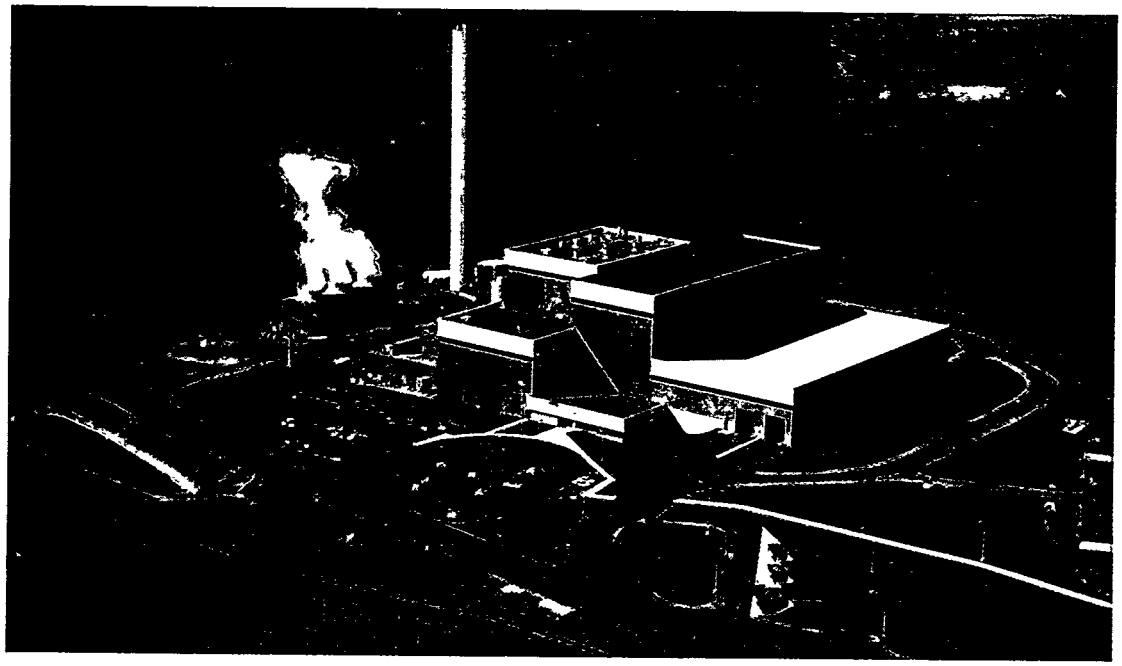
CONF-970440--

PROCEEDINGS OF

Fifth Annual North American Waste-to-Energy Conference

Research Triangle Park, North Carolina
April 22-25, 1997



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Publication #GR-WTE 0105

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FOREWORD

The NAWTEC Program Committee is pleased to present the Proceedings from its Fifth Annual North American Waste-to-Energy Conference (NAWTEC V). The Proceedings consist of manuscripts as prepared by the Conference Technical Session presenters. They represent a broad range of topics of interest to professionals in the waste-to-energy sector of the municipal solid waste management field.

We would like to acknowledge and thank the presenters who prepared manuscripts for this year's Proceedings. These individuals spend a significant amount of time preparing both their presentations and papers. We would also like to thank and acknowledge the following individuals and groups for contributing to this year's technical program:

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The NAWTEC Program Committee prides itself on offering timely and pertinent information in its technical programs and proceedings. We trust that these Proceedings will serve as a valuable resource to the reader.

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OPENING PLENARY SESSION

THE EVOLUTION OF WTE UTILIZATION A GLOBAL LOOK

The Evolution of WTE Utilization - The European Perspective

Håkan Rylander
President, International Solid Waste Association/ISWA
Managing Director, The Southwest Scania Solid Waste Company/SYSAV, Sweden

The ECO-Society

Everyone involved in the protection and proper use of raw materials, natural resources and the environment and in the daily operation of solid waste management aims to reach the "Eco Cycle Society". That means that each of us, in our present and future handling of raw materials, products, residues and waste will minimize the use of terminable resources and bring back as much as possible of them in the closed cycle after being used. The idea of the "Eco Cycle Society" is showed in **graph nr l.**

The Producer´s Responsibility

To reach the "Eco Cycle Society" it is necessary to reduce the amount of waste and to significantly increase the reuse and recycling of different materials and products. It is important to understand that wastes are simply discarded products and the design of a product can have a very significant impact on the nature of the waste that is produced. Recycling and reuse can be enhanced by designing products so that components and materials can be easily separated, by eliminating contaminating materials that inhibit recycling, and by using more recycled materials in the original products. Eliminating certain materials from products can also reduce the release of toxic materials to the environment during waste treatment.

We are beginning to see the implementation of the concept of the "Producer´s Responsibility" in laws that are being passed in various European countries requiring manufacturers to take back discarded products and packagings for reuse or recycling. In Sweden the Swedish Government in 1993 decided about guiding principles for packagings and some other products in order to reach the "Eco Cycle Society". The "Producer´s Responsibility" means both physical and economical responsibilities. The same principle will step by step be introduced for more products. The "Producers" have been given the economical and physical responsibility for the collection, recovery and recycling of used packagings. Requirements and goals have been settled for the recovery and recycling of these packagings. For news-papers, journals and old tyres there is also a "Producer´s Responsibility" from the 1st of July 1994 in Sweden.

The consequences of the "Producer´s Responsibility" for the future handling of waste will most probably be decreased amounts of Municipal Solid Waste/MSW to be treated as compared with today. For example the amounts of MSW being incinerated in Waste-to-Energy plants will decrease but it opens at the same time up the possibilities for an increased amount of burnable industrial waste being incinerated with energy recovery instead. Besides, there is or being planned a ban or very strong restrictions of landfilling organic and burnable MSW in many European countries, which will increase the need for incineration.

Establishment of Environmentally Sound Treatment and Disposal Facilities - A Combination of Methods.

Even with maximum feasible rates of waste reduction and recycling, there will still be a need for waste treatment. The state of the art of waste treatment has advanced rapidly in recent years. Today, technologies are available to effectively treat wastes in an environmentally sound manner. For example, standards for solid waste incineration units incorporate emissions monitoring and highly efficient air pollution control systems to control organic emissions, metals, acid gases and other pollutants. Today´s state-of-the-art landfills meet with similar tough stan-

dards, most of them are equipped with leachate collection systems, groundwater monitoring, systems for control of landfill gas and recovery of its energy content, and closure and post-closure care. The objective is to ensure that landfilling, when used, is performed in a manner that greatly reduces the chance of environmental degradation and also ensure that any release that does occur is quickly detected and remedied.

Solid waste management in practice must be based on **integrated systems** with **a combination of many different methods.** There should not be any contradiction between the different methods, on the contrary they should be regarded as complement to each other:

- Recovery of materials in households and industries, involving direct action by residents and industries in cooperation with those given the resonsibility for the collection, recovery and recycling of different materials and products.

- Increased utilization of the material and energy resources in industrial waste. The conservation of resources should mainly take place within the industry, by the use of low-waste technology, and by internal recovery of the residues and the waste.

- Thermal treatment of waste, with energy recovery.

- Utilization of the easy biodegradable part of the organic waste for the production of biogas and compost

- Landfilling, which always will be needed regardless of other methods utilized, for non-recyclable materials, and for residues from other waste treatment.

Results and experiences today from different countries and different used systems for solid waste management clearly shows the need of attacking the waste problem with an intergrated waste system. In order to fullfill this concept the scheme as shown in **graph nr 2** is already used or will soon be used in most municipalities in Sweden, in order to recover material- and energy resources and to get cleaner products for recycling, cleaner compost and less emissions from different treatment plants as a result of a cleaner input.

In most European countries the following list of Priority is recommended in order to solve the waste problem:

1 Waste Reduction and Minimization
2 Reuse
Recycling
3 Energy Recovery
4 Landfilling

Municipal Solid Waste Treatment in Europe

In Europe there is a total population of approximately 360 millon people, producing a total amount of Municipal Solid Waste/MSW of about 140 million tons per year (1991). Per capita this is an amount of about 400 kg per year. The total amount of MSW produced in each country is presented in **graph nr 3** as well as the production per capita. Also the composition of the MSW per country is listed. An average composition for the whole of Europe is given as a reference.

In Europe Municipal Solid Waste/MSW is disposed of in mainly four different ways: Recycling, Composting, Incineration and Landfilling. In **graph nr 4** is shown the treatment of MSW per country in Europe. All figures in the graph are in % of the total MSW per country. The figures are from 1991 and some changes have taken place since then, the recycled amount has increased and the landfilled amount has decreased in many countries. However, it is very difficult to find up-to-date figures covering all the changes that are taking place for the moment.

The effects of the introduction of the Producer´s Responsibility, the increased source recovery in households and industries and the very heavy restrictions on landfilling in many countries will most certainly dramatically change the use of different methods for treating MSW in a few years. For example, in France it will be prohibited after the year 2002 to landfill other waste than residues from other treatment, in Germany it will only be allowed after 2005 to landfill waste with a very low content of organic materials, in Sweden there is currently a proposal to prohibit landfilling of burnable waste from the year 2000 and waste with an organic content from the year 2005, in Switzerland and The Netherlands there are very heavy restrictions on landfilling, similar to those restrictions mentioned above. This means that there will be an increase in recycling, biological treatment and incineration of waste just within a few years in Europe. In many countries there are plans and measures taken to meet with this new situation.

Energy from Waste

Waste incineration is an old and established method for treating MSW in Europe. The first plant was built already during the 1890´ies. By that time waste incineration was used for hygienic aspects, not least to solve the enormous problems with cholera in the densely populated cities of Europe. Still being a method to tackle the hygienic problems it also during the 1900´ies became a method for reducing the increasing volumes of waste being generated. Incineration was not associated with any form of recovery. An objective like that is relevant for a society with linear material flows where raw materials are provided from virgin materials and the waste dumped without any recycling. This is not in accordance with a society of sustainable development. Today we are aiming at a cyclic flow. There is only one objective for waste incineration that is relevant in the eco cyclic society and that is energy recovery. Volume reduction is no more an objective but still an important parameter when comparing environmental impact. Furthermore incineration is only justified when the method is at least as favourable as other recycling or recovery alternatives. In many European countries you will not even get a permission today to build a new waste incineration plant without recovering the produced energy. Besides, the operation costs in a modern plant with advanced flue gas cleaning and a strict handling of the residues will be too high without any incomes from energy recovery.

The situation in Europe when coming to waste incineration is today actually a little bit difficult to overlook. In some countries there are a number of old, small incineration plants not meeting the EU-directives on waste incineration. Of course they have to be closed down, probably replaced with new, larger plants, but there is an uncertainty about the future amounts of waste to be incinerated due the effects of the increased recycling activities, the effects of the producer´s responsibility and of the ban or restrictions on landfilling of organic and burnable waste. Will the amounts for incineration increase, decrease or remain at today´s level? At some larger plants in Europe there is to-day an overcapacity, due the increased amounts of waste being recycled or composted. The restrictions on landfilling will probably change this situation into the opposite and there will probably soon be a demand for increased incineration capacity in many European countries.

Number of plants and capacity

In Europe there are between 450-500 MSW incineration plants with a total nominal capacity of more than 6000 tons per hour. All together there is an annual capacity of about 45 million tons, based upon 7000 hours of operation. **Graph nr 5** shows in which countries the incineration plants are located and how much of the total amount of MSW is incinerated in these plants. As already mentioned there have probably already been some changes in the figures presented in the graph and there will be even more changes in the future - less small plants, more larger plants with an increased incineration capacity and equipped with advanced flue gas cleaning systems.

In graph 5 it can be seen that France has the most incineration plants by far. However, these 225 incineration plants are relatively small as they represent 46,4% of the number of incineration plants in Europe but only incinerate 26,1% of the total amount of MSW in Europe. On the contrary the installations in Germany and in The Netherlands are relatively large: 10,1% (Ger-

many) and 2,1% (The Netherlands) of the incineration plants incinerate respectively 27, 9% and 7,3% of the European MSW.

Energy Recovery

In Europe there is some kind of energy recovery from most of the incineration plants (56% by number representing 82% of the MSW incineration capacity in 1993, probably even more today). **Graph 6** gives an overview of the energy recovery per country. In general the Scandinavian countries use a high percentage of the recovered energy to produce hot water for district heating whereas the other countries mainly produce steam for electricity production, mostly without usage of the remaining energy which has to be cooled off. However, there is a change towards better use of the produced heat outside the Scandinavian countries as well as there is a very significant tendency in the Scandinavian countries of more and more combined production and use of as well heat as electricity.

Emission Guidelines and Flue Gas Cleaning Systems

Almost every country in Europe has its own legislation concerning emissions from MSW incineration. These regulations, however, differ a lot from country to country, not only in emission limits, but also in the number of pollutants for which there are limits. Some regulations only set limits to the emission of dust, HCl, HF and CO, whereas others also include SO_2, No_x, total organic carbon (TOC), heavy metals, PCDD/F as well as certain performance demands, other than emissions.

Graph 7 gives an overview of the emission limits according to the different regulations existing in Europe. For comparison the latest EU directives on Hazardous Waste Incineration (HWC) have been included. The values in the table are related to an oxygen concentration in the flue gases of 11vol%(dry, at standard temperature and pressure: 273 K, 101,3 kPa), except for Norway (10vol% O_2) and Sweden (10vol% CO_2). An oxygen concentration of 11vol% is corresponding with a CO_2 concentration of 9 vol%.

Most of the regulations also require certain conditions to be met for the flue gases after the last air injection. For example the German regulation requires that the flue gases, after the last injection of air remain at a temperature of at least 850 degrees centigrade and a concentration of 6 vol% O_2 for at least 2 seconds. This is done to guarantee the destruction of combustible matters in the flue gases. Besides the limit values it is very important to specify the time period during which the measurements have to be averaged to meet the limit values. For example a limit value as a half hour average is more difficult to meet with as the same value over a longer period of time (time to even out peaks).

Member countries of the European Union have to comply with the EU-directives at minimum, but can have stricter limits. This is the case for example for Germany and The Netherlands, see **graph 8**. In this graph the EU Draft Directives for incineration of waste are also shown. However, it is still a draft. In **graph 9** the needed removal efficiency to reach the Dutch guidelines is shown, in relation to the raw flue gas concentration.

To reach the EU guidelines and most national guidelines advanced fluegas cleaning systems have to be installed. In **graph 10** all the different steps that could be included in such a system is shown. Of course all the steps in the graph can be used, or combinations of the different steps, to reach the different guidelines. The strictest emission guidelines (Germany, Austria, Netherlands) can be reached by using state-of-the-art cleaning techniques, but not without considerable effort. In newly designed flue gas cleaning systems the following sequence of equipment is in principle often used:

- Electrostatic Precipitators
- Multi-staged wet scrubber with waste water evaporation
- Active cokes/lime injection with fabric filter
- SCR-DeNO_x.

Residue treatment

Of the residues in general only the bottom-ash (slag) can be reused for the moment. Before reuse the bottom-ash can be crushed and/or sieved and iron scrap is removed and in many cases recycled. Several processes are under development to improve the bottom -ash quality to ensure disposal of the bottom-ash when the regulations are toughened. The bottom-ash which is not reused is landfilled, but because of the large amounts of bottom-ash which are produced from waste incineration there is a pressure to reuse as much of the bottom-ash as possible. In some countries the "gravel" fraction of the bottom-ash is used in road constructions.

Fly-ash reuse is in fact not possible for the time being: it is landfilled in a secure way - stacked in big bags, stabilized with cement or binders or in some other way safely land-filled.

As the emissions to the air to a large extent are controlled, the research is more and more focusing on the safe handling and better use of the residues.

Costs of MSW Incineration

In a TNO Environmental and Energy Research Report from 1993 the costs (the investment cost and the cost per ton) are calculated for an incineration plant which basically has the follwing equipment:

- moving grates
- boilers in which steam is produced
- a turbine and electricity generator
- a flue gas cleaning system which consists of: an ESP, a 2-staged wet scrubber and an entrained flow adsorber (reactor with subsequent fabric filter) with active cokes addition.
- a waste water treatment system which neutralizes the waste water and precipitates a gypsum sludge and heavy metals.

The costs are given with and without evaporation of the waste water. The latter is done because it is not certain whether discharge of waste water will be allowed. For the moment at most locations which are close to the sea or to a river, discharge of waste water is allowed. Both options are considered. Waste water evaporation results in a solid salts residue which has to be landfilled. The evaporated waste water is condensed and used again in the first step of the wet scrubber.

The investment and operating costs were determined for different capacities in a range from 9 tons per hour to 115 tons per hour. With an availability of the facility of 80% this is equal to an annual capacity from 63 000 tons to 806 000 tons. Each plants is calculated for a minimum of 2 separate units. The investment costs are shown in **graph 11.**

Besides investments costs also the costs per ton of MSW processed are important. These are calculated with the following assumptions:

- the availibility of the plant is 80%
- the depreciation period for a new MSW incineration plant is 25 years and the interest is 10%
- maintenance of the building/construction part is 1% of the investment for this part, maintenance for the electro/mechanical part is 5% of the investment for this part.
- personel costs 40 000 ECU per year per person.
- insurance 1% of the total investment

Besides there are of course costs for chemicals and utilities. It is assumed that the bottom-ash can be reused and that the cost for disposal of the bottom-ash equals zero. Disposal of the other residues (fly-ash, sludge, salts, used active coal mixture) is assumed to cost 182 ECU/ton. The costs per ton are shown in **graph 12.**

The net cost will of course vary very much due to the price for the produced electricity and, as in the Scandinavian countries, if the produced heat can be sold and not cooled off.

The Swedish Example

Modern waste incineration with energy recovery got its break through in Sweden during the sixties and seventies, not only because of hygienic aspects and volume reduction, but also because the energy content could be utilized for district heating purposes. Waste incineration is still a very important method for handling the waste problem and for energy recovery and will remain so in the future handling of waste in Sweden. Today about 1,8 million tons of waste are being incinerated in 21 Waste-to-Energy plants, with in all 38 furnaces - including about 1,4 million tons of MSW (of a total amount of about 3,3 million tons before a material recovery of about 0,7 million tons) and about 0,4 million tons of industrial waste. 18 of the plants produce heat and 3 of the plants are combined heat and power facilities. There will most probably be an increased production of power in the future.

Waste contains mostly materials of biological origin, only 10% have fossile origin. The waste do contain materials which should be separated from the waste before incineration. By efforts to eliminate hazardous waste from the market (for example Mercury-batteries) and by separation at the source in accordance with the scheme in graph nr 2, the remaining waste becomes cleaner and also the emissions.

During the last ten years the waste incineration system has gone through a considerable technical development. Originally the Swedish waste incineration plants were only equipped with cyclones or electrostatic precipitators for the reduction of emissions, especially dust. Nowadays all Waste-to-Energy plants in Sweden have installed advanced flue gas cleaning systems to meet with the more stringent emission standards set up by EU and the Swedish Environmental Protection Agency. From an environmental point of view, waste incineration in Sweden with advanced flue gas cleaning is a very clean way to produce energy.

Swedish Plants - capacities, type of furnaces, flue gas cleaning equipment

Plant	Capacity (tons /year)	Grate/FB	Flue gas cleaning
Avesta	45 000	Grate	ESP, Dry+Wet,FF
Bollmora	13 000	Grate	FF
Bollnäs	20 000	FB	FF
Borlänge	26 000	Grate	ESP, Wet
Eksjö	8 000	FB	FF
Göteborg	400 000	Grate	ESP, Wet
Halmstad	90 000	Grate	ESP, Wet
Karlskoga	35 000	Grate	ESP, Dry, FF
Karlstad	50 000	Grate	ESP, Dry, FF
Kiruna	18 000	Grate	FF
Köping	33 000	Grate	ESP, Dry, FF
Lands-krona	5 000	FB	Dry, FF
Lidköping	65 000	FB	Dry, FF
Linköping	230 000	Grate	ESP, Dry, FF
Malmö	220 000	Grate	Dry, FF
Mora	20 000	Grate	Dry, FF
Stock-holm	300 000	Grate	Dry, FF
Sundsvall	17 000	FB	ESP, Dry, FF
Umeå	120 000	Grate	Dry, FF
Uppsala	250 000	Grate	ESP, Wet+Dry, FF
Västervik	30 000	FB	Dry, FF

FB=Fluidized Bed ESP=Electrostatic Precipitator FF=Fabric Filter
Wet=Wet cleaning Dry=Dry cleaning.

At twelve of the twentyone plants steps have been taken to reduce the emissions of No_x.

The annual emissions from the the Swedish Waste-to-Energy plants have been reduced as follows from 1985:

Substances	Unit	1985	Today	Reduction
Dust	tons/year	420	40	90%
HCl	tons/year	8400	290	96%
SO_x	tons/year	3400	820	76%
NO_x	tons/year	3400	1600	53%
Hg	kg/year	3300	100	97%
Cd	kg/year	400	15	96%
Pb	kg/year	25000	300	99%
Dioxins	g/year	90	1,7	98%

In all 5 TWh of energy are produced from waste incineration in Sweden. All energy is used and delivered to the district heating systems and the power systems in the cities concerned. The produced energy covers almost the heating of 250 000 apartments or 15% of the district heating in Sweden every year, corresponding to the saving of 500 000 tons of oil annualy. In some cities the waste incineration stands for 30-40% of the district heating. Due to the development of the incineration technology, the high energy value of the waste and due to a very professional staff at the incineration plants, the energy efficiency in average is as high as 85%.

