

PRESS RELEASE – US-EPA REPORTS PROVE WASTE AS RENEWABLE ENERGY IS ENVIRONMENTALLY SUPERIOR TO ANY FOSSIL FUEL

FACT 1: Based upon emissions alone, modern waste to energy technology is environmentally superior to firing of any fossil fuel (including natural gas!).

FACT 2: Its environmental superiority is substantially enhanced by its greenhouse gas reduction benefits and application as a renewable energy provider.

THE CASE OF ENVIRONMENTAL SUPERIORITY BASED UPON EMISSIONS ALONE:

This document contains a detailed comparative analysis of emissions that proves modern waste to energy technology produces less HAP's (hazardous air pollutants), including dioxins than any fossil fuel for the equivalent energy output. The comparative analysis is solely based upon the most updated US-EPA official research data and reports on fossil fuel emissions. Summary of the comparative analysis is per Table 1 below.

TABLE 1: SUMMARY OF HAP EMISSIONS (*)

I T E M	DESCRIPTION	GASIFICATION TYPE WASTE TO ENERGY SYSTEM	DISTILLATE FIRED INDUSTRIAL BOILER	NO. 6 FUEL OIL FIRED INDUSTRIAL BOILER	COAL FIRED INDUSTRIAL BOILER	WOOD FIRED INDUSTRIAL BOILER	NO. 6 FUEL OIL FIRED POWER STATION	COALFIRED POWER STATION	NATURAL GAS FIRED POWER STATION	GREENPEACE "RAINBOW WARRIOR" SHIP / SMALL SHIP
1	BASIS OF EVALUATION:	Per 10.0 MWt Energy Output	Per Equivalent Energy Output	Per Equivalent Energy Output	Per Equivalent Energy Output	Per Equivalent Energy Output	Per Equivalent Energy Output	Per Equivalent Energy Output	Per Equivalent Energy Output	Per One (1) Single Ship
2	DIOXIN EMISSIONS	x 1 (Datum)	x 2	X 25	x 76	x 178	x 2	x 4	No Data Available	x 2
3	AVERAGE OF ALL OTHER HAP EMISSIONS	x 1 (Datum)	x 9	x 33	x 203	x 104	x 1.3	x 5	x 5	x 37

(*) Based upon the most updated US-EPA official research data and reports on fossil fuel emissions. For verification refer to references and calculations contained herein the detailed comparative analysis.

SAGA OF MISLEADING INFORMATION: Why then is the public and some academics perception so different from the facts in Table 1 above? It's because misleading information is the basis of their perception. That is, the US-EPA is the instigator of part and outdated information that has been adopted virtually without question by governments and regulatory authorities throughout the world, thus shaping public perception accordingly. The "part" factor of the US-EPA reports is that they indicate that waste combustion produces high HAP emissions, including dioxins. However, in drawing the conclusions in their reports, waste combustion has most always been analyzed standing alone without comparison to the common energy source of fossil fuels. That is, the results haven't been compared against any reference values or datum. The "outdated" factor of the US-EPA reports is that they are based upon antiquated waste to energy technologies and don't even include modern waste thermal degradation processes of pyrolysis and gasification.

The misleading US-EPA information remains the basis of government policy and public perception throughout the world and has helped create what can be best described as hysteria whenever a waste to energy plant is proposed for any application and "not in my backyard" is then argued to prohibit this energy source. The view is propagated by well intentioned but misinformed environmental lobby groups, including Greenpeace. Regulatory authorities throughout the world acting upon the part and outdated US-EPA information and pressure from misinformed environmentalists have prejudiced application of modern waste to energy technologies (particularly pyrolysis and gasification) and subsequently the public has been left exposed to greater levels of HAP's including dioxins than they ought to.

DETAILS OF US-EPA'S "PART" INFORMATION: The fact is; combustion or firing of any of earths organic matter (including bio-fuels, biomass, waste or fossil fuels) is going to result in trace levels of HAP's and minute levels of potentially carcinogenic emissions including dioxins. However, whilst the US-EPA has subjected waste combustion to intense environmental scrutiny for HAP emissions it has remained relatively silent on such emissions from combustion of a host of fossil fuels. So in essence, the relatively small resource of waste as energy has been put under the US-EPA microscope for HAP emissions, whilst at the same time emissions from the abundant energy sources of distillate, fuel oil, coal, wood and natural gas have been somewhat ignored.

