Renewable Power from Energy from Waste Plants – Fact or Fiction?

It is often claimed that the power produced from an Energy from Waste (EfW) plant is renewable. This claim is based on the energy freed from burning biogenic material, ie material that was recently growing such as paper, card and food.

However this claim is often made misleadingly, even claiming, somewhat bizarrely, that burning the water in food waste produces renewable power.

It is crucially important in making this renewable energy claim that the EfW process is efficient, that as much energy as possible if extracted from renewable, biogenic waste. A claim that a plant is a sustainable source of energy must be based on high energy yield, it is simply not acceptable to waste 80% of the available energy in waste – and sustainability demands that the plant should be flexible to advances in recycling and energy extraction technologies. A large, capital intensive incinerator with a 30+ year design life does not meet these requirements.

The best EfW plants will recycle plastics from the input waste prior to energy conversion – this is because the environmental benefit of recycling plastic material is vastly better than burning. (see here and WRAP[1] report). If the resultant fuel material is then refined and dried it can be converted to power much more efficiently.

To illustrate this further figures and claims made for the planned Gloucestershire Incinerator from UBB are examined in detail in this paper.

This shows that the planned Gloucestershire Incinerator produces **less than a third of the energy** that better processes would yield from the same waste input. Of the electrical energy planned **only 37.8% is renewable,** the balance being from burning of plastics.

It is right that the public demands that for large investments of public money, such as that within the £500M contract for the Gloucestershire Incinerator, large amounts of renewable energy are produced. The current Gloucestershire plant would yield just 5.5MW of renewable electricity from this proposed scheme with 80% of the potential energy simply lost.

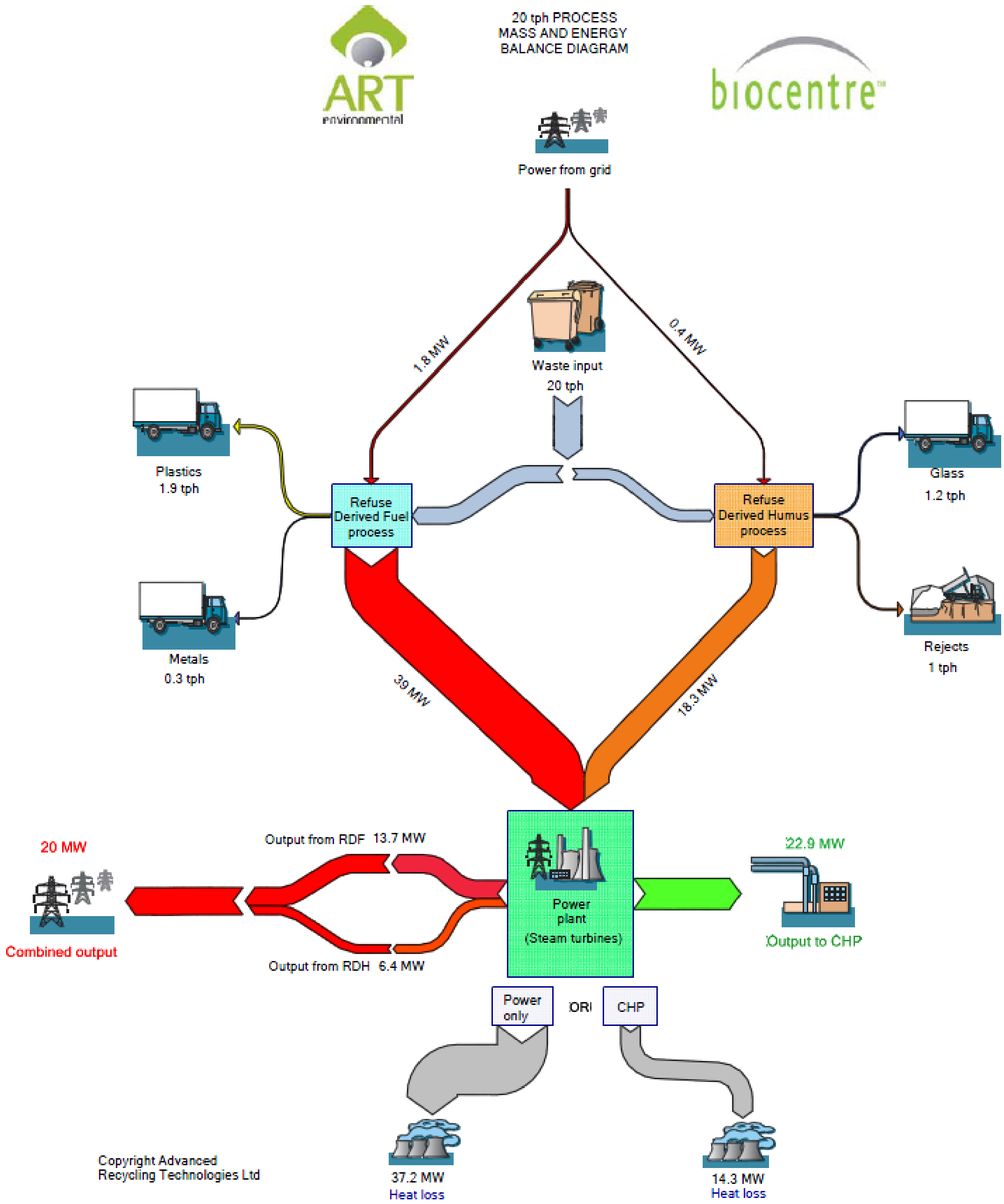
[1] WRAP final report on “Domestic Mixed Plastics Packaging and Waste Management Options” June 2008. See my appendix 11.1 section 3.2

