

**NTNU presentation
Trondheim, Norge 21. november 2005**

The present and future of biogas/bioenergy in Europe

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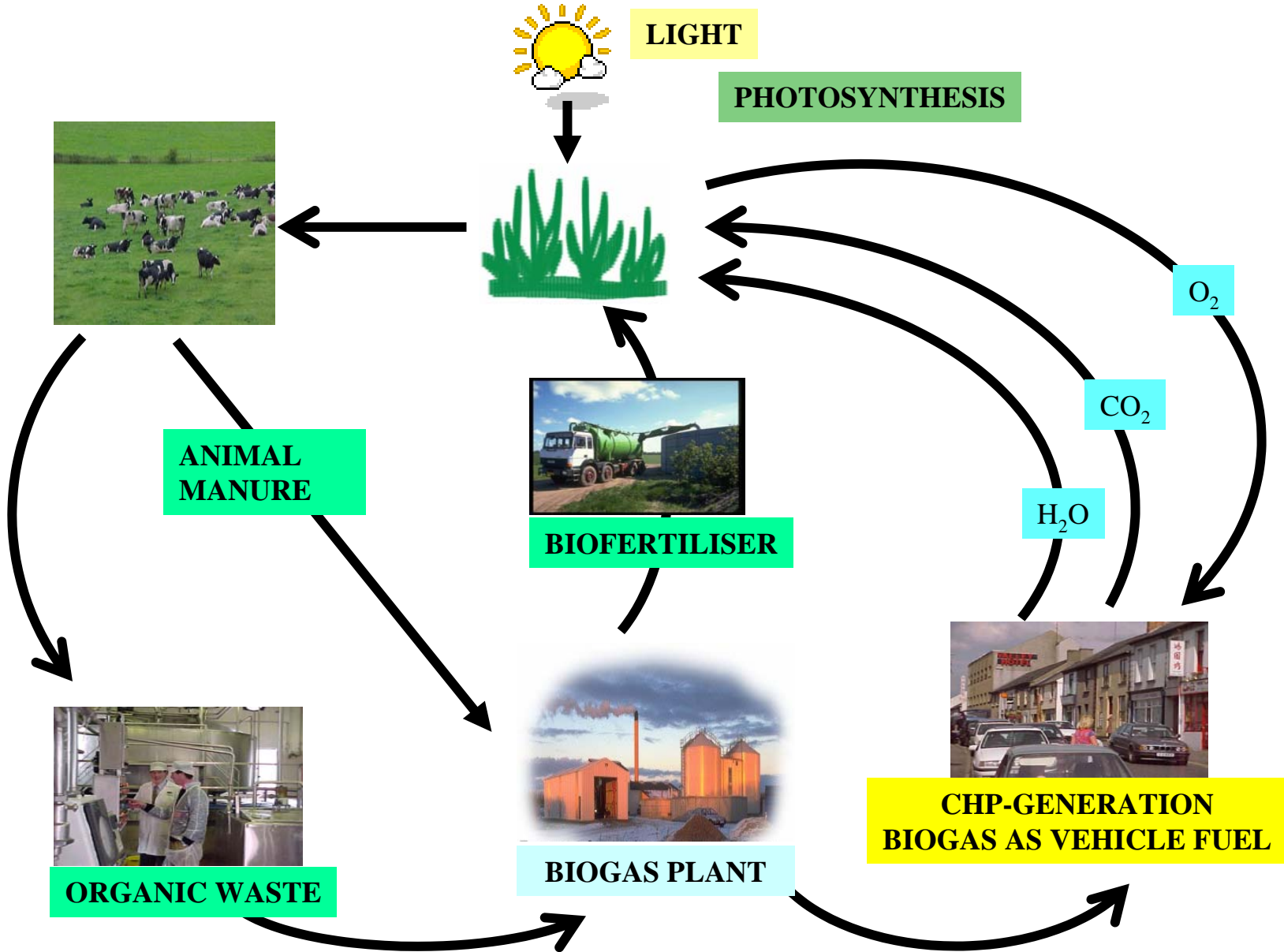
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Biogas for a sustainable clean environment



