Is Producing Energy from Waste via Gasification a Viable Option in the UK?

An Assessment of the Proposed Brent Cross Cricklewood Waste-to-Energy Scheme

Introduction

The UK has a growing waste disposal problem and an imminent issue regarding energy security and sustainability.

As to the former, in accordance with the *European Landfill Directive* targets, the *Landfill Allowance Trading Scheme* sets progressively tighter restrictions on the amount of biodegradable municipal waste – defined as paper, food and garden waste – that disposal authorities can send to landfill. Authorities will be charged at £150/tonne beyond the limit set; aiming to reach the nationwide target of 35% of 1995 landfilling levels by 2020 (letsrecycle.com, 2009).

The 2008 *UK Climate Change Act* set legally binding targets for the UK to reduce greenhouse gas emissions by at least 80% by 2050 (with CO_2 at 26% by 2020); both set against the 1990 baseline (DfT, 2009a, p106). London aims to generate 25% of its energy from local sources, alongside a 60% reduction in carbon emissions, by 2025 (GLA, 2009).

As such, there is a significant demand for new technology that will process waste in an environmentally friendly manner. It will be of further benefit if this production is decentralised

and able to serve the electricity and/or heat requirements (CHP) of the local community, especially considering that incineration without energy recovery is no longer allowed (WAW, 2009).

It is estimated that London's unrecyclable waste could provide electricity for two million homes and heat for a further 625,000 (ECLA, 2009, p16). Utilising waste for the production of energy will, in short: lower CO_2 emissions, decrease UK dependence on foreign fossil fuels, divert waste from landfill, create 'green collar' jobs and stimulate local economies (GLA, 2009).

Numerous Energy-from-Waste (EfW) technologies are presently being discussed – known as 'Advanced Thermal Treatments'; these include gasification, pyrolysis and anaerobic digestion – although, whilst incineration remains the cheapest option, it is the most realistic (and, crucially, bankable) alternative to landfill.

The November Module encapsulated various Waste-to-Energy issues, the UK's growing landfill problem and also micro-generation. This essay encompasses all three and addresses a sensitive debate that will undoubtedly be repeated across the country in the coming years. Is an example waste-to-energy gasification scheme a solution to alleviating the UK's waste and energy issues, or a costly distraction that will lead to lower recycling and increased pollution?

The Brent Cross Cricklewood Scheme

On 23rd November 2009 the London Borough of Barnet resolved to grant planning approval for the 'Brent Cross Cricklewood Regeneration Scheme', situated in suburban North West London (*see Appendix A*)[1]. The £4.5bn project entails the construction of 7,550 homes, a new high street, town square and mainline rail station and, most controversially, a £150m recycling and EfW facility[2] that will provide 16MW CHP for the entire mixed-use community (LBBPC, 2009, p8).

Gasification is the thermal decomposition of material (*explained fully in Appendix A; compared in Appendix D*) via a three-stage process; theoretically cleaner and more controlled than incineration. Firstly, waste is mechanically biologically treated (MBT) to produce a refuse derived fuel (RDF). The RDF is heated in limited oxygen, to create a synthetic gas (syngas), which is cooled and cleaned, before being used to generate electricity and potentially heat.

As a form of renewable energy, the plant would satisfy the 20% CO_2 reduction targeted by the *London Plan*, though this objective is caveated as 'flexible' (Mayor of London, 2008). Importantly, EfW applications should only be considered as 'value recovery' – at such a time as the waste cannot be reused, recycled or composted – and Renewable Obligation Certificates (ROCs) are available (ECLA, 2009, p10).

Recent recommendations by the Mayor of London are fascinating and support much of the analysis below. They are therefore included, in part, as *Appendix B* (along with an analysis of municipal waste treatment).

The scheme has dominated local and, at times, national press, and has wider repercussions for the UK and its sustainable waste management strategy.

The Brent Cross Cricklewood Debate

(i) The Case for the Developer

Support for the development has been led by Project Manager, Jonathan Joseph. In an interview (*see Appendix C*) Mr Joseph explained that the plant will produce particulates, but at a safe and strictly regulated level; and is more environmentally friendly than landfilling the RDF or burning transported natural gas, the official alternative option. Handling over 400,000 tonnes of

[1] It must be stressed that the scheme still requires consent from the Government Office for London and the Mayor's office, and also that individual details (such as the specification of the EfW unit) are yet to be finalised. The North London Waste Authority, as partner, will also be required to carry out a separate procurement process

[2] Planning was granted for a gasification plant and not an incinerator; nonetheless this is categorised under the EU's *Waste Incineration Directive* and will therefore have to meet mandatory emissions limits.

waste per annum, only 25% will be gasified, implying no change in recycling priorities[3]. Importantly, whilst there are no comparable schemes at this point in time (whether EfW or utilising the 'ENVAC' vacuum collection system (*see Appendix A for full details*)), there are likely to be by 2013, when key approvals will be decided upon (Joseph, 2009).