It's unscientific for the US-EPA or any professional scientific organization to single out one from a host of energy sources / products of combustion and not to make a comparative analysis of all (against common reference values or datum) and subsequently the resulting "part" information is an improper basis for data that governments and their regulatory authorities have relied upon. It's highlighted that this is not the first time the said US-EPA "part" information has been exposed as misleading, for example, the French Academy of Sciences prologue to their report titled "La Dioxine et ses Analogues Rapport Commun No.4", Paris, September 1994 states quote "A conjunction of historical events led to progressive construction in the opinion of reactions of fear with respect to dioxins, which do not correspond to the real data".

DETAILS OF US-EPA'S OUTDATED INFORMATION: The above-mentioned US-EPA "part" information is based upon data collected from antiquated waste to energy technologies, mainly incineration and there is no test data contained in it that is applicable to modern waste thermal degradation processes of pyrolysis and gasification. So in essence, US-EPA's "part" information that has no relevance to modern waste to energy technologies. Such outdated status of the data reinforces the above-mentioned statement, namely that the said USA-EPA "part" information is an improper basis for data that governments and their regulatory authorities have relied upon.

PUBLIC EXPOSED TO GREATER LEVELS OF HAP's THAN IT OUGHT TO: As history now has it, the result of regulatory authorities throughout the world adopting US-EPA's misleading information (and not knowing the full extent of HAP emissions from fossil fuels), is that the modern waste to energy - energy source is discouraged, thus is rarely approved and is highly regulated. Whilst at the same time the greater polluter of HAP's including dioxins, namely fossil fuel energy sources; are readily approved with very little constraint, that is, are applied under conditions where they are loosely regulated and operated relatively unchecked. It is this that has resulted in the public being left exposed to greater levels of HAP's including dioxins than they ought to. Governments, regulatory authorities and environmental lobby groups such as Greenpeace acting upon such misleading information are encouraging real day to day situations like say:

- Municipality 200 MWt coal fired power station approved against gasification type waste to energy. Additional dioxins and all other HAP's is 106,400,200 ng/A and 12,777 kg/A respectively. (*)
- Factory 45 MWt heavy fuel oil fired boiler approved against gasification type waste to energy. Additional dioxins and all other HAP's is 148,800,150 ng/A and 22,890 kg/A respectively. (*)
- Factory 10 MWt natural gas fired boiler approved against gasification type waste to energy, though the dioxins and average of all other HAP emissions of the latter shall be ½ and < 1/35th respectively of the Greenpeace "Rainbow Warrior" ship under full motor. (*)

FACTS ON PUBLIC EXPOSURE TO HAP's; THE UNTOLD TRUTH: To be repeated is that governments, regulatory authorities and environmental lobby groups such as Greenpeace acting upon misleading information are encouraging real day to day situations of public exposure to HAP's per Table 2 below.

TABLE 2: PUBLIC EXPOSURE TO HAP's (*)

ITEM	DESCRIPTION	GASIFICATION TYPE WASTE TO ENERGY SYSTEM	DISTILLATE FIRED INDUSTRIAL BOILER	NO. 6 FUEL OIL FIRED INDUSTRIAL BOILER	COAL FIRED INDUSTRIAL BOILER	WOOD FIRED INDUSTRIAL BOILER	NO. 6 FUEL OIL FIRED POWER STATION	COALFIRED POWER STATION	NATURAL GAS FIRED POWER STATION	GREENPEACE "RAINBOW VARRIOR" SHIP / SMALL SHIP
1	SUMMARY OF HAP EMISSIONS (PER TABLE 1 ABOVE): A. Dioxin Emissions B. Average of All Other HAP's	x 1 (Datum) x 1 (Datum)	x 2 x 9	x 25 x 33	x 76 x 203	x 178 x 104	x 2 x 1.3	x 4 x 5	N.D.A. x 5	x 2 x 37
2	REGULATORY REQUIREMENTS: A. Emission Regulations B. 24 hr/dy Emission Monitoring C. Regular Ind. Emission Testing	Enforced Yes Yes	Rarely Enforced No No	Rarely Enforced No No	Rarely Enforced No No	Rarely Enforced No No	Enforced Sometimes Sometimes	Enforced Sometimes Sometimes	Rarely Enforced No No	Rarely Enforced No No
3	PUBLIC EXPOSURE TO HAP's	Negligible	High	Very High	Very High	Very High	High	High	High	Very High

(*) Based upon the most updated US-EPA official research data and reports on fossil fuel emissions. For verification refer to references and calculations contained herein the detailed comparative analysis.

