IEA- Bioenergy, Task 37 BIOGAS
3. Meeting 17-18.April, 2008,
Ludlow, UK.

BIOGAS in DENMARK

State of the art and rapid developments - From 2008 and onwards!

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Energy production from biogas in Denmark

Unit: PJ per year	Potential	Production 2001	Production 2002	Production 2003	Production 2004
Animal manure	**26.0**	**0.61**	**0.70**	**0.85**	**0.91**
Sewage sludge	**4.0**	**0.86**	**0.87**	**0.87**	**0.83**
Industrial waste	**2.5**	**0.59**	**0.67**	**0.80**	**0.86**
Industrial waste, imported	**-**	**0.40**	**0.45**	**0.55**	**0.65**
Meat and bone meal	**2.0**	**0.00**	**0.00**	**0.00**	**0.00**
Household waste	**2.5**	**0.03**	**0.05**	**0.07**	**0.03**
Green waste/garden waste	**1.0**	**0.00**	**0.00**	**0.00**	**0.00**
Landfill gas	**1.0**	**0.56**	**0.62**	**0.44**	**0.46**
Total	39	3.05	3.58	3.58	3.74

Source:

Tafdrup, S. (2006). “Insufficient knowledge of gas from manure” in *Bioenergy Research*, Vol. 3, issue 14, June 2006, pp. 2-3, http://www.biopress.dk/FiB-UK.htm

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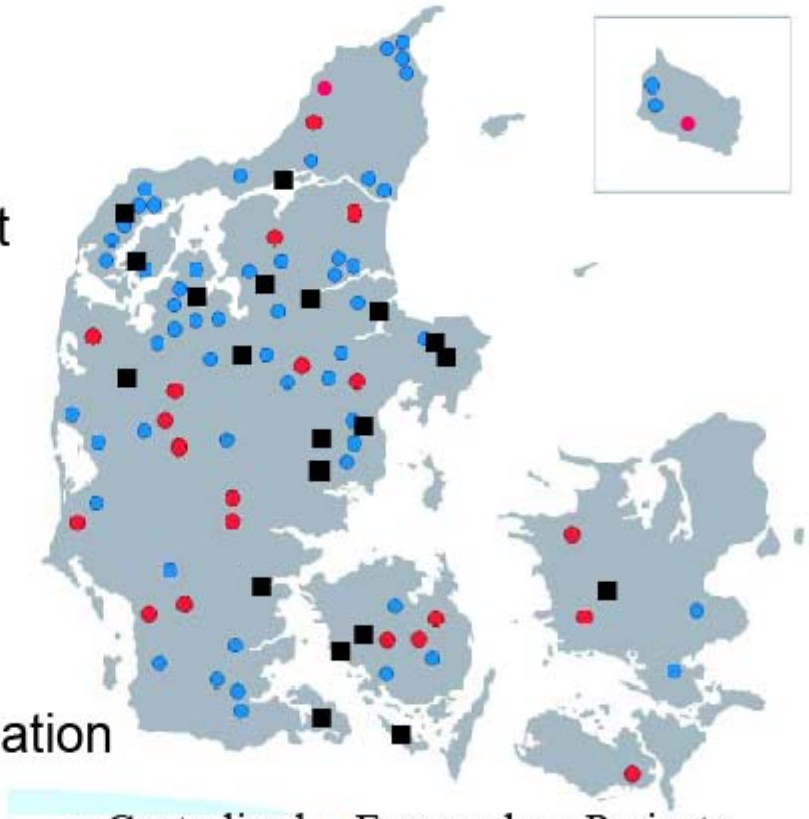
Multifunctional technology

Societal incentives

- GHG reduction
- Aquatic environment
- Life quality (odour)
- Pathogen reduction
- Energy security
- Biomass utilisation

