance of MSW management systems. Furthermore, the group recommends that an LDI be developed for each waste substream generated in a community (residential MSW, commercial MSW, C&D, etc.) so that the effectiveness of local waste reduction, recycling, and conversion programs that target these waste substreams can be more accurately measured.

Director for the City of Dallas Sanitation Services to Speak at Annual Landfill Gas Symposium

Mary Nix, P.E., director of sanitation services for the city of Dallas, will be the keynote speaker for SWANA's 34th Annual Landfill Gas Symposium to be held March 21–24, 2011, in Dallas, Texas.

In her presentation, Nix will discuss the environmental management system used by the city to manage its municipal solid waste, as well as challenges the city has faced over the last decade and solutions that have been implemented to overcome these challenges.

Nix has more than 30 years of experience in the solid waste and environmental arena. As the director for the City of Dallas Sanitation Services Department, she currently manages the city of Dallas's residential waste collection, recycling, transfer, and disposal—serving a population of 1.3 million. With an annual budget of $75 *million and* a staff of 750, her department provides competitively priced weekly collection of residential refuse and recycling, monthly bulk and heavy brush collection, operation of the state's largest landfill, and the fostering of new and innovative ways to advance solid waste practices.

The Landfill Gas Symposium is the leading forum on landfill gas utilization and technology, taking an in-depth look at beneficial use, methane offset projects, available tax and carbon credits, greenhouse gas issues, and legislative and regulatory developments. The event begins on Monday, March 21, 2010, with training opportunities, division and advocacy meetings, and an opening reception. On Tuesday, educational sessions begin with Nix's keynote address. Other

Photo: Mary Nix

Topics: Landfill, WTE, Data

highlights of the conference include the following:

Ten technical sessions, featuring over 30 presentations
Two-day landfill gas trade show
Tour of the McCommas Bluff Landfill
LFG and MOLO training courses
Earn up to 30 SWANA CEUs
Networking events, including a golf tournament

The symposium will be held at the Gaylord Texan, in Dallas, Texas, March 21–24, 2011. For more information, to view the program, or to register for this event, please visit www.lfg.swana.org.

EXHIBIT RB-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

FEB 14 2003

Maria Zannes, President
Integrated Waste Services Association
1401 H Street N.W., Suite 220
Washington, DC 20005

Dear Ms. Zannes:

EPA recognizes the vital role of the nation's municipal waste-to-energy industry, and wishes to thank you for your environmental efforts.

Upgrading of the emission control systems of large combustors to exceed the requirements of the Clean Air Act Section 129 standards is an impressive accomplishment. The completion of retrofits of the large combustion units enables us to continue to rely on municipal solid waste as a clean, reliable, renewable source of energy. With the capacity to handle approximately 15 percent of the waste generated in the US, these plants produce 2800 megawatts of electricity with less environmental impact than almost any other source of electricity. With fewer and fewer new landfills being opened, and capacity controls being imposed on many existing landfills, our communities greatly benefit from the dependable, sustainable capacity of municipal waste-to-energy plants.

We applaud the leadership taken by the Integrated Waste Services Association in coordinating research needs to continue to improve the performance of these plants. Your willingness to work with EPA and the State governments on responses to natural or man-made emergencies, including anthrax, is greatly appreciated. Our staff in the Office of Solid Waste and Emergency Response and the Office of Air and Radiation look forward to working with you on defining your research agenda and in addressing our national security concerns.

Sincerely yours,

Marianne Lamont Horinko
Assistant Administrator
Office of Solid Waste and
Emergency Response

Jeffrey R. Holmstead
Assistant Administrator
Office of Air and Radiation

EXHIBIT RB-5

Recycling and Waste-to-Energy: Are They Compatible?

2009 Update

Eileen Brettler Berenyi, PhD
Governmental Advisory Associates, Inc.
599 Riverside Avenue, Suite 1
Westport, CT 06880

June 2009

The purpose of this study is to answer the question of whether recycling and waste-to-energy are compatible waste management strategies. Critics of waste-to-energy have argued the presence of a waste combustion facility in an area inhibits recycling and is an obstacle to communities' efforts to implement active recycling programs. As this study will show, this contention has no basis in fact. In an examination of recycling rates of more than 500 communities in twenty-two states, which rely on waste-to-energy for their waste disposal, it is demonstrated that these communities recycle at a rate higher than the national average. Many of these areas have recycling rates at least three to five percentage points above the national average and in some cases are leading the country in recycling. The study concludes that recycling and waste-to-energy are compatible waste management strategies, which are part of an integrated waste management approach in many communities across the United States.

Key Findings:

- The study covers 82 waste-to-energy facilities in 22 states. Recycling data was obtained from 567 local governments, including 495 cities, towns and villages and 72 counties, authorities or districts. In addition, statewide data was obtained for each of the 22 states.

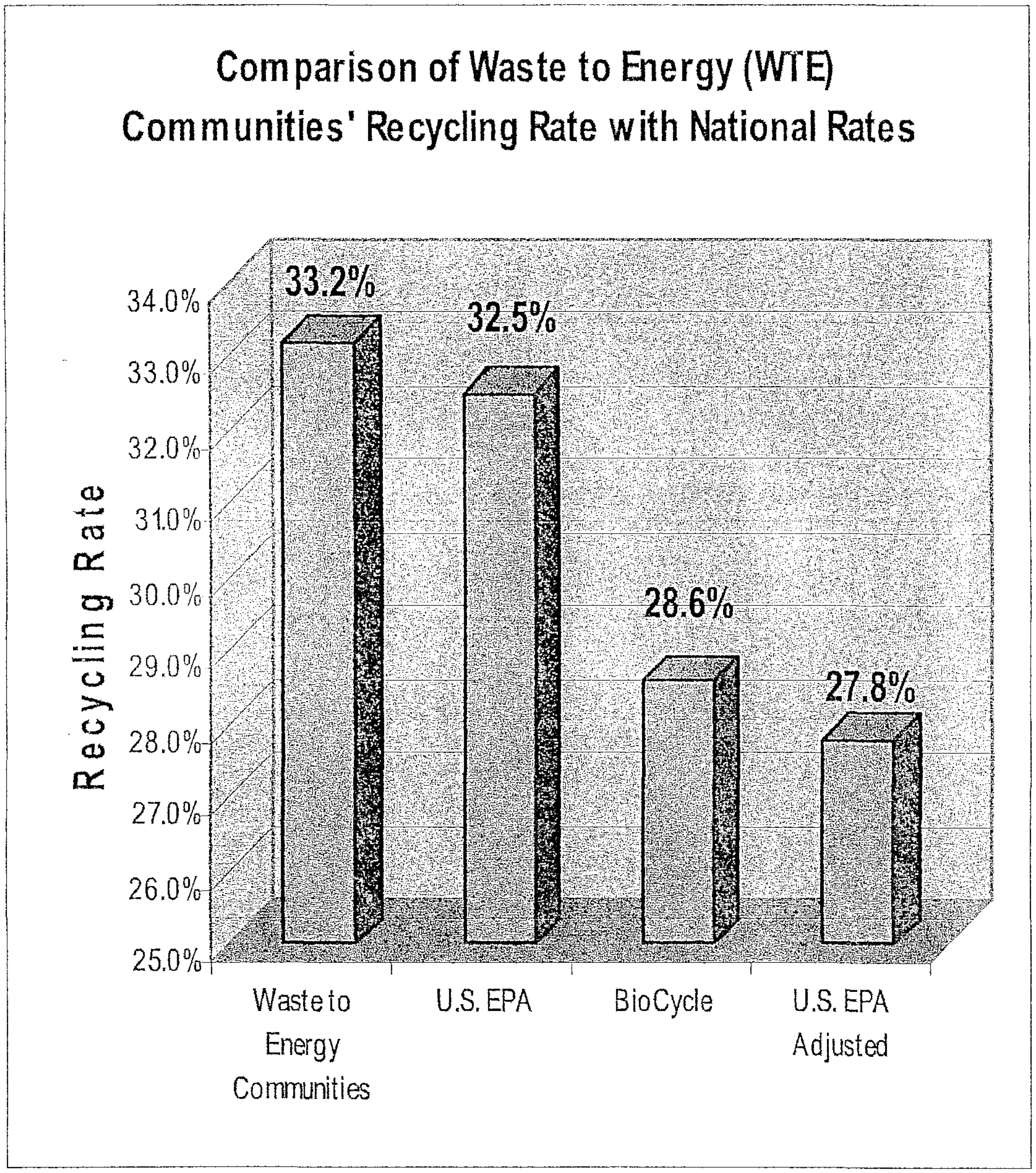
- Communities nationwide using waste-to-energy have an aggregate recycling rate **at least 5 percentage points** above the national average.

- Communities using waste-to-energy for disposal are recycling at about 33.3%, which is higher than the national rate, no matter how the national rate is calculated as shown in Figure ES-1.

- The unadjusted U.S. EPA computed national recycling rate is computed using a waste stream model and includes certain commercial/industrial components and yard waste. These materials are often excluded in individual state and local recycling tonnages. Therefore Figure ES-1also includes an adjusted EPA rate, which excludes these tonnages, adjusting the rate downwards. Table ES-1 shows aggregated state specific recycling rates of waste-to-energy communities.

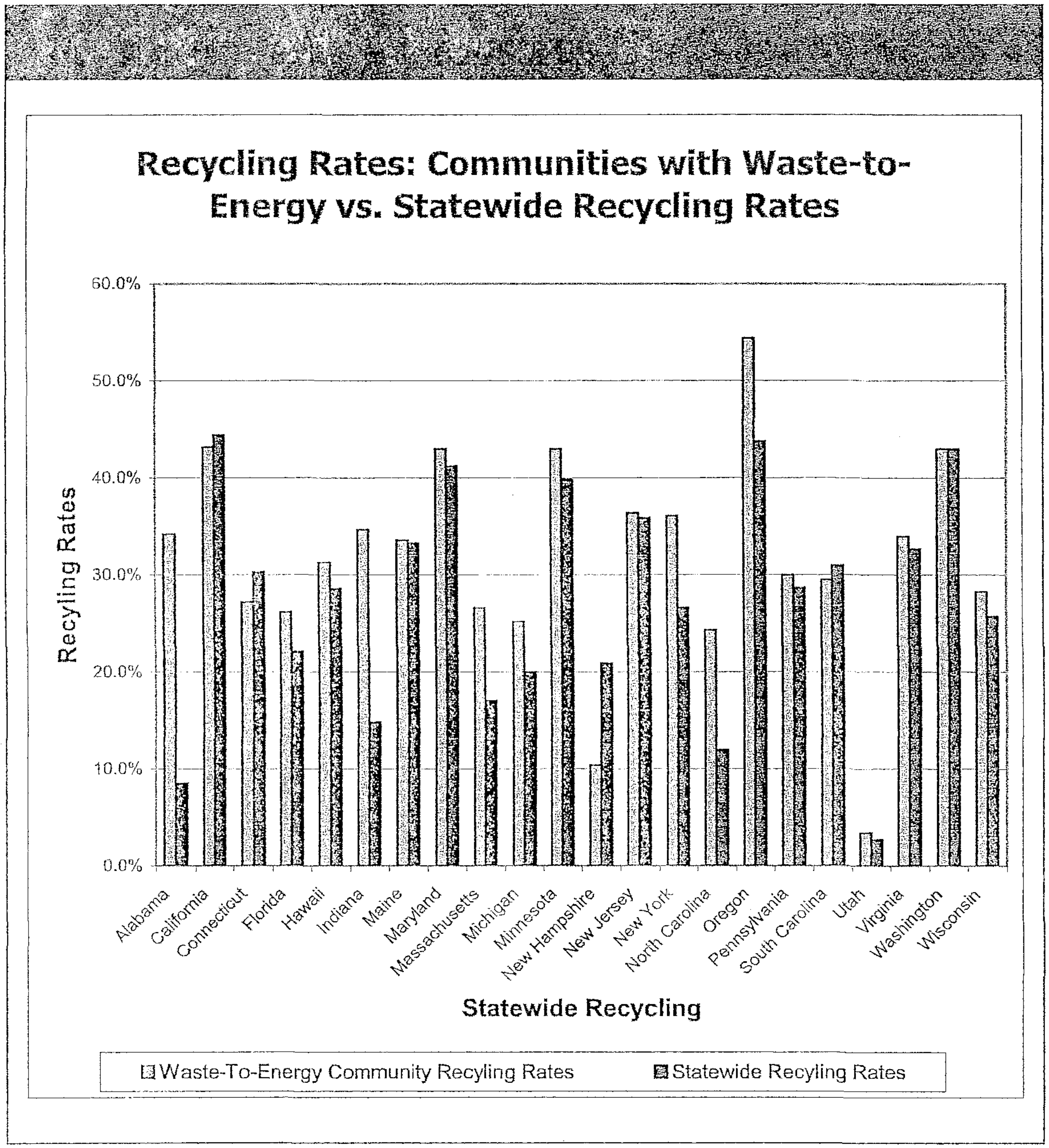
- Almost all communities using waste-to-energy provide their residents an opportunity to recycle and most have curbside collection of recyclables. In fact, some of these communities are leaders in the adoption of innovative recycling programs, such as single stream collection and food waste collection and composting. The coincident nature of recycling programs and waste-to-energy in each community is evidence that these two waste management strategies are compatible.

- Recycling rates in waste-to-energy communities closely track the statewide recycling rate in the state where they are located as shown in Figure ES-2. State solid waste policies and programs, **not** whether a community relies on waste-to-energy as a disposal option, appear to be a key determinant of local recycling behaviors and rates.


Comparison of Waste to Energy (WTE)
Communities' Recycling Rate with National Rates
Recycling Rate
34.0%
33.0%
32.0%
31.0%
30.0%
29.0%
28.0%
27.0%
26.0%
25.0%
33.2%
32.5%
28.6%
27.8%
Waste to Energy Communities
U.S. EPA
BioCycle
U.S. EPA Adjusted

State	Recycling Rate*	Number of Plants**
Alabama	34.2%	1
California	44.6%	3
Connecticut	27.2%	6
Florida	26.2%	11
Hawaii	31.3%	1
Indiana	34.7%	1
Maine	26.6%	4
Maryland	43.0%	3
Massachusetts	33.6%	7
Michigan	25.2%	1
Minnesota	43.1%	9
New Hampshire	10.4%	2
New Jersey	35.4%	5
New York	36.1%	10
North Carolina	24.3%	1
Oregon	54.4%	1
Pennsylvania	30.0%	6
South Carolina	29.5%	1
Utah	3.4%	1
Virginia	34.2%	5
Washington	43.0%	1
Wisconsin***	30.8%	2
TOTAL	**33.2%**	**82**

* New Hampshire, New York, North Carolina, Utah and Wisconsin have no commercial tonnages included due to lack of local data. In other States, commercial data is uneven. ** Three plants are excluded due to unavailability of recycling data. If the RDF and waste combustion facilities are separate, only RDF plant included. *** Data from two Minnesota counties sending waste to a waste-to-energy plant are included in Wisconsin data.



Recycling Rates: Communities with Waste-to-Energy vs. Statewide Recycling Rates
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Recyling Rates
Alabama
California
Connecticut
Florida
Hawaii
Indiana
Maine
Maryland
Massachusetts
Michigan
Minnesota
New Hampshire
New Jersey
New York
North Carolina
Oregon
Pennsylvania
South Carolina
Utah
Virginia
Washington
Wisconsin
Statewide Recycling
Waste-To-Energy Community Recyling Rates
Statewide Recyling Rates

Recycling and Waste-to-Energy
Are They Compatible?
2009 Update

Eileen Brettler Berenyi, PhD[1]

June 2009

[illegible]

Recycling is a cornerstone of solid waste policy across the United States. Residents, institutions and businesses in every urbanized area of the country, as well as in many rural areas, have the opportunity to recycle. In addition, localities in 25 states rely on waste-to-energy (WTE) as part of an integrated waste management strategy. These plants not only offer a secure disposal option, but also provide a locally based source of energy for scores of homes and public and private sector enterprises. In the current era of unstable energy and commodity prices, recycling and waste-to-energy are complementary policies, supporting sustainability and long-term resource conservation.

However, despite the exponential growth of residential and commercial recycling programs over the last decade in all areas of the country, critics of waste-to-energy have argued that a waste-to-energy plant in a given region thwarts or inhibits recycling efforts, since waste is needed to "feed" the plant. These critics argue that, due to the need for waste, there is little incentive for localities using these plants to invest in recycling, thereby diverting waste away from the WTE plant

This study examines the relationship between recycling and the use of waste-to-energy by a local government. If the critics are correct, then communities using waste-to-energy facilities should have lower recycling rates than those that do not and should perform below national averages with respect to recycling. To address this question, the study surveyed communities relying on waste-to-energy plants for disposal and also obtained statewide and national recycling data.

[illegible]

The purpose of the study is to determine whether there is a relationship between levels of recycling and reliance on waste-to-energy for disposal. In order to answer this question, one first has to select a measure of recycling and then, using this measure, compare specific communities using waste-to-energy to regional or state and national levels of recycling.

Thus, the study had three main steps:

1) Determine an appropriate measure of recycling to be applied on the state and local level;
2) Delineate communities using waste-to-energy and determine their level of recycling; and
3) Obtain statewide and national recycling levels for purposes of comparison.

---

[1] The author is president of Governmental Advisory Associates, Inc., Westport, CT. This work was partially funded by the Energy Recovery Council, Washington DC.

This study uses the recycling rate as a measure of the level of recycling in a community. There are various definitions of a recycling or recovery rate[2].

As used in this paper, the recycling rate encompasses only those materials found in municipal solid waste stream. It is defined as the percentage of tonnage recycled of the total tonnage of materials generated in the municipal waste stream. Because a measure of waste generation is often difficult to obtain, this study uses the sum of the tonnage disposed plus tonnage recycled or recovered as the "tons generated."

The recycling rate is calculated by totaling the tons of materials recycled across individual communities and dividing this total by the sum of tons of materials recycled plus tons disposed by these communities, i.e., recycling rate = tons recycled/ (tons disposed + tons recycled). The rates used in this paper are based on tonnages of materials that are actually recycled or disposed and do not as include credits for material reuse or reduction.[3]

There are two national recycling rates that are often used for purposes of comparison. They are the U.S. Environmental Protection Agency (EPA) rate and a rate that is periodically calculated by *BioCycle Magazine*, based on a nationwide survey of states.

The EPA Recovery (Recycling) Rate[4]

The EPA national rate is derived using a materials flow model and does not solely rely on direct tonnage measurements. It includes waste and recyclables from residential, commercial and institutional sources. Thus, for example, fiber generated and recovered from print companies or direct mail companies as well as corrugated cardboard recovered at the source and sent directly to fiber mills for reuse in the manufacturing process is captured in the EPA rate. Furthermore, the EPA rate includes metals found in appliances, furniture, tires, batteries as well as wood waste recycled from various sources. Finally, the EPA rate includes yard waste, food and other organics. Explicitly excluded from EPA calculations are construction and demolition (C&D) waste recovery and disposal. To the extent possible, this study follows the EPA definition of waste categories to be included in the calculation of a recycling rate.

However, because EPA is focused on deriving a national recycling rate from a materials flow perspective, it is able to derive total tonnages by calculating the production quantities of various materials found in the municipal waste stream and the amounts of these materials that are recovered. Dividing materials into durable and non-durable goods, EPA obtains much of its data from surveys of national manufacturing and trade associations specializing in particular materials, both in terms of production and recovery statistics.

---

[2] The two main national rates cited are those of the U.S. Environmental Protection Agency and one calculated by *BioCycle* Magazine. Individual states use variations of the site-specific method.

[3] Certain states in calculating recycling rates give tonnage or percentage credits for waste re-use, waste transformation, or the existence of certain types of recycling programs.

[4] U. S. Environmental Protection Agency, Solid Waste and Emergency Response. *Methodology for MSW Characterization Numbers* http://www.epa.gov/epaoswer/non-hw/muncpl/msw99.htm

This data is national in scope and cannot be disaggregated into state and local components. It provides a national benchmark, but includes data that is often not available to state and local governments. Many local governments do not track commercial or industrial recycling. Even if they do attempt to extract tonnage data from commercial enterprises, data collection may be incomplete or sporadic. In particular, business-to-business recycling is difficult for governmental agencies to measure. For example, corrugated cardboard may be separated at various retail or wholesale locations, picked up by a private hauler and sent directly to a port for export or to a mill, circumventing any processing facilities. Often the local jurisdiction will have no record of this type of recycling, despite the large amount of tonnage, such recycling involves.

In contrast to the EPA approach, when states and local governments calculate their data on waste generation, disposal and recycling, they rely on tonnage data obtained from disposal sites and other waste facilities within their states. They may not capture the breadth of materials included in the EPA analysis. According to the EPA data, the commercial sector has shown very high rates of recycling, particularly with respect to corrugated cardboard. However, state and local government reporting systems may not capture these recycling efforts. Thus, recycling tonnages may be underreported. In addition, many states do not separate wood wastes and bulky wastes from their construction and demolition waste category. While these recoverable waste streams are included in the national EPA recovery rate, they are not broken out on a state and local level. Finally, many states and localities are not yet tracking yard waste composting tonnage. Again, such tonnage may be missing from specific rates calculated within this report, further depressing the recycling rates given the high tonnages and rate of recovery of organics reported on a national basis.

Thus, the EPA approach to measurement of recycling cannot be applied to state and local programs. Rather, in order to obtain data on recycling, one must rely on site-specific tonnage data.

Adjusted EPA Recycling Rate

For the purposes of comparison, an attempt is made to adjust the EPA rate in order that it more closely matches the recycling data that is collected by state and local solid waste agencies. Two adjustments to the rate are made. First, the recovered tonnage represented by non-retail corrugated cardboard, included in the EPA rate, is reduced. Second the recovered tonnage of durable metals, found in commercial/industrial streams is reduced. The remaining tonnages are totaled and divided by EPA's calculated waste generation number and an adjusted recovery rate is derived. Using this approach, the adjusted EPA rate is 27.8%.

More specifically, according to the EPA data, approximately 44 million tons out of the 81.8 million tons recovered in 2006 or 54% is made up of paper and paperboard.[5] Of that 44 million tons of fiber products, about 23 million tons are corrugated boxes.[6] A good portion of these corrugated boxes go back to manufacturers or fiber mills in a closed loop process, bypassing any state of local record keeping. According to the American Forest and Paper Association, which assists the U.S. EPA in the compilation of these paper and paperboard statistics, about

[5] U.S. Environmental Protection Agency. "MSW Generation, Recycling, and Disposal in the U.S.: Facts and Figures. http://www.epa.gov/osw/nonhaz/municipal/pubs/msw06.pdf., p.6

[6] U.S. Environmental Protection Agency: "Municipal Waste Characterization-2006 Report: 2006 Data Tables. http://www.epa.gov/osw/nonhaz/municipal/pubs/06data.pdf. Table 4.

75% of the corrugated cardboard produced in the United States is directly recycled at the mill, factory, wholesale level or retail level.[7] Thus, only 25% of the recycled corrugated would be managed through the municipal waste stream. Using the more conservative estimate that 50% of the corrugated cardboard tonnage reported by EPA is recovered as part of the municipal waste system, EPA recovered tonnage totals are reduced accordingly and 11.3 million tons are subtracted from the total amount recovered. In addition, 10% of the tons of ferrous and non-ferrous metals found in durable goods are also subtracted from the EPA recovered totals, since it is conservatively estimated that this percentage represents waste that is recovered from industrial or commercial sources and normally outside the municipal waste stream. In making these two modifications, the EPA categories more closely match those that are reported by state and local governments. The new adjusted rate provides a benchmark, which more closely tracks the waste under state and local record keeping management.

The BioCycle Recycling Rate[8]

A second national recycling rate that is periodically published is the rate compiled by *BioCycle* Magazine. Calculations are based on specific state level data. *BioCycle's* rate is developed from responses to surveys sent to state level officials, in which aggregated statewide data is obtained The national rate is calculated by summing the waste generation and recycling tonnage, respectively, for all states. *BioCycle* also focuses only on the municipal waste stream, excluding C&D waste. However, in contrast to the EPA analysis, the *BioCycle* survey does not rely on production data, but uses state level waste stream and recycling data.

This study follows the *BioCycle* approach and uses actual state and local waste disposal and recycling tonnage. The specifics of the methodology are discussed below.

[illegible]

In this study, the local and statewide recycling rates are derived from actual tonnages provided by governmental entities, private waste hauling firms and recycling processors. The array of local communities relying on waste-to-energy is drawn from the author's own database of waste-to-energy facilities, as well as state and local reports.[9]

Community Specific Data[10]

This study goes beyond other surveys in that it includes specific disposal and recycling tonnage data for those localities, counties or districts which rely on waste-to-energy for disposal for all or a portion of their municipal waste stream. All municipal waste disposal tonnage is included for each community. Similar to disposal tonnages, actual recycling tonnages is obtained on a community-level basis. Based on disposal and recycling amounts, a recycling rate is calculated for each locality. Further, tonnage is aggregated to calculate a recycling rate for the group of localities or counties using a particular waste-to-energy facility. In the case, where a state has

---

[7] Interview, Stan Lancey, Chief Economist, American Forest and Paper Association, September 2008.

[8] Ljupka Arsova, Rob van Haaren, Nora Goldstein, Scott M. Kaufman, Nickolas J. Themelis. "The State of Garbage in America". *BioCycle*, December 2008, vol. 49, no.12, p.22.

[9] Eileen Brettler Berenyi, Municipal Waste Combustion in the United States: 2005-2006 Yearbook and Directory (Westport, CT: Governmental Advisory Associates, Inc. 2006). Two facilities in temporary closure at time of study are not included. Specific reports for each state are listed in the reference section.

[10] All data is from 2006 as this is the last year for which the *BioCycle* data is available. If 2006 data did not exist, tonnages from the most recent year were used.

multiple waste-to-energy facilities, disposal and recycling tonnages are aggregated to a state level.

In each case, tonnage is obtained directly from the state, county, district or locality. State and local recycling reports as well annual financial reports or budgets are used. Key state and local personnel were contacted and interviewed to gain access to unpublished local level data or to secure specific explanations of existing information. Additional sources, including reports and interviews with private recycling firms and data from recycling processing facilities are used. In conjunction with state and local solid waste officials, efforts are made to follow the EPA definition in terms of types of wastes included. Finally, using interviews, published reports, or web sites, the study notes the types of recycling programs in each area, i.e. curbside collection of recyclables, yard waste collection, or recycling center access.

Statewide Data

Statewide data is obtained largely from published annual reports provided by state agencies. Attention is paid to ensure that similar waste stream definitions are used across all states. In some cases, multiple sources of data are used in order to segregate waste stream categories to be included in calculations. As with the local level data, there is great variation in the coverage of statewide data. In one case, no current state information could be found, and the published *BioCycle* data was used. In almost every state, data is aggregated from annual reports submitted by local reporting units.

Overall, communities using 82 waste-to-energy plants in 22 states were surveyed. In total, disposal and recycling data were obtained from a total of 567 municipal authorities, including 72 counties or solid waste districts and 495 cities, towns and villages. Total population covered by the study was 41.5 million people. Two facilities in Michigan and a facility in Iowa are excluded from the study due to insufficient data.

Table 1 breaks down number of plants, number of local governments serviced by these plants and populations included in the study by state. Efforts were made to include all communities using a plant, but in certain cases communities were excluded due to insufficient data. As can be seen, Florida, New York, Pennsylvania and Connecticut are states that have made a significant commitment to waste-to-energy as a disposal alternative. However, even in areas where there is a waste-to-energy facility, landfills are relied upon to handle excess waste or as a back-up disposal option. Thus in very few instances do localities represented rely entirely on waste-to-energy for disposal.

TABLE 1
[illegible] Facilities, Local Government and Population [illegible]

State	Number of WTE Plants Included*	Included Localities with WTE facility	Population of localities included in survey
Alabama	1	2	298,192
California	3	5	2,082,069
Connecticut	6	184	3,081,621
Florida	11	10	8,494,222
Hawaii	1	1	899,593
Indiana	1	1	860,454
Maine	4	58	630,669
Maryland	3	4	1,952,955
Massachusetts	7	158	3,239,216
Michigan	1	1	596,666
Minnesota	9	27	3,376,057
New Hampshire	2	34	199,312
New Jersey	5	5	2,182,216
New York	10	14	4,275,024
North Carolina	1	2	179,553
Oregon	1	1	305,265
Pennsylvania	6	7	4,869,512
South Carolina	1	1	331,917
Utah	1	1	268,187
Virginia	5	13	2,659,944
Washington	1	1	440,706
Wisconsin**	2	35	250,275
TOTAL	**82**	**567**	**41,473,625**

* Three plants are excluded due to unavailability of recycling data. If the RDF and waste combustion facilities are separate, only RDF plant included. ** Data from two Minnesota counties sending waste to a waste-to-energy plant are included in Wisconsin data.

[illegible] WTE Community Recycling Rates [illegible]

For WTE communities, recycling rates and the tonnage upon which they are based are aggregated to state level as shown in Table 2. The overall recycling rate for waste-to-energy communities shown at the bottom of the table is 33.2%. However, it must be reiterated that depending on the state or locality, tonnages shown on Table 2 may not include any commercial recycling or yard waste composting. Based on national averages, both of these types of recycling constitute large quantities with high rates of recovery and would certainly add to overall recycling rates. With these amounts included in all local and state calculations, overall recycling rates in the communities shown might rise as much as five to seven percentage points.

State	Recycling Rate*	Tons Recycled	MSW Disposed	Number of Plants **
Alabama	34.2%	65,100	125,000	1
California	44.6%	1,694,873	2,107,444	3
Connecticut	27.2%	907,213	2,422,708	6
Florida	26.2%	3,184,586	8,978,107	11
Hawaii	31.3%	415,372	910,817	1
Indiana	34.7%	163,450	308,199	1
Maine	26.6%	96,788	266,984	4
Maryland	43.0%	1,614,668	2,139,967	3
Massachusetts	33.6%	1,607,923	3,184,527	7
Michigan	25.2%	245,360	730,000	1
Minnesota	43.1%	1,685,268	2,220,804	9
New Hampshire	10.4%	18,068	154,974	2
New Jersey	35.4%	922,143	1,682,033	5
New York	36.1%	1,874,923	3,185,184	10
North Carolina	24.3%	27,629	86,100	1
Oregon	54.4%	259,438	477,137	1
Pennsylvania	30.0%	1,863,423	4,348,366	6
South Carolina	29.5%	132,008	314,812	1
Utah	3.4%	8,917	265,138	1
Virginia	34.2%	1,119,532	2,150,031	5
Washington	43.0%	258,810	340,533	1
Wisconsin***	30.8%	35,436	79,494	2
TOTAL	**33.2%**	**18,200,927**	**36,611,984**	**82**

* New Hampshire, New York, North Carolina, Utah and Wisconsin have no commercial tonnages included due to lack of local data. In other states, commercial data is uneven. ** Three plants are excluded due to unavailability of recycling data. If the RDF and waste combustion facility are separate, only RDF plant included. *** Data from two Minnesota counties sending waste to waste-to-energy plant included in Wisconsin data.

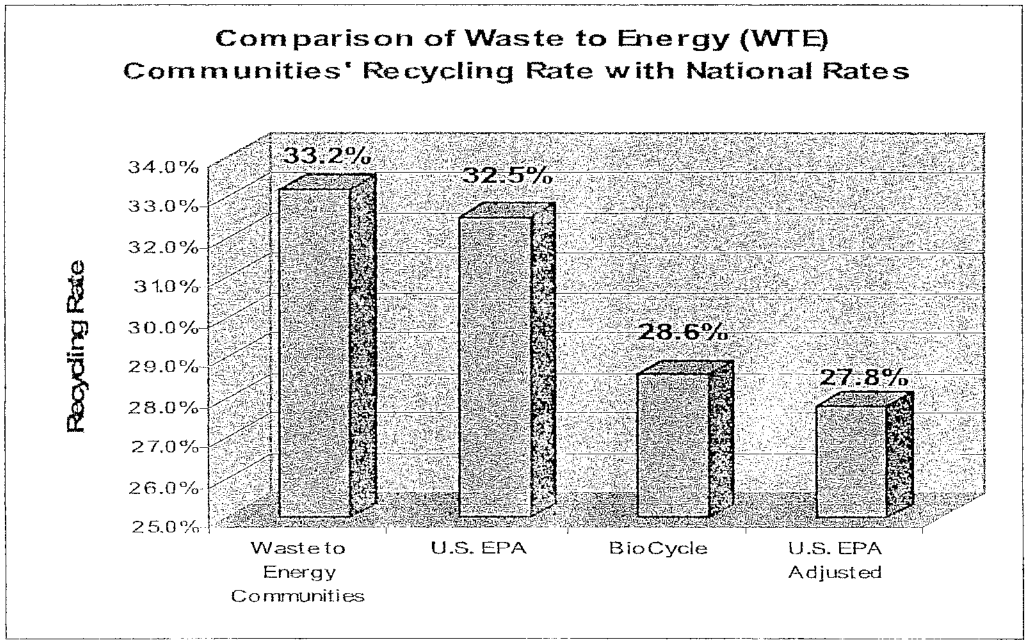


Figure 1 graphically compares the recycling percentage of WTE communities to the U. S. EPA's unadjusted and adjusted nationwide recycling rate as well as to the *BioCycle's measure*. One observes that the WTE communities' recycling rate exceeds both the EPA and *BioCycle* national percentages, which are 32.5% and 28.6% respectively. While the unadjusted EPA rate is provided for comparison purposes, the adjusted EPA rate, also shown on the figure, more closely reflects the municipal waste stream. Interestingly, at 27.8%, it closely corresponds to the rate reported by *BioCycle*, using state based tonnage. However the *BioCycle* rate remains the more appropriate measure, since it is obtained using a similar methodology to that employed in this study.

Waste-to-energy communities have a recycling rate which exceeds the EPA rate despite the fact that the rate shown for these communities does not include significant commercial recycling tonnages. **Downwardly adjusting the EPA rate to account for commercial/industrial tonnage, one observes that WTE communities have an average rate that is 5.4 percentage points greater than the EPA rate.** Similarly, waste-to-energy communities have an aggregated recycling rate nearly five percentage points above the national average reported by *BioCycle*. On an aggregate basis communities relying on waste-to-energy are recycling at higher rates than the national averages, no matter how these averages are calculated. In addition, on a state-by-state basis many individual communities are recycling at rates well above the national averages.

[illegible]

In order to further examine the question of how the existence of a waste-to-energy plant in a given region may impact levels of recycling, a statewide recycling rate for all communities in the state was calculated for those states in which the waste-to-energy facilities are located. If waste-to-energy does depress recycling rates, than one would expect that states which have a high reliance on waste-to-energy would have lower recycling rates than those states which have lower percentages of their MSW disposed by communities using waste-to-energy plants.

Table 3 shows the percentage of statewide MSW disposed by the waste-to-energy communities within the state as well as the statewide recycling rate for all communities across the state. States are listed in order of their statewide recycling rate with the states having the highest recycling rates at the top, and those with the lowest at the bottom. If reliance on waste-to-energy has an impact on recycling rates, than the states near the top of the list, which have the highest recycling rates, should have the lowest percentage of the waste going to waste-to-energy facilities, while those states towards the bottom of the list with lower recycling rates, should have a higher percentage of their waste disposed by communities using waste-to-energy. A quick perusal of the table shows that this is not the case. Both Maryland and Minnesota have over 40% of their MSW disposed by communities relying on waste-to-energy, but also have among the highest recycling rates of the 22 states. Similarly, states with minimal reliance on waste-to-energy have low recycling rates.

State	% State MSW Disposal Disposed by WTE Communities in Study*	Statewide Recycling Rate for All Communities
California	4.5%	44.4%
Oregon	14.8%	43.8%
Washington	6.5%	43.0%
Maryland	47.8%	41.2%
Minnesota	54.2%	39.8%
New Jersey	23.7%	35.9%
Indiana	3.9%	35.0%
Massachusetts	52.9%	33.3%
Virginia	35.8%	32.7%
South Carolina	9.1%	31.0%
Connecticut	85.0%	30.3%
Pennsylvania	43.3%	28.7%
New York	31.9%	26.6%

Wisconsin	1.6%	25.7%
Hawaii	72.9%	23.4%
Florida	36.0%	22.1%
New Hampshire	24.7%	20.9%
Michigan	6.1%	20.0%
Maine	38.4%	17.1%
Utah	11.3%	14.2%
North Carolina	1.0%	12.0%
Alabama	2.0%	8.5%

*Includes all MSW disposed by selected communities.

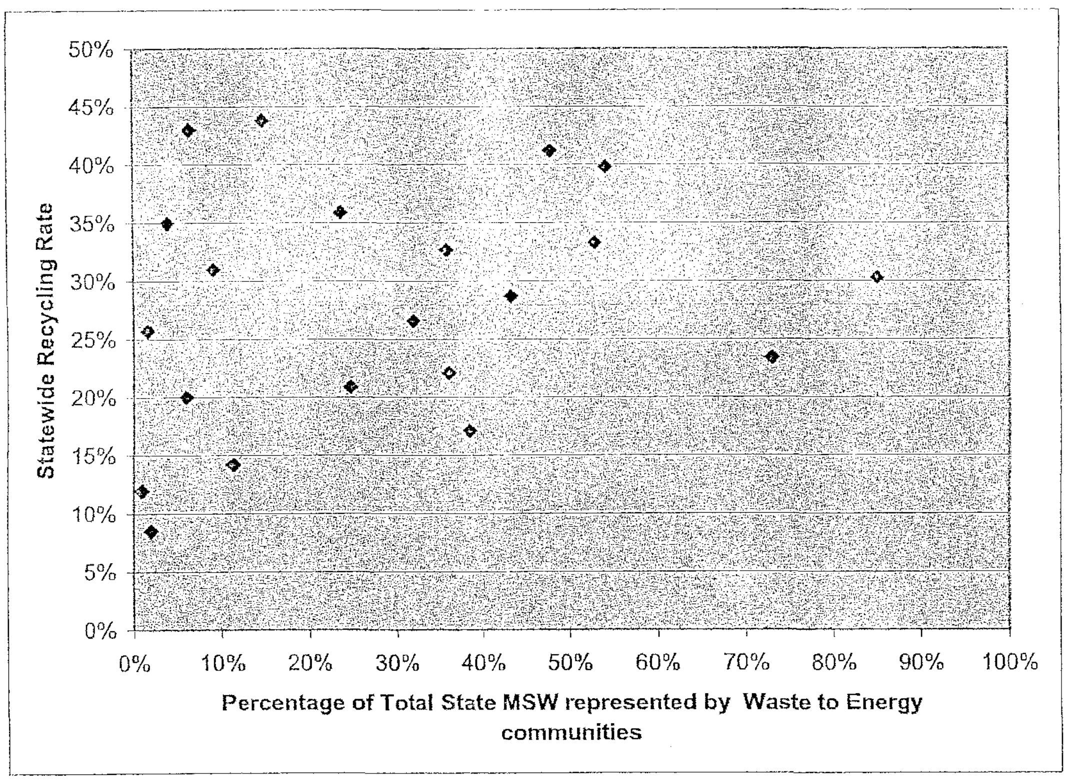


Figure 2 graphs the same data that is shown in tabular form. The percentages along the bottom of the table depict the percentages of state MSW handled by waste-to-energy communities within the state. The vertical percentages are the statewide recycling rates. Each point is the state recycling rate and the percentage of statewide MSW represented by waste-to-energy communities in the state. If critics of waste-to-energy are correct, than states with high recycling rates should be found in the upper left of the graph, which represent states that rely on little or no WTE for disposal, while states with low recycling rates should be found in the lower right portion of the graph, which represents states that dispose of a high percentage of their waste through WTE. The data should be falling along a line sloping downward from the upper left to the lower right of the figure. The information simply does not bear out this conclusion. As one moves horizontally across the graph, there are various recycling rates represented in each category, with little discernible pattern. Reliance on waste-to-energy appears to have no impact on statewide recycling behavior. In fact, some of the states with the lowest level of recycling also have only a small portion of their waste going to WTE facilities.

While reliance on waste-to-energy has no impact on the level of recycling within a state, are there any patterns in recycling behavior which do emerge among communities which rely on waste-to-energy? One method by which to address the question is to compare recycling rates of communities using waste-to-energy in a particular state with the aggregate statewide recycling rate of communities across the state. Again if critics are correct, than recycling rates for communities relying on waste-to-energy within a state should be below the statewide rate, which represents the aggregate of all communities within the state. Figure 3 graphs this comparison. This figure points to the conclusion that with few exceptions, recycling rates in waste-to-energy communities are similar to the statewide rate.

It appears that the implementation of statewide recycling policies is closely associated with local recycling levels, whether or not these communities are sending their waste to a waste-to-energy facility or to a landfill or transfer station. Waste to energy is one component of an integrated waste management strategy. Statewide recycling mandates, grant and loan programs, landfill diversion regulations appear to influence all communities, no matter what mode of waste disposal is used.

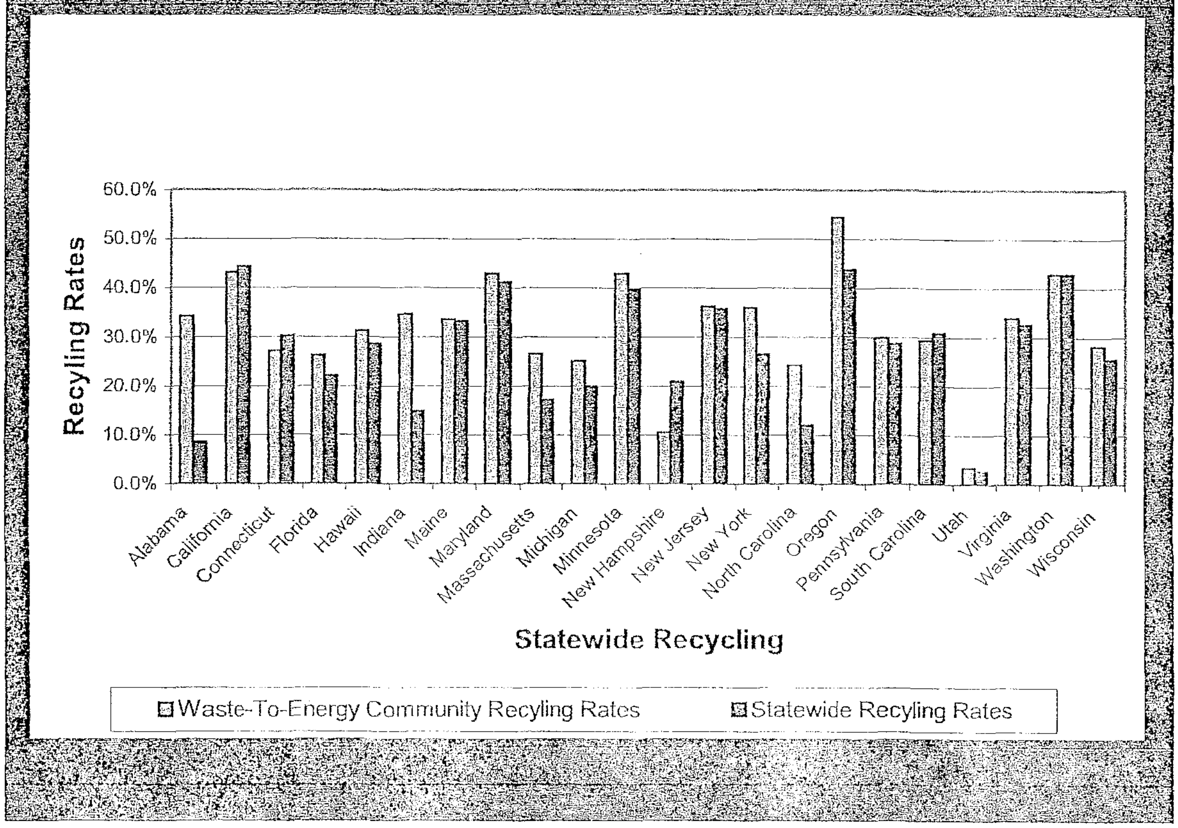


FIGURE [illegible]
Recycling Rates: Communities [illegible] Rates

[illegible]

With the exception of certain small communities included in this study, all localities have access to recycling programs. Some of these programs may be voluntary, provided by public sector, non–profit agencies, or the private sector by subscription. Even if curbside collection is voluntary or unavailable, the local government provides drop off locations for residents and businesses. Other communities in the sample have been leaders in recycling and have been early adopters of curbside collection and most recently, single stream recycling. These efforts have been undertaken in conjunction with state policies, which have mandated landfill diversion rates, implemented landfill bans on certain materials, and provided recycling incentive programs through grants, loans and technical assistance.

Finally, the extent to which recycling is an integrated part of the solid waste program in certain of these communities can be demonstrated by the fact twenty-four of the 82 facilities or about 30% have a materials recovery facility (MRF), which is co-located with the waste-to-energy facility or owned by a public entity, which is also responsible for the waste-to-energy facility. It is doubtful that a local government, district or authority would invest in the construction of a processing facility for recyclables, if there was a lack of material to process.

On a nationwide basis, waste-to-energy does not have an adverse impact on recycle rates. The most influential factors that affect local recycling rates appear to be state policies and the proactive stance of a municipality. Communities using waste-to-energy have recycling rates that **are five percentage points or more** above the national average, whether these communities are compared to adjusted EPA or *BioCycle* data.

Therefore, it can be concluded that recycling and waste-to-energy are compatible waste management strategies. They form part of a successful, integrated waste management approach in many communities across the United States.

REFERENCES

GENERAL REPORTS

- Arsova, Ljupka, Rob van Haaren, Noral Goldstein, Scott M. Kaufman, Nickolas J. Themelis. "The State of Garbage in America", **BioCycle,** December 2008, vol. 49, no.12, p.22.
- Berenyi, Eileen Brettler. **Materials Recycling and Processing in the United States: 2007-2008 Yearbook and Directory, Fifth Edition** (Westport CT: Governmental Advisory Associates, Inc., 2008).
- Berenyi, Eileen Brettler. **Municipal Waste Combustion in the United States: 2005-2006 Yearbook and Directory, Eighth Edition** (Westport CT: Governmental Advisory Associates, Inc., 2006).
- Kiser, Jonathan V. L. *Recycling and Waste-to-Energy: The Ongoing Compatibility Success Story.* **MSW Management,** May/June 2003.
- Simmons, Phil, Nora Goldstein, Scott M. Kaufman, Nickolas J. Themelis, and James Thompson, Jr. "The State of Garbage in America". **BioCycle,** April 2006, Vol.47, No. 4, p.26
- U. S. Environmental Protection Agency, Solid Waste and Emergency Response. **Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2006.** November 2007. http://www.epa.gov/epaoswer/non-hw/muncpl/msw99.htm
- U. S. Environmental Protection Agency, Solid Waste and Emergency Response. *Methodology for MSW Characterization Numbers.* http://www.epa.gov/epaoswer/non-hw/muncpl/msw99.htm
- U. S. Environmental Protection Agency, Solid Waste and Emergency Response. *2006 MSW Characterization Data Tables.* http://www.epa.gov/epaoswer/non-hw/muncpl/msw99.htm

STATE –BASED REFERENCES

References are listed alphabetically by state and include reports and interviews

ALABAMA

- Interview with Dixie Bray, Recycling Coordinator, Huntsville Solid Waste Management District, 256-880-6054
- **Materials Recycling and Processing in the United States: 2007-2008 Yearbook and Directory** (Westport CT: Governmental Advisory Associates, Inc. 2008). Fiber tonnages for Huntsville and Madison County.
- Statewide data from "The State of Garbage in America" **BioCycle,** vol. 47, no. 4 p. 26

CALIFORNIA

- California Integrated Waste Management Board. Statewide Profile for the State of California

- California Integrated Waste Management Board. Jurisdiction Calculation to Establish 50% Per Capita Equivalent

- California Integrated Waste Management Board. **Targeted Statewide Waste Characterization Study: Detailed Characterization of Construction and Demolition Waste,** Cascadia Consulting, June 2006.

