Cost structure and incentives for biogas in Denmark

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biochain

Scale effects

Logistics

Input markets

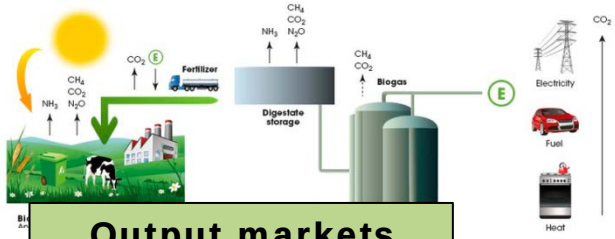
price

price

price

Scale effects

Logistics



Output markets

Energy markets

Certificates?

Bioenergy

Input markets

Output markets

Optimisation Tool

Private

Socio Economic

Regulation and financing

Manure treatment

Fertilizer

Output markets

Fertilizer and manure treatment

Regulation and financing

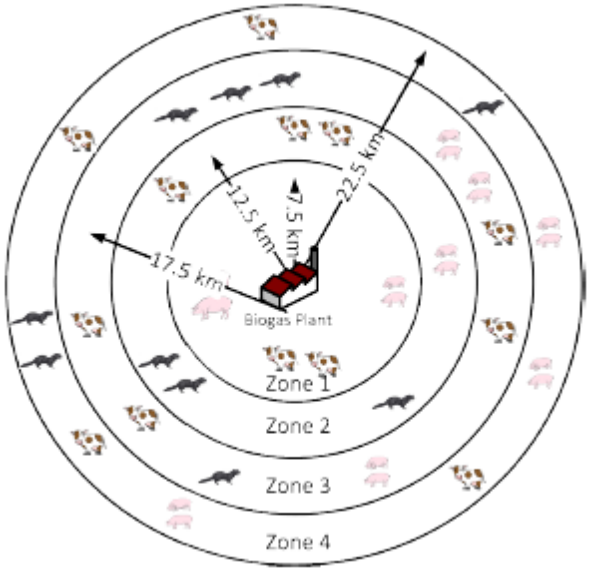
- Ownership structures
- Risk handling
- Market structures
- Choice of primary output
- Incentive regulation
- Command & control
- Optimal use of biomass

WP1

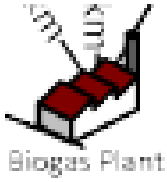
Value chain optimisation

Scale effects – economies of scale

- Collection costs and density of resources
  - trade off between distance and size of resource



