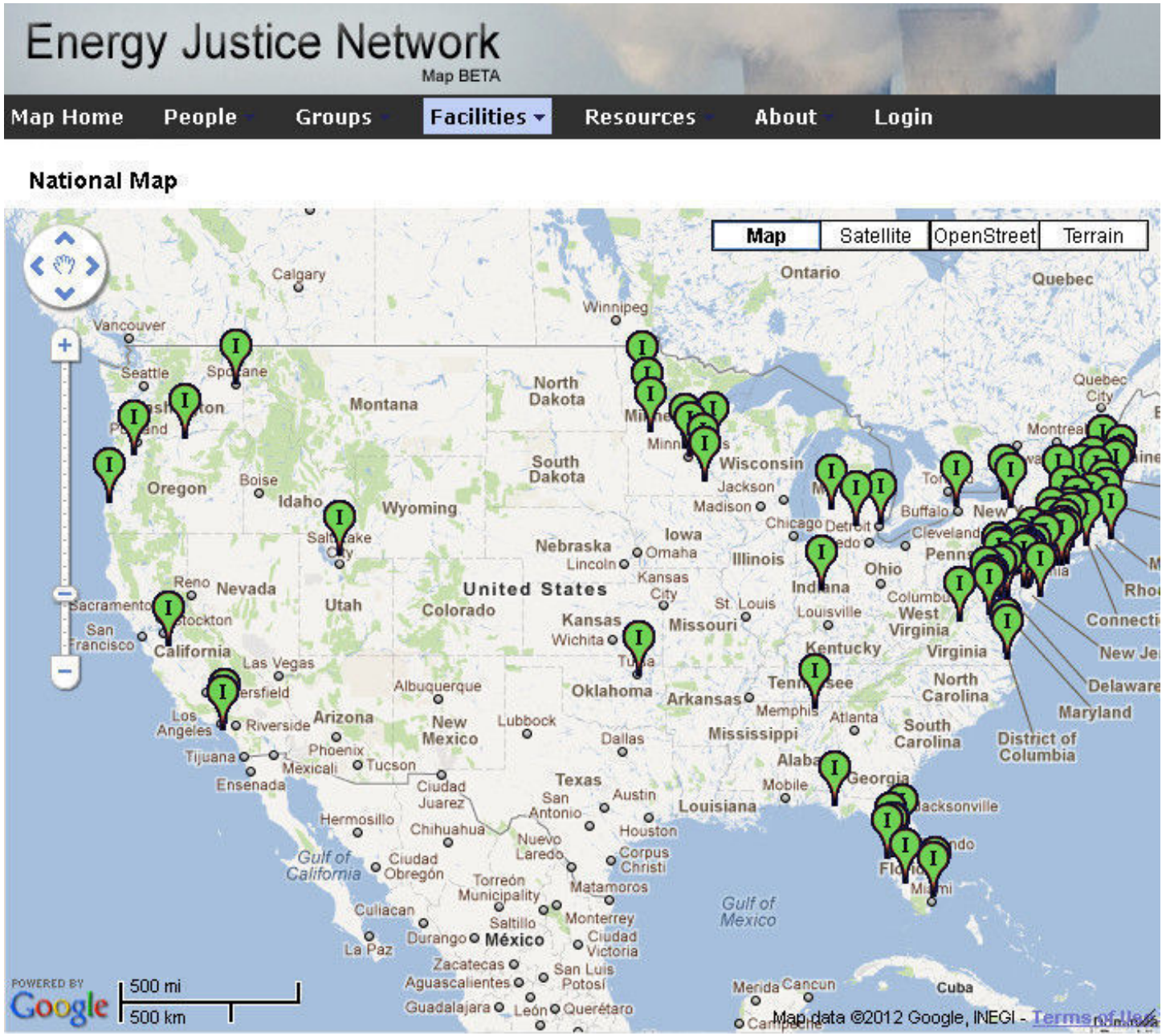
Energy Justice Network

www.EnergyJustice.net

...helping communities protect themselves from polluting energy and waste technologies

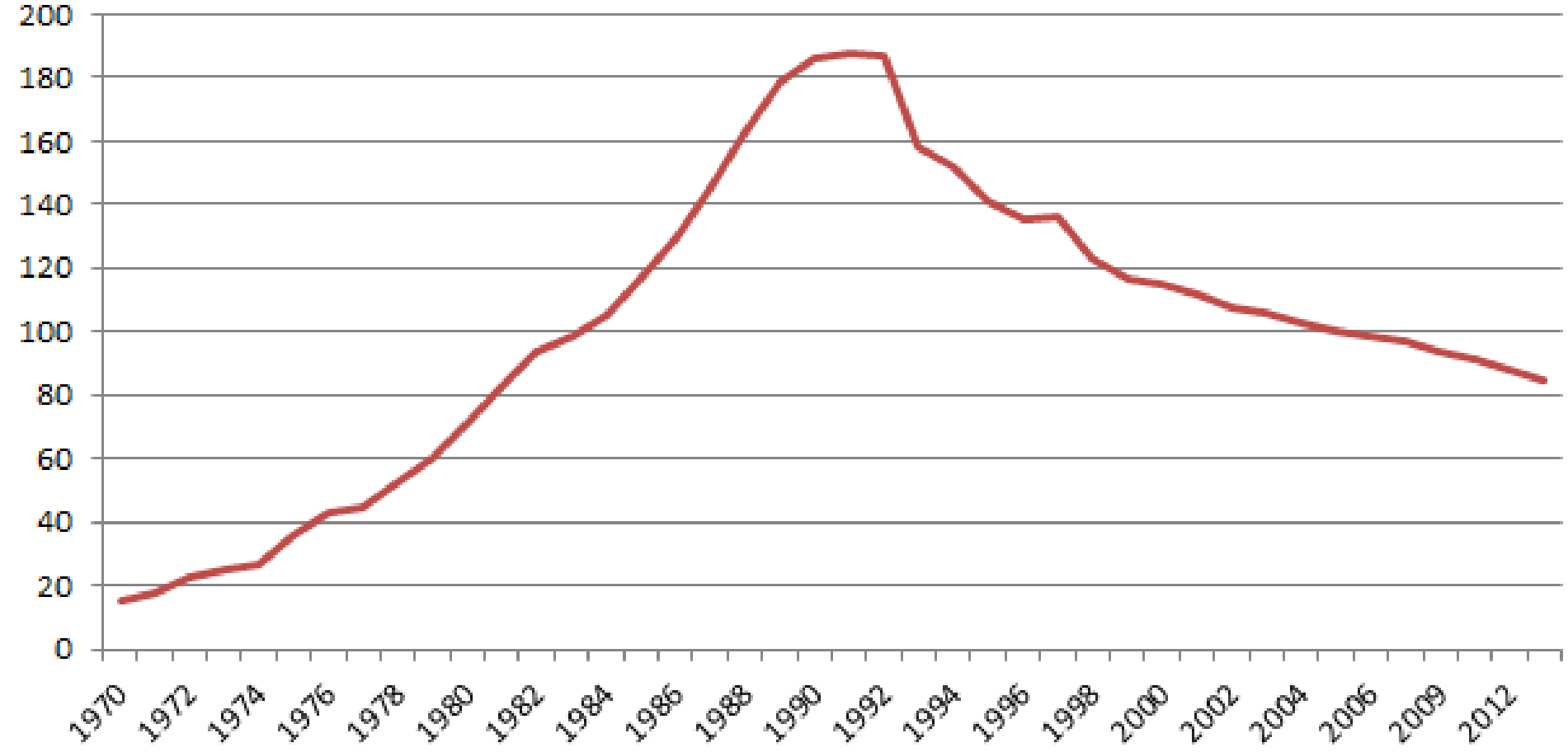
Biomass / Waste Incineration

www.EnergyJustice.net/incineration/



www.EnergyJustice.net/map

Number of Commercial Trash Incinerators Operating in the U.S.



World's largest waste corporation driving away from incineration

WASTE MANAGEMENT

THE WALL STREET JOURNAL.

Jan 3, 2014: "Big Waste Hauler Rethinks Startups"

[pulls out of gasification, pyrolysis, plasma and trash-to-ethanol investments, selling off Agilyx, Enerkem, Fulcrum, Genomatica & InEnTec]

Jul 29, 2014: "Waste Management to Sell Wheelabrator for $1.94 Billion"

[pulls out of long-standing ownership of Wheelabrator, the second-largest operator of conventional incinerators in U.S.]

Incinerators: Names Used

- Waste-to-energy (WTE)
- Energy from Waste (EfW)
- Trash-to-steam
- Conversion technologies
- Biomass
- Advanced Thermal Tech
- Waste to Fuel (WTF?)