- Carla Collado, "City Puts Emphasis on Many Methods of Recycling" *Grunion Gazette*, May 12, 2008. City of Long Beach recycling tonnages.

- City of Inglewood **Draft Solid Waste Report and Plan of Action, Fiscal Year 2003-2004**

- City of Los Angeles **Solid Waste Integrated Resource Plan Fact Sheet—2006**

- City of Long Beach **Annual Budget --2006-2007.**

- City of Modesto- **2006-2007 Hauler Quarterly Recycling Reports**

- City of Modesto, Interview Beverly McCullough, Recycling Coordinator, City of Modesto, 209-577-5494

- County Sanitation Districts of Los Angeles County**, Weighmaster Automated Transaction System, AB939 Report, 5/23/2008.** Data for Commerce Waste to Energy Facility.

- Norcal Waste Systems of San Mateo County, *Presentation to the South Bayside Waste Management Authority, Facility Operation Services,* May 22, 2008. Tonnage data on recycling and waste diversion.

- Stanislaus County, Department of Environmental Resources. **Diversion Tonnages by Material (Includes Transformation Credit).**

- Stanislaus County, Department of Environmental Resources. Interview with Ron DeLong Solid Waste Manager, Stanislaus County Environmental Resources 209-525-6781.

<u>**CONNECTICUT**</u>

- Bristol Resource Recovery Facility Operating Committee. **Annual Report, 2006**

- Connecticut Department of Environmental Protection. **Tons of MSW Recycled in FY2006 by CT Municipalities** – Based on data reported to the CT DEP by the Municipalities in Their FY2006 Annual Municipal Recycling Reports as Entered in the CT DEP Solid Waste Database as of 6/20/2008.

- Connecticut Department of Environmental Protection. **Town by Town MSW Recyclables—Summary Report: Recycling Data Based on Municipal Annual Recycling Reports**, Submitted to CT DEP. MSW Disposal Data Based on Reports Submitted to CT DEP by Solid Waste Facilities

- Connecticut Department of Environmental Protection. **State Solid Waste Management Plan, Amended December 2006.**

- Interview with Bill Petrone, 123 Murphy Road Recycling, 860-746-3200. Commercial recycling tonnages.

- Interview with Judy Belaval, Connecticut Department of Environmental Protection. 860-424-3237.

- **Materials Recycling and Processing in the United States: 2007-2008 Yearbook and Directory** (Westport CT: Governmental Advisory Associates, Inc. 2008). Commercial Fiber tonnages.

FLORIDA

- Florida Department of Environmental Protection. **2006 Annual Solid Waste Report-Appendix B, Tables 3B, 4B, 5B-1, 5B-2.**
- Interview, Suzanne Boroff, Florida Department of Environmental Protection, Recycling Program, 850-245-8718.
- Interview, Greg Grotecloss, Supervising Engineer, McKay Bay Refuse to Energy Facility, 813-242-5408.
- Interview, Nina Stokes, Recycling Coordinator, City of Tampa. 813-348-6515.

HAWAII

- City and County of Honolulu, Department of Environmental Services. Oahu Recycling 2006 by Material Tons by Material Type. http://envhonolulu.org/solid_waste/
- R.W. Beck. **Final Report: 2006 Waste Characterization Study, City and County of Honolulu, April 2007.**
- State of Hawaii, Department of Health, Office of Solid Waste Management. **Report to the Twenty-Fourth Legislature, State of Hawaii 2008, Solid Waste Management.** December 2007.

INDIANA

- City of Indianapolis, Department of Public Works, *Request for Proposals for Solid Waste Receipt, Processing and Disposal for the City of Indianapolis*, October 2007.
- Interview with Cal Davidson, White River Recycling, 317-539-2024, for commercial recycling tonnages in Marion County
- Interview with Michelle Weddle, Indiana Department of Environmental Management, Office of Land Quality. Solid Waste Facility Reports, 317-233-4624.
- Interview with Lisa Laflin, Recycling Coordinator, City of Indianapolis, 317-327-4664
- Interview with Mike Laverty, Operations Manager, Republic Services, 317-716-0677
- Indiana Department of Environmental Management, Office of Land Quality. **Solid Waste-2006 Solid Waste Facilities Annual Report**
- Indiana Department of Environmental Management, Office of Land Quality. **2006 Summary of Indiana Solid Waste Facility Profiles** – for recycling tonnages
- **Materials Recycling and Processing in the United States: 2007-2008 Yearbook and Directory** (Westport CT: Governmental Advisory Associates, Inc. 2008). Commercial fiber tonnages.

MAINE

- Ecomaine. RWS Neighborhood Recycling Year to Date Totals for July 1, 2005 through June 30, 2006.
- Maine State Planning Office. Interview with Sam Morris, Office of Recycling, 207-287-8054,
- Maine State Planning Office. **2006 Bulky Waste & Recycling Per Person in Maine.**
- Maine State Planning Office. **2006 Commercial Waste & Recycling in Maine**
- Maine State Planning Office. **2006 Recycling Association Town Summary in Maine**
- Maine State Planning Office. **Solid Waste Disposal Capacity Report.** Prepared for the Joint Standing Committee on Natural Resources of the 123rd Legislature, March 2007.

MARYLAND

- Maryland Department of the Environment. **2007 Maryland Waste Diversion Activities Report.** Recycling and Operations Program, Waste Management Administration, December 2007.

MASSACHUSETTS

- Commonwealth of Massachusetts, Executive Office of Environmental Affairs, Department of Environmental Protection. **2006 Solid Waste Data Update on the *Beyond 2000 Solid Waste Master Plan.*** February 2008.
- Commonwealth of Massachusetts, Executive Office of Environmental Affairs, Department of Environmental Protection. *How MassDEP Calculates Municipal Residential Recycling Rates*, July 2007.
- Commonwealth of Massachusetts, Executive Office of Environmental Affairs, Department of Environmental Protection. **Solid Waste Master Plan: 2006 Revision**, June 2006.
- Commonwealth of Massachusetts, Executive Office of Environmental Affairs, Department of Environmental Protection. *Total Tons Disposed, Recycled, Composted, Generated and Diverted by Municipality.*
- Commonwealth of Massachusetts, Office of the Secretary of the Commonwealth, Citizen Information Service. *A Listing of Counties and the Cities and Towns Within.*

MICHIGAN

- Kent County Department of Public Works, Interview with Dennis Kmiecik, Solid Waste Division Director, 616-336-4369.
- **Materials Recycling and Processing in the United States: 2007-2008 Yearbook and Directory** (Westport CT: Governmental Advisory Associates, Inc. 2008).

- Michigan Department of Environmental Quality. *Recommendations for Improving and Expanding Recycling In Michigan.* February 22, 2005.
- Michigan Department of Environmental Quality. **Report of Solid Waste Landfilled in Michigan, October 1, 2006—September 30, 2007.** January 31, 2008.
- Michigan Recycling Partnership. **Expanding Recycling in Michigan.** April 2006.

MINNESOTA

- Minnesota Pollution Control Agency. **2006 MSW and Recycling Data.** By Individual Counties.
- Minnesota Pollution Control Agency. **2006 Solid Waste Policy Report.** February 2008.
- Minnesota Pollution Control Agency. **Report on 2006 SCORE Programs: A Summary of Waste Management in Minnesota.** December 2007.

NEW HAMPSHIRE

- Concord Regional Solid Waste/Resource Recovery Cooperative. Delivered Tonnages by Locality.
- New Hampshire Department of Environmental Services. *Beyond the Numbers—Analyzing State & Federal Recycling Rate Methodology.*
- New Hampshire Department of Environmental Services. **Solid Waste Report to the Legislature 2006.** September 2006.

NEW JERSEY

- Department of Environmental Protection, Division of Solid and Hazardous Wastes. *2006 Generation, Disposal and Recycling Rates by County in New Jersey.* May 20, 2008.

NEW YORK

- County of Oswego. **2008 Budget Department of Solid Waste.**
- Interview with William Grimmke, Director Department of Public Works, Washington County, 518-746-2445.
- Interview, Gus Ribeiro, Environmental Program Specialist, Bureau of Waste Reduction and Recycling, New York State Department of Environmental Conservation, 518-402-8705.
- Interview with Frank Visser, Director of Solid Waste Programs, Oswego County Department of Solid Waste, 315-591-9280
- New York State, Department of Environmental Conservation, Bureau of Waste Reduction and Recycling. *Recycling Calculations by Planning Unit - 2005 and 2006, unpublished.*
- Onondaga County Resource Recovery Agency. **Annual Report on Recyclables Recovered 2007.**

- Town of Huntington. *2007 Solid Waste Report.* Audrey Gallo, 631-754-5794.

NORTH CAROLINA

- City of Wilmington. **Departmental Strategic Business Plans, FY 2006-2007.** Department of Public Utilities, Performance Measures.
- Interview with Ray Church, Director Department of Environmental Management, New Hanover County, 910-798-4400.
- New Hanover County, Department of Environmental Management. Recycling and Solid Waste, Year to Date of Recyclables Collected. www.nhcgov.com
- State of North Carolina, Department of Environment and Environmental Resources. **Solid Waste Management Annual Report July 1, 2005-June 30, 2006.**

OREGON

- Marion County Environmental Services Division, Department of Public Works. **Marion County Solid Waste Management Plan Update 2008.** March 2008.
- State of Oregon Department of Environmental Quality, Land Quality Division. **2006 Oregon Material Recovery and Waste Generation Rates Report.** November 2007.

PENNSYLVANIA

- Dauphin County, Department of Solid Waste Management and Recycling. **2006 Recycling Report.**
- Lancaster County Solid Waste Management Authority. *http://www.lcswma.org*
- State of Pennsylvania, Department of Environmental Protection, Bureau of Land Recycling and Waste Management. *County Recycling by Materials 1989 to 2005. Unpublished data.*
- State of Pennsylvania, Department of Environmental Protection, Bureau of Land Recycling and Waste Management. **County Waste Destinations in Tons of Waste for Year 2005.**

SOUTH CAROLINA

- Department of Health and Environmental Control. **South Carolina Solid Waste Management Annual Report. Fiscal Year 2007.**

UTAH

- State of Utah, Department of Environmental Quality, Division of Solid and Hazardous Waste. **Disposal Facilities, Recyclers and Disposal Volumes.**
- Wasatch Integrated Waste Management District. *Does Davis County Recycle?* March 5, 2007

VIRGINIA

- Department of Environmental Quality. **The Virginia Annual Recycling Rate Report, Calendar 2006 Summary.** November 2007.
- Interview with Steve Coe, State of Virginia Department of Environmental Quality, 804-698-4020. Specific breakdown of tonnage numbers.

WASHINGTON

- Spokane Regional Solid Waste System. **2007 Annual Report**, April 21, 2008.
- State of Washington, Department of Ecology. **Solid Waste in Washington State—16th Annual Status Report.** December 2007.

WISCONSIN

- Interview with Cynthia Moore, Recycling Program Coordinator, Recycling and Solid Waste Section, Bureau of Waste & Materials Management, Wisconsin Department of Natural Resources, 608-267-7550.
- Interview with Brian Tippetts, Director LaCrosse Disposal System, 608-785-6161
- Interview with Al Zeltner, Barron County Waste to Energy Facility. 715-357-6566.
- LaCrosse Disposal System. **On Solid Ground: Annual Report 2007.**
- Wisconsin Department of Natural Resources, Recycling and Solid Waste Section, Bureau of Waste & Materials Management. "*Annual Recycling Tons: 2003-2006 by County and Responsible Unit.*" Unpublished data.
- Wisconsin Department of Natural Resources, Recycling and Solid Waste Section, Bureau of Waste & Materials Management. "*MSW Tonnage by Responsible Unit.*" Unpublished data.

EXHIBIT RB-6

MSW Management
The Journal for Municipal Solid Waste Professionals

October 18th, 2011 7:32am PST

Time for a Harder Look at Composting?

Posted By John Trotti 1 Comment

For those who have not heard of the deaths of two young men at a Lamont, CA, composting facility, first let me share the story as reported by John Cox, staff writer for *The Bakersfield Californian.*

Family says Arvin brothers killed, injured at composting site protected only by painters' masks

As federal officials opened an investigation into Wednesday's [October 12] death of a 16-year-old at a Lamont composting facility, family members complained that the young man and his injured brother had been given only flimsy painters' masks to protect them from deadly fumes.

A spokesman for the U.S. Department of Labor said Thursday that investigators began looking into the accident because the person who died, Armando Ramirez, was a minor. Cal-OSHA is also investigating the accident.

Authorities said Ramirez and his 22-year-old brother, Eladio Ramirez, were overcome by fumes inside an 8-foot-deep drainage tunnel at Community Recycling and Resource Co. and taken to Kern Medical Center, where Armando was pronounced dead. Family members said Eladio was left brain dead. [Subsequently, Eladio died on October 14 after he was removed from life support.]

County officials said they detected a high concentration of hydrogen sulfide inside the tunnel. Sour gas, as it is more commonly known, is a byproduct of the composting product that attacks the central nervous system.

Relatives said the brothers had complained about strong odors at the facility. They said painters' masks and rubber boots were the only protection offered to them.

Family members said the two brothers had worked for several months at the facility irrigating compost piles, though a Cal-OSHA spokeswoman said the older brother was employed by A & B Harvesting Inc.

Neither brother mentioned any danger associated with their jobs, she said, but they did speak of a "strong odor" at the job site. "They said from a far distance it stank, like it was toxic," she said in Spanish.

Erika Monterroza, a spokeswoman for Cal-OSHA, said the Lamont facility had no record of workplace violations, though a county official said the plant had a history of falling afoul of land-use rules.

Monterroza said the younger of the two brothers was cleaning the inside of the drain pipe when he was overcome by fumes. As a matter of policy, she declined to use the brothers' names.

The other brother went into the pipe to rescue the first victim and was also overcome by fumes, Monterroza said. She added that a third victim who was not identified was also injured and treated.

You may believe that the hydrogen sulfide gas induced deaths of the Ramirez brothers can be written off as the result of a tragic, but far-fetched, situation, thus hardly justification for placing the entire practice under a microscope . . . but is it?

Before I put my foot in it, let me point out that I am an amateur composter who three or four times a week turns the crank on my rather small collection of food scraps and trimmings in an effort that keeps the neighbors and some of my plants happy. Granted this does not make me a master of anything, but it does entitle me to a minor seat in the Amen Corner.

That said—and here comes my foot bound for the effluent—I see composting getting preferential treatment when it comes to public oversight. No landfill today could begin to get away with the lack of leachate and air emissions management practices deemed acceptable at all too many compost operations. Double-lined what? Leachate monitoring what? Not when it comes to a favorite of the public policy brigade.

While hydrogen sulfide gas may not be your everyday compost pile problem, don't tell that to the citizens of Arvin or Lamont today, and, in literal fact, who's to say that it isn't more prevalent than any of us might believe? And therein lies the crux of the issue from my standpoint.

The Cal-OSHA spokeswoman summed it up perfectly when she said that there was no record of workplace violations at the facility. Does this mean that it wasn't a problem, or was it that they weren't looking at composting facilities with the same fervor they might with a landfill? Furthermore, where are there the regulations and oversight over what materials and combinations of materials can go into compost facilities? One more question while I'm at it: What leads us to believe that composting is always a better solution to organic materials management than bioenergy production or, for that matter, landfilling?

Without subjecting compost operations to the same standards of oversight and pollution management as we do landfills, we will remain as ignorant of the health and safety threat as the Ramirez brothers, their parents, guardians, neighbors, Cal-OSHA, the unnamed county officials, and all the people in the Lamont area who smelled the "strong odor" and considered it "just part of the environment."

Goh asks Cal-OSHA for update on safety at Lamont composting facility

BY John Cox Californian staff writer
jcox@bakersfield.com | Thursday, Oct 20 2011 05:39 PM

Last Updated Thursday, Oct 20 2011 05:41 PM

County Supervisor Karen Goh pressed Cal-OSHA Thursday to send a representative to Tuesday's Board of Supervisors meeting to provide information about "any immediate threats to worker safety" at the Lamont composting facility where two brothers were killed last week.

A Cal-OSHA spokeswoman for the agency responded that the agency would have a representative at the meeting, but that the person's comments would be limited.

"It's important to note that because we have (an) ongoing investigation, the information that that representative can share will be limited in scope," Erika Monterroza said. "We can't compromise an ongoing investigation."

Goh's request came a day after state Sen. Michael Rubio called on the board to shut down the business, Community Recycling & Resource Recovery Inc., and for the county prosecutor's office to join a potential criminal investigation of the operation. Goh and other county supervisors have said they need more information before deciding what to do about the accident.

Goh said in a news release Thursday afternoon that county staff had been trying to work with Cal-OSHA but that they had received "little to no response."

Monterroza countered that staff there did not hear from Goh's office until Thursday.

Goh clarified that although she personally received a prompt answer, other county officials had not received similar attention.

"We are concerned that we have not received more specific information regarding whether there are any immediate threatens to worker safety," she said in an interview. "We are very concerned."

On Oct. 14, two days after the fatal accident, Cal-OSHA ordered the company to stop having workers use water hoses to clean out a drainage tunnel where the brothers -- one of them 16 years old -- are believed to have inhaled a deadly concentration of hydrogen sulfide. That order was not disclosed publicly until Wednesday.

Authorities say 16-year-old Armando Ramirez, working under papers falsely indicating he was 30, was cleaning out an 8-foot-deep drainage tunnel when he was overcome by fumes. They say his 22-year-old brother, Heladio Ramirez, saw him unconscious and went down to rescue him, only to be overcome as well. A third worker who did not enter the tunnel also was overcome but was treated and released.

Armando Ramirez was declared dead later that day. Heladio Ramirez was rendered brain dead by the accident and removed from life support later in the week.

County District Attorney Lisa Green said Wednesday that she would ask Cal-OSHA what help her staff might need, but that she lacked the personnel to undertake her own investigation.

EXHIBIT RB-7

GCI TECH NOTES
DIOXIN AND RELATED COMPOUNDS
DIOXIN HOMEPAGE

 Gossman Consulting, Inc.

GCI TECH NOTES©

Volume 2, Number 05 *A Gossman Consulting, Inc. Publication* *May, 1996*

Dioxins	How to interpret and understand dioxin (PCDD/PCDF) data from emission tests and industrial / environmental samples. click here for more information

DIOXINS - PRIMER AND COMMENTARY

David L. Constans

Several thousand people, primarily male teenagers or young adults, subject themselves to potential physical damage, including brain damage and in some cases death, by purposely inhaling solvents and propellants. The street name is "huffing". Over half claim that they would not have "huffed" if they had known it was dangerous.

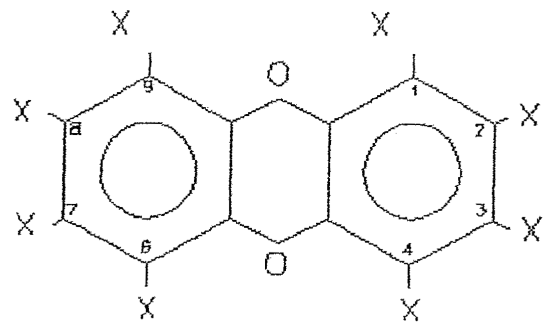
On the other hand, we have people who have an extreme fear of man-made chemicals. In both cases it is a general lack of knowledge that creates the majority of the problem. It would be naive to believe that education alone will prevent some people from abusing their bodies with chemicals or cause others to throw off their fear and sing the praises of chemicals.

We must see chemicals that surround us for what they are: some are good, some are bad, most are benign, and we must use our knowledge to discern the difference. There is no purpose here in discussing the damaging properties of solvents and how harmful the practice of "huffing" certainly is. Anyone who receives Tech Notes is going to be well aware of this. However, it is worthwhile to shed some light on the other end of the spectrum.

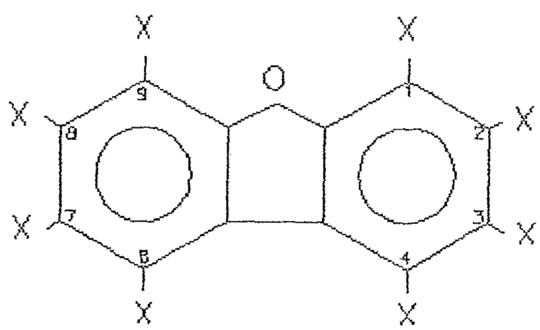
One of the most feared set of compounds are the polychlorinated dibenzodioxins and polychlorinated dibenzofurans (PCDDs and PCDFs), frequently shortened to "dioxins and furans" or merely "dioxins". The use of these short names has lead to a certain amount of confusion in the public. As an example, it is common for chlorinated solvent manufacturers to add a chemical stabilizer to their products called, "p-dioxane" (also called: 1,4-dioxane, tetrahydro-1,4-dioxin, tetrahydro-p-dioxin and others). It is not unreasonable for someone without a background in chemistry to think this is the dioxin of story and legend. In this case, p-dioxane is a ring structure comprised of four carbons and two oxygen atoms, with the oxygen atoms located in the para (p) positions; that is, the 1 and 4 positions in the ring. If this compound had only one oxygen, it would be called a "furan". A furan with one oxygen and four carbons in a ring is a compound called tetrahydrofuran (also called butylene oxide, furanidine, hydrofuran and others). This compound is a common solvent used to formulate a glue used to bond PVC pipes together. By definition, a "furan" is "any hetrocyclic ring compound made up of one or more kinds of atoms". By that definition, dioxins are a subset of furans. There are hundreds of compounds that could possess dioxin, dioxane, dioxan, furane or furan in their name. None of which are remotely related to the PCDD's or PCDF's. With so many compounds that have these infamous names, rather than discuss which are not PCDDs or PCDFs perhaps it is better to discuss what PCDDs or PCDFs are.

Rarely does anyone in the media explain what PCDDs or PCDFs are, let alone the toxic equivalency factor (TEF) assigned to each. One would think such important information, needed to understand the risk of "dioxin" emissions, would be carefully and frequently communicated. Sadly, it is not.

A polychlorinated dibenzodioxin is two benzene rings joined together by two oxygen atoms. A polychlorinated dibenzo-furan is similar but has only one oxygen atom. These compounds are expressed by the following diagrams.



polychlorinated dibenzodioxin



polychlorinated dibenzofuran

The "X's" can represent either hydrogen or chlorine atoms. If all of the "X's" but one are hydrogen with the one being chlorine, the compound would be called monochlorinated dibenzodioxin (furan). If there were two chlorine atoms, it would be "dichlorinated". If there were three "tri-" and four "tetra-", on through penta (5), hexa (6), hepta (7) and octa (8). In all there are 75 different chlorine/hydrogen combinations of PCDDs and 135 combinations of PCDFs. The number and positions of the chlorines makes a difference in the chemical and toxic properties of individual compounds.

After many years of research, researchers have determined the relative toxicities for the 210 different compounds that make up the PCDDs and PCDFs with the most toxic, 2,3,7,8-tetrachlorodibenzodioxin, being assigned a toxic equivalency factor (TEF) of One (1). The others are assigned values of 0.5, 0.1, 0.05, 0.01, 0.001 or zero. The 210 different compounds breakdown as follows for each TEF.

TEF	Number of Compounds
1	1
0.5	2
0.1	8
0.05	1
0.01	3
0.001	2
zero	193

To calculate the toxic equivalent quantity (TEQ) emitted from a source, the measured quantity of each of these compounds is multiplied by its assigned TEF. Then the results are summed to produce a single TEQ value. It is this TEQ value that is used in calculating the health risk associated with living near a combustion source.

Commentary:

The risk to human health due to dioxin emissions is a source of frequent and heated debate. It is interesting to note that there are 193 of these "most-feared-of-all" compounds (91.9% of the possible 210 compounds) that are considered by researchers to have relative toxicities of zero. If this were not the case, those of us that ate flame-grilled meat, drove in rush hour traffic or sat around a smoky fire would be very ill; but, of course, we're not. The EPA issued their famed dioxin reassessment in June of 1994. Buried intheir final conclusion (page 9-87) is the following statement, "...there is currently no clear indication of increased disease in the general population attributable to dioxin-like compounds." The French Academy of Sciences issued a dioxin report as well. The academy's report stated, "PCDD/ PCDF...toxicity in man is infrequent and not serious." The report further stated, "no fatal case of poisoning by these products has ever been reported."

As expressed earlier, we must view the chemicals that surround us for what they are: some are good, some are bad, most are benign. It is our knowledge that discerns the difference. It would be interesting to ask these kids that are "huffing", half of which claim they did not know it was dangerous, if they believed inhaling dioxins to be more dangerous than "huffing". Regardless of the answer, we will have lots of educating to do.

15

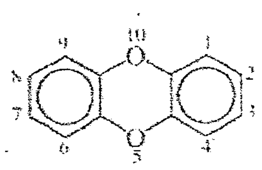
DIOXIN AND RELATED COMPOUNDS

15.1 GENERAL DISCUSSION

Polychlorinated dibenzo-*p*-dioxins are tricyclic aromatic compounds with extreme high toxicity. These compounds received high publicity for their destructive actions in Indochina. The deadly effect of Agent Orange, the forest defoliant used in Vietnam, is attributed to these polychlorinated dibenzo-*p*-dioxins occurring in phenoxy acid herbicide, 2,4,5-T. Agent Orange was a liquid mixture soluble in oil and insoluble in water with a specific gravity 1.285. It was composed of *n*-butyl esters of 2,4,5-trichlorophenoxy acetic acid (2,4,5-T), 2,4-dichlorophenoxy acetic acid (2,4- D), and 2,3,7,8-tetrachlorodibenzo-*p*-dioxin in percent ratio of 52.5 : 46.9 : 0.0037, respectively (Westing 1984).

Structure

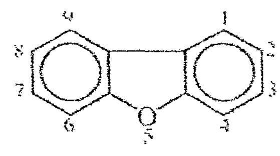
The structure of dibenzo-*p*-dioxin is as follows:



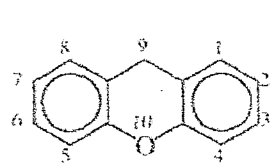
(dibenzo *p* dioxin)

One to eight chlorine atoms can bind to different positions in the ring, producing a total of 75 isomers. These would contain 10 dichloro, 14 trichloro, 22 tetrachloro, 14 pentachloro, 10 hexachloro, and 2 each of monochloro and heptachloro monomers and 1 octachloro isomer of dioxin. Chlorine-rich isomers are susceptible to photochemical dechlorination. In 2,3,7,8-TCDD chlorine atoms occupy positions at 2, 3, 7, and 8 in dibenzo-*p*-dioxin.

The structures of dibenzofuran and xanthene are as follows:



(dibenzofuran)



[9*H*)-xanthene]

Chloro substitution in the aromatic rings, similar to dioxins, can give rise to several polychlorinated dibenzofurans and their isomers.

Physical Properties of 2,3,7,8-TCDD

White crystalline solid; mp 303°C (577°F); decomposes above 700°C (1292°F); vapor

A Comprehensive Guide to the Hazardous Properties of Chemical Substances, by Pradyot Patnaik

pressure 1.5×10^{-9} torr at 25°C (77°F); insoluble in water (solubility 0.317 ppb), solubility in nonpolar organic solvents is higher (chloroform 0.037%).

15.2 USES AND EXPOSURE RISK

2,3,7,8-Dioxin, the principal toxic impurity in chlorophenoxy herbicides, has been in use in chemical warfare to destroy crops and defoliate jungles. It occurs as an impurity in trace amount in the herbicide 2,4,5-T. It is formed as a by-product in the synthesis of 2,4,5-trichlorophenol. It has been detected in distillation bottom tars from 2,4-dichlorophenol, in pentachlorophenolic wastewaters, in forest fires; and in smoke emissions from municipal incinerators. Combustion gases, soots, and ashes from explosions of chlorinated phenol plants were found to contain dioxins.

Trace dioxins have been detected in soil, sediment, vegetation, fruits, fish and mammalian tissue, and bovine milk. 2,3,7,8-substituted isomers and other polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofurans have been detected in the surface samples at many PCBs disposal facilities. The major source of human exposure to dioxin is the food chain. Dioxins bioaccumulate in adipose tissue in humans. According to an estimate, the long-term average daily intake of dioxin in humans is 0.05 ng/day (Hattemer-Frey and Travis 1987).

Dioxins have been detected in sealed dried sewage sludges even after several years of storage. The natural enzyme chloroperoxidase, commonly found in soils can biosynthesize dioxin in garden compost piles, peat bogs, and sewage containing phenols and chloride (Gribble 1998).

The 2,3,7,8-isomer, which is the most toxic dioxin, can be formed by photochemical or thermal reactions of 2,4,5-T or other phenoxy herbicides (Rappe 1978; Akermark 1978). Heating salts of 2,4,5-T at 400–450°C (752–842°F) or the ester at 500–580°C (932–1076°F) (Ahling et al. 1977) produced this isomer to the extent of 1000 and 0.3 ppm, respectively.

Dioxins absorb onto soil and exhibit little downward mobility. It undergoes lateral erosional movement due to water and wind and partial photodegradation in nature. The half-life reported for 2,3,7,8-TCDD are somewhat varying, from 3.5 to 5 years and 10 years (Westing 1984). The 2,3,7,8-TCDD contamination in soils is confined to the top layer only. Therefore, its poisoning of underlying groundwater may not take place unless the soil is sandy or has low organic content (U.S. EPA 1986a).

Ryu et al. (2003) have reported the formation of dibenzofuran from phenol and benzene in combustion gas exhaust systems. Chlorination at 200–400°C (392–752°F) over the particle beds containing $CuCl_2$ produced chlorinated dibenzofurans. The authors have detected 2,3,7,8 congeners of both chlorinated dibenzofurans and -dibenzodioxins in the product mixtures the formation of which depended on the gas-particle contact time.

15.3 FORMATION OF DIOXINS AND DIBENZOFURANS IN INCINERATORS

Dioxins and dibenzofurans form catalytically from pentachlorophenol wastes, chlorinated phenol precursors, and from nonchlorinated compounds by the reaction of phenol with inorganic chloride ion in the low-temperature region of the incinerator plant. Karasek and Dickson (1987) determined with optimum temperature range as 250–350°C (482–662°F) for the formation of dioxins from pentachlorophenol. Eklund et al. (1986) observed that the formation of these toxic compounds depended on the HCl concentration in the incinerator. Such formation is probably caused by phenol and HCl and may be controlled by injecting suitable alkaline sorbent along with the fuel. These compounds may also be formed from the carbon particulates in the incinerators. The concentrations of dioxins produced from pentachlorophenol were much higher than those produced from carbon (Dickson et al. 1988). In addition, carbon catalyzed the formation of dioxins from pentachlorophenol. An occurrence of surface-catalyzed reactions on the fly ash has been proposed. Similar surface phenomena involving adsorption of precursor compounds on carbon in the fly ash, as well as oxidation of carbon, were also suggested by Vogg et al. (1987) to explain the mechanism of dioxin–dibenzofuran formation in the municipal solid waste incinerator at a low-temperature region of 300°C (572°F).

Hagenmaier et al. (1987) studied the catalytic effect of fly ash on the formation and decomposition of dioxins and dibenzofurans under oxygen-deficient and oxygen-surplus conditions. While under oxygen-deficient conditions, fly ash catalyzed dechlorination or hydrogenation reaction, in the presence of surplus oxygen an increase in polychlorinated dibenzo-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) was observed.

During high-temperature incineration of PCBs and polychlorobenzene wastes, no 2,3,7,8-TCDD was detected in stack emissions, slag, or wash water, while some PCDDs were detected only in ppt amounts in stack emission (Brenner et al. 1986). The levels of PCDDs and PCDFs in the incinerator flue gases were found to be slightly high when the amount of wet leaves in the municipal solid waste was higher (Marklund et al. 1986). The increase in polyvinyl chloride (PVC) content in the waste feed did not produce emissions with detectable concentrations of dioxins and dibenzofurans (Carrol 1988; Giugliano et al. 1988). There is no evidence that the amount of PVC in the wastes affects the formation of PCDDs and PCDFs.

15.4 HEALTH HAZARD

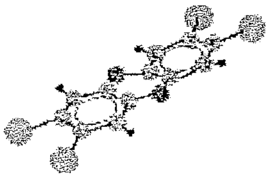
The long-term effect on humans due to dioxins from herbicide spray has been very serious. Dioxins can produce a wide range of metabolic dysfunctions, even at a very low level of nanograms to micrograms per kilogram of mammalian body weight. Laboratory tests on animals show that dioxins can cause cancer and birth defects and induce genetic damage. However, not all polychlorinated dioxins pose such a severe health hazard. It is primarily the 2,3,7,8-tetrachloroisomer, and to a lesser extent, some of the hexachloro isomers that are indeed hazardous. Few of the pentachloro dioxins are highly toxic but not carcinogenic. Monochloro, dichloro (except 2,7-dichloro isomer), trichloro, and heptachloro compounds have a much lower order of toxicity and are neither carcinogens nor teratogens. Thus it is interesting to note that chlorine substitutions on the aromatic rings of dibenzo-*p*-dioxin (and dibenzofuran) in certain numbers at certain positions can convert an "innocuous" molecule to an extremely "dangerous" one.

Chlorinated dibenzo-*p*-dioxins that present moderate to extreme health hazards are listed in Table 15.1. The toxicity data of halogenated dibenzofurans are presented in Table 15.2.

TABLE 15.1 Toxicity of Polychlorinated Dibenzo-*p*-dioxins

Compound/CAS No.	Formula/MW	Health Hazard
2,7-Dichloro dibenzo-*p*-dioxin [33857-26-0]	$C_{12}H_6Cl_2O_2$ 253.08	*Teratogen:* can cause developmental abnormalities in cardiovascular system *Carcinogen:* can cause tumor in liver and leukemia in mice *Toxicity:* moderate; 60 times less toxic than 2,3,7,8-TCDD (Sijm and Opperhuizen 1988) *Eye irritant:* 2 mg had mild effect on rabbits
1,3,6,8-Tetrachlorodibenzo-*p*-dioxin [33423-92-6]	$C_{12}H_4Cl_4O_2$ 321.96	*Teratogen:* shows fetotoxicity in rats (harmful to embryo)

Dioxin Homepage



- What is Dioxin?
- Dioxin and Cancer
- Dioxin and Other Health Problems
- Dioxin in the Food Supply
- EPA's Dioxin Reassessment Report
- Links to Other Good Resources on Dioxin
- Incineration
- Archived Dioxin Articles: Incineration, Health, Politics
- Dioxin-Related Email Lists / Archives

NEW! (4/11/2011): Congress pushes EPA to complete the dioxin reassessment in a letter to Lisa Jackson.

7/11/2006: National Academy of Sciences releases new report on EPA's study of dioxin health effects. See related press releases:

- National Academies New Study Concludes Dioxin is Toxic (Center for Health, Environment and Justice)
- EPA Dioxin Assessment Understates Uncertainties, May Overstate Cancer Risk (National Academy of Sciences)

What is dioxin?

Dioxins and furans are some of the most toxic chemicals known to science. A draft report released for public comment in September 1994 by the US Environmental Protection Agency clearly describes dioxin as a serious public health threat. The public health impact of dioxin may rival the impact that DDT had on public health in the 1960's. According to the EPA report, not only does there appear to be no "safe" level of exposure to dioxin, but levels of dioxin and dioxin-like chemicals have been found in the general US population that are "at or near levels associated with adverse health effects."

Dioxin is a general term that describes a group of hundreds of chemicals that are highly persistent in the environment. The most toxic compound is 2,3,7,8-tetrachlorodibenzo-p-dioxin or TCDD. The toxicity of other dioxins and chemicals like PCBs that act like dioxin are measured in relation to TCDD. Dioxin is formed as an unintentional by-product of many industrial processes involving chlorine such as waste incineration, chemical and pesticide manufacturing and pulp and paper bleaching. Dioxin was the primary toxic component of Agent Orange, was found at Love Canal in Niagara Falls, NY and was the basis for evacuations at Times Beach, MO and Seveso, Italy.

Dioxin is formed by burning chlorine-based chemical compounds with hydrocarbons. The major source of dioxin in the environment comes from waste-burning incinerators of various sorts and also from backyard burn-barrels. Dioxin pollution is also affiliated with paper mills which use chlorine bleaching in their process and with the production of Polyvinyl Chloride (PVC) plastics and with the production of certain chlorinated chemicals (like many pesticides).

Does dioxin cause cancer?

Yes. The EPA report confirmed that dioxin is a cancer hazard to people. In 1997, the International

Agency for Research on Cancer (IARC) -- part of the World Health Organization -- published their research into dioxins and furans and announced on February 14, 1997, that the most potent dioxin, 2,3,7,8-TCDD, is a now considered a Group 1 carcinogen, meaning a "known human carcinogen."

Also, in January 2001, the U.S. National Toxicology Program upgraded 2,3,7,8-TCDD from "Reasonably Anticipated to be a Human Carcinogen" to "Known to be a Human Carcinogen." See their reports on dioxins and furans from their most recent *11th Report on Carcinogens*. Finally, a 2003 re-analysis of the cancer risk from dioxin reaffirmed that there is no known "safe dose" or "threshold" below which dioxin will not cause cancer.

A July 2002 study shows dioxin to be related to increased incidence of breast cancer.

What other health problems are linked to dioxin exposure?

In addition to cancer, exposure to dioxin can also cause severe reproductive and developmental problems (at levels 100 times lower than those associated with its cancer causing effects). Dioxin is well-known for its ability to damage the immune system and interfere with hormonal systems.

Dioxin exposure has been linked to birth defects, inability to maintain pregnancy, decreased fertility, reduced sperm counts, endometriosis, diabetes, learning disabilities, immune system suppression, lung problems, skin disorders, lowered testosterone levels and much more. For an detailed list of health problems related to dioxin, read the People's Report on Dioxin.

How are we exposed to dioxin?

The major sources of dioxin are in our diet. Since dioxin is fat-soluble, it bioaccumulates, climbing up the food chain. **A North American eating a typical North American diet will receive 93% of their dioxin exposure from meat and dairy products** (23% is from milk and dairy alone; the other large sources of exposure are beef, fish, pork, poultry and eggs). In fish, these toxins bioaccumulate up the food chain so that dioxin levels in fish are 100,000 times that of the surrounding environment. **The best way to avoid dioxin exposure is to reduce or eliminate your consumption of meat and dairy products by adopting a vegan diet.** According to a May 2001 study of dioxin in foods, "The category with the lowest [dioxin] level was a simulated vegan diet, with 0.09 ppt.... Blood dioxin levels in pure vegans have also been found to be very low in comparison with the general population, indicating a lower contribution of these foods to human dioxin body burden."

In EPA's dioxin report, they refer to dioxin as *hydrophobic* (water-fearing) and *lipophilic* (fat-loving). This means that dioxin, when it settles on water bodies, will rapidly accumulate in fish rather than remain in the water. The same goes for other wildlife. Dioxin works its way to the top of the food chain.

Men have no ways to get rid of dioxin other than letting it break down according to its chemical half-lives. Women, on the other hand, have two ways which it can exit their bodies:

- It crosses the placenta... into the growing infant;
- It is present in the fatty breast milk, which is also a route of exposure which doses the infant, making breast-feeding for non-vegan/vegetarian mothers quite hazardous.

If you're eating the typical North American diet, this is where you are getting your dioxin from:

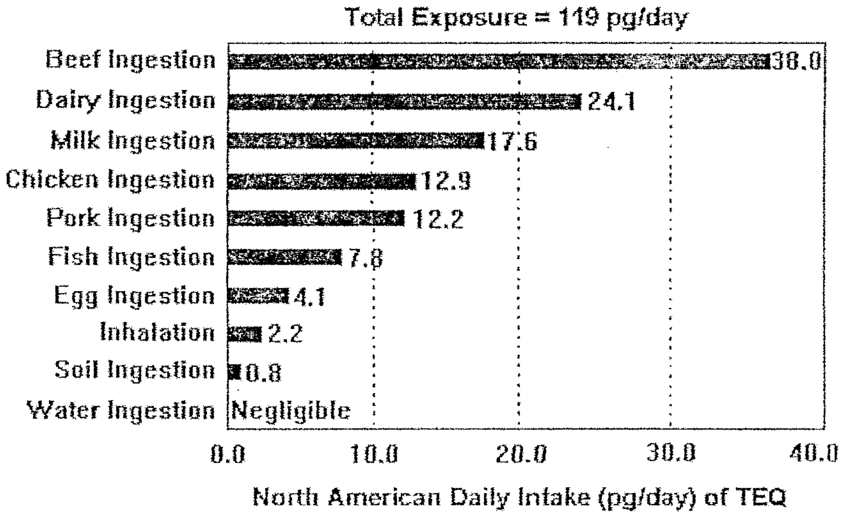


Chart from <u>EPA Dioxin Reassessment</u> Summary 4/94 - Vol. 1, p. 37
(Figure II-5. Background TEQ exposures for North America by pathway)

[A TEQ is a dioxin Toxic EQuivalent, calculated by looking at all toxic dioxins and furans and measuring them in terms of the most toxic form of dioxin, 2,3,7,8-TCDD. This means that some dioxins/furans might only count as half a TEQ if it's half as toxic as 2,3,7,8-TCDD.]

Levels of Dioxin in U.S. Food Supply (1995):

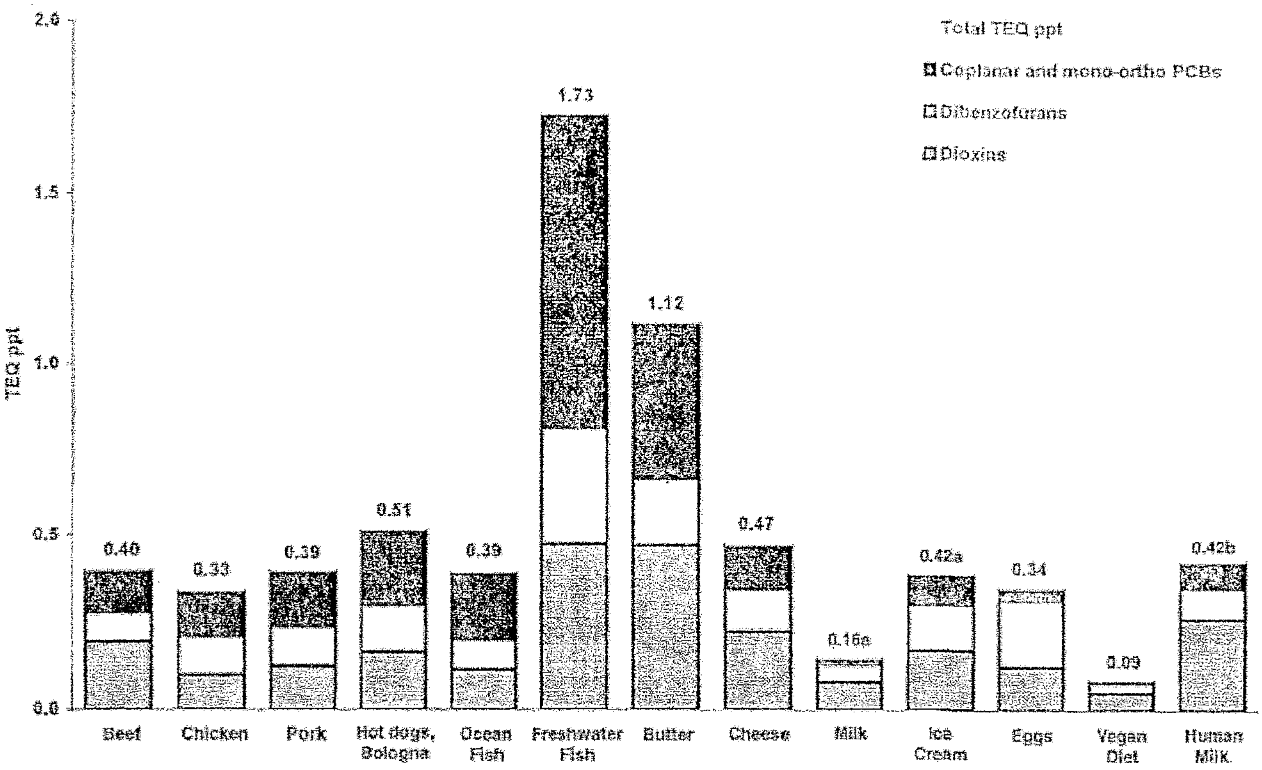


EXHIBIT RB-8

EPA AIR EMISSIONS FROM MSW

http://www.epa.gov/wastes/nonhaz/municipal/wte/airem.htm
Last updated on Wednesday, July 27, 2011

Wastes - Non-Hazardous Waste - Municipal Solid Waste

You are here: EPA Home »Wastes »Non-Hazardous Waste »Municipal Solid Waste »Energy Recovery »Air Emissions from MSW Combustion Facilities

- Energy Recovery Home
- Basic Information
- Waste Management Hierarchy
- Related Regulations
- Frequent Questions
- Additional Information

Air Emissions from MSW Combustion Facilities

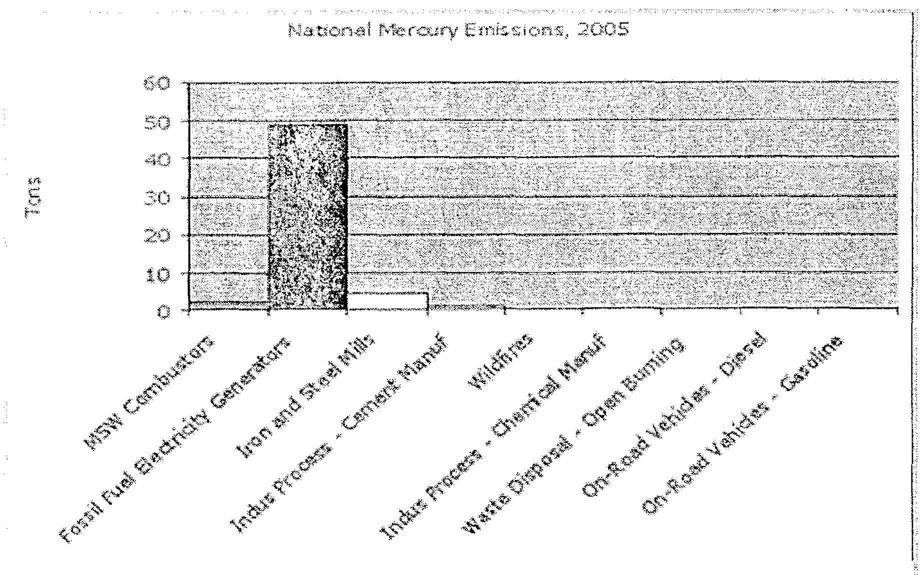
- Comparison with emissions from other sources
- History of changes over time from MSW combustion facilities and other sources
- Air toxics emissions
- Air toxics impacts
- Steps EPA is taking to make sure MSW combustion facilities stay safe
- Dioxins
- Greenhouse Gases (GHGs)

Comparison with emissions from other sources

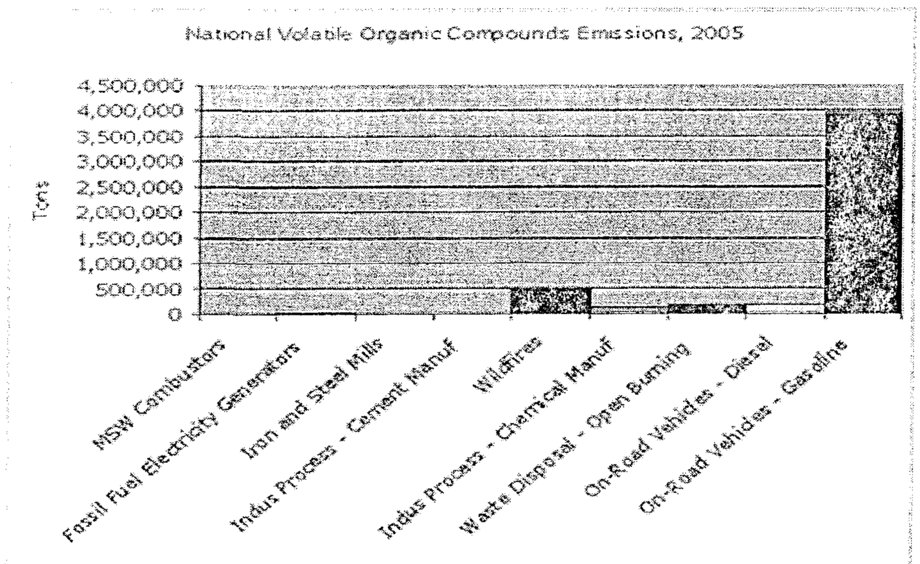
The graphs below compare the emissions of municipal solid waste (MSW) combustors (also called Waste to Energy plants) emissions to emissions from other sources like:

- Coal and natural gas fired power plants (Fossil Fuel Electricity Generators);
- Iron and Steel Mills;
- Cement Manufacturers;
- Wildfires;
- Chemical Manufacturing;
- Waste Disposal via Uncontrolled or Open Burning; and
- Diesel and Gasoline Vehicle Emissions.

