# Biogas Technology in Agrowaste Management in Europe

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# Biogas Technology in Agriculture in Europe - Driving Forces

- Waste Treatment & Material Processing
- Direct Environmental Impacts
- Renewable Energy

# Biogas Technology in Waste Processing and Hygienisation –driving forces 1

- Reduction of pathogens
  - less infections in the farm
  - no spreading of diseases
  - in many cases initially the most important reason
- Improved soil improver & nutrients availability
- Animal By-Product regulation have caused additional requirements & costs for biogas plants: less competative ?
- However, in the future all materials have to be hygienised (and controlled) before agricultural use ?

# Biogas Technology - Direct Environmental Impacts – driving forces 2

- Less odours, increasingly important in obtaining environmental permits for new livestock centres
- Less nutrients and organic material leaching into water bodies
- Less evaporation of ammonia ?
- Reduced greenhouse gas emissions from manure management and soil applications ? Included in national climate policies ?

# Renewable Energy – driving forces 3

- Kyoto Protocol
- Increase of Renewable Energy in EU from 6 % in 1995 to 12 % by 2010, capacity increase 140 Mtoe/a
- Increase in Biogas Production,  15 Mtoe by 2010
- EU Directives
  - RES-E-directive 2001/77/EC opens markets for renewable electricity
  - CHP-directive (coming) stimulates micro-CHP < 50 kWe
  - GAS directive opens gas grids for biogas
  - Biofuel directive,  5.75 % by 2010

# Renewable Energy – Driving Force 3
# Making sustainability profitable ?

- Subsidies
  - Investments in biogas plants & production of electricity & fuel
  - In some countries up to ca. 20 cent/kWh
  - Selling green electricity, buying non-renewable electricity
  - Higher price for biogas electricity from crops than from wastes
  - More subsidies for smaller plants, new larger plants are split to smaller ones
  - In energy sector 50 % European research money for nuclear energy

# Biogas – Renewable Energy – Environmental Benefits

- Easy to store -renewable energy
- Different upgrading concepts are feasible both in large and small scale
  - Injection into gas grid
  - Combined heat and power generation
  - Vehicle fuel

- How to obtain highest environmental benefits from biogas ?
  - The importance & alternatives in replacing fossil fuels and decreasing greenhouse gas emission in different sectors, e.g. transport
  - Life cycle assessment including alternative /complementary renewable energy technologies are required
  - How we should produce heat, electricity, cooling and transport fuel in the future ?
  - Biogas for vehicle fuel, not for heat and electricity generation ? Case by case decisions ?
  - How subsidies should be used in the future ?

# Status of Biogas in Selected European Countries

# Uptake across Europe

| COUNTRY | Farm related digestion capacity | Factors influencing the adoption of AD technology |
|---|---|---|
| Austria | 139 + 50 under construction<br>200 GWh installed or in construction in 2004 | • Regional and national government support for a renewable energy policy<br>• Guaranteed purchase of biogas produced electricity at preferential rates: 0.165 - 0.103 € $kWh^{-1}$ (depending on size of installation) |
| Germany | 2500 (~4000 expected by end 2005)<br>Anticipated installed electrical generating capacity of 950 MW by end 2005 | • Renewable energy resources act ('feed in laws')<br>• Guaranteed priority purchase of biogas produced (and other renewable) electricity at preferential rates for a 20 year period, base price paid ranges from 0.084 - 0.115 € $kWh^{-1}$<br>• Bonuses for electricity produced from energy crops, use of CHP, and use of new technologies; these can add a further 0.1€ $kWh^{-1}$<br>• Scale-down in subsidies from 2005 to encourage efficiency and process development |

# Uptake across Europe

| COUNTRY | Farm related digestion capacity | Factors influencing the adoption of AD technology |
|---|---|---|
| Denmark | 22 CAD receiving mainly (80%) animal slurry + 40 farm-scale digesters. | • Investment grants to help meet capital costs (currently 20%)<br>• Long term loans at low interest rates<br>• Legislative requirement for 9 month storage for slurry<br>• Favourable prices for biogas produced electricity<br>• Exemption from energy taxes<br>• Demonstration programmes and research support<br>• Opportunities for district heating |
| Sweden | 10 CAD co-digestion plants + 5 farm-scale plants | • Encouragement of the use of biogas as a vehicle fuel through low taxation |
| Switzerland | 69 farm-scale digesters | • Subsidy of biogas derived electricity prices at 0.10 € $kWh^{-1}$<br>• Grants of up to 8% of installation costs |

# Co-digestion

- Most farm-based and CAD facilities use animal (cattle or pig slurry) slurry as the major substrate, often supplemented with other organic wastes or energy crops.
- In Germany ~94% of agro-biogas plants use co-digestion for more efficient gas production = electricity production.
- In Germany over 30 different organic by-products and wastes from food- and agro-industries are used, but energy crops and crop residues are most common as importing wastes onto the farm leads to reduced subsidies.
- Economic digestion of manure without co-substrate can only be achieved in large-scale farming.
- Shorter contracts with waste producers, more competition for waste among biogas plants and other uses of wastes

# Biogas Potential in Europe

Agrowastes  1500 million tons/a of which 750 million tons are crop residues

# Biogas Technology

# Developments in Biogas Concept Technology

- Covered structures to recovery all gases
- Reactors: wet processes common, dry processes getting more common especially in crop digestion
- Post-digestion to recovery residual methane from digestate
- Biogas upgrading technology coming more common
- Decentralised biogas fuelling technology ?
- Concepts to ensure sufficient feedstocks for biogas production

# Biogas Upgrading


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# Crops – a reminder

| Substrates | Dry matter content (DS%) | Organic dry substance in DS% | Biogas Yield Nm3/T substrate | Methane content (%) |
|---|---|---|---|---|
| Dairy cow slurry | 8 | 85 | 20 | 55 |
| Fattening cattle slurry | 10 | 85 | 34 | 55 |
| Pig slurry | 5 | 85 | 18 | 60 |
| Chicken manure | 25 | 75 | 93 | 65 |
| Meadow grass average from 3-4 cuts/year | 18 | 91 | 98 | 54 |
| Maize silage | 33 | 96 | 190 | 53 |
| Grass silage average from 3-4 cuts/year | 35 | 89 | 183 | 54 |
| Grain milled | 87 | 98 | 597 | 53 |
| Corn-Cop-Mix, 5,3% fibre | 60 | 98 | 391 | 53 |
| Total plant grain silage | 40 | 94 | 195 | 53 |
| Potato distillery residues | 6 | 87 | 35 | 56 |
| Vegetable residues | 6 | 87 | 35 | 56 |
| Rape seed cake | 91 | 93 | 612 | 63 |
| Canteen residues high fat | 18 | 92 | 90 | 68 |
| Canteen residues low fat | 14 | 82 | 44 | 69 |
| Flotation fat | 12 | 90 | 108 | 68 |