What is Clean Power ? What is Green Power ?

What is Waste-to-Energy's Role in Utility Restructuring ?

by Leo Pierre Roy, President & COO
Energy Answers Corporation, Albany, NY
April, 1997

Impending utility restructuring and the advent of retail wheeling have created both chaos and opportunity in the electric utility industry, and like earlier deregulation actions (airlines and telecommunications) it promises lower rates to customers. As a result of new competition, in an industry that has never really had any, utilities are being forced to market, for the first time, what has been a commodity product. Your local electric utility is now attempting to do what Frank Perdue did for the chicken: create brand awareness. Not surprisingly, and knowing of the American people's professed environmental sensibilities, a number of utilities have begun to position the electricity that they produce as "clean power," "green power," and "environmentally friendly power." What do these terms mean? How does one assess the relative merits of one source of electricity from another? And where does waste-to-energy, which recovers energy and other resources from waste materials, fit in? In short, what is the best way to produce electricity while treading lightly on the planet?

Before embarking on our journey to define cleaner, greener power, let's assess where we have been. (See Figure 1) In 1994, nearly three quarters of U.S. utility power generation came from fossil fuels. Coal power, at 44%, was the largest source, with natural gas at 20% and oil at 10%. Nuclear power produced 15% of our energy needs. Hydroelectric produced some 11%, and all other renewables were responsible for less than 1%. Worldwide, the production and use of fossil fuels contributed some 60% of all manmade greenhouse gas emissions.[1] By now everyone is aware of concern about air emissions and the debate over global warming, and has heard the notion that sustainability is a good thing-- that our use of natural resources should be sustainable into the future. Utilities are responding to this growing awareness by offering "Green Power" options, purporting to meet our energy needs in "environmentally friendly" ways. But just how eco-friendly are they?

[1] Statement of David I. Bransby, Auburn University, U.S. DOE - National Energy Policy Plan Roundtable, Athens, GA, October 11, 1994.

1994 U.S. Utility Power Generation By Energy Source

	Oil	Coal	Nuclear	Gas	Hydroelectric	WTE	Other Renewables
Megawatts	69,919	301,098	99,148	133,854	75,196	3,268	2,274
Percentage	10.2%	43.7%	14.8%	19.5%	11.0%	0.5%	0.3%

Source: Energy Information Administration, *Electric Power Annual 1994 Volume I.*

Figure 1

Last year Massachusetts Electric (A New England Electric System Company) introduced "Green Options" in a consumer choice pilot program to 10,000 of its residential and small business customers. (The so-called green choices appear in Figure 2.) The options relied heavily on fossil fuel sources, and one was over 50% nuclear. Only one option, Northfield Mountain Energy, was 100% renewable energy, from hydroelectric plants. Kermit the Frog, of Muppets fame, is not alone in observing that "It's not easy being green." Enova Energy has successfully marketed its green power portfolio in a Southern California pilot as well, even though its largest power source is nuclear.[2] Is this really green power? When one begins to do an analysis of the environmental impacts of electricity generation, one quickly realizes that nothing's perfect. How do we judge energy sources? On the basis of emissions? On the basis of sustainability?

Fossil fuel burning requires strip mining the landscape or otherwise sucking carbon out of the crust of the earth and throwing it into the atmosphere. Coal, gas and oil burners emit greenhouse gases and severely impact natural resources through their extraction and transportation. Dangers of oil spills such as the one from the Exxon Valdez are well known, but environmental damage is also caused by acidic mill tailings and pipelines which often run through sensitive wetlands. While natural gas and clean coal technologies produce cleaner air emissions than most fossil fuels, they're still not sustainable in the long run. It takes far longer to produce this fuel than it takes to burn it. We humans consume in just one year a quantity of fossil fuels that took nature roughly one million years to create.[3]

What are the environmental impacts of other energy sources? Nuclear power may not emit greenhouse gases, but it is not sustainable, either. There is a natural limit to the availability of radioactive ores, and nuclear wastes create management problems for millions of years. Hydroelectric dams impact fish habitat and can restrict recreation. Windmill farms are unsightly, solar is not yet efficient on a large scale, and geothermal can be exhausted. This leaves biomass waste-to-energy sources.