UNCOVERING THE FACTS: What is highly questionable about the US-EPA “part” and outdated information is that this organization failed to make comparison to their own research on HAP emissions from fossil fuels, even though a plethora of this data is readily available from their own official records! To correct this now possibly for the first time ever, this same most updated US-EPA official research data on fossil fuels has been used in a complete comparative analysis of both HAP and non-HAP emissions from a range of energy sources, namely gasification type waste to energy systems and a range of fossil fuels and wood, per the detailed comparative analysis in Table 4 herein.

VERIFICATION OF THE FACTS: Importantly, the results of the detailed comparative analysis can be easily tested and interrogated by any party, as all US-EPA references and all HAP and non-HAP emission calculations are appended to this document per Table 3 below, or the references can be download at www.epa.gov/ttn/chief/ap42/ch01/index.html

TABLE 3: COMPARATIVE ANALYSIS APPENDIX SCHEDULE

APPENDIX NO.	DESCRIPTION	PAGES / SIZE OF FILE
1	Graph Representation of the Comparative Analysis HAP and Non-HAP Results	10 Pages / 0.3 MB Pdf File
2	References & Calculations for Gasification Type Waste to Energy Systems	5 Pages / 0.75 MB Pdf File
3	References & Calculations for Distillate Fired Industrial Boiler	14 Pages / 1.3 MB Pdf File
4	References & Calculations for No.6 Fuel Oil Fired Industrial Boiler	14 Pages / 1.6 MB Pdf File
5	References & Calculations for Coal Fired Industrial Boiler	14 Pages / 1.3 MB Pdf File
6	References & Calculations for Wood Fired Industrial Boiler	14 Pages / 1.1 MB Pdf File
7	References & Calculations for No.6 Fuel Oil Fired Power Station	13 Pages / 1.5 MB Pdf File
8	References & Calculations for Coal Fired Power Station	14 Pages / 1.2 MB Pdf File
9	References & Calculations for Natural Gas Fired Power Station	10 Pages / 1.0 MB Pdf File
10	References & Calculations for Greenpeace “Rainbow Warrior” Ship	11 Pages / 1.0 MB Pdf File
11	Copies of Correspondence to US-EPA, Greenpeace and Others. (*)	2 Pages / 0.4 MB Pdf File

(*) Such organizations have been invited to interrogate the results of the detailed comparative analysis.

THE CASE OF ENVIRONMENTAL SUPERIORITY BASED UPON GREENHOUSE GAS REDUCTION BENEFITS & OTHER ENVIRONMENTAL BENEFITS:

Per introduction above and the detailed comparative analysis below, the case supporting modern waste to energy technologies is proven based upon emissions alone. Other related environmental studies that are completed and that are in the process of being drafted for upcoming press releases are:

