Commercial issues and technology developments in organic waste treatments

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Wastes and Resources

- **MSW and C&I : strategies and policies, EU WFD & UK x 4**
- **The Waste Hierarchy**
- **Waste composition : organics, variability (quantity, quality, composition)**
- **Landfill diversion targets of biodegradable municipal sold waste**
- **Renewable Energy : carbon issues, EU and UK targets**
- **Wastes as resources = a paradigm shift**
- **Strategies - policies – delivery ... integrated or disconnected ?**

Definitions and Data

England 2006/07 : best available data for MSW

	Recycled	Residual	Combined
Garden waste	**35%**	**6%**	**13.5%**
Food waste (70% moisture) (90% volatile solids)	**1**	**33**	**24.1**
Paper & Card	**45**	**17**	**24.8**

(Source : Parfitt for Defra)

Definitions and Data

Biodegradable Municipal Solid Waste (million tonnes)

	MSW	C&I
Kitchen food	**6.1**	**5.7**
Garden	**6.4**	**4.2**

Also paper and cardboard , wood and textiles depending on technology

	2010	2013	2020
Old MSW definition	**13.7**	**9.1**	**6.3**
New MSW definition	**26.8**	**17.8**	**12.5**
	by 35%	**by 50%**	**by 65%**

Biogenic or Fossil ?

	Fraction of total (% of wet waste)	Biogenic content (kg/tonne)	Fossil content (kg/tonne)
Paper	22	75	2
Organic	45	66	1
Others	17	36	11
Plastic	9.4	1	63
Glass	2.9	0	0
Metal	3.1	1	0
Total	100	178	76

(Source : Astrup 2009, for Denmark)

‘Deeming’ for ROCs = 50%, England MSW = 68%

Waste Prevention and Recycling

- **WRAP “Love Food Hate Waste”**
- **Home composting + food waste digesters**
- **Food Waste Disposal Units = diversion not prevention**
- **Windrow composting : aerated/non-aerated, no food waste (ABPR), source segregated to meet PAS 100 (2011 update), no sewage sludge, no longer ‘shred and spread’**
- **In-Vessel Composting : can take food waste, possible use of heat**

Recyclables in England

	1996/97	2009/10
Paper and card	49.5% 555,000 tonnes	16.1% 1,300,750 tonnes
Glass	27.3 306,000	8.2 765,890
Garden/food	24.8 278,000	39.5 3,713,560
Co-mingled	0	19.9 1,865,930
Dry recycling rate	6%	24%
Green recycling rate	1	16

A hierarchy of energy from waste ?

- **Energy efficiency : waste prevention**

- **Source segregated biomass fuel (energy crops, waste wood, biowaste)**
  - **anaerobic digestion**
  - **power generation, co-combustion/co-firing, biomass boilers**
  - **biofuels**

- **MBT/MHT : dry recyclables (quality), + a fuel product (2 mtpa by 2010 ? 26 by 2020 ?)**

+ Co-combustion of mixed residual waste (less NIMBY ?)
  - **Cement kilns, industrial boilers, power stations ... ???**

- **Good Quality Combined Heat and Power + cooling (or 'CHCP enabled') + water recycling**
  - **80% + efficiency, appropriate scale = decentralised generation and/or RDF 'feeders'**

- **Electricity from residual carbon (25% efficiency up to 34% ?)**

- **New technologies (still to be proven - pyrolysis/gasification ? plasma arc ? use of syngas ? hydrogen fuel cells ?**

- **Mass burn incineration without energy recovery**
- **Energy from landfill gas**

Source-segregated Biomass Carbon as Fuels

- **Biomass energy crops as fuel (issues of use of water, food crops, NO_x)**
- **Wood waste as fuel : WRF + reuse, recycling + energy recovery**
- **Segregated C+I biomass (food waste as fuel) industrial complexes**
- **Source segregated MSW garden and/or kitchen food wastes as fuel (2% collected in 2007)**
- **AD**
  - **Long history of AD and sewage and agricultural manures/slurries**
  - **Biomass + sewage sludge (Leicester, January 2011 Ofgem market review)**
  - **WIP New Technologies Demonstrator Programme + WRAP + Defra**
  - **IVC (batch, tunnel, container = may use energy), linked to AD/gasification ?**
- **Small scale (5-20-50+ ktpa)**
- **Biofuels**

Wood Waste as a Fuel

- **Sources**
  - **Managed woodlands (additional 2 million tonnes by 2020)**
  - **Wood industry**
  - **Waste wood (C&I = 4.5 million tonnes, C&D = 5.0, MSW = 1.0)**
  - **Imports of wood chips (>17 million tonnes ? >2,000 MW ?)**
    (North American pine beetle problems)

- **Options**
  - **Wood fired boilers (replacing coal)**
  - **Wood and co-firing (e.g. Drax + coal, + energy crops)**
  - **Wood fired CHP, but fewer proposals**
  - **March 2010, 7 = planning permission, 50 proposed**

- **Issues**
  - **Forestry waste and non-C&D wood waste excluded from WID (auditing ?)**
  - **ROCs favour efw versus recycling**

Anaerobic Digestion : Wet or Dry

- 2008 Milk Road Map
  - On-farm livestock slurries (1,000 farms by 2010, long term aim of 40% from renewables)
  - Industrial dairy wastes + centralised AD plants (3 by 2015)
  - Water Industry (20% from renewables by 2020, including AD)
  - Added food waste = C&I+MSW ‘dry’ kerbside collections (but waste licensing issues)

- In-house food industry AD could provide 20% of energy requirements (‘polygeneration’)

- Cleaning and refining syngas (biomethane) for use as a transport fuel

- 20- 50% of residential heating ? (ADBA, Nat. Grid report of 2009) – limited heat used now, storage ?

