Residual Waste Processing- *Alternatives to Landfill*

APSE Waste and Recycling Advisory Group Meeting

Alloa, Thursday 10 January 2008

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Overview

A. Current position of landfill in Scotland
B. Legislation impacting the future of landfill
C. Residual Waste Processing - alternatives to landfill – *with focus on energy-recovery options*

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A. Current position of landfill in Scotland

Historical Perspective

- Remains primary mechanism for handling waste
- Total waste continues to grow → undermining efforts at diversion from landfill
- Bottom of waste hierarchy but still critical to process
- Pace of change in last 10 years:
  - Legislative LFD, PPC etc
  - Economic factors (rising gate fee + landfill tax)
- Landfill operations:
  - fundamentally wrong or poorly managed historically
- Late 90's:
  - 257 landfill sites in Scotland

Historic Trend of Waste Management Licences in Scotland.

Annual Throughput thousand tpa	1998/ 1999	2000/ 2001	2001/ 2002	2002/ 2003	2003/ 2004	2004/ 2005	2005/ 2006
150 +	13	14	14	16	12	10	2
75 to <150	49	48	49	47	47	47	34
25 to < 75	44	42	40	37	31	31	22
0 to <25	158	170	154	151	142	143	103
Total No. Sites	264	274	257	251	232	231	161
Approximate Capacity (million tpa)	16.5	16.7	16.3	16.0	14.7	14.5	9.6

Source: SEPA Waste Data Digest (no's 1-7)

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Impact of introduction of PPC Regime

- **Advent of PPC:**
  - Level playing field
  - Reduction waste types
  - Greater separation

- **Scotland 2007:**
  - 1 Hazardous site
  - 43 Non-Hazardous
  - 7 Non-Hazardous sites refused and not re-applied

- Exclusion of smaller/ remote/ single company sites

Waste Data Scotland

- **Emphasis on diversion from landfill:**
  - MSW only
- **SEPA Waste Digest 7 shows for Scotland 2005/6:**
  - 3.39M tonnes household waste (73% to landfill)
  - 19.3M tonnes business waste
  - 7.3M tonnes to landfill (6% down on 2004/05)
  - 27.1% average recycling / composting of MSW (up from 4.5% in 2000)
- **MSW** still increasing annually (driven by increase in households) – although at a lower rate of increase
- **C&I** wastes – rising Commercial and declining Industrial but overall increase, linked to economic growth
- **Audit Scotland** estimate total waste management costs likely to rise for estimated waste management infrastructure, from £351M in 2005/6 to £580M in 2019/20;

Economic Drivers: Landfill Tax and Gate Fee

- **1996:** LFT – nil/tonne; Gate Fee ~ £5-8/tonne.
- **2007:** LFT - £24/tonne; Gate Fee ~ £15-20 / tonne
- **2011**: LFT - £48/tonne; Gate Fee ~ £20-25 / tonne (and rising)

- Total cost of landfill disposal of 1 tonne waste:

- 1996: £5-8
- Present: ~ £40
- 2011: £63 +

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Current Position of Landfill in Scotland

- **In Summary**
  - Waste to landfill reducing steadily but investment in alternative technologies necessary for next step up, or there is a significant risk of failing to meet LFD targets
  - Less sites/ more focused/ better regulated
  - Specialist sites developing- and integrated waste solutions
  - Need to also address diversion of C&I wastes from landfill