Status of digestible biomass in the 15 EU-countries

	Cattle manure	Pig manure	Total manure	Population (humans)	Municipal waste generation		Sewage sludge	Industrial org. waste
	(1993)	(1993)	(1993)	(1993)	Total waste (450kg/capita)	Org. waste (30% of total)	(1990)	Digestible <35%DM (100 kg/cap)*
	mill. t	mill. t	mill. t	mill.	mill. t	mill. t	mill. t	mill. t
Austria	25	8	32	7,7	3,5	1,0	**2,3	0,8
Belgium	35	14	49	9,9	4,5	1,3	0,7	1,0
Denmark	22	22	44	5,1	2,3	0,7	1,3	0,5
Finland	14	3	17	***5,1	***3,1	0,7	0,1	0,5
France	211	26	238	56,5	25,5	7,6	0,6	5,7
Germany	167	51	218	62,7	28,2	8,5	1,8	6,3
Greece	6	3	9	10,0	4,7	1,4	-	1,0
Ireland	66	3	69	3,5	1,6	0,5	0,6	0,4
Italy	80	15	95	57,6	25,9	7,8	**3,4	5,8
Luxembourg	2	0,2	2	0,4	0,2	0,02	0,02	0,04
Netherlands	48	28	77	14,9	6,7	2,0	0,3	1,5
Portugal	14	6	20	10,3	***3,4	1,0	-	1,0
Spain	53	37	89	38,9	17,5	5,3	10,0	3,9
Sweden	19	5	24	8,6	3,9	1,2	0,2	0,9
U. Kingdom	125	16	141	57,3	25,8	7,7	1,0	5,7
Total EU	887	237	1124	348,5	156,8	46,9	22,32	35,04

* Estimated figures, based on fixed data from Denmark, Finland and the Netherlands, ** 1994 data, *** 1996 data
 Source: Holm-Nilsen, J.B. & Al Seadi, T. (1997): The Future of Biogas in Europe. Altener Programme, Final Report Phase II



Manure based co-digestion biogas plant - the basic Danish concept

Animal manure and slurry from local farms

- Dairy and cattle slurry
- Pig slurry
- Poultry manure

Organic wastes

- Waste from food processing industries
- Vegetable and catering waste
- Household waste, source separated

INPUTS

Biogas Plant

- Homogenisation
- Pasteurisation
- Digestion and gas production



- Odour reduction
- Fibre and liquid separation
- Nutritionally defined product

Agricultural biofertiliser

Improved utilisation of plant nutrients

- Reduced consumption of mineral fertilisers
- Reduced water pollution
- Disease and weed seed free biofertiliser
- Separated fibre/soil improver

OUTPUTS

Biogas for combined heat and power generation

- Renewable energy source
- Displacement of fossil fuel
- CO₂ - neutral
- Reduced air pollution
- Effective energy utilisation

Waste Collection

- Tankers
 - 20 m³
 - 30 m³
- Tippers
- Pipeline
- Average distance to plant
- Emptying cycle



Pre-Treatment

- Hygienic step if recycling nutrients
- Separate unit to gurantee of retention time
- Elimination of pathogens and weeds



Digesters

- Steel or concrete tanks
- Insulated
- Processes
 - mesophilic
 - thermophilic



After Storage

- Second digester
- Buffer for return of digestate or
- Buffer before after treatment



After Treatment: e.g. separation

- Separation in solid and liquid fraction
- Different technologies
- Centrifuge
 - solid fraction 12 %
 - liquid fraction 88 %



Solids Fraction

- Will contain most Phosphorous
- Dry matter content up to 30 %



Fluid Fraction – post treatment

- Various technologies can separate the liquid fraction in
 - concentrated nutrients
 - reject water



Gas Storage

- Equalize gas production
- Max for 24 hours storage
- Size depends on utilization of gas