Farmers incentives

- Income and survival
- Environmental legislation



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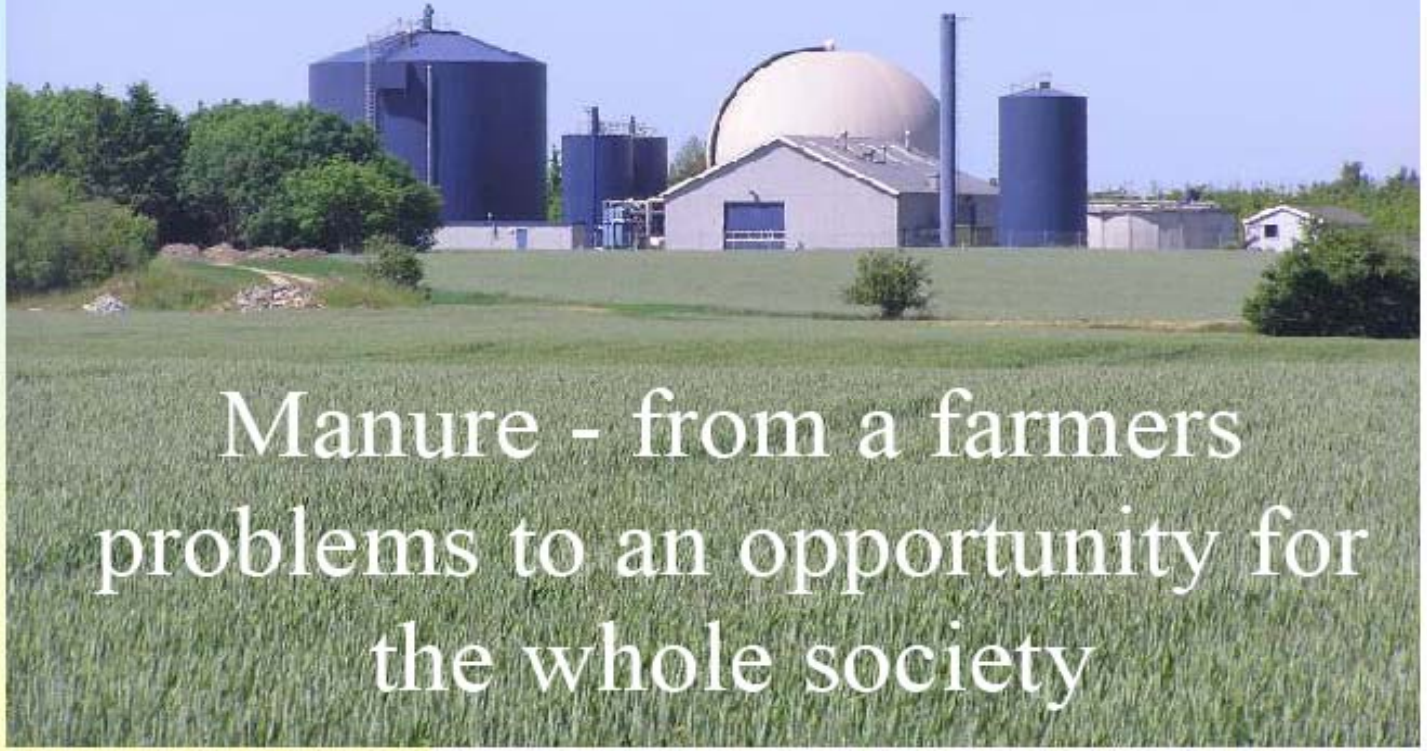
25 years of Danish biogas experience