Mr Joseph suggests that this scheme will meet all energy and waste targets, and therefore dismisses much of the anti-campaign as 'scaremongering' and 'technology misunderstanding' (Hayes, 2009), citing a scientific report by SLR Consulting, though this firm was not willing to publicise its findings.

This view is not disputed by DEFRA, which encourages EfW if recycling options have been exhausted. The department claims no credible evidence of adverse health outcomes for those living near plants – municipal waste incineration accounts for less than 1% of UK emissions of dioxins – though the governmental position has not been updated for some time (DEFRA, 2007).

Regularly referenced gasification operators such as Energos claim a proven technology, ultra-low emissions and, remarkably, an improvement in surrounding air quality (Energos, 2009, p2 & 3). There is, however, very little scientific data to support that view at this time.

An undoubted benefit of this pioneering scheme will be 'proof of concept' and a future benchmark, considering that associated risks can only be assessed when commercial prototypes are installed and operated over a set time period (pfi, 2009).

(ii) The Case for the Opposition

Vociferous resistance to the EfW facility has been led primarily by local Friends of the Earth (FoE) and Liberal Democrat groups (*interview transcript in Appendix C*). These organisations accept that gasification has many advantages over incineration, but is untested and included purely to meet renewable energy (the *London Plan*) targets (Colacicco, 2009 and Fletcher, 2009). They also believe that the following disadvantages are shared:

- Natural resources/recycling are destroyed/undermined (due to resource competition)
- The fuel produced will not offset that used in manufacturing new products
- Toxic ash and air emission pollution is generated
- Climate change is worsened (FoE, 2009)

A key pillar of this argument has been the evidence provided by waste disposal expert Professor Paul Connett, who has spent 25 years campaigning against incinerator use. Connett maintains that the distinction between incinerator and gasifier is irrelevant, as both will produce

[3] Thereby fulfilling Recommendations 1, 2 and 6 in Appendix B. In fact, an 85% waste recovery figure is targeted (LBBPC, 2009, p196)

the same extremely harmful nano-particles[4] and dioxins (Connett, 2009, sl64-81) that, contrary to the statements of developers, are not specifically regulated at this time (Seaton, 2009).

His exhaustive presentation, citing the influential environmental justice campaigners, Green Action, also concludes that gasification will use more energy and struggle to scale to a commercial viable level (Connett, sl95-109).

There is now general concurrence with the view that any combusting EfW scheme will produce, to some degree, CO_2, carcinogenic dioxins and other toxins[5]. The Tellus Institute, an independent, not-for-profit think-tank, argued that, whilst gasification was able to successfully lower waste volumes and produce six times as much energy as landfill sites, both recycling and landfill methane-recapture saved more energy and CO2 respectively (McKenna, 2009). It concluded that gasification will not have a major role to play (Tellus, 2008, p7 (table), 26, 36).

Taking a broader look at the available data, GAIA is one of the most influential international groups campaigning against gasification and fervently discourages these 'Incinerators in Disguise'. Their up-to-date and oft-cited *An Industry Blowing Smoke* report lists ten reasons to support their argument (*expanded upon in Appendix E*), including those mentioned above by FoE, plus poor efficiencies, high outlays (*see Appendix D – 'Cost' Column*) and an insignificant social return (Ciplet, 2009).

The report is exceptionally well researched and uses mostly peer-reviewed journal articles and primary evidence, especially when discussing incidences of health risk.

Dr Jeffery Morris of Zero Waste (*transcript in Appendix C*) reinforces the argument that, whilst there is no reliable empirical data on gasification toxins, they will: (a) be net emitters of CO_2; and (b) generate similar net energy to mass burn incineration. They are expensive, unproven and detrimental to recycling strategies (Morris, 2009).

Lastly, the only recent journal paper (aimed specifically at the scientific community) regarding waste conversion technologies concluded that the gasification of RDF had the highest overall environmental impact[6] (Khoo, 2009, p1892).

In summary, the aforementioned organisations and individuals have provided a balanced, well-researched argument against the use of gasification. The key question, as always: is this environmental dogma or a malleable position if evidence from a gasifier proved to the contrary? Whilst that remains to be seen – most likely in the next few years when enough operational data is available – I am content to accept their current opposition as scientifically valid.