- Scale of biogas plant



- Scale and costs of biogas storage

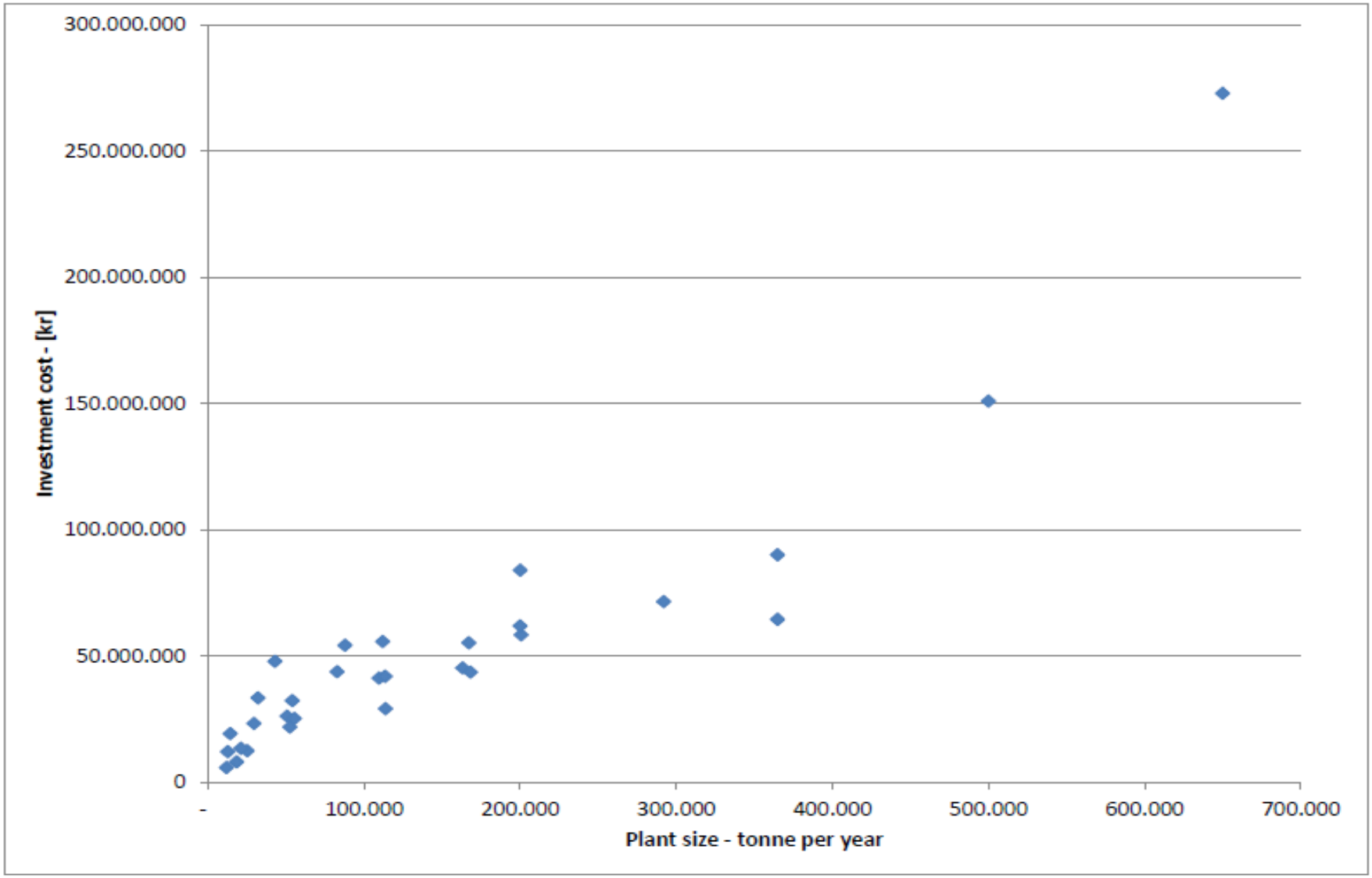
- Scale of upgrading facility and costs

Scale effects - some relations

- **Cost reducing**
  - Investment cost
  - Operational cost
    - manpower/labour cost
    - more stable condition/less loss/larger machinery
- **Cost increasing**
  - Transport cost (distance)
  - Loss in case of excess output/CHP demand/critical supplies

Scale effects – in plant size (investment)

Lau Linnet master thesis project, DTU August 2013



Scale effects DK

(Source: IFRO Rapport 220 , Biogasproduktion i Danmark – Vurderinger af drifts- og samfundsøkonomi , June 2013)

