Energy from Waste (EfW)

Northwest Opportunities Study

Envirolink Northwest

Final Market Intelligence Report

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Part 1. Market Intelligence Report

Energy from Waste (EfW): Northwest Opportunities Study

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Introduction

Around 7.5 million tonnes of commercial & industrial waste (C&IW) were generated across the Northwest in 2006. Much of this could not be recycled and nearly 4 million tonnes were sent for disposal, mainly to landfill which is a major challenge for the region. Energy recovery offers a potential option for the Northwest to address current and future C&IW arisings and meet government targets for reduced landfill disposal. Energy recovery will also have a positive impact by helping companies, especially in chemicals, food processing, paper etc and the potential to reduce energy poverty in local communities through integrated CHP schemes.

This document is the first of a series of market intelligence reports by Envirolink Northwest to support the development of the environmental technologies sector in the Northwest region. It summarises the results of a study by Optimat Ltd that provides a comprehensive review of:

- Future C&IW arisings in the Northwest to district level
- An assessment of the associated energy recovery potential
- Current and planned energy from waste (EfW) technology capability and capacity in the Northwest
- Sub-regional need for EfW

A key aim of the report is to provide value adding information that will help companies make informed decisions on the suitability of EfW technology for their business and opportunities for the region.

The overall approach adopted for the study was based on a combination desk research, primary research and analysis is summarised below

Desk based review current and 2020 C&IW arisings using secondary research to quantify the commercial, industrial in the Northwest currently sent for landfill, in terms of the suitability of different EfW technologies to meet future regulatory requirements for waste disposal and sustainable energy. This included assessment of a breakdown sub-regional C&IW arisings.

EfW and C&IW review using three different growth scenarios, recycling and recovery rates that could be introduced in order to assess the opportunity potential and investment requirements for EfW in the Northwest.

EfW gap / need analysis to assess the impact of current and future EfW demand / supply dynamics in the Northwest. Results from the analysis provided the basis of conclusions on the Northwest's EfW capability/capacity and recommendations on sub-regional need for EfW.

C&IW Classification

C&IW covers a wide range material compositions and substances from manufacturing, processing, retail, wholesale and public sectors. For the purposes of this report, C&IW's were classified into nine main waste groups in accordance with EUROSTAT definitions (EWCStat 2004) and recovery rates defined in the Urban Mines 2007 report.

Waste Group	Included Wastes
Chemical Wastes	Solvents, acids/alkalis, used oil, catalysts, wastes from chemical preparation, residues and sludges
Healthcare	Healthcare wastes
Metallic Wastes	Metallic wastes
Non-Metallic Wastes	Glass, paper & card, rubber, plastic wood, textiles
Discarded equipment	End of Life Vehicles, batteries, waste electronics (WEEE), other discarded equipment
Animal & Vegetable Wastes	Food, manure, other animal and vegetable wastes
Mixed (ordinary) Wastes	Household, undifferentiated wastes and sorting sludges
Common Sludges	Sludges (common) and dredgings
Mineral Wastes	Combustion residues, contaminated soils, solidified mineral wastes, other mineral wastes

C&IW Classification

Energy recovery potential for varies significantly between the major C&IW groups and therefore suitability for commercial development, which has been a key challenge to address waste arisings from commerce and industry. An indication of the energy recovery potential is shown below.

Waste Groups	Included Wastes	Proportion by Weight (%)	Energy Recovery Potential
Chemical	industrial solvents, acids/alkalis, used oil, catalysts, chemical preparation wastes, residues and sludges	19	Medium
Healthcare	mixed hospital and industrial medical wastes	1	High
Metallic	various metal wastes	10	Low
Non-metallic	glass, paper/card, rubber, plastic, wood, textiles	27	High
Discarded equipment	end of life vehicles, batteries, waste electronic and other discarded equipment	>1	Low
Animal & vegetable	food, manure, other vegetable and animal wastes	6	High
Mixed ordinary	household, undifferentiated wastes and sorting residues (similar to MSW)	24	High
Common sludges	sludges and residues	5	Medium
Mineral	combustion residues, contaminated soils, solidified mineral and other wastes	7	Medium

Energy Recovery Potential from Northwest C&IW

The above analysis suggests that non-metallic, mixed ordinary and chemical fractions represent around 70% of C&IW arisings, with medium to high energy recovery potential.

However, different EfW technologies may be needed for the different waste groups and energy recovery rates will also vary across the nine Northwest sub-regions, which have implications for commercial development.

Northwest Baseline C&IW Arisings 2006

Around 7.53 million tonnes of C&IW waste arisings were recorded for the Northwest in 2006 with 3.59 million tonnes recycled, composted or recovered. Only 50,000 tonnes were sent for energy recovery, leaving a net balance of nearly 3.9 million tonnes landfilled.

Baseline arisings (06) for NW	7.53 million tonnes
Baseline % Recycled/Composted/Land Recovery	48%
Baseline tonnes Recycled/Composted/Land Recovery	3.59 million tonnes
Baseline % EfW	0.65%
Baseline tonnes EfW	0.05 million tonnes
Baseline % Recovery (incl. Recycling/Composting/Land Rec)	48.65%
Baseline tonnes Recovery (incl. Recycling/Composting/Land Rec)	3.64 million tonnes
Baseline % remaining arisings landfilled (after Recycl/Comp/Rec)	51.35%
Baseline tonnes remaining arisings landfilled (after Recyc/Comp/Rec)	3.87 million tonnes

Northwest C&IW baseline data for 2006

Energy recovery is not feasible from all of the remaining 3.9 million tonnes of C&IW due to material types, composition variations, low calorific value etc across the region. For example, energy recovery from some C&IW groups such as some in-organic chemical residues and sludges may not be achievable. These challenges precipitated several studies[1][2][3][4] in the Northwest, which provided the basis of the C&IW baseline figures below for energy recoverable C&IW after recycling/composting at a sub-regional level.

Waste Group	Blackburn with Darwen	Blackpool	Halton	Warrington	Cheshire	Cumbria	Greater Manchester	Lancashire	Merseyside	Totals
Chemical wastes	9,648	3,126	20,624	12,096	0	33,134	179,277	34,985	71,638	**364,530**
Health care	328	211	182	330	1,161	714	4,577	2,033	2,674	**12,210**
Metallic wastes	0	0	0	0	0	0	0	0	0	**0**
Non-metallic wastes	0	0	0	0	0	0	0	0	0	**0**
Discarded equipment	0	0	0	0	0	0	0	0	0	**0**
Animal & vegetable wastes	1,362	908	891	1,212	12,200	0	39,229	7,857	14,508	**78,168**
Mixed (ordinary) wastes	3,632	1,965	1,869	4,109	12,992	8,298	49,354	20,363	20,225	**122,807**
Common sludges	2,773	743	177,620	2,368	7,297	5,439	23,862	3,649	9,052	**232,802**
Mineral wastes	4,669	433	14,192	3,234	11,900	0	33,288	0	14,458	**82,175**
Total	**22,413**	**7,387**	**215,377**	**23,349**	**45,550**	**47,587**	**329,587**	**68,887**	**132,555**	**892,691**

Baseline Energy Recoverable Potential of C&IW by Waste Group (2006)

The baseline estimates above indicate that energy was recoverable from nearly **900,000 tonnes** of C&IW arisings across the Northwest in 2006, although energy was only recovered from **50,000 tonnes** (5%). This suggests that EfW offers the potential to reduce the Northwest's landfill by 22% or **850,000 tonnes** of C&IW.

[1] *Study to fill Evidence Gaps for Commercial & Industrial Waste Streams in the North West Region of England, Urban Mines, 2007*
[2] *Waste Strategy for England, Defra, 2007, Annex A, Table A.12*
[3] *3rd Waste Management Monitoring Report, North West Regional Technical Advisory Body, August 2007*
[4] *State of the Northwest Economy - Long term Forecasts, Regional Economic Forecasting Panel, May 2008*

In terms of volumes by waste type, chemical wastes which accounted for some 41% were the largest group followed by common sludges (26%) and mixed ordinary wastes (14%). The energy recovery potential eg calorific value for most of these waste fractions ranged from medium to high.

In terms of C&IW arisings by sub-region, Greater Manchester with around 37% produced the most waste followed by Halton (24%) and Merseyside (15%). Collectively, these three sub-regions accounted for over three quarters of all C&IW in the Northwest for 2006. They are therefore considered to be priority areas for energy recovery.

Modelling Future C&IW Arisings

There a number of factors that could significantly impact on the energy recovery potential from future C&IW arisings in the Northwest. For example, recycling/composting rates could decline due to changing global demand for recyclates. Conversely, the level of total C&IW arisings could increase during times of economic growth.

Three different growth scenarios were developed to forecast the energy recovery potential use EfW technology for C&IW arisings in the Northwest upto 2020. These were based on different recycling levels from an industry survey reported the 2007 Urban Mines report and a modest 1% annual growth rate in the economy upto 2020. The three scenarios and resulting growth in energy recovery potential for C&IW arisings are shown below.