Manure - from a farmers problems to an opportunity for the whole society

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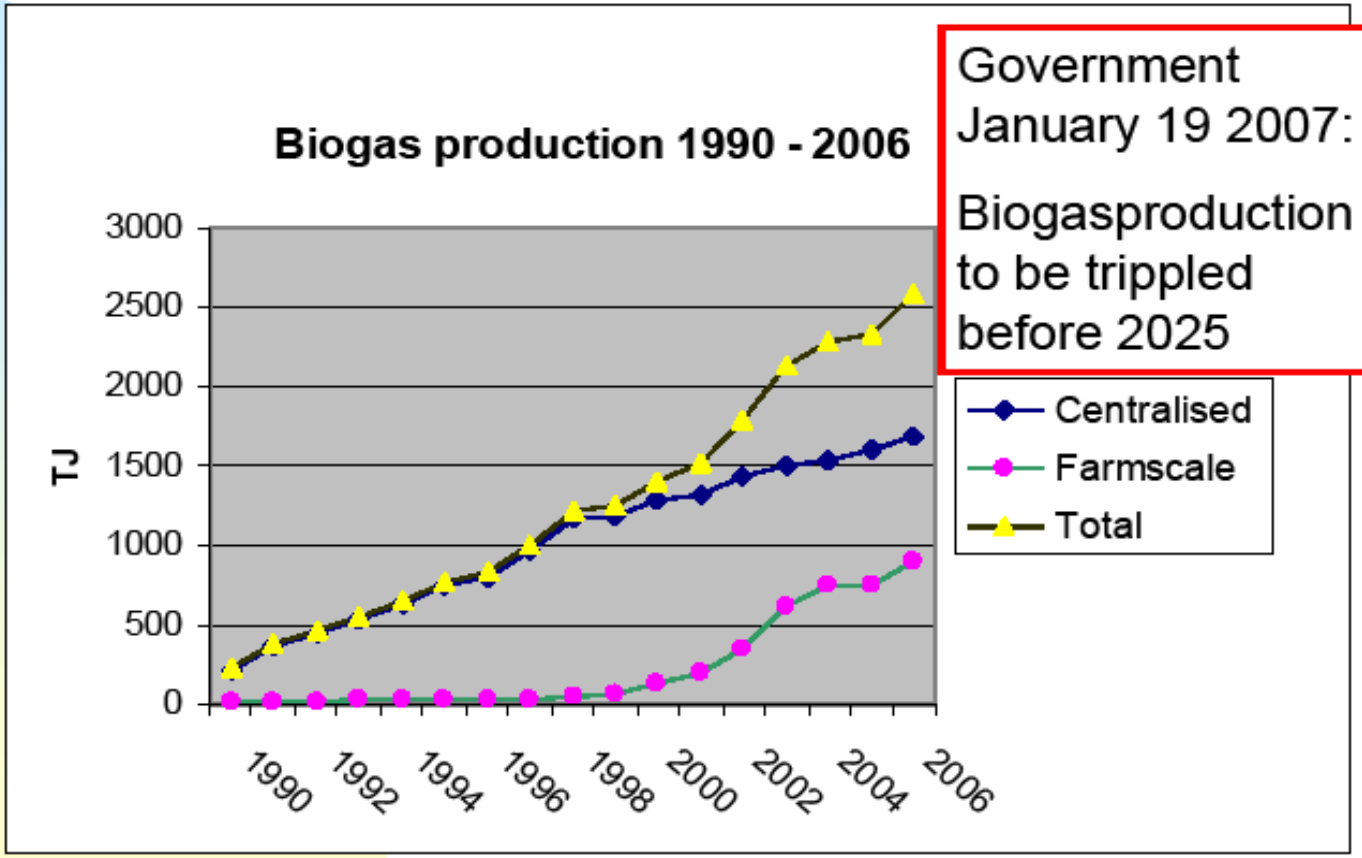
Development manurebased plants



Government January 19 2007:

Biogasproduction to be trippled before 2025

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Renewed priority to biogas

as specified in the 21st of February 2008 political agreement

- Substantially improved feed-in tariff for electricity. All biogas plants will now receive a total of **DKK 0,745 per kWh** (or an additional payment of DKK 0,405 per kWh when biogas is used together with natural gas). The tariff will be adjusted annually with 60 % of the price index increase.
- As indicative objective biogas is expected to grow from presently 4 to 10 PJ or more by 2020. The increase is equal to the production from 50 centralised biogas plants or 4 new plants per year until 2020. In reality existing plants will expand in parallel with new plants being built.

How big can biogas become?

- At present biogas contributes 4 PJ or ½ % of Denmarks energy consumption.
- 10 PJ in 2020 equals 1,2 % when gross consumption is reduced by 4 %.
- The total Danish resources suitable for biogas production could produce 40 PJ per year ~ 5 % of present gross consumption.
- Time will show… if we'll be successful … and if additional resources such as energy crops or even sea weeds end up being financially realistic.