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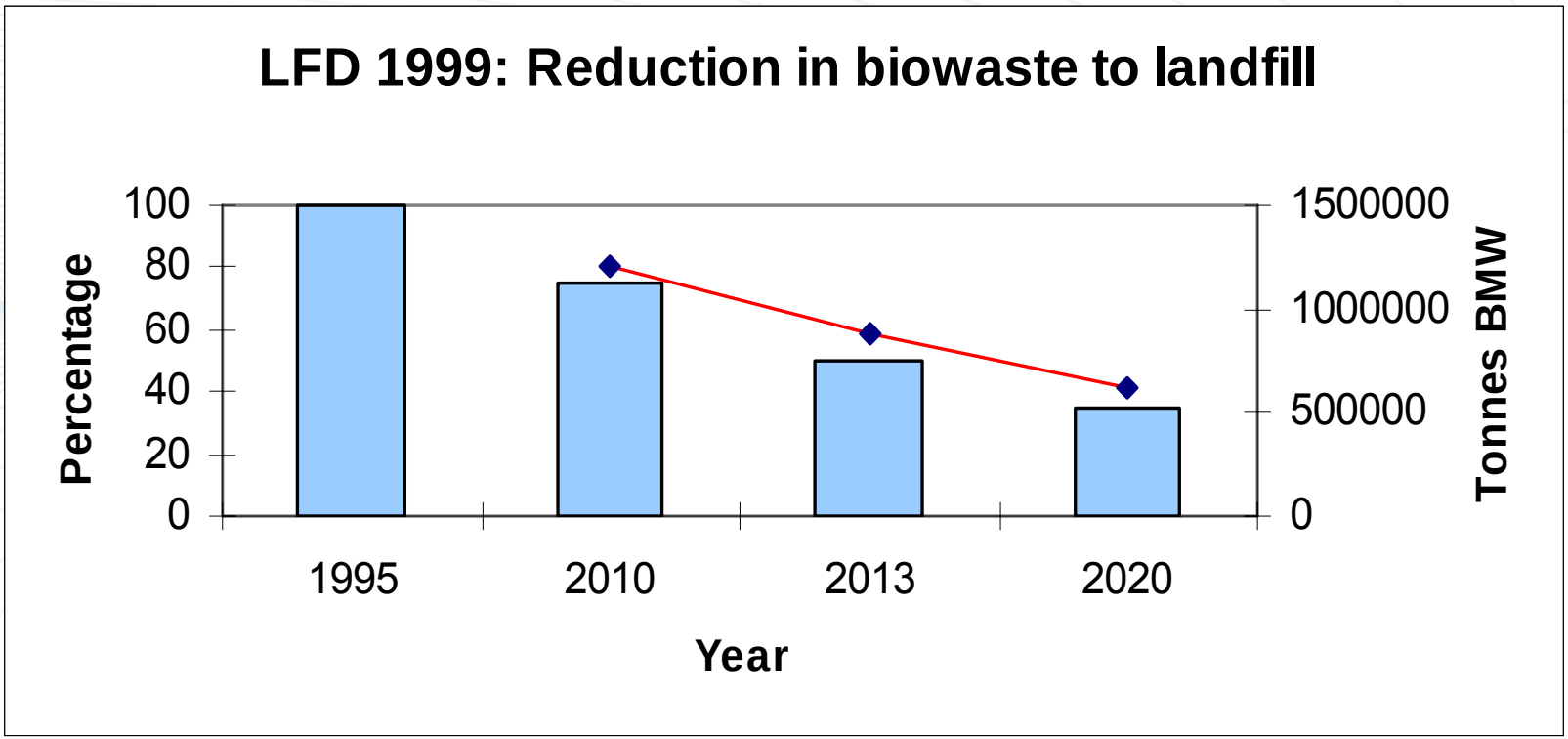
B. Legislation impacting future of landfill

EU Landfill Directive (1999)

- Seeks to reduce the negative environmental effects from landfilling.
- Key implications include:
  - Pre treatment of waste prior to landfill
  - Reduction in biodegradable MSW to landfill
  - Ban on co-disposal of hazardous, non hazardous and inert waste
  - Ban of liquid wastes to landfill, last phase 30th October 2007
  - Potential for increase in landfill tax and tradable permits on a quota basis
  - Pressure for development of recycling, composting and other waste treatment facilities.