Energy Available From Typical Waste Mix

A well designed EfW process extracts as much useful energy from the material which cannot be recycled.

The planned Gloucestershire incinerator will produce 14.5MW (net of parasitic loads) electricity from 190 ktpa of mixed residual waste including plastics. This compares very poorly to better designed processes, such as the Biocentre process illustrated below.

The diagram below shows the energy balance for the Biocentre process using 20 tph of a typical municipal waste mix equivalent to 175,000 tpa.



So as a direct comparison the Biocentre process delivers the following typical energy outputs for 190,000 tpa of input, with the fuel going to suitable industrial power plants (steam turbines):

21.7 MW electricity output PLUS 24.9 MW heat output, giving 45.6MW useful power output, over 3X that from the planned Gloucestershire incinerator

Alternatively all of the energy output can be used for heat in which case the process delivers 51.4 MW of fuel suitable for a heat plant

The far greater efficiency from this type of system compared to mass burn incineration comes from:

- Fuel refined to consistent high specification, low in contaminants. The fuel can be converted in far more efficient and smaller plants, with less parasitic loads.
- The fuel is dried before conversion, using natural bio-drying. In the case of Biocentre this is particularly efficient because the input material is refined prior to drying.
- The fuel can be converted where needed. Either in CHP enabled power plants built on industrial estates with high heat loads, such as at Slough Heat and Power, or in smaller scale heat only, or heat and power plants built on high heat use industrial users. An excellent example in Gloucestershire is Dairy Crest which is just a few km from the planned incinerator, but too far to transport heat economically. Taking the fuel to the user is much more efficient than generating electricity where the waste heat has no users.

Fuel can be burnt at the point of use so heat is immediately available to industrial processes. The higher efficiency of this process, combined with the flexibility to use the fuel where needed gives a far better useful renewable power figure than a mass burn incinerator. The carbon footprint is consequently far superior.

Renewable Energy Produced from the Proposed Gloucestershire Incinerator

In Gloucestershire, the applicant claims that based on historical waste mix data that 52.6% of the energy in the residual waste stream comes from biomass (biogenic) material and so can be classed as a renewable energy source. This includes a paper and card rich source of commercial and industrial waste. Using the same mathematics the biomass proportion of residual waste from the six waste collection authorities is slightly less at 49.5% - see table below

However this is just the proportion of the calorific value (CV) of biomass in the residual waste, it does not equate to the proportion of power produced from the biomass fraction. In the same way that cardboard has calories but will not make you fat we must also look at the conversion process to calculate the proportion of power which can be classed as renewable. If you have ever tried to set fire to a potato you will know that this is not a useful way produce heat. Biomass contains far more water than the plastics, and water requires much energy to “burn off”. Energy is required for what is called “activation energy” (the energy required to ignite the material) and to liberate (evaporate) the water in the material. The wetter the material the more energy is lost. Incinerating unprocessed food waste for example which is typically 70% moisture takes more energy to deal with the moisture than is released from the materials CV.

96% of the energy available from biomass in the Gloucestershire waste stream comes from paper and card, itself a recyclable material. It is important that this material is kept dry otherwise further renewable energy may be lost. Water is sometimes added in waste bunkers to prevent spontaneous combustion of the mixed waste.

If you subtract the lost energy in dealing with water from the available energy for the residual waste figures presented by the applicant you can calculated the proportion of power generated by the plant which can be attributed to biogenic (renewable) sources, see table below

This shows that just **37.8%** of the power produced by the proposed development can be classed as renewable – that is coming from biogenic / biomass sources.

Given a claimed net electrical output of 14.5MW for the plant this means the county will generate **just 5.48 MW of renewable energy** (48000 MWh per annum) from this enormous investment. The contract cost is around £20M per year so this gives a cost for renewable energy of £416 / MWh, 4 times the cost of other renewable sources such as wind[2].