- **Waste As Renewable Energy:** The cellulose based or renewable portion of MSW or RDF (typically ranging from 60% to 100%) provides for greenhouse gas reduction (it’s the same as biomass / cellulose used to produce so called “bio-fuels”). This environmental study proves a typical gasification type waste to energy system provides for millions of tonnes of fossil fuel reduction, plus millions of tonnes of greenhouse gas reduction over its life cycle.
- **Waste as Renewable Energy is Environmentally Superior to Most Alternative Uses of Biomass & Waste:** Environmental study based upon latest US-EPA and UK-DEFRA reports proves that gasification type waste to energy systems produce less HAP’s than alternative energy / non-energy uses of biomass and waste (e.g. bio-fuels, digester and composting processes, etc.).
- **Waste as Renewable Energy Produces Nil Solid Residues:** Gasification type waste to energy systems can comply with nil solid discharge (solid residues are recycled into non-hazardous metal and mineral products by refining or vitrification). However, for applications where solid residue is discharged, this environmental study based upon latest US-EPA and UK-DEFRA reports proves that it’s comparable to the hazardous constituents of solid residues from coal and wood firing, plus alternative biomass and waste utilization processes (e.g. bio-fuel, digester and composting processes, etc.). Further, the study proves that for such applications the hazardous constituents of the solid residue are “contained” for safe treatment or disposal, whereas for the alternative of fossil fuel energy, the extra hazardous constituents or HAP’s that it produces are “uncontained” in the atmosphere and contribute to far greater public exposure of HAP’s / dioxins.
- **Waste as Renewable Energy May Help Prevent Potential of the Next Pandemic:** The 2003 cost of SARS contagion in Asia alone was US\$59 Billion (ref. source Asian Development Bank). Many encephalitis type pathogens including BSE, CJD, plus SARS, Avian virus, etc. are temperature resistant up to 316 C (ref. Brown P and Gadjusek DC, *Journal of Infectious Diseases* 161:467-472, 1990). This environmental study verifies that biomass and waste are potential hosts for temperature resistant pathogens, which gasification type waste to energy systems destroy, but which alternative biomass and waste utilization process (e.g. bioreactor, digester and composting processes), may emit or harbor in their processing or end product stages.

TABLE 4: COMPARATIVE ANALYSIS OF HAP & NON-HAP EMISIONS (*)

