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Norwegian Institute for
Sustainability Research

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The implications of economic instruments on biogas value chains

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- Waste resources
- Biogas
- Biobased materials
- Construction
- Packaging
- Energy
- Food
- Food waste
- Furniture and fabrics
- Plastic
- Process industry
- Transport

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Agenda

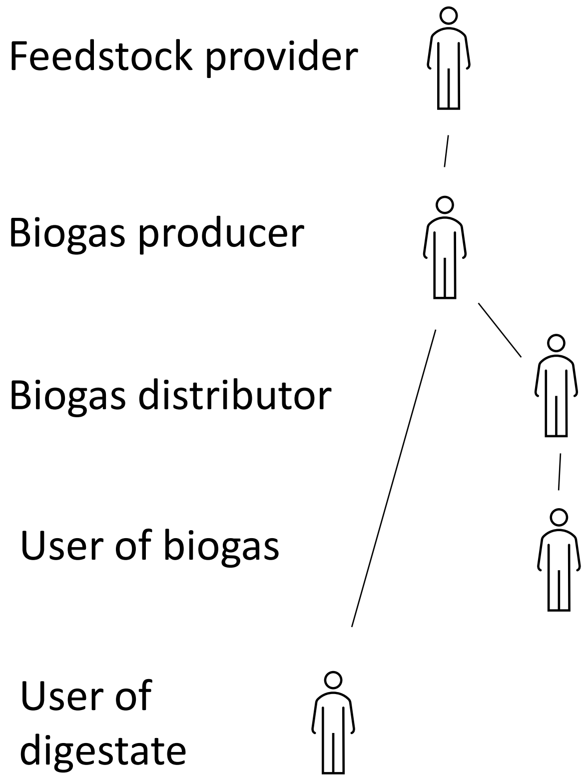
- Impact of economic instruments
- Type of economic instruments
- Connection between greenhouse gas emissions and economy of biogas plant (Norway)
- What happens to the economy of a biogas plant if you move a Danish biogas value chain to Norway (theoretically) and vice versa?

Impact of economic instruments

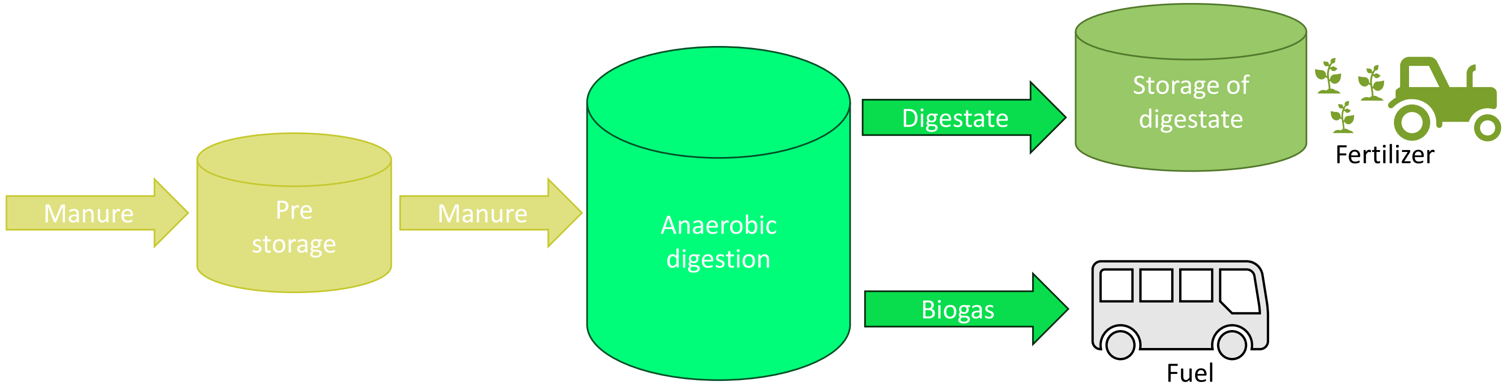
- New value chains (increased biogas production)
- Configuration of new and existing biogas value chains:
  - Feedstocks
  - What the biogas is used for
  - What digestate is used for
  - If CO_2 from upgrading is captured