2020 Scenario A

Waste classed as *'Recoverable'* in the Urban Mines 2007 report with 2006 recycling levels deducted - the remainder being treated via Energy from Waste

2020 Scenario B

Waste classed as *'Recoverable'* and *'Possibly Recoverable'* in the Urban Mines 2007 report with 2006 recycling levels deducted - the remainder being treated via Energy from Waste

2020 Scenario C

Waste classed as *'Recoverable', 'Possibly Recoverable'* and 50% of *'Don't Know'* in the Urban Mines 2007 report with 2006 recycling levels deducted - the remainder being treated via Energy from Waste

Waste type	Tonnes treated via EfW in NW		
	Scenario A	Scenario B	Scenario C
Chemical wastes	364,530	625,583	655,438
Health care	12,210	56,930	61,103
Metallic wastes	0	0	0
Non-metallic wastes	0	0	0
Discarded equipment	0	0	283
Animal & vegetable wastes	78,168	89,491	100,222
Mixed (ordinary) wastes	122,807	247,869	546,929
Common sludges	232,802	262,327	262,359
Mineral wastes	82,175	118,869	135,385
Total NW EfW	**892,691**	**1,401,068**	**1,761,720**

Energy Recovery Potential Forecast from C&IW in Northwest (2020)

The growth scenarios indicate that the energy recovery potential C&IW in the Northwest could double over the period using the above assumptions. This would have implications for the demand and availability of EfW plant and the overall opportunity potential for the Northwest. A forecasting model for the growth scenarios is included in the Appendix, which can also be used as a tool to assess and compare different growth rates on future C&IW arisings across the Northwest.

Energy from Waste Activity Review

The baseline data indicates that energy recovery from C&IW in the Northwest, was only 50,000 tonnes in 2006 or 5%, representing less than 1% of total C&IW arisings. Results from this study indicate that regulatory drivers, climate change issues and increasing costs of landfill are starting to impact on business interest and activity in EfW both in the Northwest and across the UK. Companies are actively looking at options to reduce landfill disposal and some sectors have been implementing a number of approaches such as waste minimisation and increasing recycling. In some sectors such as food and drink, companies have already invested in EfW plant, especially in anaerobic digestion (AD) for their biodegradable waste fractions. However, waste volumes generated by individual companies are often too small to be economically viable. Local authorities and waste management companies are currently and planning to invest in lager scale EfW plant that could address some of the EfW plant capacity issues. An assessment of existing and planned EfW investment projects across the Northwest are shown below.

Existing or Planned	Operator Name	Site Location	Technology Type	Capacity	Comments
Existing	PDM Group	Widnes, Cheshire	Bubbling fluidised bed	260,000 tpa	Combustion of meat and bonemeal with electricity sold to the Grid and steam to an adjacent chemical plant.
Existing	Castle Cement	Ribblesdale Lancashire	Co-incineration		The Ribblesdale kiln uses waste solvents, hydrocarbons, chipped tyres and meat and bonemeal as substitutes for fossil fuels
Existing	Neerok Ltd T/A Woodhead Bros Meat Co	Colne, Lancashire	Co-incineration	4,000 tpa	Meat and bonemeal
Existing	Pentagon Chemicals	Workington, Cumbria	?	1750 tpa	Chemicals
Existing	Greater Manchester Waste	Bolton, Lancashire	Moving grate	125,000 tpa	Mainly MSW but also Commercial wastes (only 1% in 2006). Generates around 10MW p.a.
Existing	Veolia Environmental Services	Ellesmere Port, Cheshire	Rotary Kiln - High temp incineration (1200 C)	100,000 tpa	Mainly C&I - uncertain if there is Energy recovery
Planned	Energos	Knowsley	Gasification	80,000 - 95,000 tpa	Main feedstock will be MSW. Capable of generating 8MW. Two year build time.
Planned	PDM Group	Widnes, Cheshire	Food fuelled fluidised bed	150,000 tpa	Planning permission granted to new 8MW facility. Due for comissioning in 2010. Includes depackaging plant for packaged food
Planned	New Earth Energy/Biossence	Hooton Park, Wirral	Gasification and pyrolysis	400,000 tpa	Planning application submitted early 2009. Will accept MSW and Commercial wastes and planned to commission in 2010. Will generate up to 40MW of electricity p.a.
Planned	New Earth Energy/Biossence	Widnes Waterfront	Composting, biological treatment and solid recovered fuel preparation	200,000 tpa	Planning application submitted early 2009. Targeting organic and residual waste. Subject to planning construction will start later in 2009.
Planned	Biossence	Hooton Park, Wirral	Autoclave and gasification	400,000 tpa	Planning approved - mainly MSW but will include residual C&IW. Will generate 20MW p.a.
Planned	WRG	Lostock, Northwich, Cheshire		350,000 tpa	Project announced mid 2007 - planning application expected soon. Plant to treat MSW and C&I
Planned	Peel Environmental	Ince Marshes, Cheshire		600,000 tpa	Application submitted Feb 2006. Public Inquiry held in May 2008 - awaiting decision. EfW plant is part of a wider Resource Recovery Park plan

Current and Planned EfW Projects in the Northwest

The review indicates that there is currently around 360,000 tonnes of EfW plant capacity existing in the Northwest that is primarily focused at recovering energy from C&I waste streams. In addition, there are seven planning applications for over 2 million tpa capacity EfW plants across the Northwest, which at various stages of development.

Energy from Waste (EfW) Gap Analysis

Collectively, existing and planned EfW plant would amount to around 2.5 million tonnes per annum capacity in the Northwest, if approved. Most of this additional EfW plant capacity is aimed at MSW with residual C&IW. About 550,000 tpa plant capacity of the planned investment is directly aimed at C&IW, although the remaining 2 million tpa planned capacity could on the face of it accommodate all three 2020 C&IW growth scenarios for energy recovery from 1-2 million tpa of C&IW by 2020

Waste type	Tonnes treated via EfW in NW		
	Scenario A	Scenario B	Scenario C
Chemical wastes	419,017	719,092	753,409
Health care	14,035	65,439	70,237
Metallic wastes	0	0	0
Non-metallic wastes	0	0	0
Discarded equipment	0	0	325
Animal & vegetable wastes	89,852	102,868	115,203
Mixed (ordinary) wastes	141,163	284,919	628,681
Common sludges	267,600	301,538	301,575
Mineral wastes	94,458	136,636	155,621
Total NW EfW	**1,026,126**	**1,610,492**	**2,025,052**

Future Demand Scenarios for C&IW EfW Plant Capacity by 2020

Further examination of existing and planned EfW plant suggests that most of these will not be suitable for some of the difficult waste groups. For example, chemicals, mineral residues and common sludges are forecast to jointly account for between 780,000 tpa and 1,200,000 tpa of C&IW for energy recovery by 2020. Suitable EfW plant where high temperature EfW technologies such as fluidised bed will be required, although existing and planned capacity is estimated at between 250,000 and 500,000 tpa. This would suggest a potential EfW capacity gap of between **530,000** to **700,000 tpa** by 2020. Furthermore, some of the planned facilities don't include energy recovery but just incineration where planning permission is less likely. The study also suggests there will be over capacity in EfW plant in the region for certain waste groups eg biodegradable food, animal, mixed ordinary etc and some of this capacity could be used for chemical waste streams.

A key issue to be considered is how to best address the projected EfW capacity gaps across the Northwest region and where there will be sub-regional EfW demand/capacity issues. The following chart highlights the projected future gaps in EfW capacity at a sub-regional level, especially where there are relatively high levels of difficult C&IW waste groups.

Waste type	Blackburn with Darwen	Blackpool	Halton	Warrington	Cheshire	Cumbria	Greater Manchester	Lancashire	Merseyside	Totals
Chemical wastes	28,435	5,589	35,353	21,019	50,526	57,752	314,930	114,582	125,222	753,409
Health care	1,887	1,215	1,044	1,901	6,679	4,110	26,326	11,696	15,380	70,237
Metallic wastes	0	0	0	0	0	0	0	0	0	0
Non-metallic wastes	0	0	0	0	0	0	0	0	0	0
Discarded equipment	104	0	19	0	0	0	0	0	202	325
Animal & vegetable wastes	1,854	1,193	1,191	1,777	16,643	0	54,977	16,703	20,866	115,203
Mixed (ordinary) wastes	18,304	9,938	10,602	20,750	66,821	43,059	251,596	104,100	103,512	628,681
Common sludges	3,663	936	223,437	2,979	9,587	7,409	31,110	10,458	11,997	301,575
Mineral wastes	8,600	618	20,548	6,193	19,961	0	55,083	21,012	23,608	155,621
Totals Recovered via EfW	**62,847**	**19,488**	**292,194**	**54,619**	**170,216**	**112,329**	**734,022**	**278,550**	**300,787**	**2,025,052**
From total 2020 waste arisings	265,200	93,511	392,760	242,018	1,112,204	920,575	2,972,005	1,506,349	1,153,536	8,658,158
Total recycled	130,945	37,814	52,491	110,416	643,410	614,469	1,284,944	795,360	456,330	4,126,180
Overall Recovery Rate (Rec + EfW	73.1%	61.3%	87.8%	68.2%	73.2%	79.0%	67.9%	71.3%	65.6%	71.0%

Potential Northwest Sub-Regional EfW Plant Demand for C&IW (2020)

The analysis suggests that greatest need for EfW facilities under scenario 3 will vary considerably across the regions and will arise mainly from areas with large chemical, processing and manufacturing industries where there are gaps in suitable EfW facilities, namely:

- Greater Manchester - 350,000 tpa arisings
- Halton – 243,000 tpa arisings
- Lancashire – 146,000 tpa arisings
- Merseyside – 140,000 tpa arisings

It should be noted that the above growth scenarios are based on maintaining above UK average recycling targets and only 1% annual growth rates. Small changes to the growth rate could have considerable impact on C&IW supply and EfW plant capacity.