The incinerated amount of waste has been more than doubled since 1980. During the same period the production of energy from the Swedish Waste-to-Energy plants have been almost quadrupled. This is due to the fact that the energy content of the waste has increased but most of all because the introduction and use of a more efficient technique for energy recovery. Less energy has been cooled off since 1980. In 1986 about 1,5 million tons of waste were incinerated with an energy production of 3, 4 TWh. Today about 1,8 million tons are incinerated with an energy production of 5 TWh.

While the incinerated amount has increased with 20% since 1986, the energy production has increased with 47%, and different emissions have decreased between 54% to 99%.

After energy recovery the waste incineration treatment costs in the Swedish Waste-to-Energy plants vary somewhere between 200-400 Swedish Crowns/ton, depending upon age, size and equipment of each plant. Without energy recovery the cost would have been doubled.

Waste incineration with energy recovery will even in the future be one of the more important methods in Sweden to reduce the waste amount, to protect the environment and to take care of energy resources.

Conclusion

Waste-to-Energy is an established and well functioning method for waste treatment and energy recovery and the most effective way of taking care of the energy content of waste. Waste is to a very large extent to be considered as a bio-fuel and the incineration of waste decreases the need of fossil fuels to be burned, resulting in a decrease of the emissions of green-house gases.Due to far-reaching restrictions on landfilling of MSW in Europe there will most probably be an increased need for waste incineration with energy recovery, as a complement to recycling and biological treatment of waste. New plants will be equipped for using the produced energy for heating purposes as well as for electricity production. The strict emission guidelines already implemented in for example Germany and The Netherlands will most probably, at least to some extent, be introduced in the other EU-countries, resulting in the installation of very advanced flue gas cleaning systems.

There is only one objective for waste incineration that is relevant in the eco cyclic society and that is energy recovery. Volume reduction is no more an objective but still an important parameter when comparing environmental impact. Furthermore incineration is only justified when the method is at least as favourable as other recycling or recovery alternatives. □

References:

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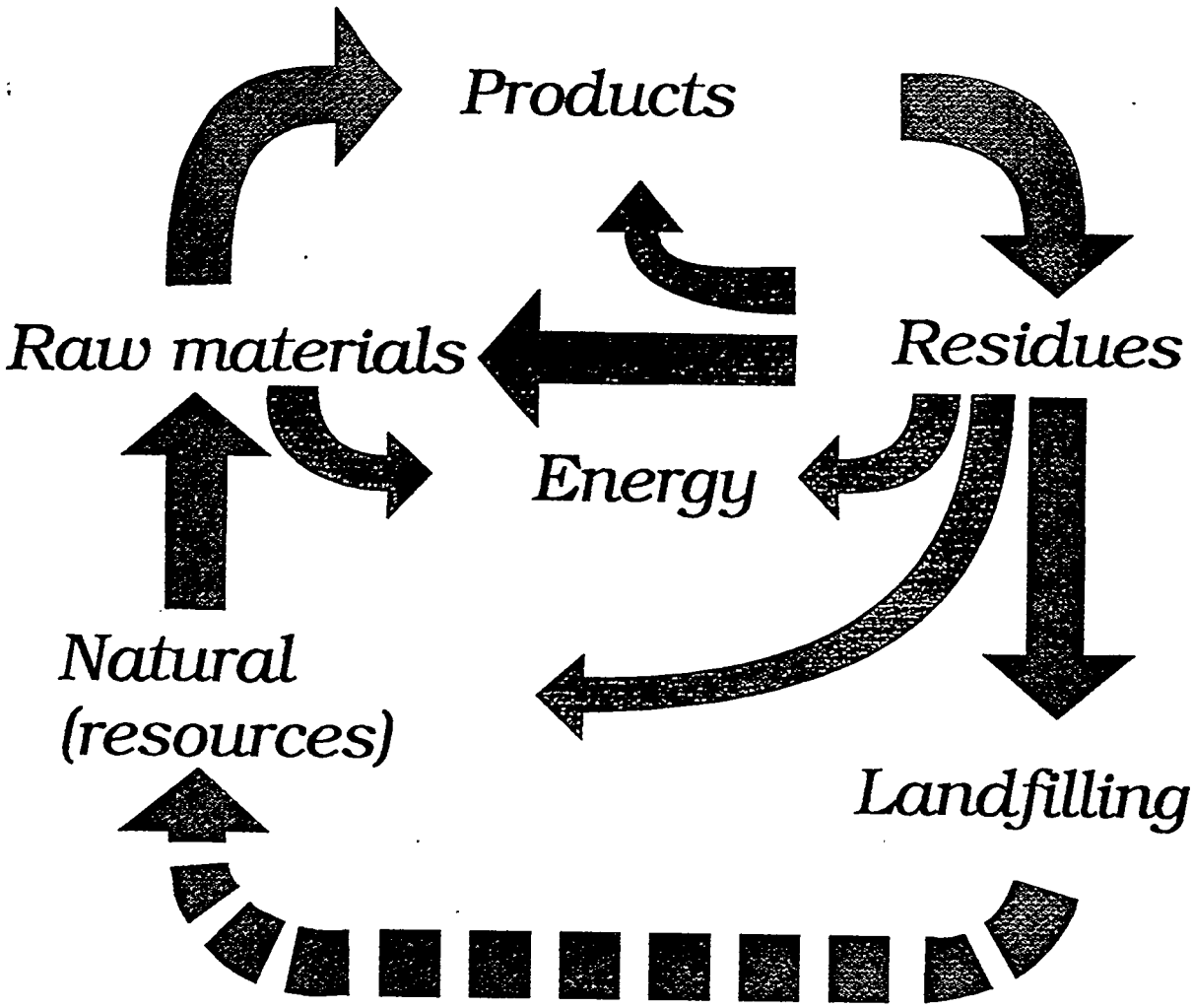
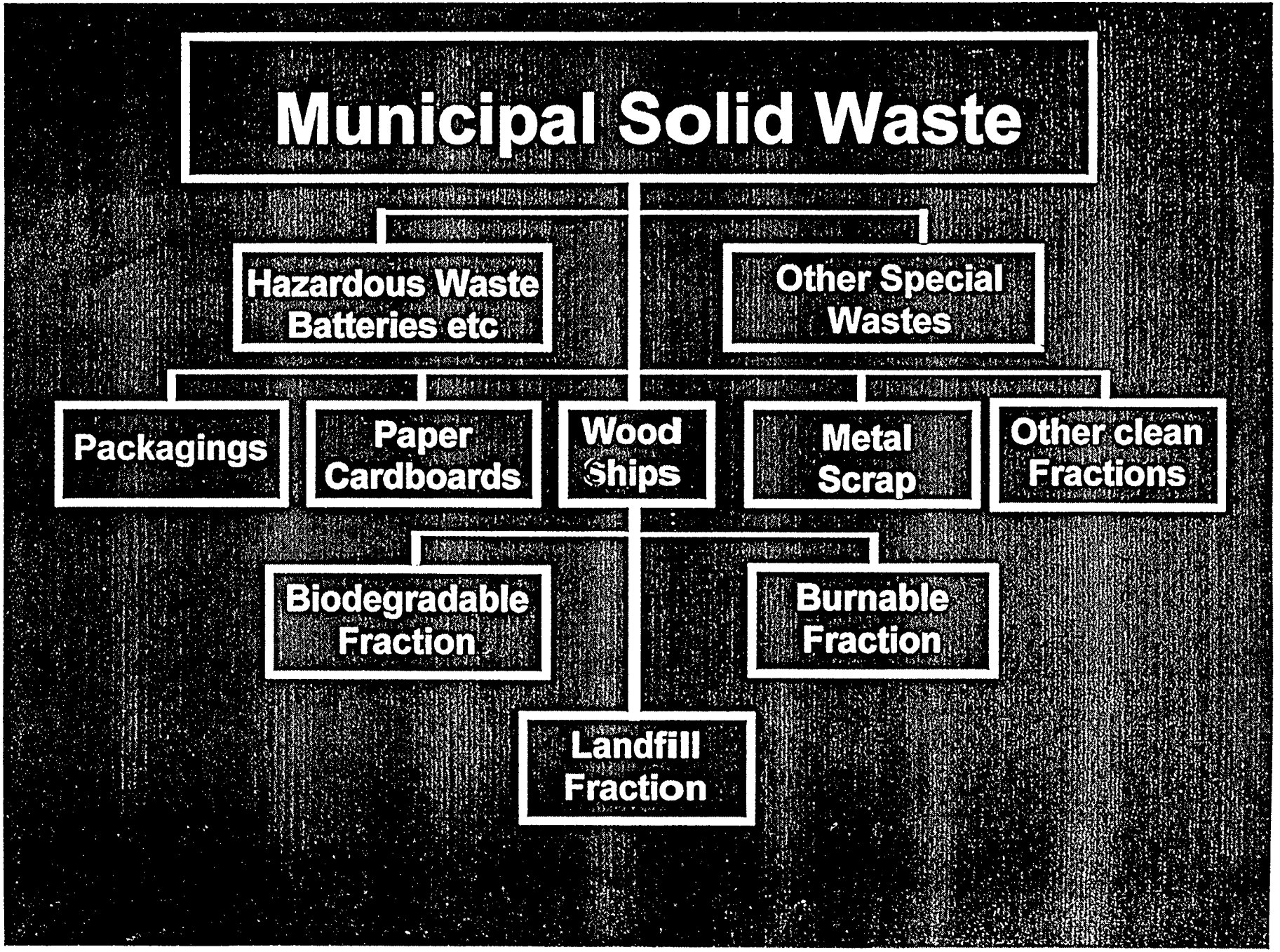
" Closed Cycle Society"




Municipal Solid Waste
Hazardous Waste Batteries etc
Other Special Wastes
Packagings
Paper Cardboards
Wood Ships
Metal Scrap
Other clean Fractions
Biodegradable Fraction
Burnable Fraction
Landfill Fraction

Graph 3

Composition of Municipal Solid Waste per country in Europe
All figures consider total MSW per country

Country	Amount of MSW		Putrescibles/ fines Wt%	Paper Wt%	Plastic Wt%	Glass Wt%	Metals Wt%	Miscell (textiles incl.) Wt%
	k tonnes /yr	kg/capita						
A	2,800	370	30	30	9	10	4	17
B	3,500	350	47	28	7	7	4	7
CH	3,700	550	30	31	13	7	6	13
D	25,000	410	44	24	7	9	6	10
DK	2,600	510	40	35	5	4	5	11
E	13,300	340	49	20	7	8	4	12
F	20,000	360	25	30	6	12	5	22
GR	3,150	310	53	18	7	3	4	15
I	17,500	300	40	22	7	8	3	20
IRL	1,100	310	55	20	10	3	3	9
L	180	480	47	28	7	7	4	7
N	2,000	470	25	32	7	4	4	28
NL	7,700	520	38	35	7	7	5	8
P	2,650	260	60	22	4	3	4	7
S	3,200	380	30	40	9	7	3	11
SF	2,500	500	30	40	6	4	3	17
UK	30,000	520	42	28	7	8	9	6
Europe	140,880	395	40	27	7	8	6	13
min-max[1)]		260-550	25-60	18-40	4-13	3-12	3-9	6-28

Treatment of Municipal Solid Waste per country in Europe

Country	Amount ktonnes/yr	Incineration	Landfill	Composting	Recycling
A	2,800	11	65	18	6
B	3,500	54	43	0	3
CH	3,700	59	12	7	22
D	25,000	36	46	2	16
DK	2,600	48	29	4	19
E	13,300	6	65	17	13
F	20,000	42	45	10	3
GR	3,150	0	100	0	0
I	17,500	16	74	7	3
IRL	1,100	0	97	0	3
L	180	75	22	1	2
N	2,000	22	67	5	7
NL	7,700	35	45	5	16
P	2,650	0	85	15	0
S	3,200	47	34	3	16
SF	2,500	2	83	0	15
UK	30,000	8	90	0	2
Europe	140,880	24	63	6	8

MSW Incinerators in Europe

Country	Number of incinerators per country	% of total number of incinerators in Europe (%)	Incineration capacity per country (ktonnes/yr)	%of total incineration capacity in Europe (%)
A	2	0.4	340	0.8
B	24	4.9	2.240	5.2
CH	30	6.2	2.840	6.6
D	49	10.1	12.020	27.9
DK	30	6.2	2.310	5.4
E	15	3.1	740	1.7
F	225	46.4	11.330	26.1
I	28	5.8	1.900	4.4
L	1	0.2	170	0.4
N	18	3.7	500	1.2
NL	10	2.1	3.150	7.3
S	21	4.3	1.860	4.3
SF	1	0.2	70	0.2
UK	31	6.4	3.670	8.5
Europe	485	100.0	43.140	100.0
EU	413	85.2	37.530	87.0

Level of energy recovery in the different countries in Europe

Country	Number of incinerators per country	% of total number with energy recovery (%)	Incineration capacity per country (ktonnes/yr)	% of total capacity with energy recovery (%)
A	2	100	340	100
B	24	46	2,240	64
CH	30	80	2,840	90
D	49	100	12,020	100
DK	30	100	2,310	100
E	15	27	740	73
F	225	42	11,330	70
I	28	64	1,900	76
L	1	100	170	100
N	18	28 [1)]	500	83
NL	10	90	3,150	97
S	21	100	1,860	100
SF	1	100	70	100
UK	31	16	3,670	32
Europe	485	56	43,140	82
EU	413	54	37,530	80

1) On 13 small incinerators it is assumed that no heat is recovered

Graph 7

Emission guidelines for Municipal Solid Waste combustion in Europe (see text for explanation)

Component		A 1989	B 1982	CH 1991	D 1990	DK 1991	I	N	NL 1989	S	UK 1992	EC 1989 MSW	EC Haz. waste	Component
Dust	mg/Nm^3	15	100	10	10	30	30	10	5	20	30	30	5	Dust
HCl	mg/Nm^3	10	100	20	10	50	50	100	10	100	30	50	5	HCl
HF	mg/Nm^3	0.7	5	2	1	2	2	-	1	1	2	2	1	HF
SO_2	mg/Nm^3	50	-	50	50	300	300	300	40	200	300	300	25	SO_2
CO	mg/Nm^3	50	1000	50	50	100	100	100	50	100	100	100	50	CO
NO_x (as NO_2)	mg/Nm^3	100	-	80	200	-	-	-	70	400	350	-	-	NO_x (as NO_2)
TOC (as C)	mg/Nm^3	20	-	20	10	20	20	-	10	-	20	20	5	TOC (as C)
Heavy metals														Heavy metals
Hg	mg/Nm^3	0.05	-	0.1	0.05	-	-	0.1	0.05	0.03	0.1	0.2	0.05	Hg
Cd	mg/Nm^3	0.05	-	0.1	-	-	-	-	0.05	-	0.1	0.2	-	Cd
Hg+Cd	mg/Nm^3	-	-	0.1	-	0.2	0.2	-	-	-	-	-	-	Hg+Cd
Cd+Tl	mg/Nm^3	-	-	-	0.05	-	-	-	-	-	-	-	0.05	Cd+Tl
Pb	mg/Nm^3	-	-	1	-	1	-	-	-	-	-	-	-	Pb
Zn	mg/Nm^3	-	-	1	-	-	-	-	-	-	-	-	-	Zn
Pb+Zn+Cr	mg/Nm^3	2	-	-	-	-	-	-	-	-	-	-	-	Pb+Zn+Cr
Pb+Cr+Cu+Mn	mg/Nm^3	-	-	-	-	5	5	-	-	-	-	5	-	Pb+Cr+Cu+Mn
As+Ni	mg/Nm^3	-	-	-	-	1	-	-	-	-	-	1	-	As+Ni
As+Co+Ni	mg/Nm^3	0.5	-	-	-	-	-	-	-	-	-	-	-	As+Co+Ni
Tot.rest	mg/Nm^3	-	-	-	0.5	-	-	-	1	-	1	-	0.5	Tot.rest
PCDD/F	ng TEQ/Nm^3	0.1	-	-	0.1	-	4000 1)	2	0.1	0.1	1	-	0.1	PCDD/F
Conditions		11% O_2	11% O_2	11% O_2	11% O_2	11% O_2	11% O_2	10% O_2	11% O_2	10% CO_2	11% O_2	11% O_2	11% O_2	Conditions
Temperature	°C		800		850	850	950	800	850		850	850	850	Temperature
Residence time	s		1		2	2	2	1.5	2		2	2	2	Residence time
Oxygen conc.	vol%		6		6	6	6	-	6		6	6	6	Oxygen conc.

Emission levels for waste incineration plants in Europe

Pollutants mg/nm³	Germany 17.BImSchV	Netherlands, BLA (1 hour average)	EU *)
Hydrogen chloride	10	10	10 (60)
Hydrogen fluoride	1	1	1 (4)
Sulfur oxides	50	40	50 (200)
Nitrogen oxides	200	70	200 (400)
PCDD/PCDF (ng/m_o^3 TEQ)	0.1	0,1	0.1 ng/m_o^3 (6-16 hours)
Dust	10	5	10 (30)
Cd + Hg	0.05 + 0.05	0.05 + 0.05	0.05+0.05
Heavy metals (remainings)	0.5	1	0.5
CO	50	50	50 (daily average)

*) Draft Directive Incineration of Waste, 20.08.94, GH016
daily average values for new plants: > 3 ton/hour
between ( ): half-hourly average values.

All values are related to 11% O_2 and dry flue gas

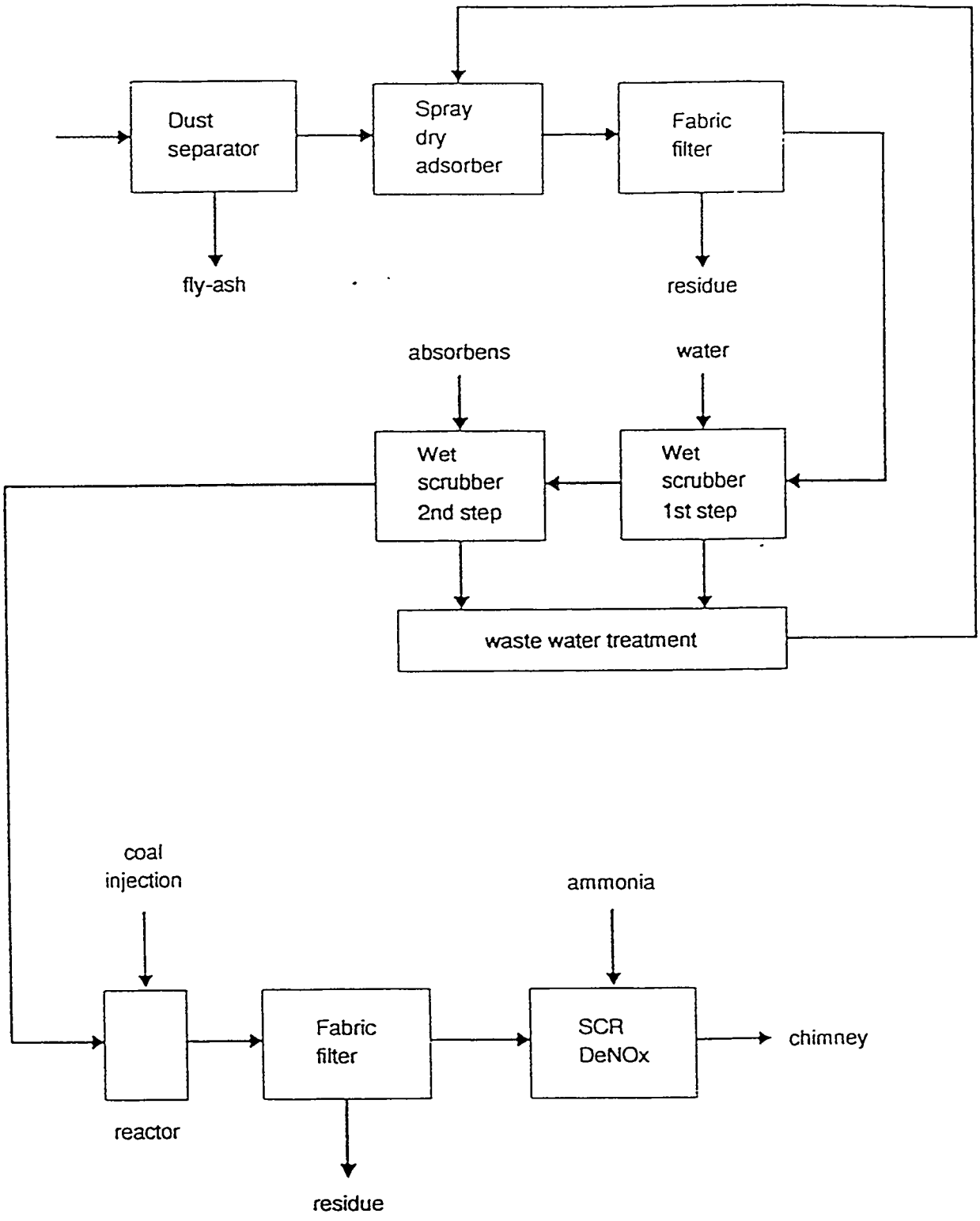
Component	Raw flue gas concentration		Dutch guideline	Removal [1] efficiency (%)
	minimum	maximum		
Dust	2 000	5 000	5	99,9
HCl	800	3 000	10	99,7
HF	10	100	1	99,0
SOx (as SO_2)	200	1 500	40	97,3
NOx (as NO_2)	200	500	70	86
CO	10	50	50	[2]
TOC (as C)	1	20	10	50[2]
Heavy metals:				
- Hg	0.1	1	0.05	95
- Cd	0.1	0.5	0.05	90
- others	1	5	1	80
PCDD/F (ng TEQ/m^3) [3]	1	10	0.1	99