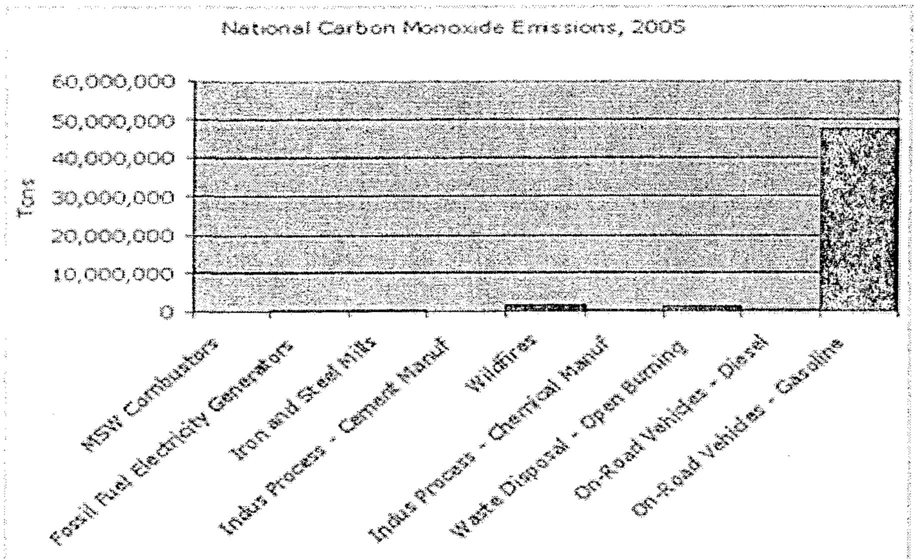
These graphs are based on EPA's 2005 National Emissions Inventory data. More information is available at EPA's Clearinghouse for Inventories and Emissions. On-road vehicle emissions (from cars, trucks, etc.) are responsible for most of the volatile organic compounds, carbon monoxide, and hazardous air pollutants generated. Of these sources, fossil fuel electricity generators are responsible for most of the mercury and particulate matter generated.



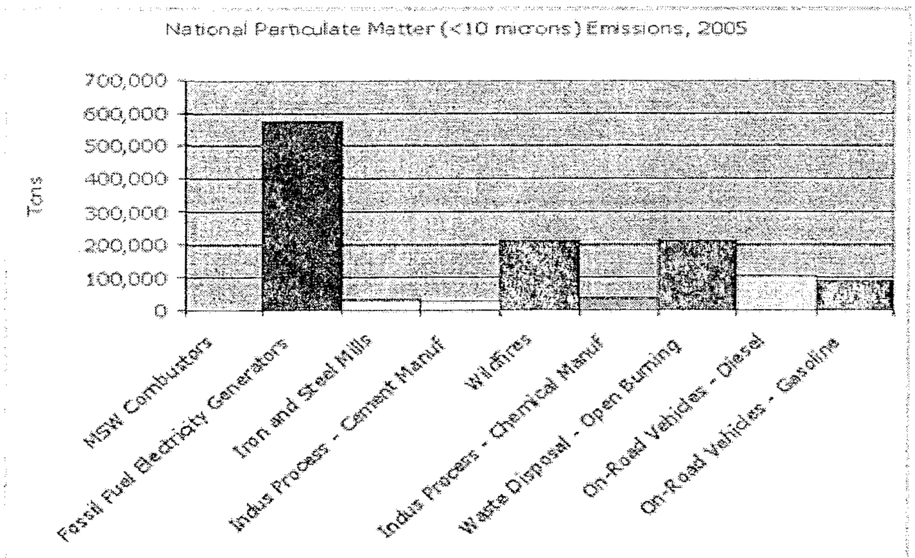
Text Version



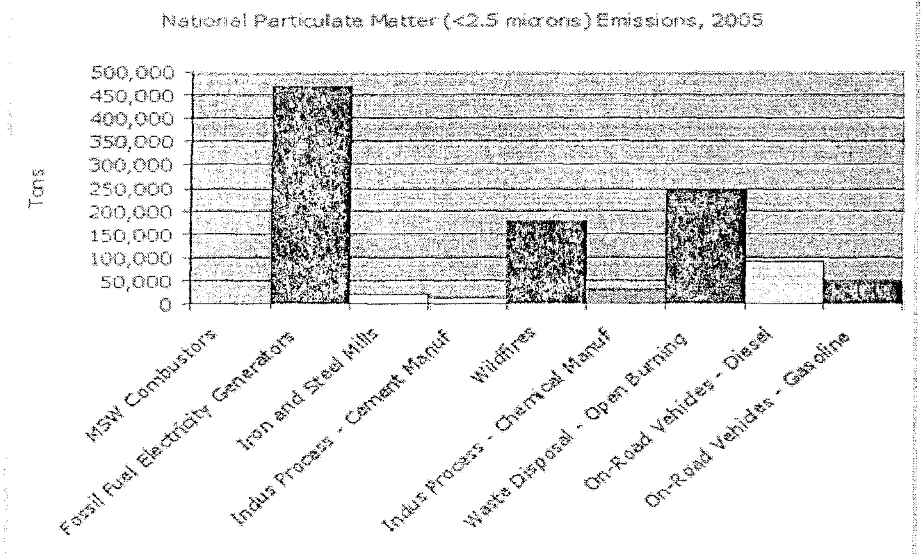
Text Version



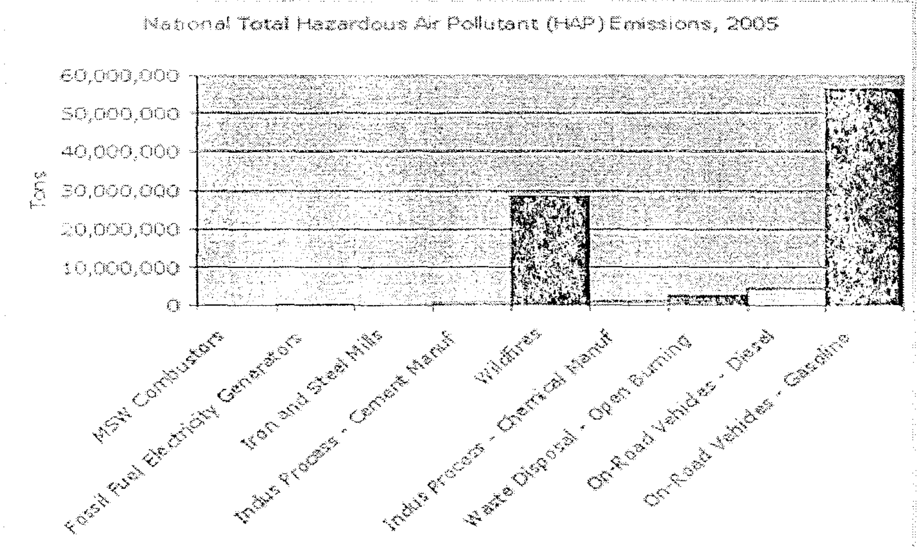
Text Version



Text Version



Text Version



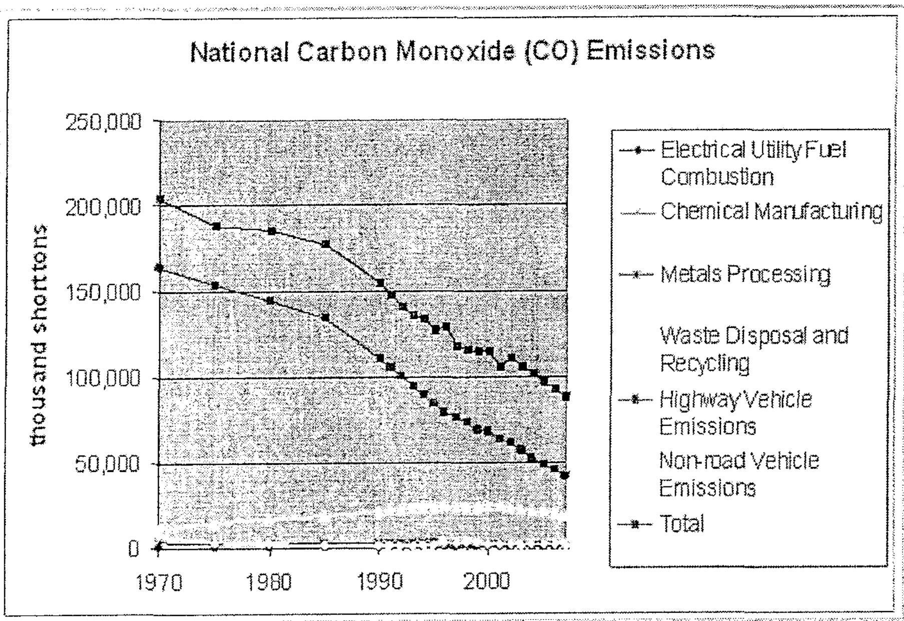
Text Version

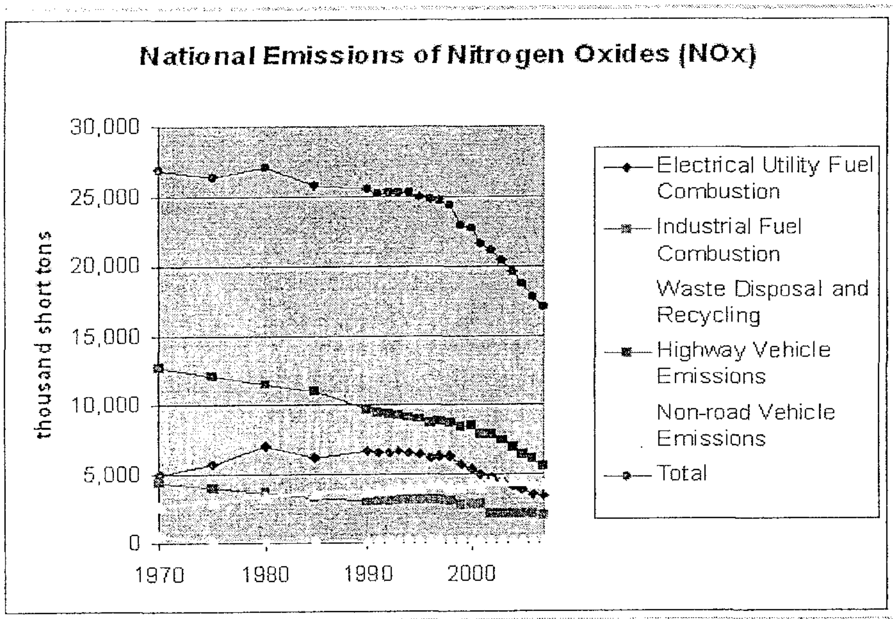
History of changes over time from MSW combustion facilities and other sources

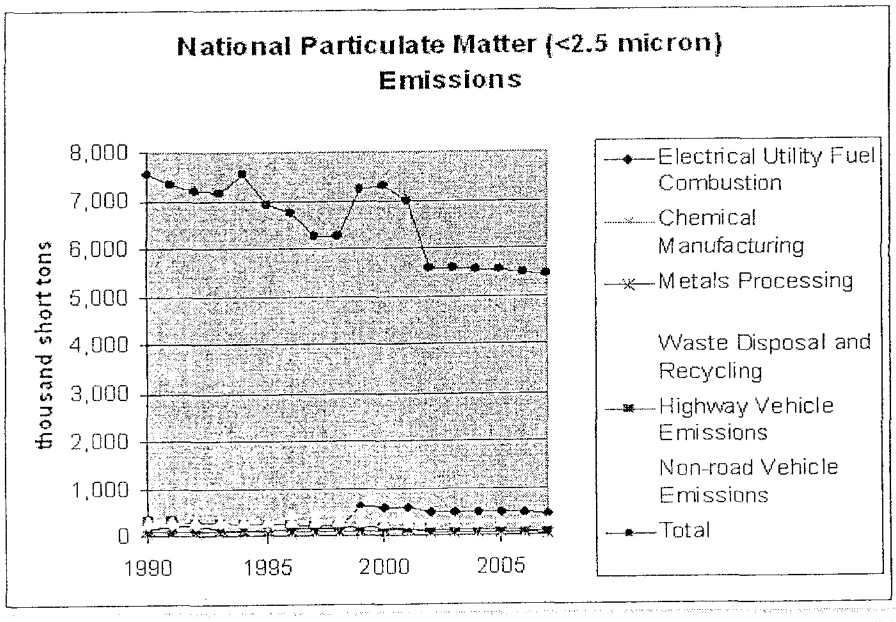
In 1990, EPA developed Maximum Achievable Control Technology (MACT) standards under the Clean Air Act for municipal solid waste (MSW) combustors. Emissions from MSW combustion facilities decreased by a factor of twenty after the MACT controls were put in place. The table below shows emission trends from 1990-2005 based on available data from the National Emissions Inventories. Total emissions of hazardous air pollutants have dropped more than 94 percent in this time period from nearly 58,000 tons in 1990 to about 3,300 tons in 2005.

Emissions from other source categories have declined over time as well. The graphs below indicate trend data for carbon monoxide (CO), nitrogen oxides (NOx), particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), and volatile organic compounds (VOCs). Total emissions are illustrated on the graphs as well as emissions from well-known source categories. Vehicle emissions are a major source for many of these pollutants. This is important to note because it puts into perspective the exposure and hazard potential from industrial sources. The Air Emission Sources website provides information on other pollutants. For more information on trends, please visit National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data. MSW combustion facilities are combined with other industries in the "Waste Disposal and Recycling" category.

(Click on images for a larger size)

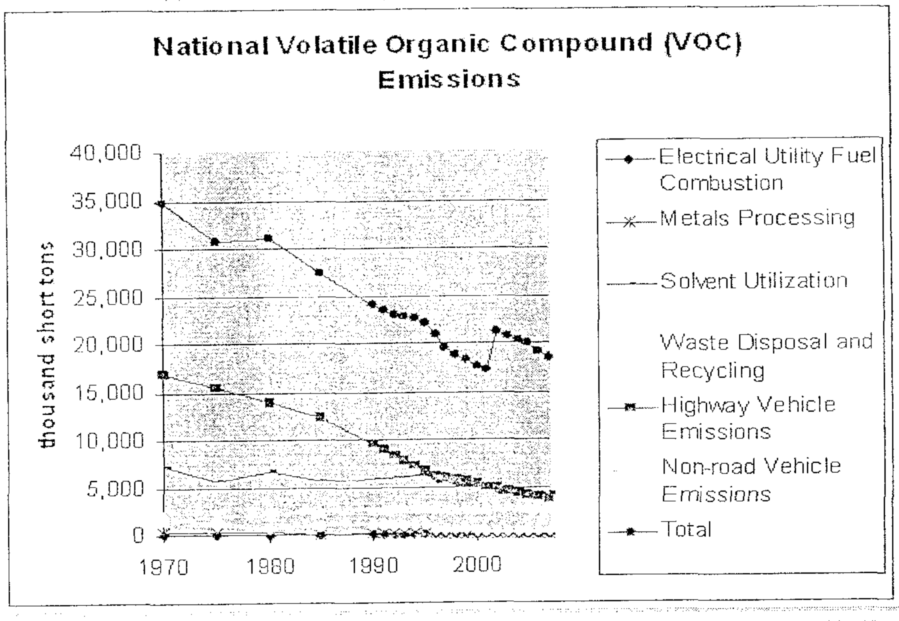






Air toxics emissions

The table below shows how much emissions from MSW combustion facilities have declined post-MACT from 1990-2005. You can see from the table below that these regulations have significantly reduced emissions, in many cases, by more than 95 percent.



Emissions from Large and Small MSW Combustion Facilities Pre- vs. Post-MACT Comparison

Pollutants	1990 Emissions (tons per year)	2005 Emissions (tons per year)	Percent Reduction
Mercury	57	2.3	96%
Cadmium	9.6	0.4	96%
Lead	170	5.5	97%
Particulate Matter	18,600	780	96%
Hydrogen Chloride	57,400	3,200	94%
Sulfur Dioxide	38,300	4,600	88%
Nitrogen Oxides	64,900	49,500	24%

Dioxin and furan emissions are measured in grams on what is known as a "toxic equivalent quantity" or TEQ basis. There are many kinds of dioxins and furans. "TEQ" takes into account the fact that different dioxin and furan molecules have different hazard levels. Dioxin and furan emissions declined more than 99 percent from 4,400 grams TEQ in 1990 to 15 grams TEQ in 2005.

Air toxics impacts

The toxics generated by MSW combustion facilities are tightly regulated by the Maximum Achievable Control Technology (MACT) standards under the Clean Air Act. All activities that involve combustion, such as power plants, cement plants, metal smelters, and fuel-fired engines generate air emissions. The risk from these emissions must be put into context. EPA conducts ongoing evaluations of air toxics in the United States, which include estimates of cancer and non-cancer (nausea, asthma, bronchitis, etc.) health effects based on chronic exposure from outdoor sources. EPA's Air Pollution and Health Risk web page helps to put risk into perspective.

Case-specific data for an MSW combustion facility in Montgomery County, Maryland show that the overall cancer and non-cancer risk to human health has always been below EPA benchmarks and — in many cases — have actually decreased over time despite incorporating new risk methods and more exposure pathways. Multiple independent risk studies EXIT Disclaimer were conducted before and after the MSW combustion facility was built and the risk posed by the plant has been continually re-analyzed.

Steps EPA is taking to make sure MSW combustion facilities stay safe

The states and EPA work together to ensure that MSW combustion facilities are complying with emission standards. States have developed regulations of their own to implement the federal MACT standards. You can check the compliance status of MSW combustion facilities and other types of facilities in your area at: Environmental Compliance History Online.

EPA is also voluntarily re-examining the MACT emissions levels using additional MSW combustion facility data through 2008. Preliminary analysis of these data shows that emissions have been well below the existing MACT standards and maintain high performance levels. You can check on the latest regulatory updates at EPA's Air Toxics website.

You can also find information on land, water, and air emissions at EPA's one-stop shop for environmental data known as Envirofacts.

Continued state and EPA efforts to reduce the amount of hazardous material in MSW also translate into lower emissions. For example, improving mercury management practices and phasing mercury out of products like thermostats means there is less mercury in MSW and hence less mercury emissions from MSW combustion facilities.

Dioxins

"Dioxins" refer to a group of chemical compounds that share similar characteristics. Dioxins are known to cause cancer in animals and likely in humans. They may also cause other reproductive or developmental effects. Dioxins from MSW combustion facilities are not present in the waste itself, they are by-products generated from the combustion of chlorinated wastes. Improved combustion technology and air pollution controls have dramatically reduced the quantity of dioxins emitted from MSW combustion facilities. The US Government's Interagency Work Group on dioxin has prepared a useful question and answer document EXIT Disclaimer. This workgroup is composed of federal agencies that address health, food, and environmental concerns. Some relevant highlights from this document include:

> Over the past few decades, EPA has aggressively looked for ways to reduce and control dioxins in the environment in the United States. Collectively, these actions have resulted in strict controls on all of the known and quantifiable major industrial sources of dioxin releases. As a result of EPA's efforts, along with efforts by state governments and private industry, known and quantifiable industrial emissions in the United States have been

reduced by more than 90% from 1987 levels. For example,(municipal waste combustors are estimated to have emitted collectively nearly 18 pounds of dioxin toxic equivalents in 1987, but under EPA regulations they are now expected to emit less than 1/2 ounce per year. Similarly, medical waste incinerators emitted about 5 pounds of dioxin equivalents in 1987, but under EPA regulations they now will be limited to about 1/4 ounce annual emissions. EPA has implemented similarly strict standards for other dioxin sources.

Greenhouse Gases (GHGs)

Estimates of greenhouse gas emissions from US MSW combustion facilities range from 10 to 20 million metric tons, depending on the different methods used to estimate the biogenic fraction of MSW. Regardless, it is a small fraction of the nearly six billion tons emitted by the combustion of fossil fuels. Per unit of electricity produced, the MSW combustion facilities generate less GHGs than coal or oil, but slightly more GHGs per unit energy than natural gas. EPA's climate change website addresses air emissions of electricity generation from different sources. The value reported on this website for MSW (2,988 pounds of carbon dioxide per megawatt-hour) includes emissions for both the biogenic *and* fossil fractions of MSW. However, when considering carbon dioxide (CO2) emissions from MSW combustion, it is necessary to count only emissions from fossil fuel-based products, like plastics. The *biogenic fraction of MSW is material generated from living organisms and is already in the planet 's* carbon cycle. This biogenic fraction should not be included when determining the GHG outputs of combusting MSW for energy recovery. In the table below, we use EPA's eGrid (a database of information on electrical generators in the United States) that indicates about 53 percent of the energy generated by MSW combustion facilities is from biogenic sources and 47 percent is fossil-derived power. eGrid relies on the Department of Energy's Energy Information Administration methodology for allocating MSW to biogenic/non-biogenic energy (which, in turn, relies on EPA's Annual MSW Report) and information about MSW combustor type.

Fuel	***CO2 (pounds per megawatt hour)***
MSW	1016
Coal	2249
Oil	1672
Natural Gas	1135

Life-cycle emission analysis of MSW combustion considers factors like:

- Avoided methane emissions from landfills;
- Energy generation potential that offsets fossil fuel use;
- Metals recovery (recycling);
- Emission savings from the avoidance of long-distance transport to landfills.

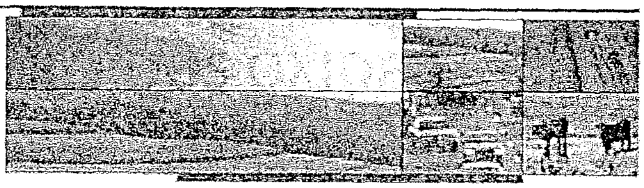
Two EPA-sponsored models have been developed to examine life-cycle emissions from different management methods of MSW: the Waste Reduction Model (WARM) and the MSW Decision Support Tool (DST) (PDF) (2 pp, 470K, about PDF). These models both show that MSW combustors actually reduce the amount of GHGs in the atmosphere compared to landfilling. The savings are estimated to be about 1.0 ton of GHGs saved per ton of MSW combusted.

EXHIBIT RB-9

Nitrous Oxide

You are here: EPA Home Climate Change Nitrous Oxide Sources and Emissions

Sources and Emissions



Where Does Nitrous Oxide Come From?

Nitrous oxide (N_2O) is produced by both natural and human-related sources. Primary human-related sources of N_2O are agricultural soil management, animal manure management, sewage treatment, mobile and stationary combustion of fossil fuel, adipic acid production, and nitric acid production. Nitrous oxide is also produced naturally from a wide variety of biological sources in soil and water, particularly microbial action in wet tropical forests.

Nitrous oxide emission levels from a source can vary significantly from one country or region to another, depending on many factors such as industrial and agricultural production characteristics, combustion technologies, waste management practices, and climate. For example, heavy utilization of synthetic nitrogen fertilizers in crop production typically results in significantly more N_2O emissions from agricultural soils than that occurring from less intensive, low-tillage techniques. Also, the presence or absence of control devices on combustion sources, such as catalytic converters on automobiles, can have a significant affect on the level of N_2O emissions from these types of sources.

Emission inventories are prepared to determine the contribution of emissions from different sources. The following sections present information from inventories of U.S. human-related and natural sources of N_2O globally. For more information on international emission of N_2O from human-related sources, visit the International Analysis section of this site.

Human-Related Sources in the United States

Table 1 shows the level of emissions from individual sources for the years 1990, 1995, 2000 and 2005 to 2008.

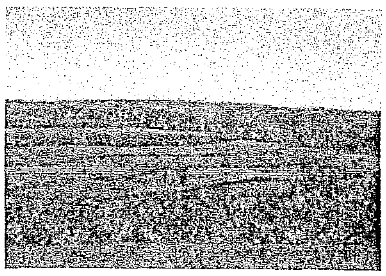
Table 1 U.S. Nitrous Oxide Emissions by Source ($TgCO_2$ Equivalents)

Source Category	1990	1995	2000	2005	2006	2007	2008
Agricultural Soil Management	203.5	205.9	210.1	215.8	211.2	211.0	215.9
Mobile Combustion	43.9	54.0	53.2	36.9	33.6	30.3	26.1
Nitric Acid Production	18.9	21.0	20.7	17.6	17.2	20.5	19.0

Manure Management	14.4	15.5	16.7	16.6	17.3	17.3	17.1
Stationary Combustion	12.8	13.3	14.5	14.7	14.5	14.6	14.2
Adipic Acid Production	15.8	17.6	5.5	5.0	4.3	3.7	2.0
Wastewater Treatment	3.7	4.0	4.5	4.7	4.8	4.9	4.9
N_2O from Product Uses	4.4	4.6	4.9	4.4	4.4	4.4	4.4
Forest Land Remaining Forest Land	2.7	3.7	12.1	8.4	18.0	16.7	10.1
Composting	0.4	0.8	1.4	1.7	1.8	1.8	1.8
Settlements Remaining Settlements	1.0	1.2	1.1	1.5	1.5	1.6	1.6
Field Burning of Agricultural Residues	0.4	0.4	0.5	0.5	0.5	0.5	0.5
Incineration of Waste	0.5	0.5	0.4	0.4	0.4	0.4	0.4
Wetlands Remaining Wetlands	+	+	+	+	+	+	+
International Bunker Fuels	1.1	0.9	0.9	1.0	1.2	1.2	1.2
Total for U.S.	**322.3**	**342.5**	**345.5**	**328.3**	**329.5**	**327.7**	**318.2**

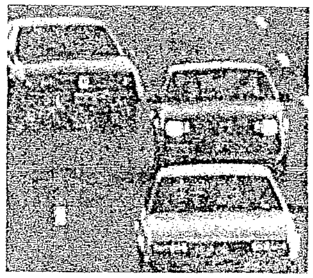
Source: U.S. Emissions Inventory 2010: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008.

The principal human-related sources of N_2O are described below. For each source, a link is provided to the report entitled "US Emissions Inventory 2010: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008," prepared by EPA, which provides detailed information on the characterization and quantity of national emissions from each source. This report, hereafter referred to as the "U.S. inventory report," provides the latest descriptions and emissions associated with each source category and is part of the United States' official submittal to the United Nations Framework Convention on Climate Change (UNFCCC). The U.S. inventory report also describes the procedures used to quantify national emissions, as well as a description of trends in emissions since 1990.

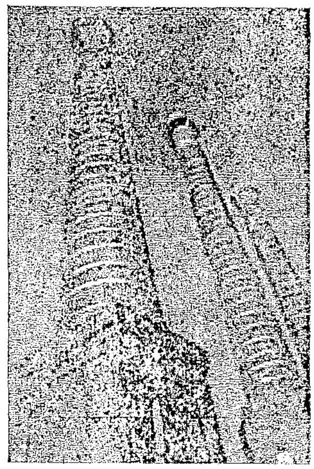


Agricultural soil management. Nitrous oxide is produced naturally in soils through the microbial processes of denitrification and nitrification. These natural emissions of N_2O can be increased by a variety of agricultural practices and activities, including the use of synthetic and organic fertilizers, production of nitrogen-fixing crops, cultivation of high organic content soils, and the application of livestock manure to croplands and pasture. All of these practices directly add additional nitrogen to soils, which can then be converted to N_2O. Indirect additions of nitrogen to soils can also result in N_2O emissions. Indirect additions include those processes by which applied fertilizer or manure nitrogen volatilizes into ammonia and oxides of nitrogen and then is ultimately re-deposited onto the soil in the form of particulate ammonium, nitric acid, and oxides of nitrogen. Surface run-off and leaching of applied nitrogen into ground water and surface waters can also result in indirect additions of nitrogen to the soil. The U.S. inventory report provides a detailed description on N_2O emissions from agricultural soil management and how they are estimated (see the Chapter entitled "Agriculture").

Mobile and stationary sources of fossil fuel combustion. Nitrous oxide is a product of the reaction that occurs between nitrogen and oxygen during fossil fuel combustion. The volume emitted varies with the fuel type, technology, or pollution control device used, as well as maintenance and operating practices. For example, catalytic converters can promote the formation of N_2O, although the latest technical modifications to converters are addressing this problem. The U.S. inventory report provides a detailed description on N_2O emissions from fuel combustion sources and how they are estimated (see the chapter entitled "Energy").



Nitric acid production. Nitric acid is an inorganic compound used primarily as a feedstock for synthetic commercial fertilizer. It is also a major component in the production of adipic acid and explosives. Virtually all of the nitric acid produced in the United States is manufactured by the catalytic oxidation of ammonia in which N_2O is formed as a by-product and is released from reactor vents into the atmosphere. The U.S. inventory report provides a detailed description on N_2O emissions from nitric acid production and how they are estimated (see the Chapter entitled "Industrial Processes").



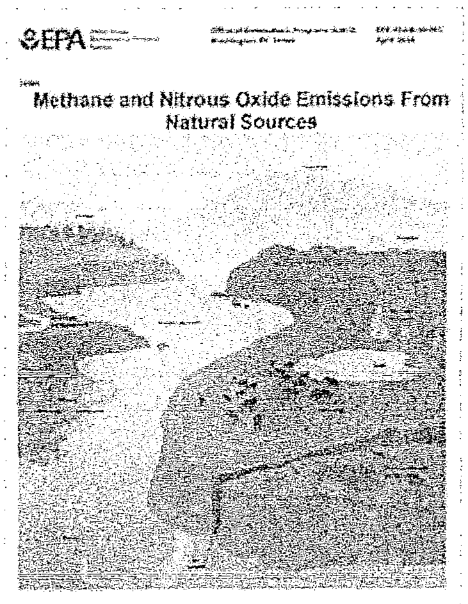
Livestock manure management. Nitrous oxide is produced as part of the nitrogen cycle through the nitrification and denitrification of the organic nitrogen in livestock manure and urine. The production of N_2O from livestock manure depends on the composition of the manure and urine, the type of bacteria involved in the process, and the amount of oxygen and liquid in the manure system. Nitrous oxide emissions are most likely to occur in dry manure handling systems that have aerobic (in the presence of oxygen) conditions, but that also contain pockets of anaerobic (in the absence of oxygen) conditions due to saturation. It should be noted that emissions from livestock manure and urine deposited on pasture, range, or paddock lands, as well as emissions from manure and urine that is spread onto fields, are accounted for under the source category of "Agricultural Soil Management". The U.S. inventory report provides a detailed description on N_2O emissions from livestock manure management and how they are estimated (see the Chapter entitled "Agriculture").

Human sewage. Domestic human sewage is usually mixed with other household wastewater, which includes shower drains, sink drains, washing machine effluent, etc. and transported by a collection system to either an on-site (e.g., a septic system) or centralized wastewater treatment plant. Nitrous oxide (N_2O) may be generated during both nitrification and denitrification of the nitrogen present, usually in the form of urea, ammonia, and proteins. These compounds are converted to nitrate via nitrification, an aerobic (in the presence of oxygen) process converting ammonia-nitrogen into nitrate (NO_3). Denitrification occurs under anaerobic conditions (in the absence of oxygen), and involves the biological conversion of nitrate into dinitrogen gas (N_2). Nitrous oxide can be an intermediate product of both these processes. The U.S. inventory report provides a detailed description on N_2O

emissions from human sewage and how they are estimated (see the Chapter entitled "Waste").

Adipic acid production. Although only responsible for about 1 percent of the total nitrous oxide emissions in the U.S., adipic acid production is an important category from an individual plant perspective and because of the efforts that have been made to reduce emissions from those plants. N_2O is generated as a by-product during the production of adipic acid which is used in the production of nylon and as a flavor enhancer for some foods. This white crystalline solid is used in the manufacture of synthetic fibers, coatings, plastics, urethane foams, elastomers, and synthetic lubricants. The U.S. inventory report provides a detailed description on N_2O emissions from adipic acid production and how they are estimated (see the chapter entitled "Industrial Processes").

Natural Sources - Global Emissions



See EPA's Methane and Nitrous Oxide Emissions From Natural Sources (PDF) (194 pp, 1.9MB, About PDF), published April 2010.

Natural emissions of N_2O primarily result from bacterial breakdown of nitrogen in soils and in the earth's oceans. Globally, soils covered by natural vegetation are estimated to produce 6.6 Tg of N_2O annually and oceans are thought to add around 5.4 Tg of N_2O annually to the atmosphere (U.S. EPA). Together, these two sources account for over 90 percent of the natural sources. Nitrous oxide is also produced in smaller quantities from chemical reactions in the atmosphere. In some ocean areas, large areas of surface water can become oxygen depleted, allowing active denitrification in open water. Large amounts of oceanic nitrous oxide can also arise from denitrification in marine sediments, particularly in nutrient rich areas such as those of estuaries.

It is important in studies of N_2O emissions to account for the various interactions between natural processes and human influences in the nitrogen cycle, since human impacts can significantly enhance the natural processes that lead to N_2O formation. For example, the nitrogen nutrient loading in water bodies due to fertilization and run-off to streams can enhance N_2O emissions from these natural sources. Human-related ammonia emissions have also been shown to cause N_2O emissions in the atmosphere through ammonia oxidation.

References

IPCC 2007: Climate Change 2007: The Physical Science Basis EXIT Disclaimer Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)].

Methane and Nitrous Oxide Emissions From Natural Sources (PDF) (194 pp, 1.9MB, About PDF), April 2010.

EXHIBIT RB-10

US EPA SUPERFUND FACT SHEET
EPA JACKSONVILLE ASH SITE SUMMARY

U. S. Environmental Protection Agency
Region 4
Jacksonville Health Zone 1
Superfund Update Fact Sheet

Jacksonville, Florida | **Duval County** | **July 2011**

The United States Environmental Protection Agency (EPA), Region 4, is committed to informing the citizens affected by the cleanup activities of the Superfund Sites within Health Zone 1 of cleanup progress. This fact sheet provides information related to water bodies surrounding Superfund cleanup location(s).

Jacksonville Ash Sites

The Jacksonville Ash Superfund sites are comprised of three facilities in Jacksonville, Duval County, Florida: the **Forest Street Incinerator**, the **5th & Cleveland Incinerator**, and the **Lonnie C. Miller, Sr. Park**. The Forest Street Incinerator occupies approximately 460 acres of land and, together with the 5th & Cleveland Incinerator, operated as the City of Jacksonville's municipal solid waste incinerator from the 1940s until the 1960s. Combustion ash, clinker, and ash residues were disposed of on each of the incinerator properties and also on the land that was later redeveloped into the Lonnie C. Miller, Sr. Park. Current land uses on this large site include residential, commercial, recreational, and public services, including the Forest Park Head Start School and the Emmet C. Reed Community Center.

The City of Jacksonville conducted a preliminary assessment at the sites and found significantly elevated lead levels in the soil and ground water due to the presence of incinerator ash on the sites. Elevated levels of arsenic, metals, and dioxins were also found in soils at each of the three facilities. From 1997 through 2004, EPA conducted a series of investigations, analyzing for metals, semi-volatile organics, pesticides, polychlorinated biphenyls (PCB), and dioxins in soils, surface water, sediments and ground water at each of the three sites.

The surface water migration pathway was of potential concern because elevated levels of arsenic and lead were detected in sediment samples from McCoy's Creek during the investigation. In 2004, EPA funded the Duval County Health Department *Fish Tissue Study and Exposure Investigation* on the Ribault River and McCoy's Creek. Based on this study, detected levels of metals and dioxins in fish were below levels of concern for human consumption, and no recommendation or advisory was issued. Currently, all three of the sites are being cleaned up following the completion of the comprehensive site-wide Remedial Action Work Plans.

Brown's Dump

The Brown's Dump Superfund site is located in the City of Jacksonville. Approximately 80 acres in size, the site consists of the former Mary McLeod Bethune Elementary School, an electrical substation of the

Jacksonville Electric Authority (JEA), surrounding single family homes and multiple family complexes (e.g., apartments).

From the late 1940s until the mid-1950s, the site was an operating landfill used to deposit ash from the City of Jacksonville's municipal incinerators (Jacksonville Ash sites). Investigations have indicated that ash is present within the site at depths varying from the surface to, in some locations, greater than 20 feet below land surface. After closure of the landfill in 1953, the property was obtained by the Duval County School Board in 1955, through condemnation procedures, for construction of a school. At approximately the same time and later, land surrounding the original landfill began to undergo development of residential homes and apartment complexes.

The original location of the dumping operation is centered on the northern portion of the former Mary McLeod Bethune Elementary School. School year 2000/2001 was the last year the school operated. Elevated levels of lead, arsenic, other inorganics and dioxin/furans were found in soils. Additionally, lead was detected in sediment samples collected from Moncrief Creek. The groundwater and surface water samples did not show any detectable levels of lead.

In summary, sampling performed to date indicates that sediment does not contain ecologically significant concentrations of contamination, and contaminants found in soil do not appear to be migrating to other media. Ongoing cleanup activities at the Brown's Dump site include stabilization of the banks of Moncrief Creek in addition to contaminated soil excavations.

Kerr McGee (Jacksonville)

The Kerr McGee Chemical site is located at 1611 Talleyrand Avenue along the western shoreline of the St. Johns River in Duval County, Florida. The site was included on the National Priorities List in March 2010 following the Tronox, Inc. bankruptcy.

The site occupies approximately 31 acres and is located within a heavily industrialized area of the City of Jacksonville. The site is bordered to the north by the Port of Jacksonville, to the south by undeveloped property and a trucking company, to the east by the St. Johns River, and to the west by Talleyrand Avenue. Residential and commercial properties are also located near the site. The site is currently unused.

From 1893 to 1978, the site was utilized as a fertilizer and pesticide formulating, packaging, and distributing facility. These operations resulted in the release of various contaminants to the soil, ground water, and sediments in the St. Johns River. Ground water beneath the site discharges to the St. Johns River, and testing of this discharge indicates that dissolved metals, pesticides, and PCBs are reaching the river at levels above ecological screening levels.

From 1984 to 2005, under the jurisdiction of the Florida Department of Environmental Protection (FDEP) and EPA, the potentially responsible party conducted several environmental studies to define the nature and extent of the site contamination. The results of these investigations revealed the presence of volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyls, and metals. EPA is currently in the process of evaluating this information, as well as public comments, to determine the best approach to site cleanup.

Fairfax Street Wood Treater

The Fairfax Street Wood Treater (FSWT) site is a former wood treatment operation located at 2610 Fairfax Street, Jacksonville. The 12-acre site is located in a residential area of Jacksonville, immediately adjacent to two elementary schools, a private school/day care, and several residential properties (both single family and multi-unit).

EPA Superfund Emergency Response and Removal Actions began in August 2010. The Removal Action is currently ongoing and expected to be completed by the fall of 2011. The purpose of the Removal Action is to stabilize the site and remove the most highly contaminated materials, including building materials, surface soils, sediment, and surface water in the on-site detention basin. EPA is also evaluating the need for additional response actions to address long-term clean up of the site. EPA is in the process of determining whether the site qualifies for Superfund Remedial action.

From 1980 to 2010, Wood Treaters LLC pressure treated utility poles, pilings, heavy timber, and plywood products using the wood treating preservative chromated copper arsenate (CCA). CCA is characterized by a bright green color and is composed of waterborne oxides, or salts, of chromium, copper, and arsenic. The copper serves as a fungicide, the arsenic serves as an insecticide, and the chromium binds the copper and arsenic to the wood. Wood was pressure treated with CCA and allowed to drip dry on site.

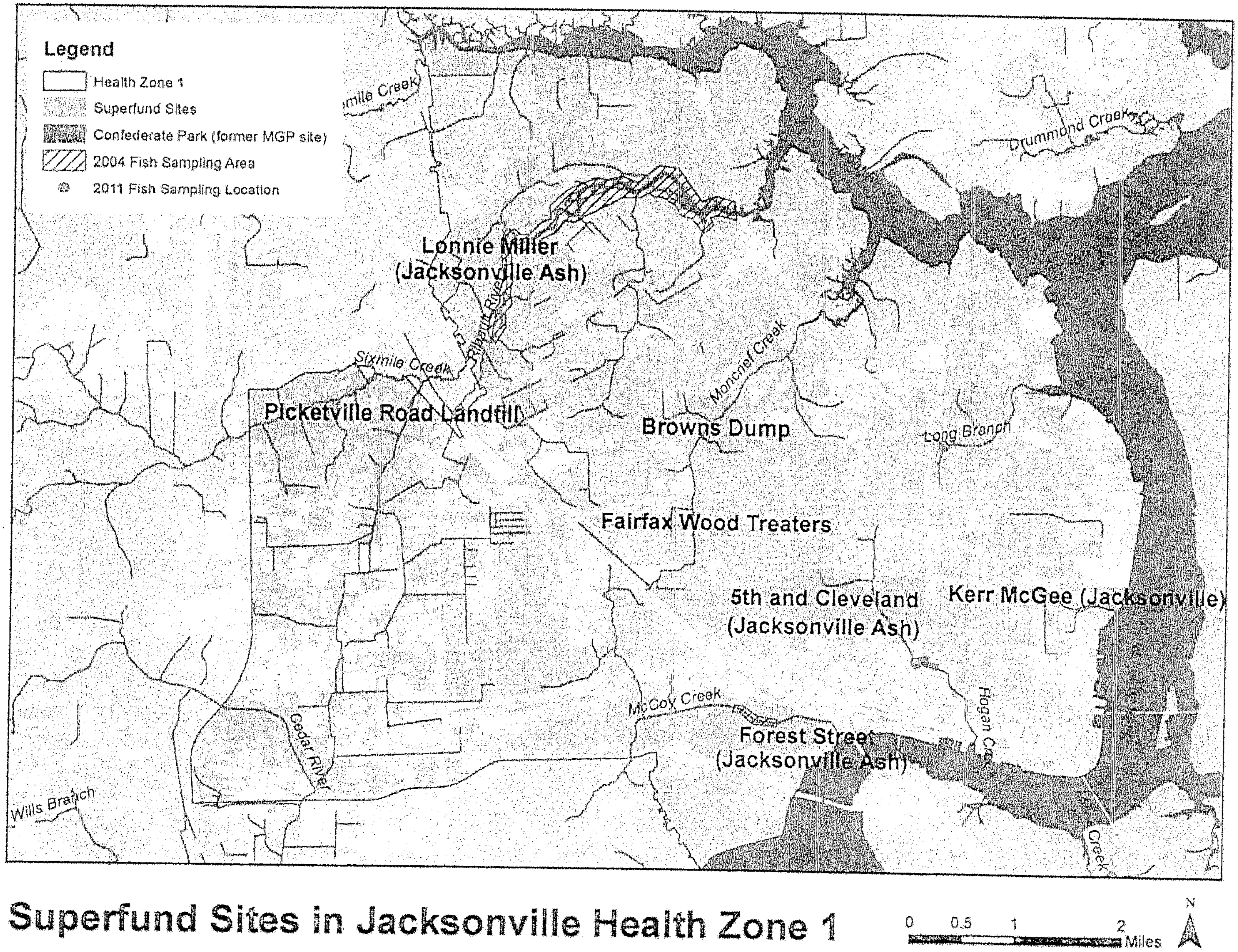
While the treated wood drip-dried, CCA was deposited onto the ground and concrete drip pad, causing contaminated soil. During rain events, the CCA mixed with rain water resulting in contaminated stormwater. Some of the CCA contaminated stormwater was collected and reused for wood treating, and some of it was uncontrolled and flowed off the site and onto surrounding properties. Wood treating operations resulted in soil contamination with chromium, copper and arsenic.

During operation, stormwater was diverted to ditches along the northern and western property boundaries and drained to a retention pond at the northwestern corner of the property. An overflow pipe is located in the retention pond discharges into Moncrief Creek, a tributary of the Trout River. Low levels of arsenic contamination have been found in Moncrief Creek.

Picketville Road Landfill

The Pickettville Road Landfill site occupies approximately 52 acres in Jacksonville, Duval County, Florida adjacent to Little Sixmile Creek. Landfill operations began at the Site in 1968. Initially all types of wastes were disposed at the site, including municipal waste, and industrial wastes such as oil, lead acid battery liquid waste, battery casings, light turpentine sludge, and PCBs. However, in 1971, municipal waste was diverted to other municipal landfills and the site was dedicated for the disposal of hazardous wastes.

Physical construction of the remedy was completed in 1997, and ground water monitoring demonstrates that natural attenuation of ground water contamination is occurring. Ground water monitoring has continued for more than ten years, and over this period volatile organic compounds have attenuated to below cleanup standards and natural attenuation of other contaminants is proceeding as expected. Ongoing operation and maintenance activities consist of groundwater monitoring and site maintenance.