LFD 1999: Reduction in biowaste to landfill



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Waste and Emissions Trading Act 2003

- Includes measures to allow the achievement of Landfill Directive targets
- Provides targets under the Landfill Directive between the devolved administrations, and sets out the introduction of landfill allowances and the LATS system.
- Provides powers for obtaining data from landfill operators to assist in the monitoring of the scheme.
- Provides statutory obligation for each devolved administration to prepare a strategy to achieve the reduction of biodegradable waste sent to landfill.

Landfill Tax Regulations

- **1996:** The Government publishes its waste strategy for England and Wales “Making Waste Work” and Landfill tax is introduced at **£7/tonne** on active waste going to landfill and £2/tonne for inactive wastes.
- **1999**: Landfill tax is placed on a ‘landfill escalator” of £1/year until 2004 taking it up to £14/tonne, with rate for inactive waste frozen at £2/tonne.
- **2002:** increase in annual escalator to £3/tonne, with government aim of ‘reaching £35/tonne’
- **2007:** Landfill tax at £24/tonne (April 2007) and increase in escalator announced to £8/t annually from 2008/09 to 2010/11 to **£48/tonne by 2010/11**.

Policy (MSW)

- **National Waste Strategy Scotland: (2000)**
  - Framework for Scotland to reduce the amount of waste being sent to landfill and to manage waste in a more sustainable way.
  - A means for implementation of WFD, HWD and PWD
  - Established the formation of 11 Waste Strategy Areas in Scotland with the aim of encouraging partnerships and joint working.
- **National Waste Plan: (2003)**
  - Move away from historic heavy reliance on landfill
  - Landfill in 2020 will account for a maximum of 31% of residual waste management.

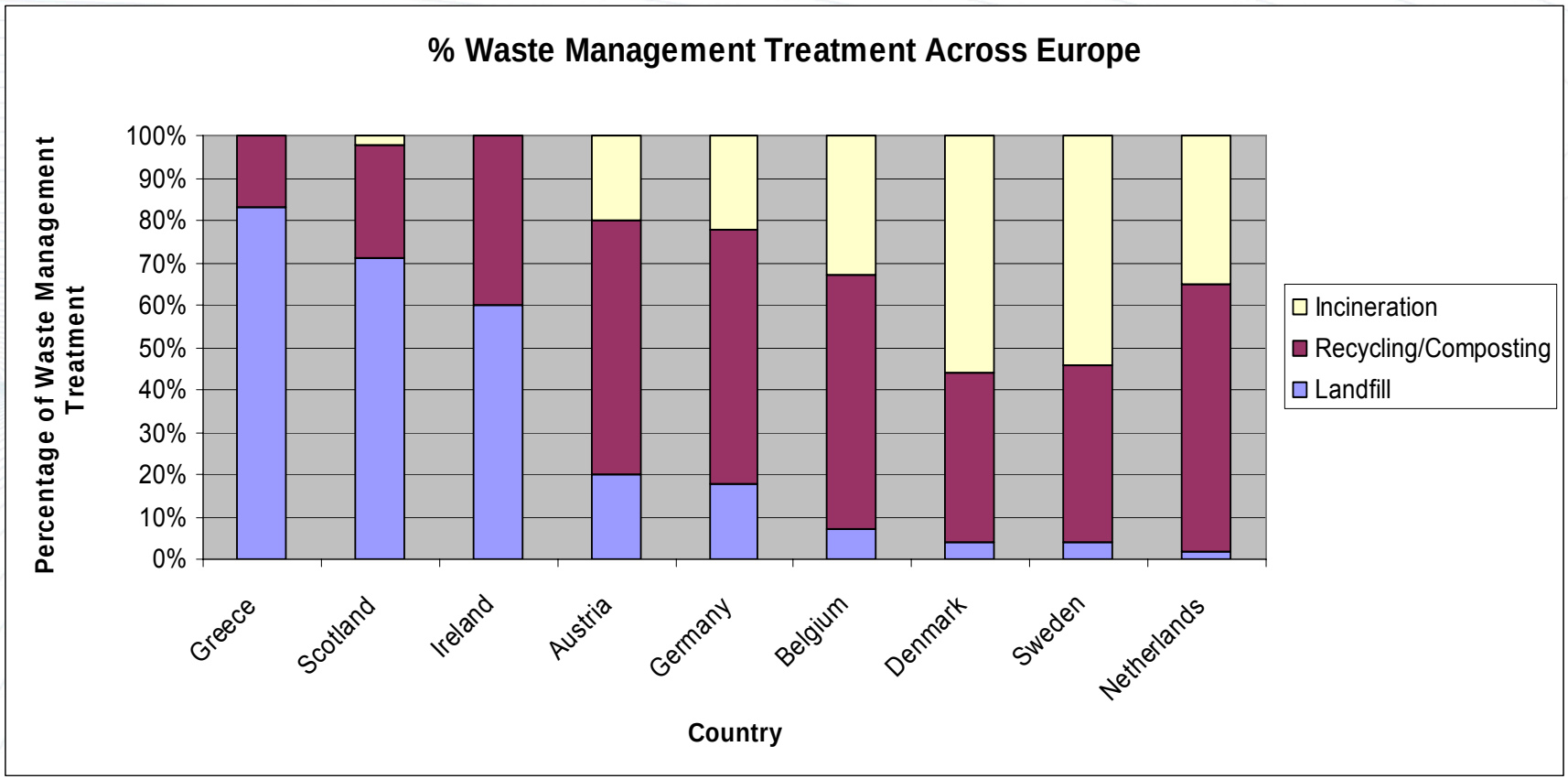
Policy (non-MSW)