[1]) The removal efficiency required to comply the maximum value with the Dutch guideline 'Richtljin Verbranden 1989'

[2]) Not taken care of in flue gas claening system

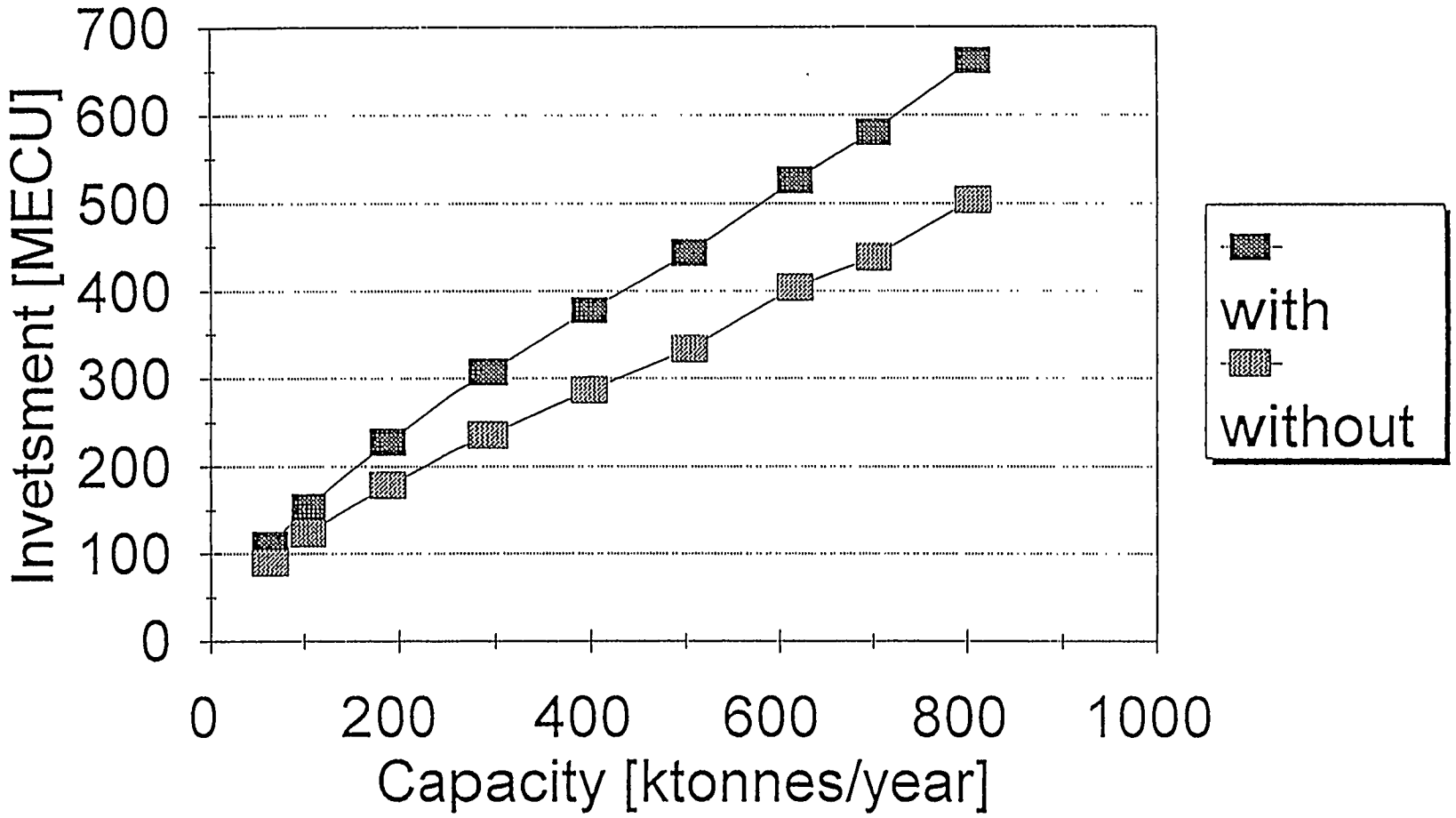
[3]) TEQ = Toxicity Equivalent Quantity (related to 1,2,7, 8-TCDD)

Graph 10


Dust separator
Spray dry adsorber
Fabric filter
fly-ash
residue
absorbens
water
Wet scrubber 2nd step
Wet scrubber 1st step
waste water treatment
coal injection
ammonia
Fabric filter
SCR DeNOx
chimney
reactor
residue

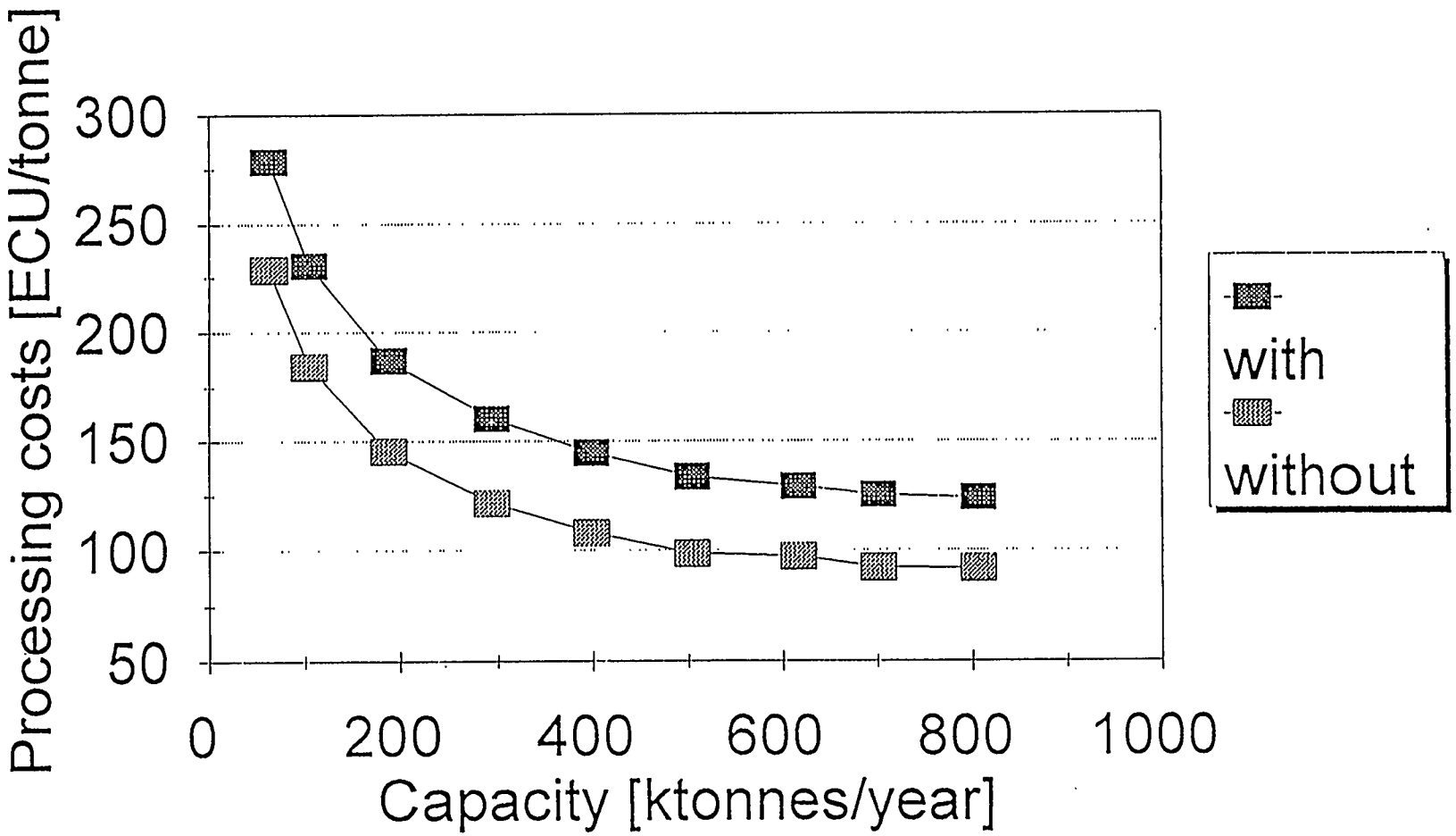
Investment cost new MSWC facility

With/without waste water evaporation



Costs per tonne new MSWC facility

With/without waste water evaporation



The Evolution of WTE Utilization - A Global Look
Asian Perspective - Waste Incineration and It's Value in Japan

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INTRODUCTION

Incineration carries significant weight in waste disposal in general. Seventy-five percent of the total quantity of municipal solid waste is incinerated. In the year 1994, there were a total of 1,854 incineration plants in Japan. Waste heat from MSW incineration is utilized for a power generation at most large-scale incineration plants.

In 1994, a total of 3,376 industrial waste incineration plants existed in Japan. They have been contributing much toward waste volume reduction, improvement of the quality of landfill materials through conversion of organic substances into inorganic substances which are more beneficial for landfill purposes, and conservation of resources by energy recovery.

But air pollution by exhaust substances -- especially dioxin -- from incineration plants pose a problem. This may place a big hurdle before future incineration plant projects. Small batch-type incineration furnaces are slowly dying out. Some municipalities will jointly construct a large incineration plant among themselves while others will consider introducing RDF producing plant, which is getting popular. More efforts will be made to melt and solidify the incineration residue, reduce the environmental load imposed by pollutants in the exhaust gas from now on.

GENERATION OF WASTE

Good health and comfortable life call for various foods, clothes and a house. All these essential items, however, are reduced to waste ultimately. Industrial waste is generated in a manufacturing process and in the distribution stage for a product. Waste is closely related to our health. In actuality, promotion and maintenance of health give rise to municipal solid waste and industrial waste.

Generated waste, if left as it is, gives out a bad odor and results in the breeding of noxious insects, which leads to a public hygiene problem highly detrimental to the human body. Thus presence of waste involves a risk to health. Waste is treated so as to make it into a state less harmful to the human body. Thus its disposal can contribute toward the enhancement of public hygiene and the preservation of the living environment. If it is improperly treated or disposed of, however, the waste or the treatment facility affects the environment with resultant physical harm and risk. Some measure to reduce this risk is therefore demanded. Thus health and waste are in complicated interrelation with each other.

The correlation between health and waste and that between waste disposal and physical risk are shown in Fig. 1. Probably dioxin is arousing the greatest concern now as a very dangerous byproduct of waste treatment. An exhaust gas is generated from incineration or some other intermediate process in a waste disposal system. Hazardous substances in such an exhaust gas are diffused into the air in large quantities, and they deteriorate the environment and adversely affect the human health -- that is, they are a serious threat to the human health. A leachate from a landfill site for incineration ash or the like contains hazardous chemical substances, which pollute underground water and surface water. These substances are taken into the bodies of various living things and condensed and may then be taken into human bodies also.

Breaking this circulation chain threatening human health is absolutely essential. Air pollution is controlled under the Air Pollution Control Law now, and water pollution under the Water Pollution Control Law. Soot, dust, nitrogen oxides, sulfur oxides and hydrogen chloride from waste incineration plants are under statutory control, but dioxin is still exempted from the regulation. Aside from dioxin, cadmium, mercury and some other possibly dangerous heavy metals are not under statutory control in Japan. But they are regulated under a law in some other countries.

WASTE DISPOSAL AND BASIC PRINCIPLE

The basic principle underlying waste disposal is shown in Fig. 2. Generation of waste is controlled at source by households and business enterprises, in which the waste originates. Recyclable components of such waste are separately discharged to facilitate recycling.

Municipalities and waste disposal agents, who dispose of waste, sort out useful components from the collected waste and put them in a recycling route. If recycling is not an appropriate action because of the technical difficulty involved in it, the environmental load, etc., volume reduction by incineration with every effort to take appropriate environment preservation action, and use of the energy derived from the incineration should be promoted. The ultimate residue is subjected to the proper final disposal.

The municipal waste disposal by municipalities and regional governments in Japan was initiated upon the promulgation of the "Dirt Removal Law" in 1990. Infectious diseases were rampant in Japan at that time, and it was therefore an important task to take effective measures against the generation of infectious insects and unsanitary water channels. Attention was directed to waste disposal from the standpoint of public hygiene action.

In 1954, after the end of World War II, the "Public Cleansing Law" was introduced to secure a hygienically sound living environment, followed by the "Waste Disposal and Public Cleansing Law" in 1970. These two constitute the main framework of the present waste management legislation. The "Waste Disposal and Public Cleansing Law had a widened regulatory coverage extended from municipal solid wastes to "industrial wastes" generated from industrial activities. Thus a complete legislative framework for environment conservation was established.

In the 20 years from the enactment of the original "Waste Disposal and Public Cleansing Law", the Japanese people's life style and economic structure have undergone drastic changes with their economic affluence in the background, with resultant quantitative growth and diversity in nature of wastes. Mass-production and mass-consumption in the human society have resulted in the depletion of forests, mineral resources, etc., the warming of the earth, acid rain, destruction of the ozone layer, sea pollution and other global environment problems. It has been realized that waste management holds the key to "sustainable growth".

Under the circumstances, the "Law for Promotion of Resource Recycling and Reuse" and the new "Waste Disposal and Public Cleansing Law" were enacted in Japan as basic statutory regulations regarding waste disposal and recycling in 1991. The "Law for Promotion of Resource Recycling and Reuse" aims at promoting recycling at the production, distribution, and consumption stages, having resources effectively used, suppressing generation of wastes and conserving environment.

Measures for waste reduction through waste discharge control, promotion of recycling, etc. were incorporated into the revised Waste Disposal and Public Cleansing Law. Furthermore, the Law for Promotion of Separate Collection and Recycling of Packaging Waste was enacted in June, 1995 and put into force in April, 1997.

As shown in Table 1, the earliest actions related to waste disposal were public hygiene measures including those for preventing contagious diseases. A shift was subsequently effected to environment hygiene measures to maintain urban functions and preserve living environment. Today waste disposal is quite significant for the purpose of global environment preservation.

WASTE DISPOSAL AT PRESENT

Disposal of Municipal Solid Waste

Japan is quite densely populated in comparison with other countries of the world, and its industries and population concentrate in cities. In its populous cities, waste generation density is high, but space resources are scarce. The difficulty in acquiring suitable land in such a city for a waste treatment or disposal site has been increasing every year. Pronounced difficulty in its acquisition is encountered in the case of a final disposal site which demands a very large space. In Japan, extra efforts have therefore been made to reduce generated waste by various intermediate treatments. Incineration, a process which can sharply reduce the volume of waste and is hygienic, is extensively adopted. In 1993,74.3% of the total quantity of waste discharged in that year was directly incinerated, 9.4% was separated and crushed, put in a high-speed composting process or otherwise treated, and 1.9% was processed in some other ways. Thus 85.6% of the discharged waste was subjected to some form of intermediate processing. The

quantity buried at landfill sites was reduced by the promotion of such intermediate processing from 15.3 million tons in 1992 to 14.96 million tons in 1993.

Fig. 3 is a diagram showing the entire disposal flow of a municipal waste. Besides domestic waste collected by the municipal authorities, bulky refuse is also discharged from house holds. In addition, some ordinary business waste from small businesses such as food left-over from restaurants in a town and twigs cut off by gardeners is brought directly to facilities run by the municipal authorities.

According to the results of the Ministry of Health and Welfare's survey in 1991, the quantities of waste disposed of at the municipal facilities throughout Japan add up to approx. 50 million tons. That is, approx. 1 kg of waste is generated per capita per day in Japan. Some waste from households or elsewhere, although it a very slight portion of the aggregate quantity, is subjected to "backyard disposal" -- kitchen refuse of a farmer's house used as a fertilizer in his field, combustible waste burnt at a backyard and so on.

Another part of the generated waste is retrieved through a private route such as one provided by a self-governing organ of a local community, as a substance of value instead of being discharged as unwanted stuff for collection by a municipality. This is called "group collection". Various unwanted items in a substantial quantity including old paper, cloth, metal and a glass bottle are retrieved in this way. While 2.2 million tons of waste collected by municipalities were recycled in 1993, 1.9 million tons were picked up by citizens' group collection. Thus a quantity virtually equal to that recycled by municipalities was collected through private-sector routes. The above group collection figure was based on municipalities' statistics, and a substantial additional quantity was presumably collected by resource retrieval agents and others. The voluntary private-sector activities contribute significantly to resource recovery. To encourage such voluntary recycling activities, some municipalities grant a subsidy based on the collected quantity, lend or furnish the tools and others necessary for the recovery activities, provide information for collection agents, made publicity effort directed to residents of the community and perform other actions.

To prolong the service lives of landfill sites, many municipalities incinerate the entire quantity of combustible waste in principle. The rest of the waste is separated into non-combustibles and waste which, if incinerated, may have an evil consequence and is therefore directly buried at a landfill site. Organic waste such as garbage is composted or fed to animals on trial. Composters used at households, a major source of garbage, play an important part in waste reduction. Waste paper, glass, metal, etc. are collected as recyclable items or separated waste. Part of such waste is further screened and recycled at recycling facilities, and bulky waste containing paper, glass, metal, etc. (large-size waste articles such as home electric appliances or furniture) is crushed, and different substances of value are sorted out and retrieved. A typical waste disposal system for minimization of the final-disposal quantity is illustrated in a diagram in Fig. 4 below.

Disposal of Industrial Waste

The industrial waste discharged is divided into three groups for recycling, intermediate treatment and final disposal, as shown in Fig. 5. Of approx. 403 million tons of industrial waste discharged, approx. 250 million tons (62%) were given an intermediate treatment, approx. 92 million tons (23%) were recycled, and approx. 61 million tons (15%) were sent directly to final disposal sites.

The approx. 250 million tons of industrial waste subjected to an intermediate treatment were dissipated to approx. 97 million tons, out of which approx. 69 million tons were recycled and 28 million tons were finally disposed of. Approx. 89 million tons (22% of that total quantity) were finally disposed of.

The ways of industrial waste disposal differ with waste categories, states at the time of discharge, etc. Most of ashes and the like is directly brought to final disposal sites. Items which cannot be recycled finally disposed of or are unsuitable for recycling or final disposal directly in the state in which they are discharged, are given some intermediate treatment. Waste oil, waste acid, waste alkali and other items in liquid state are given treatments such as separation of oil and water or neutralization, etc. Sludge (which is left after treatment of a waste liquid) is put through a dehydration or drying process or the like to reduce its moisture content. Waste oil, waste plastics and other organic industrial waste are incinerated or treated otherwise. Such intermediate treatments turn some industrial waste into dehydrated sludge, incineration residue or the like, reducing the weight or volume.

In April 1992, there are a total of 12,970 facilities for intermediate treatment and final disposal of industrial waste throughout Japan. (That figure, however, is the total number of facilities of stipulated scale or larger scale, in respect of which an official notification is required under Article 15 of the government law. There are supposedly many small facilities free of that obligation to notify.) Of these intermediate treatment and final disposal facilities, 10,440 are operated for intermediate treatment, and 2,530 for final disposal; thus intermediate treatment facilities account for 80% of the total number. The number of incineration plants is 3,376 as indicated in Table 2.

CONCLUSION

Most putrefactive (organic) substances in waste are turned into water and carbon dioxide by incineration and then diffused into the air, and non-putrefactive ash is left. It does not rot and is therefore sanitary. Its weight is only 1/6 of the weight of the original garbage, and its volume is 1/10 to 1/20 of the volume of the original garbage. Waste Disposal methods other than landfill are valued highly in Japan where a landfill site is extremely difficult to acquire. According to an estimate, the utility of a landfill site increases even tenfold to twentyfold if garbage is not directly buried there. Hence incineration is the primary waste disposal method in Japan now. Seventy-five percent of the municipal solid waste discharged throughout the country is incinerated. This is at a very high level as compared with the similar percentages in other countries of the world, and Japan leads the world in incineration technology. Japan's success in neutralizing the biohazard and organic toxity accomplished by incineration and in reducing the volume is highly evaluated.

A combustion exhaust gas is generated from a waste incineration process. As waste contains a variety of substances, the exhaust gas contains hydrogen chloride and other hazardous gases. Accordingly, an emission standard was established in respect of soot and dust, sulfur oxides, nitrogen oxides and hydrogen chloride under the Air Pollution Control Law. Various pollution preventive means were installed in waste incineration plants throughout Japan to reduce the adverse effect on the environment to meet the specified emission requirements. Many large-scale facilities and many facilities in an urban area adopted a very strict self-imposed standard higher than the emission standard under the Air Pollution Control Law since the operation of such plants may seriously affect the environment and residents.