Superfund Sites in Jacksonville Health Zone 1

ADDITIONAL INFORMATION

Jacksonville Ash Repositories
Jacksonville Urban League
903 West Union Street
Jacksonville, FL 32205
or
Bradham Brooks Public Library
1755 West Edgewood Avenue
Jacksonville, FL 32208

Brown's Dump Repository
Clanzel T. Brown Center
4415 Moncrief Rd.
Jacksonville, FL
904-764-8752

Kerr McGee (Tronox) Repository
Jacksonville Public Library
Eastside Branch
1390 Harrison Street
Jacksonville, FL 32206

Fairfax Repository
Dallas James Graham Branch Library
2304 N. Myrtle Avenue
Jacksonville, FL 32209

Picketville Repository
Jacksonville Main Public Library
303 N. Laura Street
Jacksonville, Florida 32202

Further information can be provided by EPA- Region 4 Representatives

Jacksonville Ash & Brown's Dump
Joe Alfano
Remedial Project Manager
(404) 562-8933 or (800) 435-9234
Alfano.Joe@epa.gov

Kerr McGee (Tronox)
Robenson Joseph
Remedial Project Manager
(404) 562- 8891 or (800) 435-9234
Joseph.robenson@epa.gov

Fairfax Wood Treater
Cathy Amoroso
Remedial Project Manager
(404) 562-8637 or (800) 435-9233
Amoroso.cathy@epa.gov

Picketville Superfund Site
Scott Martin
Remedial Project Manager
(404) 562- 8916 or (800) 435-9234
Martin.scott@epa.gov

L'Tonya Spencer
Community Involvement Coordinator
(404) 562-8463 or (877) 718-3752
Spencer.Latonya@epa.gov

U.S. EPA – Region 4
Superfund Division
61 Forsyth Street, SW
Atlanta, GA 30303

Region 4: Superfund

Jacksonville Ash

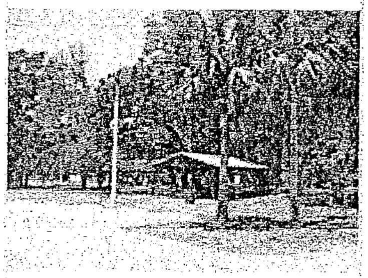
Site Summary Profile

EPA ID: FLSFN0407002
Location: Jacksonville, Duval County, FL
Lat/Long: 30.345109, -081.670247
Congressional District: 03
NPL Status: Superfund Alternative Site
Affected Media: Soil
Cleanup Status: Construction Underway - Physical cleanup activities have started.
Site Reuse/Redevelopment: Continued Residential, Commercial, Recreational, and Public Services land uses.
Site Manager: Joe Alfano (alfano.joe@epa.gov)

National Information

CERCLIS Site Profile
Additional Site Documents
Site Contaminants of Concern

Photos/Multimedia



Lonnie C. Miller park on the Jacksonville Ash site.
- Additional Site Photos
- Site Video

Additional Resources

Site Cleanup Terms - can be found in EPA's glossary
EPA Guides to Cleanup Technologies
Superfund Community Involvement (PDF) (17 pp, 130K, About PDF)

Site Background

EPA will host a public meeting on the Jacksonville Ash, Kerr McGee, Picketville, and Brown's Dump sites on July 14, 2011, at 2 p.m. at Fresh Ministries located at 616 A Philip Randolph Blvd, Jacksonville, FL 32202 and at 6 p.m. at the Kennedy Community Center located at 1133 Ionia St, Jacksonville, FL 32206. Additional information about the water bodies surrounding Superfund cleanup location(s) are available in the Jacksonville Health Zone 1 Fact Sheet.

The Jacksonville Ash site is comprised of three facilities in Jacksonville, Duval County, Florida: the Forest Street Incinerator, the 5th & Cleveland Incinerator, and the Lonnie C. Miller, Sr. Park. The Forest Street Incinerator occupies approximately 460 acres of land and, together with the 5th & Cleveland Incinerator, operated as the City of Jacksonville's municipal solid waste incinerator from the 1940s until the 1960s. Combustion ash, clinker, and ash residues were disposed of on each of the incinerator properties and also on the land that was later redeveloped into the Lonnie C. Miller, Sr. Park. After incinerator operations ceased, the properties were briefly used as a construction debris depository, a quail farm, and a junkyard. Current land uses on this large site include residential, commercial, recreational, and public services, including the Forest Park Head Start School and the Emmet C. Reed Community Center.

The site is not listed on the NPL, but is considered to be an NPL-caliber site and is being addressed through the Superfund Alternative Approach. This approach uses the same investigation and cleanup process and standards that are used for sites listed on the NPL.

Threats and Contaminants

The City of Jacksonville conducted a Preliminary Contamination Assessment at the site and found significantly elevated lead levels in the soil and ground water due to the presence of incinerator ash on the site. Elevated levels of arsenic, metals, and dioxins were also found in soils at each of the three facilities.

Site Cleanup Plan

The Record of Decision (ROD) for the site was issued in 2006. Major cleanup elements for the site included:

Removal of ash-related contamination to a depth of up to two feet in residential areas.
Placement of a two foot clean soil cover over ash-related contamination in non-residential areas.

Cleanup Progress

As an interim measure, the City of Jacksonville installed a fence to restrict access to the most highly contaminated areas of the site. The City also began covering the exposed ash with gravel, sod, and compost to reduce potential exposure.

The City of Jacksonville began the Remedial Design of the selected site remedy under a Consent Decree signed in July 2008.

Additional soil sampling will be required to comply with the State of Florida Global Risk Based Corrective Action (RBCA) standards for arsenic and dioxin that were signed into law in June 2003. The additional soil sampling will proceed simultaneously with the design of the selected remedy.

Site cleanup activities are being led primarily by potentially responsible parties (PRPs) with oversight by EPA.

The first phase of the remediaton started in April of 2010 and has resulted in the excavation of ash - contaminated soil from approximately 300 residential yards. The second phase will start in early 2011 and include the remaining properties that require remediation.

Enforcement Activities

In May 1999, EPA sent Special Notice Letters to the City of Jacksonville identifying the City as a PRP for the Jacksonville Ash site.

The City of Jacksonville voluntarily entered into an Administrative Order on Consent with EPA in September 1999 to perform a Remedial Investigation/Feasibility Study (RI/FS) for the site.

A Consent Decree for the PRP's completion of the Remedial Design/Remedial Action was lodged with Florida Superior Court in July 2008. The final settlement was for the estimated remedial cost of $96 million.

Community Involvement

EPA has conducted a range of community involvement activities at the Jacksonville Ash site to solicit community input and to ensure that the public remains informed about site activities throughout the site cleanup process. Outreach activities have included fact sheets, public notices, interviews, and public meetings on cleanup activities and updates.

Fact Sheets

- Fact Sheet, July 2011 (PDF) (5 pp, 296K, About PDF)
- Fact Sheet, November 1999 (PDF) (8 pp, 79K, About PDF)
- Fact Sheet, May 2000 (PDF) (11 pp, 543K, About PDF)
- Jacksonville Ash L.C. Miller Park Site Reuse Fact Sheet(PDF) (1 pg, 1.0MB, About PDF)
- Jacksonville Ash 5th and Cleveland Reuse Fact Sheet (PDF) (1 pg, 900K, About PDF)
- Jacksonville Ash Forest Street Reuse Fact Sheet (PDF) (1 pp, 659KB, About PDF)
- EPA Children's Health Fair & Environmental Justice Showcase Recognition Event October 7, 2011 (PDF) (1 pp, 536.98KB, About PDF)
- EPA Children's Health Fair & Environmental Justice Showcase Recognition Event October 8, 2011 (PDF) (1 pp, 450.91KB, About PDF)

Future Work

Phase 2 of the remediation will begin early in 2011.

Site Administrative Documents

Site Repository

For more information or to view any site-related documents, please visit the site information repository at the following location. As new documents are generated, they will be placed in the information repository for public information.

Jacksonville Urban League
903 West Union Street
Jacksonville, FL 32205

Bradham Brooks Public Library
1755 West Edgewood Avenue
Jacksonville, FL 32208

Administrative Record Index

- Administrative Record, 1999 (PDF) (4 pp, 170K, About PDF)
- Administrative Record, 2004 (PDF) (10 pp, 557K, About PDF)
- OU-1 (PDF) (13 pp, 880K, About PDF)

For documents not available on the website, please contact the Region 4 Freedom of Information Office.

EXHIBIT RB-11

DOES BURNING GARBAGE TO PRODUCE ELECTRICITY MAKE SENSE?

WASTE-TO-ENERGY IS A CLIMATE-FRIENDLY, RENEWABLE ENERGY SOURCE

WASTE NOT, WANT NOT THE FACTS BEHIND WASTE-TO-ENERGY

IS IT BETTER TO BURN OR BURY WASTE FOR CLEAN ELECTRICITY GENERATION

SCIENTIFIC AMERICAN™

Permanent Address: http://www.scientificamerican.com/article.cfm?id=does-burning-garbage-to-produce-energy-make-sense

Does Burning Garbage to Produce Electricity Make Sense?

Such incinerators are making progress in the U.S. but critics remain

By Julia Pyper and ClimateWire | Friday, August 26, 2011 | 11 comments

From the sidewalk there's almost no evidence that behind the walls of the energy-from-waste plant in Alexandria, Va., an incinerator is burning garbage at more than 1,700 degrees Fahrenheit and providing electricity to thousands of homes.

"Everything that the resident puts out on the street in a trash can comes here," said Bryan Donnelly, the facility manager. At his location, that amounts to about 350,000 tons of municipal waste per year.

The plant, built in 1988, processes garbage from all of Alexandria and Arlington, Va., and some parts of the District of Columbia and Maryland. Heat from the high-temperature incineration of waste, which company representatives call a "clean burn," runs a generator that puts 23 megawatts of electricity back on the grid -- enough to power 20,000 homes.

The facility is owned and operated by Covanta Energy Corp., one of the leaders in converting solid waste into energy, with 41 plants in North America. On average, the company produces 550 to 750 kilowatt-hours of electricity per ton of waste, said Chief Sustainability Officer Paul Gilman. While the power comes from burning garbage, there's a big difference between a traditional incinerator and what Covanta does, he said -- "we're a power plant."

"We have the same waste hierarchy as the E.U.: reduce, reuse, recycle, energy recovery and disposal," said Gilman. "[This] is that step we call the 'fourth R.' After you reduce, reuse and recycle that, you take the step of energy recovery before you put it in the ground."

To make sure the energy is generated cleanly, Covanta says, there are a number of high-tech pollution controls in place. That includes a baghouse to capture particulate matter (such as mercury), carbon injections to absorb heavy metals, dioxins and furans, and the addition of lime to neutralize acid gases. Computer systems closely monitor pollutant levels to make sure they remain as low as possible.

But some communities and environmentalists question whether those measures are enough, while waste-to-energy facilities are rejected in places where it is still more economical to send waste to landfills. There are also concerns over harmful greenhouse gas emissions, the sustainability of energy recovery plants and whether or not they inhibit recycling efforts.

Many of these worries were expressed in public comment submissions last week in response to Covanta's petition to have energy from waste included in the main tier of New York state's renewable portfolio standard (RPS). Opponents say labeling waste as a renewable energy source will take dollars away from projects like wind and solar. Some claim the action also detracts from the larger issue -- that there needs to be more recycling and less waste to begin with.

How to turn trash into energy and offset emissions

There are currently 86 waste-to-energy facilities in the United States. According to the Energy Recovery Council, they provide 2,700 MW of clean electricity on a 24-hour-per-day, 365-day-per-year basis -- enough to power about 2 million homes.

In Europe there are more than 400 of these facilities. Another 300 facilities, many of which are in China and Japan, are located around the world, in 40 countries in total.

The way the system works is this: A dump truck drops the municipal waste into a warehouse-sized pit. Then a giant claw (much like one that picks up loot in an arcade game) grabs nearly a truckload of garbage and dumps it into an incinerator.

Technology developed in Europe mixes the waste at temperatures of up to 2,000 degrees Fahrenheit. The heat then makes steam, which runs a turbine and produces electricity.

Metals are separated. Covanta claims to recycle 400,000 tons of metal per year. Leftover ash, now a cement-like product, is carted off to line landfills.

Today's incinerators pollute less because of U.S. EPA's strict maximum available control technology (MACT) regulations, said Nicholas Themelis, a Columbia University professor of engineering and waste-to-energy researcher. The MACT standards forced companies to introduce scrubbing technology. According to Covanta, its technology performs 60 to 80 percent better than required under the MACT standard.

In a 2007 memo, EPA compared the industry's emissions performance for major pollutants between 1990 and 2005. The report found a 24 percent decrease in nitrogen oxide, an 88 percent drop in sulfur dioxide and a decrease in dioxins and mercury of 99 percent and 96 percent, respectively, over the time period.

But Covanta's Gilman said the real savings are in reducing landfill methane emissions. For every ton of waste that goes through the facility, he contends, a ton of greenhouse gas emissions is avoided. Two-thirds of the incinerated material is biomass. The remaining one-third is essentially a fossil fuel.

Carbon savings come from the offsetting of methane emissions that would have been released if the ton of waste had gone to a landfill. Methane is 21 percent more potent as a global warmer than carbon dioxide.

Themelis said emissions reductions are probably a little lower than what the company suggests.

Based on these reductions, a study published in the journal *Waste Management & Research* determined that municipal solid waste constituted a "stabilization wedge" that could mitigate atmospheric concentrations of greenhouse gases. Authors said that if global waste was managed as it is in many parts of Europe -- more recycling, use of the waste-to-energy process and the limited use of landfills -- it would reduce greenhouse emissions by 1 billion tonnes per year.

One researcher on the paper was a Covanta employee, however, and not all analyses of waste-to-energy projects have painted such a positive picture.

Emissions improvements questioned

Covanta has applied for main-tier status in New York's RPS, a program to increase the state's renewable energy capacity to 30 percent by 2015. The theory is that energy from waste provides reliable baseload energy and significant greenhouse gas reductions.

New York already classifies "wastes" as renewable resources, but becoming part of the state's renewable portfolio would make Covanta eligible for ratepayer funding. Last Friday, the comment period closed on Covanta's petition.

Laura Haight, senior environmental associate at New York Public Interest Research Group (NYPIRG), says that if the petition passes, waste will take incentives away from more sustainable technologies like wind and solar. She also says that presenting the issue as though incineration offsets landfill emissions is the wrong approach.

"In framing this whole debate as incineration versus landfills, they're pushing the needle back 20 years," said Haight. "Twenty years ago, people used to say we need to do more recycling; now we're talking about more burying or burning. No, we need to be doing more recycling."

Haight points out that more energy is saved by reusing materials instead of destroying them. Also, rather than being burned, biomass could be composted and used for energy recovery, she said.

While not taking a direct stance on the petition, the New York State Department of Environmental Conservation (DEC) also presented some concerns. The DEC wrote in its comments that Covanta was denied entry to the RPS in 2004 because in the year 2000, mercury emissions from waste-to-energy facilities in New York were an average of six times higher than coal.

The report also found waste-to-energy facilities "continue to emit most air pollutants at emission rates that are greater than coal-fired power plants on a per megawatt-hour (MWh) basis."

"This is a big issue here in New York," said Haight. "They're seeking to be included as a clean energy source, so we need to push hard on the issue of the emissions. Even though they have improved over the years, that doesn't mean they should be considered clean energy."

Last week, Covanta received the go-ahead to start building a C$250 million plant in Clarington, Ontario, where officials have said they see the project as a sustainable way to manage waste.

Reprinted from Climatewire with permission from Environment & Energy Publishing, LLC. www.eenews.net, 202-628-6500

INTEGRATED WASTE SERVICES ASSOCIATION

Waste-To-Energy is a Climate-Friendly, Renewable Energy Source

www.wte.org/climate

In determining the sources to include under a greenhouse gas emissions cap, policymakers should evaluate the complete lifecycle of the source. Sources that reduce greenhouse gases over their lifecycle should be encouraged rather than regulated. Applying a lifecycle analysis to waste-to-energy facilities demonstrates that they are net reducers of greenhouse gases and should be treated accordingly under any policy to regulate greenhouse gas emissions. Crafting a climate policy that recognizes the benefits of waste-to-energy will have the desired effect of providing incentives to renewable energy sources that minimize greenhouse gases and promote energy independence and fuel diversity. Waste-to-energy facilities should qualify as sources of offsets in any climate change program and be excluded as a source regulated under a cap.

Waste-to-Energy Basics

Waste-to-energy facilities generate electricity and steam using municipal solid waste as the primary fuel source. The facilities burn waste in specially designed boilers to ensure complete combustion and employ modern pollution control equipment to scrub emissions.

The result is clean, renewable energy. Nationwide, 87 waste-to-energy plants supply about 2,500 megawatts of generating capacity to the grid. These plants divert approximately 90,000 tons of waste each day from landfills, generating nearly 17 billion kilowatt hours of electricity per year. This is enough to meet the electricity needs of almost two million homes and represents nearly 20 percent of all non-hydro renewable electricity generation in the U.S. To put this in context, it would take 7.8 million tons of coal to produce the same amount of electricity from a coal-fired power plant. Additionally, waste-to-energy plants generally operate in or near metropolitan areas, increasing transmission efficiency and improving distribution bottlenecks.

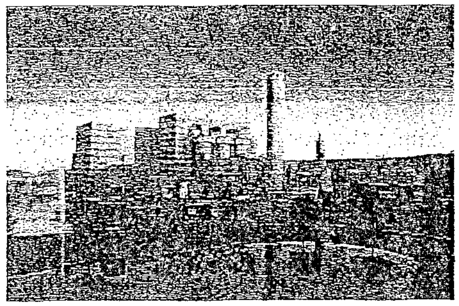
Currently, waste-to-energy facilities process only 8 percent of the municipal solid waste produced in the U.S. each year. This largely untapped resource of readily-available biomass does not require large-scale conversion of arable land or diversion of compostable materials.

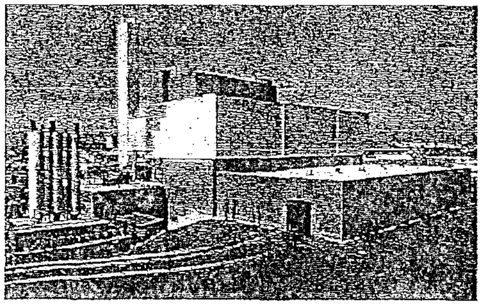
Waste-to-Energy Reduces Greenhouse Gases and Should be Encouraged

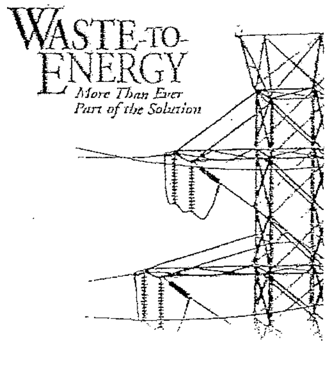
Although waste-to-energy facilities emit CO_2 as part of their process, they achieve a net reduction of greenhouse gas emissions over their lifecycle and should not be covered under an emissions cap.

Waste-to-energy emits two types of CO_2: biogenic and anthropogenic. Most of the emissions (67%) are biogenic. These emissions result from the combustion of biomass, which is already part of the Earth's natural carbon cycle – the plants and trees that make up the paper, food, and other biogenic waste remove CO_2 from the air while they are growing, which is returned to the air when this material is burned at a waste-to-energy facility. Because they are part of the natural carbon cycle, greenhouse gas policies should not seek to regulate these emissions.

The remaining CO_2 emissions are anthropogenic. They come from man-made substances in the waste that is combusted, such as unrecyclable plastics and synthetic rubbers. Despite these emissions, waste-to-energy facilities more than offset these emissions through three separate mechanisms.







Integrated Waste Services Association
1730 Rhode Island Avenue, N.W. Suite 700 | 202-467-6240

Waste-To-Energy is a Climate-Friendly, Renewable Energy Source

www.wte.org/climate

Waste-to-energy facilities reduce greenhouse gas emissions in each of the following ways:

- by generating electrical power or steam, waste-to-energy avoids CO_2 emissions from fossil fuel-based electrical generation;
- the waste-to-energy combustion process eliminates the methane emissions that would have occurred if the waste was placed in a landfill; and
- the recovery of metals from municipal solid waste by waste-to-energy facilities is more energy efficient than the production of metals from raw materials.

As a result of these mechanisms, waste-to-energy produces electricity at a net emission rate of ***negative*** 3,636 lbs of CO_2/ MWh. In other words, on a lifecycle basis, for every ton of trash burned at a waste-to-energy plant, approximately one ton of CO_2 equivalents is reduced.

Climate change policies that only look at the end of the stack may inadvertently include net reducers like waste-to-energy facilities. This would unnecessarily penalize facilities that provide climate change benefits and would be inconsistent with state and regional greenhouse gas programs like the Regional Greenhouse Gas Initiative (RGGI), which exclude waste-to-energy facilities from the definition of covered sources. It would also be inconsistent with international carbon regimes. For example, the Clean Development Mechanism established under the Kyoto Protocol accords waste-to-energy projects offset status for displacing fossil fuel-fired electricity generation and eliminating methane production from landfills. Any federal climate change program should similarly recognize waste-to-energy as an important tool to meet greenhouse gas reduction goals and should treat waste-to-energy as a renewable energy source and an eligible offset project category.

Renewable Energy Policies Should Promote Waste-to-Energy Facilities

Federal, state, and local governments have enacted a variety of laws that recognize waste-to-energy as a renewable energy source. At the federal level, waste-to-energy has been recognized as an important source of renewable energy since the inception of the industry over 30 years ago. The Federal Power Act, the Public Utility Regulatory Policy Act (PURPA), the Biomass Research and Development Act of 2000, the Pacific Northwest Power Planning and Conservation Act, the Internal Revenue Code, the Energy Policy Act of 2005, Executive Order 13123, and Federal Energy Regulatory Commission regulations all recognize waste-to-energy as a renewable source of energy. Most recently, the Emergency Economic Stabilization Act, also recognized waste-to-energy as a renewable energy source by providing a two-year extension of the renewable energy production tax credit for waste-to-energy facilities and other renewable sources.

States Defining Waste-to-Energy as Renewable in State Law (as of 1/1/09)

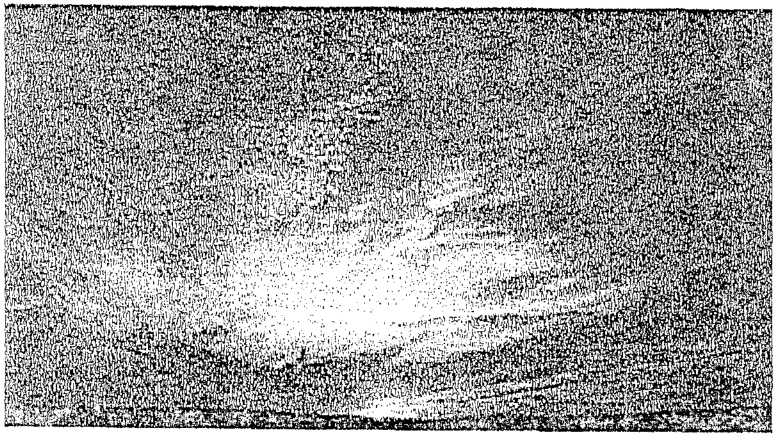
Alaska	Maine	New York
Arkansas	Maryland	Oregon
California	Massachusetts	Pennsylvania
Connecticut	Michigan	South Dakota
District of Columbia	Minnesota	Virginia
Florida	Montana	Washington
Hawaii	Nevada	Wisconsin
Iowa	New Hampshire	
Indiana	New Jersey	

Policies aiming to increase renewable energy production (production tax credit or renewable energy standard) and reduce greenhouse gas emissions (cap-and-trade) should rely on waste-to-energy to assist in these efforts. Increased use of waste-to-energy will help promote energy independence, reduce dependence on fossil fuels, and reduce greenhouse gas emissions. In conclusion, it is essential that any future climate and renewable policies continue to encourage the development and operation of waste-to-energy facilities.

For more information, please contact Ted Michaels, President of IWSA, at 202-467-6240 or tmichaels@wte.org.

Integrated Waste Services Association
1730 Rhode Island Avenue, N.W. Suite 700 | 202-467-6240 | www.wte.org

WASTE NOT, WANT NOT: THE FACTS BEHIND WASTE-TO-ENERGY



Data and facts show that waste-to-energy avoids greenhouse gas emissions, generates clean renewable energy, promotes energy independence, and provides safe reliable disposal services.

Waste Not, Want Not: The Facts Behind Waste-to-Energy

Report by:
Ted Michaels
President
Integrated Waste Services Association

September 2008

The Integrated Waste Services Association (IWSA) was formed in 1991 to promote integrated solutions to municipal solid waste management challenges.

IWSA encourages the use of waste-to-energy technology as an integral component of a comprehensive, integrated solid waste management program.

In addition to providing essential trash disposal services cities and towns across the country, today's waste-to-energy plants generate clean, renewable energy. Through the combustion of everyday household trash in facilities with state-of-the-art environmental controls, IWSA's members provide viable alternatives to communities that would otherwise have no alternative but to buy power from conventional power plants and dispose of their trash in landfills.

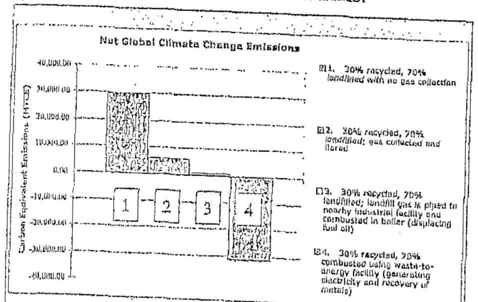
The 87 waste-to-energy plants nationwide dispose of more than 90,000 tons of trash each day while generating enough clean energy to supply electricity to about 2.3 million homes nationwide.

There is a national need for energy sources that promote energy independence, avoid fossil fuel use, and reduce greenhouse gas emissions. Waste-to-energy is well-positioned to deliver these qualities while also providing for safe and reliable disposal of household trash. Application of EPA's lifecycle analysis demonstrates that for every ton of waste processed at a waste-to-energy facility, a nominal one ton of carbon dioxide equivalents is prevented from entering the atmosphere. As progressive environmental policymakers in Europe have learned, waste-to-energy not only reduces a nation's carbon footprint, it is compatible with high recycling rates and helps to minimize the landfilling of trash.

The Role of Waste-to-Energy in Mitigating Climate Change

Waste-to-Energy reduces greenhouse gas emissions

Waste-to-energy achieves the reduction of greenhouse gas emission through three separate mechanisms: 1) by generating electrical power or steam, waste-to-energy avoids carbon dioxide (CO_2) emissions from fossil fuel based electrical generation, 2) the waste-to-energy combustion process effectively avoids all potential methane emissions from landfills thereby avoiding any potential release of methane in the future and 3) the recovery of ferrous and nonferrous metals from MSW by waste-to-energy is more energy efficient than production from raw materials.



Data Source: Thorneloe SA, Weitz K, Jambeck J. Application of the U.S. Decision Support Tool for Materials and Waste Management. WM Journal 2006 August.

These three mechanisms provide a true accounting of the greenhouse gas emission reduction potential of waste-to-energy. A lifecycle analysis, such as the Municipal Solid Waste Decision Support Tool, is the most accurate method for understanding and quantifying the complete accounting of any MSW management option. A life cycle approach should be used to allow decision makers to weigh all greenhouse gas impacts associated with various activities rather than targeting, limiting or reducing greenhouse gas emissions on a source-by-source basis. *(IPCC, EPA)*

The Municipal Solid Waste Decision Support Tool is a peer-reviewed tool, available through the U.S. Environmental Protection Agency and its contractor RTI International, which enables the user to directly compare the energy and environmental consequences of various management options for a specific or general situation. Independent papers authored by EPA (such as *"Moving From Solid Waste Disposal to Management in the United States," Thorneloe (EPA) and Weitz (RTI) October, 2005; and "Application of the U.S. Decision Support Tool for Materials and Waste Management," Thorneloe (EPA), Weitz (RTI), Jambeck (UNH), 2006*) report on the use of the Municipal Solid Waste Decision Support Tool to study municipal solid waste management options.

These studies used a life-cycle analysis to determine the environmental and energy impacts for various combinations of recycling, landfilling, and waste-to-energy. The comprehensive analysis examines collection and transportation, material recovery facilities, transfer stations, composting, remanufacturing, landfills, and combustion. The results of the studies show that waste-to-energy yielded the best results—maximum energy with the least environmental impact (emissions of greenhouse gas, nitrogen oxide, fine particulate precursors, and others). In brief, waste-to-energy was demonstrated to be the best waste management option for both energy and environmental parameters and specifically for greenhouse gas emissions.

When the Municipal Solid Waste Decision Support Tool is applied to the nationwide scope of waste-to-energy facilities that are processing 30 million tons of

trash—the waste-to-energy industry prevents the release of approximately 30 million tons of carbon dioxide equivalents that would have been released into the atmosphere if waste-to-energy was not employed.

Recognition of Waste-to-Energy as a Contributor to Climate Change Solutions

International Acceptance

The ability of waste-to-energy to prevent greenhouse gas emissions on a lifecycle basis and mitigate climate change has been recognized in the actions taken by foreign nations trying to comply with Kyoto targets. The European Union (Council Directive 1999/31/EC dated April 26, 1999) established a legally binding requirement to reduce landfilling of biodegradable waste. *Recognizing the methane release from landfills*, the European Union established this directive to prevent or reduce negative effects on the environment "including the greenhouse effect" from landfilling of waste, during the whole life-cycle of the landfill.

The Intergovernmental Panel on Climate Change (IPCC) has also recognized the greenhouse gas mitigation aspect of waste-to-energy. The IPCC acknowledges that "incineration reduces the mass of waste and can offset fossil-fuel use; in addition greenhouse gas emissions are avoided, except for the small contribution from fossil carbon." This acknowledgement by the IPCC is particularly relevant due to the IPCC being an independent panel of scientific and technical experts that shared the Nobel Peace Prize with Al Gore.

The German Ministry of the Environment published a report in 2005 entitled "Waste Sector's Contribution to Climate Protection," which states that "the disposal paths of waste incineration plants and co-incineration display the greatest potential for reducing emissions of greenhouse gases." The German report concluded that the use of waste combustion with energy recovery coupled with the reduction in landfilling of biodegradable waste will assist the European Union-15 to meet its obligations under the Kyoto Protocol.

Under the Kyoto Protocol, the Clean Development Mechanism (CDM) is a method of emissions trading that allows the generation of tradable credits (Certified Emission Reductions [CERs]) for greenhouse gas emissions reductions achieved in developing countries, which are then purchased by developed countries and applied toward their reduction targets. CERs are also accepted as a compliance tool in the European Union Emissions Trading Scheme.

Waste-to-energy projects can be accorded offset status under the CDM protocol (AM0025 v7) by displacing fossil fuel-fired electricity generation and eliminating methane production from landfills. *An associated* CDM memorandum that set out methodology for including waste-to-energy, among others, in CDM projects. The memorandum, entitled "Avoided emissions from organic waste through alternative waste treatment processes," stated in part that CDM status could be accorded projects where "the project activity involves … incineration of fresh waste for energy generation, electricity and/or heat" where the waste "would have otherwise been disposed of in a landfill."

Domestic Recognition

The contribution of waste-to-energy to reduce greenhouse gas emissions has been embraced domestically as well. The U.S. Conference of Mayors adopted a resolution in 2004 recognizing the greenhouse gas reduction benefits of waste-to-energy. In addition, the U.S. Mayors Climate Protection Agreement supports a 7 percent reduction in greenhouse gases from 1990 levels by 2012. By signing the agreement, mayors have pledged to take actions in their own communities to meet this target, and have recognized waste-to-

> *"Generation of energy from municipal solid waste disposed in a waste-to-energy facility not only offers significant environmental and renewable benefits, but also provides greater energy diversity and increased energy security for our nation."*
>
> —The United States Conference of Mayors, Adopted Resolution on Comprehensive Solid Waste Disposal Management (2005)

How are greenhouse gases measured?

There are two types of carbon dioxide emissions: biogenic and anthropogenic. The combustion of biomass generates biogenic carbon dioxide. Although waste-to-energy facilities do emit carbon dioxide from their stacks, the biomass-derived portion is considered to be part of the Earth's natural carbon cycle. The plants and trees that make up the paper, food, and other biogenic waste remove carbon dioxide from the air while they are growing, which is returned to the air when this material is burned. Because they are part of the Earth's natural carbon cycle, greenhouse gas regulatory policies do not seek to regulate biogenic greenhouse gas emissions. (IPCC)

Anthropogenic carbon dioxide is emitted when man-made substances in the trash are burned, such as plastic and synthetic rubber. Testing of stack gas from waste-to-energy plants using ASTM Standards D-6866 can determine precisely the percentage of carbon dioxide emissions attributable to anthropogenic and biomass sources. Long-term measurements of biogenic CO_2 from waste-to-energy plants measure consistently at approximately sixty-seven percent. The amount of anthropogenic CO_2 is approximately 1,294 lbs/MWhr when considered as a separate factor. However, when other unit operations are also factored in on a life cycle basis—such as avoided CO_2, avoided methane, and recovered materials—the result is a negative value of 3,636 lbs/MWhr. This approach is favored by the IPCC, which has endorsed the use of life cycle assessment.

One must remember that direct emissions are only part of the equation. Because we live in a three-dimensional world, we must look at all inputs if we are truly interested in reducing how much greenhouse gas is being released to the atmosphere and how to reduce that number by the greatest amount. The use of waste-to-energy: avoids landfilling and prevents subsequent methane generation; replaces and offsets electric power generated by fossil fuels and offsets their higher greenhouse gas emissions; and recovers and recycles metals that can be used in products rather than virgin materials, which results in a large greenhouse gas savings.

It is the large amount of greenhouse gases avoided by the use of waste-to-energy compared to the limited amount of direct carbon dioxide emissions emitted through the combustion of trash that has led to the conclusion that for every ton of trash processed by a waste-to-energy plant, approximately one ton of carbon dioxide equivalents are avoided.

Air Emissions of Waste-To-Energy and Fossil Fuel Power Plants (Pounds per Megawatt Hour)

Fuel Type	Direct CO_2[1]	Life Cycle CO_2E[2]
Coal	2,138	2,196
Residual Fuel Oil	1,496	1,501
Natural Gas	1,176	1,276
Waste-to-Energy[3]	1,294	-3,636

[1]Based on 2007 EPA eGRID data except WTE which is a nationwide average using 34% anthropogenic CO_2.
[2]Life Cycle CO2E for fossil fuels limited to indirect methane emissions using EPA GHG Inventory and EIA power generation data. Life Cycle value would be larger if indirect CO_2 was included.
[3]Life Cycle CO_2E for WTE based on nominal nationwide avoidance ratio of 1 ton CO_2E per ton of MSW using the Municipal Solid Waste Decision Support Tool, which includes avoided methane and avoided CO_2.

energy technology as a means to achieve that goal. As of July 2, 2008, 850 mayors have signed the agreement.

Columbia University's Earth Institute convened the Global Roundtable on Climate Change (GROCC), which unveiled a joint statement on February 20, 2007 identifying waste-to-energy as a means to reduce CO_2 emissions from the electric generating sector and methane emissions from landfills. This important recognition from the GROCC, which brought together high-level, critical stakeholders from all regions of the world, lends further support that waste-to-energy plays an important role in reducing greenhouse gas emissions. The breadth of support for the GROCC position is evidenced by those that have signed the joint statement, including Dr. James Hansen of the NASA Goddard Institute for Space Studies, as well as entities as diverse as American Electric Power and Environmental Defense.

The History and Role of Waste-to-Energy as a Renewable Energy Resource

Municipal Solid Waste is a Renewable Fuel

The sustainable nature of MSW is a major component of its historic renewable status. For more than three and a half decades, despite all of the efforts of EPA and many others to reduce, reuse and recycle, the U.S. diversion rate of municipal solid waste has climbed to barely above 30%. During this same time period, the solid waste generation rate has more than *doubled* and the population has risen by more than 96 million people. Furthermore, for the past several years, the national average diversion rate has increased by less than one percentage point per year. Today, Americans dispose of 278 million tons of municipal solid waste per year of which less than 30 million tons is used as fuel in waste-to-energy facilities. It is clear to see that for the foreseeable future there will be no end to an amount of municipal solid waste available as a renewable fuel.

> *Waste-to-energy plants are a "clean, reliable, renewable source of energy" that "produce 2,800 megawatts of electricity with less environmental impact than almost any other source of electricity." Communities "greatly benefit from the dependable, sustainable [solid waste disposal] capacity of municipal waste-to-energy plants."*
>
> —USEPA letter from Assistant Administrators Marianne Horinko, Office of Solid Waste and Emergency Response, and Jeffery Holmstead, Office of Air and Radiation to IWSA, 2/14/03

Waste-to-Energy has a Long Track Record as Renewable

Policymakers for three decades (since the inception of the commercial waste-to-energy industry) have recognized municipal solid waste as a renewable fuel. The most recent statutory recognition came in section 203 of the Energy Policy Act of 2005, which defined municipal solid waste as "renewable energy."

While the Energy Policy Act of 2005 is the most recent example, waste-to-energy is given full renewable status for the municipal solid waste it processes under a number of statutes, regulations, and Executive Orders, including:

- the Federal Power Act
- the Public Utility Regulatory Policy Act
- the Biomass Research and Development Act of 2000
- the Pacific Northwest Power Planning and Conservation Act
- Section 45 of the Internal Revenue Code
- Executive Order 13423
- Federal Energy Regulatory Commission regulations (18 CFR.Ch. I, 4/96 Edition, Sec. 292.204)
- statutes in more than two dozen states, including more than a dozen renewable portfolio standards.

The production of clean energy from garbage has been attained by a heavy investment by the waste-to-energy industry and its municipal partners. Waste-to-energy facilities achieved compliance in 2000 with Clean Air Act standards for municipal waste combustors. More than $1 billion was spent by companies and their municipal partners to upgrade facilities, leading EPA to write that the "upgrading of the emissions control systems of large combustors to exceed the requirements of the Clean Air Act Section 129 standards is an impressive accomplishment."

Waste-to-Energy Generates Much Needed Baseload Renewable Power

It is important to consider that waste-to-energy plants supply power 365-days-a-year, 24-hours a day and can operate under severe conditions. For example, Florida's waste-to-energy facilities have continued operation during hurricanes, and in the aftermath of the storm provide clean, safe and reliable waste disposal and energy generation. Waste-to-energy facilities average greater than 90% availability of installed capacity. The facilities generally operate in or near an urban area, easing electric transmission to the customer and minimizing waste transport. Waste-to-energy power is sold as "baseload" electricity to utilities that can rely upon its supply of electricity. There is a constant need for trash disposal, and an equally constant need for reliable energy generation.

Waste-to-Energy Actively Participates in the REC Markets

Municipalities and companies that own and operate waste-to-energy facilities are already actively participating in the renewable energy trading markets. Waste-to-energy is included in many state renewable portfolio standards and has traded frequently in those markets. Facilities have also sold RECs to entities interested in acquiring RECs on a voluntary basis. Furthermore, waste-to-energy facilities have successfully won bids to sell RECs to the federal government through competitive bidding processes.

States Defining Waste-to-Energy as Renewable in State Law (as of 6/30/08)

Alaska	Maine	New York
Arkansas	Maryland	Oregon
California	Massachusetts	Pennsylvania
Connecticut	Michigan	South Dakota
District of Columbia	Minnesota	Virginia
Florida	Montana	Washington
Hawaii	Nevada	Wisconsin
Iowa	New Hampshire	
Indiana	New Jersey	

Waste-to-Energy is Compatible with Recycling

Statistics compiled for more than a decade have proven that waste-to-energy and recycling are compatible despite many attempts by naysayers to conclude otherwise. Since research on the subject began in 1992, communities that rely upon waste-to-energy maintain, on average, a higher recycling rate than the national EPA average.

WTE Community Average Recycling Rate vs. National Average

Year	WTE Recycling Rate	National Recycling (4)
2004	34% (1)	31%
2002	33% (2)	30%
1992	21% (3)	17%

(1) Source: J. V. L. Kiser, based on feedback from 94 WTE communities.
(2) Source: J. V. L. Kiser, based on feedback from 98 WTE communities.
(3) Source: J. V. L. Kiser, based on feedback from 66 WTE communities.
(4) Source: U.S. EPA, based on most recent data available during the study year.

Communities that employ integrated waste management systems usually have higher recycling rates and the use of waste-to-energy in that integrated system plays a key role. Specific examples of why waste-to-energy communities are successful recyclers include:

- communities with waste-to-energy plants tend to be more knowledgeable and forward thinking about recycling and MSW management in general;
- communities with waste-to-energy plants have more opportunities to recycle since they handle the MSW stream more;
- the municipal recycling program can be combined with on-site materials recovery at the waste-to-energy plant (e.g. metals recovered at a waste-to-energy plant post-combustion usually cannot be recycled curbside and would otherwise have been buried had that trash been landfilled); and
- waste-to-energy plant officials promote recycling during facility tours and conduct community outreach efforts that may not be occurring in other locations.

Many communities are connected to off-site recycling programs, such as curbside collection, drop off centers, MRFs, and/or yard waste management. In addition to the typical metals, glass, plastic, and paper from household and/or commercial sources, the communities reported having recycling programs for handling other materials. These ranged from batteries, used oil, and e-waste, to household hazardous waste, public and school outreach programs, and tires management, to scrap metals, food waste, and artificial reef construction projects.

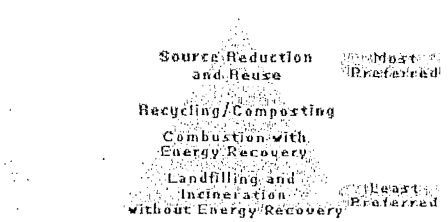
The U.S. Environmental Protection Agency and the European Union Prefers Waste-to-Energy to Landfilling

Waste-to-energy has earned distinction through the U.S. Environmental Protection Agency's solid waste management hierarchy, which recognizes combustion with energy recovery (as they refer to waste-to-energy) as preferable to landfilling. EPA recommends that after efforts are made to reduce, reuse, and recycle, trash should be managed at waste-to-energy plants where the volume of trash will be reduced by 90%, the energy content of the waste will be recovered, and clean renewable electricity will be generated.

Municipal solid waste should be managed using an integrated waste management system. IWSA encourages and supports community programs to reduce, reuse, recycle and compost waste. Unfortunately, one hundred percent recycling rates are not technically, economically, or practically feasible. After waste is reduced, reused, and recycled, waste will be leftover that must be managed. That is where waste-to-energy comes in.

As noted earlier, EPA's hierarchy is consistent with actions taken by the European Union, which went further by establishing a legally binding requirement to reduce landfilling of biodegradable waste. The result has been increased recycling rates, higher waste-to-energy usage, reduced greenhouse gas emissions, and less dependence on fossil fuels.

Solid Waste Management Hierarchy



Source: U.S. Environmental Protection Agency

EPA's Solid Waste Management Hierarchy underscores the importance of waste-to-energy as a critical component of any sustainable integrated waste management system.

Waste-to-Energy Reduces Greenhouse Gas Emissions in Three Important Ways

Avoided methane emissions from landfills. When a ton of solid waste is delivered to a waste-to-energy facility, the methane that would have been generated if it were sent to a landfill is avoided. While some of this methane could be collected and used to generate electricity, some would not be captured and would be emitted to the atmosphere. Waste-to-energy generates more electrical power per ton of municipal solid waste than any landfill gas-to-energy facility.

Avoided CO_2 emissions from fossil fuel combustion. When a megawatt of electricity is generated by a waste-to-energy facility, an increase in carbon dioxide emissions that would have been generated by a fossil-fuel fired power plant is avoided.

Avoided CO_2 emissions from metals production. Waste-to-energy plants recover more than 700,000 tons of ferrous metals for recycling annually. Recycling metals saves energy and avoids CO_2 emissions that would have been emitted if virgin materials were mined and new metals were manufactured, such as steel.

Environ. Sci. Technol. **XXXX,** *xxx,* **000–000**

Is It Better To Burn or Bury Waste for Clean Electricity Generation?

P. OZGE KAPLAN,*,† JOSEPH DECAROLIS,‡ AND SUSAN THORNELOE§

National Risk Management Research Laboratory, United States Environmental Protection Agency (U.S. EPA), Research Triangle Park, North Carolina 27711, and Department of Civil Engineering, North Carolina State University, Raleigh, North Carolina 27695

Received August 26, 2008. Revised manuscript received December 13, 2008. Accepted December 30, 2008.

The use of municipal solid waste (MSW) to generate electricity through landfill-gas-to-energy (LFGTE) and waste-to-energy (WTE) projects represents roughly 14% of U.S. nonhydro renewable electricity generation. Although various aspects of LFGTE and WTE have been analyzed in the literature, this paper is the first to present a comprehensive set of life-cycle emission factors per unit of electricity generated for these energy recovery options. In addition, sensitivity analysis is conducted on key inputs (e.g., efficiency of the WTE plant, landfill gas management schedules, oxidation rate, and waste composition) to quantify the variability in the resultant life-cycle emissions estimates. While methane from landfills results from the anaerobic breakdown of biogenic materials, the energy derived from WTE results from the combustion of both biogenic and fossil materials. The greenhouse gas emissions for WTE ranges from 0.4 to 1.5 $MTCO_2e$/MWh, whereas the most agressive LFGTE scenerio results in 2.3 $MTCO_2e$/MWh. WTE also produces lower NO_x emissions than LFGTE, whereas SO_x emissions depend on the specific configurations of WTE and LFGTE.

Introduction

In response to increasing public concern over air pollution and climate change, the use of renewable energy for electricity generation has grown steadily over the past few decades. Between 2002 and 2006, U.S. renewable electricity generation—as a percent of total generation—grew an average of 5% annually (*1*), while total electricity supply grew by only 1% on average (*2*). Support mechanisms contributing to the growth of renewables in the United States include corporate partnership programs, investment tax credits, renewable portfolio standards, and green power markets. These mechanisms provide electric utilities, investment firms, corporations, governments, and private citizens with a variety of ways to support renewable energy development. With several competing renewable alternatives, investment and purchasing decisions should be informed, at least in part, by rigorous life-cycle assessment (LCA).

In 2005, a total of 245 million tons of MSW was generated in the United States, with 166 million tons discarded to landfills (*3*). Despite the increase in recycling and composting rates, the quantity of waste disposed to landfills is still significant and expected to increase. How to best manage the discarded portion of the waste remains an important consideration, particularly given the electricity generation options. Although less prominent than solar and wind, the use of municipal solid waste (MSW) to generate electricity represents roughly 14% of U.S. nonhydro renewable electricity generation (*1*). In this paper we compare two options for generating electricity from MSW. One method, referred to as landfill-gas-to-energy (LFGTE), involves the collection of landfill gas (LFG) (50% CH_4 and 50% CO_2), which is generated through the anaerobic decomposition of MSW in landfills. The collected LFG is then combusted in an engine or a turbine to generate electricity. A second method, referred to as waste-to-energy (WTE) involves the direct combustion of MSW, where the resultant steam is used to run a turbine and electric generator.

Clean Air Act (CAA) regulations require capture and control of LFG from large landfills by installing a gas collection system within 5 years of waste placement (*4*). The gas collection system is expanded to newer areas of the landfill as more waste is buried. Not all LFG is collected due to delays in gas collection from initial waste placement and leaks in the header pipes, extraction wells, and cover material. Collected gas can be either flared or utilized for energy recovery. As of 2005, there were 427 landfills out of 1654 municipal landfills in the United States with LFGTE projects for a total capacity of 1260 MW. It is difficult to quantify emissions with a high degree of certainty since emissions result from biological processes that can be difficult to predict, occur over multiple decades, and are distributed over a relatively large area covered by the landfill.

CAA regulations require that all WTE facilities have the latest in air pollution control equipment (*5*). Performance data including annual stack tests and continuous emission monitoring are available for all 87 WTE plants operating in 25 states. Since the early development of this technology, there have been major improvements in stack gas emissions controls for both criteria and metal emissions. The performance data indicate that actual emissions are less than regulatory requirements. Mass burn is the most common and established technology in use, though various MSW combustion technologies are described in ref *6*. All WTE facilities in the United States recover heat from the combustion process to run a steam turbine and electricity generator.

Policy-makers appear hesitant to support new WTE through new incentives and regulation. Of the 30 states that have state-wide renewable portfolio standards, all include landfill gas as an eligible resource, but only 19 include waste-to-energy (*7*). While subjective judgments almost certainly play a role in the preference for LFGTE over WTE, there is a legitimate concern about the renewability of waste-to-energy. While the production of methane in landfills is the result of the anaerobic breakdown of biogenic materials, a significant fraction of the energy derived from WTE results from combusting fossil-fuel-derived materials, such as plastics. Countering this effect, however, is significant methane leakage—ranging from 60% to 85%—from landfills (*8*). Since methane has a global warming potential of 21 times that of CO_2, the CO_2e emissions from LFGTE may be larger than those from WTE despite the difference in biogenic composition.

