Potential greenhouse gas mitigation from waste to energy options in Ireland

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Outline

- GHG emissions and energy in Ireland
- Drivers for change: National and European Policy
- Waste Stream Composition in Ireland
  - Municipal Solid Waste (MSW) and Agricultural Waste
- Options and Potentials
  - Thermal Treatment and BioTreatment
Greenhouse Gas Emissions

• Ireland’s Kyoto Target is 60 Mt CO$_2$ equivalent per annum
  – 13% above 1990 emissions of 53.2 Mt CO$_2$
    equivalent per annum

• In 2003 emissions exceeded 66 Mt CO$_2$
  equivalent per annum
  – 25% above 1990

• Recent projections indicate emissions will exceed 69 Mt CO$_2$
  equivalent per annum
  – 30% above 1990 by 2008

(SEI, 2005)
Energy in Ireland

• Energy (electricity sector) is responsible for 24.6% of national GHG emissions
  – Agriculture is responsible for 27% of national GHG emissions

• Largely based on fossil fuels such as coal, oil and peat

• 89% of the total (electricity, heat and transport) energy requirements are imported
European and National Energy Policy

• *Ireland Green paper on sustainable energy (1999)*
  – Set the target of 500MW of electricity from renewables to be added in the period 2000 – 2005

• *RES-E Directive on renewable electricity (2001)*
  – By 2010 it is Ireland policy to supply 13.2% of electricity from renewable sources
Other Influential Policy

• **EU Landfill Directive (1999)**
  – Maximum of 75% of total amount of biodegradable waste generated in 1995 can be landfilled by 2006
  
  – Decreased to 50% by 2009 and 35% by 2016

• **EU Nitrates Directive (1991)**
  – Ireland committed to reducing water pollution from agricultural sources
  
  – National Nitrates Action Plan 2004
Waste in Ireland

Total of 74 million tonnes
Streams with High Biomass Composition

- Municipal Waste: 2.3 million tonnes
- Agricultural Waste: 56 million tonnes
Municipal Solid Waste (MSW) Composition

Total of 2.3 million tonnes

(EPA, 2001)
Municipal Solid Waste (MSW)

Biodegradable Components

65% of MSW is biodegradable

- Paper and Cardboard (804 ktonnes)
- Organic Waste (578 ktonnes)
- Textiles (60 ktonnes)
# Municipal Solid Waste (MSW) Disposal and Recovery Rates

<table>
<thead>
<tr>
<th></th>
<th>Disposal</th>
<th>Recovery</th>
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<tbody>
<tr>
<td></td>
<td>Landfill</td>
<td>Recycled</td>
<td>Waste to Energy</td>
<td>Bio-Treatment</td>
</tr>
<tr>
<td>Paper</td>
<td>79%</td>
<td>21%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Organics</td>
<td>96%</td>
<td>-</td>
<td>-</td>
<td>4%</td>
</tr>
<tr>
<td>Textiles</td>
<td>93%</td>
<td>7%</td>
<td>-</td>
<td>-</td>
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</tbody>
</table>
Municipal Solid Waste (MSW)
Disposal and Recovery Scenarios
Paper, Organics and Textiles

(SEI, 2005)
Municipal Solid Waste (MSW)

Proposed Thermal Treatment Plants

(Ktonnes ‘000)

- Dublin 890
- Mid West 260
- North East 212
- South East 270
- Connaught 330
- Total ~1.96 million tonnes

(EPA, 2004)
Municipal Solid Waste (MSW) Thermal Treatment Plant Example

- Process 150,000 tonnes per annum of MSW
- 14MW capacity, exporting 11MW to the national grid enough energy to support 16,000 homes
- Approximately 65% of the waste stream is organic material (97500 tonnes per annum)

(www.indaver.ie)
Municipal Solid Waste (MSW) Lifecycle CO₂ Emissions

- 1833 g CO₂ per kWh produced from MSW
- 642 g CO₂ per kWh derived from fossil sources (i.e. plastics)

987 g CO₂ per kWh

Coal

642 g CO₂ per kWh

MSW

* Avoided Emissions related to landfill

70 kg of methane per tonne of MSW equivalent to 1610 g CO₂ per tonne

(IEA Bioenergy, 2003)
Municipal Solid Waste (MSW) Thermal Treatment Plant

* Equivalent energy generation from coal would result in 88 ktonnes CO₂.