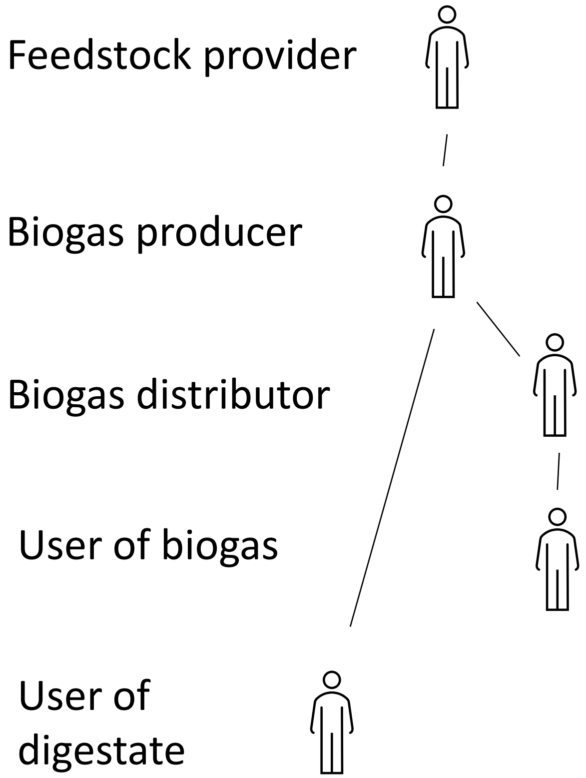
As the framework conditions and purpose of biogas value chains differs from country to country, the appropriate econonomic instruments will be different.

The intention of economic instruments is to affect the decisions of the actors in the biogas value chain