Although WTE and LFGTE are widely deployed and analyzed in the literature (*9–13*), side-by-side comparison of the life-cycle inventory (LCI) emission estimates on a mass

* Corresponding author phone: (919) 541-5069; fax: (919) 541-7885; e-mail: kaplan.ozge@epa.gov.

† On Oak Ridge Institute for Research and Education postdoctoral fellowship with U.S. EPA.

‡ North Carolina State University.

§ U.S. EPA.

10.1021/es802395e CCC: $40.75

per unit energy basis is unavailable. LCI-based methods have been used to evaluate and compare solid waste management (SWM) unit operations and systems holistically to quantify either the environmental impacts or energy use associated with SWM options in the broad context of MSW management (*14–16*).

The purpose of this paper is to present a comprehensive set of life-cycle emission factors—per unit of electricity generated—for LFGTE and WTE. In addition, these emission factors are referenced to baseline scenarios without energy recovery to enable comparison of the emissions of LFGTE and WTE to those of other energy sources. While the methodology presented here is applicable to any country, this analysis is based on U.S. waste composition, handling, and disposal, with which the authors are most familiar. In addition, parametric sensitivity analysis is applied to key input parameters to draw robust conclusions regarding the emissions from LFGTE and WTE. The resultant emission factors provide critical data that can inform the development of renewable energy policies as well as purchasing and investment decisions for renewable energy projects in the prevailing marketplace.

Modeling Framework

The LFGTE and WTE emission factors are based on the composition and quantity of MSW discarded in the United States in 2005 (Table S1 of Supporting Information (SI)). We excluded the estimated quantity and composition of recycled and composted waste.

The emission factors are generated using the life-cycle-based process models for WTE (*17*) and LF/LFGTE (*18*) embedded in the municipal solid waste decision support tool (MSW-DST). The MSW-DST was developed through a competed cooperative agreement between EPA's Office of Research and Development and RTI International (*19–22*). The research team included North Carolina State University, which had a major role in the development of the LCI database, process, and cost models as well as the prototype MSW-DST. While a summary is provided here, Table S2 (SI) provides a comprehensive set of references for those interested in particular model details. The MSW-DST includes a number of process models that represent the operation of each SWM unit and all associated processes for collection, sorting, processing, transport, and disposal of waste. In addition, there are process models to account for the emissions associated with the production and consumption of gasoline and electricity. The objective of each process model is to relate the quantity and composition of waste entering a process to the cost and LCI of emissions for that process. The LCI emissions are calculated on the basis of a combination of default LCI data and user-input data to enable the user to model a site-specific system. For example, in the landfill process model, one key exogenous input is the efficiency of the LFG collection system. The functional unit in each process model is 1 ton of MSW set out for collection. The MSW includes the nonhazardous solid waste generated in residential, commercial, institutional, and industrial sectors (*3*).

Each process model can track 32 life-cycle parameters, including energy consumption, CO_2, CO, NO_x, SO_x, total greenhouse gases (CO_2e), particulate matter (PM), CH_4, water pollutants, and solid wastes. CO_2 emissions are represented in two forms: fossil and biogenic. CO_2 released from anthropogenic activities such as burning fossil fuels or fossil-fuel-derived products (e.g., plastics) for electricity generation and transportation are categorized as CO_2-fossil. Likewise, CO_2 released during natural processes such as the decay of paper in landfills is categorized as CO_2-biogenic.

The management of MSW will always result in additional emissions due to collection, transportation, and separation of waste. However, for this analysis, the configuration of the SWM system up through the delivery of the waste to either a landfill or WTE facility is assumed to be same.

TABLE 1. Inputs to the Landfill Process Model

	LFG collection system efficiency [a] (%)	oxidation rate (%)
during venting	0	15
during first year of gas collection	50	15
during second year of gas collection	70	15
during third year and on of gas collection	80	15

[a] We assumed efficiency of the collection system based on the year of the operation and the ranges stated in U.S. EPA's AP-42 (*8*).

Electricity Grids. While LFGTE and WTE provide emissions reductions relative to landfill scenarios without energy recovery, the generation of electricity from these sources also displaces conventional generating units on the electricity grid. The process models in MSW-DST can calculate total electricity generated and apply an offset analysis on the grid mix of fuels specific to each of the North American Electric Reliability Council (NERC) regions, an average national grid mix, or a user-defined grid mix. Because our focus is on the emissions differences between WTE and LFGTE technologies, the emissions factors reported here exclude the displaced grid emissions.

For reference purposes, emission factors for conventional electricity-generating technologies are reported along with the emission factors for WTE and LFGTE (*23*). These emission factors on a per megawatt hour basis include both the operating emissions from power plants with postcombustion air pollution control equipment and precombustion emissions due to extraction, processing, and transportation of fuel. The background LCI data are collected on a unit mass of fuel (*23*); when converted on a per unit of electricity generated basis, the magnitude of resultant emissions depends on the efficiency of the power plant. A sensitivity analysis was conducted on plant efficiencies to provide ranges for emission factors.

Estimating Emission Factors for Landfill Gas-to-Energy. The total LCI emissions from landfills are the summation of the emissions resulting from (1) the site preparation, operation, and postclosure operation of a landfill, (2) the decay of the waste under anaerobic conditions, (3) the equipment utilized during landfill operations and landfill gas management operations, (4) the production of diesel required to operate the vehicles at the site, and (5) the treatment of leachate (*18*). The production of LFG was calculated using a first-order decay equation for a given time horizon of 100 years and the empirical methane yield from each individual waste component (*18, 24*). Other model inputs include the quantity and the composition of waste disposed (Table S1, SI), LFG collection efficiency (Table 1), annual LFG management schedule (Figure 1), oxidation rate (Table 1), emission factors for combustion byproduct from LFG control devices (Table S3, SI), and emission factors for equipment used on site during the site preparation and operation of a landfill. While there are hundreds of inputs to the process models, we have modified and conducted sensitivity analysis on the input parameters that will affect the emission factors most significantly.

The emission factors are calculated under the following scenario assumptions: (1) A regional landfill subject to CAA is considered. (2) A single cell in the regional landfill is modeled. (3) Waste is initially placed in the new cell in year 0. (4) The landfill already has an LFG collection network in place. (5) An internal combustion engine (ICE) is utilized to generate electricity. (6) The offline time that is required for

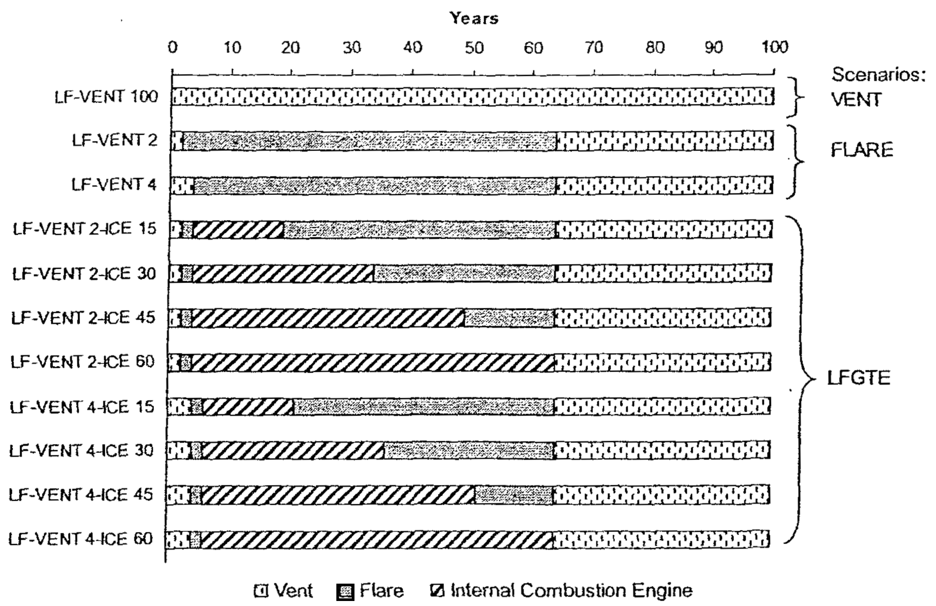


FIGURE 1. Annual landfill gas management schedule assumed for alternative scenarios.

the routine maintenance of the ICE is not considered. (7) The LFG control devices are assumed to have a lifetime of 15 years. (8) The LFG will be collected and controlled until year 65. This assumption is based on a typical landfill with an average operating lifetime of 20 years in which LFG production decreases significantly after about 60 years from initial waste placement. This is based on the use of a first-order decay equation utilizing empirical data from about 50 U.S. LFG collection systems.

The timing of LFG-related operations has significant variation and uncertainty that will influence the total emissions from landfills as well as the emission factors per unit of electricity generated. To capture these uncertainties and variation, several different management schemes were tested. Figure 1 presents the different cases considered for LFGTE projects. Each case differs according to the management timeline of the LFG. For instance, LF-VENT 2-ICE 15 corresponds to no controls on LFG for the first two years, after which the LFG is collected and flared in the third and fourth years. From year 5 until year 19, for a period of 15 years, the LFG is processed through an ICE to generate electricity, after which the collected gas is flared until year 65. Finally from year 65 on, the LFG is released to the atmosphere without controls.

To quantify the emissions benefit from LFGTE and WTE, landfill emissions occurring in the absence of an energy recovery unit can serve as a useful comparison. Thus, three baseline scenarios without electricity generation were defined for comparison to the energy recovery scenarios: LF-VENT 100 (LFG is uncontrolled for the entire lifetime of the LF), LF-VENT 2 (LFG is uncontrolled for the first two years, and then the LFG is collected and flared until year 65), LF-VENT 4 (LFG is uncontrolled for the first four years, and then the LFG is collected and flared until year 65). Since emissions are normalized by the amount of electricity generated (MW h) to obtain the emission rates, an estimate of hypothetical electricity generation for the baseline scenarios must be defined. The average electricity generation from a subset of the energy recovery scenarios is used to calculate the baseline emission rates. For example, emission factors [g/(MW h)] for LF-VENT 2 are based on the average of electricity generated in LF-VENT 2-ICE 15, LF-VENT 2-ICE 30, LF-VENT 2-ICE 45, and LF-VENT 2-ICE 60. Additional sensitivity analysis was conducted on oxidation rates where scenarios were tested for a range of 10–35%.

Estimating Emission Factors for Waste-to-Energy. The total LCI emissions are the summation of the emissions associated with (1) the combustion of waste (i.e., the stack gas (accounting for controls)), (2) the production and use of limestone in the control technologies (i.e., scrubbers), and (3) the disposal of ash in a landfill (*17*).

Emissions associated with the manufacture of equipment such as turbines and boilers for the WTE facility are found to be insignificant (<5% of the overall LCI burdens) and, as a result, were excluded from this analysis (*25*). In addition, WTE facilities have the capability to recover ferrous material from the incoming waste stream and also from bottom ash with up to a 90% recovery rate. The recovered metal displaces the virgin ferrous material used in the manufacturing of steel. The emission offsets from this activity could be significant depending on the amount of ferrous material recovered. Total LCI emissions for WTE were presented without the ferrous offsets; however, sensitivity analysis was conducted to investigate the significance.

In the United States, federal regulations set limits on the maximum allowable concentration of criteria pollutants and some metals from MSW combustors (*5*). The LCI model calculates the controlled stack emissions using either the average concentration values at current WTE facilities based on field data or mass emission limits based on regulatory requirements as upper bound constraints. Two sets of concentration values (Table S4, SI) are used in calculations to report two sets of emission factors for WTE (i.e., WTE-Reg and WTE-Avg). The emission factors for WTE-Reg were based on the regulatory concentration limits (*5*), whereas the emission factors for WTE-Avg were based on the average concentrations at current WTE facilities.

The CO_2 emissions were calculated using basic carbon stoichiometry given the quantity, moisture, and ultimate analysis of individual waste items in the waste stream. The LCI model outputs the total megawatt hour of electricity production and emissions that are generated per unit mass of each waste item. The amount of electricity output is a function of the quantity, energy, and moisture content of the individual waste items in the stream (Table S1, Supporting Information), and the system efficiency. A lifetime of 20 years and a system efficiency of 19% [18000 Btu/(kW h)] were assumed for the WTE scenarios. For each pollutant, the following equation was computed:

$$\text{LCI\_WTE}_i = \sum_j \{(\text{LCI\_Stack}_{ij} + \text{LCI\_Limestone}_{ij} + \text{LCI\_Ash}_{ij}) \times \text{Mass}_j\}/\text{Elec} \quad \text{for all } i \ (1)$$

where LCI_WTE_i is the LCI emission factor for pollutant i [g/(MW h)], LCI_Stack_{ij} is the controlled stack gas emissions for pollutant i (g/ton of waste item j), $LCI\_Limestone_{ij}$ is the allocated emissions of pollutant i from the production and use of limestone in the scrubbers (g/ton of waste item j), LCI_Ash_{ij} is the allocated emissions of pollutant i from the disposal of ash (g/ton of waste item j), $Mass_j$ is the amount of each waste item j processed in the facility (ton), and Elec is the total electricity generated from MSW processed in the facility (MW h). In addition, the sensitivity of emission factors to the system efficiency, the fossil and biogenic fractions of MSW, and the remanufacturing offsets from steel recovery was quantified.

Results and Discussion

The LCI emissions resulting from the generation of 1 MW h of electricity through LFGTE and WTE as well as coal, natural gas, oil, and nuclear power (for comparative purposes) were calculated. The sensitivity of emission factors to various inputs was analyzed and is reported. Figures 2–4 summarize the emission factors for total CO_2e, SO_x, and NO_x, respectively.

Landfills are a major source of CH_4 emissions, whereas WTE, coal, natural gas, and oil are major sources of CO_2-fossil emissions (Table S5, SI). The magnitude of CH_4 emissions strongly depends on when the LFG collection system is installed and how long the ICE is used. For example, LF-VENT 2-ICE 60 has the least methane emissions among LFGTE alternatives because the ICE is operated the longest (Table S5, SI). CO_2e emissions from landfills were significantly higher than the emissions for other alternatives because of the relatively high methane emissions (Figure 2, Table S5).

The use of LFG control during operation, closure, and postclosure of the landfill as well as the treatment of leachate contributes to the SO_x emissions from landfills. SO_x emissions from WTE facilities occur during the combustion process and are controlled via wet or dry scrubbers. Overall, the SO_x emissions resulting from the LFGTE and WTE alternatives are approximately 10 times lower than the SO_x emissions resulting from coal- and oil-fired power plants with flue gas controls (Figure 3). The SO_x emissions for WTE ranged from 140 to 730 g/(MW h), and for LFGTE they ranged from 430 to 900 g/(MW h) (Table 2, Table S5). In a coal-fired power plant, average SO_x emissions were 6900 g/(MW h) (Table S6 and S7, SI). Another important observation is that the majority of the SO_x emissions from natural gas are attributed to processing of natural gas rather than the combustion of the natural gas for electricity-generating purposes.

The NO_x emissions for WTE alternatives ranged from 810 to 1800 g/(MW h), and for LFGTE they ranged from 2100 to 3000 g/(MW h) (Figure 4, Table 2, Table S5). In a coal-fired power plant, average NO_x emissions are 3700 g/(MW h) (Tables S6 and S7, Supporting Information). The emission factors for other criteria pollutants were also calculated. Besides CO and HCl emissions, the emission factors for all LFGTE and WTE cases are lower than those for the coal-fired generators (Tables S5–S8, SI).

While we have provided a detailed, side-by-side comparison of life-cycle emissions from LFGTE and WTE, there is an important remaining question about scale: How big an impact can energy recovery from MSW make if all of the discarded MSW (166 million tons/year) is utilized? Hypothetically, if 166 million tons of MSW is discarded in regional landfills, energy recovery on average of ~10 TW h or ~65 (kW h)/ton of MSW of electricity can be generated, whereas a WTE facility can generate on average ~100 TW h or ~600 (kW h)/ton of MSW of electricity with the same amount of MSW (Table 3). WTE can generate an order of magnitude more electricity than LFGTE given the same amount of waste. LFGTE projects would result in significantly lower electricity generation because only the biodegradable portion of the MSW contributes to LFG generation, and there are significant inefficiencies in the gas collection system that affect the quantity and quality of the LFG.

Moreover, if all MSW (excluding the recycled and composted portion) is utilized for electricity generation, the WTE alternative could have a generation capacity of 14000 MW, which could potentially replace ~4.5% of the 313000 MW of current coal-fired generation capacity (*26*).

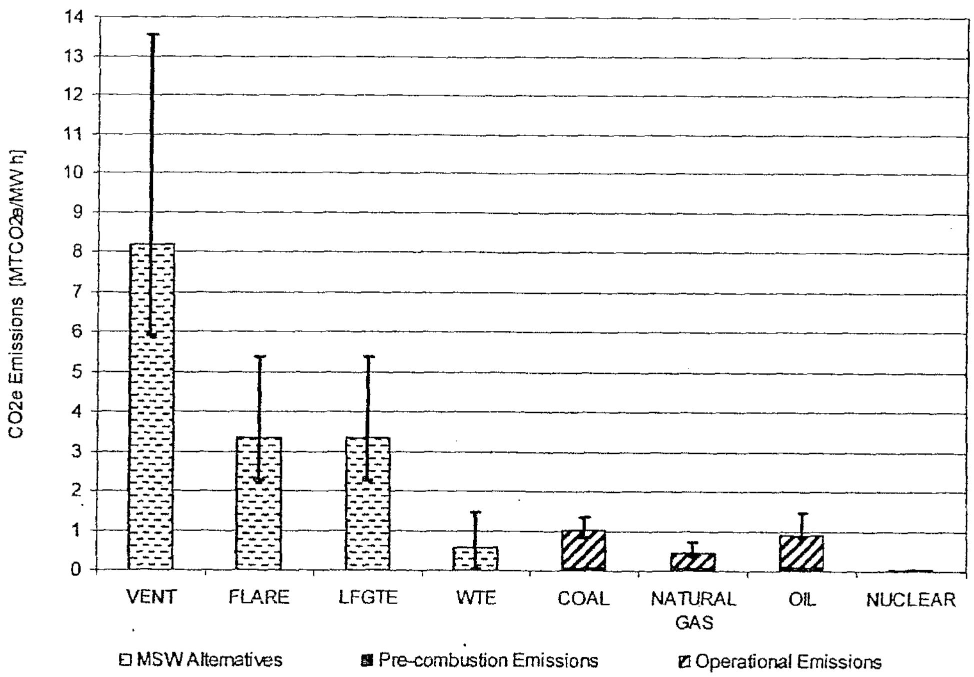


FIGURE 2. Comparison of carbon dioxide equivalents for LFGTE, WTE, and conventional electricity-generating technologies (Tables S5–S8, Supporting Information, include the full data set).

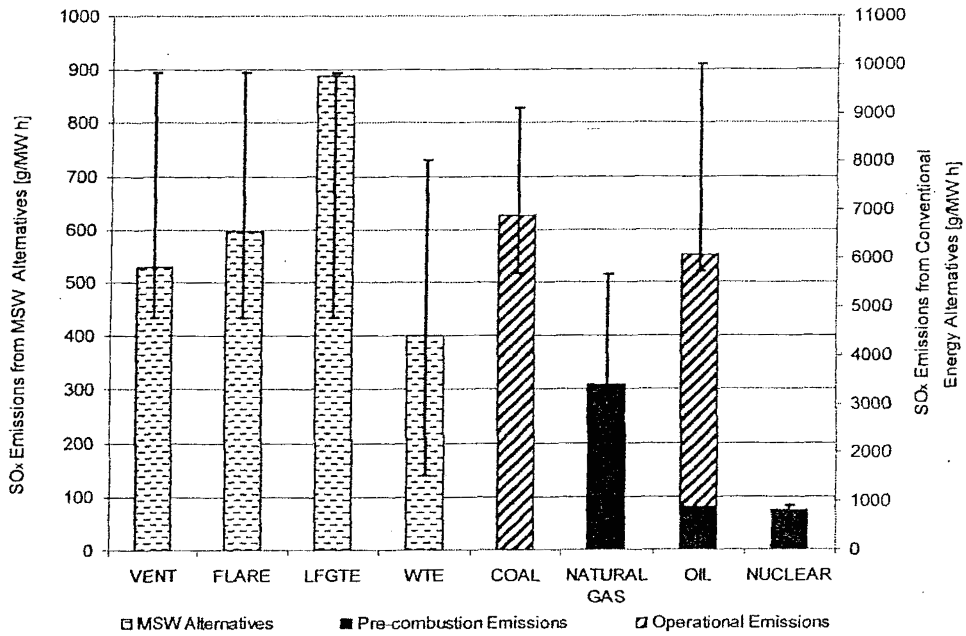


FIGURE 3. Comparison of sulfur oxide emissions for LFGTE, WTE, and conventional electricity-generating technologies (Tables S5–S8, Supporting Information, include the full data set).

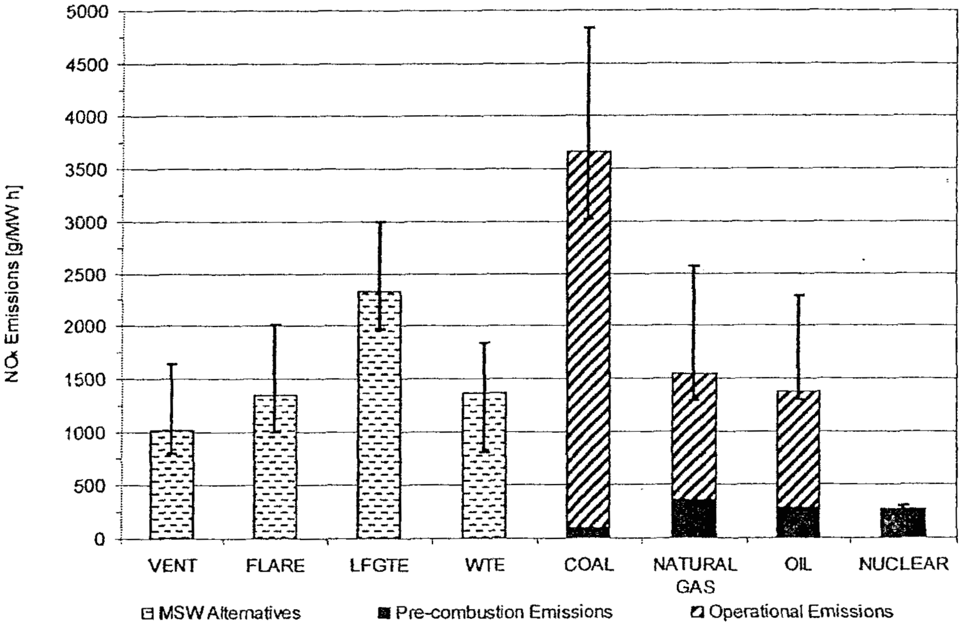


FIGURE 4. Comparison of nitrogen oxide emissions for LFGTE, WTE, and conventional electricity-generating technologies (Tables S5–S8, Supporting Information, include the full data set).

A significant portion of this capacity could be achieved through centralized facilities where waste is transported from greater distances. The transportation of waste could result in additional environmental burdens, and there are clearly limitations in accessing all discarded MSW in the nation. Wanichpongpan studied the LFGTE option for Thailand and found that large centralized landfills with energy recovery performed much better in terms of cost and GHG emissions than small, localized landfills despite the increased burdens associated with transportation (*13*). To quantify these burdens for the United States, emission factors were also calculated for long hauling of the waste via freight or rail. Table S9 (SI) summarizes the emission factors for transporting 1 ton of MSW to a facility by heavy-duty trucks and rail.

Sensitivity analysis was also conducted on key inputs. With incremental improvements, WTE facilities could achieve efficiencies that are closer to those of conventional power plants. Thus, the system efficiency was varied from 15% to 30%, and Table 2 summarizes the resulting LCI emissions. The variation in efficiencies results in a range of 470–930 kW h of electricity/ton of MSW, while with the default heat rate; only 600 (kW h)/ton of MSW can be generated. The efficiency also affects the emission factors; for example, CO_2-fossil emissions vary from 0.36 to 0.71 Mg/(MW h).

The emission savings associated with ferrous recovery decreased the CO_2e emissions of the WTE-Reg case from 0.56 to 0.49 $MTCO_2e$/(MW h). Significant reductions were observed for CO and PM emissions (Table 2).

TABLE 2. Sensitivity of Emission Factors for WTE to Plant Efficiency, Waste Composition, and Remanufacturing Benefits of Steel Recovery

	baseline factors		Sensitivity on: system efficiency	waste composition		steel recovery	
Input Parameters Varied[a]							
heat rate [Btu/(kW h)]	18000	18000	*[11000, 23000]*	18000	18000	18000	18000
efficiency (%)	19	19	*[15, 30]*	19	19	19	19
composition	default	default	default	*all biogenic*	*all fossil*	default	default
stack gas limits	reg	avg	*reg/avg*	reg	reg	*reg*	*avg*
steel recovery	excludes	excludes	excludes	excludes	excludes	*includes*	*includes*
Results: Criteria Pollutants							
CO [g/(MW h)]	790	790	[500,1000]	740	880	−110	−110
NO_x [g/(MW h)]	1300	1500	[810, 1800]	1200	1400	1200	1400
SO_x [g/(MW h)]	578	221	[140, 730]	550	620	450	90
PM [g/(MW h)]	181	60	[38, 230]	180	190	−190	−310
Results: Greenhouse Gases							
CO_2-biogenic [Mg/(MW h)]	0.91	0.91	[0.58, 1.2]	1.5	0.03	0.91	0.91
CO_2-fossil [Mg/(MW h)]	0.56	0.56	[0.36, 0.71]	0.02	1.5	0.49	0.49
CH_4 [Mg/(MW h)]	1.3E−05	1.3E−05	[8.1E−06, 1.6E−05]	1.6E−05	7.9E−06	−5.0E−05	−5.0E−05
CO_2e [$MTCO_2e$/(MW h)]	0.56	0.56	[0.36, 0.71]	0.02	1.45	0.49	0.49
Results: Electricity Generation							
TW h [b]	98	98	[78, 160]	61	37	98	98
(kW h)/ton	590	590	[470, 930]	470	970	590	590
GW [c]	12	12	[9.7, 20]	7.6	4.7	12	12

[a] For each sensitivity analysis scenario, the input parameters in italics were modified and resultant emission factors were calculated and are reported. [b] The values represent the TWh of electricity that could be generated from all MSW disposed into landfills. [c] 1 TWh/8000 h = TW; a capacity factor of approximately 0.91 was utilized.

TABLE 3. Comparison of Total Power Generated

	total electricity generated from 166 million tons of MSW, TW h	total power [a], GW	electricity generated from 1 ton of MSW, (kW h)/ton
waste-to-energy	78−160	9.7−19	470−930
landfill-gas-to-energy	7−14	0.85−1.8	41−84

[a] 1 TW h/8000 h = TW; a capacity factor of approximately 0.91 was utilized.

The composition of MSW also has an effect on the emission factors. One of the controversial aspects of WTE is the fossil-based content of MSW, which contributes to the combustion emissions. The average composition of MSW as discarded by weight was calculated to be 77% biogenic- and 23% fossil-based (Table S1, SI). The sensitivity of emission factors to the biogenic- vs fossil-based waste fraction was also determined. Two compositions (one with 100% biogenic-based waste and another with 100% fossil-based waste) were used to generate the emission factors (Table 2). The CO_2e emissions from WTE increased from 0.56 $MTCO_2e$/(MW h) (WTE-Reg) to 1.5 $MTCO_2e$/(MW h) when the 100% fossil-based composition was used (Table 2, Figure 2). However, the CO_2e emissions from WTE based on 100% fossil-based waste were still lower than the most aggressive LFGTE scenario (i.e., LF-VENT 2-ICE 60) whose CO_2e emissions were 2.3 $MTCO_2e$/(MW h).

The landfill emission factors include the decay of MSW over 100 years, whereas emissions from WTE and conventional electricity-generating technologies are instantaneous. The operation and decomposition of waste in landfills continue even beyond the monitoring phases for an indefinite period of time. Reliably quantifying the landfill gas collection efficiency is difficult due to the ever-changing nature of landfills, number of decades that emissions are generated, and changes over time in landfill design and operation including waste quantity and composition. Landfills are an area source, which makes emissions more difficult to monitor. In a recent release of updated emission factors for landfill gas emissions, data were available for less than 5% of active municipal landfills (*27*). Across the United States, there are major differences in how landfills are designed and operated, which further complicates the development of reliable emission factors. This is why a range of alternative scenarios are evaluated with plausible yet optimistic assumptions for LFG control. For WTE facilities, there is less variability in the design and operation. In addition, the U.S. EPA has data for all the operating WTE facilities as a result of CAA requirements for annual stack testing of pollutants of concern, including dioxin/furan, Cd, Pb, Hg, PM, and HCl. In addition, data are available for SO_2, NO_x, and CO from continuous emissions monitoring. As a result, the quality and availability of data for WTE versus LFGTE results in a greater degree of certainty for estimating emission factors for WTE facilities.

The methane potential of biogenic waste components such as paper, food, and yard waste is measured under optimum anaerobic decay conditions in a laboratory study (*24*), whose other observations reveal that some portion of the carbon in the waste does not biodegrade and thus this quantity gets sequestered in landfills (*28*). However, there is still a debate on how to account for any biogenic "sequestered" carbon. Issues include the choice of appropriate time frame for sequestration and who should be entitled to potential sequestration credits. While important, this analysis does not assign any credits for carbon sequestered in landfills.

Despite increased recycling efforts, U.S. population growth will ensure that the portion of MSW discarded in landfills will remain significant and growing. Discarded MSW is a viable energy source for electricity generation in a carbon-constrained world. One notable difference between LFGTE and WTE is that the latter is capable of producing an order of magnitude more electricity from the same mass of waste. In addition, as demonstrated in this paper, there are significant differences in emissions on a mass per unit energy basis from LFGTE and WTE. On the basis of the assumptions in this paper, WTE appears to be a better option than LFGTE. If the goal is greenhouse gas reduction, then WTE should be considered as an option under U.S. renewable energy policies. In addition, all LFTGE scenarios tested had on the average higher NO_x, SO_x, and PM emissions than WTE. However, HCl emissions from WTE are significantly higher than the LFGTE scenarios.

Supporting Information Available

MSW composition, physical and chemical characteristics of waste items, detailed LCI tables and sensitivity results, and emission factors for long haul of MSW. This material is available free of charge via the Internet at http://pubs.acs.org.

Literature Cited

(1) Energy Information Administration. Renewable Energy Consumption and Electricity Preliminary 2006 Statistics. www.eia.doe.gov/cneaf/solar.renewables/page/prelim_trends/rea_prereport.html (accessed Aug 26, 2008).

(2) Energy Information Administration. Annual Energy Review 2006. www.eia.doe.gov/emeu/aer/elect.html (accessed Aug 26, 2008).

(3) U.S. Environmental Protection Agency. *Municipal Solid Waste in the United States: 2005 Facts and Figures*; EPA/530/R06/011; U.S. EPA: Washington, DC, 2006.

(4) Federal plan requirements for municipal solid waste landfills that commenced construction prior to May 30, 1991 and have not been modified or reconstructed since May 30, 1991; final rule. *Fed. Regist.* **1999**, *64* (215).

(5) Standards of performance for new stationary sources and emission guidelines for existing sources: Large municipal waste combustors; final rule. *Fed. Regist.* **2006**, *71* (90).

(6) Ruth, L. A. Energy from municipal solid waste: A comparison with coal combustion technology. *Prog. Energy Combust. Sci.* **1998**, *24*, 545–564.

(7) Database of State Incentives for Renewable Energy. Rules, Regulations, & Policies for Renewable Energy. http://www.dsireusa.org/summarytables/reg1.cfm?&CurrentPageID=7&EE=0&RE=1 (accessed Aug 26, 2008).

(8) U.S. Environmental Protection Agency. AP-42 Fifth Edition. Compilation of Air Pollutant Emission Factors. http://www.epa.gov/ttn/chief/ap42/ch02/index.html (accessed Aug 26, 2008).

(9) Cheng, H. F.; Zhang, Y. G.; Meng, A. H.; Li, Q. H. Municipal solid waste fueled power generation in China: A case study of waste-to-energy in Changchun City. *Environ. Sci. Technol.* **2007**, *41*, 7509–7515.

(10) Eriksson, O.; Finnveden, G.; Ekvall, T.; Bjorklund, A. Life cycle assessment of fuels for district heating: A comparison of waste incineration, biomass- and natural gas combustion. *Energy Policy* **2007**, *35*, 1346–1362.

(11) Jaramillo, P.; Matthews, H. S. Landfill-gas-to-energy projects: Analysis of net private and social benefits. *Environ. Sci. Technol.* **2005**, *39*, 7365–7373.

(12) Themelis, N. J.; Ulloa, P. A. Methane generation in landfills. *Renewable Energy* **2007**, *32*, 1243–1257.

(13) Wanichpongpan, W.; Gheewala, S. H. Life cycle assessment as a decision support tool for landfill gas-to energy projects. *J. Cleaner Prod.* **2007**, *15*, 1819–1826.

(14) Eriksson, O.; Carlsson Reich, M.; Frostell, B.; Bjorklund, A.; Assefa, G.; Sundqvist, J. O.; Granath, J.; Baky, A.; Thyselius, L. Municipal solid waste management from a systems perspective. *J. Cleaner Prod.* **2005**, *13*, 241–252.

(15) Kaplan, P. O.; Ranjithan, S. R.; Barlaz, M. A. Use of life-cycle analysis to support solid waste management planning for Delaware. *Environ. Sci. Technol.*, in press.

(16) Thorneloe, S. A.; Weitz, K.; Jambeck, J. Application of the U.S. decision support tool for materials and waste management. *Waste Manage.* **2007**, *27*, 1006–1020.

(17) Harrison, K. W.; Dumas, R. D.; Barlaz, M. A.; Nishtala, S. R. A life-cycle inventory model of municipal solid waste combustion. *J. Air Waste Manage. Assoc.* **2000**, *50*, 993–1003.

(18) Camobreco, V.; Ham, R.; Barlaz, M.; Repa, E.; Felker, M.; Rousseau, C.; Rathle, J. Life-cycle inventory of a modern municipal solid waste landfill. *Waste Manage. Res.* **1999**, 394–408.

(19) Harrison, K. W.; Dumas, R. D.; Solano, E.; Barlaz, M. A.; Brill, E. D.; Ranjithan, S. R. A decision support system for development of alternative solid waste management strategies with life-cycle considerations. *ASCE J. Comput. Civ. Eng.* **2001**, *15*, 44–58.

(20) Kaplan, P. O.; Barlaz, M. A.; Ranjithan, S. R. Life-cycle-based solid waste management under uncertainty. *J. Ind. Ecol.* **2004**, *8*, 155–172.

(21) Solano, E.; Ranjithan, S.; Barlaz, M. A.; Brill, E. D. Life cycle-based solid waste management—1. Model development. *J. Environ. Eng.* **2002**, *128*, 981–992.

(22) RTI International. Municipal Solid Waste Decision Support Tool. https://webdstmsw.rti.org/ (accessed Aug 26, 2008).

(23) National Renewable Energy Laboratory. U.S. Life-Cycle Inventory Database. http://www.nrel.gov/lci/about.html (accessed Aug 26, 2008).

(24) Eleazer, W. E.; Odle, W. S.; Wang, Y. S.; Barlaz, M. A. Biodegradability of municipal solid waste components in laboratory-scale landfills. *Environ. Sci. Technol.* **1997**, *31* (3), 911–917.

(25) Environment Agency. *Life Cycle Inventory Development for Waste Management Operations: Incineration*; R&D Project Record P1/392/6; Environment Agency: Bristol, U.K., 2000.

(26) U.S. Department of Energy. *Electric Power Annual 2005*; DOE/EIA-0348(2005); U.S. DOE: Washington, DC, 2006.

(27) U.S. Environmental Protection Agency. *Background Information Document for Updating AP42 Section 2.4 Municipal Solid Waste Landfills*; EPA/600/R-08-116; U.S. EPA: Washington, DC; http://www.epa.gov/ttn/chief/ap42/ch02/draft/db02s04.pdf.

(28) Barlaz, M. A. Carbon storage during biodegradation of municipal solid waste components in laboratory-scale landfills. *Global Biogeochem. Cycles* **1998**, *12*, 373–380.

ES802395E

Is It Better To Burn or Bury Waste for Clean Electricity Generation?

P. Özge Kaplan, Joseph DeCarolis, and Susan Thorneloe

Environ. Sci. Technol., **Article ASAP** • DOI: 10.1021/es802395e • Publication Date (Web): 10 February 2009

BEFORE THE ARIZONA CORPORATION COMMISSION

IN THE MATTER OF THE APPLICATION OF MOHAVE ELECTRIC COOPERATIVE, INC. FOR APPROVAL OF A WASTE-TO-ENERGY FACILITY AS A PILOT PROGRAM UNDER THE RENEWABLE ENERGY RULES OR, IN THE ALTERNATIVE, FOR A LIMITED WAIVER	DOCKET NO. E-01750A-10-0453

REBUTTAL TESTIMONY OF ROBERT T. ESTES

ON BEHALF OF MOHAVE ELECTRIC COOPERATIVE, INCORPORATED

November 7, 2011

TABLE OF CONTENTS

I. EXECUTIVE SUMMARY

Mr. Robert Estes is a Principal Environmental Scientist with URS Corporation. URS was engaged by Reclamation Power Group, LLC ("RPG") in 2008 to assist it in the air quality permitting process associated with the municipal waste to energy ("W-T-E") facility it proposes to build in the Phoenix metropolitan area. URS also sorted 15,300 pounds of City of Glendale residential trash so an outside laboratory could analyze the segregated trash. Mr. Estes explains the significant air quality and pollution control requirements applicable to the W-T-E facility planned by RPG and the post permitting compliance requirements. He concludes that the requirements applicable to RPG's planned W-T-E facility are significant. The compliance requirements are designed to ensure the permit and pollution control requirements are not only installed, but maintained during the facility's operation. There will be a full and fair opportunity to raise air quality concerns relating to the operation of RPG's planned W-T-E and to have them addressed through the air quality permitting process.

II. INTRODUCTION AND PURPOSE OF TESTIMONY

Q: Please state your name and occupation.

A: My name is Robert Thomas Estes. I am a Principal Environmental Scientist at the Phoenix, Arizona office of URS Corporation, an international engineering and services company.

Q: What is your education and work background, relative to this matter?

A: I received a Bachelor of Science degree in Environmental Science from Northern Arizona University in December, 1977. I was employed for over 13 years with the corporate Environmental Department at Arizona Public Service Company, and then I entered the environmental consulting field in 1991. Throughout my 34-year professional career, I have focused primarily on air quality regulatory requirements, including permitting, permit compliance and regulatory compliance, and secondarily on emissions and ambient air quality measurements. I have a strong background in air quality permitting services involving industrial facilities and am known to most permitting agencies throughout the southwest U.S.

Q: On whose behalf are you testifying in this proceeding?

A: I am testifying on behalf of Mohave Electric Cooperative, Incorporated.

Q: What is the purpose of your testimony?

A: I will explain the efforts undertaken by URS on behalf of Reclamation Power Group, LLC ("RPG") relating to RPG's planned Waste-To-Energy ("W-T-E") facility and how the public will be protected by the air quality permitting requirements applicable to the W-T-E facility and the on-going compliance required after air quality permits are issued.

III. RELATIONSHIP TO RPG

Q: What is your relationship to Reclamation Power Group ("RPG")?

A: URS was retained by RPG in 2008 to prepare a minor source air quality permit application, which was to be submitted to the Maricopa County Air Quality Department, for a planned bubbling bed boiler that would be fired with refuse-derived fuel to produce steam that would power an electrical generator. I had written the proposal to RPG and was the project manager for the assignment. In that capacity I was the primary point of contact for RPG and directed the work of other URS staff on the project.

During the course of our assignment, URS researched the applicable regulations and determined that there is a special provision in the federal Clean Air Act[1] that requires most new solid waste incinerators, including the planned RPG W-T-E facility, to obtain a state operating permit under Title V of the Act, even though the facility will in all other respects still be a minor source.

Q: Was the assignment expanded?

A: We received additional authorization to assist RPG with an assessment of residential municipal solid waste from haulers of City of Glendale waste. A copy of the assessment of the 15,300 pounds of residential MSW sorted by URS is attached to my testimony as Exhibit RE-1. The assessment was undertaken so the segregated fuel material could be analyzed by a laboratory contracted separately by RPG. URS used the material heat content values from the analysis (Btus per pound) to estimate emissions of regulated air pollutants. URS also used the chlorine content values to estimate hydrogen chloride emissions, which are classified as a hazardous air pollutant. All other emission calculations were based on emission factors for combustion of municipal solid waste that were published by the U.S. Environmental Protection Agency.

Q: Did URS secure the necessary air quality permits for RPG?

A: No. Our work was suspended in mid-2009, before the application was finalized. Our understanding was that RPG needed to pursue other matters relative to the project, such as site location and a contract for the electrical power, before the application could be finalized. My next contact regarding the project was when recently contacted regarding providing testimony in this matter.

[1] See, §129(e) of the Clean Air Act

IV. GENERAL DESCRIPTION OF PLANNED RPG W-T-E FACILITY

Q: Please describe your understanding of the planned RPG W-T-E facility, in general terms.

A: The facility would receive municipal solid waste brought in by contract haulers, much like a transfer station. A series of machines and processes would separate out recyclable materials, such as glass, metal, plastic and paper – these materials would be accumulated and sold to recycling facilities. The remaining material (refuse-derived fuel) would be fed into the bubbling-bed boiler and burned as fuel. The steam produced would turn a steam turbine, which would be mechanically linked to an electrical generator to produce electricity. The steam would be condensed back into water using a cooling tower. The condensed water would then be pumped back through the boiler to produce steam again. The boiler emissions would be treated with a series of pollution control processes and equipment, including selective non-catalytic reduction to reduce nitrogen oxides, a spray dryer to reduce acid gases and mists, and a fabric filter baghouse to collect particulate matter.

V. APPLICABLE FEDERAL AND LOCAL AIR QUALITY PERMITTING AND POLLUTION CONTROL REQUIREMENTS

Q: What are the federal and local air quality permitting requirements applicable to the planned RPG W-T-E facility?

A: The pollution control equipment I mentioned in response to the last question will be designed to reduce the annual emissions of particulate matter and nitrogen oxides well below the 100 ton threshold for determining a major source of these pollutants under the federal air quality operating permit regulations (commonly referred to as the Title V permitting program)[2] and the status of the boiler would be "synthetic minor" for nitrogen oxides and particulate matter. Annual uncontrolled emissions of the other criteria pollutants (carbon monoxide, volatile organic compounds and sulfur dioxide) would also be below 100 tons, thus the boiler would be a "true minor" source for those pollutants. Similarly, the spray dryer is anticipated to control at least 10 percent of the annual emissions of hydrogen chloride, thus the boiler would be a "synthetic minor" source for that pollutant. Estimated annual emissions of other hazardous air pollutants, such as metals, dioxins and furans, were substantially below the major source threshold. Since the planned facility would not exceed any major source thresholds, it would not be subject to the federal air quality operating permit regulations, on the basis of annual controlled emission rates. However, due to the special provision in the federal Clean Air Act mentioned above, RPG must still apply for a Title V air quality operating permit from Maricopa County.[3]

Q: What are the federal and local air pollution control requirements applicable to the planned RPG W-T-E facility?

A: The applicable federal regulations are the New Source Performance Standards (NSPS)[4] and more specifically, Subpart Eb "Standards of Performance for Large Municipal Waste Combustors for which Construction is Commenced After September 20, 1994 or Reconstruction is Commenced After June 19, 1996". This regulation establishes enforceable emission limitations on opacity, particulate matter, cadmium, lead, mercury, sulfuric acid, hydrogen chloride, dioxin/furans, nitrogen oxides and carbon monoxide. In

[2] See, 40 CFR Parts 70 and 71.
[3] There is another set of federal permitting regulations called the New Source Review program. However, those rules would not apply to the RPG W-T-E facility because the emissions of criteria pollutant per year from the planned RPG W-T-E facility will fall below the threshold 250 ton criteria.
[4] See, 40 CFR Part 60.

the case of mercury and acid gas emissions, the rule also establishes percent removal requirements.

Subpart Eb also establishes a number of facility pre-construction requirements, such as development of a siting plan and a waste management plan, which must include multiple public hearings and interactions between the applicant, the permitting agency and affected stakeholders. In addition, Subpart Eb establishes enforceable requirements for waste combustor operating practices, operator training and certification, boiler startup, shutdown and malfunction events, ash handling, initial and periodic emissions and equipment performance testing, continuous emissions monitoring, episodic and periodic reporting of various information and events to the permitting agency and the EPA, and recordkeeping.

Regulations to control hazardous air pollutant emissions from "area" (minor) source boilers have been promulgated under the National Emission Standards for Hazardous Air Pollutants (NESHAP)[5] applicable to boilers constructed after June 4, 2010. This rule establishes emission limits for particulate matter, carbon monoxide and mercury, and it establishes specific operating requirements for the equipment used to control these emissions. This rule also establishes requirements for minimizing of boiler startups and shutdowns, conducting emissions performance tests and fuel analyses, and demonstrating continuous compliance with the emission limits.

Maricopa County regulations require implementation of demonstrated Best Available Control Technology (BACT) for regulated air pollutants that will be emitted at specified thresholds.[6] Based on the anticipated emission rates calculated for the RPG W-T-E facility, BACT will be required for particulate matter, nitrogen oxides and sulfur dioxide. Although a BACT analysis will need to be included in an air permit application, URS

---

[5] See, 49 CFR 63 subpart JJJJJJ

[6] See, §301 of Maricopa County Air Pollution Control Rule 241.

anticipates that the planned fabric filter baghouse, the selective non-catalytic reduction, and the spray dryer, respectively, will constitute BACT for these pollutants.

Q: Maricopa County is classified as not in attainment with the National Ambient Air Quality Standards (NAAQS) for particulate matter and ozone. What regulations are in place to ensure that the planned RPG W-T-E facility won't make the nonattainment situation worse?

A: As described above, controls on particulate and nitrogen oxide emissions, which meet the requirements for BACT, will be required at the RPG W-T-E facility to comply with applicable federal and state regulations and the permit. Nitrogen oxides are a precursor chemical to the formation of ozone in the atmosphere.

During the facility siting process required by NSPS Subpart Eb described above, comprehensive dispersion modeling using sophisticated computer models will be required to demonstrate, under a wide range of potential meteorological circumstances, that none of the ambient standards under the NAAQS will be exceeded.

The RPG W-T-E facility will not be subject to emission offsets, since its annual emissions are anticipated to be less than the applicability threshold for the federal New Source review regulations.

VI. COMPLIANCE MECHANISMS

Q: How do Maricopa County and the U.S. Environmental Protection Agency make sure that permitted emission sources such as the planned RPG W-T-E facility comply with the emission limits, pollution control technology requirements, and the monitoring, recordkeeping and reporting requirements in the applicable regulations?

A: The Title V permit will include a citation of all applicable federal and local regulations; this clarifies the requirements for the permittee and helps to facilitate enforcement of violations. Comprehensive emissions testing will be required within a short time period following initial startup of the facility, and will be required at least annually after that. The continuous emissions monitoring system must undergo detailed quality assurance testing at least annually. The reports for these tests must be submitted to Maricopa County and the EPA for approval, thus making them an available public record.