The purposes of introduction of an incineration plant include the reduction of the waste volume to prolong the service lives of final disposal sites, the conversion of organic substances into inorganic substances for stabilization into a state fit for final disposal and the recovery of energy by utilizing the characteristics of the waste in its original state. The order of priority for these purposes and their relative weight may differ according to the place and the plant operating organization. Many of the municipality officials in charge, however, say that the prolongation of the incineration plant service life is the primary purpose.

The followings are some of the findings and conclusions.

1) The available practicable solutions to the waste problem are waste reduction at source, promotion of recycling, volume reduction by intermediate treatment and its proper final disposal.

2) Landfilling is an essential way of waste disposal, but it is extremely difficult to acquire the land for a landfill disposal site because of space availability and the concern about the environmental risk involved in such disposal.

3) Incineration is valued highly as a beneficial method of reducing the waste volume, stabilizing the substances to be buried and recovering energy.

4) Desirable municipal waste management in the future should feature the following:
   - Waste dischargers' best possible waste reduction efforts.
   - Recovery of newspapers, magazines, etc. by group retrieval or through other volunteer activity.

- Municipalities' recovery and recycling of recyclable items such as glass and metal. Crushing of bulky waste and recovery and recycling of metal. Incineration of the rest and combustible waste. Landfill disposal of the other items. In fact, the amount to be disposed of at landfill disposal sites can be minimized by this combination of processes.

5) Waste is composed of various substances, and reduction of the environmental risk from treatment and disposal facilities to zero in a strict sense would be impossible. Hence it is important to take safety ensuring measures with the locations of those facilities, waste inflow control, the seepage control function, the monitoring system, etc. all taken into consideration.

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Table 1. History of waste-related legislation

Year	Purpose	Law
1900	Public hygiene measure	Dirt Removal Law
1954	Living environment preservation	Public Cleansing Law
1970	Domestic environment preservation	Waste Disposal and Public Cleansing Law
1991	Global environment preservation	Revision of the Waste Disposal and Public Cleansing Law Law for Promotion of Resource Recycling and Rence
1995	Global environment preservation (Promotion of recycling of packaging waste)	Law for Promotion of Separate Collection and Recycling of Packaging Waste

Table 2. Numbers of incineration plants (in April, 1994).

	number
Plants for incinerating sludge	514
Plants for incinerating waste oil	522
Plants for incinerating waste plastics	2,122
Industrial waste incineration plants (excluding those mentioned above)	218
Total	3,376

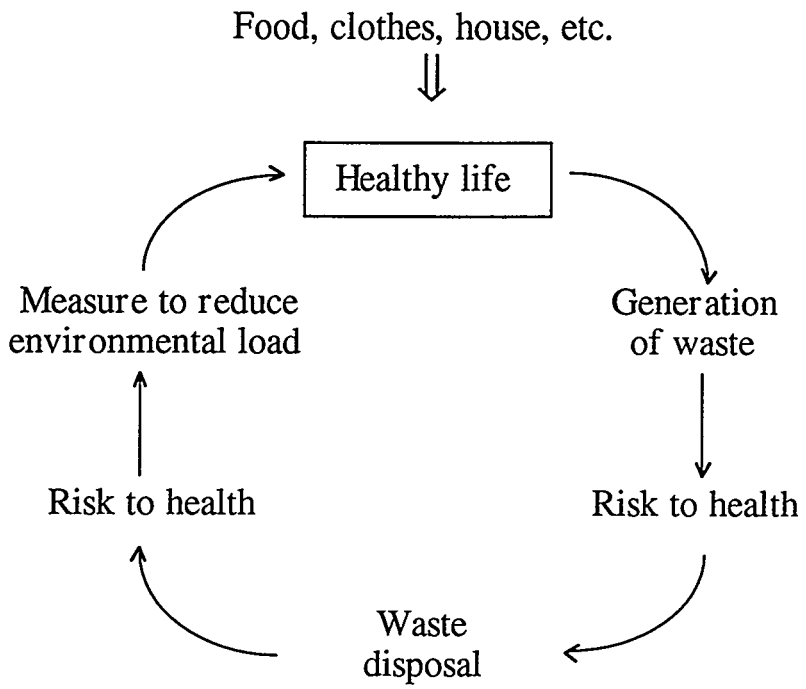

Figure 1. Interrelation Between Health and Waste and Interrelation Between Waste Disposal and Health.

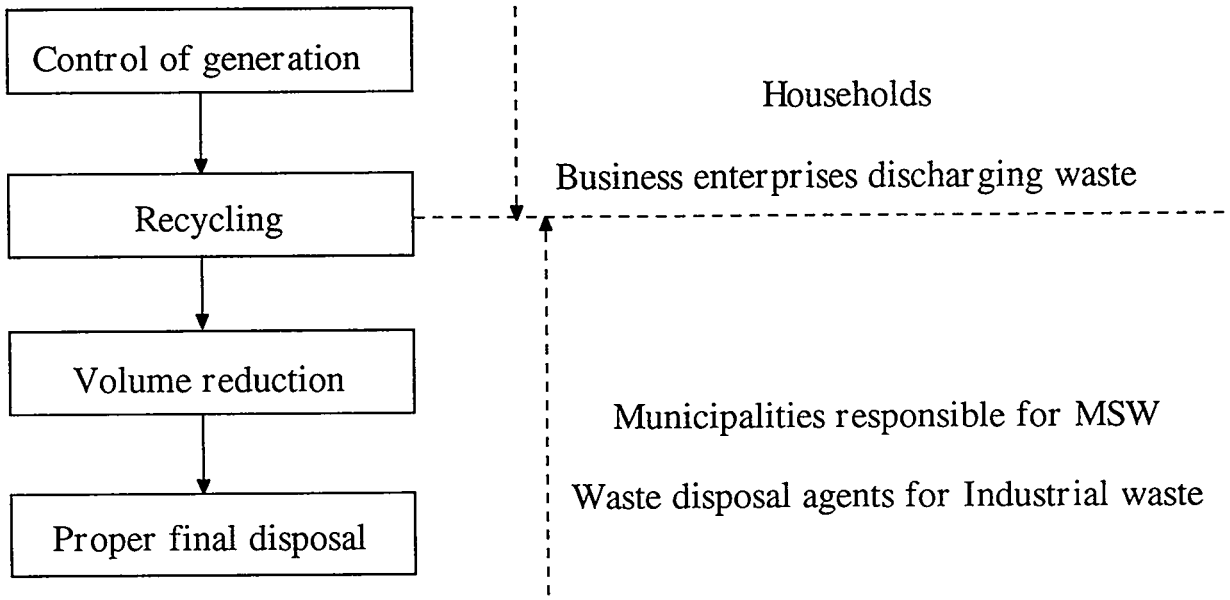

Figure 2. Basic Principle Underlying Waste Disposal.

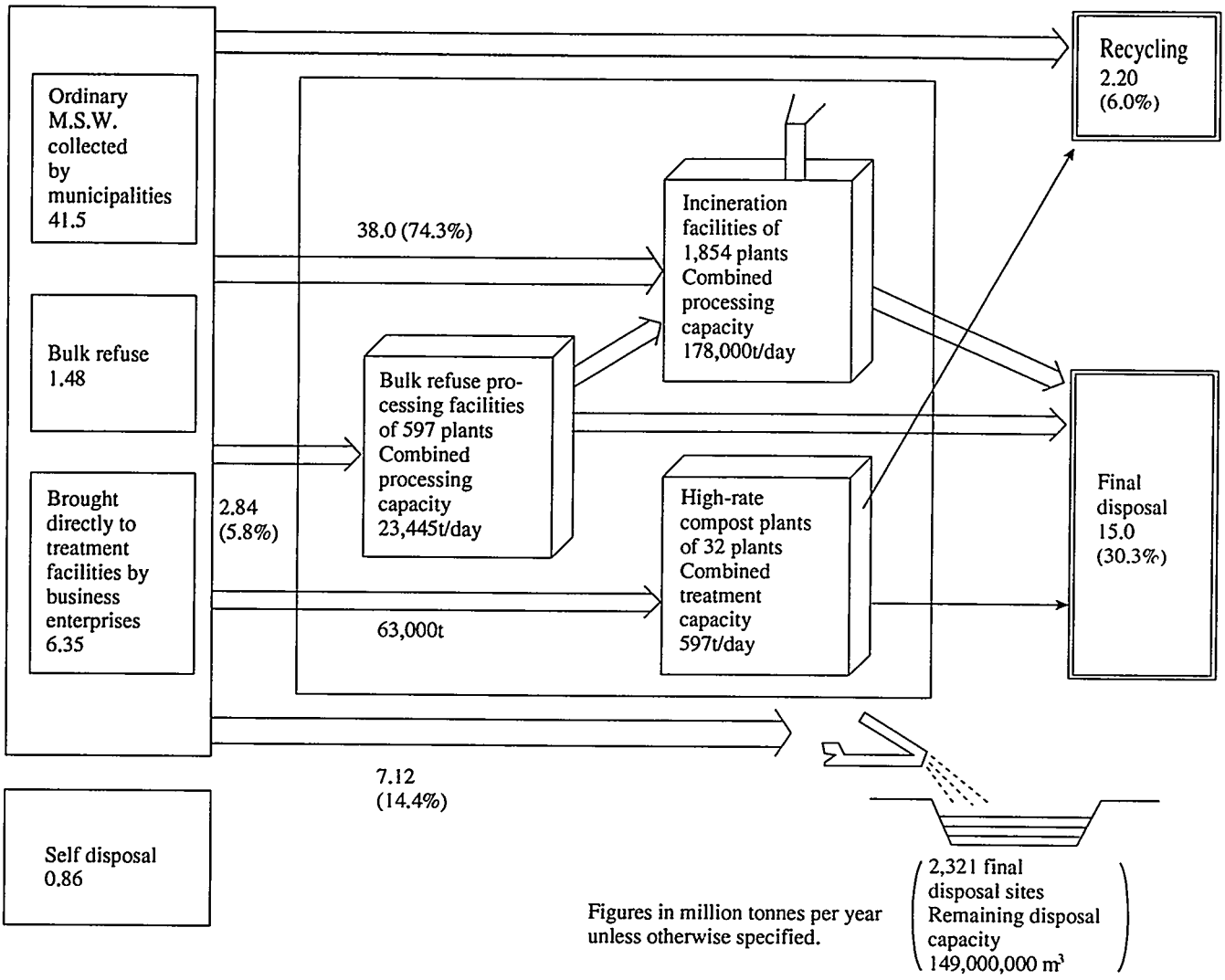

Figure 3. Waste Disposal Flow Diagram (1993).

Since: "Survey of Waste Disposal" by the Water Supply and Environmental Sanitation Department of the Ministry of Health and Welfare Japan.

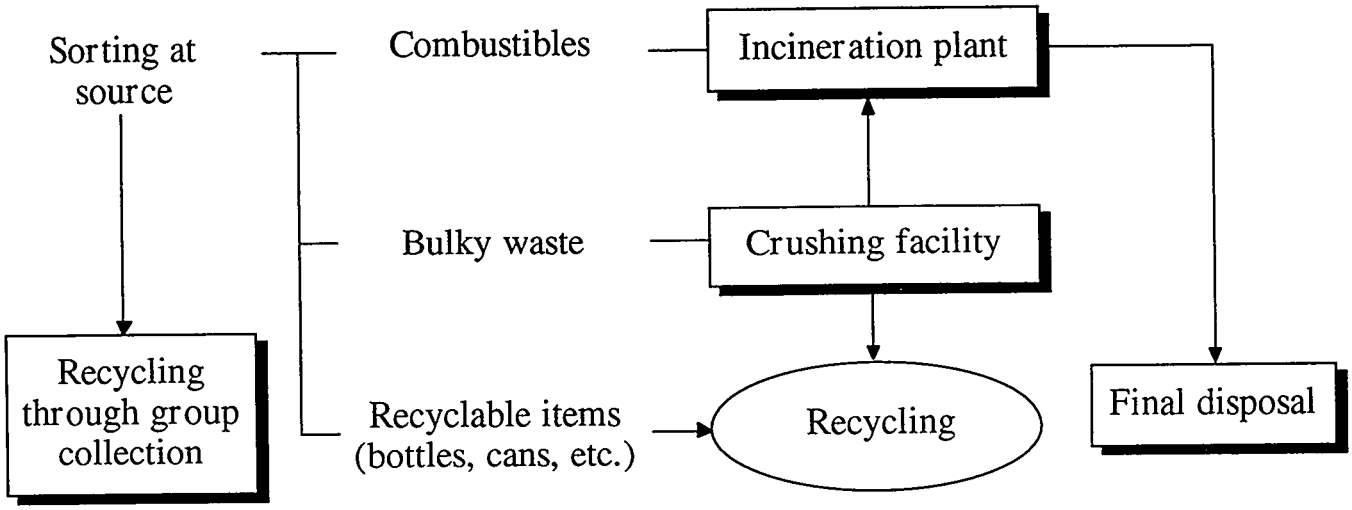

Figure 4. Waste Disposal System for Minimization of Final-disposal Quantity.

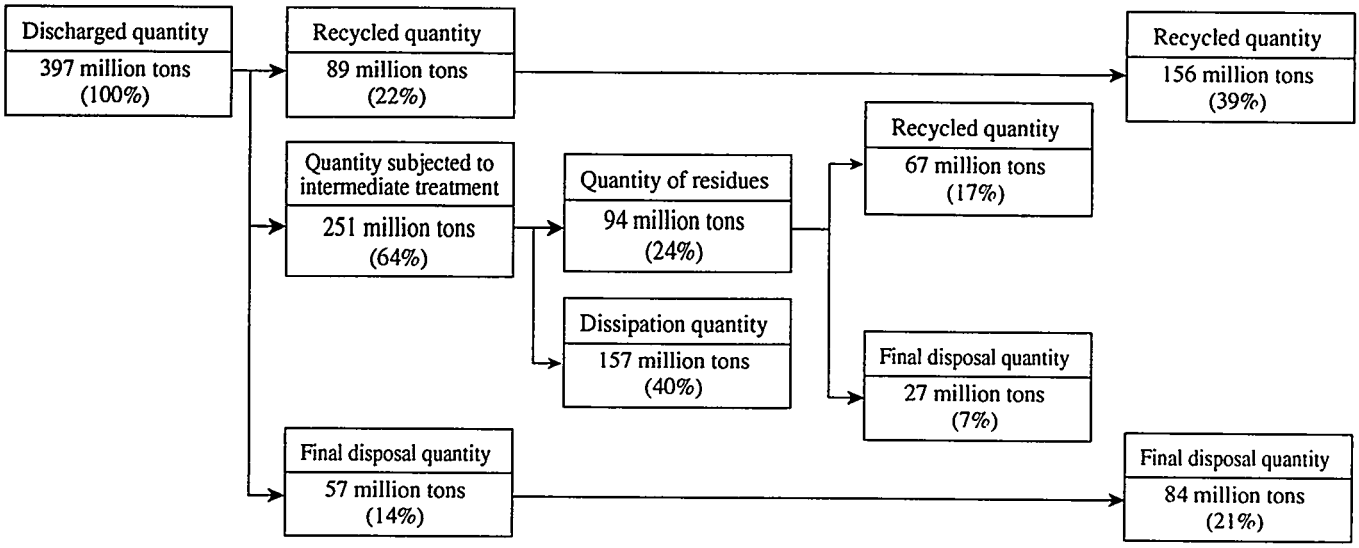

Fig. 5 Industrial Waste Disposal Flow (1993)

Bridging the Information Gap

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INTRODUCTION

Waste management facilities of every type are unpopular for a wide variety of reasons. Waste-to-Energy (WTE) plants, commonly described dismissively as 'burners' or 'incinerators' are the least popular. Yet any technical, informed and objective review of the facts show that the recovery of energy from material which has reached the end of its useful life has a valid role to play in society. The challenge for society is to ensure that WTE achieves its rightful role within a menu of waste management options, in a balanced, integrated and sustainable strategy. In many parts of the world, sophisticated arguments are presented to sceptical, doubtful and often hostile groups of stake-holders. These arguments explain why and how waste should be managed, and although the technical cases are well-rehearsed, proposals are often rejected by potential host communities, who opt instead for an often inferior solution.

This paper reviews the factors that shape public responses to planned developments which they perceive as unwelcome. The conflict between technically excellent arguments and perception-driven hostility is explored, and a tool-box of responses given by way of advice to waste planners and developers.

WTE - CONFUSED OBJECTIVES

Energy recovery is the most controversial of the waste management options. Everyone agrees that waste prevention is the supreme aspiration, and that there should be a reduced dependency on landfill disposal. Voices of dissent are raised when considering whether energy recovery is a valid adjunct to materials recovery and composting, or merely a waste-hungry prelude to disposal. There are sound reasons for recognising that both opinions have a basis in fact. In many countries waste management strategies are developed around just this confused ambiguity. A brief review of the European Union's waste strategy provides useful illustrations of this situation.

Approximately 60 per cent of municipal solid waste (MSW) in Europe fetches up with no prior treatment in landfills of variable quality. Martin[1] reports that landfill leachate pollutes aquifers at an annual rate of 120 km^2. One of the most significant pressures towards improving landfill operation is aimed at the putrescible fraction of landfilled waste. Composting bio-waste is mandatory in Austria, the Netherlands, several German regions and parts of Belgium. Thirty million Europeans now enjoy selective collection systems for bio-waste. France will introduce a ban on landfilling untreated waste within the next few years. The imminent draft EU landfill directive is set to ban organic wasteprogressively from landfills. Future policy will make pre-treatment of wastes a requirement of landfill. Under the German law, only waste which cannot be recycled may be landfilled. Organic content must not be greater than three or five per cent (depending on the landfill type). It is inevitable that some form of thermal processing will be required for the bulk of German MSW currently landfilled. Here, WTE is regarded as a waste pre-treatment technique.

Renewable energy resources currently provide Europe around 63 million tonnes of oil equivalent (Mtoe) each year, nearly five per cent of primary energy needs. The European Commission's Action Plan for Renewable Energy Sources in Europe was contained in the Madrid Declaration[2], and set a goal of delivering 15 per cent of Europe's primary energy demand from renewables (including biomass and waste) by 2010. Also relevant to renewable energy is the EU Altener programme, which aims:

- to reduce dependence on imported energy
- to protect the environment by limiting emissions of greenhouse gases

Under Altener, the annual contribution of biomass and waste is set to rise across the EU to 20 terawatt-hours per year (TWhpa) by 2005 (up from 6.3 TWhpa in 1991). This resource will comprise 10.4 per cent of all EU renewables by 2005, and will deliver 0.8 per cent of the Union's primary energy demand by that time. One of Altener's targets is for 7.8 per cent of the Union's primary energy demand to come from renewables, compared to 3.7 per cent in 1991. Here, WTE is viewed as a real contribution to renewable energy, with global environmental benefits.

EU policy and the Framework Waste Directive

Council Directive 75/442/EEC established (in 1975) the basis for a system to co-ordinate waste management in the European Community, to limit arisings. This was later amended by the 1991 Waste Framework Directive. A number of subsequent instruments helped implement these principles,

particularly the 1989 Waste Management Strategy[3] and the 1991 Waste Framework Directive[4]. The latter document established the familiar hierarchy:

- prevention and minimisation
- recycling, recovery and re-use
- optimisation of final disposal

The use of waste 'principally as a fuel or other means to generate energy' is considered as a form of recovery.

EU waste strategy review

In July, 1996, the European Commission published a controversial proposal for a review of the EU waste management strategy[3] and a draft Council Resolution[5], which set out the Commission's views on the original strategy. In this review, the Commission adhered to the 1989 hierarchy of prevention, recovery and safe final disposal. However, elaboration in the Review showed a clear preference for materials recycling over energy recovery, making the following points:

- recovery is at the core of any sustainable waste management policy
- material recovery implies separation of wastes at the source
- end-users and consumers should carry out source-separation
- energy strategies relying on waste supplies should not be detrimental to the principles of prevention and material recovery

The review states that "....preference should be given, where environmentally sound, to the recovery of material over energy recovery operations. This general rule is based on the fact that material recovery has a greater effect on waste prevention than energy recovery". The author of the review[6] confirmed that, as a general rule, "material recycling should be favoured above incineration with energy recovery". This view is broadly shared by Ken Collins MEP, chairman of the European Parliament's environment committee. He expressed the view[7] that "....where possible it is better to recover materials than energy, because the world's resources are clearly finite". Here, we see a grudging acknowledgement that WTE provides a second-best resource conservation option.

Finally there are intriguing reports[8] that the European Commission's environment directorate plans to classify incineration with energy recovery as a disposal option under EU law. This apparently comes in response to pressure from some Member States anxious to ban trans-frontier shipments of waste for energy recovery. Re-defining this activity as a disposal operation would allow such bans. This does not seem to be due to an aversion to incineration. The Danish government is reportedly embarrassed by the flow of MSW imports arriving from Germany for incineration. Denmark seems concerned that these imports will consume the capacity needed for its own MSW. In Germany, a shortage of waste for installed plants is seen as the reason why two regions have blocked exports of wastes that the Belgian and French cement industries want for fuel. Here, WTE becomes a strategic economic policy tool.