Tabel 2.6 Forventede driftsudgifter for planlagte biogasanlæg

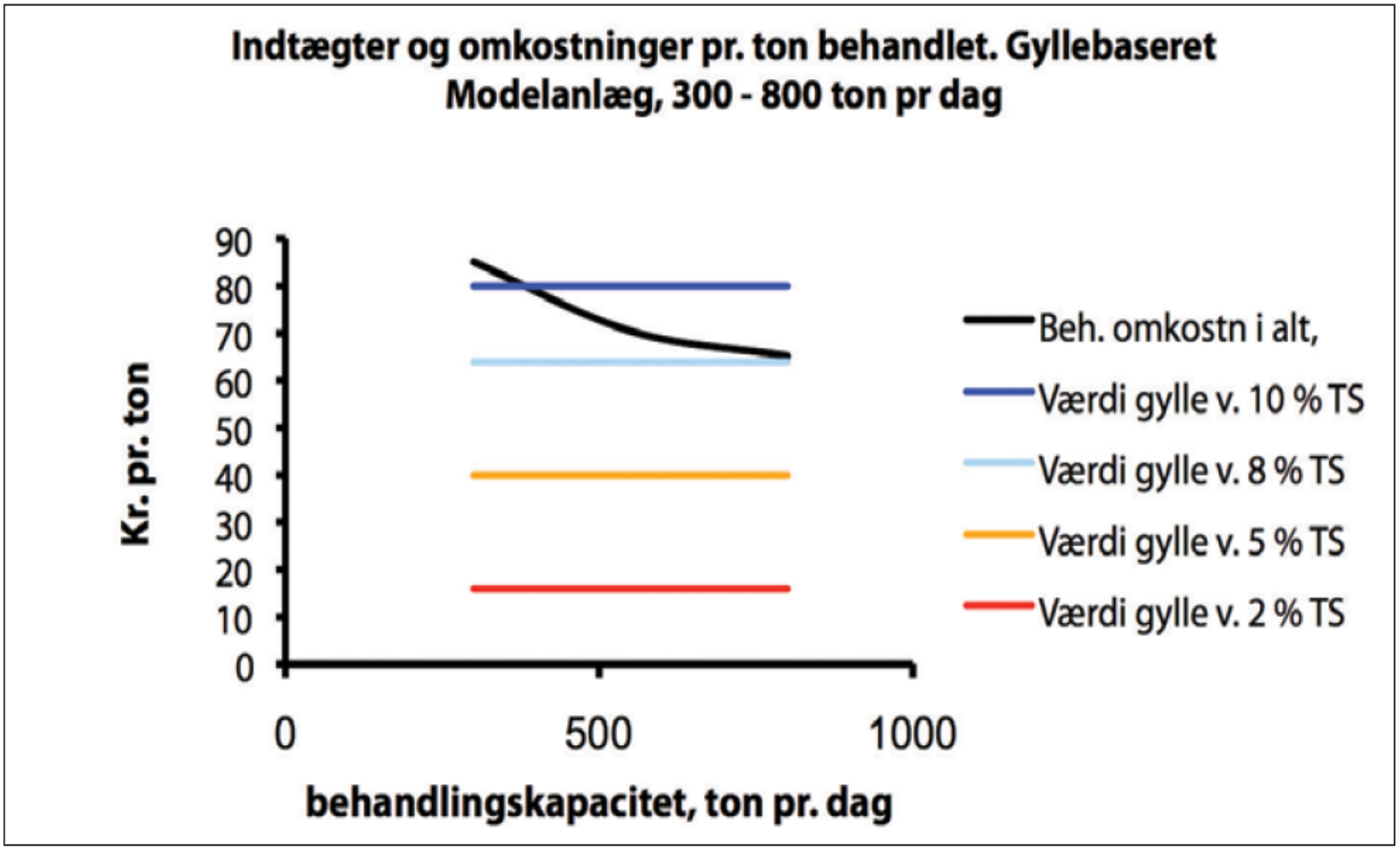
Selskabsøkonomi	Gennemsnits -anlæg	Gennemsnit anlæg < 1000 tons input/dag	Gennemsnit anlæg > 1000 tons input/dag	Økologiske anlæg
Input (tons pr. år)	263.617	192.191	452.546	76.000
Biogas (m^3 pr. år)	10.045.182	8.392.884	15.814.839	2.650.000
Driftsudgifter (1000 kr.)	14.898	19.055	15.479	5.420
Heraf (%)				
- Køb af biomasse	70	73	74	54
- El	4	3	6	4
- Adm. + mandskab	13	9	20	20
- Vedligeholdelse	13	15		22
Driftsudgifter (kr. pr. m^3 biogas)	1,5	1,9	1,2	1,2
Driftsudgifter (kr. pr. m^3 biomasse)	63	83	40	70

Kilde: Egen analyse

Note: Omkostninger for de enkelte poster stemmer ikke med summen, da ikke alle observationer er til stede for alle omkostninger. Der er således nogen usikkerhed på andel af de enkelte omkostningskategorier.

Cost dataDK: Scale effects

Source: Tybirk, K. (red.) 2010. Kogebog for etablering af biogas med 12 faktaark. Agro Business Park/ Innovationsnetværket for Biomasse. November 2010



Figur 2. Behandlingsomkostninger/tilført ton biomasse falder ved større anlæg (sort kurve). Grafen viser desuden værdien af gylle med forskelligt tørstofindhold.

Cost data: Avfall Norge

Source:**Utvikling av biogass i Norge *Avfall Norge-Rapport nr 6/2011***

Kostnader ved biogassproduksjon I Norge, Sverige og Danmark

Tabell 1. Kostnader for forskjellige innsatsfaktorer i Norge, Sverige og Danmark.