Technologies

- Conventional boilers
- Fluidized Bed
- Gasification
- Pyrolysis
- Plasma Arc
- Catalytic cracking
- Thermal Depolymerization
- Cement kilns
- Industrial Boilers (paper mills, utility boilers)
- Fischer-Tropsch / Gas-to-Liquids (gasification/liquefaction)
- Cellulosic Ethanol (waste-to-ethanol)

Fuel Conversion Technologies

- Cellulosic Ethanol (waste-to-ethanol)
- Pyrolysis
- Thermal Depolymerization
- Fischer-Tropsch / Gas-to-Liquids (gasification/liquefaction)
- Acid Hydrolysis

Biomass Incineration: Wastes/Fuels

Includes…

- Municipal Solid Waste (Trash)
- Tires
- Sewage Sludge
- Construction / Demolition (C&D) Wood Waste
- Animal Factory Wastes
- Paper & Lumber Mill Wood Wastes
- Agricultural Crop Residue
- Energy Crops
- Forest Cutting
- "Urban" Wood Waste (tree trimmings)
- Landfill Gas
- Digester Gas

Experimental Types of Incinerators Don't Work

Gasification, plasma arc and pyrolysis:

- **Can't run continuously**
- **Can't be run effectively at commercial scale**
- **Can't process heterogenous feedstocks like trash**
- **Companies with no real history bamboozle local officials into subsidizing projects that fail, technically and financially**
- **The companies usually lie about their emissions, claiming zero emissions or "no smokestack"**

EPA says pyrolysis/gasification = incineration

40 CFR 60.51a:

- **Municipal waste combustor**, MWC, or municipal waste combustor unit: (1) **Means any setting or equipment that combusts solid, liquid, or gasified MSW including, but not limited to**, field-erected incinerators (with or without heat recovery), modular incinerators (starved-air or excess-air), boilers (i.e., steam-generating units), furnaces (whether suspension-fired, grate-fired, mass-fired, air curtain incinerators, or fluidized bed-fired), and **pyrolysis/combustion units**.
- **Pyrolysis/combustion unit** means **a unit that produces gases**, liquids, or solids **through the heating of MSW, and the gases**, liquids, or solids produced **are combusted and emissions vented to the atmosphere**.

"**A municipal waste incinerator** 'combusts' solid waste and thus **is functionally synonymous with municipal waste combustor**."
(www.epa.gov/ttn/nsr/gen/rm_2.html)

Pyrolysis is a failed technology

Patent review company:

- **has been seeing pyrolysis projects for 14 years**
- **none of them are legitimate**
- **they're just splitting combustion into two steps, making it more expensive, less efficient and not any cleaner**
- **sees a steady stream of guys in their 50s-70s who worked at corporations, thought it's a great idea, and go out and promote it and get money by whatever means and get some patent coverage mainly to help get the money, but none are legit**

Pyrolysis is a failed technology

Rubber Manufacturers Association:

- **“Major tire companies like Goodyear and Firestone once invested ‘immense resources’ in pyrolysis but could not find markets for the byproducts or even a way to integrate them into their own products. And scores of start-ups have tried and failed to make money from tire pyrolysis.”**
- **“The road is littered with the carnage of people who were trying to make this technology viable.”**

Pyrolysis is a failed technology

- **Not intended for continuous operation**
  - **Runs batch processes**
  - **Mainly used at demonstration scale**
- **Can only operate on homogenous fuels**

Environmental Protection Agency:

- **While technically feasible, tire pyrolysis – a process in which tires are subjected to heat in an oxygen-starved environment and converted to gas, oil and carbon char – has been inhibited by the high capital investment required and steep operating costs**

Technologies and Risk

Source: Gershman, Brickner & Bratton, Inc. August 2012

Alternative	Risks/Liability	Risk Summary
Mass Burn/WaterWall	Proven commercial technology	Very Low
Mass Burn/Modular	Proven commercial technology	Low
RDF/ Dedicated Boiler	Proven commercial technology	Low
RDF/Fluid Bed	Proven technology; limited U.S. commercial experience	Moderate to Low
Anaerobic Digestion	Proven technology; limited U.S. commercial experience	Moderate to Low
Mixed-Waste Composting	Previous large failures; No large-scale commercially viable plants in operation; subject to scale-up issues	Moderate to high
Pyrolysis	Previous failures at scale, uncertain commercial potential; no operating experience with large - scale operations	High
Gasification	Limited operating experience at only small scale; subject to scale-up issues	High
Chemical Decomposition/ Depolymerization	Technology under development; not a commercial option at this time	High

Pyrolyzer's Proposed Facility in Logansport, Indiana

PYROLYZER
Waste to Energy Technologies

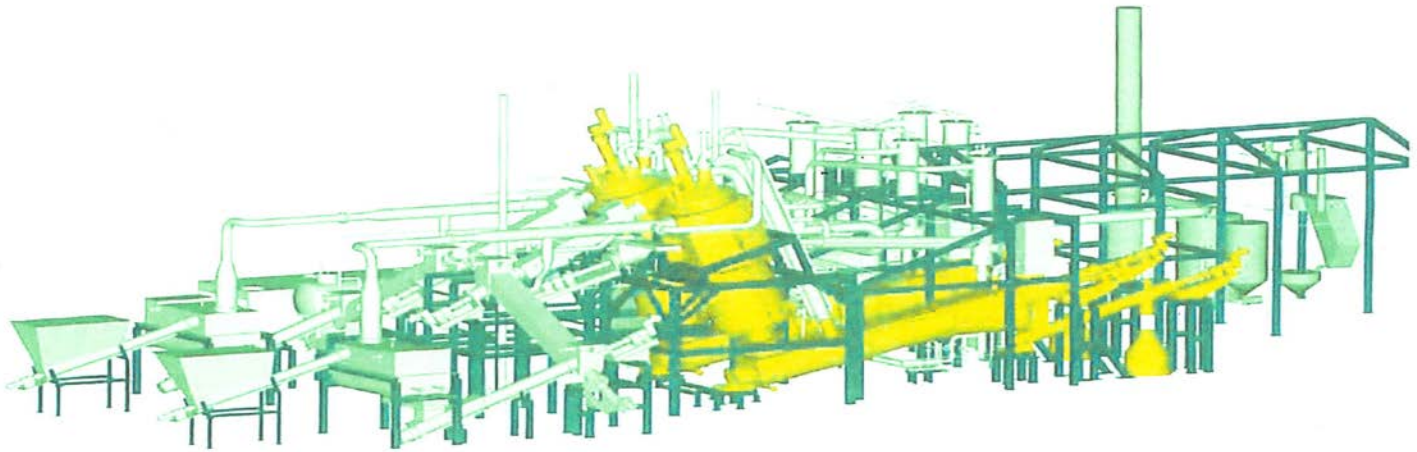
LMU RFP Response
Proposal for Waste to Energy Facility

Proposal:

LMU Electric Generating Plant

For:

300 MW Waste to Energy Facility



Pyrolyzer equipment

6,000 tpd facility proposed in Logansport, IN points to a two reference plants:

- **Undisclosed location, Germany**
  - **only 4 tpd**
  - **only operated ‘over’ 2,500 hours in 14 years (about 7 1/2 days per year)**
  - **described as “not intended for continuous operation.”**
- **Eilenburg, Germany**
  - **37 ton per day but did not achieve this – only ran 1600 hours in it’s life**
  - **Only processed total of 2,500 tons in a year (2002)**
  - **Longest continuous run was 15 days**
  - **Contract cancelled due to financial reasons!**

William O. Howland, Jr., Director, DC Department of Public Works:

"The technology the vendor is proposing - plasma gasification and combined cycle WTE - has not been successfully modeled either in the United States or abroad. In the US, there is a plant on the drawing board in Florida which has been significantly downsized since its inception and is still not operational. Further, the project has run into problems getting a turbine manufacturer to accept the risk and provide a warranty because the derived fuel is not sufficiently clean of metals and other particulate matter. Japan has several gasification facilities that vary in size and are run intermittently. Further, these facilities rely on a more homogenous feedstock than MSW. A mixed product like MSW will create additional challenges to keep a facility up and running on a constant basis."

-November 13, 2009 email to DC Mayor's Office

KOACH ENERGY

"Environmentally Friendly Tire recycling to Petroleum"

…would have been the world's largest tire incinerator, using a pyrolysis / gasification system to process 1,200 – 2,400 tons of tires/day

Chester, Pennsylvania Mayor:

Feb 4th, 2008: “[I]t is clear to me that Koach Energy is not the type of business that is consistent with the city's current or future development efforts. They very well may be an attractive addition to some other municipality's business base, but the City of Chester and my administration have fought for far too long in our efforts to transform our local economic base away from this type of industry. …we are not interested and would not support bringing in businesses that would further feed into the perception that potentially polluting industries are welcome in the City of Chester. In the past, that may have been acceptable to some but my interest is in the future and my focus will continue to be centered on how we move this city forward with new and exciting developments that build upon the momentum we have generated. Now is not the time to take a step backwards and focus on drawing in industries that interestingly always seem to think the City of Chester needs them more than they need us.

As Mayor, I feel it is my duty to clearly state that Koach Energy, regardless of their job creation claims and their alleged charitable benefits, is not aligned with the future direction of the City of Chester. I will not support businesses that will directly harm the city's current positive economic trend which further reinforces the perceptions that some apparently have had that Chester should be the home for potentially polluting industries.

Koach Energy in NJ

After kicking it out of Chester City, Pennsylvania, the company teamed up with Rutgers University's EcoComplex in New Jersey.