It was estimated from regional company registrations that more than 1500 companies across the Northwest region account for the chemical, mineral waste and common sludge arisings. The majority of these companies are mainly clustered around the three sub-regions above. It will be important to take this into account when considering the type, size and location of future development of future EfW plants. This will be covered separately in the Part 2 Opportunity Report.

Conclusions

The following conclusions are drawn, based on the results of this study.

1. Over 3.9 million tonnes (50%) of the 7.5 million tonnes of C&IW arisings from the Northwest in 2006 was landfilled after recycling and composting, with energy recovery from an estimated 50,000 tonnes out of a recoverable 900,000 tonnes.

2. By 2020, energy recoverable fractions of C&IW arisings in the Northwest are forecast to increase by between 1 million and 2 million tonnes per annum under three different growth/recycling scenarios. Six of the nine sub-regions (Greater Manchester, Lancashire, Merseyside, Halton, Cheshire and Cumbria) will have energy recoverable C&IW fractions above 100,000 tonnes per annum, with Greater Manchester having a projected 734,000 tonnes per annum.

3. This study estimates an EfW plant capacity gap of between 530,000 to 700,000 tonnes per by 2020, for recoverable C&IW under the three growth scenarios. Four sub-regions are judged to be at greatest risk from the EfW gap, namely:
    - Greater Manchester
    - Lancashire
    - Halton
    - Merseyside

4. The combined existing and planned 2.5 million tonnes per annum EfW plant capacity in the Northwest is not suitable for all of the C&IW fractions, especially for certain chemicals, sludges and mineral wastes, which accounts for the largest share (37%) of Northwest's total C&IW arisings.

5. Energy recovery from chemical, mineral and sludge wastes will require development of suitable EfW technologies due to the diversity of the chemical, mineral and sludge waste streams in the Northwest eg additional capacity in more advanced thermal treatment (ATT) technologies such as fluidised bed, plasma etc.

6. Development of appropriate EfW plant, especially in the four sub-regions highlight above would have a major environmental impact and economic benefit on the whole region. Development options for the region are considered in the Part B Opportunity Report

Recommendations

The following recommendations are made for public sector intervention to support deployment of EfW and maximise the environmental and economic benefits to the Northwest.

1. Focus future investment in EfW capacity towards more advanced technologies that will address major challenges related to difficult C&IW streams eg chemicals, minerals and sludges

2. Develop appropriate EfW capacity in sub-regions that generate most of the Northwest's difficult C&IW eg Greater Manchester, Lancashire, Merseyside and Halton

3. Investigate the most effective EfW capability development route in order to maximise environmental and economic benefits to the Northwest.

Glossary of Abbreviations

AD Anaerobic digestion

ATT Advanced thermal treatment

CHP Combined Heating and Power

C&IW Commercial and Industrial Waste

CV Calorific Value

EfW Energy from Waste

Ktpa Thousand tonnes per annum

LATS Landfill Allowance Trading Scheme

MBT Mechanical and Biological Treatment

MSW Municipal Solid Waste

RDF Refuse Derived Fuel

ROC Renewables Obligation Certificate

SRF Solid Recovered Fuel

tpa Tonnes per annum

Appendix A - Sources of Information

- Waste Strategy for England', DEFRA, 2007
- 'Municipal Waste Management', DEFRA, 2007
- State of the Northwest Economy - Long term Forecasts, Regional Economic Forecasting Panel, May 2008
- 'Development of a wider Waste Action Plan for England's North West', NWDA, 2008
- 'Regional Waste Strategy for the North West', North West Regional Assembly, 2004
- '3rd Waste Management Monitoring Report', North West Regional Technical Advisory Board (NWTAB), 2007
- Energy from Waste, Northwest Energy Forum presentation notes, 2006
- Study to fill Evidence Gaps for Commercial & Industrial Waste Streams in the North West Region, NWTAB, 2007
- An Introduction to Waste Technologies Report, UK Waste Technologies Associates, 2008
- 'Quantification of the Potential Energy from Residuals in the UK', The Institution of Civil Engineers/The Renewable Power Association, March 2005

Appendix B – C&IW 2020 Growth Scenarios

Contents & Sources

This workbook contains a summary of commercial & industrial waste arisings in 2006 for nine NW sub-regions
Three scenarios have been created to model possible requirement for Energy from Waste facilities using waste arisings projected to 2020
The model enables further scenarios to be created by varying the annual growth rate in arisings and the No of years projected

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Model Parameters and Northwest Overview
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Blackburn with Darwen - projections (2020)
Blackpool - baseline data (2006)
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Halton - projections (2020)
Warrington - baseline data (2006)
Warrington - projections (2020)
Cheshire - baseline data (2006)
Cheshire - projections (2020)
Cumbria - baseline data (2006)
Cumbria - projections (2020)
Greater Manchester - baseline data (2006)
Greater Manchester - projections (2020)
Lancashire - baseline data (2006)
Lancashire - projections (2020)
Merseyside - baseline data (2006)
Merseyside - projections (2020)
Classifications

Authors: Optimat Limited
Commissioned by: Envirolink Northwest
Date: Jan-09

Data Sources

Study to fill Evidence Gaps for Commercial & Industrial Waste Streams in the North West Region of England. Urban Mines. May 2007

Waste Strategy for England, Defra, 2007, Annex A, Table A.12

3rd Waste Management Monitoring Report, North West Regional Technical Advisory

State of the Northwest Economy - Long term Forcasts, Regional Economic Forecasting Panel, May 2008

Parameters & NW overview

Annual growth rate in waste arisings	1.00%
Number of years projected forward from 2006	14

2020 Scenario A

Waste classed as *'Recoverable'* in the Urban Mines 2007 report with 2006 recycling levels deducted - the remainder being treated via Energy from Waste

2020 Scenario B

Waste classed as *'Recoverable'* and *'Possibly Recoverable'* in the Urban Mines 2007 report with 2006 recycling levels deducted - the remainder being treated via Energy from Waste

2020 Scenario C

Waste classed as *'Recoverable', 'Possibly Recoverable'* and 50% of *'Don't Know'* in the Urban Mines 2007 report with 2006 recycling levels deducted - the remainder being treated via Energy from Waste

Waste type	Tonnes treated via EfW in NW		
	Scenario A	Scenario B	Scenario C
Chemical wastes	419,017	719,092	753,409
Health care	14,035	65,439	70,237
Metallic wastes	0	0	0
Non-metallic wastes	0	0	0
Discarded equipment	0	0	325
Animal & vegetable wastes	89,852	102,868	115,203
Mixed (ordinary) wastes	141,163	284,919	628,681
Common sludges	267,600	301,538	301,575
Mineral wastes	94,458	136,636	155,621
Total NW EfW	**1,026,126**	**1,610,492**	**2,025,052**

Appendix C - Northwest 2020 sub-region C&IW forecasts

Main Results

This worksheet contains details on:

Scenario A - Waste treatment via EfW by waste type and sub-region
Scenario B - Waste treatment via EfW by waste type and sub-region
Scenario C - Waste treatment via EfW by waste type and sub-region
Estimate of waste arisings per business (by employee sizeband and sector)

Scenario A - Waste treatment via EfW by waste type and sub-region

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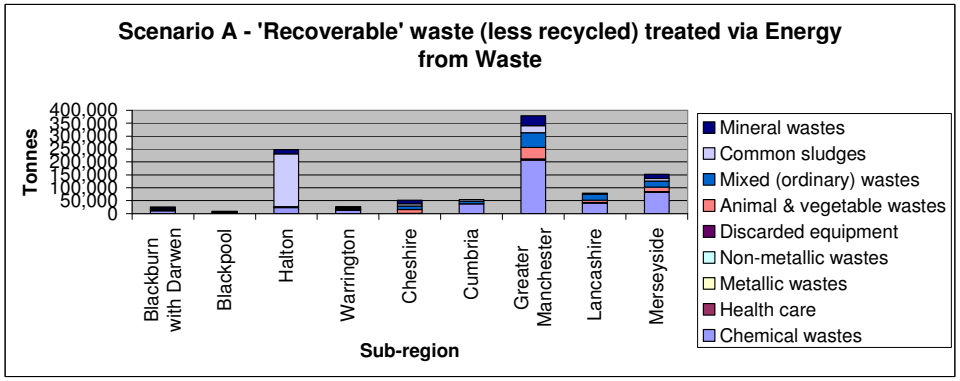
Waste classed as 'Recoverable' in the Urban Mines 2007 report with 2006 recycling levels deducted - the remainder being treated via Energy from Waste