[4] Nano-particles (10-c800 nm) are very difficult to capture, remain suspended for long periods and are able to pass into the bloodstream and organs, potentially causing major health problems (Connett, 2009, sl66)

[5] A fact neglected by many developers' marketing material (e.g. Energos) and inconspicuous in its absence from the Barnet planning application. Other features worthy of reference are potential corrosion, gas leakage (Emmanuel, 2004) and the leaking of waste stream toxins, as has happened in Australia (Rootes, 2009, p831)

[6] Life cycle assessment is carried out to determine the environmental impacts of the various waste conversion systems including global warming potential, acidification potential, terrestrial eutrophication and ozone photochemical formation (Khoo, 2009, p1892)

(iii) The Neutral Position

Brent Borough is one of the few neutral stakeholders in the debate. It remains concerned about the potential congestion impacts surrounding the facility (Brent Planning Department, 2009)[7].

As an exponent of independent scientific opinion, an interview was conducted with Joe Schwager of Juniper Consulting (*Appendix C*). The firm has led the EfW field and their output is referenced by FoE and UK Without Incineration Network; as well as developers, banks and governments. All EfW will produce some dioxins (though regulations will only get stronger); but existing research is mostly irrelevant as new technology will be vastly improved. If cleaned up, gasification has a future (Schwager, 2009).

The technology-neutral North London Waste Authority[8] notes that incineration remains the only available process (of those preferred by the Mayor) proven at the necessary scale, cost and efficiency for its *Joint Waste Strategy* (2009, p96).

Comparable Data

Frustratingly, while there is much anticipation regarding the potential of gasification, there are too few comparable facilities (*discussed in Appendix* F) to draw any direct conclusions (Juniper, 2009, p3).

Independent campaigner, Michael Ryan, has examined the rates of infant deaths in the electoral wards around incinerators, producing maps to exhibit the down-wind, localised effects on mortality (UKHR, 2009). Considering the aforementioned research, Ryan is astonished that no academic has been willing to examine the data and challenge the Health Protection Agency (HPA) (Ryan, 2006 and Hayes, 2009).

The HPA has indeed chosen not to investigate this correlation[9], even though pressed by MPs for public health emissions information (Hansard, 2009) and recognised as a 'knowledge gap' by the London Assembly (ECLA, 2009).

The agency concluded that, whilst adverse health effects could not be completely ruled out, potential damage from modern, regulated incinerators was likely to be insignificant. It specifically states that it does not recommend further studies: a surprisingly definite position (HPA, 2009, p1).

[7] It is worth noting at this juncture that noise, visual and traffic pollution are not likely to be significantly affected and have therefore been overlooked for the sake of brevity. These were all a relatively minor concern to objectors of the scheme
[8] The body organises waste disposal in seven North London Boroughs, including Barnet
[9] Let alone new EfW technologies; note Recommendation 2 in Appendix B

Considering the latest science noted above, not to mention significant public health concerns, why is the government so reluctant to update its research? Maybe this is too significant a risk to take prior to May 2010's national and local elections?

Conclusion

At Brent Cross Cricklewood and, it seems, for many similar projects throughout the UK, gasification is likely to be neither the panacea for the UK's waste and energy issues, nor may it be readily dismissed.

The irony of a 'pioneering' technology being criticised for a lack of comparable data will not be lost on the developer: however, on this occasion, the opposition has most certainly argued its case more effectively.

The evidence for incineration's adverse impact on local health is mounting and Brent Cross's gasification plant will have to exhibit, amongst its many other challenges, that it is far cleaner and safer than its predecessors. Any comparable scheme must prove that recycling is prioritised, with EfW – perhaps in a modular and flexible format – as a secondary option.

Importantly, the final decision regarding gasification at Brent Cross will not be required until at least 2013 and it is very likely that the scientific community will have an improved understanding of EfW at that time.

Limitations

Crucially, there is limited long-term, peer-reviewed science supporting the claims of developers or opponents and thus it will only be empirical evidence that provides a foundation for their argument and a more complete analysis herein.

The lack of scientific investigation on this matter was surprising – especially the reluctance of the UK government to investigate health impacts – though understandable at times considering the multitude of time, technology and feedstock variables to be considered.

As such, this essay has had to take a broad approach to the various factors: environmental, energy-production, health, social, etc.

Implications for Existing Orthodoxy

Environmentalists are keen to focus higher on the 'waste hierarchy' and improved recycling measures ... but is that realistic if the UK wants to divert substantial amounts from landfill in the long-term and alleviate national energy concerns? This is a paradoxical theme running through many facets of the intended ‘low carbon economy’.

It seems very likely that EfW options will be required in the near future and thus it is crucial that the environmental and health effects are closely monitored and effectively relayed to campaigners and members of the public. If relevant, it may then be considered how EfW may support, but not replace, ‘reduction, re-use and recycling’ targets.

Implications for Future Research

A geographically-focused, long-term cost/benefit analysis of gasification at a particular site, incorporating a range of feedstocks, would massively benefit public understanding of this highly controversial technology. Additionally, the waste industry would benefit from an assessment as to whether EfW processes do detrimentally impact local ‘reduce, re-use, recycle’ initiatives, as so many of the aforementioned ‘opponents’ claim.

