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Biogas in Denmark - Present and future

Teodorita Al Seadi, MSc
Research coordinator, Principal scientist

University of Southern Denmark
Institute of Chemical Engineering, Biotechnology and Environmental Technology
Niels Bohrs Alle 1; 5230 Odense M
Denmark

Summary

Introduction: High priority to climate change policies

- Increased political interest in biogas

The present: Denmark is a “biogas country”

- Biogas state of the art anno 2009
- Current technologies and concepts
- Existing framework and economy
- Incentives and barriers

The future : Denmark as fossil free economy

- “Green Growth” and the role of biogas
- Incentives and challenges ahead

Conclusions

Remarkable change of political priorities

Top political priorities

Climate change

- Reduction of GHG emission from agriculture

Security of energy supply

- The oil and gas reserves from North Sea will be exhausted within the next 10 years

Green energy

- New business opportunities

=> Increasing political interest in biogas

Increasing political interest in biogas

February 2008: The Government Energy Agreement

- Significant improvement of economic frames for biogas production

December 2008: Agriculture and Food Ministry report "Agriculture and climate"

- Highlights the impact of agriculture on climate change
- Potential of 20 PJ biogas energy from vegetable biomass

June 2009: The Government signs the "Green Growth" agreement

- "A green growth vision for nature, environment, climate and agriculture"

=> by 2020 at least 50 % of animal slurry must be processed, mainly through AD in biogas plants

THE PRESENT:

State of art 2009 - agicultural biogas plants

Biogas production, plants types and ranges of capacity

Overall biogas production in Denmark = 4 PJ/ year (*incl. biogas from WWT, landfill and industrial biogas)*

of which biogas from agricultural plants = 2 PJ/ year

- **20 joint biogas plants; 50-600 m3 biomass/ day**
- **60 farm scale biogas plants; 5-100 m3 biomass / day**

-Technically well operating
- Economically viable
- Co-digestion of organic wastes mandatory (up to 25 % of feedstock-)

Why is organic waste necessary ?	**1 t liquid manure, 5% DM**	**=> 20 m3 biogas**
	1 t organic waste	**=> up to 1000 m3, biogas, depending on quality**
		=> extra income from treatment fees

Feedstock types and amounts

Animal manure and slurries	**1.3 mil t/ year**
Organic wastes	**0.3 mil t/ year**

Source: Tafdrup 2009

Advantage of scale

Economic break even
related to share of organic wastes and biogas yield

	Per day treatment capacity, m^3 biomass/day		
	300 m^3/day	550 m^3/day	800 m^3/day
Break even level of waste admixture	21 %	13 %	10 %
	m^3 biogas/ m^3 biomass		
Break even biogas yield	34	27	25

Calculation preconditions:

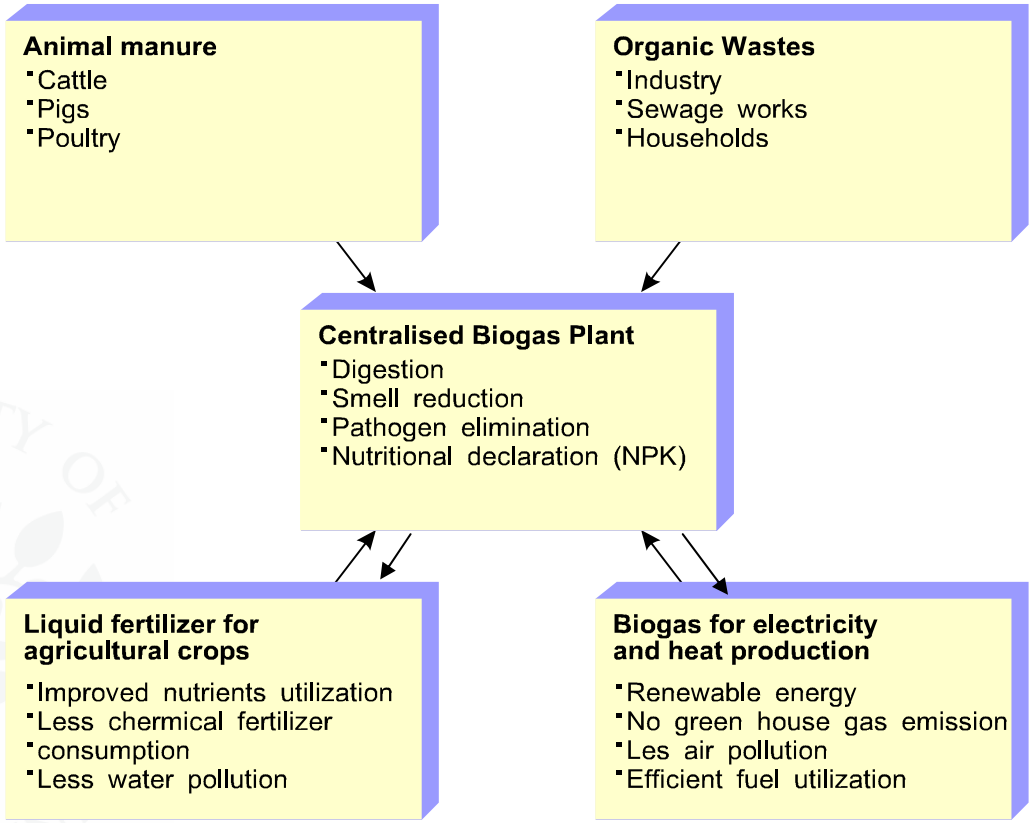
Gas yield from manure	22 m^3 biogas/m^3
Gas yield from waste	75 m^3 biogas/m^3
Gate fee (receipt of waste)	50 DKK/m^3 waste
Biogas sales price	2 DKK/m^3 biogas