Biomass is defined by the U.S. Department of Energy as "wood, wood waste, peat, wood liquors, railroad ties, pitch, wood sludge, municipal solid waste, agricultural waste, straw, tires, landfill gases, fish oils, and/or other waste."[4] Biomass is essentially stored solar energy, captured in either raw or processed plant material. Examples of biomass include fast-growing trees and grasses, like hybrid poplars or switchgrass, agricultural residues like corn fiber or rice straw, wood waste such as sawdust, tree prunings, and yard clippings, or paper, natural rubber, cloth, food waste, and other municipal solid waste. Municipal solid waste is mostly biomass... over 70% is paper, wood, yard waste, cloth, and food waste. (See Figure 3)

---

[2] Renewables, *Power*, January/February 1997, p. 12.

[3] Rogene A. Buchholz, *Principles of Environmental Management*, p. 403.

[4] Energy Information Administration, *Electric Power Annual 1994*, Volume I, July 1995, p. 5.

"Green Options" in Massachusetts Electric's Choices: New England Pilot Program

	Oil	Coal	Nuclear	Gas	Hydro	Other Renewables
AllEnergy	10%	38%	14%	22%	10%	6%
Enova Energy	14%	21%	57%	< 1%	6%	2%
Northfield Mountain Energy					100%	
Working Assets Green Power, Inc.	0-5%			35-50%	30-45%	3-10%

Source: Massachusetts Electric (A NEES Company) brochure.