Naturally, it would be fascinating to return to the Brent Cross Cricklewood gasification plant in five, ten and fifty years’ time to empirically assess the environmental (waste management, energy production, etc), social and health impacts.

APPENDICES

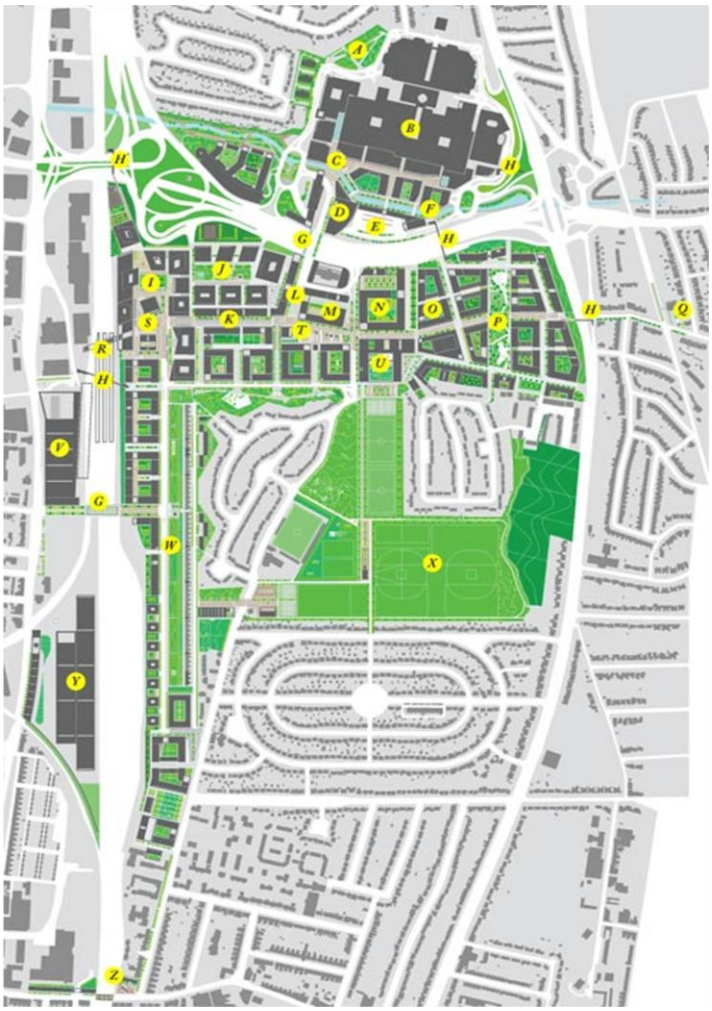
Appendix A: Location and Description of *Brent Cross Cricklewood* Planned Scheme

The regeneration area (shown photographically below) is situated in North West London, approximately three miles from the city centre. It covers over 150 hectares, bordered by Brent Cross Shopping Centre in the North, The A41 (Hendon Way) in the East, Cricklewood Lane in the South and the A5 (Edgware Road) in the West. The A406 (North Circular Road) also passes through the site East to West, as does the Midland Mainline rail infrastructure North to South.

A. Brent Cross Shopping Centre
B. Brent Cross Bus Station
C. Claremont Way Industrial Est
D. Whitefield Estate
E. Clitterhouse Playing Fields
F. Brent Cross Flyover
G. Toys R Us
H. Brent Cross Tube Station
I. Whitefield School
J. A406 (North Circular Rd)
K. A5 (Edgware Rd)
L. M1
M. A41
N. Midland Mainline
O. Tesco Brent Cross

The diagram below shows the indicative layout of the development project. The reader's attention is drawn to **V: The Waste and Recycling Facility** (mid-left).

A. Sturgess Park
B. Brent Cross Shopping Centre
C. Brent Cross Square
D. Multiplex cinema & leisure
E. New Brent Cross bus station
F. Riverside Park
G. New road bridge(s)
H. New pedestrian bridge(s)
I. Commercial district
J. Office Square
K. High Street
L. Community centre & library
M. Leisure centre
N. Food store
O. Health centre
P. Eastern Park
Q. Brent Cross tube station
R. Train station
S. Station Square
T. Market Square
U. New Whitefield School
V. Waste and recycling facility
W. Brent Terrace Park
X. Clitterhouse Playing Fields
Y. Rail freight facility
Z. Cricklewood Station



<u>Relevant Supporting Information</u> (highly pertinent features are underlined)

Brent Cross Waste Facility Design

Through careful use of multi-storey buildings and basements the facility has been designed to <u>minimise its visual impact</u> and to be accommodated on a <u>relatively compact site</u>. The new state-of-the-art facility will replace the current very basic facility, from which almost all of the waste is sent to landfill.