ITEM	DESCRIPTION	GASIFICATION TYPE WASTE TO ENERGY SYSTEM	DISTILLATE FIRED INDUSTRIAL BOILER	NO. 6 FUEL OIL FIRED INDUSTRIAL BOILER	COAL FIRED INDUSTRIAL BOILER	WOOD FIRED INDUSTRIAL BOILER	NO. 6 FUEL OIL FIRED POWER STATION	COALFIRED POWER STATION	NATURAL GAS FIRED POWER STATION	GREENPEACE "RAINBOW WARRIOR"SHIP / SMALL SHIP
1	BASIS OF EVALUATION:	Direct Comparison	Direct Comparison	Direct Comparison	Direct Comparison	Direct Comparison	Direct Comparison	Direct Comparison	Direct Comparison	Comparative Analysis
2	ENERGY OUTPUT	Per 10 MWt	Per 10 MWt	Per 10 MWt	Per 10 MWt	Per 10 MWt	Per 10 MWt	Per 10 MWt	Per 10 MWt	Per 1.0 MWt (Per 1 Ship)
3	EMISSION DATA SOURCE:	References A / B	References C / H	References C / H	References D / H	References E / H	References C / H	References D / H	References F / H	References G / H
4	FUEL CALORIFIC VALUE:	6,500 Btu/lb	140,000 Btu/gal	150,000 Btu/gal	10,130 Btu/lb	7,500 Btu/lb	150,000 Btu/gal	10,130 Btu/lb	1,060 Btu/f ³	140,000 Btu/gal
5	EMISSION BASIS:	Controlled (SDA+FF)	Uncontrolled	Uncontrolled	Uncontrolled	Controlled (Mech. Collector)	Controlled (ESP+FGR)	Controlled (SDA+FF)	Uncontrolled	Uncontrolled
6	EMISSION FLOW RATE: ⁽¹⁾									
	A. HAP's (Hazardous Air Pollutants):									
	(a) Dioxins / Furans: ⁽²⁾⁽³⁾									
	(i) Typical Maximum	0.1 I-TEQ ng/Nm ³	N.D.A.	60.0 I-TEQ ng/L	98.5 I-TEQ ng/kg	173.3 I-TEQ ng/kg	4.71 I-TEQ ng/L	4.8 I-TEQ ng/kg	N.D.A.	28.05 I-TEQ ng/L
	(ii) Typical Average	0.013 I-TEQ ng/Nm ³	N.D.A.	4.0 I-TEQ ng/L	40.395 I-TEQ ng/kg	33.976 I-TEQ ng/kg	0.314 I-TEQ ng/L	0.6 I-TEQ ng/kg	N.D.A.	2.48 I-TEQ ng/L
	(b) VOC's	0.4845 mg/Nm ³	2.49 lb/Kgal	2.49 lb/Kgal	0.184 lb/T ⁽⁹⁾	0.017 lb/Mbtu	0.1245 lb/Kgal ⁽⁶⁾	9.1864x10 ⁻² lb/T	5.4x10 ⁻³ lb/10 ⁶ Btu	0.35 lb/Mbtu