- PAS 110 Quality Protocol for digestate + Quality Protocol for biomethane

- 2009 – Defra = 80 mt of animal slurry, 18-20 mt of food waste, 1.7 mt of sewage sludge

- 2010 – Coalition : ‘... measures to promote a (huge) increase in efw through AD’

Anaerobic Digestion Programmes

New Technologies Demonstrator Programme 2003-2009, £19m for 7 new technologies

•Biocycle/Greenfinch	Ludlow	5kt

WRAP/Defra Organic Capital Support Programme 2008, £10m

•Lower Ruel Bioenergy	Gnossal (Staffs)	30kt

Defra Demonstration Project 2009, £10m

•Biocycle/Greenfinch	Ludlow	pre-treatment
•Blackmore Vale (BV) Dairies	Dorset	
•GWE Biogas Ltd	Driffield	50kt
•Staples Vegetables	Lincs	
•United Utilities/National Grid	Davyhulme	

British Gas and Biomethane Demonstration Projects, 2010

•GWE Biogas Ltd		
•Adnams Brewery (+ superarket food waste)		3 + 12.5kt
•Potter waste		
•Dillington Biogas		
•Thames Water + Scotia Gas Networks	Didcot	

Best Use of Biogas

	Carbon Savings
▪ Using biogas to generate electricity (supported by ROCs + FiTs)	-62kgCO_{2e}
▪ Using biogas on-site for CHP (supported by ROCs, FiTs and HotROCs)	-86kgCO_{2e}
▪ Pumping biogas straight to the Grid (supported by Hot ROCs)	-85kgCO_{2e}
▪ Using biogas as a vehicle fuel (no government support), but 6 DfT Demonstration trials in 2010)	-97kgCO_{2e}

(Source : Eunomia 2010)

- Quality Protocol for Biomethane
- Biomethane connections built by network operator and costs ‘socialised’

Some Concerns with Anaerobic Digestion

- **Feedstocks : manures, kitchen food waste not kitchen waste, C&I food processing + catering wastes, bio/biodegradable wastes, limited paper + card ... contamination, ABPR ?, bioplastics, contracts**
- **Planning : scale + catchment area, permitting, farm ... regional ... (multi) NIMBYism**
- **Handling : storage (caddies + bags), collection, health and safety (bioaerosols), de-packaging**
- **Energy outputs : wastes v. products, markets (power, heat, fuels, water), grids for gas, CRC ?**
- **Digestate + liquid outputs : PAS 110 (not PAS 100) as a biofertiliser, available landbank, licensing or exemptions, stability, odours ... substitute for oil-based fertilisers and $C0_{2e}$**
- **Underpinning science : which technologies (wet or dry, feedstock preparation) ,**
  UK context, agri/soil impacts
- **Fiscal support : grandfather rights, low values of FiTs + RHI, ROCs to be replaced with CfD ?**
- **2 per week to meet 10% of energy by 2020 (ADBA) ?**
  (February 2010 : 11 permitted, 2 in process, 51 in permit pre-applications)
  (June 2010 : 41 operational, 13 being built, 50 planned)
  (February 2011 : 37 operational, 60 planned/under construction)
- **Food waste to livestock = x2 $C0_{2e}$ savings. Japan gives grants for this option**

OFT Market Review 2011

- **Requested by Ofwat, and related to feedstocks comprising sewage, household food waste, waste products from food and farming industries**

  - whether price regulation of sewage-sludge treatment, recycling and disposal services remains appropriate, what scope there is to encourage greater competition, and what implications this may have for economic regulation

  - whether there are any barriers specific to efficient investment in and use of 'co-treatment' where waste from a variety of different sources is treated at a single facility

  - what might be done to encourage efficient investment in advanced treatment techniques across the economy more widely.