This quick tour shows a certain schizophrenic approach to WTE as a waste management tool. It is seen by some policy-makers as a means to an end, although the end might be diversion of waste from landfill, it might be pre-treatment of organic wastes prior to landfill, and it might be as a source of renewable or alternative energy displacing fossil fuel consumption. If waste strategists cannot decide whether WTE is really a form of resource recovery or a disposal option, one might sympathise with a concerned member of the public in a community faced with hosting a new WTE facility.

There are encouraging signs that once entrenched positions on the 'matter vs. energy' debate are giving way to a more balanced search for the real goal of sustainable waste management - the best practicable environmental option for all waste streams. The UK National Recycling Forum is part way through its own policy wrangles in this area. The Recycling Council of Ontario has also explored this route, approving a new policy towards incineration[9]. The Recycling Council of Ontario believes that energy from waste, fuel substitution and incineration should be considered on a case-by-case basis only if:

- It is clearly demonstrated that reduction, re-use and recycling initiatives are maximised
- Any technique used to handle remaining residual materials is of net benefit to the environment and economically sound

- Energy from waste or fuel substitution initiatives meet or exceed stringently enforced environmental performance standards
- Incineration of solid non-hazardous waste includes energy recovery

This review was at least partly provoked by the decision of the incoming Ontarian Progressive Conservative government to repeal the ban on any new energy from waste incinerators.

The real dilemma will lie not in relative positions or fractions of the waste stream, but in absolute tonnage routed one way or another. The competition will be for tonnes of recyclables or fuel, not for percentage points. Project scale will be the most important issue to resolve, managing the trade-offs between economies of scale and available material. The social dimension, i.e. public attitudes towards waste management alternatives, is likely to become increasingly important.

There are several alternatives to conventional MSW combustion being explored around the world. Although public acceptability is not the main driver, there can be little doubt that any incidental increment in popular support will be a welcome benefit. In the Netherlands[10], work is underway to develop co-combustion systems for a range of waste streams in coal-fired power stations. Wood waste, sewage sludge and refuse-derived fuel (RDF) are promising options. Integrating waste management facilities, but leading with the materials recovery option[11] has been successful in Britain. In Japan, the Toyohashi plant[12] blends waste incineration, with sewage treatment and a composting plant, producing electricity, hot water and steam. German packaging waste recovery policy has shifted to allow combustible packaging to be converted to gas which is permitted to be burned. Plastic packaging can be added to steel furnaces, where it serves as a reducing agent, in a material sense rather than simply as a source of energy. In Thailand[13] a $US70 million WTE plant is being built to burn MSW and lignite, generating 20 MW of electricity.

PUBLIC PERCEPTION

If given a choice, people tend to prefer things as they used to be (or seemed to be) than they are now. They also tend to prefer things as they are now, rather than risk something worse in future. The nature of the environmental problems are complex and far from understood. Public perceptions of these issues are sometimes clouded and communication processes often imperfect. The public are now bombarded, and confused, with information and opinions that often conflict. As a result they lose confidence and withdraw the trust that they once placed in the hands of the experts and decision-makers. This leads to a breakdown in communication and Not In My Back Yard (NIMBY) reactions become almost inevitable. However, because the issues are complex, the public may lack the expertise to endorse decisions themselves, becoming increasingly dependent upon views of experts. Given this dilemma, and a lack of confidence in establishment-based experts, groups claiming to represent the public interest take a more active role, demanding more information, more communication and involvement in decisions,.

The public receives information from many sources, which frequently conflict with one another. All of these elements play a role in shaping our perception of reality (see figure 1). It is hardly surprising when pollster Robert Worcester[14] claims that "[the public] tell us that they are sceptical of politicians and journalists. Industry's and the government's scientists are little more believed than are business leaders and senior civil servants and their ministers. The public don't know whom to trust".

Perception and trust

Gaskell[15] observes that "to have trust in someone is to anticipate the future, to behave as if the future were certain. Trust gives us confidence to make choices in an increasingly complex world, without it we are condemned to anxiety and inaction". Loss of trust triggers a switch from passive to active(see figure 2), the sceptical view is no longer acceptable and a search is initiated to alleviate uncertainty by the public themselves. Studies in more than twenty countries show that Green Activism is growing[16]. Loss of trust and increased activism create a demand for better communication to disseminate information and public participation to rebuild trust. However, mis-trust and activism are by no means universal. It is understandable that there are communication problems when raising awareness of global concerns given

the fact that experts themselves can rarely reach agreement. Locally, however, where there is greater scope for data acquisition and understanding, this is less of an excuse, and problems of distrust and NIMBY reactions here are the result of a breakdown in communication between the general public and the experts upon whom they rely.

The need for openness

The British Royal Commission on Environmental Pollution reported on its detailed investigation into waste incineration[17]. One of the areas it investigated was that of public concern, finding that "relations between the plant operator and the community are also important in explaining differences in the level of concern". The Royal Commission recommended that the "waste management industry should adopt a policy of openness in providing information to the public". A key section of the Royal Commission's report notes that "Before the public will accept a large incineration plan, whether existing or proposed, the site operator will have to earn their trust and establish his credibility as a source of accurate and impartial information". The UK Government replied formally to the Royal Commission, observing that "Openness by the waste management industry may well lead to improvements in the public perception of waste disposal". The apparent view that industry should shoulder the burden of persuading the public that energy recovery was a fine waste management option was modified somewhat in the UK national waste strategy[18], when the Government set out a target for overall recovery - including energy. This obliged the policy-makers themselves to help deliver the policy.

MAKING COMMUNICATION EFFECTIVE

Petts [19] has identified four areas where the communication process is beset by problems:

- Message Problems: e.g. deficiencies in knowledge and scientific understanding; large uncertainties in risk estimation; highly technical language.
- Source Problems: e.g. disagreements between experts; resource limitations which prevent reduction of uncertainty; use of technical legalistic language leading to a lack of trust and credibility in experts; limited understanding of the interest, concerns, and preferences of different communities.
- Channel Problems: e.g. biased media reporting; premature disclosure of information; inaccuracies in interpretation of information, one-way information flows; over simplifications, distortions, inaccuracies in technical information.
- Receiver Problems: e.g. lack of interest; inaccurate perceptions; unrealistic expectations about the effectiveness of regulatory action; reluctance to make trade-offs between risks and costs; difficulties in dealing with probabilistic information; suspicions of industry's motives.

So how can communication be improved, to improve public perceptions and rebuild trust? Furnham[20] recommends four actions for dealing with the general public:

- Acknowledge that there is a risk of pollution, accidents etc.
- Explain the preventative action being taken, and any plans to cope with outcome of any problems or disasters.
- Stress that perfection is unrealistic and that a process of improvement is a more important and practical way forward.
- Build trust.

Likewise, Gaskell[15] suggests six points for cultivating a reputation:

- Technical competence is crucial, don't deny the risks, because few will believe it is risk-free.
- Acknowledgement - admit mistakes of the past, respond to crises quickly and effectively.
- Disclosure - be more forthcoming about who you are and what you stand for.
- Accountability - articulate areas of responsibility.
- Take on the wider responsibilities and obligations reflecting the concerns of society.

These represent only one side of the communication process. It should be remembered that communication is a two-way process. This is highlighted by Petts[19] in the first of five ways forward for risk communication:

- Risk communication must be a two-way process: a process of bargaining. Statutory authorities, industry and the public must expect to learn and be prepared to change views.

- Risk communication which is perceived as simply risk education is unlikely to be effective, because it will almost certainly fail to address the main concerns of the public and information requirements of decision-makers
- Risk communication is an ongoing process; it is not simply a specific assessment in response to questions on a specific planning application.
- Quantified risk assessment is becoming an essential element of siting decisions where risk is a dominant factor or is perceived by the public to be a dominant factor. Subjective discussion of 'small', 'low', 'insignificant' etc. risks is no longer acceptable.
- Risk acceptability is location and time dependent. Risk communicators must understand the specific concerns for specific siting decisions.

It is clear that communication is a process of participation in a debate in which both sides learn from one another, and as a result shift to some common ground. It is clear that this participation must be with the specific local community that is likely to be affected by any decisions made.

The experience of the German Federal Environment Agency in this respect has been summarised by Johnke[21] as follows:

- In projects involving public participation, the climate in which discussions are held needs to be improved. Proponents and opponents must take each other's arguments seriously
- The data on which technical proposals are based should be disclosed at an early stage
- The fact that the situation will worsen for affected residents must be acknowledged and compensation granted if at all possible
- Decentralised solutions should be preferred; burdens must be distributed evenly within the region concerned
- Ecologically committed groups must be involved in the planning and try to accommodate opposing views
- Pollution levels must be compared and considered in relative terms. For example, waste incinerators are able to comply today with dioxin emission levels that are ten times lower than the value applicable for the open burning of wood. If the waste-related emission limits applied to wood, it would have to be shipped to an incinerator for combustion!
- The relative environmental burdens should be demonstrated in greater detail.

Public Participation

A 'ladder of participation' (see figure 3) has been widely adopted and used in the design and consideration of the public participation programmes. Described by Petts[19], "This ladder commences at the bottom with the primarily 'manipulative' methods of the public relations exercise, and with steps up the ladder of informing, consulting, placating, forming a partnership, and finally (at the top) delegating powers to the public for both decisions and implementation. In the USA, Kiser et al[22] indicate that "communities are involving citizens in the decision-making process regarding WTE projects in their communities. This public role frequently includes more than one mechanism for gathering input from citizens, and often includes formation of a citizens advisory group".

Paradoxically perhaps, public participation can slow the pace of change. Lanny Hickman[23], formerly CEO of the Solid Waste Association of North America reports that no new WTE facility has been developed in America for a number of years, primarily due to public resistance. Hickman notes that developments by industry, for example of transfer stations and material recovery facilities, are more likely to succeed than municipal initiatives, because industry has less onerous duties for public consultation. He compares discreet, innocuous municipally-owned local transfer stations which are strongly resisted, with private sector 'megafills' taking 5,000 tonnes per day for landfill disposal which may receive consent without difficulty. Hickman adds that the concept of Host Community Fees can deliver locally negotiated revenue that exceeds local tax income.

Kiser et al[22] present evidence of success explaining that "citizens who are involved say the majority of people served by modern WTE operations in the US consider the facilities to be good neighbours, based on satisfactory operation and the benefits these facilities provide to their communities". The authors conclude that "the favourable reaction to WTE plants should give other community leaders the confidence to consider integrated waste management systems of their own that include WTE".

Similar groups to those in the USA are evolving in Britain, as Lisney[24] reports on the development of community advisory forums for debating the waste management strategy for the English county of Hampshire: "These forums comprise representatives of parish councils, community environmental groups, interest groups, local residents, business and health sectors"...."The quality of debate was of an extremely high standard. It did not take very long for members to get up to speed in terms of the problem and the options for solution. This approach has been successful in some WTE projects. Lisney concludes by stressing "the importance of involving the key stake-holders in debates which have local importance, and to do so in an open and forthright way". The complex relationships between partners in consultation is illustrated in figure 4.

Willingness to embrace a public debate was instrumental in the success of Britain's most recent WTE facility - the SELCHP plant. Planned for south-east London within 200 metres of many local residents, the developers appreciated from the outset that public confidence would be a critical factor. SELCHP's managing director declared "...during a long planning and public consultation process we achieved a high level of public confidence". Throughout construction, developers kept in touch with their neighbours - directly through mail and local newspapers, and indirectly through meetings with an Incinerator Monitoring Group. A representative of this group was able to attend SELCHP board meetings, to hear of progress and register local concerns. Recognition of specific controversial issues is very important and SELCHP soon identified that the emission stack (with a height of 100 metres) would become a significant feature on the sky-line. The company undertook local public exhibitions of alternative designs, asking residents to vote for their preferred design.

Public participation and LA21

Currently, the most significant action being taken with regard to sustainable development, which includes waste management issues, stems from the 1992 Earth Summit held in Rio de Janeiro. The Summit adopted Agenda 21, a comprehensive action plan for the pursuit of sustainable development into the next century, with 40 chapters of detailed recommendations addressed to international agencies, national and local governments and NGOs. Some two-thirds of Agenda 21 applies to the local level, and consequently needs the active participation of local authorities.

As local authorities develop Local Agenda 21 (LA21) strategies, community participation should improve public perceptions and rebuild some of the trust lost in recent years. With public involvement in the LA21 process local authorities are in a position to raise awareness and improve perceptions. Worthington and Patton[25] found little agreement on which departments within local authorities should be responsible for the initiative, only half had developed formal means of co-ordinating the process, there had been minimal contacts with local environmental and business groups. Municipalities experiencing successful public participation made the following suggestions:

- Local authorities should nominate a key individual responsible for LA21 matters;
- Across-functional body should be established to transcend formal functional lines of responsibility within the municipality;
- An environmental forum should be established, to provide a focal point for all interested groups;
- Public awareness should be raised by a variety of means;
- Central government should be lobbied for direct (financial) support.

It is unlikely that there will be a return to the former dependency on experts by the general public. However, although it has been seen that the public do have an ability to deal with specialist areas, they are not in a position to collect, analyse and evaluate the large amounts of data needed to understand the environment. They will still depend on experts for this function. Any uncertainties generated through the imperfect communication between expert and public could be minimised through partnership.

Industry and participation

Understanding people's psychology and their behaviour is an important facet of business. Industry has recognised the importance of environmental awareness and the concerns that are expressed by the public about the effect of the activities of industry on the environment. As Elkington et al[26] have written "Big business has discovered that it cannot work effectively within a society that does not like its methods and refuses to buy its products". However, waste contractors will need to change their attitude, for as Petts[27] found in an assessment of a Community Involvement Programme, "The one group not fully

involved in the first phase of community consultation was the waste contractors themselves. While representatives of some contractors attended meetings, it is known that contractors in general have a poor appreciation of the importance, and methods, of communication and seem often to regard public concern as irrational and communication to be merely an 'education' exercise.

Environmentalism and participation
The 'Green Movement' is far from uncriticised. As seen earlier, environmental doom-mongers have developed low levels of trust due to their apparent failures in the light of their acquired expertise. Indeed all environmental groups are involved in public relations as are business and industry. These groups claim to be the 'voice of the environment', driven by environmental ethics. They are subject to the same communication problems that affect businesses, or other organisations out to promote their interests.

Facilitating Participation
Some people appear to need further encouragement to participate in decision-making activities. There are many reasons why people may not participate, including four outlined by Petts and Eduljee[28]:

- They may feel adequately represented by others;
- They may not feel that the impacts justify participation;
- They may be unaware that they might be affected;
- They may feel powerless to influence the decision.

Petts and Eduljee go on to state that "Whether or not they participate, will be a reflection of the information available to them. Furthermore, by not providing them with adequate information to allow them to decide on an informed basis whether or not to participate, there is potential for decision making by small 'elites'."

To some extent the success of a public participation campaign can only be judged upon the implementation of any plan derived from the consultation programme, which may take years. However, there are criteria that can be used not only for assessing a community involvement programme but also for its design, such as those used by Petts[27]:

- Representativeness of the participants.
- Effectiveness of the method.
- Compatibility with the objectives of the participants.
- Degree of awareness and knowledge achieved.
- Impact of the participation programme.

Techniques for participation
These groups and forums are only part of a number of approaches and techniques for public involvement. Petts and Eduljee[28] have outlined some of the approaches and techniques put forward in The Canadian Federal Environmental Assessment Review Office's (FEARO) manual on public involvement in Environmental Assessment, which includes descriptions on over 50 different techniques.

Public perceptions of the validity, or value, of information provided, can only be improved by a combination of accurate information provision and involvement in sustainable development. Achieving balanced dialogue will allow perceptions to evolve on both sides and return some confidence that those perceptions depict reality. This will reveal a wider picture to all: the size of problems will be more lucid and solutions more apparent.

Effective communications with WTE projects
Planning any communications strategy requires a clear definition of:

- The audience groups
- The messages to be communicated
- The appropriate media to be used

Audience Groups
The public. Many developers of waste management facilities will often attempt to communicate directly with the public. Usually, these are the nearest neighbours to a proposed development and contact is

through local public meetings, village hall exhibitions, house-to-house leaflet drops and by means of advertisements or editorial coverage in local newspapers.

Public interest groups. Local groups who claim to speak for and represent the public are often quick to rise to what they perceive is a threat to their territory. These groups are often far more enthusiastic to enjoin a debate than the public itself. Early attention should be given to identifying those bodies with a direct interest in local amenity development, environmental, archaeological or other interests. Addressing direct interest groups is an obvious approach to take, but there is also merit in considering a diverse range of less immediately relevant sectors. Having no specific 'axe to grind', these groups can give added buoyancy to support for a proposition. For example, the American League of Woman Voters[29] has published a document endorsing the combustion of waste plastics for electricity generation, in conjunction with other waste management techniques. The book states "it does not help the environment to expend large amounts of labour and money to 'over-recycle' inexpensive and benign materials like plastics". This type of 'third party endorsement' can be very supportive.

Industry. Potential supporters of WTE systems can come from unrelated sectors of industry. This has been widely seen in the packaging and other sectors, coming under increasing duties of 'Producer Responsibility', an obligation for their products beyond the point of sale. Many of these sectors are forced to take an interest in the economic and environmental impact of their products, and often advocate a mixed array of recovery options, including WTE.

Government bodies. Many national governments have prepared national waste strategies. The British national strategy[18] was published in January 1996, and set out a clear commitment to support increased WTE systems. Such a commitment needs action if they are to be anything more than posturing. Only at the national level can regulatory or economic incentives be put in place. The UK has seen the introduction of the tax on any solid wastes going to landfill, which is altering the current balance between landfill and WTE. The UK national waste strategy also includes broad resource recovery targets and advice to local authorities and others. The British government has also operated the Non Fossil Fuel Obligation for several years, levying a charge on the generation of electricity from fossil fuels, which then subsidises selected WTE projects.

Municipalities. Local government is in many ways at the focal point of public debate, and has a crucial role in shaping public perceptions. Local government is, by definition, local. It knows the issues that are important. It is also democratically accountable and must strive to reflect and shape public opinion. In waste management terms, municipalities are often charged with responsibility for many links in the chain. Waste collection, regulation, disposal and planning are duties that may rest with different parts of local government. A fine example of progress here has been demonstrated in Brescia, Italy[30]. In 1992, the town held a series of presentations between the local authority and a technical and scientific committee formed from members of local government and the public. Decisions relating to the project required unanimity before action. Community meetings, press coverage, exchanges of correspondence and a second international conference "Towards New Environmental Solidarity" crowned a successful public consultation process, following which planning consent was granted to develop a 266,000 tonnes/year WTE plant, to start operation in 1997.

Journalists. The media is an important audience, in an indirect way because journalists provide a conduit for information to the above audience groups. Public perception and ultimate fate of many projects may be influenced profoundly by the capricious whims of the media. Local newspapers often become one of the most active spheres of local heated debate on particular topics. Experience in Hamm, Germany[31] has shown the benefits of favourable media support. This, coupled with annual open days, has contributed to the WTE plant being totally acceptable to the host community.

Familiarity breeds content

The secret to successful WTE project development is likely to rest in its chosen location. There is clear evidence that proposals to develop a new facility on a new 'greenfield' site is far more likely to encounter delays or cancellations, than a project on a site already used for the same purpose. In Britain, proposals to build a new large incinerator near London (Belvedere) continue to be plagued by delays, while an existing unit in London (Edmonton) received planning permission to effectively double its capacity without a murmur. At Tyseley in Birmingham, UK construction of a £95 million WTE plant taking

350,000 tonnes/year is now complete. The planning application was submitted in November 1993 and was approved at its first hearing, with consent granted in February 1994. The unit's managing director declared "There has been very little adverse local reaction to the proposal because we made residents aware of what was involved well in advance of the work starting on site". He added that "..there has been an incinerator there since 1926, so people know what to expect". The main source of complaint came from the local Friends of the Earth representative, who opposed the project as a concept, questioning the justification of the planned scale, its economics and whether there would be sufficient waste to fuel the unit. The project team embarked on a 'consultation and awareness campaign' making "contact with residents' groups, environmental organisations and other interested parties. Press releases were issued, and press and radio interviews conducted".[32]

It is clear that replacing an old unit with a modern state-of-the-art WTE facility is almost certain to be applauded as an improvement, whatever one's feelings about energy recovery in principle.

Messages to be communicated

Acceptance for new projects depends heavily upon public participation in the process of decision-making. It is likely that support for a new WTE scheme will be shaped by the following vectors:

- The level of public involvement in the debate itself
- The degree to which this is seen as a local solution to a local problem
- The extent to which WTE reinforces and does not jeopardise those waste-related activities which the public supports (prevention, re-use, composting and recycling)
- The level of environmental and amenity concern shown by developers
- The presence of any perceived benefits of the proposed facility
- The absence of any perceived dis-benefits, or stigma arising from the project
- The demonstrated public support for the project of independent groups (local government, media, environmental groups).

It follows that the ideal messages to be communicated are those which rigorously establish, defend and reinforce the above vectors.