The experimental pilot project:

- lost $1 million last year
- couldn't find investors
- was fairly polluting ("black smoke")
- the pyrolysis side of the project failed
- The test equipment will be sold for scrap

Basic Lessons

- Garbage-in, Garbage-out.
- Nothing is 100%.
- Small amounts matter, especially if they're a small % of a BIG number.
- Over 99% of incinerator proposals are defeated by grassroots opposition or fail on their own.
- If incineration is the answer, someone asked the wrong question
- Incinerators are habitual law-breakers and Covanta is notorious

Bigger Problems with Incinerators

- Destroys materials / net energy issues
  - "waste-OF-energy" – **3-5 times** more energy saved by recycling/composting
- Environmental racism
- Global warming contribution worse than zero waste solutions
- Makes the problem "invisible" rather than making it very visible so that unsustainably-produced products can be properly dealt with

Incinerators are…

~~Trash-to-Steam~~

Trash to toxic ash and toxic air emissions

Incinerators are…

~~Waste-to-Energy~~

Waste-OF-energy

(3-5 times more energy wasted by not recycling/composting the materials burned)

Source: Morris, Jeffrey, and Canzoneri, Diana, "Recycling Versus Incineration: An Energy Conservation Analysis," Sound Resource Management Group (SRMG) Seattle, Washington, September, 1992.
www.sciencedirect.com/science/article/pii/0304389495001166

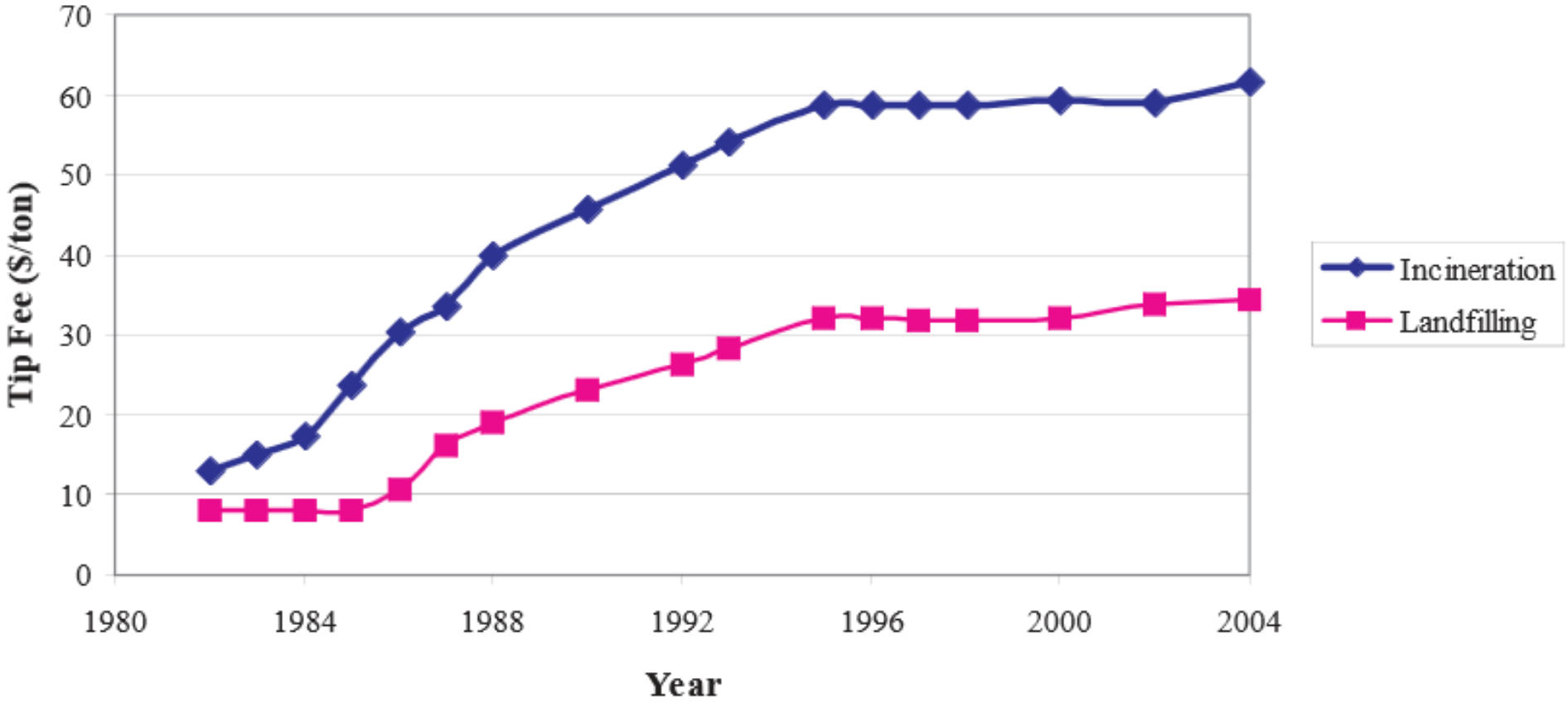
Most Expensive Way to Manage Waste

"Waste-to-energy is an additional capital cost. That is not in dispute, compared to a landfill... compared to a landfill, which is a less capital-intense structure – it is more expensive. If you had a landfill next to a waste-to-energy facility, then almost in every case, you would think the landfill is going to be cheaper."

Ted Michaels, President, Energy Recovery Council, March 18, 2013 testimony before Washington, DC City Council

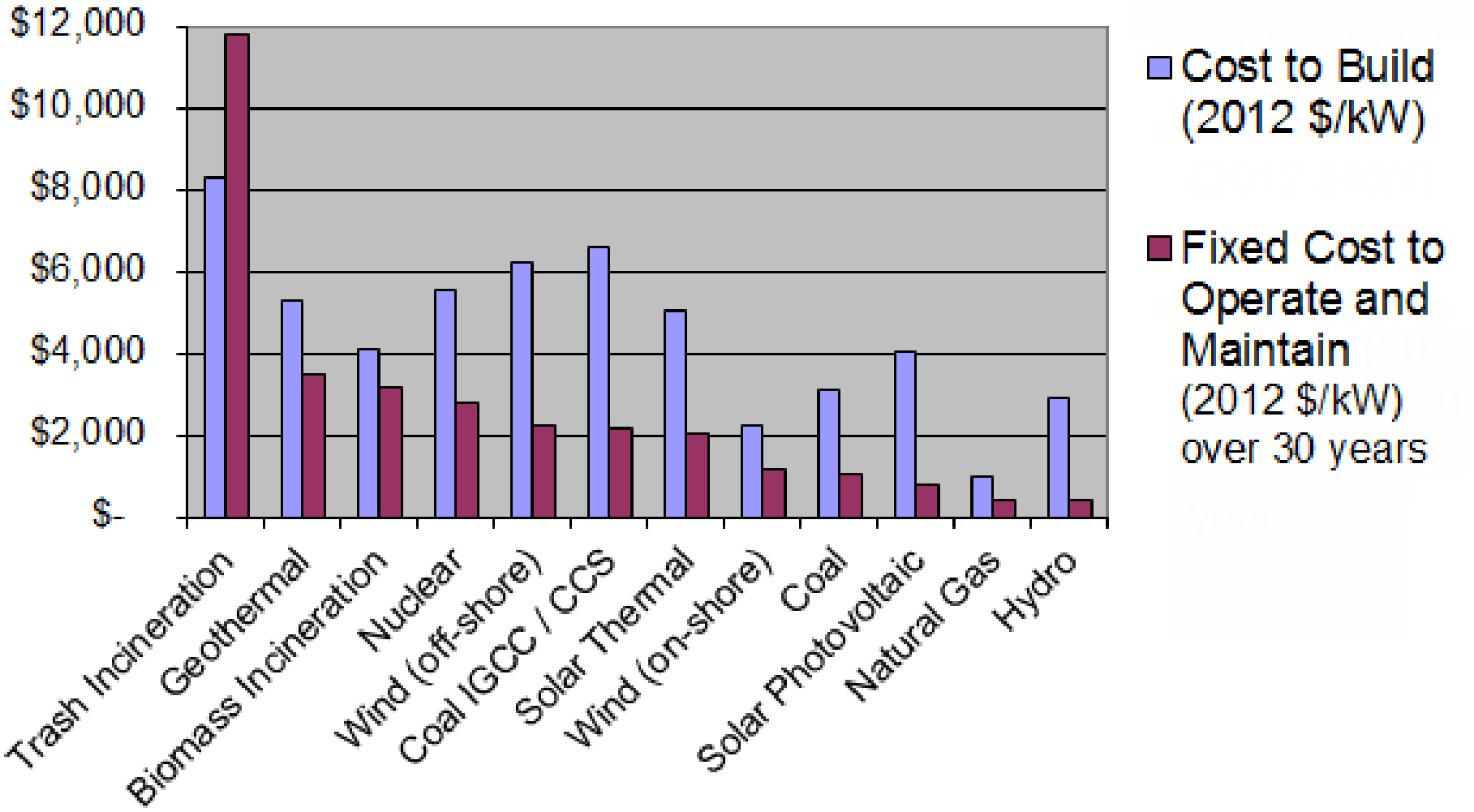
Most Expensive Way to Manage Waste

Figure 3. Landfill and Incinerator Tip Fees



Source: National Solid Waste Management Association 2005 Tip Fee Survey, p4.
www.environmentalistseveryday.org/docs/Tipping-Fee-Bulletin-2005.pdf

Most Expensive Way to Make Energy



Source: "Updated Capital Cost Estimates for Utility Scale Electricity Generating Plants," Energy Information Administration, April 2013, p.6, Table 1. Full report here: www.eia.gov/forecasts/capitalcost/pdf/updated_capcost.pdf

Problems with Incinerators: Economics

- Capital Intensive (Expensive)
- Requires long-term monopoly contracts "Put-or-Pay" contracts including “put or pay” clauses that punish local governments if they recycle / compost
- Competes with zero waste AND energy alternatives
  - Competes with wind and solar in Renewable Portfolio Standards*
- Economic incentives encourage burning more dangerous wastes (getting paid to take waste vs. paying for fuels)

* Currently, trash incineration is only in direct competition with wind and solar in Maryland’s RPS law, but this affects many other states, and biomass incineration and landfill gas burning competes directly with wind and solar in most RPS laws.