Figure 2

Municipal Solid Waste Composition

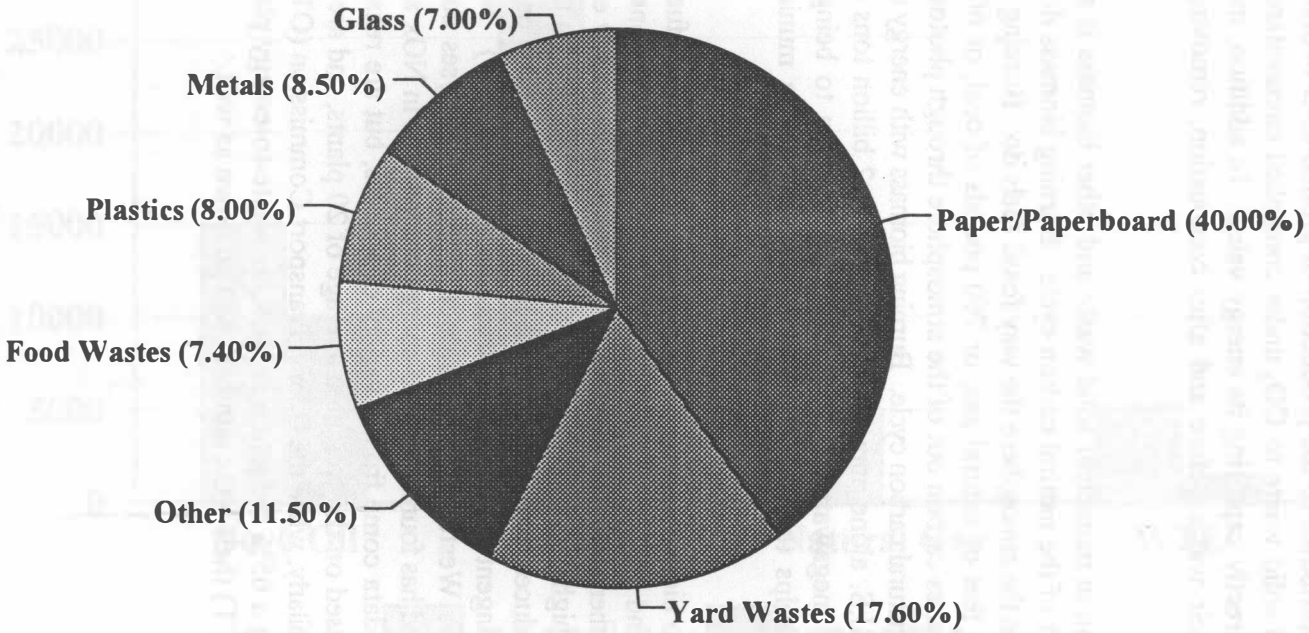


Figure 3

Source: 1990 EPA Report on Solid Waste

Municipal solid waste is destined to oxidize. Whether it is buried in a landfill or burned in a combustion facility with energy recovery, the organic fraction will eventually break down and produce carbon dioxide (CO_2). If the material is landfilled, however, over time it will also produce methane. Methane is a greenhouse gas of great concern, because it is twenty-five times more reactive than CO_2, and contributes to the production of ground level ozone and smog.[5] It is preferable to convert municipal solid waste to CO_2 under controlled circumstances, without the production of methane, while directly capturing its energy value. In addition, more advanced waste-to-energy plants process their waste before and after combustion, removing metals and other recyclable materials.

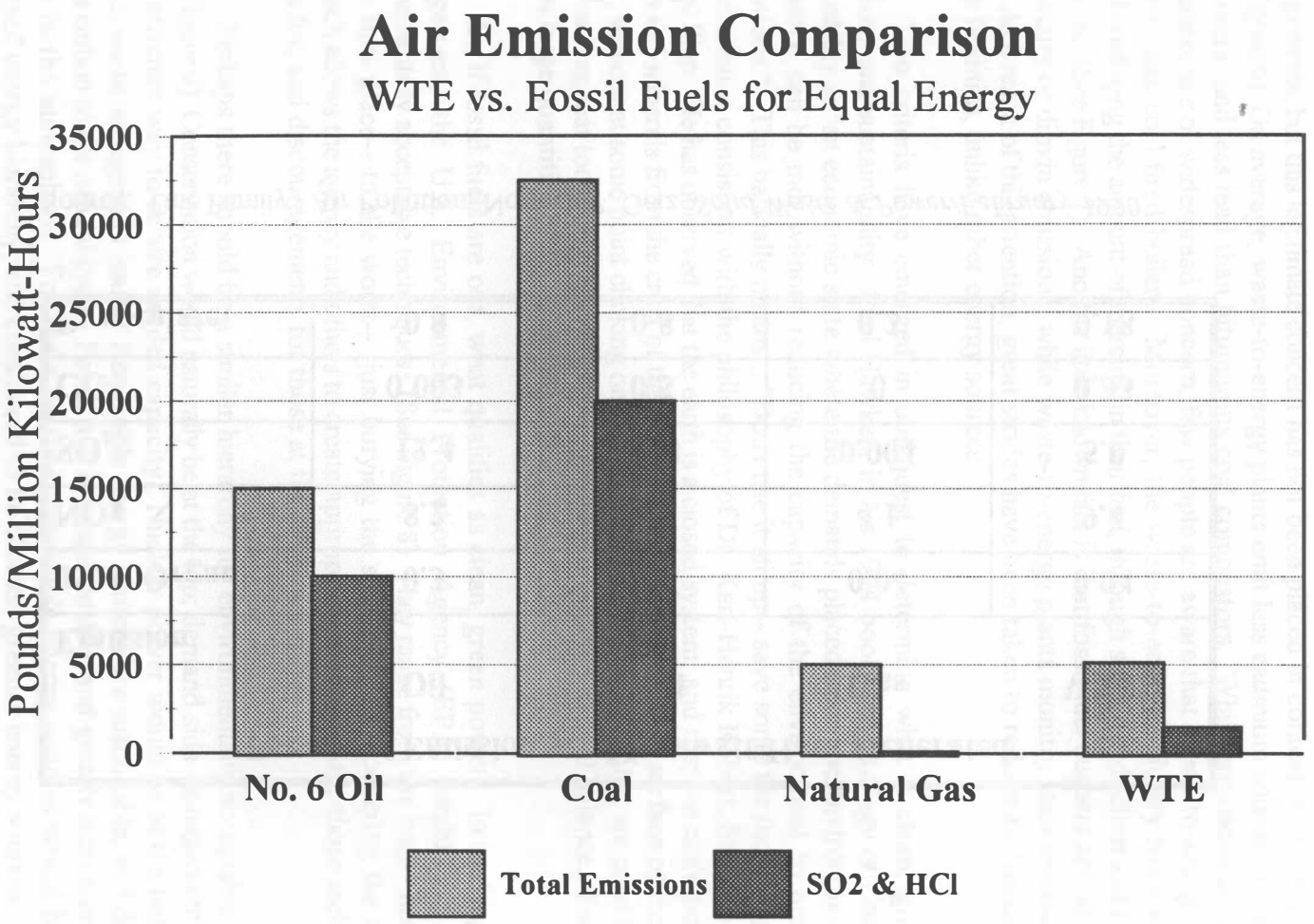
The carbon in municipal solid waste and other biomass is already "in play" on the earth's surface and is part of the natural carbon cycle. Burning biomass doesn't add to the net buildup of greenhouse gases in the atmosphere the way fossil fuels do. Burning one ton of trash biomass saves over 9,000 cubic feet of natural gas, or 760 pounds of coal, or 60 gallons of oil. Growing new biomass actually takes carbon out of the atmosphere through photosynthesis, and stores it for later use, as part of the natural carbon cycle. Burning biomass with energy recovery is both renewable and sustainable: the U.S. alone annually produces over 2 billion tons of biomass residue, enough to produce 200,000 megawatts of electricity.[6] In addition to being a sustainable energy source, waste-to-energy helps to solve the world's ever-increasing municipal solid waste management problem.