Costs, DDK per m^3 methane

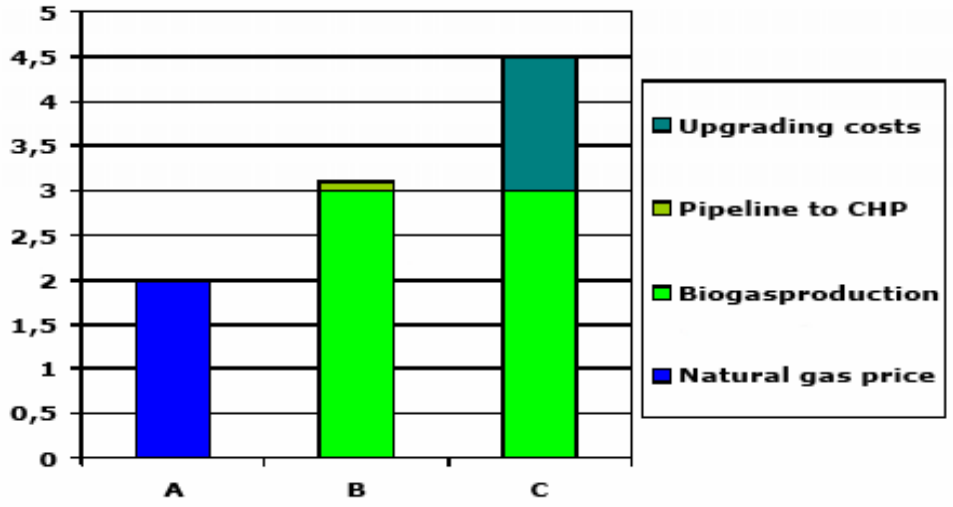
A: Natural gas price
B: Biogas send by separate pipeline to CHP
C: Biogas upgraded and injected into the grid

Natural gas approx. costs about DKK 2 per m^3 methane.

Production of biogas approx. costs DKK 3 per m^3 methane.

Transporting biogas by separate pipeline to a CHP station has a typical cost of DKK 0,1 per m^3 methane.

Upgrading and injecting into the natural gas grid has a cost of approx. DKK 1,5 per m^3 methane.



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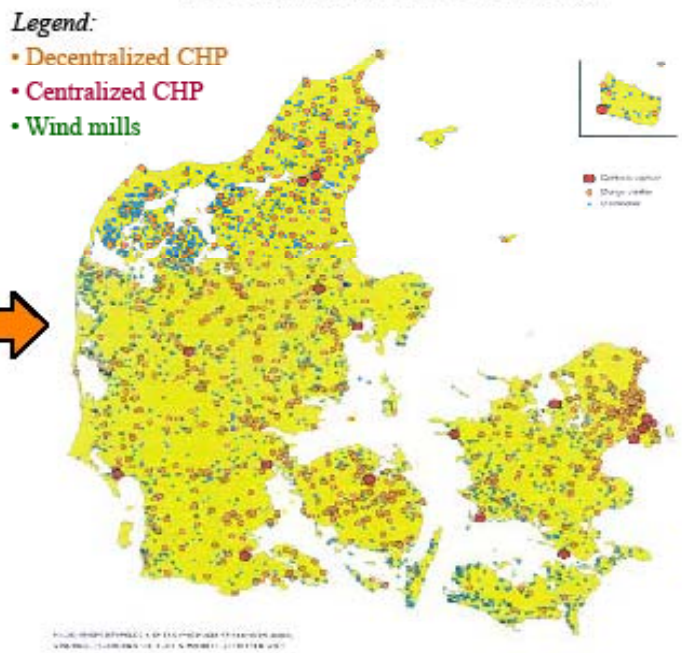
From Centralised to Decentralised CHP

Centralized production in the mid 80's

Decentralized production of today



CHP = Combined Heat and Power generation

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Agricultural and environmental advantages

- Improved fertilizer value
- Full declaration of nutrients
- Free from germs and seeds
- Reduced costs for transportation of slurry
- Reduced nitrate leaching
- Reduced odour problems
- Reduced green house gas emission
- Controlled recycling of organic waste

Actual incentives for establishment of new plants:

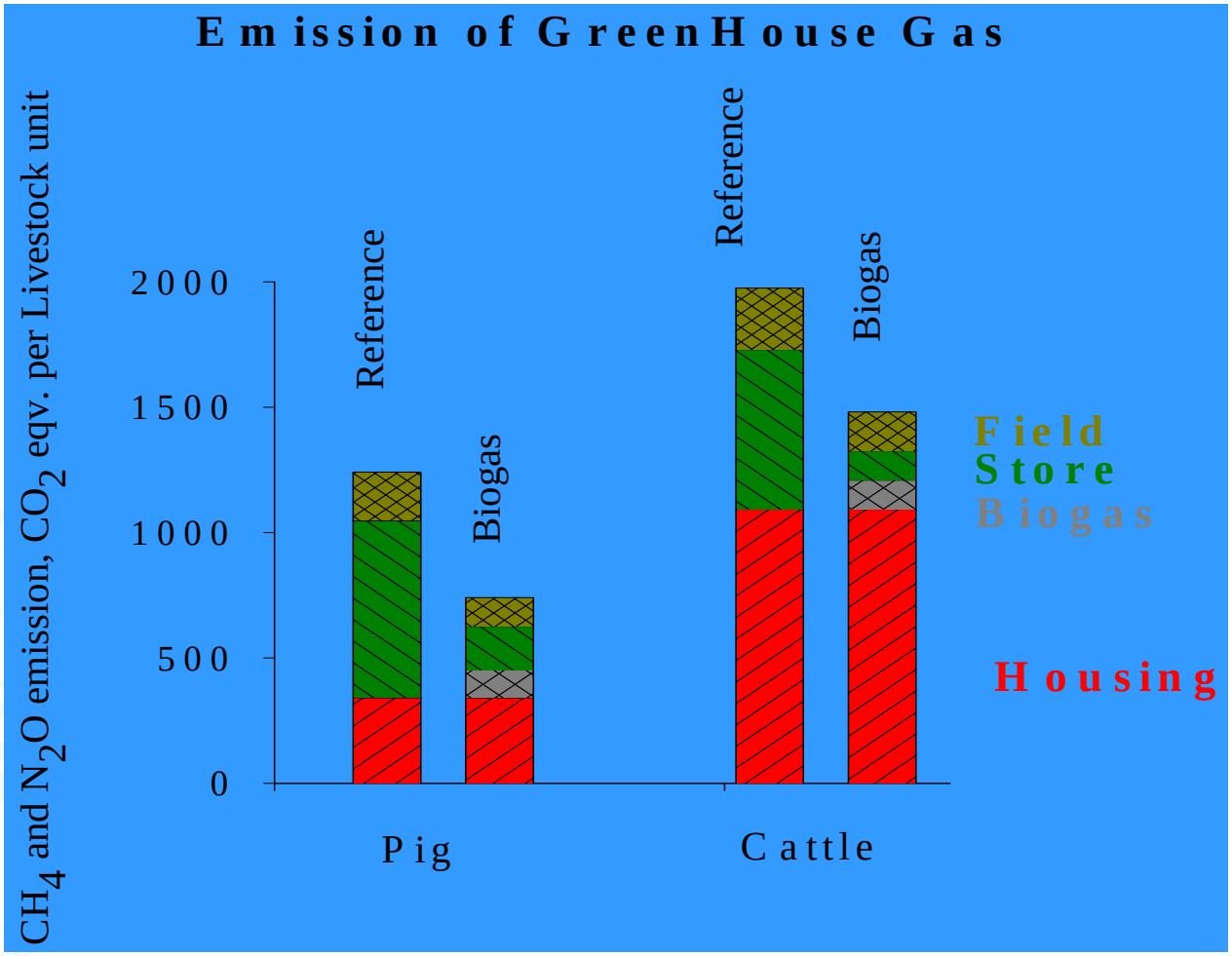
- New legislation and price conditions in place

- Socio-economic advantages of biogas production

- Fulfilment of environmental tasks
  - cheap tool for reduction of CO2 emissions (40 DKK/tons CO2)
  - 90 kg CO2 EQ. / t biomass treated

- Agricultural benefits
  - cheap slurry storage
  - less transport
  - less odours and flies at application and around the storage tanks
  - less CH4 emissions from treated manure - biofertilizer
  - cheap redistribution of slurry (centralised co-digestion)
  - sanitation and pathogens control
  - NPK declaration
  - high N-utilisation and less N- leaching
  - possibility of separation