- The UK Government will shortly be setting a new national target for the reduction of **commercial and industrial waste** going to landfill.
- On the basis of the policies set out in Waste Strategy for England 2007, levels of commercial and industrial waste landfilled are expected to **fall by 20% by 2010** compared to 2004.
- The Government is considering, in conjunction with the construction industry, a target to halve the amount of **construction, demolition and excavation wastes** going to landfill by 2012 as a result of waste reduction, re-use and recycling.
- Similar targets likely to apply in Scotland ?

Indirect Legislation

- Directive on Batteries and Accumulators
  1991 91/157/EEC
- Directive on Packaging and Packaging Waste
  1994 94/62/EC
- Directive on End of Life Vehicles (ELV)
  2000 2000/53/EC
- Directive on Waste Electrical & Electronic Equipment (WEEE)
  2002 2002/96/EC

European Context



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C. Residual Waste Processing - alternatives to landfill

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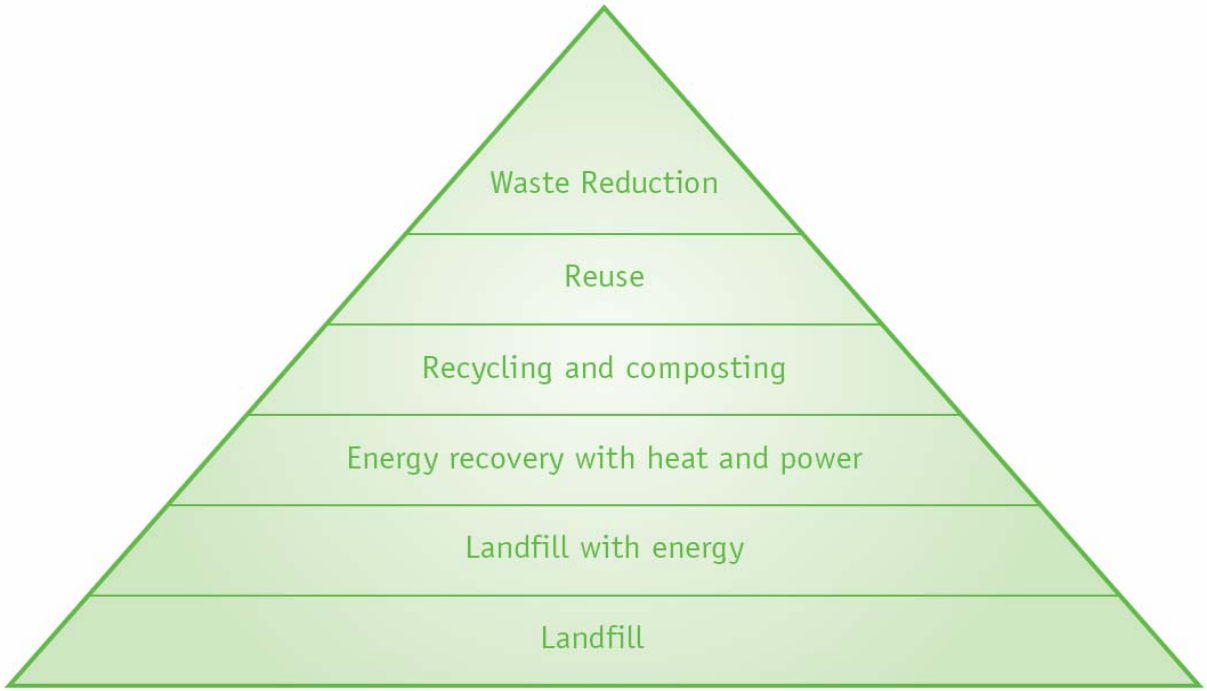
Waste Hierarchy

- Waste hierarchy concept originates from EU Waste Framework Directive 1975. Based on:
  - Reduction
  - Reuse
  - Recycling and Composting
  - Energy Recovery (heat & power)
  - Disposal
    - Landfill with gas / energy recovery
    - Landfill only
- Key aim: more sustainable use of resources
- Differing views of hierarchy: '*guiding framework*' or '*strict interpretation*'

Waste Hierarchy



Source: Strategy Unit Report- Waste Not Want Not, 2000.

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Waste Reduction and Reuse

- Evidence of lower growth rates for MSW and C&I wastes
- Impacts from Producer Responsibility regulations, e.g.:
  - WEEE Directive
  - ELV Directive
- Waste Minimisation options:
  - Packaging
  - Junk mail
  - Nappies
- **Reuse** - the multiple use of a product in its original form, for its original purpose or for an alternative, with or without reconditioning.

Recycling & Composting

- **Recycling** - using waste materials in manufacturing other products of an identical or similar nature.
  - Recycling generally the preferred option for non-renewable resources, e.g. metals, glass
  - Recycling of plastics – markets uncertainty
  - Recycling of paper / card (renewables)

- **Composting** - a natural process that breaks down materials such as garden and kitchen waste
  - Composting – provides benefits where output quality is high and end markets are secure

Energy Recovery with Heat and Power

- **Energy Recovery** - energy from waste is the recovery of energy value from waste by burning the waste directly or by burning a fuel (RDF) produced from the waste.
- Options:
  A. Mass Burn EfW (incineration);
  B. Advanced Thermal Treatment (ATT) (typically pyrolysis & gasification);
  C. Biogas / Anaerobic Digestion (AD).
- Issues:
  - Fuel preparation
  - Energy conversion options and efficiencies
  - Technology scale / plant footprint
  - Proven / reference-able technology
  - Costs – capital and operating

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Energy Recovery Options

- Type 1: production of an exhaust gas used to generate electricity using a steam turbine - EfW;
- Type 2: production of a syngas and use in a boiler, gas turbine or gas engine - ATT;
- Type 3: processing of the syngas to produce a fuel suitable for a fuel cell – ATT;
- Type 4: production of biogas and use in CHP gas engine or fuel cell - AD.