Incineration Competes with Recycling

- **Needs paper and plastics (and wood and tires) to burn effectively**
- **Must be fed enough waste**
- **Waste contracts are designed to punish recycling**

A Critical Look at the Harrisburg Incinerator Project Finances

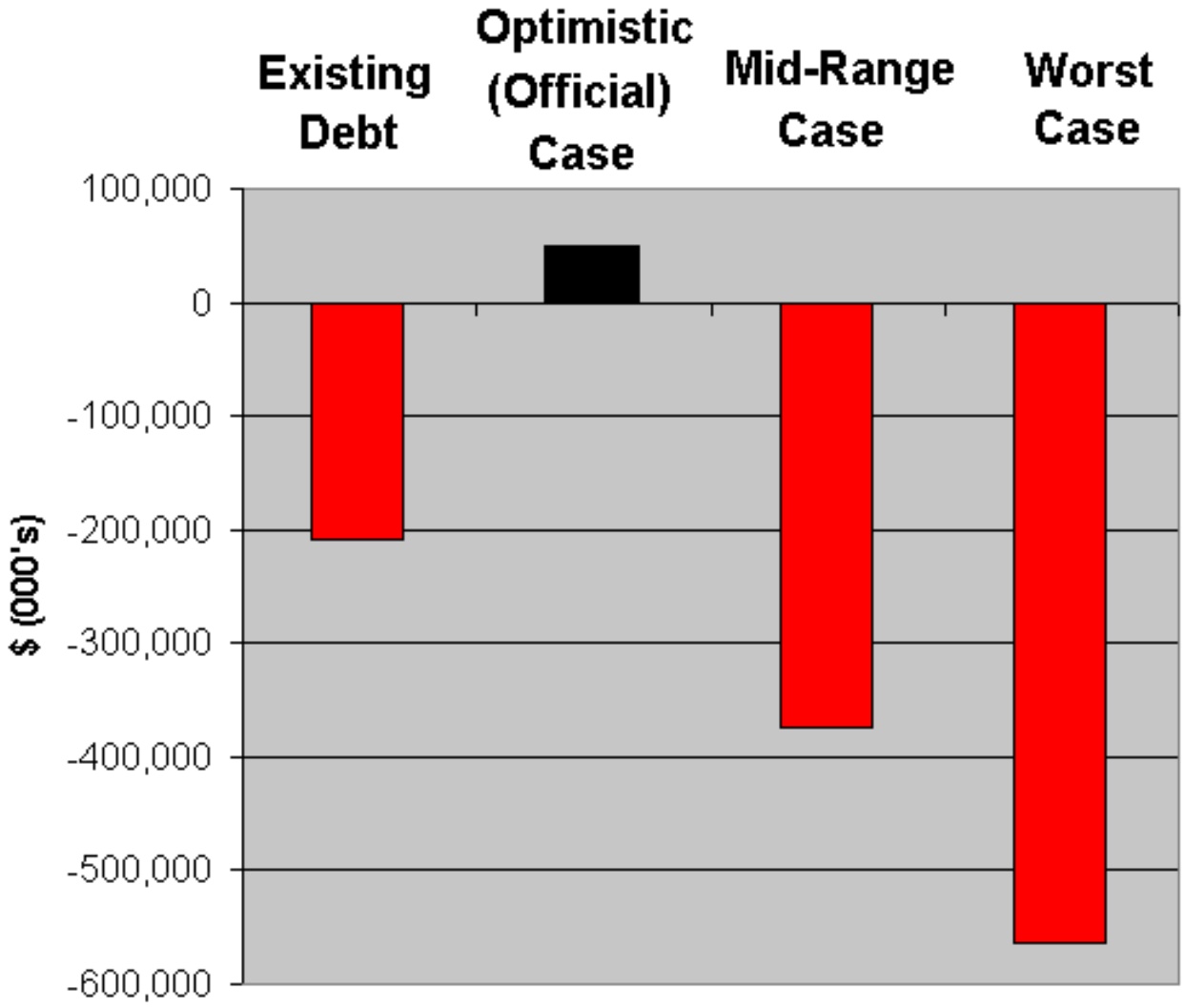
November 5th, 2003

Coalition Against the Incinerator

www.StopTheBurn.com

This and next slide excerpted from Powerpoint warning Harrisburg that it faced bankruptcy if it rebuilt its incinerator.
For full presentation, see: www.stoptheburn.com/presentation.pdf

Existing Debt vs. Incinerator Project Possibilities



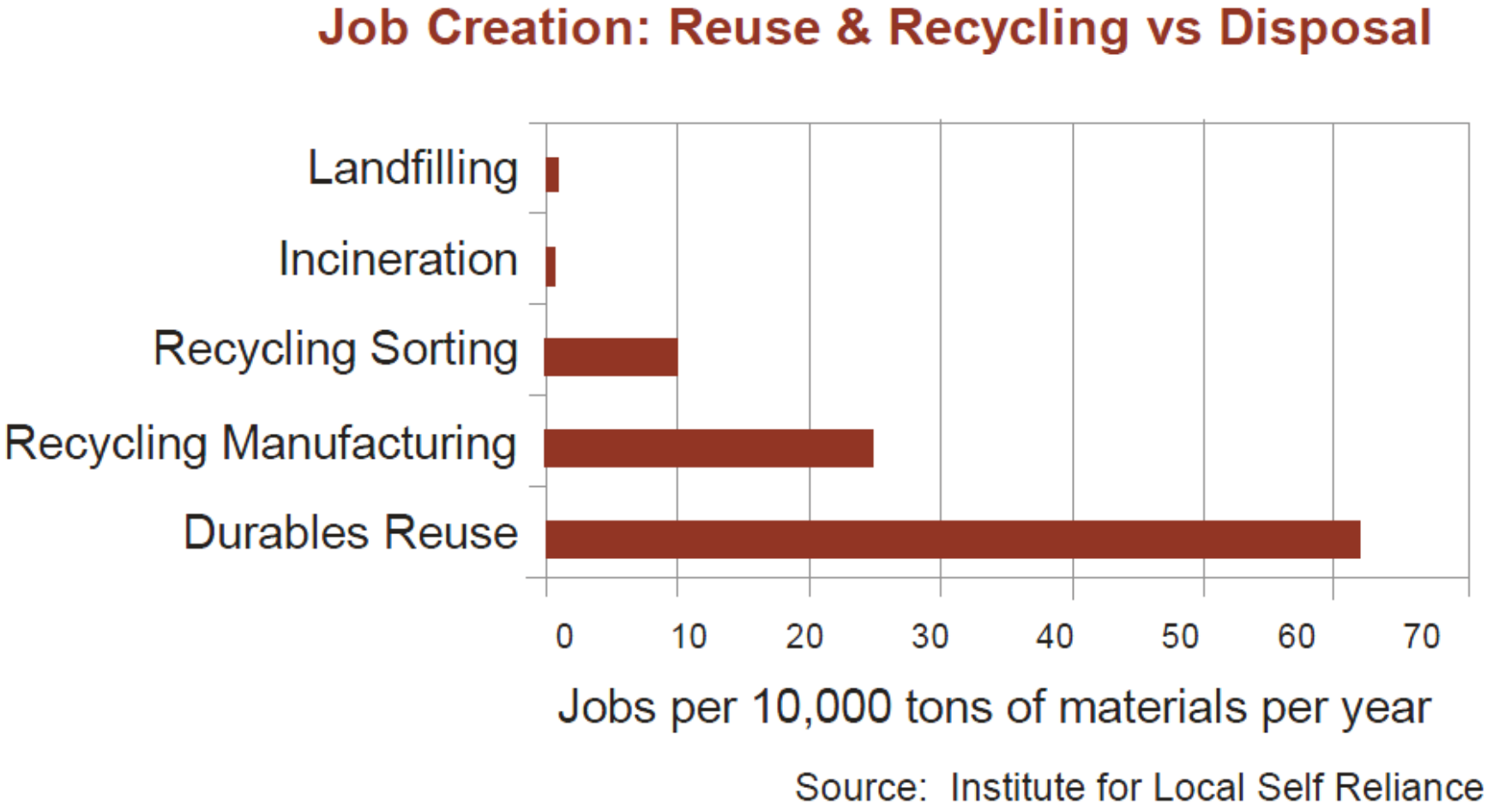
Harrisburg News Headlines

- “City of Harrisburg chapter 9 bankruptcy dismissed”
- “Harrisburg, Pennsylvania Bankruptcy Filing Rejected By Federal Judge”
- “Troubled Harrisburg now state's problem”
- “How A City Goes Broke”
- “Harrisburg Receiver Plans To Complete Transactions By June Reports”
- “Feds: Harrisburg incinerator audit ‘under review’”
- “Pa. Official: Corruption Led to Harrisburg's Money Woes”
- “Trying To Save A Broke City”
- “Harrisburg receiver says lawyers looking at incinerator audit”

Incinerators Burn Money

- Claremont, NH: 20-year “put-or-pay” contracts caused 29 towns to file for bankruptcy in 1993, which the court denied, requiring that taxes be raised to pay back the incinerator for waste the towns did not even produce
- Hudson Falls, NY and Lake County, FL – deep incinerator debt due to long-term contracts favorable to the industry
- Poughkeepsie, NY – incinerator fails to bring in enough revenue from tipping fees and electric sales to operate without millions in annual subsidies from the county
- Detroit, MI – the nation’s largest incinerators by design capacity – has cost the ailing city $1.2 billion in debt payments over 20 years, bringing the city close to bankruptcy on three occasions.
- All of New Jersey’s five trash incinerators had to be bailed out by the state taxpayers with over $1.5 Billion because they could not attract enough waste to operate at capacity.