Green House Gas emission, with and without biogas production



Biogas and slurry separation

Digestate

Fibre fraction ← Decanter → Liquid fraction

70 % of total P

25 % of total N, organic compounds

15 % of initial volume

75 % of total N, mainly as ammonia

Still no big market exists forfibre fraction. Costs of drying (50 eur/T) exceed nutrient value of fibres. Heavy metals content could be a problem; removal expensive!
Incineration seen like the only alternative; Documentation and approvals needed, moving market

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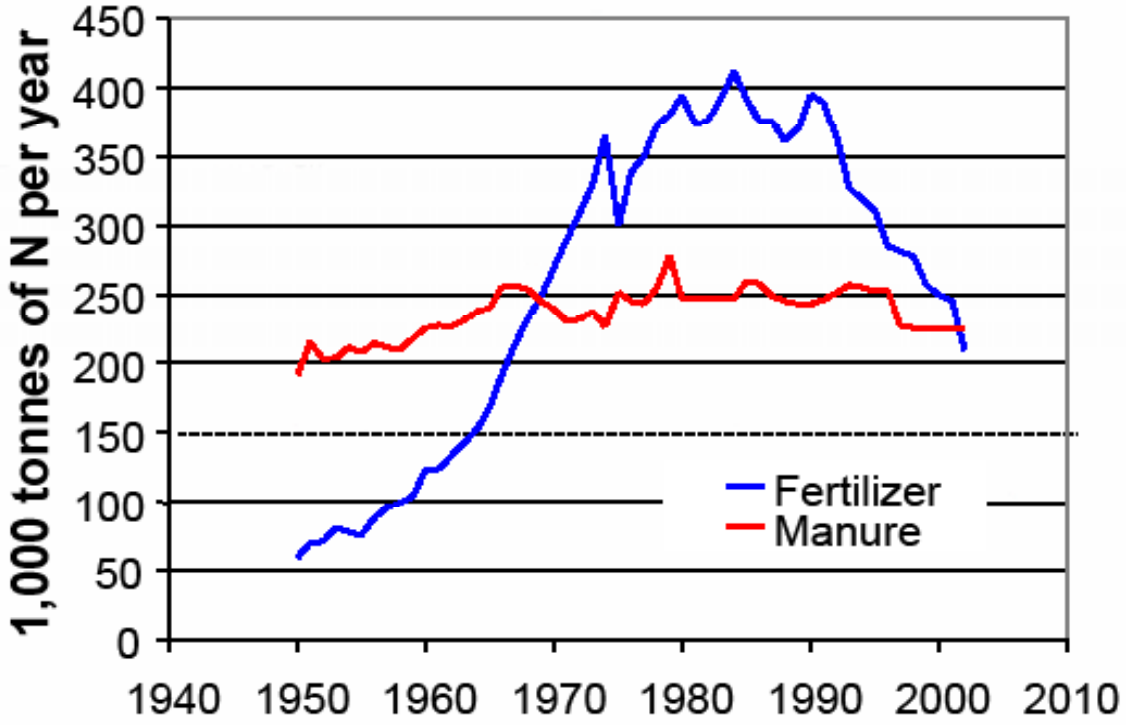
55 single-farm biogas plants in operation
Capacity: 5-50 m³ slurry per day
Orø Single-farm Biogas Plant

N-application in Denmark



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Future Danish development

- Biogas and separation
  - Removal of excess of nutrients
- Less reliant on waste
  - Higher manure share
  - Liquid slurry and fibre
  - Biomass from natural habitats
- Organic biogas plants
  - Self suppliance in nutrients
  - Self suppliance in energy
- Energy use
  - Co-generation and upgrading

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Top priorities for further R&D

- Biological and process control issues within the biogas plant - focus on finding economically viable ways to gradually improve gas yield especially from recalcitrant organic matter.
- The system of optimising energy yield and minimising green house gas emissions all the way from the stable through the biogas plant and slurry storage to the final field application.
- Focus on concepts and technical means by which operating costs can be minimised.
- Accurate technical standards to effectively protect neighbours from odour nuisances.
- Long-term strategy considerations: Why are we so focussed on a future hydrogen supply system when we already have a methane option?

Being or becoming credible

The history of agricultural biogas is the history of much too many mistakes being made and being repeated. It's the same story all the way from Europe to America and to the far East. This must change if agricultural biogas is to be successful as a credible, reliable and significant part of the future renewable energy supply. Now we are getting a golden chance to adjust and to make it right.

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