Advanced Thermal Conversion/Treatment

- **Usually in the context of MBT/BMT (e.g. East London) or MHT (e.g. Merseyside)**

(using dry fibre as a fuel (as 'floc' or 'pellets' to meet client specifications, incl. composition) (rather than wet fibre for Anaerobic Digestion)

- **Extract recyclables (quality … markets ?)**
- **= (Semi) - residual waste treatment + diversion from landfill**
- **Autoclave (e.g. Doncaster, Cardiff, Tyneside, Wakefield) and MHT (Merseyside)**
- **Pyrolysis, gasification**
- **Plasma arc gasification (APP)**
- **Syngas, biomethane, ethanol, hydrogen**
- **Reference plants in the UK ?**

Pyrolysis and/or Gasification

- **Pyrolysis :**

(coarse shredding, requires energy, absence of oxygen, 400 - 800^{0}c, medium calorific gas, liquid + char = fuels, char can be problem)

- **Gasification**

(more consistent input, coarse shredding, perhaps pyrolysed, + air/oxygen/steam, 800 - 1,100^{0}c+, high thermal efficiency, low calorific gas - including fixed carbon = fuel conversion, ash is often vitrified)

- **RDF or SRF (waste) inputs rather than crude waste inputs : 1.5 + mtpa ?**

- **Syngas/biomethane (when 'refined' = a product and not a waste), could also be fed into National Grid**

- **Cleaner emissions**

R.D.F, S.R.F. and R.R.B.F Comparison

REFUSE DERIVED FUEL

Process

COARSE MECHANICAL SIZING / MIXING

COMPOSTED MEDIUM

MECHANICAL BIOLOGICAL

TREATMENT TEMPERATURE 50 - 70 °c

PELLETISED MIXED WASTE

UNREFINED, RESTRICTED USE DUETO EMISSIONS PRODUCED

SOLID RECOVERED FUEL

Process

50 – 80°C SORTED AND SIZED

BIO DRIEDTO PRODUCE A MORE STABLE SANITISED FUEL COMPARED TO TRADITIONAL R.D.F. WITH A MORE UNIFORM QUALITY FOR END USER i.e. CEMENT KILNS

REFINED RENEWABLE BIOMASS FUEL

Process

SORTED & SIZED

TREATMENT TEMPERATURE 120 – 170°C

REFINED AND SORTED BY AUTOMATIC SYSTEMS SO PRODUCING CONSISTENT QUALITY AND CALORIFIC VALUE

A 90% STABLE BIOMASS PRODUCT WITH LESS THAN 10% RESIDUALS I.E SAND, EARTH AND GLASS - A MOSTLY INERT MATERIAL

SUITABLE FOR USE TO GENERATE ELECTRICITY AND HEAT IN CO-FIRING, GASSIFICATION AND CEMENT KILNS

New Technologies Demonstrator Programme

- Established in 2003, £30m to promote waste technologies 'new to the UK'
- Aim = to provide benchmark 'reference sites' with 8,000 operating hours by March 2009, full mass and energy balances + other research/evaluation data – all to be in public domain after independent peer review
- £19.56m spent, all facilities to have visitor centres

- Bioganix – in-vessel composting (now defunct)
- Greenfinch/Biocycle – Anaerobic Digestion (now merged with BIOGEN)
- Envar/ADAS – tunnel composting
- Merseyside Orchid – mechanical heat treatment

- Premier – Aerobic Digestion – not met 8,000 hours, technical problems
- WGT (UK) – gasification (Energos) – not met 8,000 hours, technical problems ++
- Scarborough Power – flash pyrolysis – late start, not met 8,000 hours

- Novera – gasification – pulled out, now taken over by Biossence
- Compact Power became TAREP then ETHOS – pyrolysis/gasification – pulled out

Residual Carbon = Residual Fuel/Energy Resource

- **Biogenic carbon and fossil carbon (limits to recycling of paper and plastics)**
  (> 50% paper exported. 37% of plastic bottles + 2% of mixed plastics recycled, 75% exported)

- **Wastes not targeted for separate collection (kerbside, banks) ... 10-30%**

- **Wastes not segregated by households (low participation)**

- **Contaminated wastes (including composites)**

- **Residues from collection and/or MRFs and/or processing ... including fines**

- **Other wastes : contaminated wood, household hazardous**

- **Residual MSW + residual commercial and industrial wastes**

- **"No reasonable prospect of the waste being recycled/composted" ... but carbon potential**

- **ERFs should be GQCHP = 60 – 200+ ktpa : proven technology, bankable**

Current Proposals – mid 2010

Based on ‘declared’ tonnages and MW

	million tonnes	MW
Incinerators	**>7.0**	**>400**
Anaerobic Digestion	**>5.0**	**>50**
SRF	**>4.0**	**>200**
Pyrolysis/gasification	**>3.5**	**>200**
Biomass (exempt from WFD)	**>1.5**	**>150**
Mechanical Heat Treatment	**>2.0**	**30**
Co-firing	**>2.0**	**>1,000**
Wood chips (exempt from WFD)	**>17.0**	**>2,000**

To be treated with care : tonnages and MW not always quoted

Conclusions

- Technology options + reference plants (8,000 hours)
- Mass and energy balances
- Feedstock : types, quantities, contracts and capture rates, pre-treatment
- Scale : local or regional, co-location, resource/energy recovery parks
- EA Permitting and LA planning + national infrastructure policies
- Fiscal issues : capital + revenue (ROCs, FiTs, RHI ... CfD), merchant sites
- Primacy of environment and health
- Nimbyism + community buy-in
- Risk management and risk sharing

Thank You

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