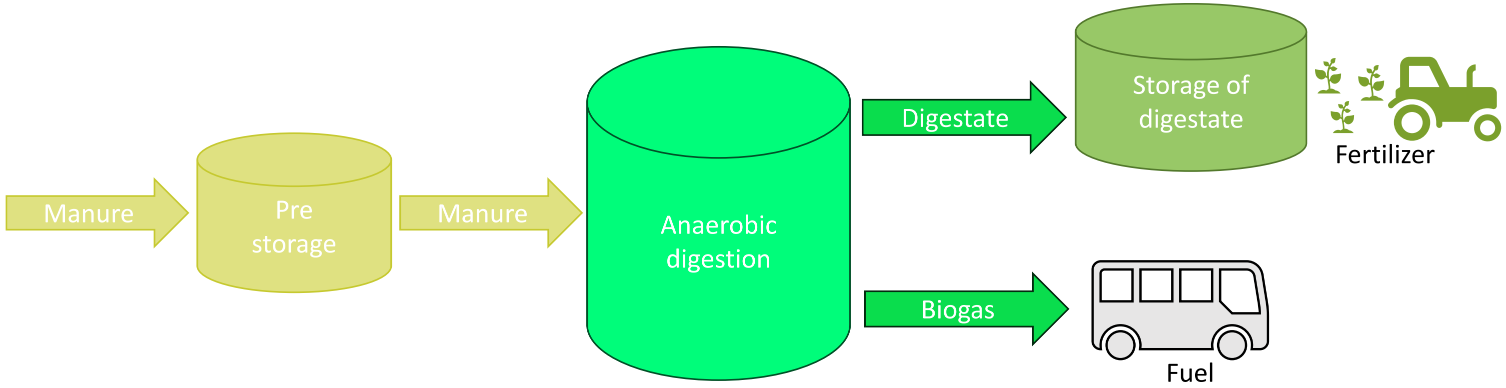
Type of economic instruments

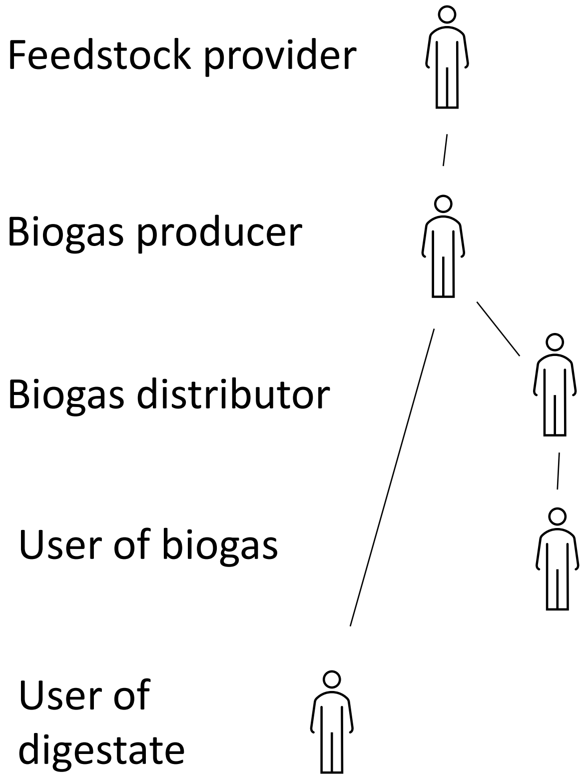




Actor	1. Feedstock	2. Biogas plant	3. Sales of upgraded biogas	4. Use of biogas	5. Distribution of digestate	6. Use of digestate as fertilizer
A. Livestock farmer	1A Support per tonne of manure for biogas production				5A1 Support per amount received/ storage rent 5A2 Investment support storage with cover	6A Investment support fertilizing equipment
B. Biogas plant	1B1 Support per tonne of manure treated 1B2 Support for manure transport	2B Investment support	3B Support per MJ of biogas sold		5B Support for manure transport	
C Distributer				C4 Investment support fuelling stations		
D. Transporter				4D1 Investment support biogas vehicles 4D2 Support for vehicle conversion		
D. Cereal farmer					5D1 Support per amount of digestate received/storage 5D2 Investment support storage	6D Investment support fertilizing equipment

Type of economic instruments





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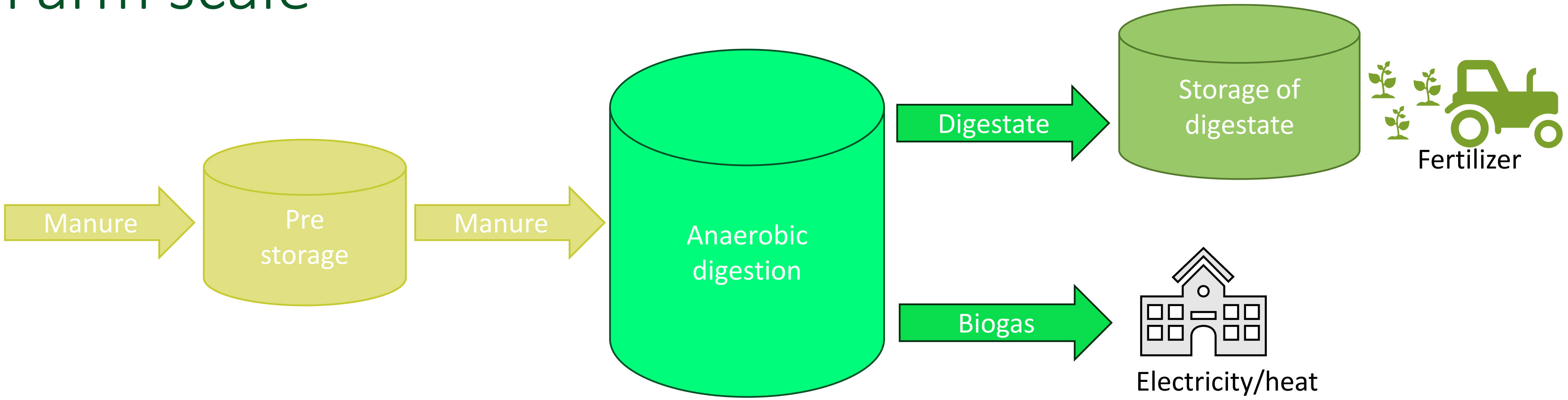
Farm scale