[2] Onshore wind cost range £80-£110 £/MWh from "Powering the Nation" Parsons Brinkerhoff 2010

Analysis of Biogenic (Renewable) Proportion of Useful Power Produced By Planned Gloucestershire Incinerator

Calculation of the proportion of useful energy from biomass material for the Javelin Park EfW Facility

Waste data from UBB5A-1 Simon Aumonier POE Appendices Table 2.4, energy data from UBB5Y Table 1. Biogenic split from UBB5Y table 2

Material Category	Cheltenham	Cotswolds	Forest of Dean	Gloucester City	Stroud	Tewkesbury	Weighted Average	Energy/kg (MJ)	Input kg/hr	Total energy available / hr (MJ)	Assumed moisture %	Water kg/hr	Energy to liberate water MJ/hr	Est. activation energy MJ/kg	Est. activation energy MJ/hr	Est. energy losses MJ/hr (AC+AG)	Usable energy MJ/hr	Biogenics only: Energy available MJ/hr	Biogenics only: activation + liberation loss energy MJ/hr	Biogenics only: Usable energy MJ/hr
Tonnage	24,817	15,086	21,327	26,705	27,403	15,056														
Paper & Card	22.59	18.04	26.95	20.77	23.61	12.53	21.46	15.90	4,654	73,996	20	931	2,717	1	4,654	7,371	66,626	73,996	7,371	66,626
Plastic film	6.66	9.56	7.27	8.98	9.27	9.80	8.48	21.30	1,840	39,183	2	37	107	1	920	1,027	38,156			
Dense plastic	10.17	14.37	9.24	14.35	10.29	9.45	11.30	24.90	2,451	61,038	2	49	143	1	1,226	1,369	59,670			
Textiles	5.12	5.72	4.05	3.96	3.30	3.65	4.22	14.30	916	13,103	15	137	401	2	1,833	2,234	10,869	6,552	1,117	5,435
Absorbent hygeine products	0.00	7.10	0.00	3.26	0.00	10.90	2.75	5.50	596	3,278	30	179	522	3	1,490	2,012	1,266	1,639	1,006	633
Wood	0.00	0.82	0.00	0.40	0.00	0.32	0.21	16.80	46	779	5	2	7	2	93	99	679	779	99	679
Combustibles	5.61	5.45	5.29	1.64	8.33	6.09	5.35	14.10	1,161	16,371	10	116	339	1	1,161	1,500	14,871	8,186	750	7,436
Non-combustibles	0.76	4.44	3.46	2.77	1.58	9.16	3.18	2.60	690	1,794	8	55	161		0	161	1,633	897	81	816
Glass	8.01	3.07	4.04	3.65	2.97	2.89	4.25	1.40	921	1,289	2	18	54		0	54	1,236	645	27	618
Garden waste	6.37	3.69	0.30	7.91	4.23	8.62	5.19	4.20	1,126	4,730	50	563	1,644	4	3,942	5,586	-855	4,730	5,586	-855
Food waste	24.19	23.18	28.17	28.30	29.23	22.11	26.38	3.50	5,723	20,030	70	4,006	11,693	4	20,030	31,723	-11,693	20,030	31,723	-11,693
Ferrous metal	2.50	2.22	2.48	1.71	2.00	1.74	2.11	0.00	458	0	2	9	27		0	27	-27			
Nonferrous metal	1.00	1.20	1.26	0.78	0.93	0.49	0.95	0.00	205	0	2	4	12		0	12	-12			
Fines <10mm	5.84	0.00	5.60	0.00	2.96	0.00	2.65	3.50	575	2,011	20	115	335	4	2,299	2,634	-623	1,006	1,317	-311
WEEE	1.07	0.90	1.75	1.13	1.01	1.52	1.21	7.10	263	1,868	2	5	15		0	15	1,853			
Specific hazardous	0.10	0.25	0.15	0.37	0.29	0.70	0.29	0.00	63	0	2	1	4	1	63	67	-67			
Totals	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**135.10**	**21,688**	**239,471**		**6,229**	**18,181**	**22**	**37,709**	**55,890**	**183,581**	**118,458**	**49,076**	**69,382**

Waste input assumed	190000	tpa
Operating hours/ann assumed	8760	hrs
Input tonnes per hour	21.69	tph
Assumed parasitic load	8	MW/hr
Assumed heat efficiency	15.3	%

From UBB5A Simon Aumonier paper Tble 2.9 page 64

Key to biogenic colour coding (per S Aumonier)

- (green) Assumed to be 100% biogenic
- (pink) Assumed to be 50/50 biogenic

Biogenic proportion of CV before moisture and activation considered	**49.5%**
Proportion of biogenic energy required for liberation of moisture and activation	**41.4%**
Energy available from biogenic origin as percentage of total usable energy	**37.8%**
Proportion of useful biogenic renewable energy from dry paper and card	**96.0%**

Analysis by Tony Manser

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