So how do biomass emissions compare to those of fossil fuels? Modern waste-to-energy is cleaner than coal and oil, and comparable with gas. While emissions data for fossil fuel burners are difficult to obtain, there is an abundance of data on waste-to-energy emissions, since these plants are the world's most highly regulated air emission sources. Based on pounds of emissions per million kilowatt hours produced, waste-to-energy is lower than coal and oil on total emissions and acid gases, in part due to stringent scrubbing requirements. (See Figure 4) Norman P. Getz (former Project Manager, Roy F. Weston, Inc.) has done extensive analyses comparing electricity generation emission factors and has found waste-to-energy comparable in NOx and lowest in particulates. (See Figure 5) These data come from a variety of sources, but are reasonably current. The waste-to-energy data are based on the weighted average of 20 plants, and are conservative; newer plants are much cleaner. Similarly, while the Ozone Transport Commission (OTC), consisting of the northeast states, is pursuing a 65% reduction in NOx, as waste-to-energy plants implement the new federal regulations (MACT) their NOx numbers will go down as well.

---

[5] Hunter R. Taylor, "Municipal Waste-to-Energy Facilities Reduce Greenhouse Gas Emissions", Institute of Gas Technology Fourth Annual National Symposium on Municipal Solid Waste Disposal and Energy Production, January 1990.

[6] Susan Williams and Kevin Porter, *Power Plays*, Investor Responsibility Research Center 1989, p. 31.



Source: America's Newest Energy Source, The AIMS Coalition, 1994

Figure 4

Electricity Generation Emission Factors

Emission	Pounds of Emission per Megawatt-Hour Generated			
	Oil	Coal	Gas	WTE
Total Organics	0.3	0.1	0.04	0.04
NOx	8.2	9.0	4.1	9.4
SO_2	12.4	16.4	0.004	5.0
CO	0.003	0.5	0	0.33
Particulates	0.8	0.8	0.2	0.18

Source: One Family's Air Pollution, Norman P. Getz, *Solid Waste & Power/February 1990.*

Figure 5

Trace metals emissions have been made into a big issue for waste-to-energy plants by activists and opponents, but this legitimate concern has not been placed in context with other energy sources. (See Figure 6) On average, waste-to-energy plants emit less cadmium and chromium than coal and oil burners, and less lead than bituminous coal combustors. While emissions of mercury into the atmosphere are of widespread concern, few people are aware that waste-to-energy plants emit less mercury than coal fired boilers. Moreover, the waste-to-energy industry has made great strides towards reducing the amount of mercury in their fuel, through source reduction and battery recycling programs. (See Figure 7). Another little known fact is that fossil fuel burners are not even regulated for mercury or dioxin emissions, while waste-to-energy plants monitor their emissions on a regular basis. As a result of this attention, great strides have been taken to reduce air toxics from waste-to-energy facilities, unlike other energy sources.

