

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 solid 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 (+ supermarket 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** **-97kgCO_{2e}**
(no government support), but 6 DfT Demonstration trials in 2010)

(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 CO_{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 CO_{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 - 800⁰c, medium calorific gas, liquid + char = fuels, char can be problem)

- **Gasification**

(more consistent input, coarse shredding, perhaps pyrolysed, + air/oxygen/steam, 800 - 1,100⁰c+, 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

Process

REFUSE DERIVED FUEL

COARSE
MECHANICAL SIZING
/ MIXING

COMPOSTED MEDIUM

MECHANICAL
BIOLOGICAL

TREATMENT
TEMPERATURE 50 -
70 °c

PELLETISED MIXED
WASTE

UNREFINED,
RESTRICTED USE
DUETO EMISSIONS
PRODUCED

Process

SOLID RECOVERED FUEL

50 – 80°C
SORTED AND
SIZED

BIO DRIED TO
PRODUCE A
MORE
STABLE
SANITISED
FUEL

COMPARED
TO
TRADITIONAL
R.D.F. WITH
A MORE
UNIFORM
QUALITY
FOR END
USER i.e.
CEMENT
KILNS

Process

REFINED RENEWABLE BIOMASS FUEL

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**

- **Bioginix – in-vessel composting (now defunct)**
- **Greenfinch/Biocyte – 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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