57 ktonnes fossil based CO₂

* Equivalent emissions avoidance from reduced landfill would result in 241 ktonnes CO₂.

Net reduction in CO₂

= 57 – 88 – 241 = - 272 ktonnes

(IEA Bioenergy, 2003)
Municipal Solid Waste (MSW) Thermal Treatment Plant

1 tonne of waste thermally treated equivalent to 1.8 tonne of CO₂ avoided

0.584 million tonne equivalent to 1.1 million tonne CO₂ avoided
Municipal Solid Waste (MSW) BioTreatment Options

• Anaerobic digestion
  – Biogas, water and compost

• Currently no plants in operation in Ireland

• Estimated generation capacity of 100 – 150 kWh per ton of MSW
Municipal Solid Waste (MSW)

Disposal and Recovery Scenarios

Paper, Organics and Textiles

![Graph showing disposal and recovery scenarios for MSW from 2001 to 2020. The graph includes bars for BioTreatment, Waste to Energy, Recycling, and Landfill. The data points are as follows:

- 2001:
  - BioTreatment: 22 ktonnes
  - Waste to Energy: 170 ktonnes
  - Recycling: 1250 ktonnes
  - Landfill: 170 ktonnes

- 2010:
  - BioTreatment: 307 ktonnes
  - Waste to Energy: 584 ktonnes
  - Recycling: 504 ktonnes
  - Landfill: 504 ktonnes

- 2020:
  - BioTreatment: 532 ktonnes
  - Waste to Energy: 604 ktonnes
  - Recycling: 930 ktonnes
  - Landfill: 364 ktonnes

SEI, 2005]
Municipal Solid Waste (MSW) BioTreatment Options

• Energy requirements could be met for
  – Between 6,700 to 10,000 homes by 2010
  – Increasing to between 11,600 to 17,400 homes by 2020
Municipal Solid Waste (MSW)

BioTreatment Options

- GHG benefits
  - An average home in Ireland uses about 4600 kWh of electricity per yr ~ 4.5 tCO$_2$ per yr
  - Potential to offset substantial proportion of between 30-45 ktCO$_2$ in 2010
    + 494 ktCO$_2$ resulting from landfill avoidance
  - Increasing to 52.2 – 78.3 ktCO$_2$ in 2020
    + 856 ktCO$_2$ resulting from landfill avoidance
Agricultural Waste Stream Composition

Total of 56 million tonnes
Agricultural Waste Stream
Disposal and Recovery

• Majority is currently managed by spreading on land
  – Soil fertiliser

• Considered recovery if managed in accordance with the farm nutrient management plan
Agricultural Waste Stream

Bio Treatment

• Anerobic digestion
  – Biogas, water and compost

• A few small on farm operations, likely to increase with available price support through AER (IV)
Agricultural Waste Stream
Bio Treatment

• Approximately 34 million tonnes waste stored and available for anaerobic digestion

• 1 tonne of waste generates 40m³ of biogas

• 1m³ biogas generates 1.7 kWh electricity
Agricultural Waste Stream
Bio Treatment

* Equivalent energy generation from coal would result in

2.27 million tonne CO₂
## Potential Contribution of Waste Streams

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<tr>
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<th>Energy Generation (million MWh)</th>
<th>Emissions Avoidance (million tonne CO₂ equivalents)</th>
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<tbody>
<tr>
<td><strong>Thermal Treatment MSW</strong></td>
<td>0.3</td>
<td>1.1</td>
</tr>
<tr>
<td><strong>Bio Treatment MSW</strong></td>
<td>0.3</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Bio Treatment Agriculture</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2.9</td>
<td>3.9</td>
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- **12% of total electricity generation**
- **6% of total GHG emissions**
Conclusions

• **Potential**
  - 12% of the current electricity demand could be met by waste biomass
  - Annual GHG emissions reductions potential is high but lifecycle analysis required to provide a more accurate picture

• **Drivers for change**
  - Policy and associated support programmes
  - Potential of guaranteed indigenous fuel
Thank You

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www.ucd.ie/ferg