The site of the new facility is strategically located to <u>maximise the use of rail</u> rather than road transport, and to ensure the most <u>efficient energy transfer to new homes and businesses</u> in the regeneration area.

Material Recycling Facility (MRF)

The MRF (served by a unique underground vacuum system, sourcing from each household: ENVAC) will be fully automated and able to separate recyclable streams into their constituent components.

Renewable Energy Conversion Facility

The renewable energy conversion facility will use fuel from the waste treatment plant to derive electricity and heat that will be used in across the scheme.

The technology proposed (gasification) does not directly combust the fuel; instead the fuel is converted into a gas which is then cleaned to remove impurities and subsequently combusted to create electricity and heat. By converting the solid fuel to gas, any impurities that may have been present are collected as a solid product, which can be disposed of safely.

Plants that use this technology are currently operating on the Isle of Wight and in Chester; numerous examples also operate in Europe and further afield in countries such as Japan, the US and Canada.

Emissions

A detailed air quality survey will be undertaken to ensure no adverse effect on local air quality from the waste handling facility and renewable energy conversion facility.

Waste will be cleaned and refined, turned into a renewable fuel, which will then be converted into a clean gas. This gas will be of a quality similar to natural gas used in conventional domestic heating systems throughout the UK. However, by utilising the gas in a single centralised combined heat and power (CHP) plant, the emissions to air will be much lower than if each household had its own central heating boiler.

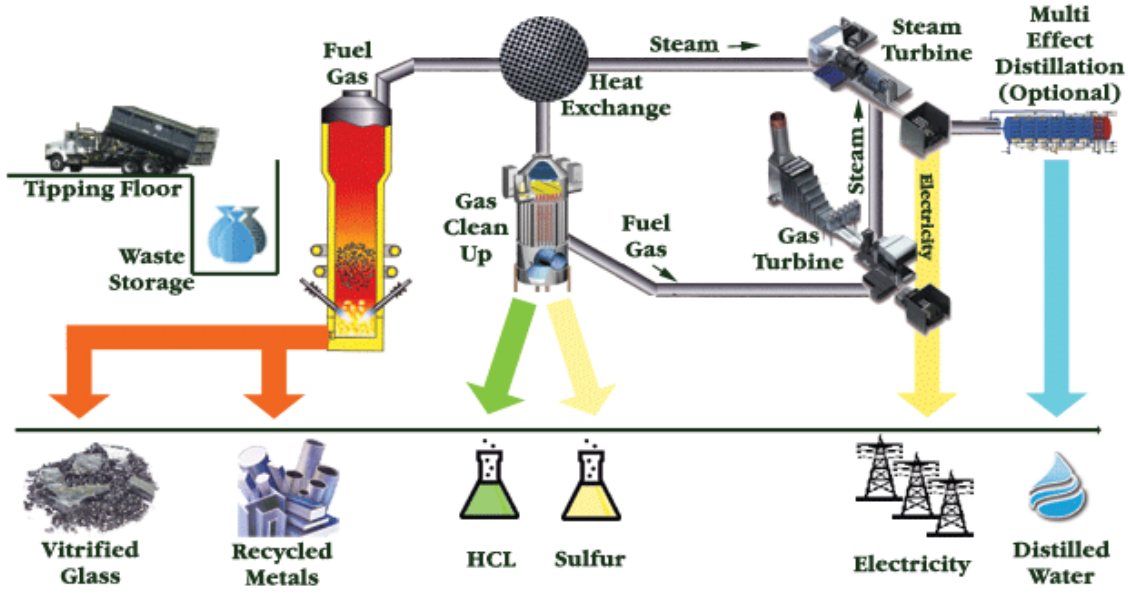
Source: BXC Partners, 2009 and *London Communications, 2009*

The application proposals are for a CHP facility linked to the development by a district heating/cooling and power network. It will be capable of supplying 100% of the heat and hot water to all the new residential units within the BXC development. The CHP plant will employ thermal processes which are described as advanced thermal technologies (ATT) or advanced conversion technologies (ACT). This includes gasification/pyrolysis but does not include mass burn incineration.

Source: LBBPC, 2009, p14

Example Gasification System

This is an indicative design and not necessarily the one proposed by Brent Cross Cricklewood Partners.



Source: Victory Gasworks, 2009

Appendix B – Abbreviated Recommendations by the Mayor of London Regarding a Sustainable Waste-to-Energy Strategy

Recommendation 1
We welcome the Mayor's commitment to identify opportunities for **introducing new waste capacity, including sites for waste management and treatment**. The Waste strategy should also set out what role the Mayor could play to coordinate the development of an **effective and cost efficient waste to energy infrastructure**.

Recommendation 2
The Mayor should set out in the Waste Strategy the GLA's conclusions as to the **climate impacts and health effects of each of the waste to energy technologies** … [which] could support a public communications strategy to **promote the schemes to the public**.