Waste type	Blackburn with Darwen	Blackpool	Halton	Warrington	Cheshire	Cumbria	Greater Manchester	Lancashire	Merseyside	Totals
Chemical wastes	11,091	3,594	23,707	13,904	0	38,087	206,074	40,214	82,346	**419,017**
Health care	377	243	209	380	1,335	821	5,261	2,337	3,073	**14,035**
Metallic wastes	0	0	0	0	0	0	0	0	0	**0**
Non-metallic wastes	0	0	0	0	0	0	0	0	0	**0**
Discarded equipment	0	0	0	0	0	0	0	0	0	**0**
Animal & vegetable wastes	1,566	1,044	1,024	1,393	14,023	0	45,093	9,032	16,676	**89,852**
Mixed (ordinary) wastes	4,175	2,258	2,148	4,724	14,934	9,539	56,731	23,407	23,248	**141,163**
Common sludges	3,187	854	204,169	2,722	8,388	6,252	27,429	4,194	10,405	**267,600**
Mineral wastes	5,367	498	16,314	3,717	13,679	0	38,264	0	16,620	**94,458**
Totals Recovered via EfW	**25,763**	**8,491**	**247,571**	**26,839**	**52,359**	**54,700**	**378,851**	**79,184**	**152,368**	**1,026,126**
From total 2020 waste arisings	**265,200**	**93,511**	**392,760**	**242,018**	**1,112,204**	**920,575**	**2,972,005**	**1,506,349**	**1,153,536**	**8,658,158**
Total recycled	**130,945**	**37,814**	**52,491**	**110,416**	**643,410**	**614,469**	**1,284,944**	**795,360**	**456,330**	**4,126,180**
Overall Recovery Rate (Recycling + EfW)	**59.1%**	**49.5%**	**76.4%**	**56.7%**	**62.6%**	**72.7%**	**56.0%**	**58.1%**	**52.8%**	**59.5%**



Scenario B - Waste treatment via EfW by waste type and sub-region

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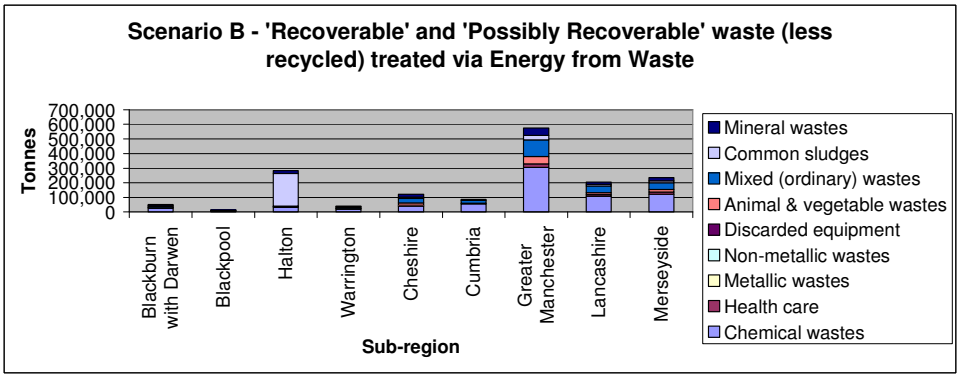
Waste classed as 'Recoverable' & 'Possibly Recoverable' in the Urban Mines 2007 report with 2006 recycling levels deducted - the remainder being treated via Energy from Waste

Waste type	Blackburn with Darwen	Blackpool	Halton	Warrington	Cheshire	Cumbria	Greater Manchester	Lancashire	Merseyside	Totals
Chemical wastes	26,928	5,416	34,341	20,401	40,878	56,043	305,470	108,119	121,496	719,092
Health care	1,758	1,132	973	1,771	6,223	3,829	24,528	10,897	14,329	65,439
Metallic wastes	0	0	0	0	0	0	0	0	0	0
Non-metallic wastes	0	0	0	0	0	0	0	0	0	0
Discarded equipment	0	0	0	0	0	0	0	0	0	0
Animal & vegetable wastes	1,714	1,120	1,110	1,590	15,368	0	50,168	12,970	18,827	102,868
Mixed (ordinary) wastes	8,341	4,523	4,641	9,449	30,234	19,423	114,191	47,201	46,915	284,919
Common sludges	3,663	936	223,415	2,979	9,586	7,407	31,106	10,451	11,995	301,538
Mineral wastes	7,607	581	19,248	5,433	18,032	0	49,919	14,355	21,462	136,636
Totals Recovered via EfW	**50,011**	**13,707**	**283,728**	**41,622**	**120,321**	**86,702**	**575,381**	**203,993**	**235,026**	**1,610,492**
From total 2020 waste arisings	**265,200**	**93,511**	**392,760**	**242,018**	**1,112,204**	**920,575**	**2,972,005**	**1,506,349**	**1,153,536**	**8,658,158**
Total recycled	**130,945**	**37,814**	**52,491**	**110,416**	**643,410**	**614,469**	**1,284,944**	**795,360**	**456,330**	**4,126,180**
Overall Recovery Rate (Recycling + EfW)	**68.2%**	**55.1%**	**85.6%**	**62.8%**	**68.7%**	**76.2%**	**62.6%**	**66.3%**	**59.9%**	**66.3%**



Scenario C - Waste treatment via EfW by waste type and sub-region

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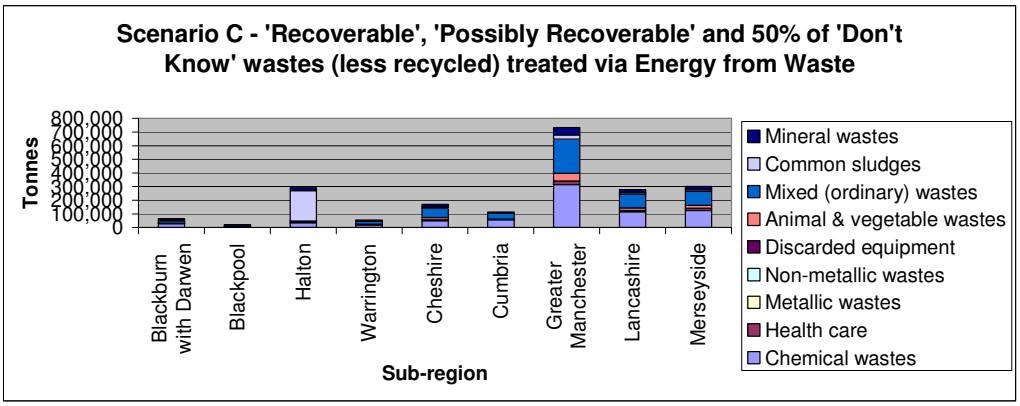
Waste classed as 'Recoverable', 'Possibly Recoverable' and 50% of 'Don't Know' in the Urban Mines 2007 report with 2006 recycling levels deducted - the remainder being treated via Energy from Waste

Waste type	Blackburn with Darwen	Blackpool	Halton	Warrington	Cheshire	Cumbria	Greater Manchester	Lancashire	Merseyside	Totals
Chemical wastes	28,435	5,589	35,353	21,019	50,526	57,752	314,930	114,582	125,222	753,409
Health care	1,887	1,215	1,044	1,901	6,679	4,110	26,326	11,696	15,380	70,237
Metallic wastes	0	0	0	0	0	0	0	0	0	0
Non-metallic wastes	0	0	0	0	0	0	0	0	0	0
Discarded equipment	104	0	19	0	0	0	0	0	202	325
Animal & vegetable wastes	1,854	1,193	1,191	1,777	16,643	0	54,977	16,703	20,866	115,203
Mixed (ordinary) wastes	18,304	9,938	10,602	20,750	66,821	43,059	251,596	104,100	103,512	628,681
Common sludges	3,663	936	223,437	2,979	9,587	7,409	31,110	10,458	11,997	301,575
Mineral wastes	8,600	618	20,548	6,193	19,961	0	55,083	21,012	23,608	155,621
Totals Recovered via EfW	**62,847**	**19,488**	**292,194**	**54,619**	**170,216**	**112,329**	**734,022**	**278,550**	**300,787**	**2,025,052**
From total 2020 waste arisings	**265,200**	**93,511**	**392,760**	**242,018**	**1,112,204**	**920,575**	**2,972,005**	**1,506,349**	**1,153,536**	**8,658,158**
Total recycled	**130,945**	**37,814**	**52,491**	**110,416**	**643,410**	**614,469**	**1,284,944**	**795,360**	**456,330**	**4,126,180**
Overall Recovery Rate (Recycling + EfW)	**73.1%**	**61.3%**	**87.8%**	**68.2%**	**73.2%**	**79.0%**	**67.9%**	**71.3%**	**65.6%**	**71.0%**



Estimate of waste arisings per business (by employee sizeband and sector)

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	Employee Sizebands and tonnes of C&I arisings						
	5 to 9	10 to 19	20 to 49	50 to 99	100 to 249	250+	**Total**
Food, drink and tobacco	10,354	5,474	24,815	37,686	245,076	223,652	**547,057**
Textiles/wood/paper/publishing	46,027	68,756	104,745	150,744	292,901	435,535	**1,098,708**
Power & Utilities	4	240,305	4,938	16,233	13,935	3,362	**278,777**
Chemical/non-metallic minerals manufacturing	32,526	19,304	181,063	143,072	252,486	209,354	**837,805**
Metal manufacturing	22,270	26,903	39,122	333,757	177,379	8,576	**608,007**
Machinery & equipment (other manufacturing)	10,888	46,484	44,328	43,412	72,988	135,417	**353,517**
Retail & wholesale	226,065	154,862	469,297	271,826	150,838	80,589	**1,353,477**
Other services	130,027	198,063	260,106	1,010,207	113,044	137,103	**1,848,550**
Public sector	15,829	45,247	219,657	61,331	50,715	213,613	**606,392**
Totals	**493,990**	**805,398**	**1,348,071**	**2,068,268**	**1,369,362**	**1,447,201**	**7,532,290**