1. Input	2. Biogas plant	3. Use of biogas	4. Use of digestate
1 Suppert per tonne of manure for biogas production	2 Investment support	3 Support per MJ of biogas produced	4a Investment support storage 4b Investmet support fertilizing equipment

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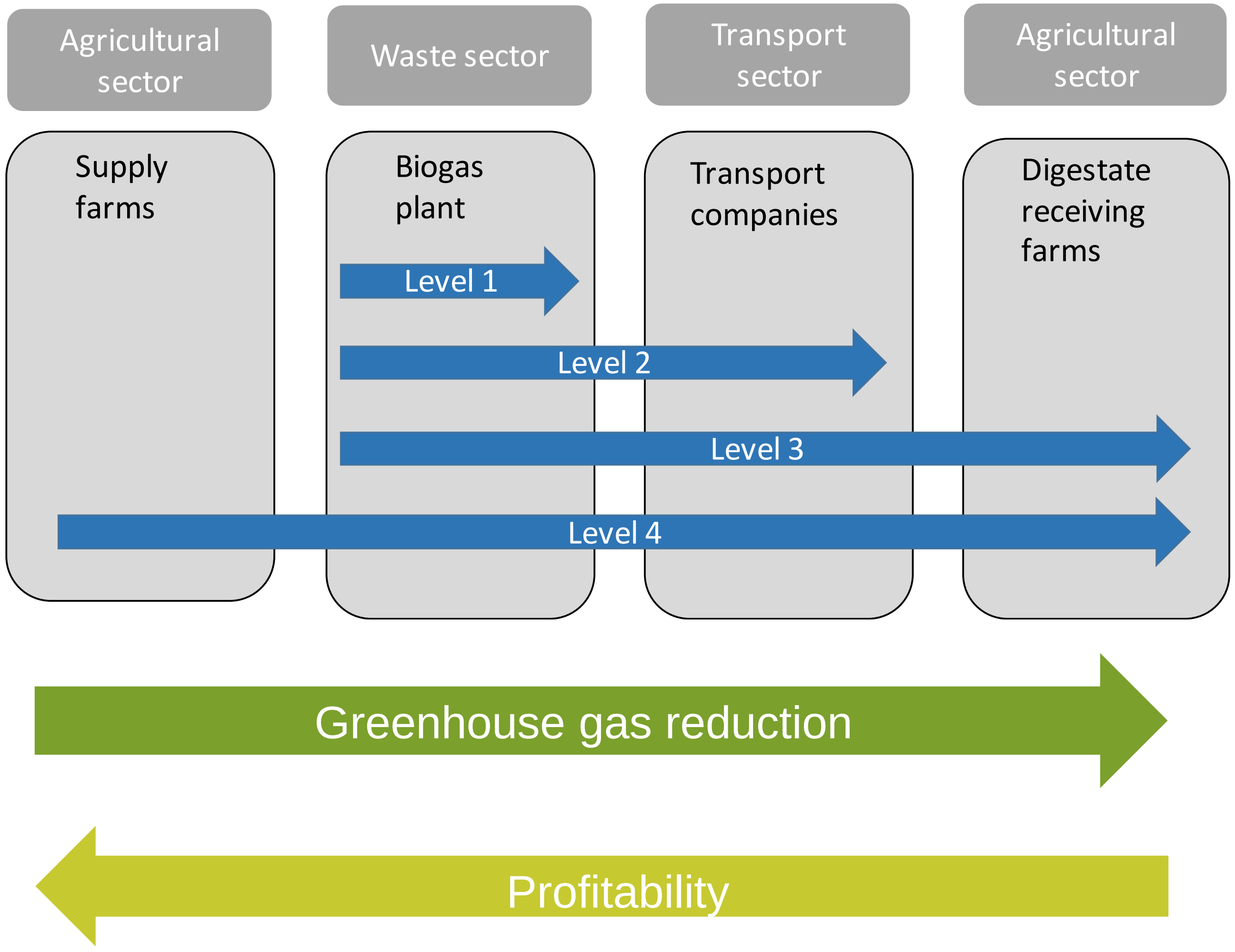
Connection between greenhouse gas emissions and economy of biogas plant for different levels of sector integration