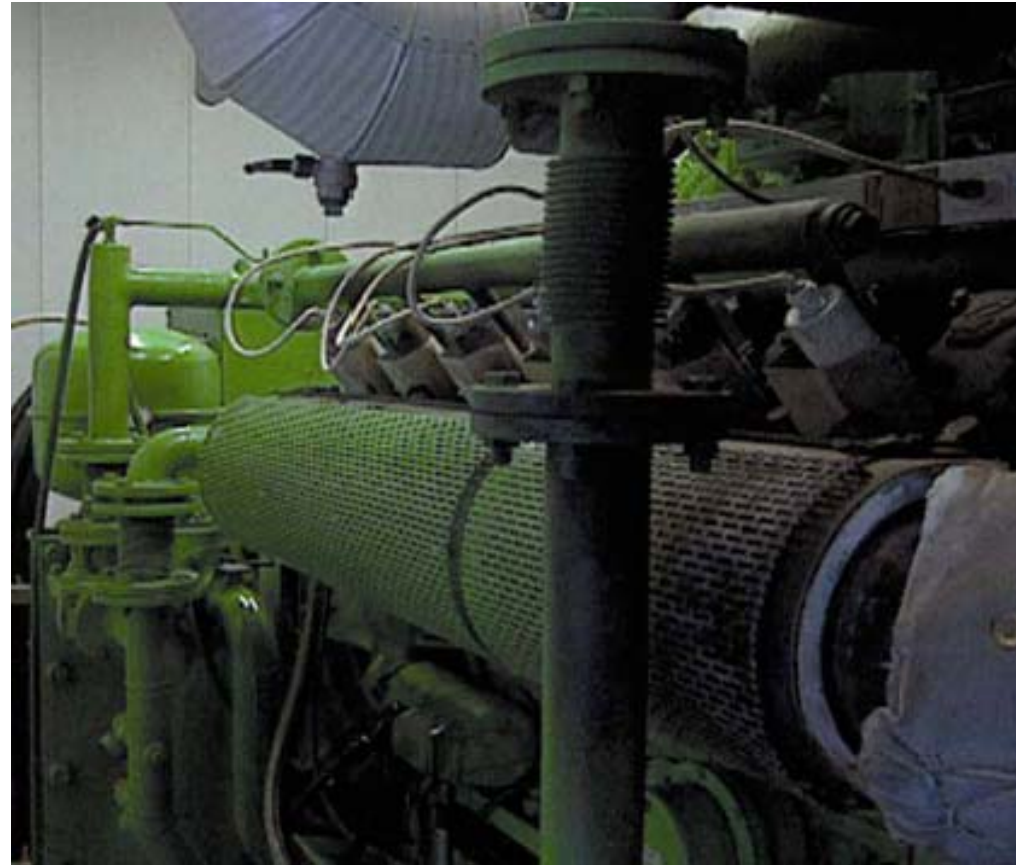
Gas Treatment

- Gas contains H₂S
- Can be removed biologically in
 - after storage
 - gas cleaning unit



Gas Utilization

- Boilers
- Internal combustion engines
- Gas turbines
- CHP applications
- Fuel cells



The future of biogas in Europe. How to make a real movement!

- Biogas production potentials – co-digestion and more:
 - * Biogas - manurebased
 - * Biogas - manure and animal byproducts
 - * Biogas - green waste; households, gardens etc.
 - * Biogas – manure & crops
 - * Biogas from industrial production
 - * Biogas from wwtp
 - * Biogas from.....



BIOGAS

for Energy and Environment

Biogas is a renewable energy source, generated by anaerobic digestion (AD), which is a microbiological anaerobic degradation of organic matter.

The main biomass substrates for biogas production are:

- animal manure
- organic waste from food industries
- source separated organic household waste
- sewage sludge from wastewater treatment
- vegetable biomass

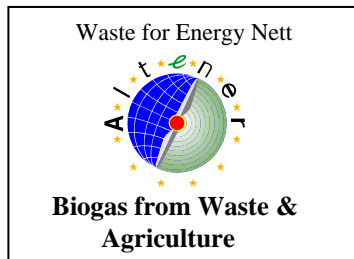
Biogas is a CO₂ - neutral energy source used for CHP-generation, replacing this way fossil fuels (coal, oil, natural gas). Digested biomass is used as organic fertiliser in agriculture.



CHP - generation unit



A modern Joint Biogas Plant



Environmental benefits of biogas

- Reduced emissions of greenhouse gases (CO₂, CH₄, and N₂O).
- Reduced air pollution with acids, salts and particles.
- Reduced water environment pollution from leaching and percolating of nutrient salts and pathogens.
- Reduced consumption of resources and increased recycling.
- Sanitation of wastes and manure.
- Reduced odour and flies nuisances.
- Lasting and environmental friendly solution to the waste disposal problem.

Environmental risks of biogas, if inadequate practices.