- Recovery of heat under these options

A. Mass Burn EfW (Incineration)

- Mass burn incineration produces hot exhaust gas that is restricted for use in a steam turbine to generate power and heat;
- Typical energy conversion efficiency (waste to electrical energy) of conventional steam turbo-generators = 18-24%;
- The technology has a long track record of operational performance, i.e. a proven, bankable technology;
- Range of different technology providers (e.g. Von Roll, CNIM, Takuma, Keppel Seghers, Volund) have similar characteristics, outputs and overall conversion efficiencies.
- Minimal pre-treatment required; produces bottom ash (typically 30% - which can be recycled as aggregate) and fly ash (typically 5% - disposed of as haz waste).
- Doesn't attract renewable energy certificates (ROCs)

B. Advanced Thermal Treatment (ATT)

- ATT produces a range of possible energy outputs, e.g. hot exhaust gas; low/med CV syngas; high CV reformed syngas (methane or hydrogen)
- Typical energy conversion efficiencies (waste to electrical energy) vary; 8-14% gasification + gas turbo generator; 14-19% for gasification + steam turbo generator; 15-22 syngas used in gas engine generator and up to 30% for large scale (200+ ktpa) combined cycle gas turbine.
- Although the technologies are well understood the majority are not fully reference-able for residual MSW feedstocks, with only a limited record of operation on MSW. .
- The technologies referred to as ATT differ widely in their characteristics, thermal outputs and the overall conversion efficiency to electricity (Energos);
- Produces char and condensate
- Classified as a renewable technology and is eligible for ROCs (x 2) on the electricity generated.

C. Biogas / AD

- AD produces methane-rich biogas suitable for direct use in CHP gas engine / turbine or fuel cell
- Traditionally used for source-segregated organic waste feedstocks, but technology providers now cite examples of residual MSW AD plants;
- Typical energy conversion efficiency (waste to electrical energy) of AD is up to 17% (source segregated) and 12% (residual MSW), using gas engines;
- AD has long track record of operational performance for source segregated organics and an emerging track record on residual MSW. i.e. proven, bankable technology;
- Range of different technology providers (e.g. Kompogas, OWS, Strabag/Linde, BTA/Enpure, RosRoca, Clarke / Haase) all with different technologies – with varying characteristics etc.
- Produces digestate with potential for end use as compost or soil conditioner – although more difficult where feedstock is residual MSW.
- Classified as a renewable technology and eligible for ROCs.

Overview of Energy Recovery Technologies

(source: SLR Report for GLA, Jan 2008)

	EfW	ATT	AD
Capex	~£45M (100ktpa) ~£75M (200ktpa)	~£50M (100ktpa) ~£85M (200ktpa)	~£9M (30ktpa)
Electrical Power	~6MWe (100ktpa) 11MWe (200ktpa)	5.5MWe (100ktpa) 11MWe (200ktpa)	~1 MWe (30ktpa)
Opex	£65/t (100ktpa) £45/t (200ktpa)	£70/t (100ktpa) 55/t (100ktpa)	~£30-40/t