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Biogas value chains in Denmark and Norway

	Denmark	Norway
Drivers	Replacement of fossil energy carriers Distribution of phosphorus	Waste (water) treatment
Typical plants	Farm based plants	Central plants
Main substrates	Manure	Food waste, sewage sludge
Use of biogas	Elecricity/heat Natural gas grid	Transport (new plants) Heat (existing plants)
Use of digestate	Fertilizer	Dewatering and composting

Ref:Eurostat

Framework conditions in Norway and Denmark

	NO	DK
Agriculture		
Average livestock unit, small farms[a]	23	86
Average livestock units, large farms[a]	61	681
Waste		
Share of households with source separation of organic waste (Hanssen et al. 2013)[b] (%)	67	30
Logistics: population density, inhabitants (inhabitants/km^2) Worldatlas (2017)	13	125
Energy		
Share of renewables in gross final consumption of energy (2016)[c] (%)	69.4	32.2
Electricity prices for household consumers, including all taxes and levies, 2016 (EURO/kWh)[b]	0.157	0.309
Gas consumption as share of gross energy consumption, 2016[d] (%)	4	14
Biogas as share of final gas consumption[b] (%)	5.2	5.0
Transport		
Share of renewable fuels for transport (2016)[e] (%)	17.0	6.8
Share of gas consumption (natural gas and biogas) used for transport[b] (%)	25.7	0.2
Share of gas in transport fuel consumption (2016)[f,g] (%)	3	0.06
Fuel prices diesel net (EURO/litre) DKV Euro Service (2017)	1.148	1.014

Main differences between Norway and Denmark

Political objectives are directed towards different sectors.