Recommendation 3
The London Waste and Recycling Board (LWARB) should provide advice on how to ensure they will **generate the waste streams necessary to support new waste to energy plants**.

Recommendation 5
LWARB should work with waste to energy operators to ensure that public concerns are dealt with, and that people are **informed of the facts and benefits of waste to energy** plants.

Recommendation 6
The Mayor should incorporate a **requirement for heat utilisation plans** in the London Plan, particularly where this could feed into new housing developments.

Source: Mayor of London, 2008

n.b. The key issues in this sub-sector at present (most notably in London) are the standardisation of PFI contracts, technologic risk and, most crucially, concern regarding planning approvals (Rose, 2009).

As supporting background, the reader's attention is drawn to the following graph, where 'energy recovered' refers to conventional incineration:

Source: NLWA, 2009, p17

Appendix C – Interview Summaries

(n.b. these are approximated summary transcripts and are not verbatim or directly attributable)

Jonathan Joseph, Brent Cross Cricklewood Partners (18/12/09 – In person)

- This is a gasification plant; not an incinerator. Incinerators are clean, but have a CO_2 footprint and a bad reputation – why would we offer that to the planners?
- There is likely to be new legislation regarding gasification, with very tough regulation
- We are committed to a 44% reduction in carbon emissions for residential buildings, compared with Part L
- There are particulates and nano-particulates, but only 0.2% - which is no more harmful than other burners, such as your domestic gas boiler (see the work by SLR consultants! [*note to reader: this work was never made available*])
- Our process is:

  1) Waste treatment – takes away all the harmful recyclables, shreds and screens everything repeatedly, leading to an odourless and harmless RDF
  2) Thermal treatment – produces a hot gas which is cooled and scrubbed thoroughly
  3) Combustion of the clean gas

  Our opponents have not understood this process

- The alternative option is a natural gas plant, but that isn't as environmentally friendly as the gas must be sourced from somewhere remote
- The existing waste transfer station (same size as the new one) is old and badly leaking water into the water table. This handles 400,000 tonnes per annum and we'll only add about 15,000 (the organic material will be anaerobically digested elsewhere); recycling won't be affected; meaning just 25% of the front gate material will produce the RDF [*note to reader: the Planning Application states 18,000*]

- This RDF in a landfill would be better than what goes in now, but it is more beneficial to burn for syngas
- The cost of the MBT build is c£75 million; the gasifier is c£80million (ready 2013-2016)
- MBT will process 125,000 tonnes of RDF; producing 16MW of CHP (which should meet all of the mixed use scheme (homes and commercial))
- We will not go ahead if not happy, hence the alternative energy strategy, which is the same price and the RDF will simply be transported somewhere else
- There aren't comparable schemes right now, but there will be by 2013 when key decisions have to be made

Combined: Lia Colacicco, Brent FoE (15/12/09 – By phone) and Phil Fletcher, Barnet FoE (15/12/09 – By phone)

- LC: Prof Connett took me off the fence when he gave us evidence on the effects of nano-particles on human health; especially being allowed so close to many schools
- LC/PF: If it's so clean why does it need at 460ft chimney to disperse the by-products? We are also concerned about the visual pollution of the stack
- PF: The technology clearly hasn't worked in Australian and German plants; even though the developers (especially EfW specialists Energos) claim success in those countries[10]. Can any of them prove their claims?
- PF: No-one understands what is actually going to get built there: the toxins are completely unknown and could be seriously harmful recalcitrant
- LC/PF: Barnet is a landowner, so isn't neutral. Brent or Camden may give you an unbiased opinion. Barnet needs its renewable obligation covered and is interested in the incentives and the fees that go with this plant[11] [12] [13]
- LC: It is an 1980s style scheme: no public transport, poor housing, etc

It should be noted that these views are echoed by the Barnet Green Party, the Cricklewood Community Forum and numerous other local residents (Ham & High, 2009 and Hayes, 2009 (Blog Section)).

10 Mr Fletcher accompanied this with a wealth of information from EfW interests in Germany, disputing any claims of 'long-term, reliable output' made by Energos (Fletcher, 2009 & Energos, 2009, p7). This information is available to the reader, but in German

11 Cllr Mike Freer, leader of Barnet, stated *"I've been reassured the air coming out of the chimney is cleaner than the air going in"* (Hanks, 2009).

12 It is also worth noting that many local authorities may be overly keen to support EfW initiatives as a recent independent poll showed that the UK will struggle to reach its 2013 landfill-diversion targets (50% of 1995 levels). As this will imply a fine of £180m, rising to £500m by 2020, perhaps central government has increased the pressure (Norton Rose, 2009)?