Detailed air permit compliance certifications, which identify each individual permit condition, the compliance status with regard to that condition, and the method(s) used to make that determination, must be submitted to Maricopa County twice annually. Electronic data reports showing all monitored emission rates and monitoring system quality assurance information must be submitted electronically to the EPA. Detailed Excess Emission and Monitoring System Performance Reports must be submitted semi-annually to both the EPA and Maricopa County.

The permit will require that malfunctions and excess emissions events be reported to the Maricopa County Air Quality Department. The reports must identify how such events will be prevented in the future.

Maricopa County sends compliance inspectors, unannounced, to all permitted facilities within the County, at least once per year. These individuals are trained to inspect all equipment, processes and facility records to ascertain compliance with the permit requirements. The County also encourages citizens who see visible emissions or notice offensive chemical odors to call the Air Quality department to report a potential violator. In such cases, the County will send a compliance inspector to the suspected source of the emissions.

VII. CONCLUSION

Q: Are the foregoing air quality permitting and pollution control requirements, coupled with the reporting and compliance requirements designed to address air pollution concerns to the environment and to the public health and safety that otherwise would be associated with RPG's planned W-T-E facility?

A: Yes. The entire process of developing and enforcing air quality permitting and pollution control requirements is intended to limit emissions so as to protect air quality and in so doing to protect the environment and the public's health and safety. The requirements applicable to RPG's planned W-T-E facility are significant. The compliance requirements are designed to ensure the permit and pollution control requirements are not only installed, but maintained during the facility's operation.

Q. Does the permitting process allow for public participation?

A: Yes. Notice will be provided to the public and an opportunity to file comments will be provided. If deemed appropriate by the regulatory agency, public hearings can be required. In my opinion, there will be a full and fair opportunity to raise and address legitimate air quality concerns relating to the operation of RPG's planned W-T-E facility through the permitting process.

Q: Does this conclude your testimony?

A: Yes it does.

EXHIBIT RE-1

Reclamation Power
Municipal Soild Waste Segregration Project - Residential Load
City of Glendale Materials Recovery Facility - August 28, 2008

Truck 6272D69 Load Weight (lbs):	17,900
Amount of MSW not sorted (lbs):	2,600
Total MSW sorted during project (lbs):	**15,300**

MSW Category	Measured Weight (lbs)	Percent by Weight (%)		Recycling Rates (%)	25-lb Sample: *RDF #1* (lbs)	10-lb Sample: *RDF #2* (lbs)	Notes
Bleached Paper	354	2.31%		**50%**	0.29	0.12	Assumed that a 12-inch stack of newspaper weighs 35 lbs (http://wastewise.tms.icfi.com/pubs/conversions.pdf)
Unbleached Paper	320	2.09%		**50%**	0.26	0.10	Assumed that one egg carton weighs 0.12 lbs (http://wastewise.tms.icfi.com/pubs/conversions.pdf)
Cardboard	329	2.15%		**50%**	0.27	0.11	Assumed that a 4 six-pack bevarage case weighs 0.99 lbs (http://wastewise.tms.icfi.com/pubs/conversions.pdf)
Non-PVC Plastic	1,890	12.35%		**85%**	0.46	0.19	Assumed that a 1-liter water bottle weighs 0.09 lbs, a HDPE milk jug weighs 0.33 lbs, and 100 grocery bags weigh 0.77 lbs. (http://wastewise.tms.icfi.com/pubs/conversions.pdf)
PVC	10	0.07%		**85%**	0.002	0.001	I added a very small portion (1"x1" for the 25-lb sample and 0.5"x0.5" for the 10-lb sample) of a "clamshell" into the samples.
Textile	599	3.92%		-	0.98	0.39	None
Glass	693	4.53%		**60%**	0.45	0.18	Assumed that a beer bottle weighs 0.53 lbs (http://wastewise.tms.icfi.com/pubs/conversions.pdf)
Non-Ferrous	5	0.03%		**60%**	0.003	0.001	I added a very small length of wire into each sample (0.5" for the 25-lb sample and 0.25" for the 10-lb sample).
Ferrous	155	1.01%		**85%**	0.04	0.02	Assumed that each 15.5 ounce "tin" can weighs 0.09 lbs (http://wastewise.tms.icfi.com/pubs/conversions.pdf)
Aluminum	76	0.50%		**70%**	0.04	0.01	Assumed that 34.21 12-ounce cans per pound of aluminum or 0.03 lbs per can (http://www.aluminum.org/AM/Template.cfm?Section=Home&TEMPLATE=/CM/ContentDisplay.cfm&CONTENTID=25033)
Large Wood & Other	137	0.90%		-	0.22	0.09	This category was mainly large pieces of wood and electronic devices.
Organics	10,732	70.14%			21.98	8.79	This is what was left over after the sorting of the MSW.
Total	**15,300**	**100.00%**		-	**25.00**	**10.00**	

BEFORE THE ARIZONA CORPORATION COMMISSION

IN THE MATTER OF THE APPLICATION OF MOHAVE ELECTRIC COOPERATIVE, INC. FOR APPROVAL OF A WASTE-TO-ENERGY FACILITY AS A PILOT PROGRAM UNDER THE RENEWABLE ENERGY RULES OR, IN THE ALTERNATIVE, FOR A LIMITED WAIVER	DOCKET NO. E-01750A-10-0453

REBUTTAL TESTIMONY OF

PROF. NICKOLAS J. THEMELIS, AND PROF. MARCO J. CASTALDI

ON BEHALF OF MOHAVE ELECTRIC COOPERATIVE, INCORPORATED

November 7, 2011

TABLE OF CONTENTS

I. EXECUTIVE SUMMARY

Professor Nickolas J. Themelis, and Professor Marco J. Castaldi, are the Director and Associate Director of the Earth Engineering Center and Department of Earth and Environmental Engineering, Columbia University. They jointly author this testimony providing basic background on waste to energy ("WTE") and its role in sustainable energy and waste management. They explain that WTE is compatible with recycling, is superior to landfilling and, after adopting Maximum Achievable Control Technology (MACT) rules of EPA, no longer present air quality and health issues as contended by the Grand Canyon Chapter of the Sierra Club's witnesses. They strongly recommend that the Arizona Corporation Commission takes whatever steps are in their power to facilitate the introduction of WTE renewable energy source in Arizona.

II. INTRODUCTION AND PURPOSE OF TESTIMONY

Q: Please state your name and occupation.

A: My name is Professor Nickolas J. Themelis. I am a Member of the National Academy of Engineering and Director of the Earth Engineering Center of Columbia University, a research group that in the last decade has published over one hundred papers and theses on many aspects of sustainable energy and waste management (www/wtert.org, Publications). I am a Stanley-Thompson Professor Emeritus and past Chair of the Department of Earth and Environmental Engineering of Columbia University. I have authored over 240 technical papers and inventor or co-inventor of twenty one patents. Currently I am directing the research theses of eleven graduate students on several aspects of sustainable waste management.

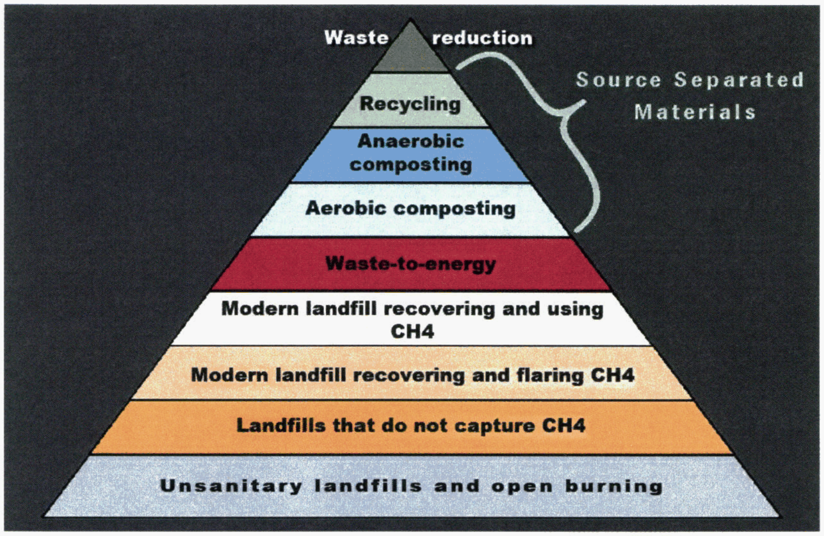


Figure 1 The Hierarchy of Waste Management

The hierarchy shows that recycling and composting are preferable and should be given priority as much as possible in the waste management system of each community. However, there are limits as to what percentage of the municipal solid wastes (MSW) of a community can be recycled or composted. Therefore, a technology has been developed for recovering energy from post-recycling wastes by combustion or gasification that generically is called waste-to-energy (WTE). For communities that cannot afford to build WTE plants, there are three types of landfills; the most preferable are sanitary landfills that protect the groundwater and try to collect as much as possible of the methane gas generated in landfills.

Q: What is the general magnitude of the generation and disposition of MSW in the U.S. and in Arizona?

A: For several years, EEC has conducted a national survey of waste generation and disposition in the fifty states. The data are provided by the Waste Management Departments of each state and in the case of Arizona by the Arizona Department of Environmental Quality

My colleague, Professor Marco J. Castaldi, is Associate Director of the Earth Engineering Center of Columbia University, Assistant Professor in the Department of Earth and Environmental Engineering of Columbia, and nationally recognized as an expert in combustion, catalytic reactors, and gasification. Unfortunately, I am unavailable to participate in the Commission's proceedings scheduled to commence November 29, 2011. However, Prof. Castaldi is available and will sponsor this testimony that we have jointly authored.

Q: On whose behalf are you testifying and what is the purpose of your testimony?

A: We are presenting testimony at the request of Mohave Electric Cooperative, Incorporated to provide some basic background on waste to energy ("WTE"), including generally addressing the fallacy of some of the arguments often raised by opponents of WTE, such as impacts on recycling and emissions. We have read the testimony submitted by the Grand Canyon Chapter of the Sierra Club and find it misleading and based largely on outdated and/or unrepresentative data.

III. THE ROLE OF WTE IN WASTE MANAGEMENT

Q: What is the accepted hierarchy of waste management?

A: The mission of the Earth Engineering Center (EEC) is to advance sustainable waste management, which is exemplified by the pyramid shown in Figure 1 below.

(BioCycle journal, October 2010, based on 2008 data; see www.wtert.org/sofos/SOG2010.pdf; also attached as NJT-1 are copies of the 2004 and 2010 State of Garbage in America reports based upon information in 2002 and 2008, respectively). In the last few years, the results of our survey are used by the EPA for calculating the greenhouse gas effects of waste management in the U.S.

The survey results definitely show that there are limits to the percent of MSW that can be recycled and composted. Our bi-annual studies have shown that the total tonnage recycled and composted nationally has ranged from 24% to 29% of the total MSW. Another 7% was combusted with energy recovery in 2008 in 87 waste-to-energy plants across the nation.

In the case of Arizona, the total tonnage recycled in 2008 was reported to be 917,373 tons, composted 63,954 tons and landfilled 5,801,208 tons. Table 1 below compares the 2008 with the 2002 data (as reported in the 2004 report).

Table 1. Comparison of Arizona generation and disposition of MSW between 2002-2008

	Population of Arizona	Tons MSW generated	Tons MSW recycled/composted	Tons MSW to WTE	Tons MSW landfilled
2002	5,456,353	6,012359	1,050359	0	4,962,000
2008	6,500,180	6,784,535	1,037,327	0	5,801,208
% change	19.1%	12.8%	-1.2%	0	16.9%

The data in Table 1 should be studied by those who think that all MSW can be recycled, without bothering to consider the scientific and statistical evidence. In this six-year period, the state population increased by 19% but the generation of MSW by only 12.8%; this means that the state gained some ground in reducing generation of MSW per person. However, after many efforts by Arizona communities to increase recycling (Claire Todd, one of Prof. Themelis' graduate students visited the Phoenix recycling facility in 2003 and described it in her thesis; www.wtert.org/sofos/Todd_thesis.pdf), the tonnage of materials recycled in the state has remained nearly constant. Because of this, the amount of MSW landfilled in Arizona, between 2002 and 2008, increased by 16.9%.

III. EMISSIONS ARE NOW EFFECTIVELY CONTROLLED

Q: What efforts have been undertaken to address emission concerns related to WTE plants and how successful have those efforts been?

A: The Earth Engineering Center has over the years examined in detail and published on the emissions of WTE plants, not only in the U.S. but in other nations, such as France, China and Korea. The thesis by Deriziotis (www.wtert.org, Publications, Theses) shows that since the U.S. WTE plants adopted the Maximum Achievable Control Technology (MACT) rules of EPA, in the nineties, they are amongst the cleanest high temperature processes, as attested to formally by EPA. For example, the dioxin emissions are always mentioned by opponents of any type of WTE; the facts are that it was an issue before MACT but it is not an issue any more. For example, assuming that the proposed WTE includes an Air Pollution Control system similar to those used in the average U.S. WTE, the dioxin emissions from this 500-ton/day plant are calculated to be less than 0.08 grams (0.0028 oz.) per year. Most likely, several times this amount is emitted in Arizona from fireworks on the 4th of July. The testimony of the Sierra Club witnesses does not appear to recognize the strides made after WTE plants adopt MACT.

IV. WTE IS SUPERIOR TO LANDFILLING

Q: What information can you provide the commission on life cycle analysis of WTE and landfill GHG impacts?

A: The foremost academic U.S. researcher in landfill engineering is Prof. Morton Barlaz of North Carolina State University. In 2009, Prof. Barlaz, as a result of a meeting between senior landfill and WTE managers, carried out at the request of Prof. Themelis an analysis of LCA studies on WTE and landfilling. We are attaching his report to this testimony as NJT-2. It shows clearly that environmentally WTE is superior to landfilling, as per the hierarchy of waste management (Figure 1), the E.U. Directive phasing out landfilling, and laws and regulations in Japan and several other developed nations.

V. WTE IS A RENEWABLE ENERGY RESOURCE

Q: Is WTE a renewable energy resource?

A: In 2009-2011, the Earth Engineering Center conducted several studies on recycling, composting and waste-to-energy in the U.S., Argentina, Chile, China, Greece, Korea, Mexico and Uruguay. Our studies have shown conclusively that after all possible recycling and composting are done, the only two alternatives for dealing with the post-recycling municipal solid wastes (MSW) are combustion or gasification with energy recovery (also called waste-to-energy) or landfilling. Therefore, waste-to-energy (WTE) is the only source of renewable energy that also avoids the environmental impacts and land use of landfilling. Why is it renewable? Because according to studies by Covanta Energy on stack gas of several WTEs across the country, using the carbon-14 ASTM-D6866 technique that EEC tested and verified in joint tests with Beta Labs of Florida, MSW contains 64-66% biogenic carbon and 36-34% fossil carbon. Therefore, according to the accepted methodology by the International Panel on Climate Change, by the European Commission, and by the EPA energy from biogenic carbon is renewable. If it were not so, the entire biofuel industry in the U.S. would not be a renewable energy source.

We note that the proposed WTE for Arizona intends to "go the extra mile" of sorting out plastics from the MSW before combustion. Therefore, the biogenic carbon content will be higher than the 64-66% observed in WTEs that burn mixed MSW as received. The actual percentage of biogenic to total carbon in the material processed in the power plant proposed by Mohave Electric Cooperative can be determined readily when the plant is running by subjecting samples of its stack gas to the ASTM C-14 method mentioned in this report.

It should also be noted that EEC, in an extensive study conducted for the American Chemistry Council which represents all the manufacturers of plastics in the U.S., determined that only 7% of the discarded plastic wastes are recycled nationally and another 9% is combusted with MSW in WTE plants. Therefore, 84% of the plastic wastes are landfilled nationally. This represents a waste of a resource that has a calorific value higher than coal. It is a resource that is produced and then wasted year after year; therefore, processes that allow the recovery of energy from plastics and other fossil-based wastes should also be considered as renewable energy sources, even though plastics originate from fossil fuels. This is being done already in some nations, such as China where the entire amount of energy produced by WTE plants is considered to be renewable and receives a credit of about $30/MWh of electricity.

Therefore the power plant proposed by Mohave Electric Cooperative meets the Arizona definition of a renewable energy resource as one "that is replaced rapidly by a natural, ongoing process and that is not nuclear or fossil fuel", certainly with regard to the biogenic carbon content of the MSW fuel and reasonably so for the plastic wastes that year after year are being buried in Arizona landfills.

International experience has shown conclusively that attaining of the "zero waste" goal can be achieved only by a combination of materials recovery (i.e., recycling) and energy recovery (WTE). By the way the only U.S. community that has attained this goal is Lee County in Florida that encompasses Fort Myers and received the EEC/WTERT 2010 Award, along with the City of Vienna.

Q: What are the economics of WTE vs. sanitary landfilling?

A: Modern waste-to-energy (WTE) plants provide a clean and renewable source of energy used in over forty nations, including the U.S., in order to avoid landfilling and also produce electricity or heat. There are over 800 such plants worldwide processing an estimated 190 million tons of MSW worldwide (27 million in the U.S.). This amount represents only 15% of the global post-recycling urban waste. The rest is landfilled contributing an estimated 3-4% of the greenhouse gases emitted by humanity.

In the first decade of the 21st century over 150 new WTE plants have been built. In the short term, building a WTE plant is more capital intensive than a sanitary landfill but over the twenty years of repaying the capital investment WTE has been more economic than landfilling. Examples are York County, PA, Lancaster County, PA, Lee County, FL (doubled its WTE capacity in 2007), Palm Beach, FL (doubling its WTE capacity in 2011), and Honolulu, HI (also doubling its WTE capacity in 2011). Opponents of WTE bring up the very few isolated examples where either poor operation and/or management has resulted in financial problems (e.g. in Harrisburg, PA). By the same token, people should not invest in new houses because there have been cases where people lost their houses when they could not pay the bank.

VI. <u>RECYCLING AND WTE ARE COMPLIMENTARY</u>

Q: Are recycling and WTE complementary?

A: Figure 2 located at the end of our testimony, based on published data for the U.S. and the E.U., compares waste management in the U.S. with various other developed nations. It can be seen that the most environmentally minded nations in the world recycle a lot, combust a lot, and landfill as little as possible. Japan, Singapore and some other nations are also at the top of this ladder because of extensive use of WTE. The U.S. is about two thirds up this "ladder" and has some way to go.

Q: Where does Arizona rank with regard to sustainable waste management?

A: Figure 3, also located at the end of our testimony, shows how the fifty states rate with respect to sustainable waste management. Connecticut has the most sustainable waste management system at this time. Maryland, thanks to its present facilities for recycling, composting and waste-to-energy, is the fifth best state in terms of waste management. This year they passed legislation that places WTE on the first tier of renewable energy sources. Figure 3 also shows that Arizona is 33rd down from the top. The proposed WTE, and hopefully others in the future, will help Arizona to climb up this "ladder".

It should also be noted that Arizona landfills about five million tons of MSW fuel and also imports over ten million tons of coal. If the five million tons of MSW were to be used as fuel in WTE power plants such as that proposed by Mohave Electric, instead of being buried as advocated by the Sierra Club of Arizona, the need to import coal to Arizona would be deceased by over 1.6 million tons.

VII. <u>CONCLUSION</u>

Q: Should the Commission reject WTE as a pilot project under its renewable energy rules based upon concerns expressed by the Sierra Club over adverse impacts on recycling, emissions, dioxins, ash or the accelerated release of stored biogenic carbon?

A: No. It is universally recognized that WTE is a reliable, clean, and renewable source of energy. It requires a larger capital investment than sanitary landfilling but in the long run it is more economic than landfilling, conserves land, reduces greenhouse gas emission and produces electricity from the fuel value of MSW.

The mission of the Earth Engineering Center of Columbia is to advance all means for sustainable waste management, including waste reduction, recycling, composting, and energy recovery by thermal treatment. We strongly recommend that the Arizona Corporation Commission takes whatever steps are in their power to facilitate the introduction of WTE renewable energy source in the State. The project proposed by Mohave Electric Cooperative will not compete but will increase recycling in Arizona and will provide an indigenous energy source that will decrease the importation of coal and will complement solar, wind and other renewable sources. At the same time it will reduce the need for transforming land to landfills and the emission of greenhouse gases by an amount estimated to range from 0.5 to 1 ton of carbon dioxide equivalent, per ton of MSW treated in WTE plants instead of being landfilled.

The evidence presented above shows clearly that there are limits to recycling, that recycling and WTE are complementary, and that delaying the construction of WTE facilities only perpetuates the need for more and more landfills.

It is truly unfortunate that some environmental organizations like the Sierra Club, whose mission is the protection of the environment, are trying to impede the adoption of a technology that has been proven, nationally and internationally, to improve environmental quality on several counts.

Q: Does that conclude your testimony?

A: Yes it does.

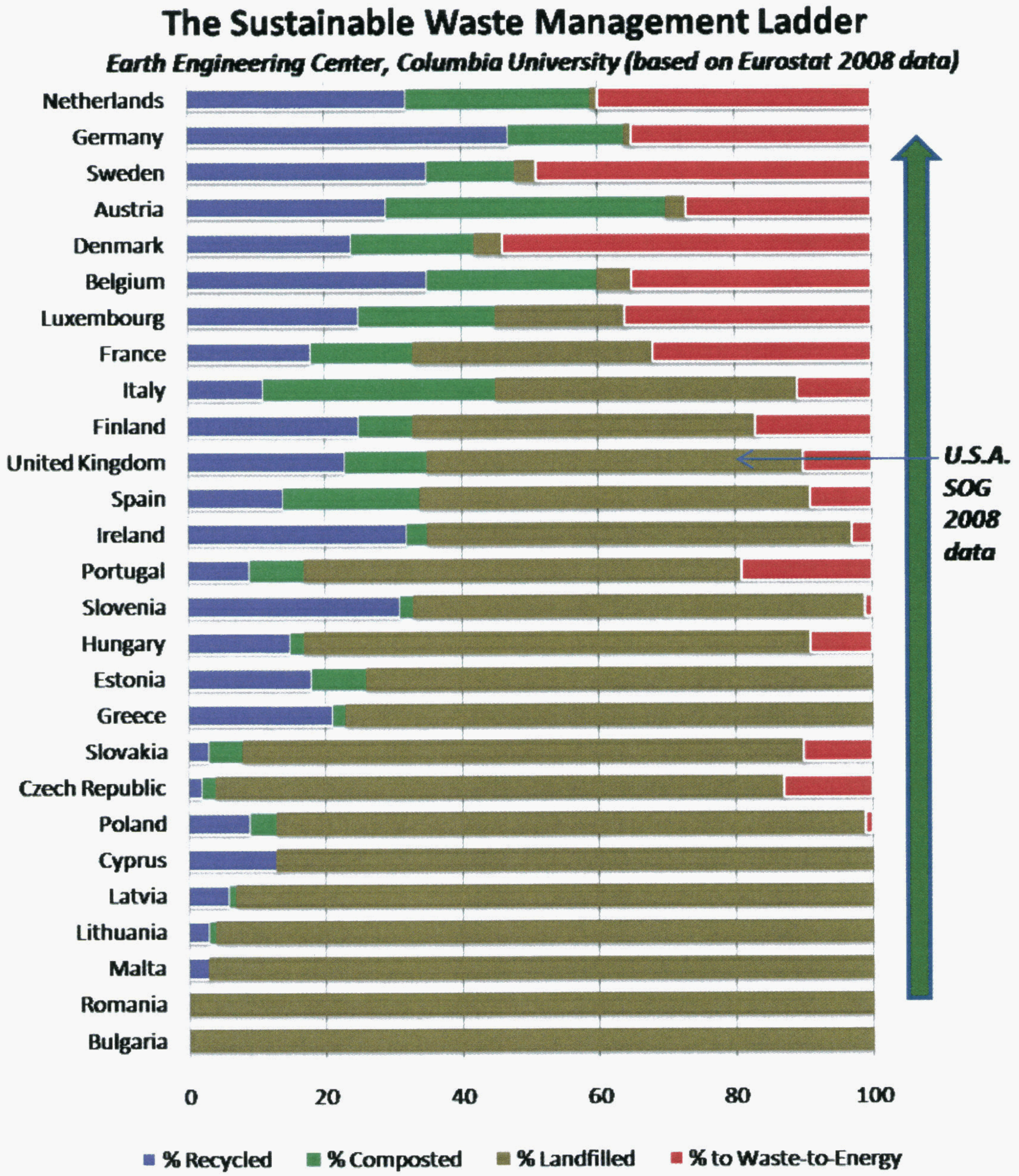


Figure 2

***Sources of Figures 2 and 3**: U.S. data are obtained from the 2008 survey of waste management in the U.S., conducted by EEC and BioCycle (BioCycle journal, October 2010). E.U. data from: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-CD-07-001/EN/KS-CD-07-001-EN.PDF; 2008 State of Garbage in America, BioCycle, Oct. 2010*

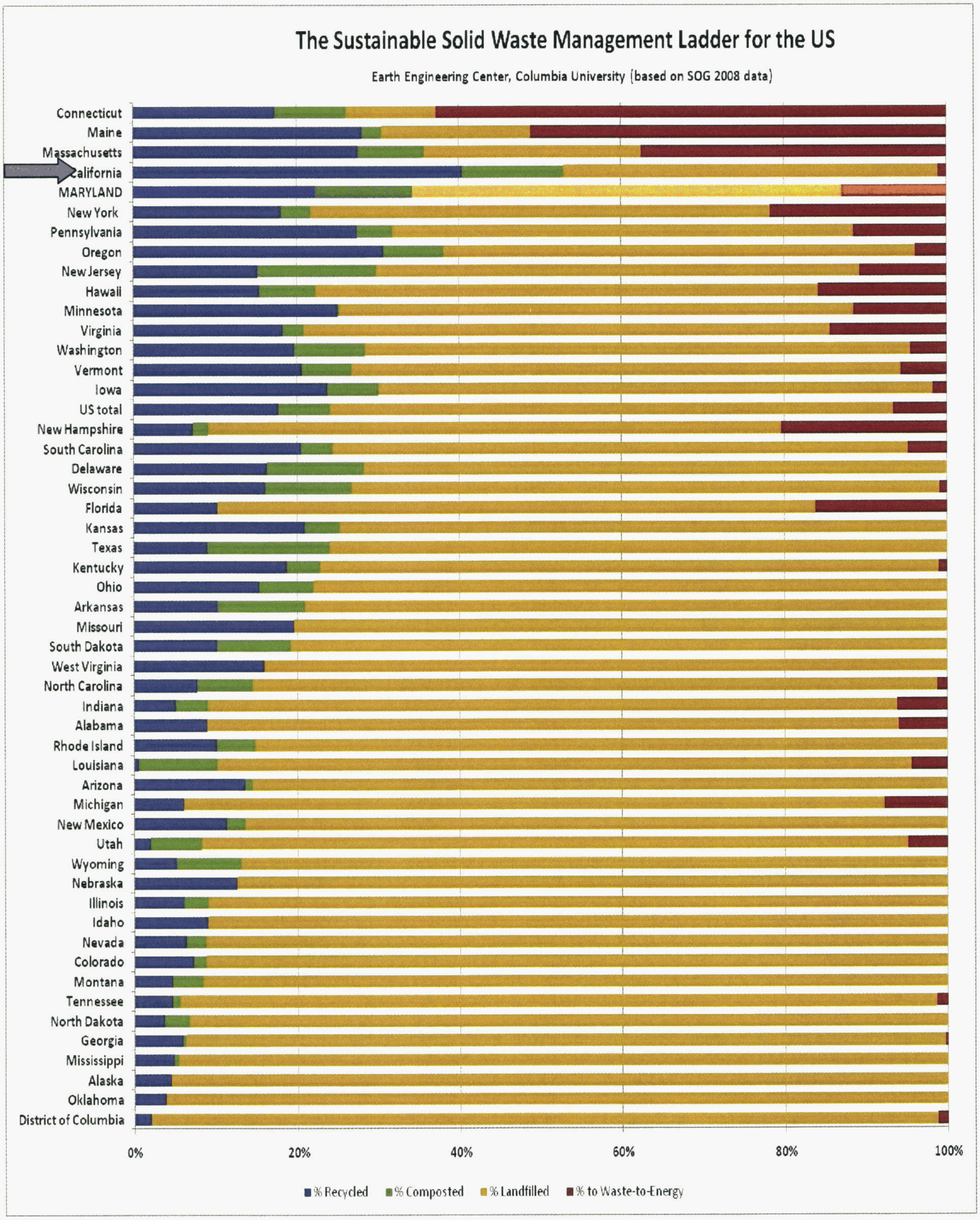

The Sustainable Solid Waste Management Ladder for the US
Earth Engineering Center, Columbia University (based on SOG 2008 data)
Connecticut
Maine
Massachusetts
California
MARYLAND
New York
Pennsylvania
Oregon
New Jersey
Hawaii
Minnesota
Virginia
Washington
Vermont
Iowa
US total
New Hampshire
South Carolina
Delaware
Wisconsin
Florida
Kansas
Texas
Kentucky
Ohio
Arkansas
Missouri
South Dakota
West Virginia
North Carolina
Indiana
Alabama
Rhode Island
Louisiana
Arizona
Michigan
New Mexico
Utah
Wyoming
Nebraska
Illinois
Idaho
Nevada
Colorado
Montana
Tennessee
North Dakota
Georgia
Mississippi
Alaska
Oklahoma
District of Columbia
0%
20%
40%
60%
80%
100%
% Recycled
% Composted
% Landfilled
% to Waste-to-Energy

Figure 3

EXHIBIT NJT-1

14th ANNUAL NATIONWIDE SURVEY
OF SOLID WASTE MANAGEMENT IN THE UNITED STATES

THE STATE OF GARBAGE IN AMERICA

A joint study with the Earth Engineering Center of Columbia University

Collaboration leads to new methodology for the 2003 survey. And the numbers are ... 26.7% of MSW recycled, 7.7% combusted in waste-to-energy plants and 65.6% landfilled.

Scott M. Kaufman, Nora Goldstein, Karsten Millrath, and Nickolas J. Themelis

IT IS GENERALLY agreed that there are two main sources of national data on how solid waste is managed in the United States. The first is *BioCycle*'s "State of Garbage in America" survey, started in 1989 and done annually since then, with the exception of 2002. The other is an annual survey that Franklin Associates conducts for the U.S. Environmental Protection Agency, known as "Municipal Solid Waste In The U.S.: Facts and Figures." State of Garbage In America has always collected tonnage data on municipal solid waste (MSW) generation, and asked states to estimate — by percent — the amounts recycled and composted, combusted, and landfilled. Conversely, Franklin Associates has always used economic and population data to estimate MSW generation on a per capita basis, and then extrapolated data to estimate tonnages recycled and composted, combusted and landfilled.

An article by Professor Nickolas Themelis of Columbia University's Earth Engineering Center in the January 2003 issue of *BioCycle*, "Analyzing Data In State of Garbage In America, EPA Reports," shed light on the differences in the data from these two approaches to tracking solid waste management in the U.S. Themelis used findings from *BioCycle*'s 2001 "State of Garbage In America" report (based on 2000 data and published in the December 2001 issue) and EPA's "Municipal Solid Waste in the United States: 2000 Facts and Figures" (also based on 2000 data) to do his comparison. The analysis highlighted where the significant differences lie. For example, *BioCycle* reported 409 million tons of MSW generated in 2000, while Franklin data reported 232 million tons. Similarly, *BioCycle* reported 131 million tons of MSW recycled while Franklin reported close to 70 million tons.

After some thought and discussion, it was decided that the best way to identify the reasons for the data differences — and to test data gathering alternatives — was to have *BioCycle* and the Earth Engineering Center collaborate on the 2003 State of Garbage In America report. The information in this article is the culmination of that collaboration, which was conducted by the authors of this report. The contributions of the state solid waste and recycling officials who provided the data for this survey (see sidebar) are most appreciated.

ORIGINAL METHODS

The fundamental approach to the 2003 State of Garbage In America survey was to request all data in actual tonnages. In previous surveys, *BioCycle* asked states to provide the annual tons of MSW generated and a percent breakdown of tons recycled, composted, combusted, and landfilled. The 2001 State of Garbage In America survey questionnaire did ask states to provide the actual tonnages used to generate the percentages, but few states supplied that data. The tonnages of MSW recycled, combusted and landfilled were calculated using the percentage breakdowns and MSW generation tons for each state. Those tonnages (based on weighted averages) were used to calculate the national rates for recycling, combustion and landfilling (see years 1988-2000 in Table 1 on page 33).

The old approach worked for several reasons: a) It was used every year, so the year-to-year data could be compared to show trends; b) The incineration and landfill data provided by the states (and used to tally generation and percents incinerated and landfilled) typically included fairly accurate tonnages because of permit requirements for landfills and combustion plants. Therefore, the balance they calculated and attributed to recycling was fairly consistent from year to year (about one-third to half the states also provided specific recycling tonnages, similar to those shown in this year's Table 10); and c) The tonnage-based approach — combined with information from the states on what categories of waste and recycled materials were included — allowed for some state-to-state comparisons.

The primary disadvantage of the "old" approach is that even though we requested data on *municipal solid waste* — i.e., only the residential and commercial/institutional streams — most states only had aggregate tons for *solid waste*, which may include construction and demolition debris, industrial waste, biosolids, etc. The same was true of

The fundamental approach to the 2003 State of Garbage In America survey was to request all data in actual tonnages.

the recycling percentages, e.g. some states include C&D debris recycled, which technically is not municipal solid waste. This reality made it difficult to get a statistically accurate reading as to how much municipal solid waste was being recycled, combusted or landfilled.

TONNAGE ONLY METHODOLOGY

To address that situation, we decided to move to a more objective, numbers-based analysis of solid waste management in the U.S. In the 2003 State of Garbage in America survey, therefore, all data was requested in actual tonnages. For instance, instead of asking states what percent of the total MSW generated was landfilled, the survey questionnaire asked for the tons landfilled in each category listed (e.g. residential, commercial, industrial, C&D, organics, tires, etc.). If a breakdown was not available, we asked for total tons landfilled. The same was done with recycling data: Instead of asking approximately what rate of recycling was being performed in a state, we requested specific tonnages recycled, broken down by categories, e.g., glass, metal, paper, etc.

In order to maximize the opportunity for direct comparisons (state by state and nationally), the next step was to calculate only the MSW portions of total solid waste generated, recycled, combusted and landfilled. That was accomplished by only including MSW stream tonnages. With landfilling, for example, that included the residential and commercial waste streams, organics, tires and "other." Not included were C&D, industrial, agricultural and imported waste. Recyclables included tons reported for glass, steel, aluminum, other metals, paper, plastic, tires, organics, wood and "other." C&D materials were not included. The tons combusted in waste-to-energy (WTE) facilities made up the third component of the estimated MSW generated (tons/year).

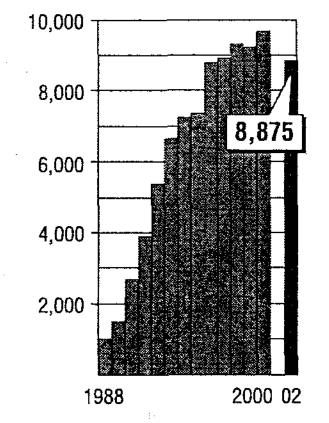
A primary goal of the methodology was to start leveling the playing field so that when the rates for each state are compared, the same categories of materials in the MSW stream are included. In this way, we have approximated a "true" MSW recycling rate, with similar parameters in place for all states. With a few exceptions (see footnotes for Table 3), all percentages/rates reported in the 2003 State of Garbage survey are calculated from tonnage numbers that the states (or other sources, including state websites) provided. Obviously, the better the information reported by each individual state, the "truer" the results. But we can say with a fair bit of confidence that what follows in these pages is a generally accurate picture of the State of Garbage in America in 2003.

One final note on the methodology. The first question on the 2003 survey asked states to provide the total tons of nonhazardous solid waste generated in 2002 (or for the most recent year that data were available). This national total (483 million tons) is more statistically similar to the generation tonnages reported in earlier *BioCycle* State of Garbage In America surveys, starting with 1989 (see Table 1). As in past years, the 2003 questionnaire asked states to indicate all categories of waste included in that total solid waste generation number. Boxes to check off included residential, commercial, C&D, industrial, agricultural, imported waste, tires and other (states were asked to specify what was included in "other"). In a few cases, states only checked off categories that are in the definition of municipal solid waste used in the 2003 State of Garbage In America methodology. In those cases, the number reported for solid waste generation is the same as the one used for "estimated" MSW generation. There are a handful of states in Table 3 where the estimated MSW generated is greater than the reported solid waste generated tons. This is usually because these states did not include recycling tonnages in the nonhazardous solid waste tons generated. Table 2 has a state-by-state breakdown (where provided) of the waste stream categories included in the reported solid waste generation tons.

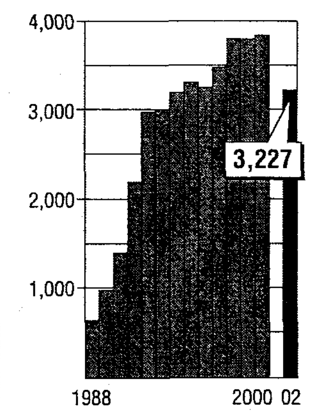
THE NATIONAL PICTURE

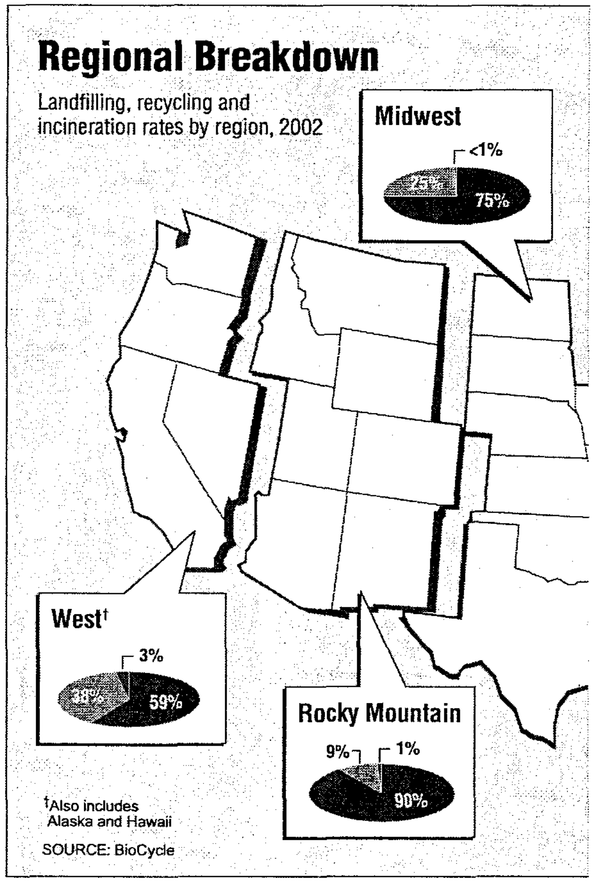
Where is the United States when it comes to solid waste management? Data in the 2003 State of Garbage report clearly indicate that we are a nation that continues to generate increasing volumes of solid waste — most of which are landfilled. In 2002, 483 million tons of solid waste were generated, based on data from 47 states. (Alabama, Alaska and Montana are not included in this total as no

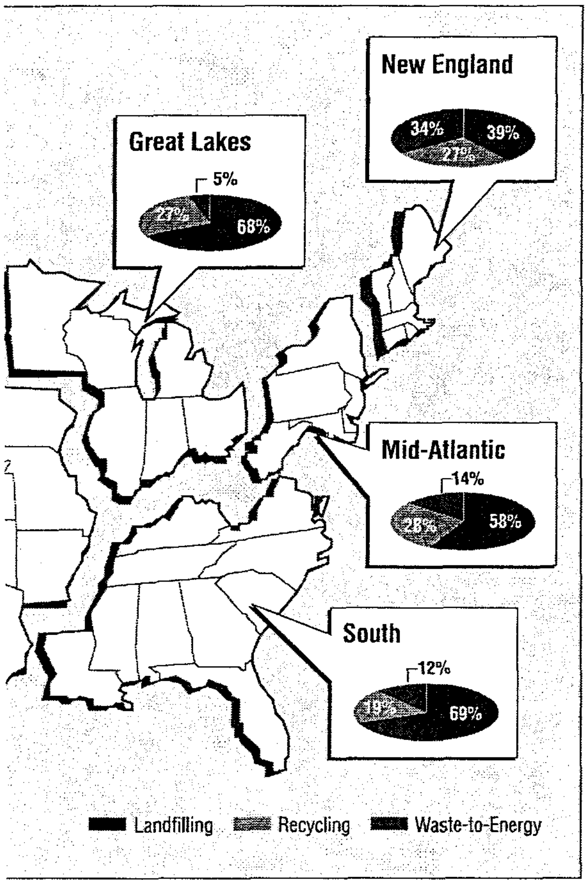
Curbside Programs



Yard Trimmings Facilities







information was provided from those states.) In 2000, 409 million tons of solid waste were generated. Over this two-year period, the U.S. population increased from 281 million to 288 million. On a per capita basis, this represents an increase from 1.46 tons in 2000 to 1.68 tons in 2002.

The more relevant number in the 2003 State of Garbage In America report is the estimated tons of municipal solid waste generated in the U.S. According to our calculations, the U.S. generated 369 million tons of MSW in 2002. That results in an average per capita generation of 1.31 tons/person in 2002 (see Table 3). Per capita rates calculated for individual states range from a low of 0.68 in South Dakota to a high of 1.73 tons in Kansas. Generally, it seems that more commercialized/industrialized states have higher per capita rates of MSW generation than those that are more agricultural. A more detailed data analysis to be published in the March issue of *BioCycle* will try to correlate per capita generation to the ratio of urban to rural population and tourism.

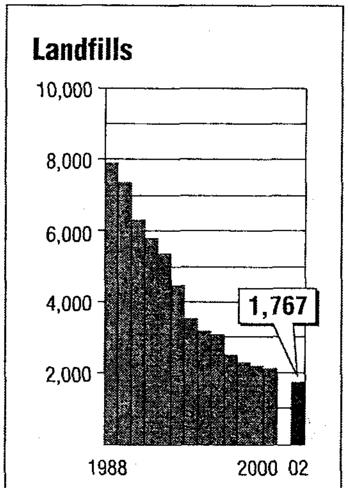
Of the 369 million tons of MSW generated in 2002, 98.7 million tons were recycled or composted, 28.5 million tons were combusted in waste-to-energy (WTE) plants, and 242 million tons were landfilled (see Table 4). That yields the following national rates — MSW Recycling: 26.7 percent; MSW to WTE: 7.7 percent; MSW Landfilled: 65.6 percent. For comparison, in the 2001 State of Garbage in America report, the national rates were 32 percent recycled, 7 percent combusted and 61 percent landfilled.

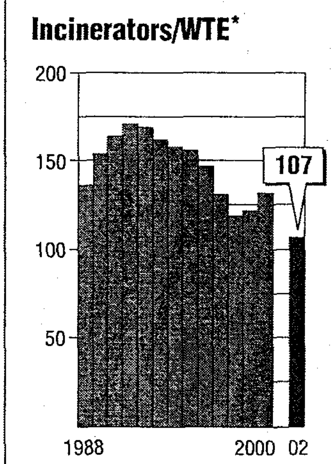
Overall, because this is the first time an estimated MSW generation number has been calculated based on actual tonnages recycled, combusted and landfilled, there is not any historical data to compare with. For example, the 2001 State of Garbage in America survey reported that 61 percent, or 249 million tons of the 409 million tons of solid waste generated in 2000, were landfilled. In 2002, 65.7 percent, or 242 million tons, of MSW were landfilled. One could attempt to compare landfill tonnages for 2000 and 2002 by using that same 65.7 percent landfilled rate in 2002 and the total solid waste generation number of 483 million tons. That yields an amount of 317 million tons of nonhazardous solid waste landfilled in 2002 (or about a 74.5 million tons differential). It seems safe to assume that this number reflects hefty tonnages of industrial and C&D waste streams.

Comparing states' recycling, combustion, and landfilling rates between the 2001 and 2003 State of Garbage in America surveys yields the following information:

Recycled: Using the recycling rates calculated for the 47 states that provided data, the 2003 State of Garbage in America survey found that 28 states had a decrease in their recycling rate from the 2001 survey, 12 states had an increase, and four stayed the same; three states did not report recycling rates in the 2001 survey.

Combusted: In terms of WTE/incineration rates (the 2001 survey did not specifically ask for waste-to-energy data, thus some states may have included data on incinerators as well as WTE plants), 16 states had a decrease in the combustion rate, 11 had an increase, four stayed the same and three states did not report WTE data in 2001. In addition, 13 of the 47 states do not have any WTE plants.





*WTE: Waste-to-energy

Table 1. State of Garbage in America survey data 1989–2002: Reported generation and estimated MSW generated, and rates of MSW recycling, incineration/waste-to-energy and landfilling[1]

Year Of Data	*Reported Generation (tons/yr)[2]*	*Estimated[3] MSW Generated (tons/yr)*	*MSW Recycled (%)*	*MSW Incineration/[4] Waste-To-Energy (%)*	*MSW Landfilled (%)*
1989	269,000,000	–	8	8	84
1990	293,613,000	–	11.5	11.5	77
1991	280,675,000	–	14	10	76
1992	291,742,000	–	17	11	72
1993	306,866,000	–	19	10	71
1994	322,879,000	–	23	10	67
1995	326,709,000	–	27	10	63
1996	327,460,000	–	28	10	62
1997	340,466,000	–	30	9	61
1998	374,631,000	–	31.5	7.5	61
1999	382,594,000	–	33	7	60
2000	409,029,000	–	32	7	61
2002	482,770,983	**369,381,411**	**26.7**	**7.7**	**65.6**

[1]Alabama, Alaska, and Montana did not report for this survey. The combined population of these three states is 6,039,747 (or two percent of total US population); [2]Data for 1989-2000 was provided to BioCycle as "MSW generation." Data for 2002 was provided as solid waste generation; [3]MSW generated is computed from reported tonnages of: [Landfill + Exported Landfill + WTE + Exported WTE + MSW Recycled] - [C&D Landfill + Industrial Landfill + Imported Landfill + Imported WTE]; [4]The 2003 "State Of Garbage In America" survey only collected data on waste-to-energy combustion. Previous surveys (1990-2000) asked more generally about "incineration."

According to our calculations, the U.S. generated 369 million tons of MSW in 2002. That results in an average per capita generation of 1.31 tons/person.

Landfilled: Based on the landfilling rates calculated for the 47 states providing data, 30 states had an increase in MSW landfilled, 14 had a decrease, and three did not have a rate reported in the 2001 report.