	Employee Sizebands and number of Local Units						
	5 to 9	10 to 19	20 to 49	50 to 99	100 to 249	250+	**Total**
Food, drink and tobacco	310	185	130	80	85	60	**850**
Textiles/wood/paper/publishing	830	560	480	205	130	35	**2,240**
Power & Utilities	40	30	50	15	15	15	**165**
Chemical/non-metallic minerals manufacturing	380	280	340	200	155	55	**1,410**
Metal manufacturing	580	470	320	130	50	10	**1,560**
Machinery & equipment (other manufacturing)	865	615	490	225	160	80	**2,435**
Retail & wholesale	10,495	5,255	2,700	770	345	230	**19,795**
Other services	12,000	7,315	4,520	1,485	830	400	**26,550**
Public sector	3,970	3,915	4,800	1,455	785	375	**15,300**
Totals	**29,470**	**18,625**	**13,830**	**4,565**	**2,555**	**1,260**	**70,305**

	Employee Sizebands and average waste arisings per Local Unit (tonnes)					
	5 to 9	10 to 19	20 to 49	50 to 99	100 to 249	250+
Food, drink and tobacco	33	30	191	471	2,883	3,728
Textiles/wood/paper/publishing	55	123	218	735	2,253	12,444
Power & Utilities	0	8,010	99	1,082	929	224
Chemical/non-metallic minerals manufacturing	86	69	533	715	1,629	3,806
Metal manufacturing	38	57	122	2,567	3,548	858
Machinery & equipment (other manufacturing)	13	76	90	193	456	1,693
Retail & wholesale	22	29	174	353	437	350
Other services	11	27	58	680	136	343
Public sector	4	12	46	42	65	570

Part 2. Opportunity Report

Energy from Waste (EfW): Northwest Opportunities Study

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Appendix A EfW Technology Profiles

Appendix B Plasma EfW Technology Suppliers

Introduction

Around 7.5 million tonnes of commercial & industrial waste (C&IW) was generated across the Northwest in 2006. Nearly 3.6 million tonnes (48%) of the waste was recycled, composted or land recovered. However, energy was only recovered from 50,000 tonnes with the balance 3.9 million tonnes (51%) landfilled.

Previous research sponsored by Envirolink Northwest suggests that there is considerable potential for energy recovery from C&IW in the Northwest using small-scale EfW technology, which could create economic development opportunities for the region. Future growth scenarios in the Phase 1 Market Intelligence Report forecast that C&IW arisings in the Northwest, after materials recovery, could grow to between 1 million and 2 million tonnes per annum by 2020. Increasing energy recovery and reducing landfill will have a significant beneficial impact on the environment, local companies and the region's economy.

This document is the second of a series of market intelligence reports by Envirolink Northwest to support the development of the environmental technologies sector in the Northwest region. It summarises the results of a study by Optimat Ltd which provides a comprehensive review of:

- EfW technologies suitable for C&IW
- Opportunities for EfW technology deployment in Northwest sub-regions
- Potential economic impacts

The overall approach adopted for the study was based on a combination desk research, primary research and analysis is summarised below

Technology profiling using desk-based research to profile and carry out an assessment of relative costs for existing and emerging EfW technologies that are suitable for energy recovery from C&IW.

Opportunity analysis to assess the different opportunities for small scale EfW plants in the Northwest and identify potential development options to maximise economic benefits for the region.

Energy from Waste Technologies

Energy from Waste (EfW) is the generic term given to a process by which energy stored in waste is extracted in the form of fuel, heat and/or electricity. These cover a number of technologies with different characteristics that make them suitable for certain waste materials. Selection of an EfW technology will require careful consideration of technical, environmental, regulatory and economic issues.

Maximising recycling and recovery from C&IW will have both environmental and economic impacts of EfW and many commercial EfW plants may have integrated recycling, composting and combined heating and power (CHP) to improve the process economics. This study is specifically evaluation micro/small scale EfW technologies for C&IW fractions, especially chemical, mineral and common sludge wastes. This could be as an integral part of an industrial process or as a stand alone facility for on/offsite energy recovery. However, for any application it is important to first consider key requirement that the EfW plant must accommodate, including:

- Flexibility to accommodate variable waste fuels types (eg organic or inorganic liquids, solids or slurries etc) and quality on plant operational performance, efficiency and energy production costs
- Ability to process and recover energy cost effectively from small quantities of waste
- Modularisation or scalability to increase plant capacity
- Special ancillary, materials handling, depackaging, recycling, pre-treatment and post treatment that will impact on production costs.
- Ability of EfW technologies to meet current and future UK and EU Waste Incineration Directive (WID) emission standards, especially NO_x and dioxin levels which will impact on capital investment
- Size of technology footprint for different EfW facilities on investment and meeting planning requirements
- Environmental Impact Assessment (EIA) and Pollution Prevention & Control (PPC) permit may be required as part of the planning process depending on plant size

The starting point for any technology section will be consideration of the waste material and selection of suitable EfW technology. C&IW can include a diverse range of materials and substances in many forms such solids, liquids and slurries, which often makes it difficult to identify one EfW technology to cover all requirements. Some EfW technology developers are now developing bespoke equipment, combining attributes from several technologies to meeting challenging requirements. For example, there has been recent developments plasma assisted gasification to accommodate more difficult non-biodegradable animal wastes. The following chart lists typical wastes groups and waste materials according to official EUROSTAT classifications for C&IW streams.

C&IW Waste Group	Included Wastes
Chemical Wastes	Solvents, acids/alkalis, paints, used oil, catalysts, wastes from chemical preparation, industrial and oil residues and sludges
Healthcare	Healthcare wastes
Metallic Wastes	Metallic wastes
Non-Metallic Wastes	Glass, paper & card, rubber, plastic wood, textiles
Discarded equipment	End of Life Vehicles, batteries, waste electronics (WEEE), other discarded equipment
Animal & Vegetable Wastes	Food, manure, other animal and vegetable wastes
Mixed (ordinary) Wastes	Household, undifferentiated wastes and sorting sludges
Common Sludges	Sludges (common) and dredgings
Mineral Wastes	Combustion residues, contaminated soils, solidified mineral wastes, other mineral wastes

C&IW Classification

Technology Requirements

Forecasts for the Northwest, quoted in the Phase 1 Market Intelligence Report predict an energy recovery potential of between 1 million and 2 million tonnes per annum of residual C&IW after material recovery, recycling and composting by 2020.

Waste type	Tonnes treated via EfW in NW		
	Scenario A	Scenario B	Scenario C
Chemical wastes	419,017	719,092	753,409
Health care	14,035	65,439	70,237
Metallic wastes	0	0	0
Non-metallic wastes	0	0	0
Discarded equipment	0	0	325
Animal & vegetable wastes	89,852	102,868	115,203
Mixed (ordinary) wastes	141,163	284,919	628,681
Common sludges	267,600	301,538	301,575
Mineral wastes	94,458	136,636	155,621
Total NW EfW	**1,026,126**	**1,610,492**	**2,025,052**

2020 Energy Recovery Potential from Northwest C&IW Forecasts

It should be noted that apart from some chemical waste fractions, most of the above residual C&IW will include mixed and often soiled materials that are currently landfilled, which will require a flexible EfW technology. In terms of volume, chemical wastes are the largest fraction, reflecting the importance of the chemicals industry to the Northwest's economy. For example, official statistics indicate there are around 1400 companies across the Northwest involved in chemical and mineral production activity.

EfW Technologies

A primary objective of this study is to assess the potential for small or micro-scale embedded EfW recovery from C&IW and the resulting environmental and economic benefits to the region. A review was undertaken to assess the suitability and availability of potential EfW to allow on-site or distributed energy recovery at the point where C&IW is generated. The reduced transport of C&IW across the Northwest would have obvious additional environmental benefits.

A brief description of potential EfW technologies is provided in the following section and technology profiles can be found in the Appendix.

Anaerobic Digestion - biodegradable materials such as animal and vegetable C&IW waste streams break down in the absence of oxygen in an enclosed vessel under controlled conditions into a digestate, liquor and biogas. The organic waste stream is passed to the anaerobic digester where biogas produced during digestion is transferred to a gasholder and used to provide internal electrical power generation and heating requirements or sold to the grid. Non-biodegradable materials such as packaging has to be removed first and a waste residue is produced which requires further treatment or landfilled. Plant sizes range from micro to large scale (<1000 tpa to >400,000 tpa)

Mechanical Biological Treatment - mechanical sorting and separation equipment are used in conjunction with biological treatment processes such as composting and/or the production of refuge derived fuels (RDF) that can be combusted in EfW plant or in an industrial furnace. MBT can handle biodegradable wastes that would otherwise and depackaging equipment, gasification and CHP equipment can be integrated with the plant, which typically range from 5ktpa – 250ktpa. Residues are generated during the process are usually landfilled.

Autoclaving - waste is sealed and treated with steam at 140-160^{o}C under pressure for 30-40 minutes in an autoclave pressure, which sterilises the waste. When the treatment is complete the residue is discharged and screened to separate out the fine material about 65 per cent from the larger fraction - the metals and plastics. The fine fraction is then separated out into a lighter material (organic fibre) from heavier material (glass and grit). Additional plant eg gasification has to be integrated if the syngas produced is to be used for heating and power generation, either in-house or exported. Plant sizes start from around 15,000 tpa and are scalable upto 400,000 tpa.