CONCLUSIONS

It is clear that public acceptance is essential for any developer - industrial or municipal - of a proposed WTE facility. Private individuals have reasonably high expectations of the quality of their lives, socially, economically and environmentally. They are unlikely nowadays to accept without question the opinions of 'experts', on allegedly necessary developments within their communities. The complexity of associated issues as probabilistic risk assessment, sophisticated technologies remote from everyday life, and high profile disagreements between opposing experts erode still further a feeling of public trust and confidence in something which is new, different and remote.

Bridging the gap between public perception of a hostile and perhaps dangerous proposal that brings no direct or personal or immediate benefit, and the necessary development of waste management facilities. falls on the other stakeholders in society. Developers - whether in the private or public sector - have a prime duty to build the trust necessary to achieve or restore public acceptance. Developers must be open, and must be seen to be open. Their communications with the host community must be active, effective and planned. While there are many means of communication open to developers, there can be no doubt that the most effective route will rest in demonstrating a partnership between industry and the community it serves. A proposed WTE unit should be appreciated as part of a wider, but still essentially local solution - and not simply as a site-specific problem.

Local Agenda 21 initiatives provide a valid model for community-based co-operation, and also offer a suitable vehicle relevant to implementing neighbourhood and regional sustainable waste management plans. As part of the route towards global sustainable development, local authorities have a key role to drive forward a productive debate between the public, industry, environmental groups and others, on the way society plans to move into the next century. Securing a really constructive debate is difficult, but experience shows that the municipalities are critical agents in any successful initiatives. Local authorities should work to stimulate LA21 planning through the creation of a high profile, cross-functional body, an environmental forum for interested groups in a continuing exercise to exchange

views and reach agreement. The debates within this type of forum should preferably precede any site-specific discussions, to establish in principle the way that a community believes progress should be made. This will help alleviate the inevitable NIMBY reaction when site-specific details are considered. In this context, national government has a duty to ensure that a broader framework is established. Local authorities should be involved, not simply as a planning authority. The local authority's own waste collection or disposal function will be in partnership with any private sector interest. The fact that the plant addresses the community's own waste arisings shows that the plant is part of a solution, not part of a problem. Local government should not adopt the attitude of impartial observer while industry battles with a community, but should strive to help the community or region address its own waste management issues.

A prospective WTE plant should ideally be planned to replace an older unit. It should be technically and environmentally of higher performance and greater efficiency, offering indirect benefits - for example demonstrating improved materials recovery and less waste to final landfill disposal. It can therefore be seen to be a better replacement, delivering a clear net benefit.

Effective dialogue calls for technical competence on the part of developers and decision-makers, of course. There must also be a willingness to explain the information - some of which will be highly technical - to the wider public. Proponents must listen to views expressed by the groups to whom they speak, and they must be seen to react to views expressed. Hostility will be far greater if a new WTE unit is proposed on a greenfield site. It is crucial that the site is acknowledged to be an integrated part of a planned system, pursuing environmentally sound objectives to the highest standards. Dis-benefits should be honestly recognised, and some form of local compensation addressed. It will be of paramount importance that developers are seen to be open from the outset. Developers also need to recognise that the public will be there for the lifetime of the plant, and beyond. Promises must be kept and dialogue should continue. A successful WTE facility will be one that becomes a part of the community that it serves. The relationship between the public and the operators (who may not be the developers) will be shaped by events at an early stage.

Increased pressure on landfill disposal will mean higher costs of this option. Tighter environmental controls on what may be landfilled will further increase costs, closing the gap between disposal and alternative management techniques. Greater enthusiasm at the international policy level for the application of Producer Responsibility, and for waste reduction (or landfill diversion) targets will tighten this stranglehold. Landfill bans on organics, mean that composting and anaerobic digestion will not suffice. Supplementary treatment will be more attractive. Higher materials recovery and recycling targets will require improved source separation for its cleaner secondary material streams. This will be assisted by isolating non-combustible recyclables and wet organics, which will deliver a higher energy content residue (better suited to energy recovery).

There is good cause to hope that structural limitations, economics, modest targets and waste composition will combine to ensure that materials and energy recovery will be complementary options. Scaling and siting of waste management facilities in the short to medium term will be the most important and difficult decisions. In the longer term, sustainable waste management can only be approached through changed public attitudes and adoption of waste minimisation targets through better design and clean technology.

With traditionally pro-incineration groups calling for a balanced, integrated approach to waste management, and with recycling-oriented bodies re-visiting established policies on energy recovery, the signs of rapprochement are very encouraging.

It is up to governments, local authorities, industry, pressure groups and consumers to ensure that we do not squander this opportunity.

Figure 1 **Shaping Public Perception**

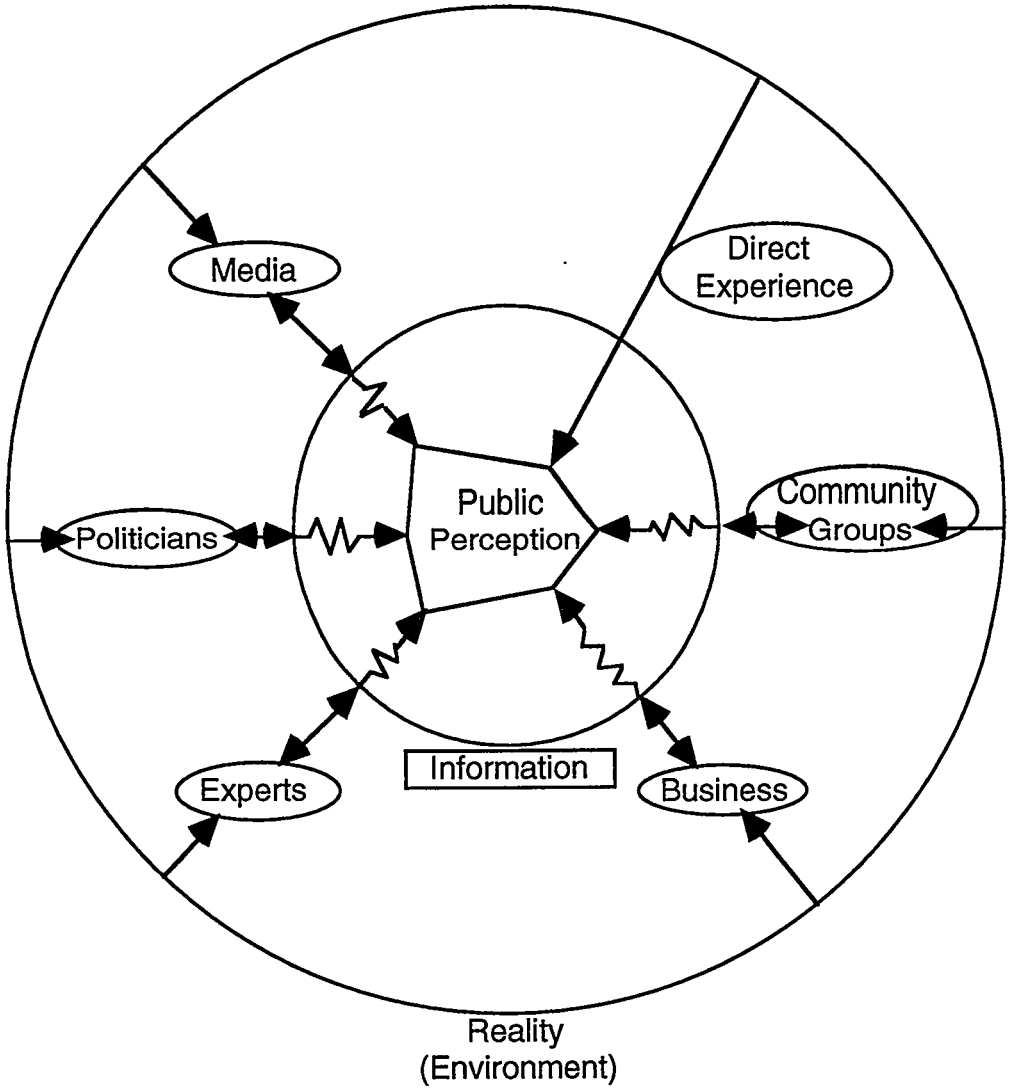


Figure 2. Transition from Passive to Active

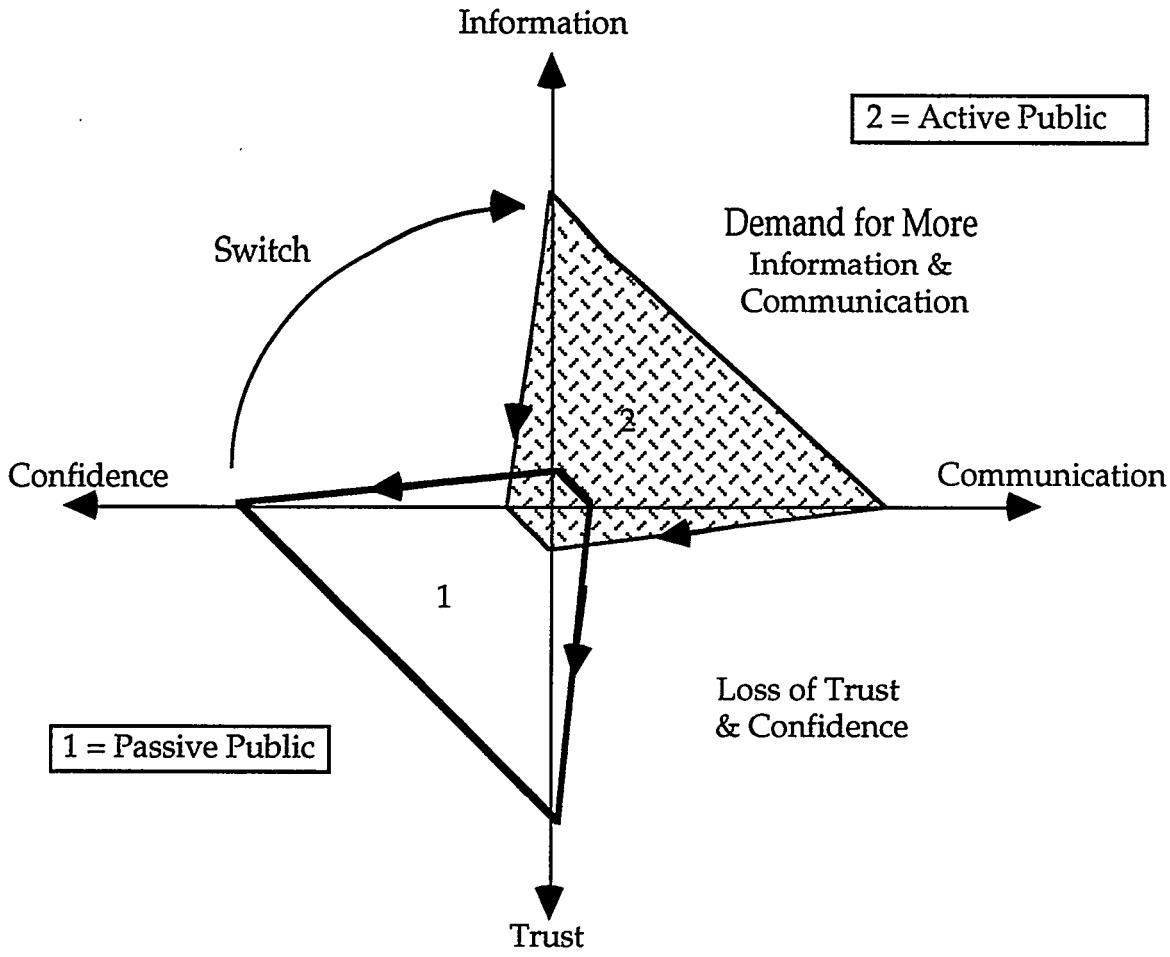


Figure 3.

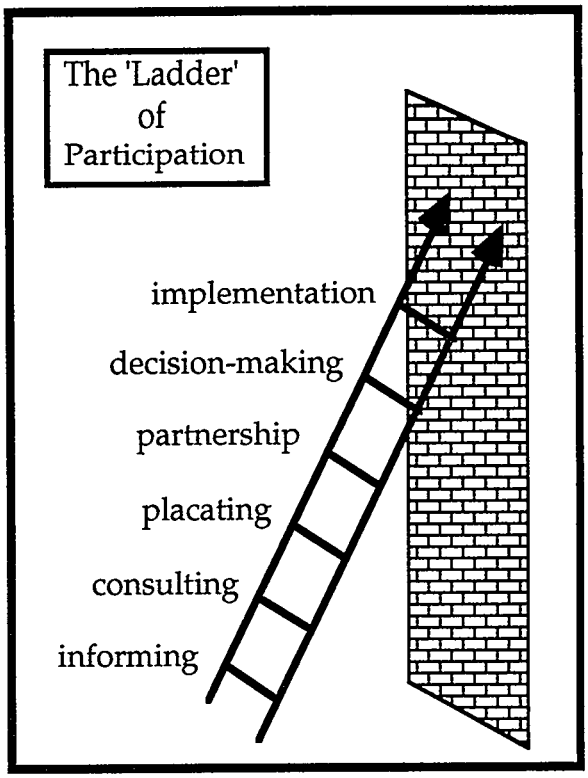
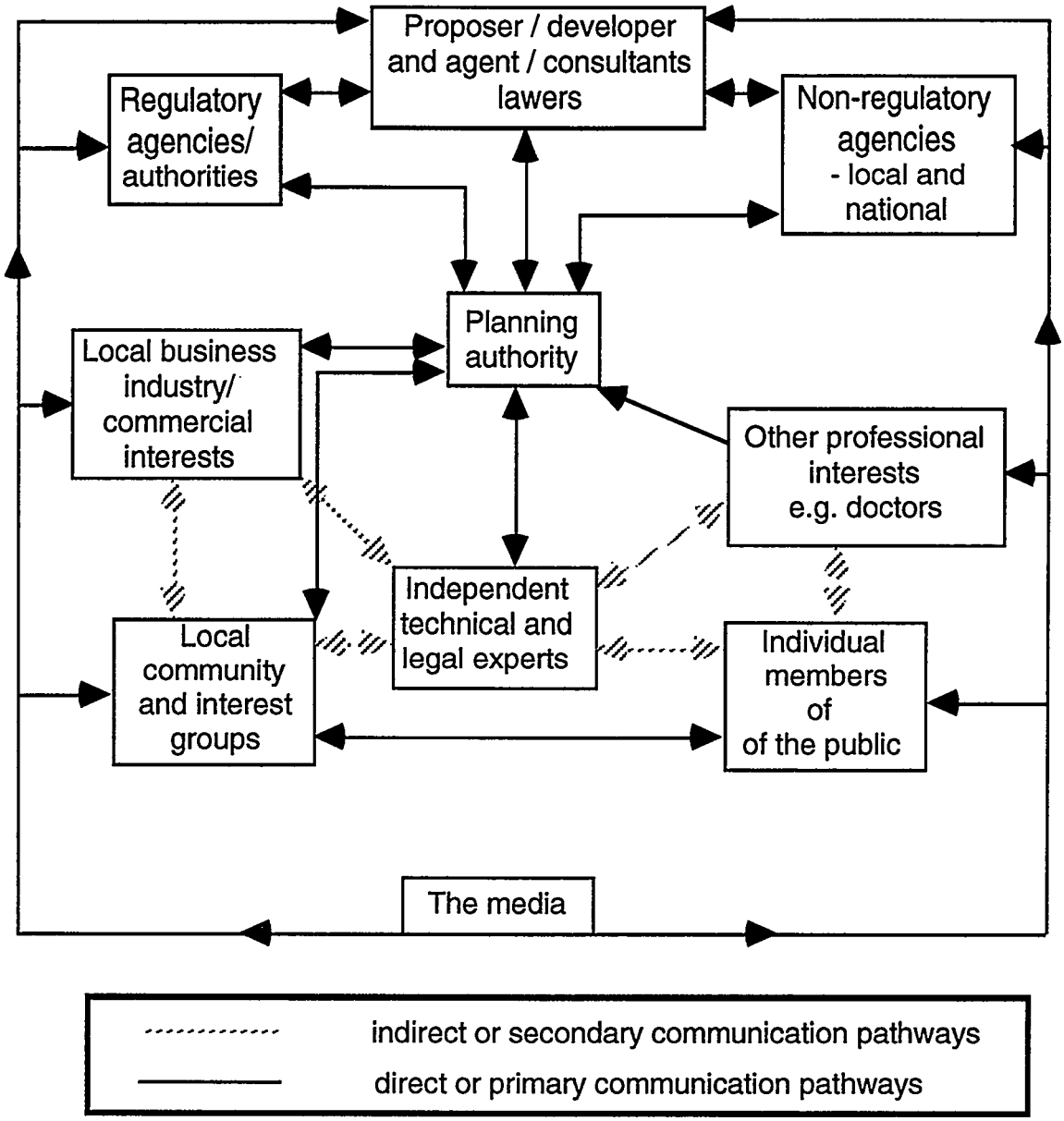

The 'Ladder'
of
Participation
implementation
decision-making
partnership
placating
consulting
informing

Figure 4. Communication Pathways



Source: Petts & Eduljee[28]

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TECHNICAL SESSION I

UTILITY RESTRUCTURING PANEL

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)

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[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

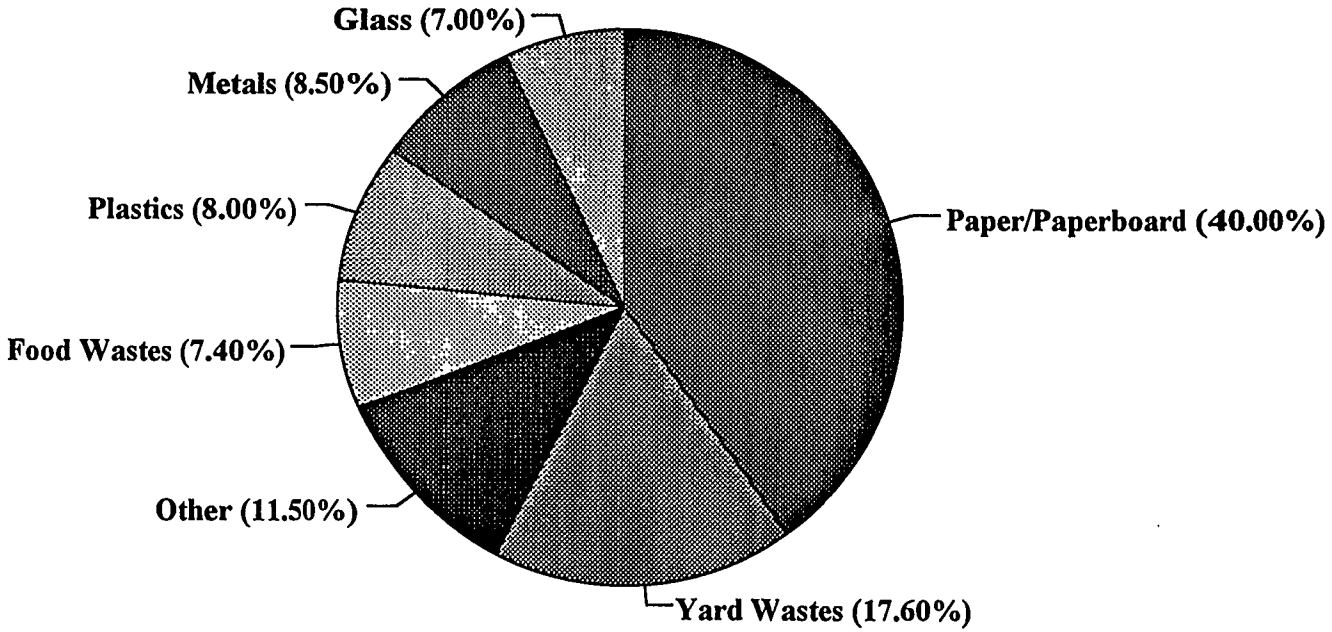

Figure 3

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.