Source: Gregersen 2009

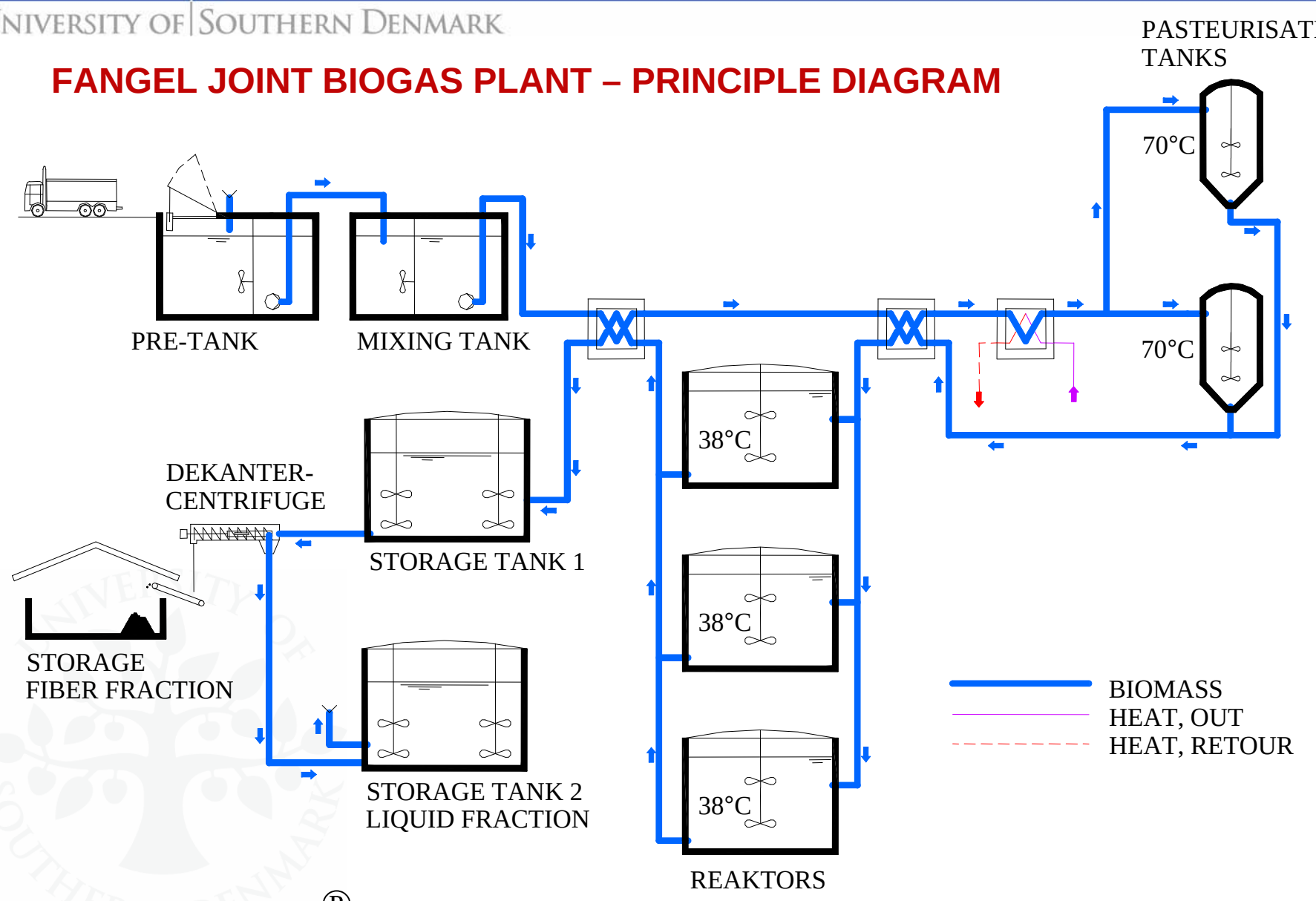

• Animal slurry is transported to/from the biogas plant by vacuum tankers (30-35 m3)
• Diesel consumption for slurry transport - equivalent to 5% of gas production
• Average distance for slurry transport: 10 km (joint plants)
Thorsø joint biogas plant
Source: Tafdrup 2009

A typical joint biogas plant

Source: Tafdrup 2009



FANGEL JOINT BIOGAS PLANT – PRINCIPLE DIAGRAM



Source: BIGADAN®

Environmental benefits

- Reduced emission of GHG gases (CO, methane and NO_2)
- Improved fertiliser value and less water pollution due better nutrient utilisation (only combined with good agricultural practices)
- Sanitation
- Reduction of bad smell
- Controlled recycling of organic wastes

Estimated environmental benefits in Denmark; ***Source: Gregersen 2009***

- Reduced GHG emission: 90 kg CO_2 eq. per t digested biomass

- Reduced Nitrogen leaching to fresh water systems: 0,11 kg N per t digested biomass

Monetised biogas externalities

Case study: 550 t biomass/day, with co-digestion of 20% organic waste

Source: RISOE

Monetised externalities:
Socio-economic value per ton biomass

Results based on biogas plant:
Biogas plant size: 550ton/day (20% waste)

	Monetised	
Agriculture		
Storage, handling and distribution of liquid manure:		
Storage savings for liquid manure	**0.13**	EUR/ton liquid manure
Transport savings in agriculture	**0.07**	EUR/ton liquid manure
Value of improved manurial value (NPK)	**0.73**	EUR/ton degassed
Value of reduced obnoxious smells	**0.67**	EUR/ton liquid manure
Industry		
Savings related to organic waste treatment	**16.82**	EUR/ton org. waste
Environment		
Value of GHG reduction (CO_2, CH_4, N_2O-reduction)	**3.01**	EUR/ton degassed
Value of reduced N-eutrophication of ground water:	**0.39**	EUR/ton degassed
Liquid manure	0.37	EUR/ton liquid manure
Org. waste spread on farm land in reference case	1.64	EUR/ton org. waste
Org. waste not spread on farm land in reference ca	-3.03	EUR/ton org. waste

Existing framework / incentives

- Price guaranty of 10 euro cents/kwh for electricity from biogas
- Heat production by CHP attractive due increasing energy prices
- Increasingly restrictive regulation concerning handling and application of manure
- Animal farmers interested to separate slurry and supply concentrated fractions to biogas plants

FUTURE: Denmark as fossil free economy

What is "Green growth"