Gasification – pre sorted waste, preferably single C&IW stream is combusted in a sealed chamber at high temperatures with the addition of an oxidant (either air or oxygen). Gasification of organic derived wastes will produce a gas which can be combusted to generate heat and power either for internal consumption, CHP schemes or export to the grid and residues are usually landfilled. Plant sizes usually start from a minimum of 25,000 tpa and go upto 250,000 tpa or higher

Pyrolysis – involves breaking down organic materials under pressure and in the absence of oxygen. The process works best when the input waste is carbon-rich and it is not suitability for non-organic C&IW. The process produces a liquid residue and gaseous output which may be combusted to generate electricity. A solid slag is also produced which may require disposal or additional processing. Plant sizes are similar to gasification from 25,000 tpa to 250 tpa or higher

Fluidised Bed Combustion – covers a number of technologies including bubbling fluidised bed (BFB) and circulating fluidised bed (CFB). A sand bed or similar inert material is fluidised by air jets, heated to high temperatures that will combust C&IW waste materials after pre-sorting the waste materials to remove heavy and inert objects and non-ferrous metals prior to processing. High thermal efficiencies achieved and CFB is claimed to handle wider wastes and gives lower NOx emissions for the same fuel than BFB technology. These tend to be larger scale continuously operated plant, typically starting from about 100,000 tpa and used for electrical power production and CHP schemes. However, there has been some development of the technology by Stewart Thermal Ltd in small scale / mini fluidised bed combustion plant that could offer potential opportunities for the Northwest.

Rotary / Oscillating Kilns – capable of handling mixed wastes with minimal treatment in a two stage continuous process, where the rotating motion moves the waste through the kiln and the tumbling action exposes the waste to heat and oxygen. Energy recovery efficiency is less than for fluidised bed combustion and flue gas cleanup equipment is usually required. Plants are usually lager scale starting from 100,000 tpa is used to generate heat and power, typically for large CHP schemes of export to the grid.

Plasma Arc - uses electrical energy and high temperatures created by an electrical arc gasifier to breaks down waste primarily into elemental gas and solid waste (slag), in a device called a plasma converter. Inert gas or air under pressure is passed through the arc into a sealed container of waste material. The temperature one meter from the arc can reach ~4000-8000°C which breaks down most types of C&IW into a gaseous form. Syngas produced is used to generate heat and power either for internal purposes, CHP or export to the grid. It is a versatile technology capable of handing solids, liquids and slurries. Plant sizes sally vary from 50,000 tpa but there has recent developments in micro and small scale plant

Technology Profiling

The following suitability/capability fit matrix provides a first past the post assessment of the suitability of different EfW technologies to recover of energy from various C&IW streams.

C&IW Waste Group	Included Wastes	EfW Technology Fit							
		Anaerobic Digestion (AD)	Mechanical and Biological Treatment (MBT)	Autoclaving	Gasification	Pyrolysis	Fluidised Bed Combustion	Rotary / Oscilating Kiln	Plasma
Chemical Wastes	Solvents, acids/alkalis, paints, used oil, catalysts, wastes from chemical preparation, industrial and oil residues and sludges				●	●	●	●●	●●
Healthcare	Healthcare wastes			●	●	●	●	●●	●●
Metallic Wastes	Metals								
Non-Metallic Wastes	Glass, paper & card, rubber, plastic wood, textiles	●	●	●●	●●	●●	●●	●●	●●
Discarded equipment	End of Life Vehicles, batteries, waste electronics (WEEE), other discarded equipment								
Animal & Vegetable Wastes	Food, manure, other animal and vegetable wastes	●●	●●	●●	●●	●●	●●	●●	●●
Mixed (ordinary) Wastes	Household, undifferentiated wastes and sorting sludges			●	●	●	●	●●	●●
Common Sludges	Sludges (common) and dredgings						●	●	●●
Mineral Wastes	Combustion residues, contaminated soils, solidified mineral wastes, other mineral wastes								●●

No fit
● Limited/possible fit
●● Resonable/good fit

EfW Technology Capability / C&IW Suitability Fit

Initial analysis suggests that energy recovery is feasible for most C&IW streams in the Northwest. However, options appear to be limited to more advanced EfW technologies for the high volume and more difficult to treat waste fractions such especially chemical, mineral and common sludges. For example plasma, rotary kiln and fluidises bed technologies are capable of recovering energy from most C&IW, while anaerobic digestion and MBT are limited to bio-degradable wastes.

There is considerable developments currently taking place in EfW technology that could offer additional solutions for energy recovery from C&IW in the Northwest. For example, there are several developments in hybrid plasma assisted technology such as Waste2Tricity's plasma gasification to produce a cleaner syngas and hydrogen which is converted into electricity via fuel cells.

A further requirement is the commercial availability of the EfW technology with micro or small-scale capacity. However, most EfW plants have been developed to meet the growing need to process large volumes of various wastes cost effectively and plants below 50,000 tpa are often not commercially viable.

The following chart highlights to availability of micro or small scale EfW plant that would be suitable for distributed energy recovery from C&IW in the Northwest.

EfW Technology	Micro /small Scale Plant Size Availability			
	<1000 tpa	1000-5000 tpa	5000-15000 tpa	15000-30000 tpa
Anaerobic Digestion	❍	●	●	●
Mechanical Biological Treatment			❍	●
Gasification			❍	●
Pyrolysis			❍	●
Autoclaving			❍	●
Fluidised Bed	❍	●	●	●
Rotary / Oscillating Kilns				●
Plasma	❍	●	●	●

	not available
❍	limited availability
●	available

EfW Plant Size Availability

In terms of availability of micro or small scale EfW plant, three technologies eg AD, Plasma and mini fluidised bed appear to provide the most suitable options, although some manufacturers will supply bespoke small scale EfW plant. Anaerobic Digesting is limited to biodegradable C&IW fractions eg animal and vegetable waste and plasma based EfW plant is available at a micro, small and large scale. Furthermore, plasma EfW technology appears to also offer a comprehensive capability and suitable fit to address the Northwest's current and forecast C&IW arisings to 2020. Some of the developments taking place eg hybrid plasma/gasification could also have a significant impact on the energy recovery potential and process economics.

Profiles of the main EfW technologies are provided in the Appendix.

Opportunities for the Northwest

This section investigates the potential opportunities resulting from deployment of EfW technology in the Northwest to address current and future C&IW arisings and potential economic benefits to the region in terms of jobs and GVA.

Potential Demand

Earlier analysis shows that the Northwest currently generates around 7.5 million tpa of C&IW across the region from around 70,000 businesses and organisations as shown below.

Sector	Employee Sizebands and number of Local Units						Total
	5 to 9	10 to 19	20 to 49	50 to 99	100 to 249	250+	
Food, drink and tobacco	310	185	130	80	85	60	**850**
Textiles/wood/paper/publishing	830	560	480	205	130	35	**2,240**
Power & Utilities	40	30	50	15	15	15	**165**
Chemical/non-metallic minerals manufacturing	380	280	340	200	155	55	**1,410**
Metal manufacturing	580	470	320	130	50	10	**1,560**
Machinery & equipment (other manufacturing)	865	615	490	225	160	80	**2,435**
Retail & wholesale	10,495	5,255	2,700	770	345	230	**19,795**
Other services	12,000	7,315	4,520	1,485	830	400	**26,550**
Public sector	3,970	3,915	4,800	1,455	785	375	**15,300**
Totals	**29,470**	**18,625**	**13,830**	**4,565**	**2,555**	**1,260**	**70,305**

Northwest Business Baseline (2006)

This data based on official statistics for the region provided the basis for subsequent analysis and breakdown of average C&IW arisings by sector, waste type and sub-region.

Sector	Employee Sizebands and tonnes of C&I arisings						Total
	5 to 9	10 to 19	20 to 49	50 to 99	100 to 249	250+	
Food, drink and tobacco	10,354	5,474	24,815	37,686	245,076	223,652	**547,057**
Textiles/wood/paper/publishing	46,027	68,756	104,745	150,744	292,901	435,535	**1,098,708**
Power & Utilities	4	240,305	4,938	16,233	13,935	3,362	**278,777**
Chemical/non-metallic minerals manufacturing	32,526	19,304	181,063	143,072	252,486	209,354	**837,805**
Metal manufacturing	22,270	26,903	39,122	333,757	177,379	8,576	**608,007**
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Other services	130,027	198,063	260,106	1,010,207	113,044	137,103	**1,848,550**
Public sector	15,829	45,247	219,657	61,331	50,715	213,613	**606,392**
Totals	**493,990**	**805,398**	**1,348,071**	**2,068,268**	**1,369,362**	**1,447,201**	**7,532,290**

Northwest C&IW Arisings by Sector (2006)

The analysis indicates that retail & wholesale and other services are the two main sectors generating C&IW in the Northwest. However, materials recovering and recycling performance rates are relatively high in these sectors. Sectors such as chemical and non-metallic minerals manufacturing on the other hand have a disproportionate level of C&IW going to landfill due to the nature of the materials and limited recycling options. Further analysis below shows volume of C&IW arisings at a sub-regional level.