	(c) POM's / PAH's ⁽⁴⁾	0.0086 mg/Nm ³	0.031 lb/Kgal	0.031 lb/Kgal	4.2x10 ⁻⁴ lb/T ⁽⁹⁾	2.13x10 ⁻⁴ lb/Mbtu	1.55x10 ⁻³ lb/Kgal ⁽⁶⁾	2.0758x10 ⁻⁵ lb/T	6.7x10 ⁻⁵ lb/10 ⁶ Btu	1.68x10 ⁻⁴ lb/Mbtu
	(d) Total Heavy Metals	0.0238 mg/Nm ³	258 lb/10 ¹² Btu	2,063 lb/10 ¹² Btu	4,847 lb/10 ¹² Btu	1.79x10 ⁻³ lb/Mbtu	129 lb/10 ¹² Btu	1.4378x10 ⁻² lb/T	4.1x10 ⁻⁵ lb/10 ⁶ Btu	N.D.A.
	(e) Mercury	0.0025 mg/Nm ³	3 lb/10 ¹² Btu	17 lb/10 ¹² Btu	16 lb/10 ¹² Btu	3.5x10 ⁻⁶ lb/Mbtu	0.5 lb/10 ¹² Btu	8.3x10 ⁻⁵ lb/T	2.5x10 ⁻⁶ lb/10 ⁶ Btu	N.D.A.
	(f) Cadmium & Thallium	0.0011 mg/Nm ³	11 lb/10 ¹² Btu	114 lb/10 ¹² Btu	44.88 lb/10 ¹² Btu	4.1x10 ⁻⁶ lb/Mbtu	0.18 lb/10 ¹² Btu	5.1x10 ⁻⁵ lb/T	1.1x10 ⁻⁶ lb/10 ⁶ Btu	N.D.A.
	(g) < PM _{2.5}	0.58 mg/Nm ³	1 lb/Kgal	4.6 lb/Kgal	19.8 lb/T	0.296 lb/Mbtu	0.38 lb/Kgal	0.1 lb/T	Negligible	Negligible
	(h) < PM _{1.0}	0.47 mg/Nm ³	0.4 lb/Kgal	1.8 lb/Kgal	5.94 lb/T	0.261 lb/Mbtu	0.12 lb/Kgal	0.04 lb/T	0.007 lb/10 ⁶ Btu	0.31 lb/Mbtu
	B. NON-HAP's (Air Pollutants):									
	(a) > PM _{2.5}	1.29 mg/Nm ³	1 lb/Kgal	4.6 lb/Kgal	46.2 lb/T	0.09 lb/Mbtu	0.30 lb/Kgal	0.34 lb/T	Negligible	Negligible
	(b) Sulfur & Compounds	32 mg/Nm ³	34.3 lb/Kgal ⁽⁵⁾	164.52 lb/Kgal ⁽⁶⁾	35 lb/T ⁽⁷⁾	0.025 lb/Mbtu	8.23 lb/Kgal ⁽⁶⁾⁽⁸⁾	1.75 lb/T ⁽⁷⁾⁽⁹⁾	5.9x10 ⁻² lb/10 ⁶ Btu	0.29 lb/Mbtu
	(c) Nitrogen & Compounds	99 mg/Nm ³	20 lb/Kgal	55 lb/Kgal	14.75 lb/T	0.355 lb/Mbtu	67 lb/Kgal	14.75 lb/T	0.174 lb/10 ⁶ Btu	4.41 lb/Mbtu
	(d) Chlorine & Compounds	5.25 mg/Nm ³	0.347 lb/Kgal	0.347 lb/Kgal	1.2 lb/T	0.019 lb/Mbtu	0.531 lb/Kgal	1.2 lb/T	N.D.A.	N.D.A.
	(e) Fluorine & Compounds	0.24 mg/Nm ³	0.0373 lb/Kgal	0.0373 lb/Kgal	0.15 lb/T	N.D.A.	N.D.A.	0.15 lb/T	N.D.A.	N.D.A.
	(f) Carbon Monoxide	12 mg/Nm ³	5 lb/Kgal	5 lb/Kgal	14.11 lb/T	0.60 lb/Mbtu	5.0 lb/Kgal	14.11 lb/T	0.082 lb/10 ⁶ Btu	0.95 lb/Mbtu
	C. Total Particulate Matter	2.35 mg/Nm ³	2 lb/Kgal	9.19 lb/Kgal	66 lb/T	0.39 lb/Mbtu	0.606 lb/Kgal	0.48 lb/T	0.007 lb/10 ⁶	0.31 lb/Mbtu