The breakdown on a regional basis (see map on pages 32-33 to identify states in each region) is as follows. The percentage rates from the 2001 State of Garbage report are in parentheses and are in the order of recycled, WTE/incineration, landfilled:

–New England: Recycled-27%; WTE-34%; Landfilled-39% (33%-36%-31%)

–Mid-Atlantic: Recycled-28%; WTE-14%; Landfilled-58% (39%-15%-46%)

–South: Recycled-19%; WTE-12%; Landfilled-69% (27%-8%-65%)

–Great Lakes: Recycled-27%; WTE-5%; Landfilled-68% (27%-5%-68%)

–Midwest: Recycled-25%; WTE-<1%; Landfilled-75% (32%-1%-67%)

–Rocky Mountain: Recycled-9%; WTE-1%; Landfilled-90% (11%-1%-88%)

–West: Recycled 38%; WTE-3%; Landfilled-59% (39%-3%-58%)

Finally, in terms of the big picture, significant tonnages of solid waste are crossing state borders, a trend that began a number of years ago as thousands of landfills closed across the country and super-sized landfills

Table 2. Tons of solid waste (nonhazardous) generated by state and waste stream categories included (2002 data unless noted)[1]

State	Reported Solid Waste Generated (tons/yr)	Residential	Commercial	C&D	Industrial	Agricultural	Imported Waste	Tires
Arizona	4,962,000	x	x					x
Arkansas	4,061,128	x	x		x			x
California	72,000,000	x	x	x	x	x	x	x
Colorado	7,673,778	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Connecticut	3,474,981	x	x		x			
Delaware	2,747,205	x	x	x	x			x
Florida[2]	25,726,175	x	x	x	x			x
Georgia	12,302,534	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hawaii	1,275,913	x	x	x	x			
Idaho	1,090,000	x	x	x				
Illinois	15,428,491	x	x	x				
Indiana	16,228,824	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Iowa	3,828,808	x	x	x	x	x	x	
Kansas	7,846,080	x	x	x	x		x	x
Kentucky	6,529,846	x	x				x	
Louisiana	3,272,331	x	x					
Maine[3]	1,844,059	x	x	x				x
Maryland	10,678,596	x	x	x	x			x
Massachusetts[3]	12,779,688	x	x	x			x	
Michigan	19,041,775	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Minnesota	5,881,543	x	x					
Mississippi	3,909,508	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Missouri	10,935,989	x	x	x	x	x		
Nebraska[3]	2,395,101	x	x		x		x	
Nevada	5,313,203	x	x	x	x			x
New Hampshire	1,327,598	x	x		x			
New Jersey[3]	18,865,390	x	x	x	x	x		x
New Mexico	2,968,729	x	x	x	x			x
New York[4]	24,775,000	x	x	x	x		x	x
North Carolina	13,500,000	x	x	x	x			x
North Dakota	4,270,000	x	x		x			x
Ohio[3]	32,184,841	x	x	x	x	x		x
Oklahoma	4,489,028	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Oregon	4,772,536	x	x	x				x
Pennsylvania	10,881,798	x	x					
Rhode Island	1,497,240	x	x	x	x	x		x
South Carolina	11,464,547	x	x	x	x			x
South Dakota	688,000	x	x	x	x		x	
Tennessee	9,852,194	x	x	x	x	x	x	x
Texas	45,300,000	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Utah	3,949,096	x	x	x	x	x		
Vermont[5]	700,000	x	x	x	x		x	
Virginia	17,499,022	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Washington[3,6]	10,470,805	x	x	x	x	x		x
West Virginia	1,963,791	x	x	x	x		x	x
Wisconsin	13,542,140	x	x	x	x			x
Wyoming	682,000	x						
Total	**482,770,983**							

[1]The following states did not report a solid waste (nonhazardous) generation amount: Alabama, Alaska and Montana; [2]2000 data; [3]2001 data; [4]1999 and 2002 data; [5]Includes wastewater treatment plant biosolids; [6]Includes petroleum contaminated soil and biosolids.

Table 3. Reported solid waste generated, estimated MSW generated, estimated MSW generated per capita, and percents of MSW recycled, combusted via waste-to-energy (WTE) and landfilled (2002 data unless noted)[1]

State	Population (2002)	Reported Solid Waste Generated (tons/yr)	Estimated[2] MSW Generated (tons/yr)	Estimated MSW Generated Per Capita[3] (tons/person)	MSW Recycled (%)	MSW To Waste-To-Energy (%)	MSW Landfilled (%)
Alabama	4,486,508	n/a	n/a	n/a	n/a	n/a	n/a
Alaska	643,786	n/a	n/a	n/a	n/a	n/a	n/a
Arizona	5,456,453	4,962,000	6,012,359	1.10	17.5	0	82.5
Arkansas	2,710,079	4,061,128	3,838,217	1.42	36.3	1.5	62.3
California[4]	35,116,033	72,000,000	54,429,851	1.55	40.2	1.6	58.1
Colorado	4,506,542	7,673,778	5,051,132	1.12	2.8	0	97.2
Connecticut	3,460,503	3,474,981	4,734,132	1.37	18.8	45	36.2
Delaware	807,385	2,747,205	1,069,042	1.32	20.4	0	79.6
Florida[5]	16,713,149	25,726,175	19,706,584	1.18	24	28.2	47.8
Georgia[6]	8,560,310	12,302,534	11,214,006	1.31	8.3	0.5	91.3
Hawaii	1,244,898	1,275,913	1,706,018	1.37	25.2	24.4	50.4
Idaho[7]	1,341,131	1,090,000	1,090,000	0.81	8.4	0	91.6
Illinois	12,600,620	15,428,491	15,951,037	1.27	32.5	0	67.5
Indiana[8]	6,159,068	16,228,824	9,542,378	1.55	35	7	58
Iowa	2,936,760	3,828,808	3,416,268	1.16	41.7	1	57.3
Kansas	2,715,884	7,846,080	4,698,338	1.73	11.5	0	88.5
Kentucky	4,092,891	6,529,846	5,465,608	1.34	11.4	0	88.5
Louisiana	4,482,646	3,272,331	4,952,900	1.10	8.1	0	91.9
Maine[9]	1,294,464	1,844,059	1,327,164	1.03	49	33.8	17.2
Maryland	5,458,137	11,172,882	8,904,464	1.63	29.2	16	54.8
Massachusetts[9]	6,427,801	12,779,688	8,307,387	1.29	31.1	37.6	31.3
Michigan	10,050,446	19,041,775	16,916,076	1.68	15.1	7	77.9
Minnesota	5,019,720	5,881,543	5,043,752	1.00	45.6	25.1	29.3
Mississippi	2,871,782	3,909,508	2,918,407	1.02	0.3	0	99.7
Missouri	5,672,579	10,935,989	7,256,744	1.28	38.9	0.3	60.8
Montana	909,453	n/a	n/a	n/a	n/a	n/a	n/a
Nebraska[9]	1,729,180	2,395,101	2,395,100	1.39	15.4	0	84.6
Nevada	2,173,491	5,313,203	3,365,570	1.55	15.8	0	84.2
New Hampshire	1,275,056	1,327,598	1,214,777	0.95	23.7	17	59.4
New Jersey[9]	8,590,300	18,865,390	10,606,326	1.23	37.9	9.1	53.1
New Mexico	1,855,059	2,968,729	2,095,052	1.13	6.5	0	93.5
New York[10]	19,157,532	24,784,000	24,775,000	1.29	29.8	17.1	53.1
North Carolina	8,320,146	13,500,000	8,981,349	1.08	11	1.3	87.6
North Dakota	634,110	4,270,000	638,804	1.01	9.4	0	90.6
Ohio[9,11]	11,421,267	13,748,996	16,211,198	1.42	23.5	0	76.5
Oklahoma	3,493,714	4,489,028	4,489,028	1.28	1	0	99
Oregon	3,521,515	4,772,536	4,074,945	1.16	48.8	4.9	46.3
Pennsylvania	12,335,091	10,881,798	12,675,854	1.03	26.8	16.5	56.7
Rhode Island	1,069,725	1,497,240	1,248,745	1.17	12.8	0	87.2
South Carolina	4,107,183	11,464,547	5,973,059	1.45	28.4	3.9	67.7
South Dakota	761,063	688,000	518,493	0.68	3	0	97
Tennessee	5,797,289	9,852,194	7,365,920	1.27	26.4	2	71.6
Texas[12]	21,779,893	45,300,000	28,531,660	1.31	24.9	0	75.1
Utah	2,316,256	3,949,096	2,471,404	1.07	4.8	4.9	90.4
Vermont	616,592	700,000	611,617	0.99	29.8	9.2	60.9
Virginia	7,293,542	21,331,253	10,877,723	1.49	29.1	19.8	51.2
Washington[9]	6,068,996	10,470,805	8,666,755	1.43	34.1	5.6	60.2
West Virginia	1,801,873	1,963,791	1,754,523	0.97	6.9	0	93.1
Wisconsin	5,441,196	13,542,140	5,592,862	1.03	24.6	3.4	72
Wyoming	498,703	682,000	693,783	1.39	1.7	0	98.3
Totals	**287,797,800**	**482,770,983**	**369,381,411**	**1.31**	**26.7**	**7.7**	**65.6**

[1]Alabama, Alaska and Montana did not report any data for the 2003 "State of Garbage in America" survey; [2]Unless otherwise noted, MSW generated is computed from reported tonnages of: [Landfill + Exported Landfill + WTE + Exported WTE + MSW Recycled] - [C&D Landfill + Industrial Landfill + Imported Landfill + Imported WTE]; [3]U.S. per capita generation excludes Alabama, Alaska and Montana; [4]MSW generation calculated using state population multiplied by 1.55 tons per capita (Nevada's per capita generation rate, chosen because highest rate in neighboring state). State provided tons landfilled and combusted via WTE; [5]2000 data; [6]MSW generation calculated using state population multiplied by 1.31 tons per capita (national rate). State provided tons landfilled and combusted via WTE; [7]State reported MSW generation and no WTE facilities. 2002 landfill tonnage provided by Chartwell Information (www.wasteinfo.com); [8]MSW generation assumed to be equal to reported tons landfilled + recycled, at same recycling rate as in 2000 (35%); [9]2001 data; [10]Detailed data for the state provided in New York State Assembly Report, "Where Will the Garbage Go?", 2002; [11]Tons of industrial wastes (10,502,763) were subtracted from reported total tons recycled; [12]MSW generation calculated using state population multiplied by 1.31 tons per capita (national rate). State provided tons landfilled and there are no WTE plants.

The 5.3 percentage points decrease in the national recycling rate between the 2000 and 2002 surveys can be attributed in part to the different approach to calculating the national rates in the 2003 State of Garbage in America report.

opened in some states. As in 2000, Pennsylvania leads in the MSW importing category, receiving 10 million tons of solid waste in 2002 (the bulk of which was landfilled). Illinois is second with 5.8 million tons and Virginia is third with 4.5 million tons imported. Michigan is fourth with 3.8 million tons imported. As with Pennsylvania, almost all imported waste is landfilled in these four states.

Table 4. Estimated MSW tonnage generated and MSW tons recycled, combusted via waste-to-energy (WTE) and landfilled (by state, 2002 data unless noted)

State	Estimated[1] MSW Generated (tons/yr)	MSW Recycled (tons/yr)	MSW To WTE (tons/yr)	MSW Landfilled (tons/yr)
Arizona	6,012,359	1,050,359	0	4,962,000
Arkansas	3,838,217	1,391,978	56,048	2,390,191
California[2]	54,429,851	21,902,181	887,270	31,640,400
Colorado	5,051,132	142,352	0	4,908,779
Connecticut	4,734,132	888,207	2,130,125	1,715,800
Delaware	1,069,042	217,842	0	851,200
Florida[3]	19,706,584	4,721,972	5,563,565	9,421,047
Georgia[4]	11,214,006	928,678	51,707	10,233,621
Hawaii	1,706,018	430,106	416,668	859,244
Idaho[5]	1,090,000	92,000	0	998,000
Illinois	15,951,037	5,191,388	0	10,759,649
Indiana[6]	9,542,378	3,339,832	647,546	5,555,000
Iowa	3,416,268	1,425,624	34,407	1,956,237
Kansas	4,698,338	539,887	0	4,158,451
Kentucky	5,465,608	625,083	2,250	4,838,275
Louisiana	4,952,900	402,200	0	4,550,700
Maine[7]	1,327,164	650,037	448,368	228,759
Maryland	8,904,464	2,599,675	1,425,915	4,878,874
Massachusetts[7]	8,307,387	2,583,736	3,127,582	2,596,069
Michigan	16,916,076	2,550,246	1,183,382	13,182,448
Minnesota	5,043,752	2,301,455	1,265,563	1,476,734
Mississippi	2,918,407	10,000	0	2,908,407
Missouri	7,256,744	2,823,100	20,350	4,413,294
Nebraska[7]	2,395,100	368,867	0	2,026,233
Nevada	3,365,570	531,804	0	2,833,766
New Hampshire	1,214,777	287,612	206,143	721,022
New Jersey	10,606,326	4,014,960	961,508	5,629,858
New Mexico	2,095,052	135,496	0	1,959,556
New York	24,775,000	7,384,000	4,247,600	13,143,400
North Carolina	8,981,349	992,009	120,751	7,868,589
North Dakota	638,804	60,000	0	578,804
Ohio[7]	16,211,198	3,808,058	0	12,403,140
Oklahoma	4,489,028	44,667	0	4,444,361
Oregon	4,074,945	1,987,246	201,161	1,886,538
Pennsylvania	12,675,854	3,399,002	2,094,778	7,182,074
Rhode Island	1,248,745	159,863	0	1,088,882
South Carolina	5,973,059	1,697,706	231,357	4,043,996
South Dakota	518,493	15,493	0	503,000
Tennessee	7,365,920	1,942,512	150,343	5,273,065
Texas[8]	28,531,660	7,106,747	0	21,424,913
Utah	2,471,404	117,686	120,146	2,233,572
Vermont	611,617	182,562	56,320	372,735
Virginia	10,877,723	3,160,931	2,151,778	5,565,011
Washington[7]	8,666,755	2,959,534	489,180	5,218,041
West Virginia	1,754,523	120,276	0	1,634,247
Wisconsin	5,592,862	1,378,470	187,824	4,026,568
Wyoming	693,783	11,783	0	682,000
Totals	**369,381,411**	**98,675,222**	**28,479,635**	**242,226,551**

[1]Unless otherwise noted, MSW generated is computed from reported tonnages of: [Landfill + Exported Landfill + WTE + Exported WTE + MSW Recycled] - [C&D Landfill + Industrial Landfill + Imported Landfill + Imported WTE]; [2]In absence of information on C&D and other non-MSW materials, the MSW generation was assumed to be 1.55 tons per capita (same as Nevada, which is in the same region); [3]2000 data; [4]MSW generation calculated using state population multiplied by 1.31 tons per capita (national rate). State provided tons landfilled and combusted via WTE; [5]State reported MSW generation and no WTE facilities. 2002 landfill tonnage provided by Chartwell Information (www.wasteinfo.com); [6]MSW generation assumed to be equal to reported tons landfilled+recycled, at same recycling rate as in 2000 (35%); [7]2001 data; [8]MSW generation calculated using state population multiplied by 1.31 tons per capita (national rate). State provided tons landfilled and there are no WTE plants.

On the export side, New York is the highest with 5.4 million tons exported in 2002 (slightly down from the 5.6 million tons exported in 2000, when New York also was the leader in this category). New Jersey is in second place, with 3.5 million tons. Third and fourth places are a close tie between Missouri (1,993,136 tons) and Maryland (1,943,124 tons). Fifth place goes to Massachusetts, with 1.7 million tons. Washington is the only other state exporting over a million tons of solid waste (1,146,331 tons). In all cases, most of the tonnages exported were landfilled in the receiving states.

THE RECYCLING SCENE

The recycling numbers in this report include organic materials composted. The 5.3 percentage points decrease (from 32% to 26.7%) in the national recycling rate, between the 2000 and 2002 surveys, can be attributed in part to the different approach to calculating the national rates in the 2003 State of Garbage in America report (i.e., using actual tonnage data versus estimated percentages). California is a case in point. The state reported that its diversion rate (i.e., materials that were not combusted or landfilled) in 2002 was 48 percent of total solid waste generated (72 million tons). This corresponds to about 35 million tons diverted. However, when we divided the 72 million tons of solid wastes by the population of California, the per capita generation was 2.05 tons, considerably higher than any other state. This indicated to us that the 72 million tons included non-MSW materials, such as C&D and industrial wastes.

Given the lack of adequate information on MSW generation in California, we assumed that the per capita generation in California was the same as in the neighboring state of Nevada (1.55 tons/person). This number is 0.24 tons higher than the U.S. average of 1.31 tons/person. At that rate, the 2002 MSW generation in California was estimated at 54.4 million tons. Then, by subtracting from 54.4 million the known tonnages of MSW combusted and landfilled, we arrived at about 22 million tons of MSW recycled. In the following months we will examine the validity of this estimate, by determining the actual tonnages of the recycled streams in California — organics composted, and wood, paper, plastic, metal, and glass recycled.

As shown in Table 3, Maine and Oregon had the highest estimated recycling rates in the U.S. (49 percent and 48.8 percent, respectively), followed by Minnesota (45.6 percent), Iowa (41.7 percent) and California (40.2 percent). In the case of Maine and Oregon, the estimated rates increased significantly since the 2000 survey (by 9% and 9.8%, respectively).

Because of the differentiation between MSW and total solid wastes generation in the 2002 survey, some states had decreases greater than 10 percent, including Delaware (59% to 20.4%), Louisiana (17% to 8.1%), Mississippi (16% to 0.3%), New York (42% to 29.8%), Rhode Island (24% to 12.8%), West

Virginia (25% to 6.9%) and Wisconsin (36% to 24.6%). It is most likely that the primary explanation for the decrease has to do with the new methodology employed this year.

Table 5 highlights the contribution of organics to the overall recycling rate. Thirty-five of the 47 states reporting had tonnage data for recycled organics (including yard trimmings and food residuals) and/or wood (non-C&D). (Note that tonnages of C&D recycled, where provided by states, is reported in Table 10.) The last column of Table 5 calculates the percentage that organics and wood represent in the MSW recycling rate. Based on data from those 35 states, organics and wood contributed an average of 28 percent of all materials recycled.

CURBSIDE COLLECTION PROGRAMS

Since the State of Garbage In America survey began in 1989, *BioCycle* has tracked the number of residential curbside collection programs in the U.S. In 1988, there were 1,042 curbside collection programs. That number quickly doubled within two years, and grew rapidly thereafter. A total of 9,709 programs were reported in the 2001 survey.

According to our data, the number of curbside collection programs in the U.S. dropped between 2000 and 2002 to 8,875 (Table 6). This is the second time a decrease has been reported. There is no way to assess whether there actually are fewer programs or if states have refined their data collection capabilities from reporting jurisdictions. Comparing data

Table 5. Organics and wood recycled (tons/year); Contribution to state MSW recycling rate (2002 data unless noted)

State	Organics[1] (tons)	Wood (tons)	Total MSW Recycled (tons)	MSW Recycling Rate (%)	Organics/Wood Contribution To Recycling[2] (%)
Arizona	316,124	44,530	1,050,359	17.5	34
Arkansas	–	145,106	1,391,978	36.3	10
Colorado	15,871	36,530	142,352	2.8	37
Connecticut	235,816	–	888,207	18.8	27
Delaware	32,360	–	217,842	20.4	15
Florida	–	1,471,782	4,721,972	24	31
Hawaii	79,401	–	430,106	25.2	18
Indiana	424,053	–	3,339,832	35	13
Iowa	294,978	103,194	1,425,624	41.7	28
Kansas	154,100	–	539,887	11.5	29
Kentucky	16,645	–	625,083	11.4	3
Louisiana	83,444	–	402,200	8.1	21
Maine	50,084	40,443	650,037	49	14
Maryland	645,230	122,101	2,599,675	29.2	30
Massachusetts	443,147	–	2,583,736	31.1	17
Michigan	739,904	–	2,550,246	15.1	29
Minnesota	167,529	–	2,301,455	45.6	7
Missouri	394,966	–	2,823,100	38.9	14
Nevada	12,675	26,433	531,804	15.8	7
New Hampshire	37,114	–	287,612	23.7	13
New Jersey	1,720,069	105,476	4,014,960	37.9	45
New Mexico	12,122	8,266	135,496	6.5	15
North Carolina	468,901	–	992,009	11	47
Ohio	1,012,951	1,346,511	3,808,058	23.5	62
Oregon	443,966	386,053	1,987,246	48.8	42
Pennsylvania	498,391	141,628	3,399,002	26.6	19
Rhode Island	72,500	–	159,863	12.8	45
South Carolina	134,712	251,042	1,697,706	28.4	23
South Dakota	13,000	–	15,493	3	84
Tennessee	162,347	30,600	1,942,512	26.4	10
Vermont	29,626	225	182,562	29.8	16
Virginia	540,282	361,565	3,160,931	29.1	29
Washington	539,717	689,706	2,959,534	34.1	42
West Virginia	680	–	120,276	6.9	1
Wisconsin	225,240	23,630	1,378,470	24.6	18

"–" = tonnages not provided; [1]Organics include yard trimmings and food residuals; [2]Represents percent contribution of organics and wood recycled to MSW recycling rate.

Table 6. Number of residential curbside recycling programs,population served, and yard trimmings composting sites by state (2002 data unless noted)

State	Curbside Programs	Population With Access To Curbside Collection	Yard Trimmings Composting Sites
Arizona	27	2,570,000	n/a
Arkansas	67	n/a	24
California	396	31,146,000[1]	100
Colorado	22[2]	618,848	5[2]
Connecticut	169	3,460,503	92
Delaware	2	4,000	0
Florida[3]	333	9,100,000	0[4]
Georgia	184	n/a	63
Hawaii	4	41,000	5
Idaho	12	n/a	n/a
Illinois	n/a	n/a	40
Indiana	79	4,170,000[1]	107
Iowa	627	1,862,314	80
Kansas	113	1,100,000	105
Kentucky	54	1,211,085	30
Louisiana	20	n/a	3
Maine[5]	40	500,000	<25
Maryland	99[1]	4,000,000	37
Massachusetts[5]	160	4,862,806	223
Michigan[6]	347	3,670,072	163
Minnesota	733	3,750,000	n/a
Mississippi	14[1]	325,000[1]	6
Missouri	216	n/a	152[7]
Nebraska[5]	8	500,000	n/a
Nevada	3	1,963,924	1
New Hampshire	42	>518,000	192
New Jersey[5]	510	7,500,000[1]	170
New Mexico	10	400,000[1]	8
New York	1,500[8]	17,230,000[8]	32
North Carolina	256	3,200,000	120
North Dakota	4	100,000[1]	40
Ohio[5]	459	6,459,072	534
Oklahoma	7	905,790	4
Oregon	133	2,641,136	41
Pennsylvania	945	9,310,252	>300
Rhode Island	26	897,000	15
South Carolina	135[1]	564,552	128
South Dakota	3	60,000	120
Tennessee	58	n/a	n/a
Texas	160[1]	5,000,000[1]	160
Utah	n/a	n/a	20
Vermont[5]	93[1]	545,000	12
Virginia	60	1,144,000[9]	14[1]
Washington[5]	150	4,923,318	41
West Virginia	51[1]	425,134	0[10]
Wisconsin	544	2,695,958	n/a
Wyoming	0	0	15
Totals	**8,875**	**139,374,764**	**3,227**

[1]2001 BioCycle, "The State of Garbage In America" data; [2]Based only on data from 12 cities and/or counties; [3]2000 data; [4]State reports 140 sites only grinding (i.e., not composting) collected yard trimmings for mulch; [5]2001 data; [6]1999 data; [7]May include yard trimmings grinding (only) facilities; [8]1998 data; [9]Based on conversion of 2.86 people/household; [10]State reports 22 sites only grinding (i.e., not composting) collected yard trimmings for mulch

from the 2001 and 2003 surveys, however, the following can be noted:

–Illinois did not report any curbside data for 2002, but noted 474 programs in 2000.

–Five states had hefty declines in curbside programs. These include Georgia (-275), California (-150), Washington (-133), Indiana (-89) and Wisconsin (-87).

–Ohio reported an increase in curbside programs (+227). Other states with increases since 2000 include Pennsylvania (+53), Missouri (+39) and Florida (+34).

Interestingly, despite the drop in curbside collection programs between 2000 and 2002 (a decrease of 834), the total population with access to curbside collection only decreased slightly (from 139,766,000 to 139,374,764). This may indicate that there has been a consolidation of some collection programs.

YARD TRIMMINGS COMPOSTING

As in the case with curbside programs, data have been collected on the number of yard trimmings composting sites since the first State of Garbage survey in 1989. According to that first report, there were 651 yard trimmings composting sites in 1988. Due to both rapid growth and better data tracking, that number more than doubled to 1,407 by 1990, and doubled again to 2,981 by 1992. Growth between 1992 and 2000 was more steady, increasing to 3,846 yard trimmings composting sites in the U.S. by 2000.

In 2002, the reported number of yard

Table 7. Number of municipal solid waste landfills and waste to energy plants, average tip fees, and capacity by state for 2002

State	*Number of MSW Landfills*	*Average Landfill Tip Fee ($/ton)*	*Total Landfill Capacity Remaining (tons)*	*Number Of WTE Plants*	*Average WTE Tip Fee ($/ton)*
Arizona	41	n/a	n/a	0	–
Arkansas	24	28.45	n/a	2	n/a
California	161	13.63	410,501,190	3	n/a
Colorado	65	n/a	n/a	0	–
Connecticut	2	n/a	n/a	6	65
Delaware	3	58.50	20,000,000	0	–
Florida	100	42.47	n/a	13	59
Georgia	60	33.50	135,349,274[1]	1	45
Hawaii	9	n/a	n/a	1	n/a
Idaho	29	n/a	n/a	0	–
Illinois	51	n/a	212,393,636[1]	0	–
Indiana	35	n/a	52,231,795[1]	1	n/a
Iowa	59	33.25	40,182,628	1	53
Kansas	51	28	n/a	0	–
Kentucky	25	27.57	36,363,636[1]	1	n/a
Louisiana	24	25	n/a	0	–
Maine	8	55	3,030,303[1]	4	65
Maryland	20	50	n/a[2]	3	49
Massachusetts	19	72.60	n/a	7	71
Michigan	52	n/a	143,939,394[1]	4	76
Minnesota	21	50	18,700,000	15	50
Mississippi	17	26	n/a	0	–
Missouri	24	33.54	41,432,836[1]	0[3]	–
Montana[4]	30	32	32,727,273	0	–
Nebraska	24	25	n/a	0	–
Nevada	23	30	60,742,056[1]	0	–
New Hampshire	10	68	15,000,000	2	81
New Jersey	12	60	40,000,000	5	60
New Mexico	35	n/a	190,966,142[1]	0	–
New York	26	50	90,000,000	10	65
North Carolina	41	30	100,000,000	1	50
North Dakota	14	26.56	n/a	0	–
Ohio	44	32.20	124,079,624[1]	0	–
Oklahoma	40	20	n/a	1	n/a
Oregon	30	34.50	n/a	1	68
Pennsylvania	49	48	298,585,524	6	74
Rhode Island	2	41.50	n/a	0	–
South Carolina	19	27	109,534,023	4	n/a
South Dakota	15	30	16,757,576[1]	0	–
Tennessee	34	28.38	n/a	1	n/a
Texas	175	27	970,000,000	2	n/a
Utah	38	n/a	n/a	1	n/a
Vermont	5	80	1,453,778	0	–
Virginia	67	n/a	251,810,045	5	n/a
Washington	21	46.48	180,002,767	4	n/a
West Virginia	18	43	>5,674,330	0	–
Wisconsin	42	36.43	30,440,024[1]	2	n/a
Wyoming	53	n/a	n/a	0	–
Totals	**1,767**			**107**	

[1]Tonnage based on conversion from cubic yards reported (conversion of 3.3 cubic yards/ton); [2]Landfill capacity remaining exceeds ten years; [3]Waste-to-energy plant burns tires for fuel; [4]2001 data from MSW Management

A THANK YOU TO CONTRIBUTORS

BIOCYCLE and the Earth Engineering Center gratefully acknowledge the assistance of the following individuals — the majority in state solid waste and recycling offices — for all of their help and persistence in providing valuable data for the 2003 State of Garbage In America survey. We appreciate your patience with our follow-up questions and the speed with which you responded. Thank you!

Arizona: David Janke. *Arkansas*: Don Murray. *California*: Lanny Clavecilla and Lorraine Van Kekerix and Matt Cotton (Integrated Waste Management Consulting). *Colorado*: Glenn Mallory and Marjorie Griek, Colorado Association for Recycling, who coordinated the gathering of data from the following individuals providing data for their city and/or county — Jeff Callahan, Boulder; Charlotte Pitt, Denver; Nancy Andrews, City of Durango and La Plata County; Mereth Meade, City of Evergreen and Preston Loos, Jefferson County; Marlene Crosby, Gunnison County Landfill; Bruce Philbrick, Loveland; Deborah Barton, Montezuma County; June Chandler, City of Montrose, Brian Wilson and Dave Jones, Montrose County; Susie Gordon, Shirley Bruns and James Birchler, Fort Collins; Chris Hoofnagle, Pitkin County; Ray Lariviere, Southeast and East Central Recycling Association; Wendy DuBord, Steamboat Springs; Bill Mack and R. Peterson, Yampa Valley. *Connecticut*: Judy Belaval, K.C. Alexander and Frank Gagliardo. *Delaware*: Tom Houska. *Florida*: Shannan Reynolds. *Georgia*: Joe Dunlop, Jay Donnaway and Randy Hartmann. *Hawaii*: Lane Otsu.

Idaho: Dean Ehlert and James Thompson, Jr. (Chartwell Information). *Illinois*: Ellen Robinson and Gary Cima. *Indiana*: Michelle Weddle, Richard Worth and Monica Hartke-

trimmings composting sites was 3,227, a decrease of 619 from the 2000 data. It is believed the primary reason for the drop was that five states providing numbers for 2000 were not able to do so for 2002 (e.g., Minnesota reported 454 in 2000 and Wisconsin reported 140).

Florida, which in 2000 noted it had 26 yard trimmings composting sites, reported no composting sites in 2002. Instead, the state explained there are 140 sites only grinding (i.e., not composting) yard trimmings for mulch. West Virginia, which noted that it had 23 composting sites in 2000, also reported none in 2002. Like Florida, this state reported that there are 22 sites grinding collected yard trimmings into mulch.

Some states reported a significant increase in the number of yard trimming composting sites between 2000 and 2002. These include Georgia (+48), Indiana (+21), Iowa (+37) and Missouri (+52) — although Missouri explained that some of its 152 sites may only be producing mulch. The only state reporting a sizable decrease is New York (-73).

LANDFILLING AND WASTE-TO-ENERGY STATISTICS

Based on data from 47 states, the total number of landfills in operation in 2002 is 1,767, a decrease of 375 from the total of 2,142 reported in 2000 (Table 7). A major reason for the decrease is not including landfills in Alabama and Alaska (which accounted for 304 landfills in 2000). Texas had 52 fewer landfills in 2002, which may be explained by the fact that, in 2000, the state noted that only 183 of its 227 landfills were active. In 2002, Texas reported 175 landfills (which is more in line with the 183 landfills in 2000). Tennessee reports a decrease of 14 landfills between 2000 and 2002. The only state reporting a significant increase of landfills in 2002 was Florida — from 61 in 2000 to 100 in 2002.

Table 7 also shows that average landfill tip fees ranged from a low of $13.63/ton in California to a high of $72.60/ton in Massachusetts.

The states also were asked to provide the amount of total landfill capacity remaining

Table 8. C&D landfills and MSW transfer stations by state for 2002 (unless noted)

State	C&D Landfills	MSW Transfer Stations
Arizona	11	120
Arkansas	35	87
California	154	458
Connecticut	27	120
Delaware	1	1
Florida	185	98
Georgia	46	70
Hawaii	2	11
Illinois	n/a	86
Indiana	9	59
Iowa	4	35
Kansas	129	65
Kentucky	128	50
Maine[1]	24	242
Maryland	5	11
Massachusetts[1]	9	194
Michigan	3	69
Minnesota	79	80
Mississippi	72	41
Missouri	4	47
Nebraska[1]	19	46
Nevada	11	9
New Hampshire	n/a	201
New Jersey[1]	1	43
New Mexico	5	130
New York	30	476
North Carolina	56	80
North Dakota	182	28
Ohio	75	59
Oklahoma	7	38
Oregon	5	135
Pennsylvania	6	73
Rhode Island	0	26
South Carolina	138	38
South Dakota	170	15
Tennessee	71	29
Texas	45	150
Utah	47	11
Vermont	1	90
Virginia	22	61
Washington	53	95
West Virginia	17	17
Wisconsin	41	81
Wyoming	2	20
Total	1,931	3,895

[1]2001 data; n/a = not available

Table 9. Waste imports and exports by state for 2002 (unless noted)

State	Imported (tons/yr)	Exported (tons/yr)
Arizona	383,000	10,000
Arkansas	168,352	370
California	26,477	616,639
Connecticut	63,396	366,003
Georgia	963,419	n/a
Illinois	5,800,977	n/a
Indiana	1,573,726	n/a
Iowa	402,780	127,785
Kansas	663,103	n/a
Kentucky	n/a	246,702
Maine	218,941	77,765
Maryland	456,663	1,943,124
Massachusetts	186,356	1,687,084
Michigan	3,831,481	n/a
Minnesota	n/a	636,225
Mississippi	537,504	n/a
Missouri	10,700	1,993,136
Nevada	534,018	0
New Hampshire	745,853	33,000
New Jersey	576,012	3,500,000
New Mexico	377,880	0
New York	567,500	5,400,000
North Carolina	n/a	882,247
North Dakota	101,196	10,000
Ohio	1,977,833	986,693
Oregon	1,625,962	18,668
Pennsylvania	9,999,557	300,000
South Carolina	954,854	507,661
Tennessee	n/a	549,053
Texas	65,603	n/a
Utah	138,700	n/a
Vermont	6,900	124,320
Virginia	4,508,839	n/a
Washington	172,708	1,146,331
West Virginia	203,869	431,956
Wisconsin	1,407,052	n/a

Tarr. *Iowa:* Becky Jolly and Jeff Geerts, Dewayne Johnson, Iowa Recycling Association, Shelly Codner (*BioCycle* contributor), and Jennifer Gitlitz (Container Recycling Institute). *Kansas*: Kent Foerster and Jami Iott and Chiquita Cornelius (Kansas BIRP). *Kentucky*: Sara Evans, Billy Hill and Bob Bickner. *Louisiana*: John Rogers. *Maine*: George MacDonald and Hank Tyler. *Maryland*: Hilary Miller, Virginia Lipscomb, Dave Mrgich, Edward Dexter and Frank Diller. *Massachusetts*: John Fischer and Amy Roth. *Michigan*: Matthew Flechter, Lucy Doroshko and Lynn Dumroese. *Minnesota*: Mark Rust, Don Kyser and Ginny Black. *Mississippi*: Mark Williams and Pradip Bhowal. *Missouri*: Rob Hargis.

Nebraska: Steve Danahy. *Nevada*: Dave Friedman and Les Gould. *New Hampshire*: Christopher Way and Marc Morgan. *New Jersey*: Ray Worob, Guy Watson, Joe Lomerson and Steve Rinaldi. *New Mexico*: E. Gifford Stack and John O'Connell. *New York*: Michael Munson, Sally Rowland, Peter Pettit, Scott Menrath and David Vitale. *North Carolina*: Scott Mouw and NC Division of Waste Management. *North Dakota*: Steve Tillotson. *Ohio*: Michelle Kenton, Andrew Booker and Patricia Raynek. *Oklahoma*: R. Fenton Rood. *Oregon*: Peter Spendelow, Marti Roberts-Pillon and Mary Sue Gilliland. *Pennsylvania*: Carl Hursh, Larry Holley, Sally Lohman, Patti Olenick, Linda Polk and Steve Socash. *Rhode Island*: Mike McGonagle and John Trevor. *South Carolina*: Celeste Duckett and Bill Culler.
South Dakota: Steven Kropp and Carrie Jacobson. *Tennessee*: Louis Bordenave and Larry Christley. *Texas*: Donna Huff, G. Michael Lindner and Scott McCoy. *Utah*: Ralph Bohn. *Vermont*: Vicky Viens and Julie Hackbarth. *Virginia*: G. Stephen Coe. *Washington*: Gretchen Newman. *West Virginia*: Carol Throckmorton and Phil Mann. *Wisconsin*: Cynthia Moore and Kurt Byfield. *Wyoming*: Bob Doctor.

measured in total tons or cubic yards. (Previous State of Garbage surveys requested total landfill capacity remaining in years.) The remaining capacity varies greatly among states providing that data (see Table 7). For example, Texas reports 970 million tons of landfill capacity remaining which, based on its 2002 MSW landfilling of about 21 million tons, corresponds to 46 years of landfill space. California, with 410 million tons of remaining capacity, has 13 years of landfill space, at current MSW landfilling rates. Other states with over 200 million tons of capacity include Illinois (212.4 million tons), Pennsylvania (299 million tons), and Washington (252 million tons).

As a final note on landfill data, in the current survey we asked states if landfill capacity is being added. Of the 47 states responding, only six replied "no" (Arizona, Nebraska, New Jersey, Oklahoma, Oregon and Virginia). Colorado, Connecticut and Texas did not answer the question.

Table 7 also includes data on waste-to-energy plants in the U.S. As noted earlier in this article, previous State of Garbage in America surveys did not specifically ask states for data on waste-to-energy combustion, but instead only asked about incineration (which may or may not include energy recovery). There were 107 WTE facilities reported for 2002, in comparison to the 132 WTE/incineration plants reported for 2000. Tipping fees at waste-to-energy plants ranged from $45/ton in Georgia (with only one WTE plant) to $81/ton in New Hampshire (with two WTE plants).

The average landfill tip fees ranged from a low of $13.63/ton in California to a high of $72.60/ton in Massachusetts.

Table 8 provides data on C&D landfills and MSW transfer stations. In 2002, there were a total of 1,931 C&D landfills, as compared to 1,825 reported for 2000. The total number of MSW transfer stations reported for 2002 is 3,895, versus 3,970 for 2000. Table 9 provides data on waste imports and exports, most of which flow through the nation's infrastructure of transfer stations.

Table 10 includes recycling tonnages reported by the states. Of the 47 states participating in the 2003 survey, only 32 provided a breakdown of the tonnages of various materials recycled. Finally, Table 11 show materials that are banned from MSW landfills in various states. For example, 21 states have bans on the landfill disposal of leaves, grass clippings and/or all yard trimmings.

Table 10. Quantity of materials recovered via recycling in 2002 (tons/year); unless noted, 32 states reporting

State	Glass	Steel	Aluminum	Other Metals	C&D	Wood	Paper	Plastic	Tires	Organics	Other
Arizona	13,521	54,933	8,857	28,038	n/a	44,530	317,015	10,205	29,608	316,124	227,528
Arkansas	2,712	430,687	4,179	73,355	n/a	145,106	317,444	35,107	9,650	n/a	373,738
Colorado[1]	12,054	2,405	775	590	50,000	36,530	63,383	1,713	250	15,871	8,781
Connecticut	33,406	n/a	n/a	101,917[2]	n/a	n/a	499,406	11,377	n/a	235,816	6,285
Delaware	4,694	17,744	5,408	0	768,172	0	88,841	37,388	22,629	32,360	9,778
Florida[3]	166,475	87,581	32,096	1,514,047	515,571	1,471,782[4]	1,341,399	54,729	53,863	n/a	n/a
Hawaii	6,559	118,634	6,560	4,325	n/a	n/a	33,012	n/a	n/a	79,401	181,615
Iowa[5]	47,409	601,569	7,058	n/a	n/a	103,194	341,691	29,724	n/a	294,978	n/a
Kentucky	6,898	171,287	14,009	n/a	n/a	n/a	410,912	3,431	1,901	16,645	n/a
Louisiana	30,596	13,391	30,000	n/a	n/a	n/a	205,829	38,940	n/a	83,444	n/a
Maine[6]	31,226	–[7]	–[7]	153,564	38,848	40,443	333,784	13,791	19,631	50,084	7,514
Maryland[8]	55,481	–[7]	4,451	251,703	2,895,499	122,101	909,447	35,930	17,282	645,230	558,050
Massachusetts[6]	412,016	–[7]	–[7]	240,144	3,146,394	n/a	1,443,453	44,976	n/a	443,147	n/a
Michigan[9]	167,447	–[7]	–[7]	869,837	n/a	n/a	712,526	40,624	n/a	739,904	19,908
Minnesota	106,877	41,982[10]	29,673	311,278[11]	n/a	n/a	841,911	45,148	n/a	167,529[12]	757,057
Missouri	170,462	224,116	91,916	61,972	n/a	–[13]	1,726,088	84,649	42,750	394,966	26,181[14]
Nebraska[6]	7,894	41,974[15]	12,957	n/a	n/a	n/a	301,708	4,334	n/a	n/a	n/a
Nevada	8,433	181,678	1,536	5,324	25,682	26,433	179,512	3,751	1,032	12,675	111,430[16]
New Hampshire	6,382	25,040	686	n/a	n/a	n/a	20,139	11,246	n/a	37,114	187,005
New Jersey[6]	259,723	–[7]	59,791	520,329	5,774,993	105,476	1,215,665	42,762	46,188	1,720,069	44,958
New Mexico	1,473	62,431	3,997	1,776	n/a	8,266	39,414	656	1,229	12,122	4,132
North Carolina[17]	49,891	83,886[15]	5,311	25,589	17,648	–[18]	267,840	17,269	62,000	468,901	11,322
Oregon	94,833	–[7]	n/a	262,390	37,151	386,053	679,971	23,647	23,327	443,966	73,059
Pennsylvania	64,890	393,317	18,732	226,934	690,019	141,628	1,184,181	36,098	31,067	498,391	803,765
Rhode Island	16,839	6,146	1,013	3,755	n/a	n/a	54,623	4,987	n/a	72,500	n/a
South Carolina	9,848	–	–	333,073	732,679	251,042[19]	438,804	25,588	49,621	134,712	455,018
Tennessee	34,214	711,688	81,035	63,584	1,332,090	30,600	511,025	33,082	61,582	162,347	253,355
Vermont	19,202	35,240	1,840	1,705	15,023	225	85,788	3,258	n/a	29,626	5,678
Virginia	72,579	–[7]	–[7]	570,871	280,608	361,565	872,044	134,447	55,888	540,282	553,255[20]
Washington	81,632	293,284	12,540	50,663	1,304,838	689,706	957,462	20,172	11,315	539,717	303,043
West Virginia	5,707	36,444	10,799	14,789	n/a	n/a	46,112	3,780	n/a	680	1,965
Wisconsin	109,470	29,890	18,220	n/a	n/a	23,630	896,170	30,980	6,150	225,240	38,720

[1]Based on data from 13 cities and/or counties; [2]Includes 11,852 tons of metal containers and 90,065 tons of scrap metal; [3]2000 data; [4]In 2002, 3,283,173 tons of wood waste generated by natural disasters and/or forest thinning, of which 1,471,782 tons diverted to wood-fired biomass plants; [5]All recycled tonnages except organics are 1999 data from "Economic Impacts of Recycling In Iowa," by R.W. Beck for Recycle Iowa (organics tonnages from 2003 "State of Garbage In America" survey response); [6]2001 data; [7]Included in "other metals"; [8]Based on data reported in 2003 "State of Garbage In America" survey response and in Maryland Dept. of Environment summary table, "County Recyclables By Commodity In tons for 2002"; [9]1999 data; [10]Steel cans only; [11]Includes mixed metals and ferrous scrap metals; [12]Food scraps only; [13]Included in organics tonnage; [14]Lead-acid batteries; [15]Steel cans and white goods; [16]Includes reported 177,317 tons of commercial recyclables and 9,688 miscellaneous tons; [17]Data from local government programs only — tonnages recycled by private businesses not available; [18]Included in C&D and organics tonnages; [19]Includes wood from yard trimmings and land clearing debris; [20]Includes commingled recyclables, textiles, used oil and oil filters, antifreeze, batteries, electronics and miscellaneous "other."

Table 11. MSW landfill disposal bans for selected materials

State	Yard Trimmings	Whole Tires	Used Oil	Lead-Acid Batteries	Batteries (General)	White Goods	Electronics	Others
Arizona		X	X	X				
Arkansas	X[1]				X			
California		X					X	
Connecticut	X[2]			X				
Delaware		X						
Florida	X		X			X		
Georgia	X	X		X				
Hawaii		X						
Idaho					X			
Illinois	X	X	X	X		X		
Indiana	X[3]	X		X				
Iowa	X	X	X	X				
Kansas		X						
Kentucky		X		X				X[4]
Louisiana		X	X	X		X		
Maine		X		X		X		
Maryland	X[5]	X	X		X			
Massachusetts	X	X		X		X	X[6]	X[7]
Michigan	X		X	X		X[8]		
Minnesota	X	X	X	X		X	X[6]	X[9]
Missouri	X	X		X		X		
Nebraska	X[1]	X	X	X		X		
New Hampshire	X		X	X				X[10]
New Jersey	X[11]							X[12]
New Mexico					X			
New York			X	X				
North Carolina	X	X	X	X		X		X[13]
North Dakota			X	X		X		
Ohio		X		X				X[14]
Oregon		X	X	X		X		X[15]
Pennsylvania	X[16]	X		X				
Rhode Island		X				X		
S. Carolina	X[17]	X	X	X		X		
S. Dakota	X		X	X		X		
Tennessee		X	X	X			X	X[18]
Texas		X	X	X				
Utah		X	X		X			
Vermont		X	X	X	X	X		X[19]
Virginia		X		X				
W. Virginia	X	X			X			
Wisconsin	X	X	X	X		X		X[12]
Wyoming				X				

[1]Leaves and grass; [2]Grass clippings; [3]Leaves, brush and woody vegetative matter >3 feet; [4]Yard trimmings are banned from a few landfills; [5]Separately collected loads of yard trimmings are banned from disposal; [6]Cathode ray tubes; [7]Glass, metal and plastic containers and recyclable paper; [8]Containing refrigerants; [9]Source separated recyclables; [10]Ni-Cad batteries; [11]Leaves only; [12]All recyclables in MSW stream; [13]Aluminum cans; [14]Yard trimmings are not banned but disposal is restricted; [15]Cars and other vehicles; [16]Truckloads comprised primarily of leaves; [17]Includes landclearing debris; [18]Oil-based paints and mercury bulbs; [19]Oil-based paint.

Texas reports 970 million tons of landfill capacity remaining which, based on its 2002 MSW landfilling of about 21 million tons, corresponds to 46 years of landfill space.

As noted throughout this report, a follow-up article will explore the 2003 State of Garbage In America findings in more depth. What seems to be evident (and thus safe to conclude), is that to truly understand solid waste management practices and trends — and the progress being made with source reduction, recycling and recovery —actual tonnages need to be recorded. We firmly believe the 2003 State of Garbage in America report is an excellent step in that direction. ■

Scott Kaufman is a graduate student in Earth and Environmental Engineering and a Junior Research Associate in the Earth Engineering Center (EEC) of Columbia University. Previously, he was an operating engineer and office manager at Vermont Compost Company in Montpelier, VT, then manager of the Manhattan Compost Project sponsored by the New York City Department of Sanitation at the NY Botanical Garden. *The support by Pratt Industries (Visy Paper) of Mr. Kaufman's studies at Columbia is gratefully acknowledged.* *Nora Goldstein is Executive Editor of BioCycle, and has been involved with the magazine's State of Garbage In America surveys since their inception.*

Karsten Millrath is a research scientist in the EEC of Columbia University, where he received his Ph.D. in Civil Engineering. Dr. Millrath is conducting research related to integrated waste management, in particular waste-to-energy (WTE) processes, and leads a project on beneficial uses of WTE residues. Nickolas J. Themelis is Director of the EEC and Stanley-Thompson Professor, Earth and Environmental Engineering, at Columbia University. EEC is the engineering unit of the Earth Institute at Columbia University, headed by Prof. Jeffrey Sachs. Prof. Themelis was the first Chair of the new Department of Earth and Environmental Engineering (1997-2000).

Reprinted From:
January, 2004
BIOCYCLE
JOURNAL OF COMPOSTING & ORGANICS RECYCLING
419 State Avenue, Emmaus, PA 18049-3097
610-967-4135
For more information, visit: http://www.biocycle.net

THE STATE OF GARBAGE IN AMERICA

Latest national data on municipal solid waste management find estimated generation is 389.5 million tons in 2008 — 69 percent landfilled, 24 percent recycled and composted, and 7 percent combusted via waste-to-energy.