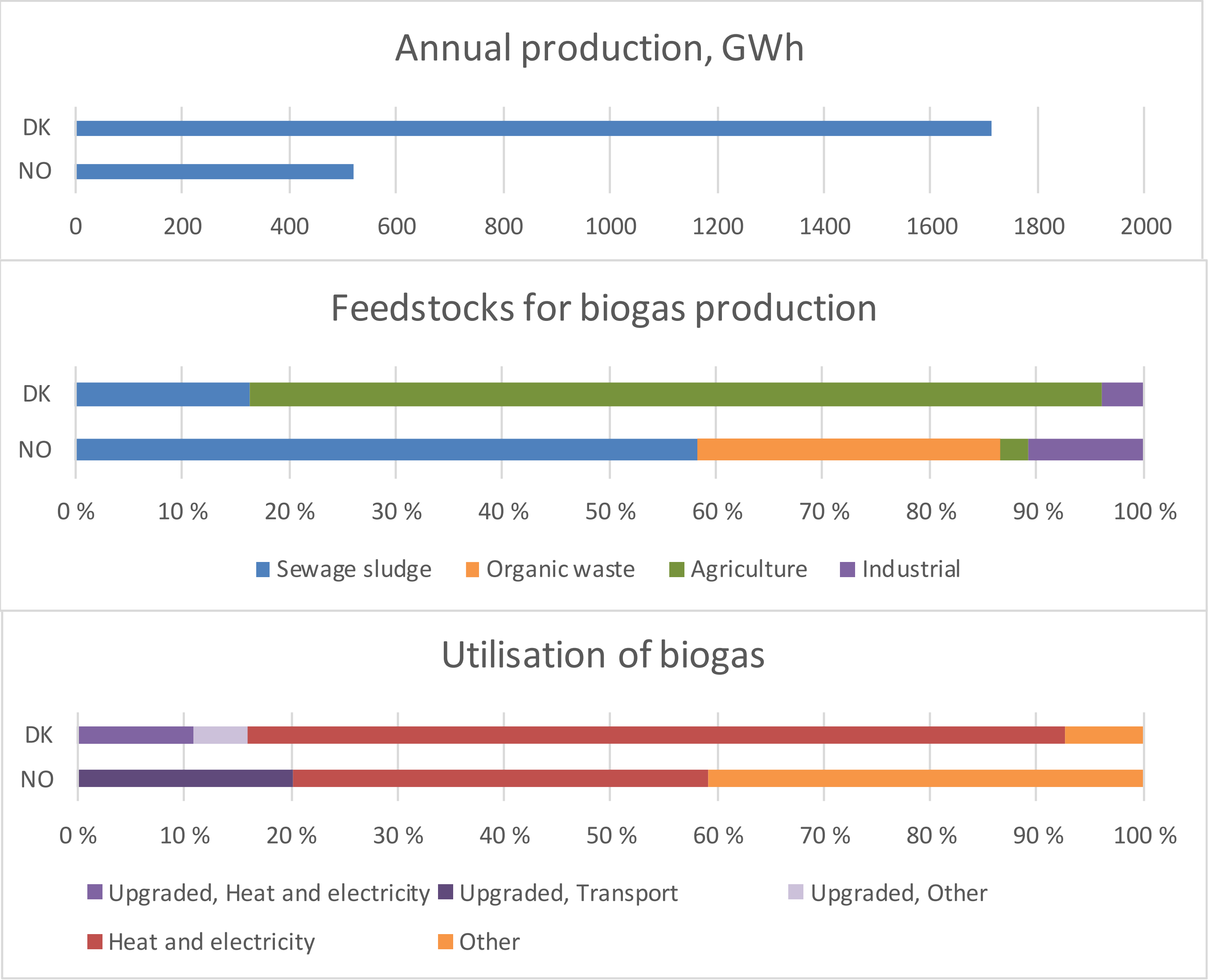
Economic incentives

Norway: mainly input-based

- ➢ Investment support biogas plants
- ➢ Support per tonne of manure treated
- ➢ *Tax exemption for biogas as a fuel*

Denmark: mainly output-based

- ➢ Feed-in tariff



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Economic results – biogas plant

	Norway	Denmark
Largest costs	• Capital and operational costs digester and pre treatment facility • Transport	• Capital and operational costs of the anaerobic digestion facility • Capital costs of the CHP plant
Income	• Gate fee organic waste (ca 60%) • Biogas sales • Manure treatment (from farmer, enabled by economic support)	• Mainly biogas sales and some income from digestate

Higher costs in Norway due to pre treatment of organic waste.

Results

NO -> DK

- Looses investment support and support per tonne of manure treated
- Saves CAPEX and OPEX from pre-treatment facilities
- 75% reduction in transport costs
- Biogas plant is assumed to pay for the waste rather than receiving a payment for waste treatment
- The total income is largely reduced leading to negative results

DK -> NO

- Looses revenue on the output side from the feed-in tariff
- Reduced CAPEX due to investment support
- Subsidy per tonne of manure is introduced, but is not sufficient to outweigh the loss of output subsidy
- Negative annual results

Conclusions

- Several value chain configurations can be profitable
- Viability of a value chain is highly dependent on structural conditions and the regulation
- The most profitable configuration might not be optimal in terms of greenhouse gas emissions reductions
- Output based support: maximising biogas production through co-digestion of manure and high-yield substrates, while avoiding losses.
- Investment and input support: increased biogas production from organic waste with less emphasis on maximizing the production.

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