Worst Way to Create Jobs



Job Creation: Reuse & Recycling Versus Disposal in the United States

Type of Operation	Jobs Per 10,000 Tons per Year
Product Reuse	
Computer Reuse	296
Textile Reclamation	85
Misc. Durables Reuse	62
Wooden Pallet Repair	28
Recycling-Based Manufacturers	25
Paper Mills	18
Glass Product Manufacturers	26
Plastic Product Manufacturers	93
Conventional MRFs[101]	10
Composting	4
Incineration	1
Landfilling	1

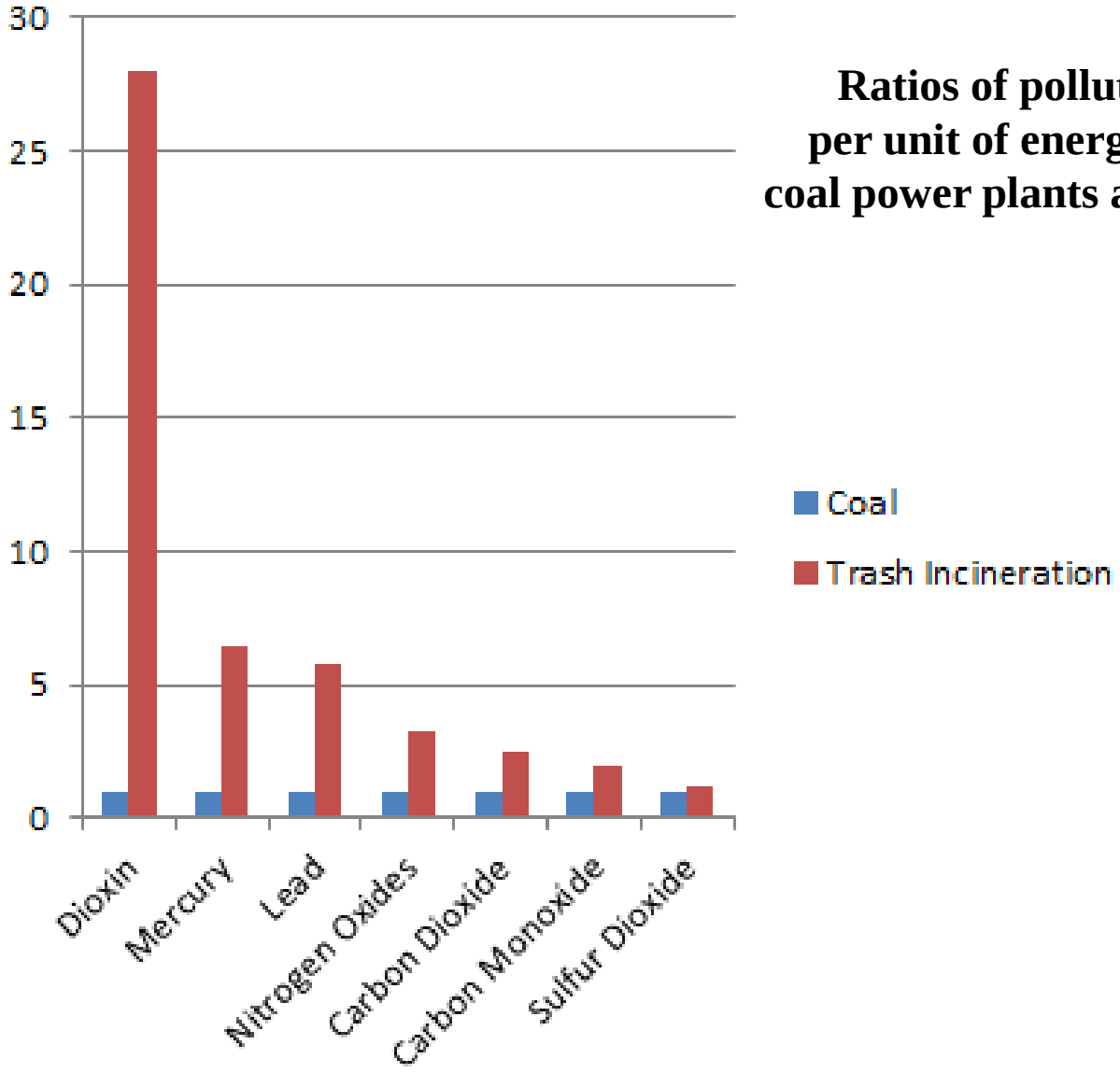
Incineration Worse than Coal

Toxic Air Emissions are…

- **Dioxins / furans** (28 times as much)
- **Mercury** (6-14 times as much)
- **Lead** (6 times as much)
- **Nitrogen Oxides** (NOx) (3.2 times as much)
- **Carbon Monoxide** (CO) (1.9 times as much)
- **Sulfur Dioxide** (SO_2) (20% worse)
- **Carbon Dioxide** (CO_2) (2.5 times as much)

www.energyjustice.net/incineration/worsethancoal

Incineration Worse than Coal



Ratios of pollution levels emitted per unit of energy produced by U.S. coal power plants and trash incinerators

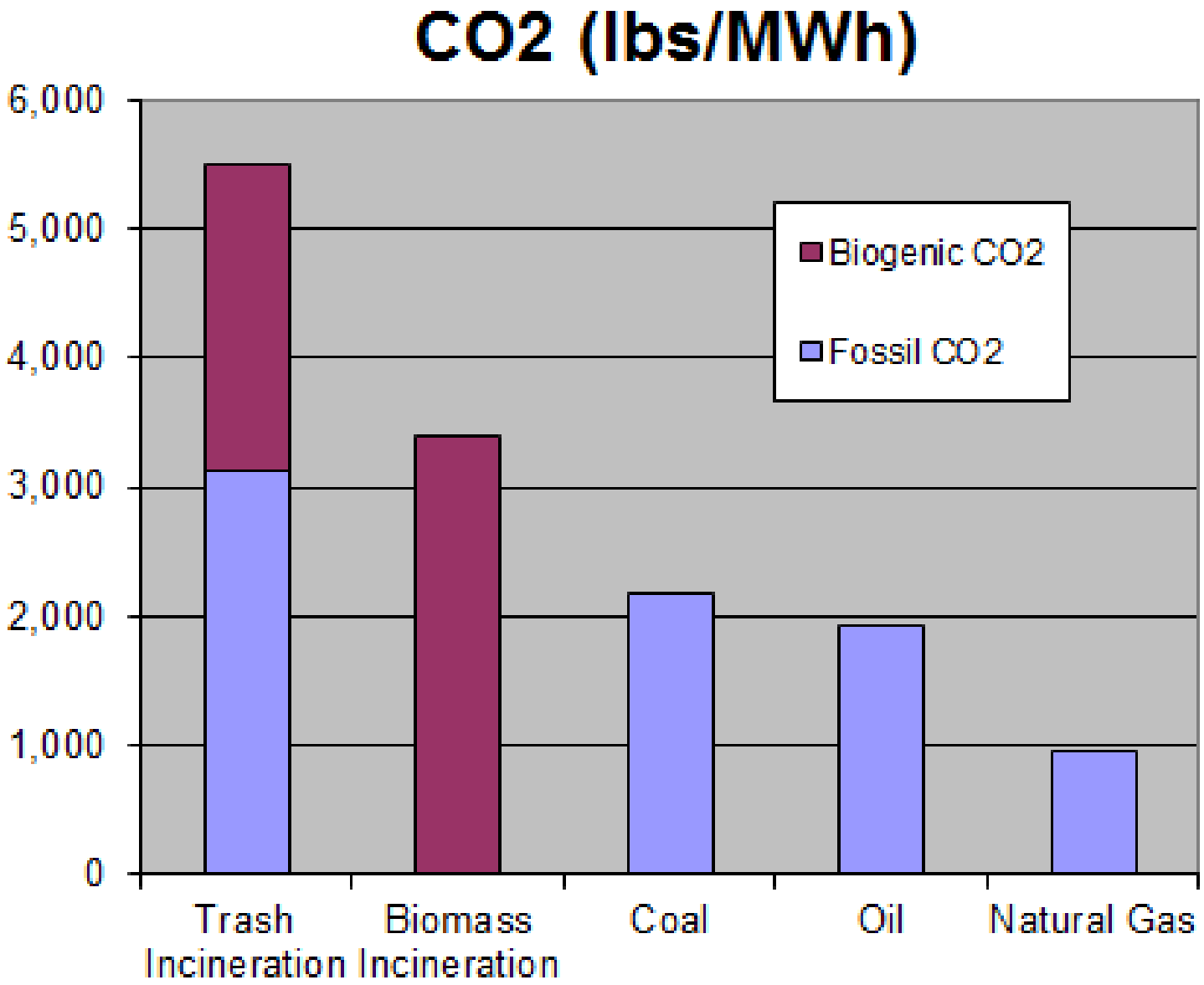
Incinerator, Not a Power Plant

“a waste-to-energy plant is designed to manage solid waste... the electricity output is a secondary function”