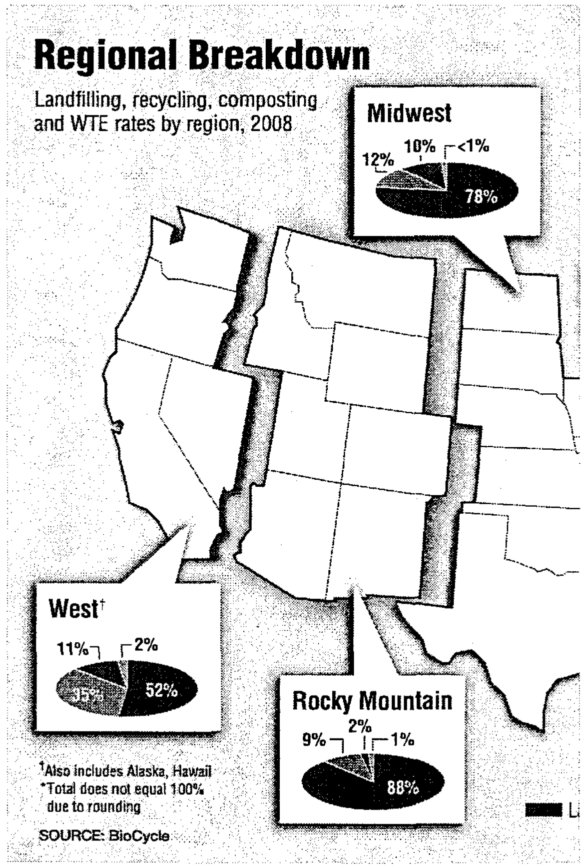
Rob van Haaren, Nickolas Themelis and Nora Goldstein

A joint study by BioCycle and the Earth Engineering Center of Columbia University

BIOCYCLE, in collaboration with the Earth Engineering Center (EEC) of Columbia University, conducts the biennial State of Garbage In America survey on the generation and management of municipal solid waste (MSW) in the United States. The State of Garbage In America Report, launched by *BioCycle* in 1989, is unique in that actual tonnage data is collected from each individual state, with waste characterization studies solely used for validation of the numbers. This is the 17th nationwide survey, reporting data from calendar year 2008. The data was gathered during the spring of 2010, using an Excel form that was e-mailed to the solid waste management departments in all 50 states and the District of Columbia. All entries were checked and validated using results of former State of Garbage in America reports, EPA waste characterization studies, and also a survey of Materials Recovery Facilities (MRF) carried out by Eileen Berenyi of Government Advisory Associates (GAA). We greatly appreciate the time spent and the contributions made by the solid waste and recycling officials listed at the end of this report. Thanks to their help and expertise, we can present the 2010 edition of "The State of Garbage in America." All tonnages are reported in U.S. tons (1.1 U.S. ton = 1 metric ton).

SURVEY METHODOLOGY

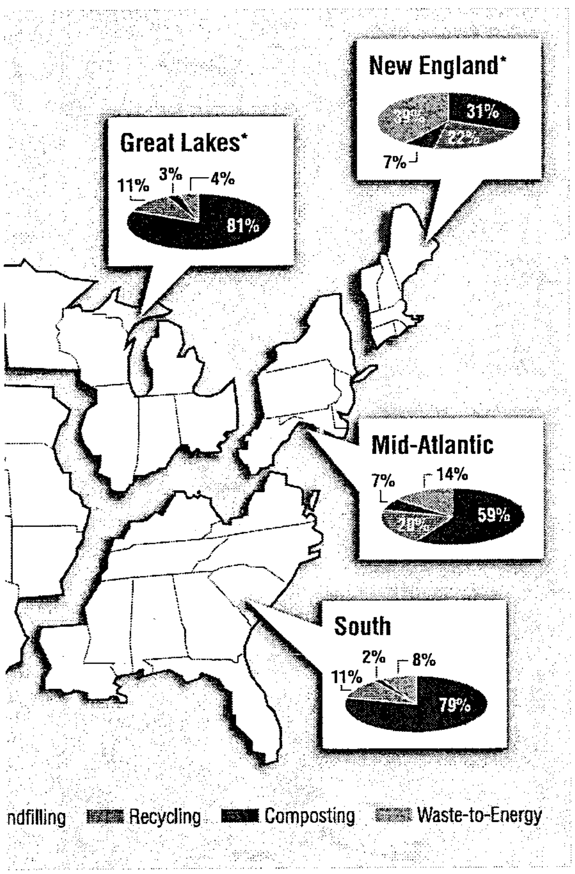
In 2004, the EEC was invited by *BioCycle* to collaborate on a science-based version of the State of Garbage survey. The State of Garbage methodology uses the principles of mass balance: all MSW generated is equal to the MSW landfilled, combusted in waste-to-energy (WTE) plants, composted and/or recycled. This relies on the assumption that all management methods employed for municipal solid waste are quantified/tracked and reported to the state agencies. According to our survey results, at least 15 states require waste management companies and local government agencies to report annual tonnages. Nineteen states reported that there was no such requirement and another 12 states did not respond to this question. Only five states did not complete the 2010 State of Garbage survey. For states where companies and local agencies are not required to report to the state, disposal data can and, in most cases, are still collected from waste management facilities. This is especially true for landfills and waste-to-energy plants, since they track all of the disposed waste by simply weighing incoming and outgoing trucks. Composting and materials recycling facilities, however, may



not have scales and/or are commercial or public enterprises that are not obligated to report tonnages received and processed to local or state government agencies.

An important part of MSW-accounting in the State of Garbage survey is "filtering out" non-MSW materials that may be included in the states' responses. The BioCycle/EEC survey uses the US EPA definition of Municipal Solid Waste, which includes: residential and commercial wastes like paper, plastic packaging, bottles and cans, tires, yard trimmings, batteries, furniture, appliances, etc. Typical "non-MSW" materials are: industrial and agricultural wastes, construction and demolition (C&D) debris, automobile scrap and sludge from wastewater treatment plants. To account for these non-MSW materials, survey respondents were asked to provide a more specific breakdown of the waste streams being reported. This was done either by estimate or from measured tonnages. The non-MSW tonnages were automatically subtracted in the Excel spreadsheet from the total generation reported.

Over the past six years (with the survey conducted every two years), the methodology developed by EEC has been further refined. In the 2008 State of Garbage In America Report (December 2008), MSW management was divided into three main categories: Landfilling, Waste-to-Energy and Recycling. After much discussion and with input from survey participants, it was decided to divide the "recycling" category



into materials recycling (i.e., recovery of paper, metals, glass, plastics) and organics recycling via composting (which includes mulch production). The tonnage sent to composting facilities appears to be tracked in many states, and EEC believes that it is useful to distinguish composting and mulching from other material recovery methods. As a result, recycled and composted tonnages are reported in separate columns in **Table** 2. It is quite likely that some smaller composting operations have, inadvertently, not been included and, therefore, the total MSW composted may be somewhat higher than reported.

In the 2010 survey, an additional "filter" on the reported composting/recycling rates for different materials was introduced: The total amount of MSW generated was estimated using the 2008 national number of per capita generation (1.38 tons/capita) and the population of the state. EEC then used EPA's MSW Facts And Figures waste characterization report (EPA, 2008) of the average (U.S.) percent composition of MSW times the population of the state to estimate how many tons of each material were generated in the state. On the basis of this information, we were able to "filter out" reported recycling tonnages that were "through the roof," most likely due to the inclusion of non-MSW materials (e.g., automobile scrap). Reported recycling tonnages that were higher than the estimated waste generation of a particular material were decreased to 100 percent of the estimated waste generation.

PROTOCOL USED FOR RECYCLING TONNAGES

For a consistent determination of the tonnages to report in the survey, the following protocol was established: Use reported tonnage unless any of the following factors were evident:

1. *States did not report a recycled material tonnage*: The GAA MRF survey reported MRF-processed tonnages that in general were one half of the recycling tonnages reported by the states. Therefore, EEC concluded that approximately 50 percent of all recycled materials are sent directly to paper and other recycling plants and do not pass through MRFs for processing. Thus, states that did not report a recycling num-

Table 1. State of Garbage in America survey data 1989–2008: Reported and estimated MSW generation and rates of MSW recycling, waste-to-energy and landfilling[1]

Year Of Data	Reported MSW Generation[2] (tons/yr)	Estimated MSW Generated[3] (tons/yr)	MSW Recycled[4] (%)	MSW Waste-To-Energy (%)	MSW Landfilled (%)
1989	269,000,000		8.0	8.0	84.0
1990	293,613,000		11.5	11.5	77.0
1991	280,675,000		14.0	10.0	76.0
1992	291,472,000		17.0	11.0	72.0
1993	306,866,000		19.0	10.0	71.0
1994	322,879,000		23.0	10.0	67.0
1995	326,709,000		27.0	10.0	63.0
1996	327,460,000		28.0	10.0	62.0
1997	340,466,000		30.0	9.0	61.0
1998	374,631,000		31.5	7.5	61.0
1999	382,594,000		33.0	7.0	60.0
2000	409,029,000		32.0	7.0	61.0
2002	–	369,381,411	26.7	7.7	65.6
2004	–	387,855,461	28.5	7.4	64.1
2006	–	413,014,732	28.6	6.9	64.5
2008	–	389,488,026	24.1	6.7	69.3

[1]2002, 2004, 2006 and 2008 estimated MSW Generated, MSW Recycled, WTE and Landfilled have been adjusted to exclude non-MSW. [2]Reported MSW Generation is reported values calculated by BioCycle prior to collaboration with Columbia University and use of current methodology. [3]Estimated MSW Generated is sum of MSW Recycled, WTE and Landfilled. [4]MSW Recycled includes composting and recycling.

Table 2. Estimated tonnage of MSW reported, recycled, composted, combusted via waste-to-energy (WTE) and landfilled (2008 data unless noted) [1,2]

State	Population (2008)	Reported MSW Generation (tons/yr)	MSW Recycled (tons/yr)	MSW Composted (tons/yr)	MSW To WTE tons/yr)	MSW Landfilled (tons/yr)	Estimated MSW Generation (tons/yr)	Per Capita Estimated Generation (tons/capita*/yr)
Alabama	4,661,900	4,498,671	472,000[3]	n/a	316,659[4]	4,498,671[4]	5,287,330	1.13
Alaska	686,293	591,400[5]	28,646[6]	-[7]	0	614,607	643,253	0.94
Arizona	6,500,180	6,718,581	917,373[8]	65,954	0	5,801,208	6,784,535	1.04
Arkansas	2,855,390	3,711,017	483,896[9]	501,221	0	3,711,017	4,696,134	1.64
California	36,756,666	n/a	24,724,726[10]	7,641,910	627,039	28,216,903	61,210,578	1.67
Colorado	4,939,456	8,493,576	540,141	110,719	0	6,824,960	7,475,820	1.51
Connecticut	3,501,252	3,423,725	607,691	302,928	2,190,873	387,542	3,489,034	1.00
Delaware	873,092	1,059,175	168,701	122,357	0	741,143	1,032,201	1.18
District of Columbia[6]	591,833	n/a	21,142	-[7]	12,791	997,150	1,031,083	1.74
Florida	18,328,340	32,326,416[11]	2,403,281[9]	n/a	3,770,416	17,161,312	23,335,009	1.27
Georgia	9,685,744	12,623,173	682,266[3]	40,000	41,350	10,765,486[12]	11,529,102	1.19
Hawaii	1,288,198	2,297,680	574,294	256,046	589,982	2,297,680	3,718,002[13]	2.89
Idaho	1,523,816	1,668,578	150,172	n/a	0	1,518,406	1,668,578	1.09
Illinois	12,901,563	23,441,094	1,003,390	497,421	0	15,150,000	16,650,811	1.29
Indiana	6,376,792	n/a	480,176[3]	375,625	586,493	8,012,706	9,455,000	1.48
Iowa	3,002,555	4,003,953[13]	924,364[3]	247,574	69,537[4]	2,652,855	3,894,330	1.30
Kansas	2,802,134	3,494,097	727,853	147,888	0	2,597,584	3,473,325	1.24
Kentucky[6]	4,269,245	n/a	1,185,541[9]	258,752	63,700	4,827,483	6,335,476	1.48
Louisiana	4,410,796	5,656,995	29,800	565,166	259,000	4,981,510	5,835,476	1.32
Maine	1,316,456	1,535,489	333,132[9]	28,969	607,463	217,290	1,186,854	0.90
Maryland	5,633,597	6,477,317	1,461,164	781,293	847,659[4]	3,461,764	6,551,880	1.16
Massachusetts	6,497,967	8,360,000	2,300,000	680,000	3,133,200	2,236,800	8,350,000	1.29
Michigan	10,003,422	12,095,000	844,328[3]	-[7]	1,081,011	12,086,000[14]	14,011,339	1.40
Minnesota	5,220,393	5,926,951	2,589,954	17,630	1,187,600	6,530,938	10,326,122	1.98
Mississippi	2,938,618	n/a	129,839[6]	15,161	0	2,553,238	2,698,238	0.92
Missouri	5,911,605	7,529,041	951,860[3]	-[7]	0	3,899,961	4,851,821	0.82
Montana	967,440	n/a	66,662[9]	54,098	0	1,317,324	1,438,084	1.49
Nebraska	1,783,432	n/a	322,500[3]	-[7]	0	2,242,879	2,565,379	1.44
Nevada	2,600,167	3,640,579	229,128[3]	85,721	0	3,299,832	3,614,681	1.39
New Hampshire	1,315,809	1,315,627	89,739[9]	23,438	254,040	877,148	1,244,365	0.95
New Jersey	8,682,661	6,687,781	2,012,583[9]	1,913,678	1,400,000[4]	7,842,764	13,169,025	1.52
New Mexico	1,984,356	2,028,463	230,865	45,279	0	1,755,747	2,031,891	1.02
New York	19,490,297	16,990,152	3,060,363	627,949	3,681,134	9,556,442	16,925,888	0.87
North Carolina	9,222,414	n/a	668,498	589,139	107,837	7,264,586	8,630,060	0.94
North Dakota	641,481	687,348	26,695	22,783	0	687,394	736,872	1.15
Ohio	11,485,910	15,291,980	2,037,688	876,813	0	10,337,719	13,252,219	1.15
Oklahoma[6]	3,642,361	n/a	170,000	-[7]	0	4,224,393	4,394,393	1.21
Oregon	3,790,060	4,972,389	1,421,850	339,877	181,666	2,689,119	4,632,513	1.22
Pennsylvania[15]	12,448,279	n/a	4,677,083	748,723	1,951,447	9,666,692	17,043,945	1.37
Rhode Island	1,050,788	1,075,931	101,883	48,380	0	864,583	1,014,846	0.97
South Carolina	4,479,800	4,452,348	914,056	167,457	212,118	3,155,304	4,448,935	0.99
South Dakota	804,194	573,754	71,041	62,850	0	565,148	699,039	0.87
Tennessee	6,214,888	5,681,594	251,112	50,000	74,327	5,039,337	5,414,776	0.87
Texas	24,326,974	n/a	2,634,275	4,360,000	0	22,170,707	29,164,982	1.20
Utah	2,736,424	n/a	51,159	161,628	126,739	2,241,353	2,580,879	0.94
Vermont	621,270	425,957	120,499	36,112	33,246	394,610	584,467	0.94
Virginia	7,769,089	15,589,091	2,716,198	379,826	2,135,407[6]	9,627,472	14,858,903	1.91
Washington	6,549,224	9,039,590	1,461,403[9]	640,619	332,301	4,986,236	7,420,559	1.13
West Virginia[6]	1,814,468	n/a	337,661	-[7]	0	1,772,720	2,110,381	1.16
Wisconsin	5,627,967	n/a	831,552	540,600	51,250	3,727,151	5,150,553	0.92
Wyoming	532,668	729,089	43,745	65,668[8]	0	729,647	839,060	1.58
Total	**304,059,724**	**245,113,602**	**69,283,968**	**24,497,252**	**25,926,285**	**269,780,521**	**389,488,026**	**1.28**

n/a = not available. [1]Estimated MSW Generation, MSW Recycled, WTE and Landfilled have been adjusted to exclude C & D and other non-MSW materials where possible. [2]All State disposal figures have been adjusted for import/export; imported waste is excluded, exported waste is included. [3]From Berenyi GAA Survey report (multiplied by 2). [4]Includes non-MSW. [5]Estimated as 75% of the total waste generated. [6]2006 data. [7]Included with recycling figure. [8]Likely to be underreported. [9]Adjusted for when States reported a metals recycling figure higher than the estimated generated metal wastes according to EPA waste characterization study. Figure is adjusted to 100% the metal generation according to this EPA characterization estimate (8.4% of 1.38 * population). [10]California recycling tonnage is an estimate of the total tonnage recycled, adjusted for industrial and agricultural sources, but not C&D. [11]Includes C&D and WTE ash. [12]Includes C&D, Agricultural and Industrial Waste. [13]Includes (some) C&D. [14]Assuming 3.3 gate cubic yards per ton. [15]2005 data.

ber were assigned a tonnage equal to two times the MRF tonnage in the state, as reported by the GAA survey.

2. *Overestimate of recycled tonnages*: As discussed earlier, for any recycled material where the state-reported tonnage was in excess of the EPA's average estimate of waste generation, the recycling of that material was set to 100 percent of the generated material.

3. *Data not reported*: In a few cases where tonnages were not reported (recycled, composted, waste-to-energy, landfilled) or numbers were obviously too low or too high, cross-reference was made to the 2006 data, as reported in the 2008 State of Garbage in America survey.

4. *Underreporting of recycled tonnages*: When the recycling tonnage appeared to be underreported by the state, and the GAA MRF number was not higher than that provided by the state, the data is marked as "Likely to be underreported."

Readout

NATIONAL AND REGIONAL PICTURE

Table 1 summarizes the State of Garbage survey data from 1989 through 2008. The overall results of the 2010 State of Garbage in America survey (2008 data) are: An estimated 389.5 million tons of MSW were generated, most of which (270 million tons) were sent to landfills. This represented 69 percent of the total MSW and was three million tons higher than two years ago. An estimated 7 percent, nearly 26 million tons, were combusted with energy recovery in

Table 3. Quantity of materials recycled per state in 2008, per category (tons/year)

	Single Stream	Dual Stream		Individual Materials Recycled							
State	Commingled Recyclables	PMG-Containers[1]	Paper Fiber	Paper Fiber	Iron/Steel Scrap[2]	Plastics	Glass	Aluminum	Other Metals	Tires	Others
Arizona	157,151	–	–	372,523	4,979	18,495	22,101	13,294	240,191	88,640	–
Arkansas	–	–	–	425,372	617,231	29,374	2,227	225,090	112,524	26,923	–
Colorado	12,443	–	–	366,990	1,009,572	11,912	81,049	26,939	–	40,808	–
Connecticut	–	–	–	461,735	98,068[3]	15,900	24,837	7,054	–	97	–
Delaware	37,687	–	–	91,741	23,674	2,006	4,729	49	–	8,815	–
Florida	–	–	–	2,144,375	52,075	86,279	125,836	35,400	2,592,318	46,791	–
Idaho	150,172	–	–	–	–	–	–	–	–	–	–
Illinois	9,158,265	–	–	–	–	–	–	–	–	–	–
Kansas	–	–	–	422,092	214,810	9,342	9,058	5,017	50,543	9,580	7,411[4]
Kentucky	–	–	–	231,326	1,437,226	4,617	4,688	12,295	102,751	942,361	–
Louisiana	29,800	–	–	–	–	–	–	–	–	–	–
Maine	–	–	–	245,294	87,399	15,963	43,402	2,232	96,541	28,473	–
Maryland	–	149,711	921,775	–	–	5,949	190	–	218,635	36,737	53,604[5]
Massachusetts	–	–	–	1,180,000	740,000	100,000	240,000	–	–	–	–
Minnesota	992,046	–	–	901,879	517,441	52,197	126,391	–	–	–	–
Mississippi	–	–	–	–	–	–	–	–	–	93,592	–
Missouri	6,318,111	–	–	–	–	–	–	–	–	–	–
Montana	–	–	–	47,569	111,190	803	282	1,709	54,724[6]	–	–
Nevada	–	–	–	247,197	424,726	30,737	7,565	4,580	424,726	6,975	–
New Hampshire	39,640	–	–	37,871	211,590	2,375	9,853	807	–	–	–
New Jersey	–	–	–	761,400	1,894,833	86,855	326,572	107,869	11,028[7]	39,081	–
New Mexico	30,012	–	–	104,937	87,149	2,848	471	3,979	432	1,037	–
New York	–	81,130	–[8]	1,723,468	234,778	100,929	168,693	14,116	–[9]	–	–
North Carolina	–	–	–	342,008	69,242	23,947	69,446	–[10]	–	147,055	16,800[11]
North Dakota	21,907	–	–	3,728	990	46	–	24	–	–	–
Ohio	161,018	–	–	828,359	721,502	48,501	39,833	118,818	469	119,188	–
Oregon	–	–	–	773,547	354,558	39,796	101,763	32,885	9,155[12]	19,029	–
Pennsylvania	–	–	–	557,578	19,074	56,625	57,447	47,603	1,062,090	49,730	–
Rhode Island	–	40,111	59,715	–	2,057	–	–	–	–	–	–
South Carolina	–	–	–	487,553	30,633	19,885	14,914	6,158	254,338	53,537	–
South Dakota	–	–	–	44,267	19,535[13]	2,005	–	974	4,260	–	–
Tennessee[14]	–	–	–	97,791	57,923	6,358	11,920	2,793	–	74,327	–
Texas	2,634,275	–	–	–	–	–	–	–	–	–	–
Utah	51,159	–	–	–	–	–	–	–	–	–	–
Vermont	4,722	14,556	60,391	–	34,830[15]	–	–	–	–	6,000	–
Virginia	–	–	–	872,416	718,219	29,413	26,526	–	–	67,161	–
Washington	–	–	–	1,283,907	1,067,478[16]	43,295	94,077	12,842	104,866	40,124	–
West Virginia	–	–	–	22,165	3,217	688	777	623	105	–	–
Wisconsin	–	–	–	601,860	22,616[17]	34,251	95,752	7,994	17,829[18]	51,250[19]	–
Wyoming	43,745[20]	–	–	–	–	–	–	–	–	–	–

[1]Plastic-Metal-Glass containers. [2]Can include automobiles, white goods, steel cans, etc. [3]48,070 tons from WTE metals recovered, 5,971 from steel cans. [4]Electronic waste, lead acid batteries and textiles. [5]Miscellaneous MSW recyclables. [6]White goods. [7]Vehicle batteries. [8]Included with 81,130 tons. [9]Included with iron and steel scrap. [10]Included in iron and steel scrap. [11]Other materials and special wastes. [12]Tin cans. [13]Data from a few larger scrap metal yards; does not include restricted use/C&D landfill sites. [14]Numbers represent MSW recycled, postconsumer and residential programs only. [15]Does not include large amount from salvage yards (unregulated). [16]Includes *commercial/industrial ferrous metals, large appliances (white goods) and tin cans.* [17]*Food and beverage containers, white goods, batteries, electronics.* [18]*Scrap metal only.* [19]50% of 102,500 estimated tons generated. [20]All materials shipped from recycling facilities combined.

WTE plants. The total recycling and composting tonnages for 2008 were estimated to be close to 94 million tons, or 24 percent of the total MSW. They consisted of over 69 million tons of materials recycled and 24.5 million tons of yard trimmings and some food wastes composted or mulched.

It is interesting to note that national MSW generation dropped between 2006 and 2008, from 413 million tons in the 2008 State of Garbage Report to 389.5 million tons in this 2010 Report. This may be a reflection of the economic downturn, as well as the more detailed exclusion of non-MSW materials that was done in the survey of 2008 data.

Table 4. Number of municipal solid waste landfills and waste-to-energy plants, average tip fees and landfill capacity by state for 2008 (unless noted)

State	Number of MSW Landfills	Average Landfill Tip Fee ($/ton)	Landfill Capacity Remaining (units listed)	Number of WTE Plants	Average WTE Tip Fee ($/ton)
Alabama	31	25[1]	-	1[2]	25[3]
Alaska	245	-	-	2	-
Arizona	44	-	-	0	-
Arkansas	24	35	600+ yrs	1	-
California	135[4]	-	1,900,000,000 cy	3	-
Colorado	56	30.47	-	0[5]	-
Connecticut	2[4]	63	190,000 cy	7[6]	64
Delaware	3	58.9[7]	5,000,000 cy[7]	0	-
District of Columbia	-	-	-	0	-
Florida	50	37	-	12	52.95[7]
Georgia	63	34.92	572,000,000 cy	1[7]	-
Hawaii	-	-	-	0	-
Idaho	24	-	-	0	-
Illinois	45	-	1,024,452,000 cy[7]	0	-
Indiana	35[7]	29.57[7]	325,341,444 cy	1	-
Iowa	45[4]	40.71	118,616,405 tons	1[7]	64[7]
Kansas	51[4]	30[1]	-	0	-
Kentucky	34[7]	29.21[7]	212,043,842 tons[7]	2[7]	-
Louisiana	26[4]	46	186,177,934 tons	0	-
Maine	8	35-85[7]	15,834,570 cy	4	-
Maryland	23	52	8,235,391 cy	9[7]	-
Massachusetts	16	72	2,506,455 cy[7]	7	69
Michigan	50[7]	-	461,824,259 cy[7]	3[7]	-
Minnesota	21	50	27,000,000 cy[7]	9	55
Mississippi	18	25	288,142,319 cy	0	-
Missouri	21	-	217,579,836 cy	7[7]	-
Montana	30	42	92,025,335 cy[7]	0	-
Nebraska	23[7]	-	-	0	-
Nevada	22[8]	-	-	0	-
New Hampshire	7	77	12 yrs	2	68[9]
New Jersey	13	68[10]	-	5	85
New Mexico	30	28	162,033,429 cy[7]	0	-
New York	27	44.69	219,535,298 tons	10	72.34
North Carolina	40[7]	35[1]	157,920,815 tons[7]	1[7]	-
North Dakota	13	34	22,680,000 cy	0	-
Ohio	42[7]	32[7]	667,843,591 cy[7]	0	-
Oklahoma	38[7]	15-22[7]	-	0	-
Oregon	33[7]	35[7]	-	1[7]	-
Pennsylvania	48[7]	-	265,000,000 tons[7]	6[7]	-
Rhode Island	2	52	2,700,000 tons	0	-
South Carolina	18	35	130,267,111 tons	1	-
South Dakota	15	39.5	74,000,000 cy	0	-
Tennessee	34[4]	34[10,11]	145,533,153 tons	0	-
Texas	191	27.8	1,439,621,096 tons	1[7]	-
Utah	34	-	300,000,000 tons	1	-
Vermont	5	96[7]	-	0	-
Virginia	56[4]	-	249,070,298 tons[7]	12[4]	-
Washington	15	52.65	223,000,000 tons	3[12]	98
West Virginia	19[7]	45.18[7]	-	0	-
Wisconsin	33	42.5	91,500,000 cy[11]	2	51
Wyoming	50	55	-	0	-
Total or average	**1,908**	**44.09**	-	**115**	**67.93**

[1]Estimate. [2]Provides steam only to military base. [3]Same as MSW landfilled. [4]Active only. [5]Currently one facility in the permitting process. [6]One is tire burner. [7]2006 data. [8]Class I and II landfills. [9]Co-op fee. Spot is $88. [10]2009 data. [11]Based on survey of 24 landfills. [12]Only one is taking MSW.

Table 2 provides the main results of the 2008 data, by state. The "Reported MSW Generated" column shows the raw generation number as provided by each state. It may differ from the "Estimated MSW Generation" column because of differences between definitions of MSW, as discussed earlier. Some states base this number on an extrapolation of occasional measurements of household MSW generation. The "Estimated" generation number is a summation of the MSW sent to each of the four recovery and disposal methods. All tonnages have been adjusted for import and export, assigning waste to the place of generation, not where it was disposed (e.g., out of state landfilling). On average, 1.28 tons of MSW were generated per capita in 2008. This is 0.10 tons/capita lower than 2006. Hawaii reported the highest per capita generation number: 2.89 tons/capita. However, it has to be taken into account that the population number is skewed by the high influx of tourists — around 7 million people visit Hawaii each year.

Figure 1 provides a breakdown, by region, of recycling, composting, combustion and landfilling rates. According to the 2008 state data, the West leads the nation in recycling (35%) and composting (11%). New England has the second highest recycling rate (22%), followed by the Mid-Atlantic (20%). The Midwest has the second highest composting rate (10%), followed by New England and the Mid-Atlantic (7%). With respect to combustion with energy recovery, New England is the leader by combusting 39 percent of its MSW. The Mid-Atlantic region is a distant second with 14 percent of the MSW combusted. The Rocky Mountain region has the highest landfilling rate (88%), followed by the Great Lakes (81%), the South (79%) and the Midwest (78%).

RECYCLING AND COMPOSTING ACTIVITY

The tonnages of specific materials recycled in 2008 are shown in **Table** 3. All but 10 states and the District of Columbia provided data on at least one recycled material. Sixteen states had data available on tons collected through single-stream recycling programs; only four states reported aggregated dual stream data. Table 3 shows the "as reported" tonnages for various materials. It can be seen that some states have reported material recycling figures that most likely included non-MSW, primarily in the categories "Iron and Steel Scrap" and "Other Metals." States that were adjusted for this in the final results of Table 2 are: Arkansas, Florida, Kentucky, Maine, Montana, Nevada, New Hampshire, New Jersey and Washington (see item No. 2 in section above titled "Protocol Used For Recycling Tonnages").

The State of Garbage survey requested information on the number of curbside recycling collection programs and population served by curbside recycling in each state, as well as the number of MRFs, drop-off sites and "pay-as-you-throw" programs. Only 25 states had data on curbside programs, and only 21 reported the population served by such programs. These states reported a total of 4,371 curbside recycling programs; New York State did not report a number, but according to the 2006 State of Garbage in America Report (2004 data), New York had 1,500 curbside programs. The total population served by these programs amounts to 87.9 million, of which 23.6 million is from California. California did not report on the curbside population number, but this information was obtained from the calrecycle.ca.gov website (calrecycle.ca.gov, 2010).

The State of Garbage survey also requested information on the number of facilities composting yard trimmings in each state. Thirty states reported a total of 2,284 facilities. New Jersey reported the most sites (345) that compost over 1.9 million tons of MSW yard trimmings.

LANDFILLS, WASTE-TO-ENERGY AND LANDFILL GAS RECOVERY

The State of Garbage results for number of landfills and WTE plants, gate ("tipping") fees for these facilities, and remaining landfill capacity are shown in **Table** 4. Where states did not provide 2008 data, data from the 2008 State of Garbage Report (2006 data) were used. A total of 1,908 MSW landfills were reported. (Interestingly, when *BioCycle* conducted the first State of Garbage In America survey in 1989, there were almost 8,000 MSW landfills in the U.S.). Average gate ("tipping") fees have increased slightly since the 2008 SOG survey; landfill and WTE gate fees were, on average two dollars higher than in 2006, at $44.09 and $67.93 per ton of handled waste, respectively.

Another section of the 2010 State of Garbage survey requested data on the recovery of landfill gas (LFG). Twenty-eight states reported that 260 out of 1414 landfills recovered landfill gas. However, some of the non-LFG landfills may be closed. A total of 95 landfills reported volumes of LFG captured: 59.1 billion cubic feet. Since LFG generally contains 500 Btu per cubic foot, the energy recovery from these 95 landfills was about 30 trillion Btu. This amount represents only 20 percent of the total LFG energy used by the U.S. in 2004 (150 trillion Btu), according to the U.S. Energy Information Administration (EIA, 2006). Since this is the first time that LFG capture was included in the State of Garbage survey, it is hoped that more states will collect and report such data in future surveys.

Readout

MSW IMPORTS AND EXPORTS, LANDFILL BANS

Waste imports and exports are shown in **Table** 5. There is an obvious discrepancy between the totals of these categories: imported MSW was almost two times higher than exported MSW. EEC believes this is due to the fact that imported wastes are much better tracked than those exported. MSW imports/exports from other countries, primarily Canada, were excluded where possible.

Table 6 shows materials banned from landfills. It can be seen that whole tires are banned from landfills in almost every state, except Alabama, Alaska, Montana, Nevada, North Dakota and Wyoming. Oil and lead-acid batteries are banned from most U.S. landfills as well. Twenty-five states ban leaves, grass and/or brush from landfill disposal. Seven states have bans on disposal of containers and/or paper. Three states do not allow disposal of construction and demolition debris.

FINAL NOTE

The U.S. Environmental Protection Agen-

Table 5. Waste imports and exports by state, where reported, for 2008 (unless noted)[1]

State	Imported (tons/yr)	Exported (tons/yr)
Alaska	–	23,207
California[2]	58,375	337,563
Connecticut	64,088	223,999
Georgia	1,857,687	–
Idaho	–	66,159
Illinois	1,893,223	–
Indiana[2]	1,318	242,799
Iowa	226,675	93,273
Kansas	537,791	98,303
Maine	243,397	60,491
Maryland	29,542	1,849,121
Massachusetts	240,000	840,000
Michigan	5,214,000	–
Minnesota	–	604,287
Mississippi	674,163	–
Missouri	65,561	1,239,069
Nevada	342,959	113,435
New Hampshire	522,782	38,558
New Mexico	613,024	–
New York	1,089,152	4,814,843
North Carolina	139,446	863,604
Ohio	2,265,321	902,234
Oregon	2,581,423	15,375
South Carolina	1,257,017	162,194
South Dakota	8,606	–
Tennessee	623,119	564,618
Texas	351,172	–
Utah	27,910	–
Vermont	–	108,431
Virginia	4,833,820	–
Washington	183,488	1,277,140
Wisconsin	1,369,938	101,590
Wyoming	–	558
Total	**27,314,996**	**14,640,850**

[1]Total imported and exported MSW, consisting of MSW landfilled, recycled, composted and incinerated in WTE plants.
[2]Includes (some) non-MSW. "–" indicates information not reported by the state.

cy issues an annual report on MSW generation and management in the U.S. (MSW Facts & Figures, 2008). The State of Garbage methodology differs from that of EPA's in several ways. First, the EPA characterizes the MSW stream for the whole nation and not on a state-by-state basis. Second, the EPA bases its results on the aggregate of several sources, including estimates of materials and products generated and their life spans, key industry associations and businesses, and waste characterization studies and surveys conducted by governments, the media and industry.

Another important difference is that EPA estimates the tonnage landfilled as the difference between its estimate of MSW generated minus its estimate of what is sent to composting, recycling or WTE plants. The State of Garbage methodology, however, is based purely on tons managed via all four methods in the responding states. **Table 7** provides data from the US EPA's MSW Facts And Figures Report (2008 data) compared to the 2010 State of Garbage in America Report (2008 data). As a result, the EPA estimate of MSW landfilled is 98.5 million tons less than what is actually disposed in

Table 6. Materials banned from landfills

State	Yard Trimmings	Containers, Paper	Whole Tires	Used Oil	Lead-Acid Batteries	White Goods	Elect-ronics	C&D	Others
Alabama				x	x				
Alaska				x	x				
Arizona			x	x	x				
Arkansas	x		x		x				
California			x	x	x	x	x		
Colorado			x	x	x		x		
Connecticut	x		x		x				
Delaware[1]	x		x						
Florida	x		x	x	x				
Georgia[1]	x[2]		x	x	x				
Hawaii			x						
Idaho			x		x				
Illinois	x		x	x	x	x			x[3]
Indiana	x		x						
Iowa	x		x	x	x	x			x[4]
Kansas			x						
Kentucky[1]			x		x				
Louisiana			x	x	x	x			
Maine			x	x[5]	x	x	x		x[6]
Maryland	x[7]		x	x[8]	x[9]				
Massachusetts	x	x[10]	x		x	x	x	x	
Michigan[1]	x	x[11]	x	x	x				
Minnesota	x		x	x	x	x	x	x	
Mississippi			x		x				
Missouri	x		x	x	x	x			
Nebraska[1]	x		x	x	x	x			
New Hampshire	x		x	x	x		x		
New Jersey	x	x	x	x	x	x	x		
New Mexico				x	x				x[12]
New York			x						
North Carolina[13]	x	x[14]	x	x	x	x			x[15]
North Dakota				x	x	x			
Ohio[1]	x[7]		x						
Oregon			x				x		
Pennsylvania[1]	x		x		x				
Rhode Island	x	x	x	x	x	x	x		
South Carolina[13]	x[7]		x	x	x	x		x	
South Dakota	x		x	x	x	x			
Tennessee			x	x	x				
Texas			x	x	x	x[16]			
Utah			x	x	x				
Vermont	x	x	x	x	x	x			
Virginia			x		x		x		
West Virginia[1]	x[17]		x	x	x				
Wisconsin	x[18]	x	x	x	x	x			
Wyoming				x	x				

[1]2006 data. [2]Yard trimmings are banned from landfills designed and built to Subtitle D standards. [3]Medical waste, mercury thermostats. [4]Hazardous and PCB wastes, free liquids, seepage, hot loads, baled solid wastes. [5]Includes toxic liquids. [6]Mercury-containing products. [7]Separately collected waste is banned from the landfill. [8]Liquid ban. [9]Hazardous waste ban. [10]Glass and metal containers, single-resin narrow-necked plastic containers. [11]Beverage containers are banned. [12]Liquids. [13]Banned materials are banned from Class 3 disposal. [14]Aluminum cans are banned. [15]Wood pallets, oil filters. [16]With CFCs. [17]Landfills can get a waiver for yard trimmings if there is no composting facility nearby. [18]Brush with a diameter smaller than 6-inches is banned from disposal.

Table 7. Comparison of US EPA and BioCycle/EEC MSW generation and management data (calendar year 2008)

MSW Data	EPA/Franklin (million tons)	BioCycle/EEC (million tons)
Total generated	249.6	389.5
Total recovery (recycling, composting, mulch)	82.9	93.8
Combustion with energy recovery	31.6	25.9
Discards to landfill	135.1	269.8

MSW landfills according to the BioCycle/EEC measurements. ■

Rob van Haaren received his M.S.in Earth Resources Engineering from the Department of Earth and Environmental Engineering of Columbia University. His thesis research was sponsored by the Earth Engineering Center of Columbia (www.eecny.org). He is currently a Ph.D. Candidate and Research Associate at the Center for Life-Cycle Analysis, Columbia University. Nickolas J. Themelis is Director of the Earth Engineering Center and Stanley-Thompson Professor Emeritus, Earth and Environmental Engineering (Henry Krumb School of Mines) at Columbia University. Nora Goldstein is Editor of BioCycle.

SURVEY CONTRIBUTORS

BioCycle and the Earth Engineering Center of Columbia University would like to thank the following state solid waste management and recycling/composting officials for their assistance with the 2010 State of Garbage In America Report. We greatly appreciate their time and willingness to participate in this national survey. Gavin Adams, Alabama; Douglas Buteyn, Alaska; Arizona Department of Environmental Quality, Arizona; Nancy Carr, California; Wolf Kray, Colorado; Judy Belaval, Connecticut; Anne M. Germain, Delaware; Shannan Reynolds, Florida; Randy Hartmann, Georgia; Lane Otsu, Hawaii; Dean Ehlert, Idaho; Ellen Robinson, Illinois; Michelle Weddle, Indiana; Becky Jolly, Iowa; Christine Mennicke , Kansas; John Rogers, Louisiana; George MacDonald, Maine; David Mrgich, Maryland; JohnFischer, Massachusetts; Matt Flechter, Michigan; Arlene Vee, Minnesota; Mark Williams, Mississippi; Brenda Ardrey, Missouri; Bonnie Rouse, Montana; Steve Danahy, Nebraska; Nevada Division of Environmental Protection - Bureau of Waste Management, Nevada; Donald E. Maurer, New Hampshire; Edward Nieliwocki, New Jersey; Connie Pasteris, New Mexico; Scott Menrath, New York; Scott Mouw, North Carolina; Steve Tillotson, North Dakota; Andrew Booker, Ohio; Mary Lou Perry, Oregon; Mike McGonagle, Rhode Island; Elizabeth Rosinski, South Carolina; Steven Kropp, South Dakota; Department of Environment and Conservation, Tennessee; Kari Bourland, Texas; Ralph Bohn, Utah; Jeff Bourdeau, Vermont; Stephen Coe, Virginia; Gretchen Newman, Washington; Cynthia Moore, Wisconsin; Craig McOmie, Wyoming.

REFERENCES

Berenyi, E.B., 2007-2008 Materials Recycling and Processing in the United States Yearbook & Directory (5th Edition), Governmental Advisory Associates, Inc., Westport, Connecticut.

U.S. Environmental Protection Agency, Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2008. www.epa.gov/epawaste/nonhaz/municipal/pubs/msw2008rpt.pdf.

Calrecycle.ca.gov: http://www.calrecycle.ca.gov/BevContainer/Curbside/.

U.S. Energy Information Administration: www.eia.doe.gov/cneaf/solar.renewables/page/landfillgas/landfillgas.html.

EXHIBIT NJT-2

SUR Center for the study of Sustainable Use of Resources

Advancing the Goals of Sustainable Waste Management

A Comparison of Alternative Solid Waste Management Practices

Dr. Morton Barlaz and Susan Dunn
North Carolina State University
April, 2009

Introduction

Representatives of the landfill and waste-to-energy industries (WTE) met in Washington D.C. on January 28 to discuss issues of mutual concern. A summary of the meeting was issued previously by Nick Themelis. One of the action items from our meeting was to provide a table summarizing life-cycle studies on solid waste management. A summary table is provided below.

The table summarizes a limited number of studies in which life-cycle analysis was used to compare the environmental performance of landfills and mass burn WTE facilities. It is recognized that there are many additional studies in which life-cycle analysis is applied to some aspect of the solid waste management system. For example, Weitz et al. (2002) showed reductions in greenhouse emissions between 1974 and 1997 that could be attributed to improved operation of landfills and WTE facilities, as well as to increased recycling.

As expected, the studies are uniform in their finding that WTE is the most effective way in which to reduce greenhouse gas emissions from solid waste management. This is based on the near complete conversion of combustible organics to CO_2 and to the avoided emissions associated with energy recovery. In no case do the studies quantitatively address potential limitations such as the quantity of waste generated in a region. However, this would apply to a relatively small fraction of the total waste in the U.S.

Summary of Life-Cycle Studies Comparing Landfills and Waste-to-Energy

Objective of Study	Functional Unit	Conclusions	Citation
To present a set of life-cycle emission factors per unit of electricity generated for LFGTE and WTE using the MSW-DST (Municipal Solid Waste - Decision Support Tool).	Mass of MSW set out for collection (MSW = nonhazardous solid waste generated in residential, commercial, and institutional, sectors)	When the objective was to compare the per unit electricity generated, WTE was a better option than LFGTE. When comparing emissions, WTE had lower NO_x, SO_x, and PM emissions than LFGTE.	Kaplan, P. O., DeCarolis, J., & Thorneloe, S. (2009). Is it better to burn or bury waste for clean electricity generation? *Environmental Science & Technology*. 2009, 43 (6), 1711–1717
To compare SWM strategies that minimize cost and GHG emissions using the MSW-DST.	Mass of MSW set out for collection	When the objective was to minimize cost, a recyclables drop-off facility was the cheapest SWM alternative. When the objective was to minimize GHG emissions, a WTE facility was shown to be superior.	Solano, E., Dumas, R. D., Harrison, K. W., Ranjithan, S. R., Barlaz, M. A., & Brill, E. D.(2002). Life-cycle-based solid waste management. II Illustrative applications. *Journal of Environmental Engineering*, *128*(10), 93-1005
To compare two strategies for treatment of organic household waste using EASEWASTE (Environmental Assessment of Solid Waste Systems and Technologies): (1) anaerobic digestion of organic household waste, (2) combustion of organic household waste with residual MSW.	Mass of separated organic household waste in Aarhhus, Denmark	The combustion scenario may supply more dwellings with energy for heating and electricity and reduce GHG emissions. However, large energy and resource savings occur with both scenarios. The results show that the combustion of organic waste is marginally better than anaerobic digestion with regards to global warming.	Kirkeby, J. T., Birgisdottir, H., Hansen, T. L., & Christensen, T. H. (2005). Evaluation of environmental impacts from municipal solid waste management in the municipality of Aarhus, Denmark (EASEWASTE). *Waste Management & Research*, *24*, 16-26.
To analyze the validity of six SWM models on three waste treatment scenarios for CO_2 emissions: landfill, combustion, and material recovery facility. The models were ARES, EPIC/CSR (Integrated Solid Waste Management Tool), MSW-DST, IWM2 (Integrated Waste Management 2), ORWARE, and UMBERTO.	Mass of household waste in Dresden, Germany	Five of the six models agreed that the MRF scenario had the lowest CO_2 emissions, followed by either the landfill or incineration scenarios. However, the paper did not differentiate CO_2-fossil and CO_2-biomass, nor did the paper include fugitive CH_4 emissions. The results are, therefore, incomplete and misleading.	Winkler, J. & Bilitewski, B. (2007). Comparative evaluation of life cycle assessment models for solid waste management. *Waste Management*, *27*, 1021-1031.

Objective of Study	Functional Unit	Conclusions	Citation
To evaluate ten SWM options on collection, long haul transportation, recycling (including transfer stations and materials recovery facilities), combustion, and landfilling for GHG, energy consumption, nitrogen oxide emissions, and cost using the MSW-DST.	Mass of MSW	When the objective was to minimize cost, the scenario with 20% recycling and 80% landfilled waste with no gas collection and control was found to be the most cost effective option. When examining impact categories such as acidification, smog, net carbon emissions, and human health a 30% recycle rate with 70% combustion using a WTE facility generating electricity and recovery of metals was the best scenario.	Thorneloe, S. A., Weitz, K., & Jambeck, J. (2007). Application of the US decision support tool for materials and waste management. *Waste Management, 27*(8), 1006-1020.
To evaluate alternative plans for SWM in the State of Delaware for cost and GHG emissions considering curbside recycling, yard waste composting, and WTE to divert waste from landfills. The MSW-DST model was used.	Mass of MSW set out for collection	Curbside recycling for only a fraction of the population was found to be the most cost effective strategy to achieve a state landfill diversion target. To meet GHG emissions at the minimum cost, using WTE for a fraction of the total waste was the optimal solution.	Kaplan, P. O., Ranjithan, S. R., & Barlaz, M. A. (2009). Use of life-cycle analysis to support solid waste management planning for Delaware. *Environmental Science & Technology*, *43*(5), 1264-1270.
To establish a technique for determining the carbon content of MSW and to use this technique to analyze the GHG impacts of WTE facilities and landfills. The MSW-DST model was used for the LCA.	29 million tons MSW	When the objective was to compare LCA results of WTE and various landfill designs for WTE emissions, WTE was found to mitigate more GHG due to electricity generation.	Bahor, B., Weitz, K., & Szurgot, A. (June 2008). Updated analysis of greenhouse gas emissions and mitigation from municipal solid waste management options using a carbon balance. Paper presented at the 2008 Global Waste Management Symposium, Colorado, September 8-10.

Legend:
LFGTE = landfill gas-to-energy
WTE = waste-to-energy
SWM = solid waste management
MSW = municipal solid waste
GHG = greenhouse gas
PM = particulate matter

Additional References Cited

Weitz, K..A, Thorneloe, S.A, Nishtala, S.R., Yarkosky, S., Zannes, M., 2002, The impact of municipal solid waste management on greenhouse gas emissions in the United States, J. Air & Waste Mngmnt. Asscn.. 52(9), p. 1000-11.