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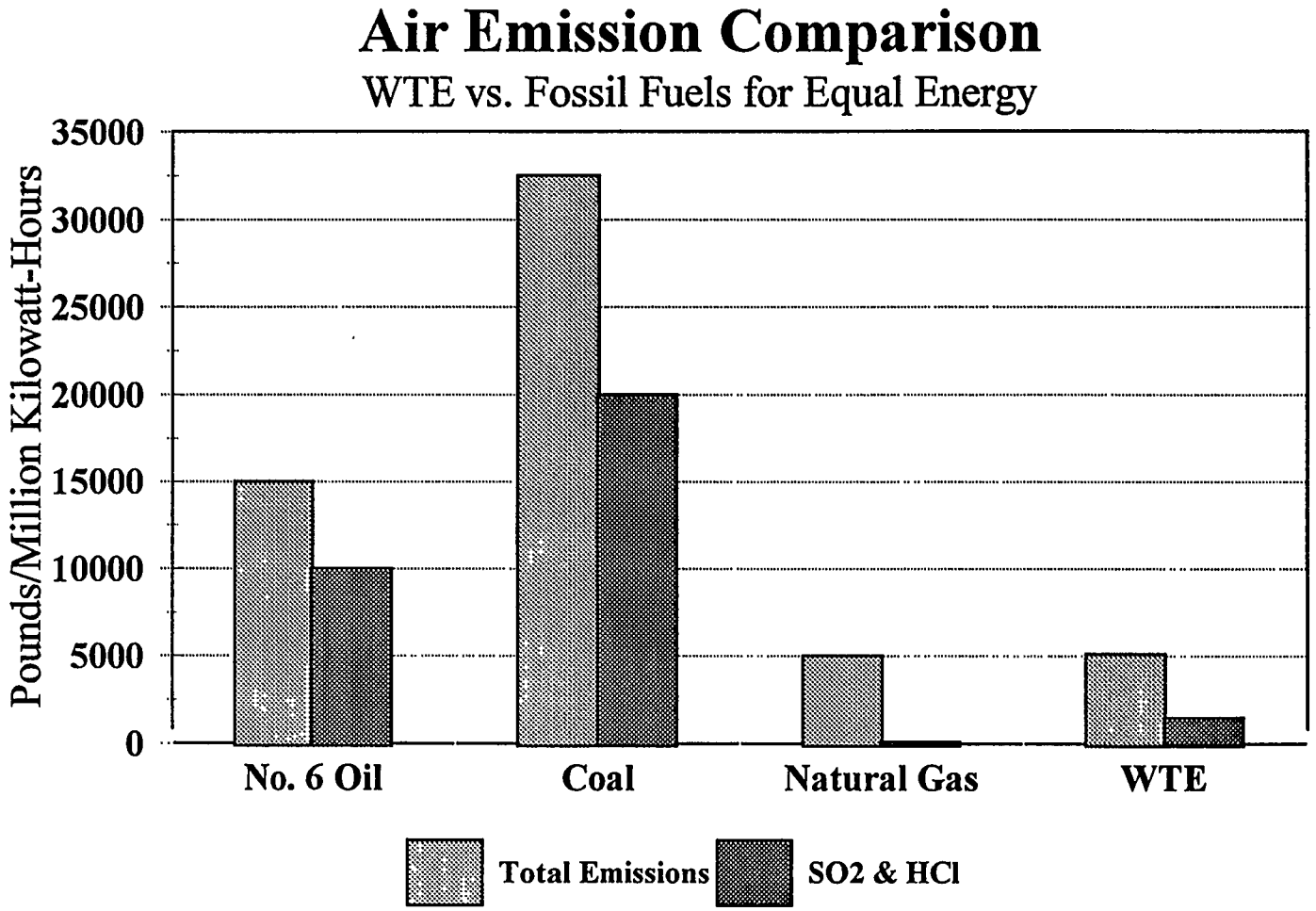
[5] Hunter R. Taylor, "Municipal Waste-to-Energy Facilities Reduce Greenhouse Gas Emissions", Institute of Gas Technology Fourth Annual National Symposium on Municipal Solid Waste Disposal and Energy Production, January 1990.

[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

Pounds of Emission per Megawatt-Hour Generated				
Emission	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.

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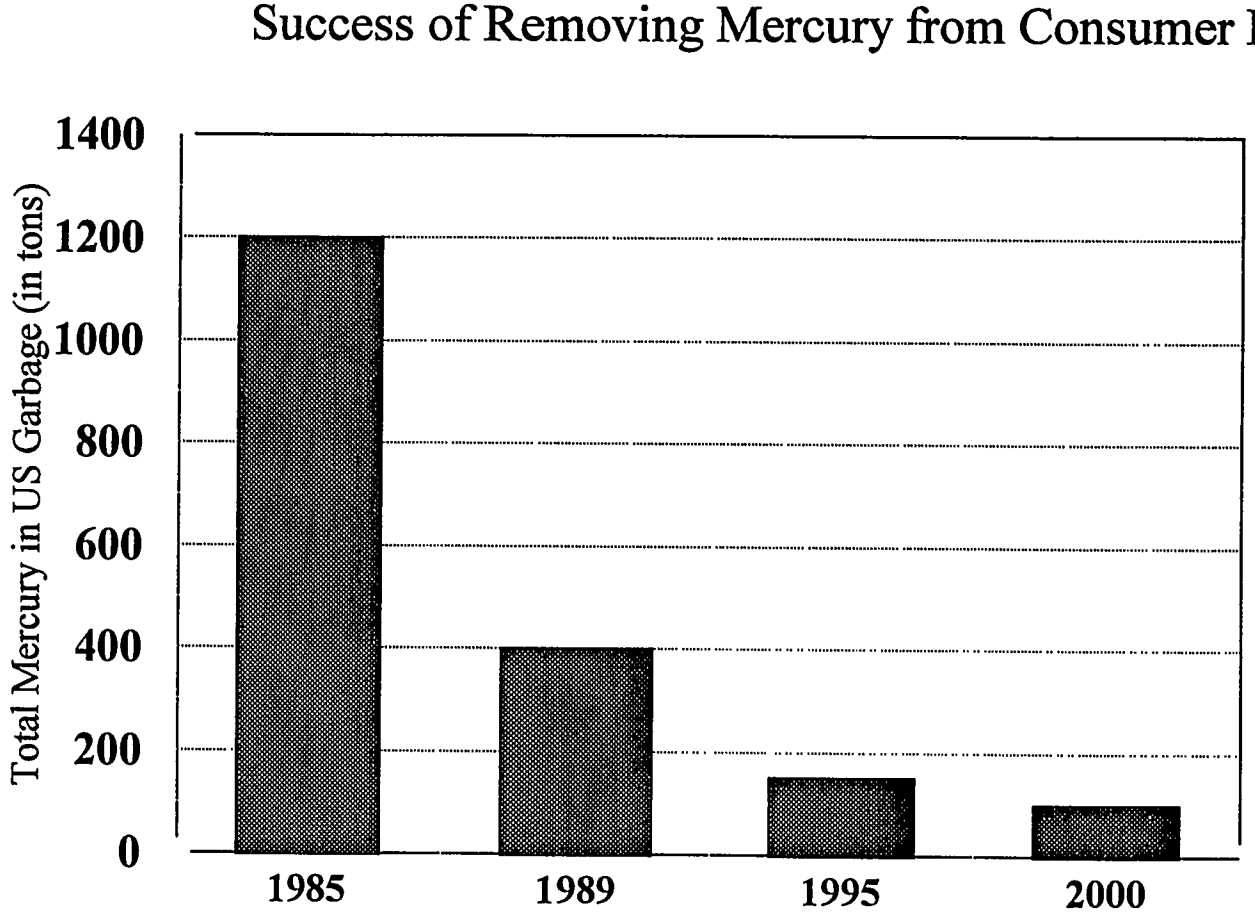
[7] Paul Hawken, *The Ecology of Commerce*, p.139

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



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

Figure 7

EPA's Solid Waste Hierarchy:

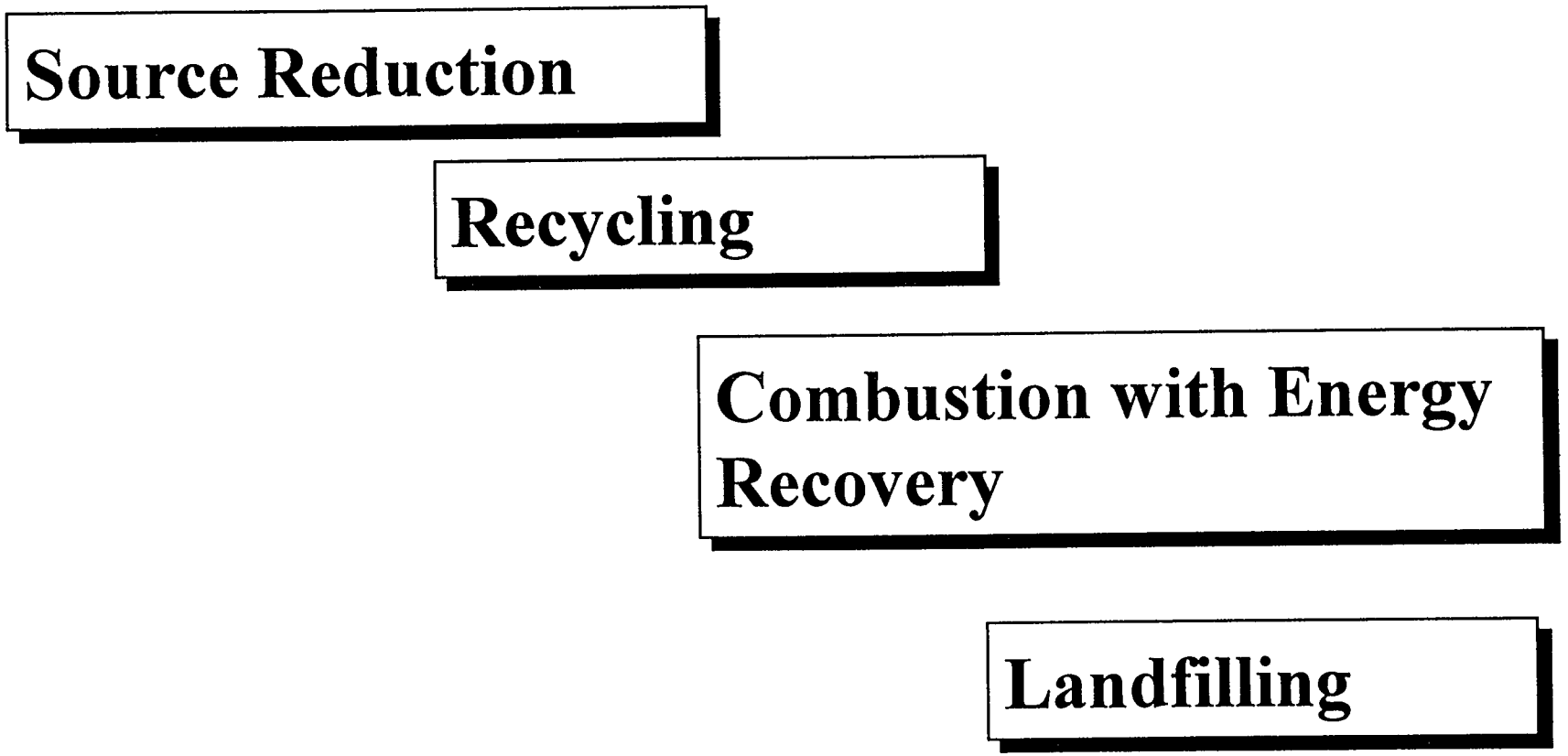


Figure 8

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.

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ERIC P. BOCK

FIFTH ANNUAL NORTH AMERICAN WASTE TO ENERGY CONFERENCE
Panel on Electric Utility Restructuring

Research Triangle Park, N.C.
April 22, 1997

THE ELECTRIC UTILITY RESTRUCTURING DEBATE - A PRIMER

I. Introduction:

Federal and state policymakers continue to push towards more deregulation and greater competition in the supply of electricity in order to reduce its cost to the ultimate consumer. Congress, citing consumer benefits realized by the deregulation of the airlines, telecommunications and trucking, is preparing to act on legislation which would require the states to allow every retail customer to choose its power supplier. Many states, however, are already moving ahead. California, for example, enacted a law last summer which will restructure the state's electric utility industry beginning in 1998 and provide complete retail choice by 2002.

The following information provides a brief overview of the key events which have led the electric utility industry from a stable regulatory regime to this period of unprecedented change. The key issues currently faced by the industry are summarized and those aspects of the debate that are of specific relevance to waste-to-energy development are highlighted. The information is intended as an introduction to the national debate on restructuring of the electric utility industry.

II. Brief Historical Overview

A. The Regulatory Compact

With the advent of the electric light bulb, enterprising companies began to obtain franchises and contracts from towns and cities to provide electric lighting of public streets and other public places. Power plants, fueled primarily by coal and oil, were relatively small and sited near the electric consumers due to the lack of technology for long distance transmission. As the use of electricity grew, competition increased between companies providing electric services to the same general customers. Duplication in facilities and other inefficiencies in service abounded. Eventually, economies of scale led to the consolidation of competing companies but acquisition of duplicative assets by the dominant corporations was, nevertheless, economically wasteful. At the same time, the emergence of the dominant utility raised the potential of unfair price and supply manipulation.

To address these problems, state policy makers established the "regulatory compact" by which utilities were granted an exclusive franchise to provide electric service, and were given a fair rate of return on capital (i.e., regulation based on cost-of service), in exchange for agreeing to reliably meet all electricity demands of the consumers. Interestingly, it is this regulated monopoly structure, which existed at the state level throughout the twentieth century, which is currently being dismantled in order to return to a fully competitive market.

B. The Era of Holding Companies

From 1910 through the 1920s, the number electric utility companies declined, primarily because of consolidation and pyramiding of utilities through holding companies. By 1932, three holding companies controlled 45% of the electricity generated in the United States. Holding companies typically operated in several states preventing any one state from effectively tracking the flow of capital and verifying costs on which the regulated rate of return for an affiliate electric utility company was based. Consequent abuses within the holding company structures, such as self-dealing, cross-subsidization, and issuance of securities based on asset "write-ups", resulted in higher than reasonable rates to consumers and vulnerability for shareholders. More importantly, as the holding companies began to acquire generation and transmission assets in different states, the interstate commerce in electricity could not, under the U.S. Constitution, be regulated by the states but only at the federal level.

C. The Public Utility Holding Company Act (PUHCA) and the Federal Power Act (FPA)

In 1935, Congress responded to these regulatory gaps by enacting PUHCA and the FPA which were to work in tandem.

1. PUHCA

Under PUHCA, holding companies are defined as owning, directly or indirectly, 10 percent or more of a gas or electric utility company. The key provision of the Act limits the operation of a holding company to a single and integrated public utility system and limits diversification to such businesses that are reasonably incidental or economically necessary or appropriate to the functioning of such an integrated system. The Act prohibits inter-company loans, service contracts and sales and strictly regulated, through the Securities and Exchange Commission, asset sales and acquisitions and other financial transactions within the holding company. The Act also provides exemptions for a holding company, which would otherwise be required to register with the SEC and become subject to regulation under PUHCA, if its business operations and those of its subsidiaries occur "predominantly" in one state, or if it is predominantly a public utility and its operations are confined to the state in which it is organized and states contiguous thereto.

2. The FPA

The FPA granted the Federal Energy Regulatory Commission (FERC), then called the Federal Power Commission, authority to regulate the "transmission of electric energy in interstate commerce and the sale of energy at wholesale [sale for resale] in interstate commerce" by private sector utilities, approve sale, merger and acquisition of electric facility assets, set "just and reasonable rates", and "promote and encourage" interconnection of electric utilities within a given region. Generally, where requirements of the FPA overlap requirements of PUHCA, the latter requirements apply. The FPA, as originally enacted, did not give FERC the authority to mandate a transmission owning utility to wheel power for another utility engaged in wholesale sales.

D. Era of Instability

During the 1930's, the federal government focused on expanding the use of electricity in remote and underdeveloped areas of the country through the creation of federal power marketing agencies ("PMAs") to develop and sell hydropower, such as the Tennessee Valley Authority and the Bonneville Power Administration. In the 1960's the federal government's focus shifted to encouraging the development of "cheap" nuclear power and ensuring coordinated planning and operation among utilities for regional reliability purposes. Growth in the sophistication

of the electric utility industry and electricity consumption increased significantly during the four decades.

In the early 1970s, however, the nation experienced a dramatic rise in the cost of generating electricity, resulting from a combination of the 1973-74 Arab oil embargo, high inflation, new environmental regulations, and the demise of the nation's nuclear power plant construction program. Proposed rate hikes by utilities were often suppressed by the public utility commissions. Consequently, the nation began to seek greater efficiencies and stable rates from utilities, a reduction in dependence on foreign oil (as well as domestic oil and gas), and a diversity in the technologies used to generate electricity.

E. The Public Utility Regulatory Policies Act (PURPA) and Non-utility Generators

In 1978, Congress enacted PURPA to encourage energy conservation, energy efficiency through measures such as cogeneration, contingency planning by utilities, adoption of "life line" rates, and development of electricity generation from small renewable resources. PURPA also granted FERC the authority to mandate wholesale transmission wheeling, but placed preconditions to the exercise of such authority which severely limited its usefulness.

Section 210 of PURPA requires utilities to buy power from qualifying cogeneration facilities and qualifying small power production facilities (termed "QFs"), at the utilities' full-avoided cost, i.e. the cost to a utility of generating the same energy or purchasing it from another source. The "must take" aspect of PURPA gave birth to a whole new industry of third party generators, introducing competition into the electric utility industry, and thereafter, aggressively advancing it. In particular, the economics of most waste-to-energy projects, whose development was strongly encouraged by the Resource Conservation and Recovery Act (RCRA)enacted by Congress two years earlier, improved significantly. Proponents of PURPA cite the almost 25% reduction in the nation's electricity prices since 1982 as evidence of the Act's success.

PURPA exempted QFs from regulation under PUHCA and the FPA. However, PURPA prohibits utilities from owning QFs. Additionally, the megawatt capacity of QF's have to meet size limits specified in the Act, and QFs have to meet certain operating, efficiency and other standards established by FERC.

F. Energy Policy Act of 1992 (EPAct)

Two key factors led to the enactment of EPAct. First, the growth of third party generators created a greater demand for guaranteed access to the transmission facilities of traditional

utilities. Secondly, companies that operated non-utility and utility businesses argued that their ability to compete in the wholesale power market was stifled by fear of having their operations regulated under PUHCA. The non-utility generators, in particular, had to develop complex and inefficient corporate structures to avoid PUHCA regulation.

1. Transmission Access

In response, Congress in EPAct provided FERC with clear authority to order any utility owning transmission to provide transmission service (including enlargement of transmission capacity if necessary) to any other entity generating electric energy for resale, and to set rates, terms and conditions for such service. However, the procedure set forth in EPAct for obtaining a "wheeling" order from FERC is time consuming. Recognizing this, FERC used the new authority granted by EPAct to issue Order 888, discussed below, which requires open transmission access to be standard operation for the industry.

A proposal developed during formulation of EPAct, although not included in EPAct but adopted as policy by FERC eight months after the Act's enactment, supported creation of regional transmission groups (RTGs) by which all users of a transmission grid voluntarily coordinate planning, establish dispute resolution procedures, and transmission owners obligated themselves to provide transmission service. Several RTGs have been established in the western part of the nation.

2. Exempt Wholesale Generators

The Act also boosted competition in the electric generation sector by establishing a new category of independent generation facilities to operate in the wholesale market that are exempt from the geographic integration, financial and corporate structure restrictions in PUHCA. Termed exempt wholesale generators or "EWGs", these facilities are not limited by the size, renewable energy source or cogeneration constraints of PURPA. Both registered and exempt holding companies under PUHCA can own and operate EWGs.

Although the EWG does not have to be a separate, but may be an undivided share of, a power plant, a regulated utility may not convert an existing plant into an EWG without approval from its state regulator. In addition, an EWG may not sell power to an affiliated utility unless every state regulating the utility approves. State regulatory agencies are to make these decisions based on considerations of public benefit and fair competition, and they are given authority to examine all necessary financial information of the purchasing regulated utility, the EWG, and any affiliate companies of the EWG.

III. FERC Orders 888/889

In the wake of EPAct, FERC moved aggressively to open the nation's transmission grid. This effort culminated with FERC's issuance of Order 888 and Order 889 in April, 1996.

A. Functional Unbundling

To ensure non-discriminatory open access to transmission for all wholesale power suppliers, Order 888 requires vertically integrated utilities to unbundle their generation/power marketing functions from their transmission functions. Order 889 imposes standards of conduct on the utilities to ensure that employees operating the transmission system do not provide to employees involved in power marketing competitive information which is not available to all other sellers and customers,. Order 889 requires the utilities to establish an electric information network (termed "OASIS") in order to provide information on transmission capacity to potential transmission customers, and requires them to obtain information about its transmission system from the same network when buying or selling power.

B. Open Transmission Access

Order 888 has essentially transformed the nation's transmission grid to common carrier status by requiring open access transmission by all public utilities that own, operate or control facilities for interstate transmission, and requiring them to file tariffs with FERC that offer other generators of wholesale power the same transmission services they provide themselves, under comparable terms and conditions. Utilities must take transmission service for their own wholesale transactions under the terms and conditions of the tariff. These terms and conditions must meet the minimum pro-forma standards, set forth in the Order, for providing transmission services and six specified ancillary services. The ancillary services range from those which are needed to effect the transaction (such as scheduling and dispatching) to services necessary to maintain the integrity of the transmission system during the transaction (such as voltage control). Utilities must establish separate rates for wholesale generation, transmission, and ancillary services to allow customers to compare such rates between utilities and other suppliers.

Intra-pool or intra-system transactions for power pools, some holding companies and other multi-lateral agreements must be under a joint, pool-wide or system-wide tariff in which all previous preferential transmission access and pricing provisions among members have been removed. Finally, the Order requires that any other entity that owns, controls or operates transmission facilities, including government-owned utilities,

and receives open access service must reciprocate by providing open access service to the transmitting utility upon request.

C. Creation of Independent System Operators

Although Order 888 did not require operational unbundling - i.e., require the utilities to establish structural institutional arrangements, short of divestiture, that would separate operation of the transmission grid and access to it from economic interests in generation - it did encourage such unbundling by supporting creation of independent system operators (ISOs). ISOs would operate a geographically-defined transmission grid, independent from the owners of the transmission facilities comprising the grid who would convey control to the ISO, to provide transmission service and the six ancillary services on an open and non-discriminatory basis to all generators of power.