Ted Michaels, President, Energy Recovery Council, March 18, 2013 testimony before Washington, DC City Council

Global Warming Pollution

Smokestack CO2 Emissions from U.S. Power Plants



Data is in pounds of CO2 per unit of energy produced (lbs/MWh)

Source: U.S. EPA Emissions & Generation Resource Integrated Database (eGRID) v.9, released 2/24/2014 (2010 data)

Nov. 2014: EPA Allows States to Ignore Biomass and Waste Incineration CO2

Under State Implementation Plans to meet the Clean Power Plan requirement to reduce CO2 emissions from existing electric generators, EPA is allowing states to totally ignore CO2 from incineration:

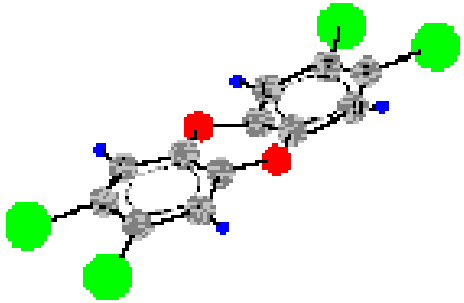
- **waste incineration CO2 to be ignored** because landfills are worse
- **biomass incineration CO2 to be ignored** so long as logging operations meet minimal forest management plans

See: www.energyjustice.net/content/citizens-urge-epa-and-congress-choose-public-interest-over-politics-energy-policy

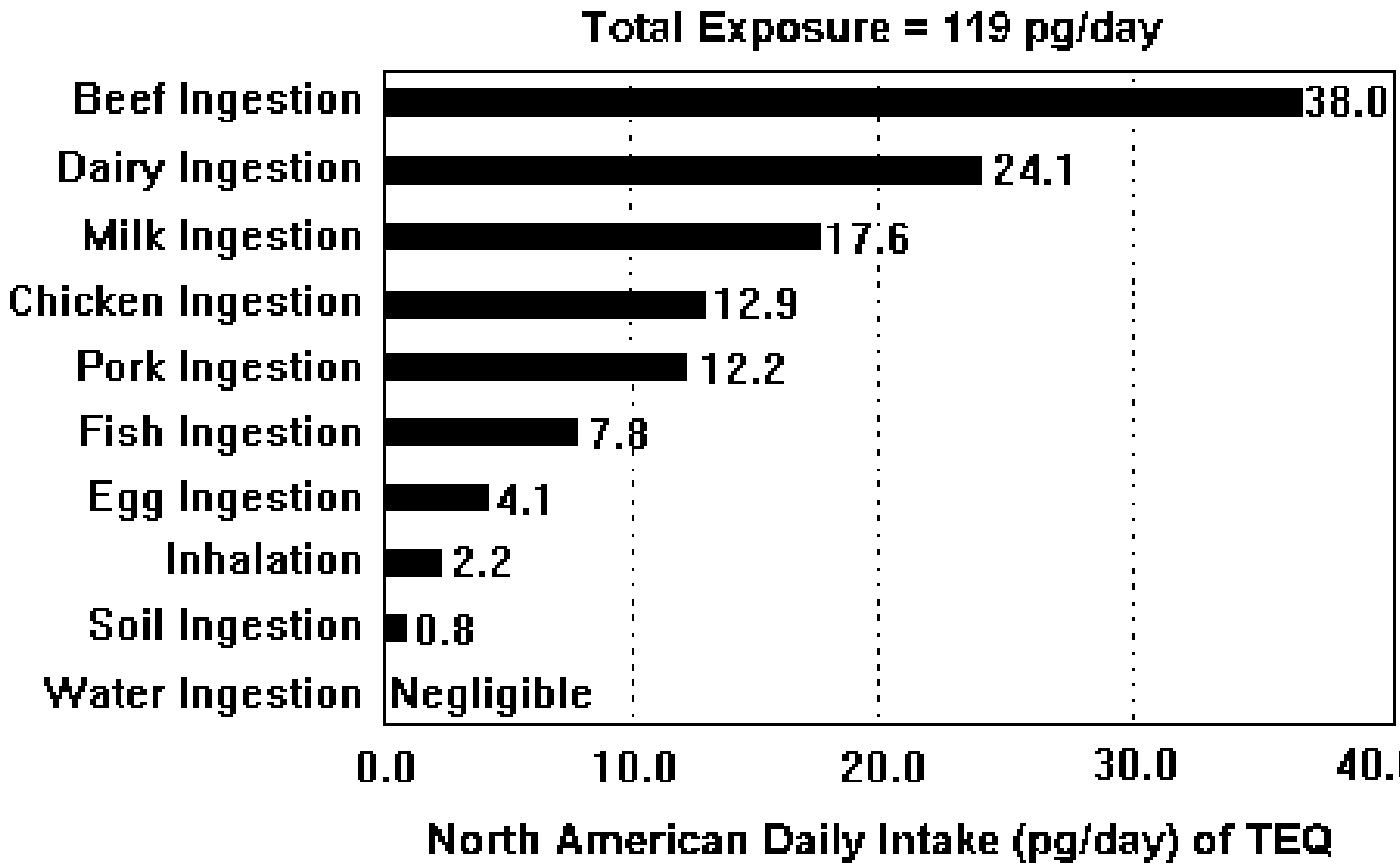
Dioxin Facts

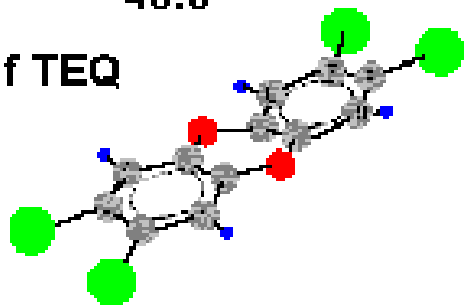
- Dioxins and furans are the most toxic chemicals known to science. They are highly toxic even in miniscule amounts.
- Dioxins cause infertility, learning disabilities, endometriosis, birth defects, sexual reproductive disorders, damage to the immune system, cancer and more.
- 93% of dioxin exposure is from eating meat and dairy products.

www.ejnet.org/dioxin/



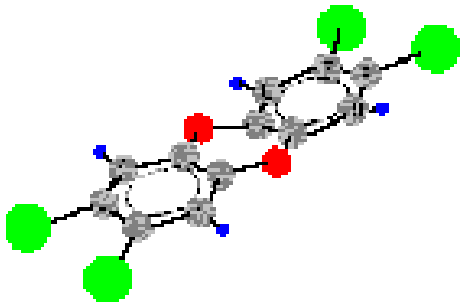
Exposure to Dioxins





How to make dioxin

- Dioxins are created by burning hydrocarbons with chlorine in the presence of oxygen.
- Dioxin emissions increase when:
  - More chlorine is in the fuel/waste stream
  - Certain metal catalysts are present (Copper, Iron, Zinc…)
  - The gases stay in a low temperature range (200-450^{o} C)



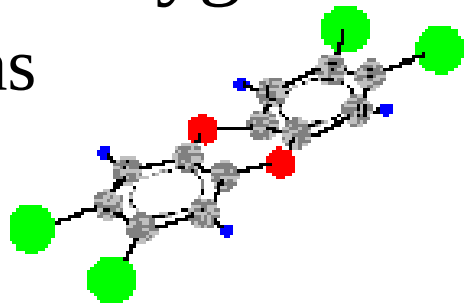
Dioxin Confusion

Alvaro Almuina, project manager, Pyrolyzer, LLC:

"dioxins are formed when organic matter and materials containing chlorine are burned in the presence of oxygen at very high temperatures"

Claims:

- Pyrolysis runs at low temperatures
  - True: and dioxins are formed at low temperatures
- Pyrolysis operates in the "absence of oxygen"
  - False: 20% oxygen in pyrolysis syngas



Continuous Emissions Monitors

- Only generally used for 3 pollutants: sulfur oxides (SOx), nitrogen oxides (NOx) and carbon monoxide (CO) plus opacity, oxygen and temperature
- Technology now exists to continuously monitor:

Ammonia (NH_4)

Carbon Dioxide (CO_2)

Hydrogen Sulfide (H_2S)

Acid Gases:
- Sulfuric Acid (H_2SO_4)
- Hydrofluoric Acid (HF)
- Hydrochloric Acid (HCl)

Products of Incomplete Combustion (PICs):
- Dioxins & Furans
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Volatile Organic Compounds (VOCs)

Particulate Matter (PM)

Metals:
- Antimony (Sb)
- Arsenic (As)
- Barium (Ba)
- Cadmium (Cd)
- Chromium (Cr)
- Lead (Pb)
- Manganese (Mn)
- Mercury (Hg)
- Silver (Ag)
- Nickel (Ni)
- Zinc (Zn)
- …and more

www.ejnet.org/toxics/cems

Incineration Worse than Landfills

- Incinerators still require landfills for their toxic ash
- Choice is NOT landfill vs. incinerator, but:

landfill

vs.

incinerator *AND* a smaller, more toxic landfill

Incineration Worse than Landfills

- Incinerators still require landfills for their toxic ash
- Choice is NOT landfill vs. incinerator, but:

landfill

vs.

incinerator *AND* a smaller, more toxic landfill

OR…

Zero Waste and minimal landfilling

Incineration Worse than Landfills

- Incinerators still require landfills for their toxic ash
- 30 tons of ash produced for every 100 tons burned

Incinerator Ash = Hazardous Waste

Incinerator ash is toxic, but the U.S. EPA allows a special test that enables it to test as non-hazardous, saving the industry a lot of money

Despite Canada relying on the same test, Vancouver's incinerator ash is leaching toxic cadmium at levels about twice the province's acceptable limits. They've had to ship the hazardous ash to a hazardous waste landfill in Alberta.