13 It is relevant to mention that for Barnet, as a 'non-deprived' London Borough, private (commercial) development remains the most realistic opportunity for high-cost, holistic regeneration

Jeffrey Morris, ZeroWaste.com & Sound Resource Management (19/12/09 – By email)

- No reliable empirical data on gasification toxins, carcinogens and particulates emissions from municipal solid waste (MSW) due to lack of experience
- They will be net emitters of fossil carbon dioxide due to the presence of plastics, synthetic textiles, synthetic rubber and other fossil carbon containing products in MSW
- Studies indicate that they will generate similar net energy to mass burn incineration (a study of mine showing this is currently being finalised for publication in *Environmental Science & Technology* journal)
- Due to the huge expense of both [gasification and incineration], and the detrimental effect on reuse, recycling and composting, there is no reason to be investing at this point
- All of the points below still apply to gasification:

    1) It is a poor economic investment
    2) Very few jobs are created for very large capital investment
    3) It is inflexible, stifles innovation and does not challenge resource over-consumption
    4) It generates a toxic ash and toxic air emissions
    5) It doesn't get rid of landfills
    6) It is unscientifically and poorly monitored

Zerowaste.com consults on pollution, conservation and the 'Consumer Environmental Index'. Mr Morris has a professional interest in this matter, though has little to gain from dismissing EfW technologies, and claims that peer-reviewed papers (including his own) will be published very shortly.

Joe Schwager, Juniper Consulting (17/12/09 – By phone)

- The firm is not 'for' or 'against' and we consult on a factual basis to whichever client: the textbook definition is very different in practice and that's what must be examined (it doesn't matter what you call it; it's what it does: there is no 'magic bullet')
- Gasification will produce some dioxins – depends on the operating specification of machine, feedstock, etc - and that's what we examine
- Gasification has been abused in the past. If the gas is properly cleaned, then correctly combusted it should be OK and the technology definitely has a role to play. But many don't as get ROCs for just burning dirty gas (cost effective to burn it quickly and move on)
- Both proponents and antis use same research and select the components that suit their argument
- One must ignore research from old technology as irrelevant. New tech looks better, but doesn't have data. EfW will be needed and we'll have to find the appropriate technology
- The regulations are strong and they will only get tougher. But, everything has some emissions and people must accept that (*further source: Juniper Consultancy, 2009, p1-3*)

Appendix D – A Comparison of Various Energy-from-Waste Technologies

	Incineration*	Gasification	Pyrolysis	Anaerobic Digestion
Input	Municipal Solid Waste (MSW) (directly, or after mechanical biological treatment (MBT) to remove recyclable items)	**Pre-treated (MBT) MSW or biomass**	Pre-treated (MBT) MSW, commercial, sewage	MSW, industrial, bio, sewage
Treatment	Furnace	**Thermal**	Thermal	Microbe digestion
Oxygen Presence	Excess	**Limited oxygen (thus effective control)**	Anaerobic	Anaerobic
Carbon / Organic Content	Medium	**High**	High	100%
Temperature	>850 °C	**>1000 °C****	300-800 °C	n/a
Output	Char / Ash	**Char / Oil / Ash / Syngas**	Char / Oil / Ash / Syngas / Metals	Digestate (fertiliser, etc), biogas and liquid fraction
Cleaning	None	**Some particulates and hydrocarbons removed**	Some particulates and hydrocarbons removed	Scrubbed pre-power phase
Energy	Heat / Power	**Syngas (mainly CO and H - 25-40% of calorific value of natural gas), burnt for Heat / Power (or used for fuel or chemical production)***	Syngas (mainly CO and H), burnt for Heat / Power (or used for fuel)	Biogas (60% Methane, 40% CO2) Power / Heat (or used for fuel)
Energy Process	Gases heat water; steam drives turbine (generally low-efficiency electricity) (c18% efficiency)	**Steam turbine, boiler or gas engine (c30% efficiency (NLWP))**	Steam turbine or gas engine	Gas burnt
Energy Production (feedstock dependent)	Medium	**Medium / High (NCV using oxygen is 10 to 15 MJ/Nm3)**	Medium (NCV is 10 to 20 MJ/Nm3)	Low
Pollutants	GHGs, acids, dioxins, furans, VOCs, heavy metals, particulates	**Likely to be GHGs, acids, dioxins, furans, VOCs, heavy metals, particulates (though depends on temperature, time and waste composition)**	Likely to be GHGs, acids, dioxins, furans, VOCs, heavy metals, particulates (though depends on temperature, time and waste composition)	Some odours
Health Impact	Evidence linking physical, mental and emotional damage within an examined geography	**Evidence limited, but some proof of adverse effects similar to incineration**	Evidence limited, but some proof of adverse effects similar to incineration	Low emissions release, therefore safe
Visual Impact	Significant (eg. high chimney	**Modular, therefore smaller**	Modular, therefore smaller	Low, though transportation

	and large surface area)			issues
Volume Decrease	Can be 90% volume (80% weight)	**80-90%**	90%	<70% (better at smaller loads)
Cost	Relatively inexpensive (c£0.6/tonne p.a.)	**Not fully understood and a large range (will be higher than incineration) - ROCs may offset - perhaps £1/tonne p.a.**	Not fully understood and a large range (will be higher than incineration) - ROCs may offset - similar to gasification	Expensive at a large scale
Proof of Concept	Proven, but inefficient	**Uncertainty regarding commercial viability (unreliable 'scale-ups' to date)**	Uncertainty regarding commercial viability (unreliable 'scale-ups' to date)	Proven, but not large-scale; efficient, but longer-term