Two criteria have emerged in our quest to determine what is clean, green power: air emissions and sustainability. Paul Hawken, in his 1994 book *The Ecology of Commerce*, defines sustainability as "an economic state where the demands placed upon the environment by people and commerce can be met without reducing the capacity of the environment to provide for future generations."[7] This basically means... "Don't use it all up-- save some for the next guy." Resource conservation is consistent with the philosophy of Dr. Karl-Henrik Robèrt, Swedish founder of The Natural Step. He has observed that the earth is a closed system, and that we can't indefinitely extract carbon and minerals from the crust of the earth, spreading them on the surface of the planet and into the air, without at some point choking on our own waste. He believes that we need to be concerned about carbon; that too much carbon in the atmosphere upsets the natural balance. Fossil fuel burning creates large quantities of air emissions and is not sustainable.

So if fossil fuels are out, what qualifies as clean, green power? In looking at solid waste management, the U.S. Environmental Protection Agency (EPA) established a hierarchy of environmentally acceptable techniques. (See Figure 8) They range from the best-- not creating waste in the first place-- to the worst-- just burying the stuff without recovering the resources. This approach allows the agency and others to create appropriate incentives for those technologies higher on the list, and discouragements for those at the bottom.

Perhaps there should be a similar hierarchy for environmentally acceptable energy sources. (See Figure 9) Conservation would naturally be at the top; demand side management is the cheapest, most efficient way to secure needed capacity. Nuclear power would be at the bottom, due to the difficult waste management issues. Renewable energy sources are sustainable, and do not contribute excess carbon to the natural cycle. Fossil fuel is unsustainable, and greatly increases the greenhouse gases in the atmosphere. For these reasons, renewable energy sources would be higher on the proposed energy hierarchy, and considered to be cleaner, greener energy sources.

---

[7] Paul Hawken, *The Ecology of Commerce*, p.139

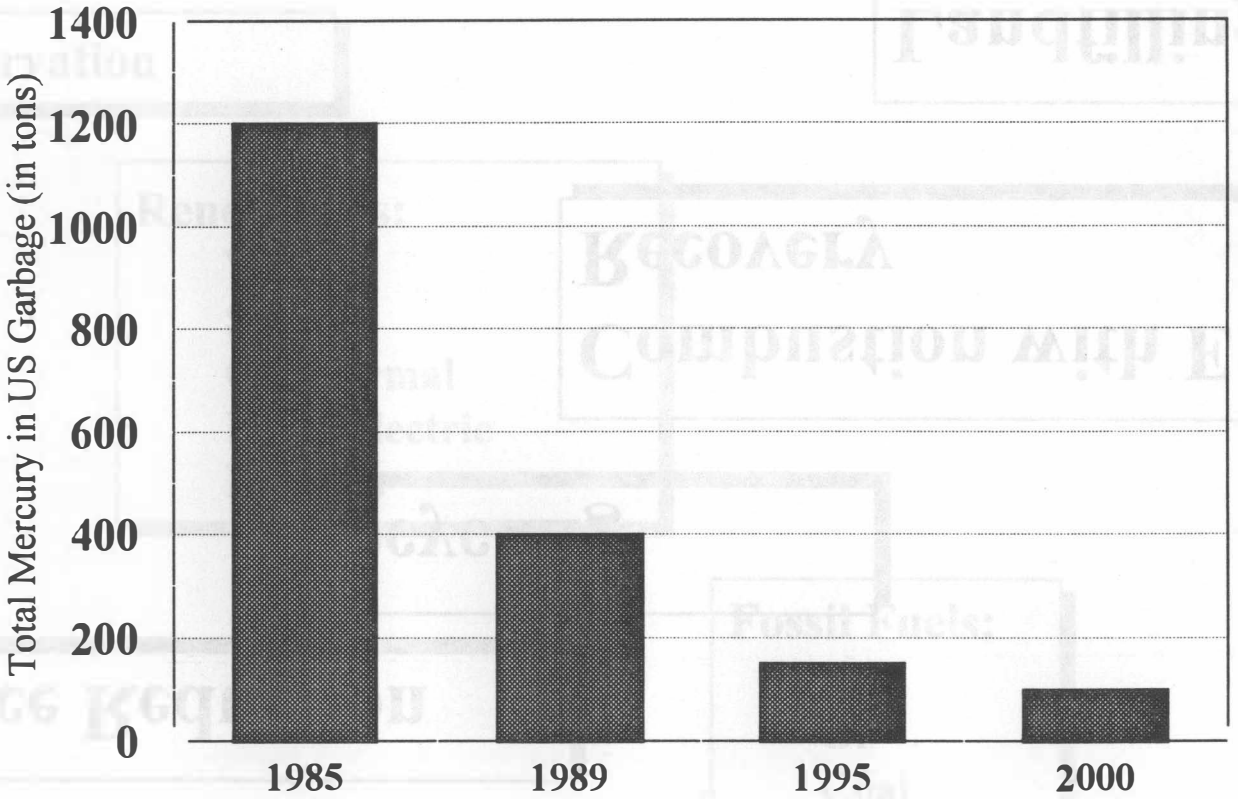
Comparison of Selected Trace Metal Emissions From Different Power Plant Sources On A Pounds of Trace Metal Emissions Per 1,000 Megawatt-hours of Electricity Production Basis