D. Federal/State Jurisdiction

In Order 888, FERC asserts jurisdiction over the rates, terms and conditions of unbundled retail transmission in interstate commerce by electric utilities, but left authority over local distribution, and over the service of delivering electric energy to end users, to the states. The Order adopted seven local distribution function indicators that the Commission will use to determine where to draw the jurisdictional line for facilities used in unbundled retail wheeling transactions.

E. Stranded Cost Recovery

FERC authorized any transmission owning utility to seek recovery of stranded costs from departing wholesale generation customers through either an exit fee or a surcharge on transmission service. For stranded costs associated with new wholesale requirements contracts, stranded costs recovery is only allowed if the contract contains an explicit stranded cost provision that permits recovery. Stranded costs resulting from departing retail customers are to be addressed by the state, but FERC declared it to be the primary forum for stranded cost determinations when a retail customer becomes a legitimate wholesale customer, such as through municipalization.

IV. State Restructuring Efforts

From the beginning of 1995 through the end of 1996, regulators in 46 states and the District of Columbia initiated, completed, or participated in formal generic, company specific, or informal processes that directly addressed retail wheeling, competition, restructuring, or alternative forms of regulation. In some states, retail wheeling pilot programs or experiments have been instituted by regulators. Legislation addressing these

same issues or establishing special study groups have been filed, introduced, or passed in 35 states since the beginning of 1995.

The states with significant restructuring activities currently are California, Arizona, Maine, Massachusetts, New Hampshire, Pennsylvania, Rhode Island, and Texas. In addition, the Pennsylvania-New Jersey-Maryland (PJM) power pool, California's three investor-owned utilities, and the New York Power Pool have filed ISO proposals with FERC. At least five other ISO-type structures are being planned in the Pacific Northwest, the Midwest, Wisconsin, Texas, and in New England. In several cases, the particular ISO is an integral part of an individual state plan to ultimately provide retail access.

V. Key Issues in the Restructuring of the Electric Generation, Transmission and Distribution Markets

The following provides a brief description of the key restructuring issues relative to the three main market components being addressed at the federal and state levels. Additional discussion on some of the issues is set forth in Section VII, Congressional Initiatives.

A. The Electric Generation Market

1. Mitigating Market Concentration

In states where the current regulated market is significantly concentrated and dominated by a small number of large vertically integrated power producers, regulators may decide that the competitive process will not work unless some or all of the generating assets of the concentrated utilities are divested or placed into an independent subsidiary. Such utilities, however, may be opposed to mandatory divestiture or corporate restructuring.

2. Stranded Cost Recovery

Regulators which decide to open electricity markets to competition will no longer regulate traditional utilities and guarantee that they receive a fair rate of return on their investments. Accordingly, the same regulators will have to decide whether such a utility should be permitted to recover prior investments in generation capacity, which were made to provide electric service to its captive customers, when such utility cannot sell some or all of its power in the competitive marketplace for a price high enough to earn a fair return on those investments. Such stranded costs would include liabilities arising from purchased power contracts under PURPA's "avoided cost" rule and long term contracts for fuel or purchased power.

An important collateral decision is the appropriate method for valuation of stranded costs. One approach to determine such costs would be to require sale of the stranded assets and allow recovery of the difference between market price and book value. FERC, in Order 888, proposes to use an administrative proceeding based on the "loss of revenues" that would have been gained but for the introduction of open competition. However, the approach has been criticized because of the tremendous forecast risks.

Additional decisions relate to how stranded costs should be recovered (options include a transmission access charge or surcharge, a utility system exit fee, and an fee for entry into the newly opened market), who should be required to pay for recovering such costs, and to what extent the utility should be required to mitigate or minimize stranded costs (e.g., through buy-outs or buy-downs of PURPA contracts).

3. PURPA Reform and the Role Of Renewables

The reform of PURPA, and specifically the proposed repeal of Section 210, arguably is one of the most important restructuring issues to the waste-to-energy industry. Proponents of PURPA reform suggest that the statute has been overtaken by events - principally the push for a more competitive marketplace in electric power generation. It is argued that PURPA's assumption that utilities would continue to be the exclusive suppliers of electricity and could, therefore, assure retail buyers for QF generated power, is no longer valid.

PURPA opponents further complain that the law has inordinately boosted consumer costs because, in many cases, the avoided cost price was tied to long run forecasts of petroleum prices which proved, ex post, to be far too high, and FERC prevented utilities and the states from adjusting the contract price after the initial contract was signed. It is claimed by traditional utilities that PURPA is the single largest factor in explaining the regional disparity in electric prices and that PURPA contracts compromise a large percentage of the stranded costs nationwide. In response, some states are considering requiring the QF owners to reopen their long-term contracts and negotiate more "realistic" prices with their utility clients as a precondition to allowing the QFs to compete in the retail market. Federal legislation introduced last year would have abrogated existing PURPA contracts under certain situations.

Significantly, the proponents of PURPA reform have argued that PURPA's objective of promoting renewable fuels has not been realized since gas, coal and oil make up 68% of the installed non-utility generating capacity.

Most renewable energy sources still generate power at a cost which will not be competitive in an open and fully interconnected

market. If the "must take" provisions in PURPA are repealed, state and federal policy makers will have to decide whether a different mechanism should be established to encourage development and use of renewable energy sources. Two mechanisms being considered by policy makers are mandatory minimum renewable energy portfolios for all suppliers of power and the imposition of surcharges on transmission service to be used by the states to fund and encourage development of renewable energy projects. However, such mechanisms may be resisted by utilities who have urged that no sector of the industry should be given a "subsidy" and by others who view the competitive stature of most renewables as already comparable to other generators participating in the market.

4. PUHCA Reform

Those seeking reform of PUHCA believe that market competition is stifled by requiring holding companies to adhere to the restrictions of PUHCA on their financing, affiliate transactions, and acquisitions and divestitures of generation and related assets. The latter issue is the key reason underlying the push for reform by the holding companies. They argue that FERC's review of mergers and acquisitions, similar review of acquisitions by states, federal anti-trust statutes, and the recognized efficiencies of holding company ownership of utilities in noncontiguous states in many cases, justify repeal of the ownership limitations in PUHCA.

In addition, many believe that the federal court decision in the *Ohio Power* case, which ruled that FERC is not authorized to evaluate the reasonableness of costs from affiliates of registered holding companies or disapprove affiliate charges that are demonstrably too high, should be overturned. The states have been similarly restricted.

A collateral issue, if the PUHCA restrictions are removed, is what respective authority should be provided to FERC, the states, or the SEC to review books, records and financial transactions of the holding company and its affiliates to ensure that consumers and shareholders are protected. Sub-issues are which companies or subsidiaries of currently registered holding companies would be subject to the review authority, and whether federal access to records should be authorized, and under what conditions, where the sole purpose is to provide them to the state regulators.

Finally, it has been argued that PUHCA's diversification restrictions stifle competition and economic efficiency because they limit the ability of other companies to enter the utility business and limit public utilities from entering into unrelated but profitable businesses.

5. The Role of Government-Owned Utilities

Federally owned utilities, i.e. the federal power marketing agencies such as TVA, and state or local government-owned utilities will be free to compete in the marketplace. However, some private utility interests view such competition to be unfair, because government-owned utilities can use tax-exempt financing to raise capital, are exempt from FERC's authority requiring filing of transmission tariffs, and have preferential access to cheap federal hydropower. It has been suggested that these advantages be removed to "level the playing field" between private and government-owned utilities and that the PMAs be privatized. (Incidently, the "level playing field" argument has also been used to argue for the removal of existing tax credits and incentives currently provided to specific types of renewable generation sources.)

6. Local Generation

Rapid technological change in generation technology has decreased the benefits of economies of scale inherent in traditional, large central station power plants. The size of these plants have typically required them to be located in remote non-developed lands. Accordingly, long-distance transmission from these plants is required at a cost which can be relatively significant, especially where there is high demand for transmission over capacity limited pathways, raising the total cost of delivered power to the consumer. Current technologies, however, best represented by modular, highly efficient, natural gas-fired generation units, which occupy less land, create the opportunity to site generating facilities nearer to the consumer, within or near urban areas, or at an industrial or commercial site. Additional technological breakthroughs could also create more local generation options, such as electric storage systems and those which will allow economically efficient aggregation of potential local generation resources which, individually, may have marginal economic value(e.g., small local landfills producing methane).

State regulators, in their role of ensuring long term availability of energy and capacity within their states, may support local generation over remote generation sources for several reasons in addition to lowering transmission costs: greater state control over the generation resource itself and to enhance reliability and stability of the regional and local energy supply system. It is worth noting that waste-to-energy projects are ideal local energy sources since locally generated solid waste can supply electricity to the same entities which generated that waste.

B. The Electric Transmission Market

Transmission is a natural monopoly susceptible to monopoly pricing and for this reason is expected to remain regulated. However, efficiencies can be gained if individual but interconnected transmission facilities are subject to coordinated and joint operation. FERC, in Order 888, encouraged states to consider requiring transmission owning utilities to unbundle operation of their transmission from their other utility functions and adopt appropriate structural measures to achieve these efficiencies. A key issue is whether such structural measures should be mandatory, and if so, what those structures should be.

The debate on structure has focused on two broad models for delivery of electricity under deregulation both of which recognize that there must be an independent grid operator (i.e., an ISO) but the models differ on the scope of the ISO's responsibilities. The first is direct access, where buyers and sellers of power are able to negotiate directly and the transmission grid, operated by the ISO, simply functions as a contract path to consummate the transactions. The second is a centralized power pool, where the pool sets a transparent market clearing price and the ISO dispatches power according to the principles of economic dispatch over the grid, which functions as a integrated contract network. An important collateral issue related to the functioning of a pool is how the market clearing price will be determined.

As noted in the earlier discussion on FERC Order 888, to effectuate a transmission transaction at least six ancillary services need to be provided in addition to the actual use of the transmission facilities. Some of these services, such as the provision of sufficient operating reserves, depend on the use of generating units connected to the transmission grid and will be priced and provided on a competitive basis. Existing owners of waste-to-energy projects should determine whether their generating units, in addition to supplying power to their customers, can competitively provide such services to third parties who seek transmission service.

C. The Electric Distribution Market

As is the case for transmission, the consensus is that electricity distribution is a natural monopoly characterized by significant economies of scale and scope, and, therefore, needs to be regulated. FERC, in Order 888, did not propose to require vertically integrated utilities to unbundle their distribution functions from the wholesale transmission functions, leaving it up to the states to decide how to ensure open and non-discriminatory access to distribution facilities.

1. Performance-Based Ratemaking (PBR)

A key issue is whether traditional cost-of service regulation of distribution facilities should be replaced in order to ensure that the distribution functions are done as cost-effectively as possible. As part of a decision to introduce retail access, where the distribution grid becomes a common carrier, some states are considering PBR for regulating the electricity distribution system, which involves setting a baseline revenue requirement, establishing incentives to encourage managers to produce at a cost below this baseline, as well as implementing a quality control mechanism.

2. Metering and Aggregation

Another key issue is how small residential customers can be given both meaningful choice in the electricity market and sufficient bargaining power to exercise that choice. Small customers will be unable to fully optimize on hourly prices in the spot market unless they have appropriate meters that yield both spot prices and level of their usage. The states will have to decide whether such metering should be mandatory and who should pay for their installation and maintenance. Metering concerns may be simplified by authorizing aggregation, where electricity is sold to a single buyer, other than the original regulated monopoly distribution company, which represents a number of customers.

3. Meaningful Consumer Choice

The regulator will have to decide what energy services a supplier at the distribution level must offer to the consumer. Such services could include billing services, availability of "green" energy (e.g., energy produced from the combustion of solid waste), and choice regarding the level and quality of electric service, i.e., quantity, peak v. off-peak, firm v. non-firm, and reliability. The emergence of "one-stop" utility services suppliers is likely if PUHCA restrictions are removed by federal legislation. For example, a company could offer to provide solid waste collection, sell energy generated by combustion of the waste , and provide all related billing services to the customer. Another example, made possible by the recently enacted Telecommunications Act, is a company offering both telecommunications and electric utility services.

VI. Other Issues Related to Restructuring of the Electric Utility Industry

A. Air Quality Concerns

EPA, the environmental community, and, in particular, states in the Northeast have expressed strong concerns that deregulation

of the electric utility industry will complicate the efforts of states and regions that are struggling to come into attainment with the Clean Air Act. Their position is that deregulation will drive-up demand for cheap coal-based power from plants currently subject to less stringent air pollution control requirements, primarily located in the Midwestern states. The result, it is argued, would be an increase in ozone forming nitrogen oxide emissions which would travel into the Northeast and damage state attainment plans there. Some have proposed that a mandatory system be established that would place a surcharge on any power that is wheeled from an area without heavy environmental restrictions to an area that faces more stringent technology control requirements.

The concern over air quality impacts resulting from a restructured industry, has raised related arguments, by some in the environmental community, that all generating resources should be ranked and their price of power set to reflect "an environmental impact balance sheet" where all externalities of the respective generating units are considered. Greenhouse gases are perhaps the most often cited externality. Certainly, waste-to-energy projects should fare well in such a system due to their value in disposing of solid waste while generating electricity. Although some states are looking at evaluating "externalities" in making power resource decisions (e.g., Oregon is considering applying a CO2 emissions standard in decisions on siting generating units), it is presently not clear whether the restructuring debate will be expanded to seriously deal with the issue.

B. Stranded Benefits: Public Responsibility Programs

Virtually all state regulatory agencies have mandated so-called "public responsibility programs" that impose on electric utilities requirements, beyond simply delivering reliable electricity at lowest costs, in order to further social and environmental policies. Utilities have been required to participate in low-income ratepayer assistance programs; energy conservation programs, including adopting baseline rates established both to protect ratepayer as a class from high rates and to require surcharges for energy use above the baseline; research and development programs; and programs to encourage energy efficiency and renewable energy production. With restructuring, such programs could become "stranded benefits" since it would be unfair to require the regulated utility to alone fund them after it no longer is the sole provider of utility services. Unless new policies and, likely more complex, regulations are put in place to ensure sufficient funding, these programs are in jeopardy.

VII. Congressional Initiatives

Key members of the House and Senate have made federal legislation to comprehensively restructure the electric utility industry down to the retail level a top priority for the 105th Congress. The two key bills introduced this year are S 237 by Senator Dale Bumpers (D-AR), Ranking Member on the Senate Energy and Natural Resources Committee, and HR 655 by Congressman Dan Schaefer (R-CO), Chairman of the Energy and Power Subcommittee of the House Commerce Committee. The Clinton Administration is also drafting legislation which is likely to be based on a preliminary draft bill prepared by the Department of Energy (DOE). The discussion below compares how the three bills address the critical issues identified in the previous section.

An additional and critical issue to be resolved at the federal level, and not clearly addressed by the three bills, is whether, or to what extent, federal legislation should preempt actions which may have already been taken by the states. Depending on how one has fared under a restructuring approach taken by a state, federal preemption may or may not be desirable. For example, California's abandonment of a mandatory minimum renewable resource portfolio for all suppliers of power and adoption, instead, of a mechanism to collect $540 million over a four year period(through the imposition of a distribution system usage fee)to enhance renewable energy development, has been criticized by the renewable energy industry but supported by the state's electric utility companies.

Finally, demands by the traditional electric utility companies that the competitive "playing field be leveled", through elimination of tax-exempt financing by local government utilities and special tax subsidies to particular types of power generating technologies, may result in separate action by Congress on legislation amending the tax code.

A. Retail Access

HR 655 and S 237 would establish a federal mandate for all electric utilities, including public power systems, to implement retail wheeling by December 15, 2000 and December 15, 2003, respectively. Retail access plans adopted prior to enactment of the bills cannot be preempted if the plans satisfy the bills' requirements. Under the DOE bill, states would have until January 1, 2000 to decide whether or not they will require retail wheeling or implement a wholesale competitive procurement model.

Under HR 655, if a state failed to adopt retail access, FERC would be authorized to act as a "backstop" and implement retail wheeling in the state. Upon the effective date for retail choice in a state, the state regulatory authority will be prohibited from regulating the rates of retail providers of electricity.

B. Stranded Costs

Both HR 655 and S 237 authorize state regulatory agencies to recover stranded costs through a separate charge as a pre-condition to a retail transaction by a former customer. S 237 expressly authorizes the state regulatory authority in calculating the amount of its stranded costs to require utilities to mitigate such costs or require the utility to sell, or to ask FERC to order sale of, all of its generating facilities and subtract the revenue received from the book value of the assets sold.

C. PURPA Repeal

The three bills all would repeal the mandatory purchase provisions of PURPA on a prospective basis. Repeal would occur under HR 655 once a state determines that all customers of an electric utility have retail choice; under S 237, upon its enactment, but only for PURPA facilities beginning commercial operations thereafter; and under the DOE bill, if a state regulatory authority adopts either the retail competition or wholesale competition models set forth in the bill.

All three bills would establish a minimum generation requirement for renewable energy, a so-called "portfolio" standard. All generators of electricity that sell power would be required to submit renewable energy credits to FERC on an annual basis. Credits could be obtained either by directly investing in renewable energy generation or by purchasing renewable energy credits on the open market from those having made such investments. The minimum renewable energy that would be required equals: two percent of a utility's generation increasing to four percent in 2010 under HR 655, five percent in 2003 increasing to twelve percent in 2013 under S 237, and five percent under the DOE bill.

The benefits of the renewable portfolio requirement to the waste-to-energy industry depends on how a "renewable resource" is defined. HR 655 and the DOE bill do not exclude energy derived from municipal solid wastes from the definition of a renewable resource. Unfortunately, S 237 currently defines the term to exclude this energy resource because of opposition from certain environmental groups to the use of waste-to-energy technology. The opposition appears to be based on two main concerns: air emissions, and in particular dioxins; and fear that waste-to-energy facilities could absorb a large amount of whatever set-asides/subsidies/or credits Congress may provide to the renewable industry to the disadvantage of less technologically mature renewable energy sources.

A bill expected to be introduced by Congressman Markey (D-MA), a key member of the House Commerce Committee on the

restructuring issue and a strong supporter of renewable energy, would condition relief from PURPA within a given state on whether the state instituted retail wheeling or mandatory generation divestiture by utilities and met minimum standards intended to preserve renewable energy development, energy conservation, and low-income consumer protections. The legislation is expected to allow a state, until full retail competition is established, to establish a bidding process to meet the state's energy capacity needs in which a specific percentage of bidding QFs would have to be renewable energy sources. Such a provision would overturn a portion of FERC's 1995 ruling invalidating California's proposed methodology of calculating full-avoided cost which took this approach.

D. PUHCA Repeal

Under HR 655, PUHCA would cease to apply to holding companies, on an individual basis, once each state in which the holding company operates determines that all customers have retail choice of electricity. S 237 would repeal PUHCA one year after the date of enactment. The DOE bill would allow FERC to remove a PUHCA restriction relative to a holding company if it determines that the restriction is not relevant to the power rates charged by the holding company or its affiliates. All three bills require holding companies (including their subsidiaries, affiliates and associate companies) to maintain and make available to FERC all books, records or other documents that FERC deems relevant to power costs and necessary for the protection of consumers. State regulatory agencies are authorized to gain access to the books and records of the holding company and its affiliated companies.

E. Mitigation of Market Power

Under the DOE bill, for states that adopt retail competition, if the state commission believes that a utility in the state has market power, FERC may order remedial action including divestiture of generating resources.

F. Public Benefit Programs

HR 655 and S 237 authorize state regulatory agencies to impose charges to fund public benefit programs, including universal service, provided such charges are imposed on a nondiscriminatory and competitively neutral basis. The DOE bill establishes a National Electric Systems Benefits Fund (NESBF) to provide matching funds to states to support conservation and energy efficiency, renewables, universal service, and research and development.

G. The Level Playing Field

HR 655 prohibits the resale of federal preference power by state and local government utilities to customers outside their current service territory. S 237 authorizes TVA to sell retail and wholesale electric energy outside of its service territory but authorizes TVA's retail and wholesale customers to buy energy from other sellers.

H. Independent System Operators (ISO)

S 237 requires that FERC, within two years, establish transmission regions and designate an ISO to manage and operate all of the transmission facilities in each region beginning on December 15, 2003. States making up a particular transmission region can form a Regional Transmission Oversight Board to oversee the ISO and would be given the same authorities FERC currently has over transmission pursuant to the Federal Power Act.

I. Regional Regulatory Agencies

Under the DOE bill, two or more states may agree to establish a regional regulatory agency (RRA), which will have authority over transmission of electric energy and sales for resale in interstate commerce (including the authority to require transmission access and to set rates and terms of service).

J. Air Quality Impacts

S 237 requires EPA to submit a study to Congress by January 1, 2000, on the impacts of restructuring on the emissions of air pollutants, and to recommend necessary changes to law to protect public health and the environment.

VIII. Conclusion

Proponent of waste-to-energy projects need to be familiar with the many restructuring issues that directly and indirectly affect the viability of these projects. Vigilant monitoring of developments to restructure the electric utility industry will be required, first at the state level, where the majority of action is currently taking place, and secondly in Washington, D.C., both at FERC and in Congress. Active participation in the debate at the state and federal levels is encouraged. Above all, proponents of waste-to-energy projects should avoid being taken by surprise and have the capability to intervene on a timely basis if necessary.