* Approx. 60% of North London Waste is presently incinerated

**Plasma gasification adds an arc of super-heated plasma to the input material and will increase yields at a far higher temperature, though by utilising more electricity

Sources: WAW 2009, FoE 2009, GLA 2009, Ciplet 2009, Tellus 2008, Fichtner 2004, Emmanuel 2004, Yassin 2009 p169, NLWP 2008 p10

Appendix E – Arguments Used Against the Construction of a Gasification Energy-from-Waste Facility

	Reason	Description	Impact
1	Harmful emissions released are equal to incineration	Particulate matter, VOCs, heavy metals, dioxins, sulfur dioxide, carbon monoxide, mercury, carbon dioxide and furans (though depends on temperature, time and waste composition). Note that solid outputs may be highly toxic and will still have to be safely disposed of	Cancer, birth defects, disrupted sexual development, etc
2	Emissions are not measured; limits are not enforced	Levels are not based on safety, but on technical feasibility (there is evidence available that certain gasification emissions may actually be equal to (mercury, lead) or higher than incineration (NOx))	Levels remain high (as above)
3	Poor operational track record	Explosions, malfunctions, shut-downs (there is not a successful example for developers to benchmark against)	Limited empirical evidence
4	Incompatible/Competes with recycling	Both processes are after the same high-value materials, such as plastic, paper and food waste (much of the pre-treated material to be gasified is naturally the most unusable, often due to its toxicity) thus support the present, unsustainable, linear approach	Economically, recycling may lose out and rates will decrease
5	More expensive than incineration	Costs have consistently risen to unacceptable levels for the tax-payer	Far more expensive than recycling
6	Inefficiency	Recycling saves more energy (especially when one considers embodied energy) and reduces raw material extraction (fuel used is not offset). Tellus suggests 2MWh/ton as compared with 660kW/ton	Energy wasted; raw materials not re-used
7	Resource depletion / Environmental damage	The Earth's natural resources will continue to be over-used. Incinerators may allow firms to covertly rid of their toxic waste	Net increase in GHGs and environmental degradation
8	Contribution to climate change	Far higher greenhouse gas emissions than recycling (note that biomass CO2 is not neutral, as some developers claim). [Incinerators actually produce more CO2/MWh than coal-fired power plants]	Global warming, etc
9	Insignificant social benefit	Considering the expense, relatively few jobs are created (as compared to recycling and composting). (The East London gasifier will cost £80m and create just 20 jobs)	Unemployment or no new employment
10	Treating natural resources is unnecessary	A commitment to 'Zero Waste' is far more logical and beneficial	Negative impact on sustainability targets

Sources: primarily Ciplet 2009 - also FoE 2009, Fletcher 2009, Emmanuel 2004, GAIA 2009, GAIA 2008 p10, Tellus 2008 p7

n.b. GAIA is the Global Alliance for Incinerator Alternatives

Appendix F – Background Information to the Lack of Existing Comparable Data

Several 'pioneering' plants in Germany have been decommissioned due to various economic and environmental factors (Fletcher, 2009).

Plants are being operated in the US, Japan and Europe and relevant data will hopefully be published soon (McKenna 2009). However, international projects operate under very different regulatory regimes, negating a meaningful comparison.

Perhaps the most relevant comparable (and potential contributor to lowering technologic risk) is the recently funded 'East London Sustainable Energy Facility', which claims it will process 100,000 tonnes of waste; generating 20MW of electrical power and 10MW of thermal capacity (applicable to 15,000 homes) (ECLA, 2009, p13 & p28).

Conversely, on the same day as the above planning was granted, Surrey County Council scrapped its plans for a 160,000 tonne EfW plant, in favour of increased household recycling schemes, a far smaller gasifier and an anaerobic digester (Butt, 2009). Emissions issues were a major factor in this decision (WRA, 2009).

Fichtner Consultants, an independent engineering advisor, stated the following:

"Many of the perceived benefits of gasification and pyrolysis over combustion technology proved to be unfounded. These perceptions have arisen mainly from inconsistent comparisons in the absence of quality information." (Fichtner, 2004, p4)

This report may be five years' old, but it should be noted that its recommendations have not yet been met.

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