	Residual Oil (lb/1000 MWh)	Bituminous Coal (Pulverized) (lb/1000 MWh)	Lignite Coal (Pulverized) (lb/1000 MWh)	WTE (average of 20 plants) (lb/1000 MWh)
Arsenic (As)	0.22	0.46	0.91	< 0.033
Beryllium (Be)	0.05	0.03	0.06	< 0.017
Cadmium (Cd)	0.18	0.10	0.11	0.063
Chromium (Cr)	0.24	4.56	5.70	< 0.19
Copper (Cu)	3.19	2.28	3.42	0.43
Mercury (Hg)	0.04	0.23	0.23	0.17
Nickel (Ni)	14.36	3.42	3.42	0.84
Lead (Pb)	0.34	0.57	0.11	0.44
Selenium (Se)	NR	0.29	0.29	< 0.022
Vanadium (V)	3.4	4.0	4.0	0.025
Zinc (Zn)	0.47	5.0	5.0	1.23

Source: How Does Waste-to-Energy "Stack" Up, Norman P. Getz, 1993 International Municipal Waste Combustion Conference, Williamsburg, VA, March 30- April 2, 1993.

Figure 6

Success of Removing Mercury from Consumer Products



Source: U.S. EPA (1992) and Malcolm Pirnie (1992)

Figure 7

EPA's Solid Waste Hierarchy:

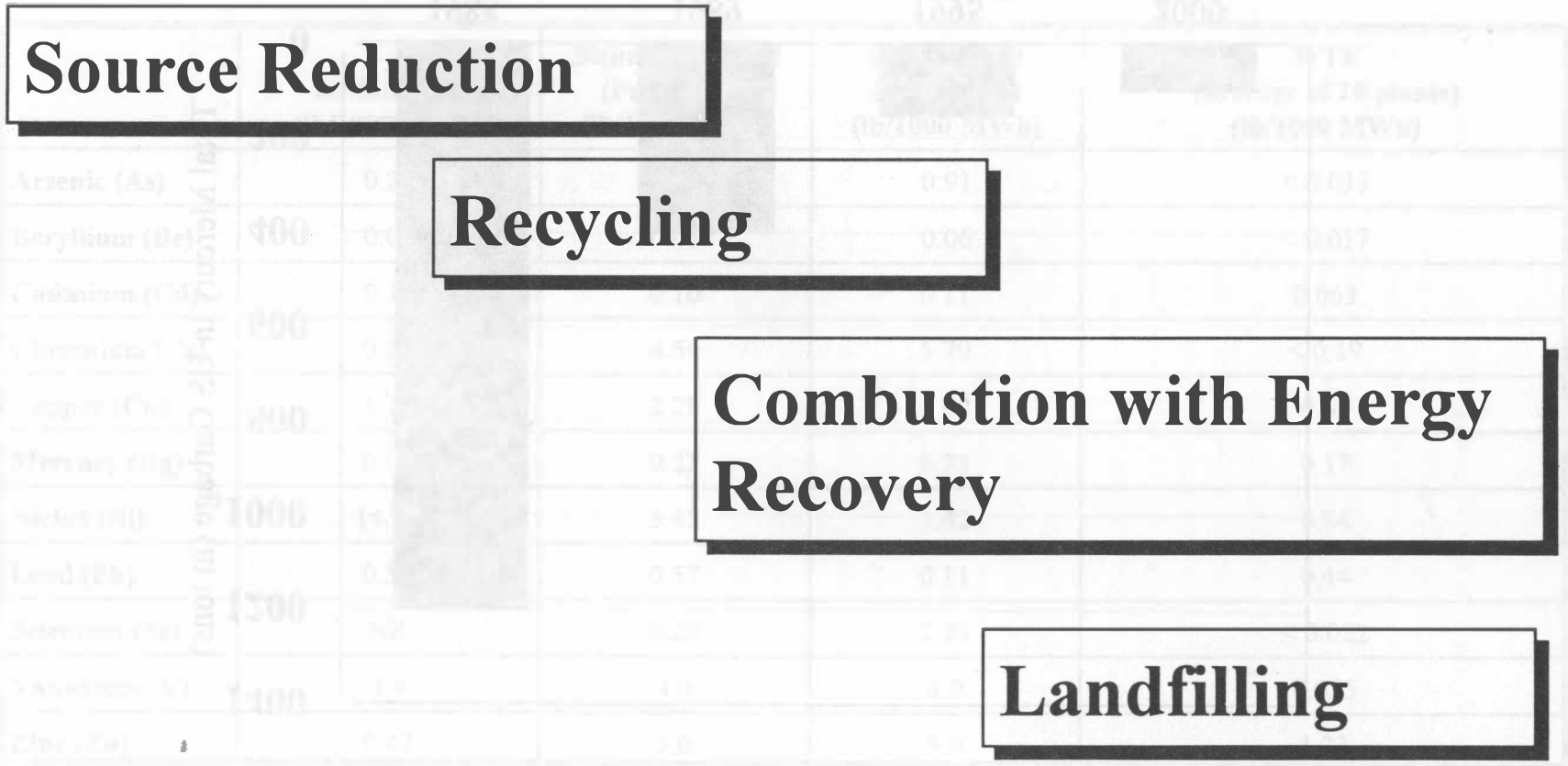


Figure 8

Suggested Energy Hierarchy:

Conservation

Renewables:
- **Wind**
- **Solar**
- **Geothermal**
- **Hydroelectric**
- **Biomass**

Fossil Fuels:
- **Gas**
- **Oil**
- **Coal**

Nuclear

Figure 9

Renewable energy, including wind, solar, geothermal, hydroelectric and biomass waste-to-energy sources, should be the majority of any "clean" or "green" power portfolio. These renewables should be given whatever price supports and tax incentives result from utility restructuring. The economic incentives will help "level the playing field" and enable renewable technologies to compete with the extractive industries such as oil and gas exploration, which have long enjoyed favorable tax positions and other incentives. Today we realize that our future depends not only on cheap energy, but also on clean and sustainable energy. Waste-to-energy industry leaders need to speak out for inclusion of biomass and other renewables in clean or green portfolio standards, in pending state and federal legislation. The chaos and opportunity created by utility restructuring enables us to make truly green choices that will affect not only the lives of the present generation, but those of generations to come.

F:\ADMIN\LPR\GREENPOW.WPD