Waste type	Blackburn with Darwen	Blackpool	Halton	Warrington	Cheshire	Cumbria	Greater Manchester	Lancashire	Merseyside	Totals
Chemical wastes	28,435	5,589	35,353	21,019	50,526	57,752	314,930	114,582	125,222	753,409
Health care	1,887	1,215	1,044	1,901	6,679	4,110	26,326	11,696	15,380	70,237
Metallic wastes	0	0	0	0	0	0	0	0	0	0
Non-metallic wastes	0	0	0	0	0	0	0	0	0	0
Discarded equipment	104	0	19	0	0	0	0	0	202	325
Animal & vegetable wastes	1,854	1,193	1,191	1,777	16,643	0	54,977	16,703	20,866	115,203
Mixed (ordinary) wastes	18,304	9,938	10,602	20,750	66,821	43,059	251,596	104,100	103,512	628,681
Common sludges	3,663	936	223,437	2,979	9,587	7,409	31,110	10,458	11,997	301,575
Mineral wastes	8,600	618	20,548	6,193	19,961	0	55,083	21,012	23,608	155,621
Totals Recovered via EfW	**62,847**	**19,488**	**292,194**	**54,619**	**170,216**	**112,329**	**734,022**	**278,550**	**300,787**	**2,025,052**

Forecast C&IW Energy Recoverable Waste Arisings by Sub-region (2020)

The analysis indicates that four sub-regions (eg Greater Manchester, Lancashire, Merseyside and Halton) will generate most C&IW arisings in the Northwest and have the greatest need for energy recovery from chemicals, minerals, common sludges and mixed ordinary waste.

The following chart indicates the number of companies in each sector and the average volume of C&IW generate per business unit that provides an indication of the type and size of EfW plants to meet current and forecast C&IW arisings.

Sector	Employee Sizebands and average waste arisings per Local Unit (tonnes)					
	5 to 9	10 to 19	20 to 49	50 to 99	100 to 249	250+
Food, drink and tobacco	33	30	191	471	2,883	3,728
Textiles/wood/paper/publishing	55	123	218	735	2,253	12,444
Power & Utilities	0	8,010	99	1,082	929	224
Chemical/non-metallic minerals manufacturing	86	69	533	715	1,629	3,806
Metal manufacturing	38	57	122	2,567	3,548	858
Machinery & equipment (other manufacturing)	13	76	90	193	456	1,693
Retail & wholesale	22	29	174	353	437	350
Other services	11	27	58	680	136	343
Public sector	4	12	46	42	65	570

Northwest C&IW Arisings by Sector and Organisation (2006)

Overall, the analysis indicates that there are around 6700 companies and organisations across the Northwest in the high C&IW generating sectors, which have the potential for some energy recovery. However, the majority of these have relatively small C&IW arisings of less than 1000 tpa, where local onsite energy recovery is probable not commercially viable. This analysis would therefore indicate the following energy recovery opportunity for the Northwest.

Sector	No of Micro/ Small EfW Plants (on-site)	Energy Recovery Potential C&IW tpa	EfW Technology Options
Chemicals & Minerals	200	500,000	Plasma
Food & Drink	120	468,000	AD
Textiles, wood, Paper & publ.	165	728,000	AD and Plasma

Opportunity Potential for Micro/Small EfW Plants for the Northwest by 2020

Collectively, the analysis indicates that there could be about 400-500 companies and organisations in the Northwest that generates C&IW in quantities suitable for energy recovery using micro/small scale EfW plants. Strongest demand at a sub-regional level is anticipated from:

- Greater Manchester
- Merseyside
- Lancashire
- Halton

In addition to the above on-site opportunities, there are over 3000 smaller enterprises in the above sectors that generate relatively low volumes of C&IW, where a merchant collection or shared facilities could be the best option.

Economic Impact Potential

Energy from Waste is currently generating considerable interest in the Northwest, across the UK and internationally driven by environmental and regulator pressures, especially to reduce landfill. Results from this study suggest that energy recovery from C&IW, particularly from difficult waste fractions such as chemicals, mineral wastes and sludges that are currently landfilled would offers potential opportunities for micro/small scale embedded EfW on-site.

This research indicates a potential demand across the Northwest for micro/small scale EfW plant of 400-500 units. Of these, anaerobic digestion technology which is well proven, available in small plant size and has easier planning credentials will probably meet much of the need from the food and drink sector and some of the textile, timber and publishing wastes. The strongest demand is expected to come from the **200** companies associated with chemicals, minerals and other sectors where EfW offers a solution to major waste management challenges. Advanced plasma thermal conversion technologies are most likely to provide a micro/small scale energy recovery option for these difficult to C&IW fractions.

Micro scale plasma assisted equipment costs could range upto £1m and beyond depending on the degree of heat and power generation, equating to a local opportunity worth upto £200m spread over the next 10 years. In addition to the Northwest, demand is anticipated from other regions in the UK and overseas, which have established chemicals and mineral processing industries, especially if the current market drivers, environmental challenges and fiscal incentives continue.

Development Options

A key objective is to maximise the economic benefit to the Northwest from development of local, national and export markets for micro/small scale plasma based EfW technology for C&IW over the next 10-15 years. Development options could include:

- Develop EfW technology locally
- Manufacture under licence
- Attract inward investment

The proposed option is to attract inward investment from an established or emerging player with breakthrough potential technology that offers scope to build local design, build, operate and supply industry capability in the Northwest. Selecting the most suitable technology will be important first step. There are more than 30 international companies (Appendix B) actively developing various plasma assisted energy recovery technologies, mainly focused on medium to large scale EfW plant.

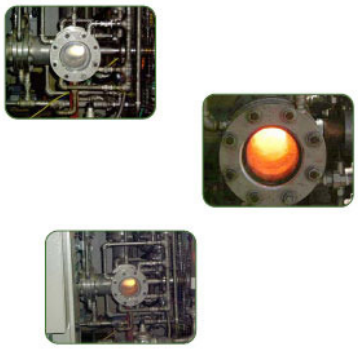
Two companies, an overseas established company Environmental Systems and Treatment (EST) and a new start UK company (Waste2Tricity) appear to be developing promising advanced plasma technology that could offer potential economic and supply chain development opportunities for the Northwest are shown below

Environmental Systems and Treatment (EST)

Contact: Yehuda Simon (Founder)

Background: Private Company in Israel, established in 2004

Technology: Plasma Arc treatment of chemical and hazardous wastes



Process Characteristics:

- Primarily a waste treatment process with option of adding heat and power production
- Can be integrated into production lines or as a stand alone treatment facility
- Low cost process claimed for handling waste volumes upto 5000 tpa

Wastes Accommodated:

- solid, liquids, slurries
- wide range of chemicals and solvents
- bottom ashes and residues from other waste treatment processes

Track Record:

- Sales in Europe and North America
- Proven low cost benefits (will provide after signing NDA)
- Developing an aggressive export sales & marketing plan

Initial Interest:

- No sales in UK but looking to develop the market
- Exploratory interest in JV, Business Alliances
- Interested in demonstrating the technology

Waste2Energy

Contacts: David Raybone (MD), Peter Jones (Director)

Tel: 0207 240 6959

Background: UK based Private Company, established in 2008

Technology: Combined plasma gasification and fuel cell technology

Process Characteristics:

- Aimed at small business / community energy recovery including CHP
- Potential to reduce costs and make the process more competitive

- Potential to develop energy plants at a cost as low as £250,000 per MW of capacity

Wastes Handled:

- MSW and carbon based C&IW

Track Record:

- No sales to date

Initial Interest:

- Requires follow-up

It is suggested that further contact is carried out with both companies to fully explore potential development opportunities.

Economic Impact Potential

Major economic impact potential by development of a new supply industry (design, build install, operate) for 200 local micro/small scale EfW plant for C&IW and development of wider UK and export markets.

- Direct local employment from inward - 20
- Local equipment/component supply – 100 jobs
- Local engineering/testing/inspection services – 50 jobs
- Local capital investment (£200m)
- Local GVA - £100m

There is a reasonably close fit between the Northwest's engineering and manufacturing capabilities with potential opportunities in EfW plant, where there is scope to develop a new supply industry is shown below.

Northwest Capability Strengths				
Raw Materials Supply	**Component Manufacture**	**Engineering Design**	**EfW Plant Fabrication /Installation /Operation**	**Plant Maintenance**
• Structural steel	• Metal castings • Forgings • Instrumentation • Burners • Pressure vessels • Environmental technology	• Risk assessment • Structural eng • Electrical eng • Civil eng	• Construction • Steel fabrication • Electrical installation • Plant operation • Facility management • Waste management • Environmental	• Inspection • Repair & Maintenance • Environmental monitoring

Supply Chain Development Potential

The overall analysis from this study suggests that micro/small scale EfW embedded technology for C&IW offers significant economic impact potential for the Northwest. Further validation of the opportunity is required to support the case for development in the Northwest.

Conclusions

The following conclusions are drawn on the opportunities in micro/small-scale embedded EfW plant for the Northwest, based on the results of this study.