(*) Based upon the most updated US-EPA official research data and reports on fossil fuel emissions. For verification refer to references and calculations contained herein the detailed comparative analysis.

TABLE 4 CONTINUED: COMPARATIVE ANALYSIS OF HAP & NON-HAP EMISIONS (*)

I T E M	DESCRIPTION	GASIFICATION TYPE WASTE TO ENERGY SYSTEM		DISTILLATE FIRED INDUSTRIAL BOILER		NO. 6 FUEL OIL FIRED INDUSTRIAL BOILER		COAL FIRED INDUSTRIAL BOILER		WOOD FIRED INDUSTRIAL BOILER		NO. 6 FUEL OIL FIRED POWER STATION		COALFIRED POWER STATION		NATURAL GAS FIRED POWER STATION		GREENPEACE "RAINBOW WARRIOR" SHIP / SMALL SHIP		
		T/A	T/A	±	T/A	±	T/A	±	T/A	±	T/A	±	T/A	±	T/A	±	T/A	±	T/A	±
7	ANNUAL EMISSIONS: ⁽¹⁰⁾	T/A	T/A	±	T/A	±	T/A	±	T/A	±	T/A	±	T/A	±	T/A	±	T/A	±	T/A	±
	A. HAP's (Hazardous Air Pollutants)																			
	(a) Dioxins / Furans: ⁽²⁾																			
	(i) Typical Maximum	1.65 x 10 ⁻⁸	3.76x10 ⁻⁸	x 2 ⁽³⁾	4.06x10 ⁻⁷	x 25 ⁽³⁾	1.21x10 ⁻⁶	x 76 ⁽³⁾	2.84x10 ⁻⁶	x178 ⁽³⁾	3.16x10 ⁻⁸	x 2 ⁽³⁾	5.89x10 ⁻⁸	x 4 ⁽³⁾	See Note	11 Below	2.81x10 ⁻⁸	x 2 ⁽³⁾		
	(ii) Typical Average	2.0 x 10 ⁻⁹	3.3x10 ⁻⁹	x 2 ⁽³⁾	2.68x10 ⁻⁸	x 13 ⁽³⁾	4.96x10 ⁻⁷	x248 ⁽³⁾	5.57x10 ⁻⁷	x279 ⁽³⁾	2.1x10 ⁻⁹	x 1 ⁽³⁾	7.3x10 ⁻⁹	x 4 ⁽³⁾	See Note	11 Below	2.4x10 ⁻⁹	x 1.2 ⁽³⁾		
	(b) VOC's	0.094	2.204	x 23	2.204	x 23	1.007	x 11	2.109	x 22	0.110	x 1.2	0.500	x 6	0.669	x 7	6.484	x 69		
	(c) POM's / PAH's	1.4 x 10 ⁻³	0.027	x 19	0.027	x 19	0.002	x 1.4	0.026	x 19	1.35x10 ⁻³	x 1	1.14x10 ⁻³	x 1	0.008	x 6	0.003	x 2		
	(d) Total Heavy Metals	0.004	0.032	x 8	0.226	x 64	0.601	x 150	0.222	x 56	0.016	x 4	0.079	x 20	0.005	x 1.3	0.005	x 1.2		
	(e) Mercury	4.1 x 10 ⁻⁴	3.7x10 ⁻⁴	x 0.9	0.002	x 5	0.002	x 5	4.33x10 ⁻⁴	x 1	6.2x10 ⁻⁵	x 0.1	4.54x10 ⁻⁴	x 1.1	2.97x10 ⁻⁴	x 0.7	N.D.A.	N.D.A.		
	(f) Cadmium & Thallium	1.76 x 10 ⁻⁴	3.72x10 ⁻⁴	x 2	0.014	x 80	0.006	x 34	5.13x10 ⁻⁴	x 3	2.33x10 ⁻⁵	x 0.1	2.79x10 ⁻⁴	x 1.6	1.36x10 ⁻⁴	x 0.8	N.D.A.	N.D.A.		
	(g) < PM _{2.5}	0.175	0.886	x 5	3.800	x 22	141.109	x 806	36.776	x 210	0.248	x 1.4	1.024	x 6	Negligible	-	Negligible	-		
	(h) < PM _{1.0}	0.078	0.354	x 5	1.520	x 20	32.504	x 417	32.421	x 416	0.099	x 1.3	0.236	x 3	0.925	x 12	5.743	x 74		
	B. NON-HAP's (Air Pollutants):																			
	(a) > PM _{2.5}	0.214	0.886	x 4	3.800	x 22	253.272	x 1,184	11.613	x 54	0.248	x 1.2	1.938	x 9	Negligible	-	Negligible	-		
	(b) Sulfur & Compounds	5.298	30.397	x 6	145.803	x 27	191.874	x 36	3.102	x 0.6	7.287	x 1.4	9.581	x 2	0.073	x 0.01	5.372	x 1		
	(c) Nitrogen & Compounds	16.392	17.723	x 1	48.737	x 3	80.859	x 5	44.046	x 3	55.415	x 3	80.859	x 5	21.591	x 1.3	81.695	x 5		
	(d) Chlorine & Compounds	0.869	0.305	x 0.4	0.281	x 0.3	6.551	x 8	2.357	x 3	0.441	x 0.5	6.551	x 8	N.D.A.	N.D.A.	N.D.A.	N.D.A.		
	(e) Fluorine & Compounds	0.040	0.033	x 0.8	0.031	x 0.8	0.808	x 20	N.D.A.	N.D.A.	N.D.A.	N.D.A.	0.808	x 20	N.D.A.	N.D.A.	N.D.A.	N.D.A.		
	(f) Carbon Monoxide	1.987	4.425	x 2	4.128	x 2	77.338	x 39	74.444	x 37	4.128	x 2	77.338	x 39	10.218	x 5	17.599	x 9		
	C. Total Particulate Matter	0.389	1.772	x 5	7.599	x 20	361.817	x 930	48.389	x 124	0.497	x 1.3	2.626	x 7	0.925	x 2	5.743	x 15		
8	HAP EMISSIONS SUMMARY:																			
	A. Typical Maximum Dioxins	Datum	x 2		x 25		x 76		x 178		x 2		x 4		N.D.A.		x 2			
	B. Average of all other HAP's	Datum	x 9		x 33		x 203		x 104		x 1.3		x 5		x 5		x 37			