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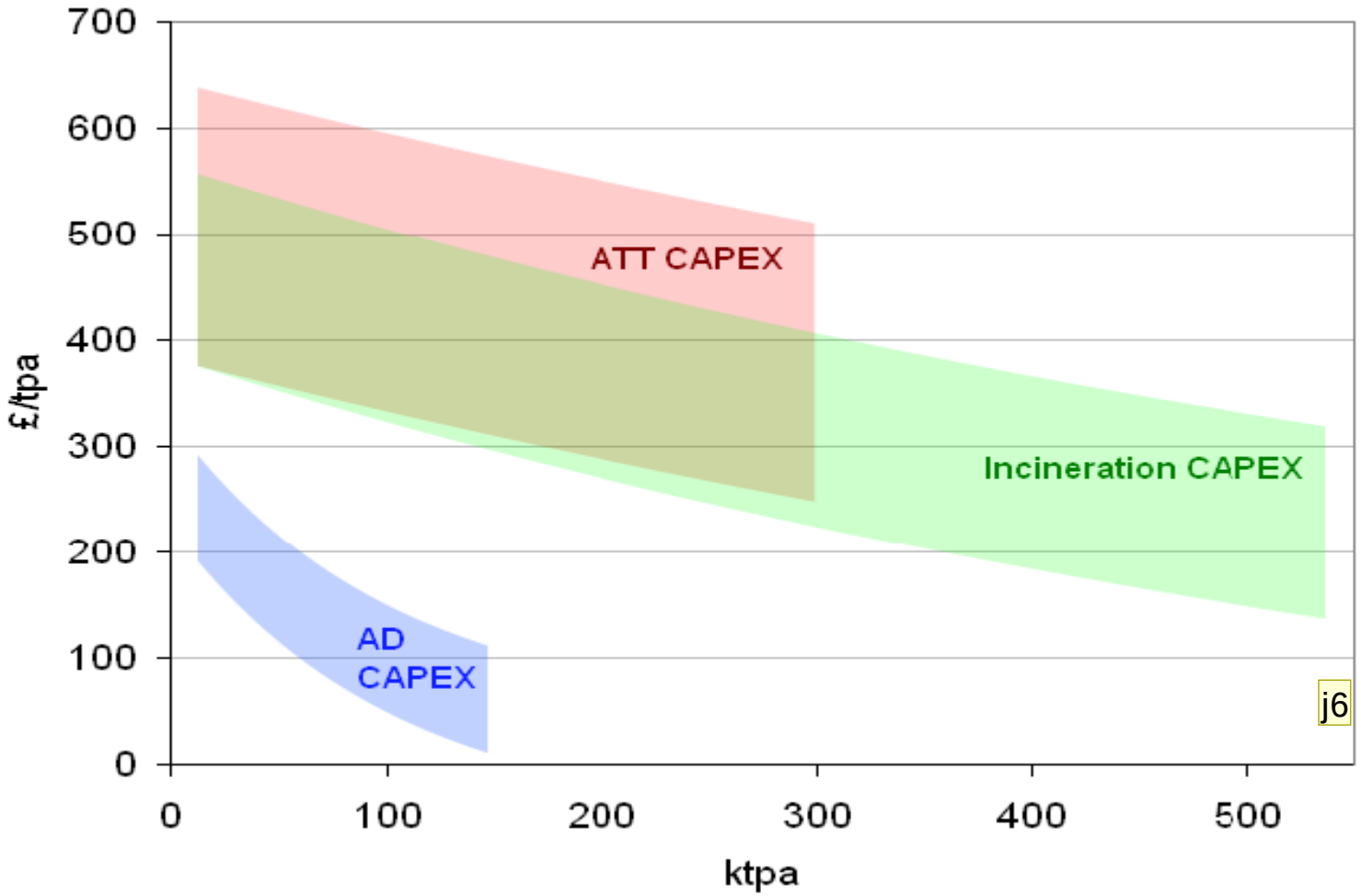
Comparison of Capital Costs of Energy Recovery Technologies



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j6 EXAMPLES eg:Iness Chlos

jcunningham, 08/10/2007

Criteria for Technology Selection

- Feedstocks – tonnage and type (merchant facility therefore process flexibility required);
- Available land;
- Proven reference-able technology;
- End use of outputs;
- Costs and bankability;
- Deliverability / planning

Key Project Elements (Avondale)

- Use of AD (with mechanical pre-sort);
- Capacity 80-100ktpa;
- Technology providers with residual waste ref. plants: *ArrowBio, Strabag, Haase, RosRoca*;
- Cat 3 ABPR Technical Standard (to permit commercial waste as feedstocks)
- Maximise biogas generation – and feed into existing landfill gas recovery system and CHP engines;
- Export of renewable power to grid (existing connection);
- Options for end-use of digestate – landfill cover, soil improver / restoration material (or drying as fuel / RDF in longer term)
- Conversion of mixed plastics into synthetic fuel – long term.

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