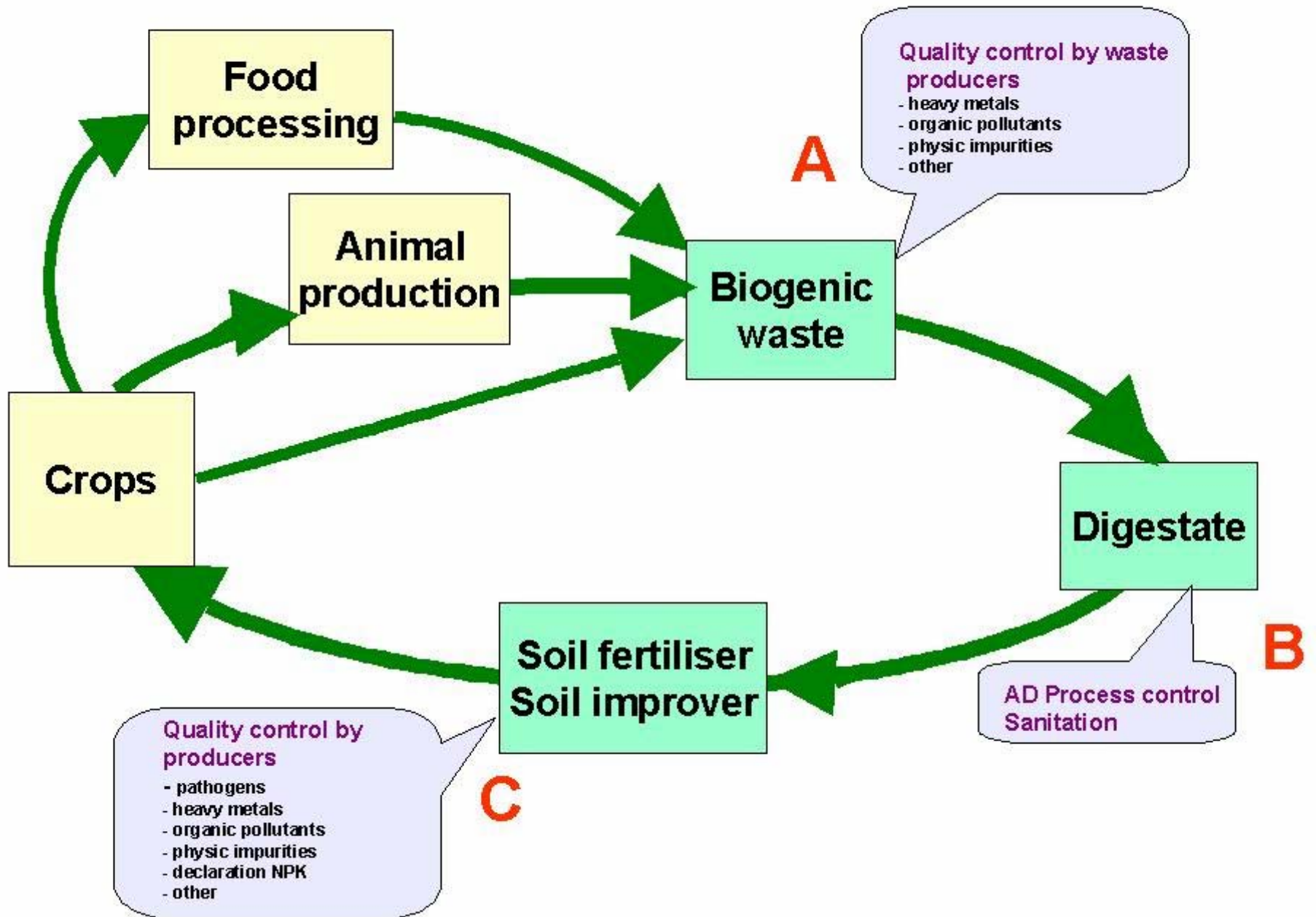
These risks can be avoided if the Good Practice - guidelines of handling fresh and digested biomass are followed.

- Risk of odour nuisances around the plant.
- Risk of traffic nuisances caused by biomass transport.
- Increased risk of NH₃ emissions from digested biomass.
- Increased risk of NO₃ leaching from digested biomass, if applied out of growing season.

The future of biogas in Europe. How to make a real movement!

- Biogas upgrading & utilisation for:
 - * Biogas for combined heat and power production.
 - * Biogas & Natural gas; integration in the European gas grid
 - * Biogas as transportation fuel
 - * Biogas as fuel in fuel cells
 - * Biogas as







Trends in Denmark

- Increased gas production (~25%) per unit received material
- Increased reduction of solids
- Pre-treatment: sterilization at 70°C and at 133 °C
- Reduced retention time (4-6 days thermo- and 7-10 days mesophilic)
- Physical layout: parallel lines, fewer pumps and moving parts
- Porcess monitoring and management
- Reduced capital cost

Land application/after-treatment

- Direct application to field
- After treatment – separation
- After treatment - upgrading



Fertilizer effect

- Nitrogen uptake increased from 40% to >70%
- Phosphorous increased from ~30% to >60%
- Substitutes chemical fertilizer – adds organic matter to the soil
- Nutrients are recycled to landf



The future of biogas in Europe.

How to make a real movement!

- Biogas as one of the most important environmental tools for the European water environment - wet organic waste streams upgrading and utilisation:
 - * No waste products and waste water.
 - * Full nutrient utilisation
 - * Fiber fraction upgraded as valued growth medias.
 - * Liquid fraction including the main nitrogen fraction as crop nutrient enriched irrigation water
 - * Remaining water as process water or....





The future of biogas in Europe. How to make a real movement!

- Biogas as one of the important tools for reduction of input towards global warming and air pollution.
- * Biogas co digestion and high biogas production yields makes biogas a strong & cheap tool for green house gas (GHG) emission reduction costs in all societies.
- * Optimised environmental benefits of externalities including human and animal health benefits makes biogas plants, of the state of art and future configurations, very attractive from the socio-economic point of view.
- * Biogas has an increasing important role to play in Europe and world-wide integrating many sectors for a higher degree of sustainability.