(*) Based upon the most updated US-EPA official research data and reports on fossil fuel emissions. For verification refer to references and calculations contained herein the detailed comparative analysis.

LEGEND:

TOC:	Total Organic Matter (VOC + POM + PAH)	Nitro-PAH:	Nitro Polycyclic Aromatic Hydrocarbon	ESP:	Electrostatic Precipitator
VOC:	Volatile Organic Compounds	PM _{2.5} :	Hazardous Particulate Matter < 2.5 micron	SDA:	Spray Dryer Absorber
POM:	Polycyclic Organic Matter	PM:	Particulate Matter	N.D.A.:	Not Data Available
PAH:	Polycyclic Aromatic Hydrocarbon (PAH + nitro-PAH)	FF:	Fabric Filter	N.D.:	Not Detected

REFERENCES:

- A. Source of all referenced Waste to Energy emissions is government accredited gaseous emission testing averaged results of Entech – Renewable Energy Technology Pty. Ltd. commercial plants at Bydgoszcz, Poland (Wojskowy Instytut Chemii, Warsaw, April 2004) and Kuznica, Poland (Cracow University of Technology, Cracow, May 2004). Additional references with a range of similar and superior emission results are available upon request.
- B. Source of referenced Waste to Energy particulate particle distribution is independent testing of Entech – Renewable Energy Technology Pty. Ltd. commercial plant at Chang Gung Municipality (Taiwan, March 1998).
- C. Source of all referenced No. 2 and No. 6 fuel oil firing emissions (except dioxins), is "Report on Revisions to 5th Edition AP-42, Section 1.3, Fuel Oil Combustion", US-EPA Contract No. EPA 68-D7-0068, WA-005, U.S. Environmental Protection Agency; Eastern Research Group, Supplement E, September 1998.
- D. Source of all referenced coal fuel firing emissions (except dioxins), is "Report on Revisions to 5th Edition AP-42, Section 1.1, Coal Combustion", US-EPA Contract No. EPA 68-D7-0068, WA-005, U.S. Environmental Protection Agency; Eastern Research Group, Supplement E, September 1998.
- E. Source of all wood fuel firing emissions (except dioxins), is "Report on Revisions to 5th Edition AP-42, Section 1.6, Wood Residue Combustion in Boilers", US-EPA Contract No. EPA 68-D7-0068, WA-005, U.S. Environmental Protection Agency; Eastern Research Group, Update, September 2003.
- F. Source of natural gas fuel firing emissions (except dioxins), is "Report on Revisions to 5th Edition AP-42, Section 1.4, Natural Gas Combustion", US-EPA Contract No. EPA 68-D7-0068, WA-005, U.S. Environmental Protection Agency; Eastern Research Group, Supplement D, July 1998.
- G. Source of all diesel engine emissions (except dioxins) is "Report on Revisions to 5th Edition AP-42, Section 3.3, Gasoline & Diesel Industrial Engines", US-EPA Contract No. EPA 68-D7-0068, WA-005, U.S. Environmental Protection Agency; Eastern Research Group, Supplement B, October 1996.
- H. Source of all dioxin emissions is "Exposure & Human Health Reassessment of TCDD & Related Compounds NAS Review Draft" U.S. Environmental Protection Authority, December 2003. Secondary source of diesel engine dioxin/ emissions is "Diesel Emissions of Polychlorinated Dibenzo-p-Dioxin & Polychlorinated Dibenzo-furan", Brian K. Gullett, Jeffrey V. Ryan, U.S. Environmental Protection Agency, 1997.

NOTES:

1. Emission rates stated in this comparative analysis are quoted from the referenced source in the unit of the referenced source.
2. All dioxin and furan emissions referenced to I-TEQ.
3. All fossil fuel dioxin and furan emissions throughout this study are based upon US-EPA data (unless noted otherwise), which in the US modern combustion technology is adopted. **For less developed countries the dioxin and furan emissions are expected to be substantially greater.**
4. Where not tested, is based upon POM/PAH emissions being 1.5% of the total VOC's, which is consistent with POM/PAH ratio of all referenced US-EPA documents above.
5. Based upon No.2 fuel oil with 0.25% sulfur content.
6. Based upon No.6 fuel oil with 1.0% sulfur content.
7. Based upon coal with 1.8% sulfur content.
8. Details are based upon "Reference-C /US-EPA" above, which is uncontrolled emissions using a electrostatic precipitator scrubber / APC device, thus extrapolation for uncontrolled emissions is based upon 95% efficiency of the AQC device.
9. Details are based upon "Reference-D /US-EPA" above, which is controlled emissions using a spray dryer absorber plus fabric filter / APC device, thus extrapolation for uncontrolled emissions is based upon counter 95% efficiency of the AQC device.
10. Based upon 24 hr/dy and 334 dy/yr operation.
11. Gas firing dioxin and furan emissions were not recorded. If consistent with all other fuels in US-EPA studies then higher CO and VOC emission in an indicator of greater incomplete combustion, which from this study CO and VOC emission or incomplete combustion appears to be linked more with dioxin and furan emission than say chlorine content, and if gas fuels are consistent with all other fuels in US-EPS studies then dioxin and furan emissions shall be present. More particularly gas fuels have very high CO and VOC emissions, thus the expectation is that gas fuels shall have high dioxin and furan emissions.

AUTHOR:

Neil R. Martin, Environmental Manager of Entech – Renewable Energy Technologies Pty. Ltd.. Contact nmartin@entech.net.au