Incineration Worse than Landfills

- Makes landfills more toxic (from ash or slag dumped) …*or worse,* they try to reuse them
- Liquid wastes (more common to fuels conversion technologies)
- Air Pollution
  - Organic pollutants (Dioxins/furans, Volatile Organic Compounds / PAHs)
  - Toxic metals (mercury, arsenic, lead, cadmium, etc.)
  - Acid Gases (Hydrogen Fluoride, Hydrochloric Acid, Sulfuric Acid)
  - Particulate matter
  - Nitrogen Oxides (NOx), Sulfur Oxides (SOx)

Trash Incinerator Health Impacts

Trash Incinerator Health Impacts

- Increased dioxins in blood of incinerator workers
- Increased cancers, especially:
  - laryngeal and lung cancers
  - childhood cancers
  - colorectal
  - liver
  - stomach
  - leukemia
  - soft-tissue sarcoma
  - non-Hodgkin’s lymphoma
- Increases in babies born with spina bifida or heart defects
- Increases in pre-term births

Medical Professionals Oppose Incineration

National:

- American Academy of Family Physicians
- American Lung Association
- British Society for Ecological Medicine

State / regional:

- American Lung Association in Florida
- American Lung Association in Georgia
- American Lung Association in Massachusetts
- American Lung Association of New England
- Florida Medical Association
- Massachusetts Breast Cancer Coalition
- Massachusetts Medical Society
- North Carolina Academy of Family Physicians
- Washington State Medical Association

Local

- Erie County Medical Society (Pennsylvania)
- Capital Medical Society (Tallahassee, Florida)
- Lane County Health Advisory Committee (Oregon)
- Physicians for Social Responsibility / Pioneer Valley (Massachusetts)

Copies of all of these groups' statements are available online at www.energyjustice.net/biomass/health/

Zero Waste Jobs

Deconstruction Crew, Second Chance, Baltimore, MD. Photo Credit: C. Seldman

What is Zero Waste?

"Zero Waste is a goal that is ethical, economical, efficient and visionary, to guide people in changing their lifestyles and practices to emulate sustainable natural cycles, where all discarded materials are designed to become resources for others to use.

Zero Waste means designing and managing products and processes to systematically avoid and eliminate the volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them.

Implementing Zero Waste will eliminate all discharges to land, water or air that are a threat to planetary, human, animal or plant health."

Source: Zero Waste International Alliance, www.zwia.org

If you're not for Zero Waste, how much waste are you for?

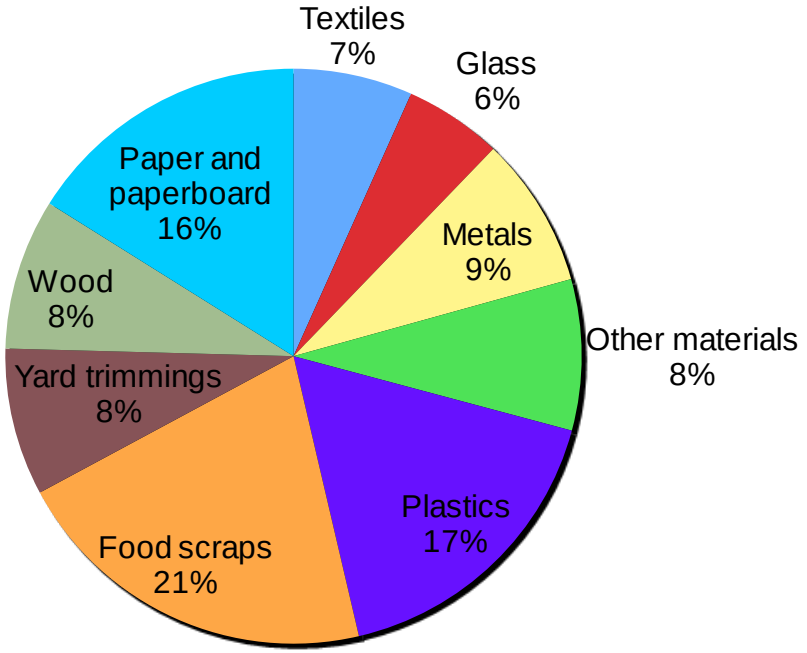
Zero waste is recognized as achieving 90% or greater diversion from landfills and incinerators.

The goal is to get as close to zero as possible, without getting caught up on the impossibility of actually hitting zero.

"Zero waste" is like "zero drug tolerance" or "zero accidents in the workplace" standards. Zero is the goal, and the right policies will get you as close as you can get.

Money Thrown Away

$11.4 billion worth of recyclable packaging wasted (sent to landfills and incinerators) in 2010



Source: “Unfinished Business: The Case for Extended Producer Responsibility,” 2012 Report, www.asyousow.org/sustainability/eprreport.shtml

AUSTIN RESOURCE RECOVERY
MASTER PLAN
DECEMBER 15, 2011

ZERO WASTE BY 2040

The Austin City Council established three benchmark goals for achieving Zero Waste:

1. Reducing by 20 percent the per capita solid waste disposed to landfills by 2012
2. Diverting 75 percent of solid waste from landfills and incinerators by 2020
3. Diverting 90 percent of solid waste from landfills and incinerators by 2040

4

DIVERSION GOALS

The Master Plan establishes more aggressive milestones to ensure the City Council's benchmark goals are achieved.

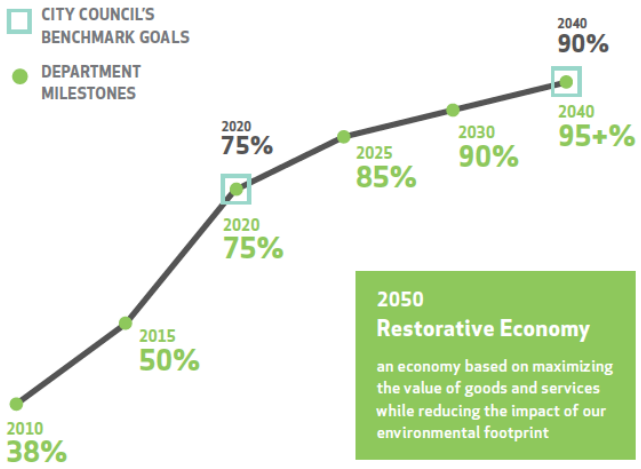
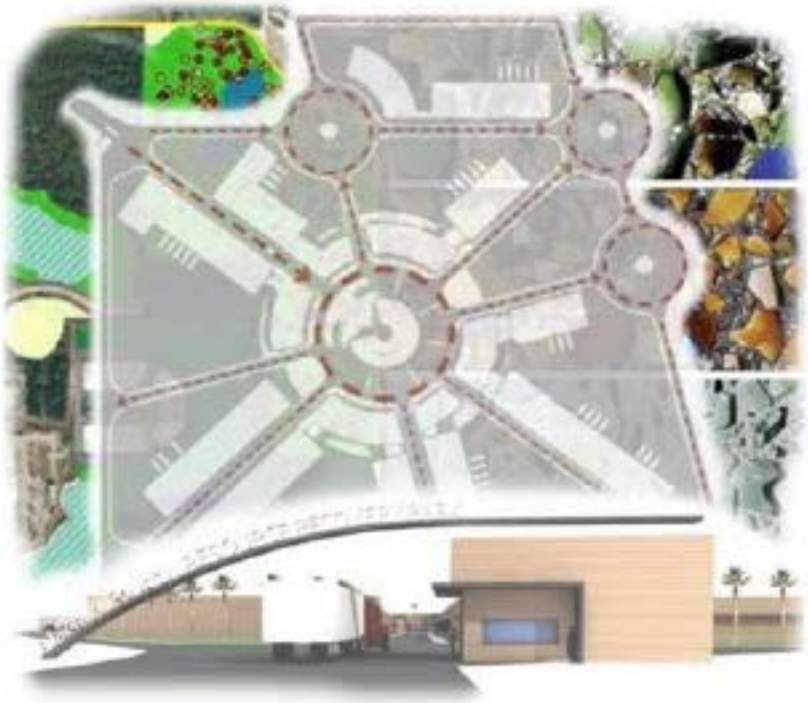


Table 1 - Projected Department Hauled Material Collection

Department Hauled Collection	In Tons				
	FY 2010 (Actual)	FY 2015	FY 2020	FY 2025	FY 2030
Total waste disposal	138,757	115,000	68,000	49,000	37,000
Total diversion: reuse, recycling, organics, HHW	82,611	115,000	205,000	277,250	332,000
Total waste generation	221,368	230,000	273,000	326,250	369,000
Diversion rate	38%	50%	75%	85%	90%

Alachua County Resource Recovery Park



Working in conjuction with the University of Florida College of Design, Construction and Planning over the Fall of 2010 through the Spring of 2011conceptual plans for the economic development of the Leveda Brown Environmental Park expansion were modeled. These proposals will help shape the eventual request for proposals for the buildout of the Resouce Recovery Park; an integral component of the Alachua County Sustainable Solid Waste Strategy. Submissions to the County covered three overarching components:

Ohio State Reported Achieving Zero Waste Last Fall

On November 3, 2012, Ohio State University achieved zero waste at its Ohio Stadium – **diverting a record 98.2%** of its total generated waste. Total attendance was 105,311.