1. Energy recovery technologies such as anaerobic digestion, mechanical and biological treatment could address much of the biodegradable fractions of C&IW in the Northwest. However, alternative technology will be needed to reduce the current and future chemical, mineral and common sludge waste arisings going to landfill, after materials recycling/recovery.
2. Micro / small-scale embedded EfW plant using plasma assisted energy recovery technology such as plasma gasification would offer a potential solution to reduce C&IW arisings at source and therefore transportation of these wastes across the region.
3. From an estimated 400-500 companies and organisations in the Northwest that generate C&IW could potentially benefit form micro/small-scale embedded EfW plant, we believe there would be demand from around 200 who currently send chemical, mineral and sludges to landfill, particularly in:
    - Greater Manchester
    - Merseyside
    - Lancashire
    - Holton
4. Plasma based EfW technologies have mainly been deployed for larger volume energy recovery plants and reducing capital/operating costs will be a key issue for the commercial viability of micro/small-scale plant. This is likely to require further development of the technology, where public sector intervention would support commercialisation.
5. Attracting an inward investor into the region who is either an established player with low volume plasma process technology or an emerging player with a potential breakthrough technology is the suggested development option. Two companies EST and Waste2Tricity have been provisionally shortlisted for further consultation.
6. Development of the micro/small-scale EfW opportunity in the Northwest is estimated to have a net economic impact on the region in terms of job created/supported (170), attracting capital investment into the area (£200m) and local GVA (£100m). This is forecast to grow as wider K and export markets develop.

7. A full due diligence will be first required to fully evaluate the technology's operational and environmental performance to ensure compliance with emissions and regulatory requirements.

Recommendations

The following recommendations are made for public sector intervention to support the development of a micro/small scale EfW supply industry in the Northwest.

1. Encourage the use and development of AD, MBT, autoclaving and other EfW technologies in the Northwest for energy recovery from biodegradable C&IW fractions.

2. Focus on advanced plasma assisted thermal conversion technologies to address the forecast 1 million tpa of chemical, mineral and sludges destined for landfill.

3. Hold exploratory discussions with potential inward investors, including EST, Waste2Energy and others and undertake a technical, environmental and commercial due diligence.

4. Carry out a phased micro/small-scale plasma EfW technology and supply industry development programme:
    - Technology development – waste treatment followed by energy recovery
    - Technology demonstration – pilot projects
    - Economic development – collaborative partnerships

Appendix A - Energy from Waste Technology Profiles

Plasma Arc

Performance

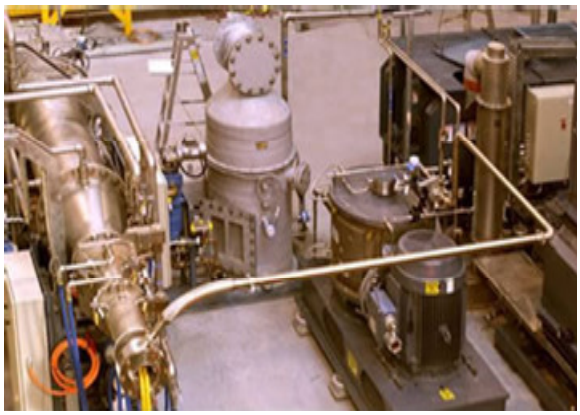
- 50ktpa to 400ktpa capacity
- High capital costs – upto £100m
- Miniature plasma arc plant available
- Relatively small footprint eg 65 sqm
- Modular design, suitable for retrofitting and new builds
- Hybrid plasma arc / gasification

Suppliers eg

Pyro Genesis

Advantages

- Proven technology for solids, liquids and slurries
- Versatile technology suitable energy recovery from most wastes
- High temperatures (upto 6000oC) reduces volumes of waste residues
- Modular and scalable plant
- Energy recovery for in-house process, CHP or grid
- Not favoured by planners and FoE



Disadvantages

- Upfront de-packing may be required
- Pre-shredding and storing of waste
- Separate recycling storage space and equipment
- Treatment costs for post cleaning of flue gases
- Poor process economics at low volumes

Mechanical Biological Treatment

Performance

- 5 ktpa to 250ktpa capacity
- Capital – £9m-£30m (£10m – 60,000tpa)
- Processing costs £18-£60/tonne (£37.5/tonne ave)
- Land requirements - 180,000tpa + 4Ha

Advantages

- Existing proven technologies - >70 plants in Europe
- Reduces waste mass to composting and syngas
- Increases CV of RDF
- Automated or manual de-packaging of different materials
- Landfilling residue will not count towards LATS targets
- Biological energy recovery, most favoured process by FoE
- Less planning restrictions
- Handle solid, liquid and slurries

Disadvantages

- Reliant on other treatment for residues
- Pre-process material recovery/recycling requires space and plant
- Waste has to comply with handling and storage residues
- Not suitable for difficult non-biological animal wastes
- Consumes significant amount of energy
- Additional capex required for electricity generation

Supplier

Oaktech Ltd (Manchester)

ArrowBio process uses water to separate out residual waste by density

Autoclaving

Performance

- 50ktpa to 400ktpa capacity
- Capital – £1m-£60m
- Processing costs £20-£100/tonne
- Land requirements - 180,000tpa + 4Ha
- Relatively small footprint – 900 sq ft for 50,000 tpa

Advantages

- Proven technology although limited UK track record
- Integrated recycling, autoclaving, gasification and energy production
- Upfront de-packaging not required, reducing costs
- Plant sizes typically range from 50,000 tpa
- Portable bespoke plant 5000tpa
- Modular and scalable plant
- Qualifies for ROCs
- Could combine with AD processes

Disadvantages

- Residues sent to landfill
- Gasification usually limited to solid dry wastes
- Consumes significant amount of energy
- Batch process limiting output
- Product must be cooled before recycling
- Poor process economics at low volumes
- Difficulty processing animal wastes

Suppliers eg

Biossence process integrates autoclaving, recycling, gasification and power generation.

ESTECH process integrates autoclaving, recycling, gasification and power generation.

Fluidised Bed

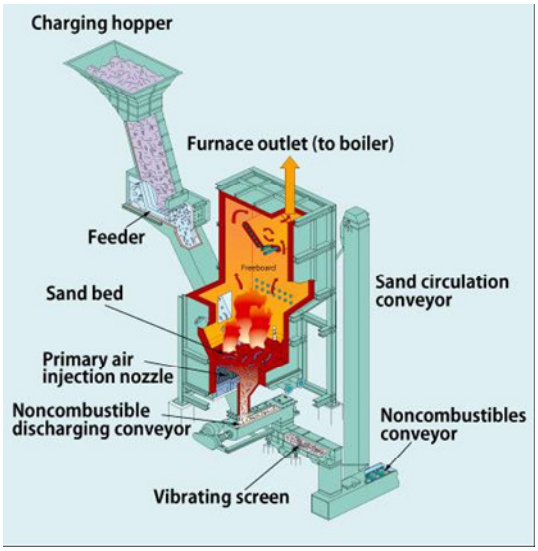
Performance

- 50ktpa to 400ktpa capacity
- Capital – £50m-£150m
- Processing costs £20-£30/tonne
- Compact design and relatively Small footprint
- Plasma arc assisted hybrid developments

Suppliers eg

JFE Engineering

Stewart Thermal Ltd (mini fluidised bed)



Disadvantages

- Treatment of waste fly and bottom ashes
- Upfront de-packaging required impacting on costs
- Pre-materials recovery/recycling space and plant required
- Gas heating during process start-up
- Pre-preparation of waste streams to aid combustion
- Planning issues around dioxin and NOx emissions
- Limited use in the UK

Anaerobic Digestion

Performance

- 5ktpa to 400ktpa capacity
- Capital – £5m-£30m 60,000 tpa
- Processing costs £20-£30/tonne
- Small footprint – 1m2 per tonne

Advantages

- Proven technology for solids, liquids and slurries
- Relatively low capital costs than for thermal processes
- Energy recovery from most biodegradable wastes including sewage sludge
- Modular and scalable plant
- Enclosed systems with no emissions
- Energy recovery for in-house process, CHP or grid
- Qualifies for ROCs
- Process most favoured by planners and FoE

Disadvantages

- May require odour control and gas cleaning equipment
- Separate recycling storage space and equipment
- Upfront de-packaging required impact on costs
- Material handling requirements
- Limited to biodegradable wastes
- Energy required for the process
- Processing of difficult animal and non-organic wastes

Suppliers eg

Andigestion,

Appendix B - Plasma EfW Technology Suppliers

- Advanced Plasma Power (APP)
- Alter NRG
- Bio Arc Technologies
- EER (Environmental Energy Resources)
- Encore Environmental Solutions
- Enersol Technologies
- Enviroarc Technologies
- Europlasma
- Forever Green Enterprises
- General Electric (GE)
- Geoplasma
- Hawkings Industries (HI)
- Hitachi Metals
- Hitachi Zosen
- Integrated Environmental Technologies (IET)
- Kawasaki Heavy Industries
- Meltran
- Mitsubishi Heavy Industries (MHI)
- MPM Technologies
- MSE Technology Applications
- PEAT International
- Phoenix Solutions
- Plasco Energy Group
- Plasma Energy Corporation (PEC)
- Plasma Environmental Technologies (PET)
- Plasma Pyrolysis Systems Inc. (PPSI)
- Plasma Renewable Energy (PRE)
- Pyrogenesis Inc.
- Radon
- Recovered Energy Incorporated (REI)
- Resorption Canada Ltd
- Retech Systems
- Scanarc Plasma Technologies
- SibAcadem Consulting
- Solena Group
- SRL Plasma
- Startech Environmental
- Tetronics
- VRI (Vanguard Research)