"We would make Denmark a centre for green growth. This requires a new industrial revolution, where we will develop a new economy, based environmental friendly, new technology"

(Declaration of the Danish prime minister at the official opening of the parliament, 7 October 2008)

- 19 June 2009: the Danish Government adopted the "Green growth" document, a vision of "green development" for nature, environment, climate and agriculture

- **Funding: 1.8 bill. Euro up to 2015**

Green growth
Agriculture as green energy provider

- **50 % of the produced animal slurry to be processed for green energy production (most of it through AD) by 2020**

- **Status in 2012 + further measures to increase the utilisation of manure for energy production.**

Green growth

How much biogas? When?

- 4 PJ biogas; 0,5 % of brute energy consumption in Denmark
- 20 PJ by 2020, if 50 % of animal manure and slurries will be processed by AD
- 40 PJ currently estimated biogas potential in Denmark (hereof 26 PJ from manure)
- 20 PJ extra after 2020, from maize and grass cuttings *(Agriculture and Food Ministry 2008: "Agriculture and climate" report)*
- On long term: Aquatic biomass ("sea salad" and other sea algae)

Incentives, subsidies and legislation

Subsidies 2010-2012

- Further development of biogas with up to 20 % subsidies
  - Joint biogas plants => 85 bill. DKK per year
  - Organic biogas plants => 15 bill. DKK per year
- Subsidies for cultivation of multi annual energy crops
- Equal subsidies for utilisation of biogas for CHP(district heating) or through the natural gas grid

Incentives and legislation

- Adjustment of the planning legislation => Municipalities must include biogas sites in their planning
- Concrete strategy of effective integration of biogas in the national energy supply
- Coordination plan for biogas development and nutrient redistribution (high density areas)
- Assistance to municipalities regarding location of new biogas plants
- Adjustment of heat supply legislation, aiming equal priorities for both the biogas and the natural gas suppliers

Processing 50 % animal manure for energy production

A highly difficult task

Possible technologies: biogas, incineration, gasification

Biogas

- **Dominant technology (> 80%) - *Danish Energy Authority***

Incineration and/or gasification

- **Applied only when suitable (technically and economically)**
- **Only for processing the fibre fraction separated after AD**

Biogas must replace natural gas

Estimated advantages:

Short to medium term

- Greatest contribution to security of supply
- Highest socio-economic benefits
- Best sale price for biogas
- Uses the existing infrastructure and CHP units

Long term

- Upgrading / grid injection
- Possibly cheaper alternative: mixed gases (down-graded natural gas and biogas)

Very long term

- Utilisation as transport fuel

New break through for biogas

- Increasing the amount of treated manure from today's 5% to 50% until 2020 - very big task!!
- Implies achievement of economic break through for biogas plants processing almost exclusively manure and slurries
- If succeeded, it will open the way for utilisation of the main part (> 80 pct.) of produced manure and slurries, after 2020
- It will have international significance for biogas development

Planning actors

Danish Biogas Association
Biogas Business Association
Ministry of Agriculture
Municipalities
Counties
Danish Heat Supply Company
Natural Gas Companies
Energinet.dk
Other ministries and authorities

- Many municipalities wish to be among the first planning the expansion of biogas
- The counties are committed to give biogas high priority

Key premises for success:

Optimisation of costs and use of proven technologies

- Sustainable economy for plants operating on slurry alone
- Location of new plants identified and approved
- Shorter time for getting the permit
- Effective integration of biogas in the overall energy supply
- Geographical coordination of biogas development with the increased need of manure and nutrients redistribution

Conclusion

The premises for the second and decisive break through for biogas in Denmark must be created now

- The first break through for biogas was achieved since 1990 up to now: operational stability, acceptable corporate economy, significant environmental and agricultural benefits. Limited by availability of organic waste

- The second and decisive break through will occur when the new plants, based on slurry, manure (with some co-digestion of energy crops) will be economic sustainable

- The next 3-5 years will show if this can be achieved and if the ambitious objectives of ”Green Growth” concerning biogas can be reached

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Thank you
for your attention!