At its October 20th home game, **OSU diverted 94.4%.** That's everything from food scraps to compostable packaging to recyclables. Source: http://sustainability.osu.edu

Zero Waste Hierarchy

- Rethink / Redesign
- Reduce
- Reuse
- Source Separate:
  - Recycle
  - Compost
  - Waste
    - Research
    - Mechanically remove additional recyclables
    - Anaerobically digest residuals
- Stabilized (digested) residuals to landfill

www.energyjustice.net/zerowaste

Environmental Hierarchy of Waste Management & Energy Production Methods / Fuels / Technologies

Solid Waste Management

Cleanest ← → **Dirtiest**

Redesign
Manufacturing
- Make products durable, recycled and recyclable
- Use materials which are more environmentally sustainable

Reduce
Toxics Use Reduction
- Reduce amounts of toxic chemicals in production
- Replace toxic chemicals with less toxic or non-toxic alternatives

Consumption Reduction
- Use less
- Buy less
- Buy stuff with less packaging
- Avoid disposables & non-recyclables

Packaging Reduction
- Bring your own bag

Reuse
Reuse
- Thrift stores
- Charity collection
- Dumpster diving
- Freecycle

Recycle
Source Separate
- Avoid mixing different types of materials

Recycle

Downcycle
- Recycling things into other products that can't be recycled – like paper into tissue paper

Compost ← Solutions
- Anaerobic Digestion

Disposal / Dispersal
Problems →

Landfill
- Landfill
- Mine Fill
- Monofill

Deregulate
- Land Application
- Beneficial Use
- Recycling toxic or radioactive wastes into consumer products or building materials

Incinerate
- Mass Burn
- Co-firing
- Fluidized Bed
- Gasification
- Plasma Arc
- Pyrolysis

Electricity Production

Cleanest ← → **Dirtiest**

Conservation
- Lighting

Efficiency
- Lighting
- Motors
- Appliances

Clean Renewables
← Solutions

Solar | **Wind** | **Micro-hydro** | **Ocean** | **Geothermal**

The electric grid can be run 100% on intermittent technologies using storage strategies to balance the load. This can include flywheel energy storage, compressed air, molten salt, hydrogen, batteries or – until we're ready to remove them – hydroelectric dams.

Dirty Energy
Problems →

Hydroelectric

Natural Gas
- Simple Cycle
- Combined Cycle
- Fuel Cell

Oil

Coal
- Conventional
- Gasification ("Clean coal")

Incineration
- (see "biomass feedstocks" list below)

Nuclear
- Fission
- [Fusion]

Transportation & Heating Fuels

Cleanest ← Transportation & Heating Fuels → **Dirtiest**

Conservation
- Mass Transit
- Carpooling
- Telecommuting
- Reduce Sprawl
- Trails-to-Rails
- Bicycling
- Walking
- Buy/Work Local

Efficiency
- Fuel Efficiency Standards
- Hybrids
- Weatherization
- Ground- and air-source heat pumps

Clean Energy
← Solutions

Clean Electricity
- Plug-in Hybrids or Full Electric Vehicles; for heating, ground- and air-source heat pumps

Sustainable Biodiesel
- From used vegetable oils or non-biotech algae *[can meet a very small portion of fuel demand]*

Dirty Energy
Problems →

Biodiesel
- Soybeans
- Sugarcane
- Palm Oil

Ethanol
- Corn-based ethanol
- Cellulosic ethanol (from biofuel feedstocks – see below)

Natural Gas

Landfill Gas
- Boiler
- Piped into natural gas lines

Oil
- [and other petroleum products]

Waste-Based Fuels
- Trash / sludge-to-ethanol (cellulosic ethanol)
- Thermal de-polymerization

Coal
- Coal-based liquid fuels

Tires
- Cement Kilns
- Paper Mills

Hazardous Waste
- Cement Kilns
- Chemical Plants

Biomass / Biofuel Feedstocks

Least Dirty ← → **Most Dirty**

Digester Gas
- Sludge
- Animal waste
- Food waste

Landfill Gas

Gases / Solids

Trees
- Tree Trimmings ("Urban Wood Waste")
- Forest Cutting

Energy Crops
- Phytoremediation plants
- Biotech

Agricultural Crop Residue

Paper / Lumber Mill Wood Waste

Animal Factory Wastes
- Poultry litter

Construction / Demolition Wood Waste
- Painted/treated wood

Sewage Sludge

Tires

Municipal Solid Waste

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Zero Waste Hierarchy (1/6)

- Redesign
  - Make products durable, recycled and recyclable
  - Use materials which are more environmentally sustainable
- Reduce
  - Toxics Use Reduction
  - Reduce amounts of toxic chemicals in production
  - Replace toxic chemicals with less toxic or non-toxic alternatives
- Consumption Reduction
  - Use less
  - Buy less (reduce advertising)
  - Buy stuff with less packaging
  - Avoid disposables & non-recyclables
- Packaging Reduction
  - includes styrofoam bans and single-use paper/plastic bag bans and taxes

Zero Waste Hierarchy (2/6)

- Reuse/Repair
  - Thrift stores
  - Charity collections
  - Dumpster diving
  - Freecycle
  - Paint blending
  - Repair centers for bikes, computers/peripherals, furniture, appliances, etc.
- Recycle
  - source-separation, not single stream
  - seek the highest end-use and avoid "downcycling"; segregate office paper from lower paper grades and other recyclables, to keep quality high
  - buy recycled; create market for glass so that glass collected for recycling is actually recycled, not dumped in landfills
  - adopt a bottle bill / wastepicking

Zero Waste Hierarchy (3/6)

- Compost
  - Curbside collection of organics (weekly), which can be done while decreasing the collection of trash and recyclables to biweekly (the smelly stuff in trash is the compostable stuff, so this encourages people to compost if they don't want trash smelling).
  - Ban clean organics (not sewage sludge!) from landfills. Sewage sludge, even after being digested, does not belong on farm fields or in urban gardens.
  - Clean compost from food scraps and yard waste can be used in gardening or landscaping.
- Research
  - on a regular basis, do a waste sort and see what remains in the waste and feed that into Extended Producer Responsibility campaigns, product bans and other measures to eliminate these residual materials from the waste stream, ensuring that they're dealt with further up in this hierarchy

Zero Waste Hierarchy (4/6)

- “Dirty” Materials Recovery Facility (MRF) for the remainder
  - pull out additional recyclable and compostable material. It's important that this not be a replacement for source separation and upstream recycling, as it will get people out of their good recycling habits and will degrade the quality of recyclables, lowering their value and ensuring less will actually be recycled.
- Anaerobic digestion
  - The remainder, if there is enough organic material in it, should be digested in order to reduce the methane generating potential, stabilizing the waste
- Monofill (landfill in separate landfill cells at existing landfills)

Zero Waste Hierarchy (5/6)

- Ensure proper landfill management (don't mismanage the landfill by managing it for energy production)
  - Minimize gas production: Do not manage the waste facility as an energy facility by stimulating gas production.
    - Keep out liquids
      - Cover the active face of the landfill to keep out rainwater, using a temporary structure
      - Do not recirculate leachate
    - Cap landfills with permanent synthetic covers and install gas collection systems in months, not years.
  - Maximize gas collection:
    - Segregate organics in landfills for best gas collection
    - Maintain high suction on collection wells; do not damp down wells or rotate off the wells to stimulate methane production

Zero Waste Hierarchy (6/6)

- Clean the gas prior to use
  - Filter toxins in the gas into a solid medium like a carbon filter; containerized and store on-site.
    - Do not send to carbon "regeneration" or "recycling" facilities [they simply incinerate the captured chemicals, polluting the air]
- The purified gas can be used:
  - for heating purposes (burned in a high efficiency boiler),
  - piped into gas lines,
  - used to make alternative vehicle fuel,
  - used in fuel cells,
  - burned for electricity in a high efficiency turbine (less preferable to uses for heating), or
  - the CO2 and methane can be segregated and sold as industrial chemical feedstocks (but not for food industry use).

- Landfill gas-to-energy should not be considered renewable (That allows it to undercut clean sources like wind and solar and puts source reduction, reuse, recycling and composting at a competitive disadvantage.)

For more Info…

- Incineration:
  - www.EnergyJustice.net/incineration
  - www.EnergyJustice.net/biomass
  - www.EnergyJustice.net/tires
  - www.no-burn.org
  - www.GreenAction.org
- Landfills and Landfill Gas Burning:
  - www.EnergyJustice.net/lfg
  - www.ejnet.org/landfills
  - www.beyondlandfilling.org
- Zero Waste:
  - www.EnergyJustice.net/zerowaste
  - www.ilsr.org/initiatives/waste-to-wealth
  - www.grrn.org/zerowaste
  - www.zwia.org

Energy Justice Network

www.EnergyJustice.net

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