Innsatsfaktor	Norge	Sverige	Danmark	Enhet
Utgifter:				
Investeringskostnader (figur 1, 2, 8, 9 og 14)	2 500-8 500	1 200-1 550[1]	500-2 100	2011-NOK/tonn kapasitet
	12,8-64,2	8,5-23,6	4,9-46,6	2011-kNOK/m³ råtnetank
Drifts- og vedlikeholdskostnader	340 – 640[2]	Mangler tall	17-182[3]	NOK/tonn behandlet
Biorest (transport og spredning)	240-500 [2 4]	Bøndene tar imot gratis	Bøndene tar imot gratis ?	NOK/tonn biorest
Gassgenerator	0,24-0,49[2]	Lite aktuelt	Mangler tall	NOK/kWh
Gassoppgradering	0,22[5]	0,06-0,28	Mangler tall	NOK/kWh
Gassdistribusjon	Mangler tall, avhenger av mange faktorer			

[1] Per tonn tilført anlegget i 2010.

[2] Kun tall fra to anlegg.

[3] Per tonn kapasitet i anlegget.

[4] Det høyeste tallet gjelder et slamanlegg med lange transportavstander og er lite representativt.

[5] Kun tall fra ett norsk anlegg.

Cost data: Agrotech input costs an plant:

Source: Biomasse til biogasanlæg i Danmark, Agrotech, April 2013

Tabel 2. Råvarepris an biogasanlæg. Kr. pr. ton tørstof inkl. transport, men ex lagring og eventuel forbehandling.

	Kr. pr. ton tørstof
Gylle	350
Dybstrøelse	120
Fast staldgødning	175
Ajle	1.250
Halm (korn, raps, frøgræs)	590
Efterafgrøder	1.440
Naturarealer	500
Randzoner	1000
Grøftekanter	720-1.200
Have-parkaffald	100-200
Akvatiske biomasser	0-300
Husholdningsaffald	0-1.000*)
Organisk industriaffald	Varierende
Energimajs	800-1.500
Energiroer	1.000-1.750
Kløvergræs	1.100
Roetopensilage	300-600

Cost example and sensitivity: inputs an plant

Source: Biomasse til biogasanlæg i Danmark, Agrotech, April 2013

Tabel 27. Balancepris for majs ved forskellig hvedepris, JB 1-3

Majshøst	JB 1-3	9000	FE			
	1 FE	1,17	kg TS			
	kg TS	10530	kg TS			
	TS %	30	%			
	kg frisk	35100				
	Ton frisk	35				
Dyrkningsomkostninger majs	kr/ha	6625	6625	6625	6625	6625
Hvedepris	kr/kg	1	1,25	1,5	1,75	2
DB i hvede efter mask. og arb. Omk.	Kr/ha	1292	2667	4042	5417	6792
Break even salgspris for majs	kr/ha	7917	9292	10667	12042	13417
Break even salgspris for majs	kr/ton	226	265	304	343	382

Forklaring:

JB 1-3 er sandjord, hvor der produceres 9000 FE pr. ha pr. år
1 FE (foderenhed) indeholder 1,17 kg tørstof
De 9000 FE udgør altså 10.530 kg tørstof
TS % er tørstofandelen, her 30 %
Kg frisk er den beregnede mængde friskmasse

Cost example and sensitivity:

Source: Tybirk, K. (red.) 2010. Kogebog for etablering af biogas med 12 faktaark. Agro Business Park/ Innovationsnetværket for Biomasse. November 2010

Tabel 1.2. Faste forudsætninger

Faste forudsætninger	
Anlægstype	Thermofil
Salgsprodukter	Biogas
Opholdstid primær reaktor, dage	20
Opholdstid, sekundær reaktor, dage	10
Gaspris, standard, kr./Nm3 CH4	4,00
Levetid anlæg, år	20
Lånerente før skat, %	5
Løbetid lån, år	20
Anlægstilskud, %	20 %
Gasledning, km	2
Varmeledning, km	2
Transportpris, kr./ton	20,- / 25,-
Købspris majsensilage, kr./ton	250,-

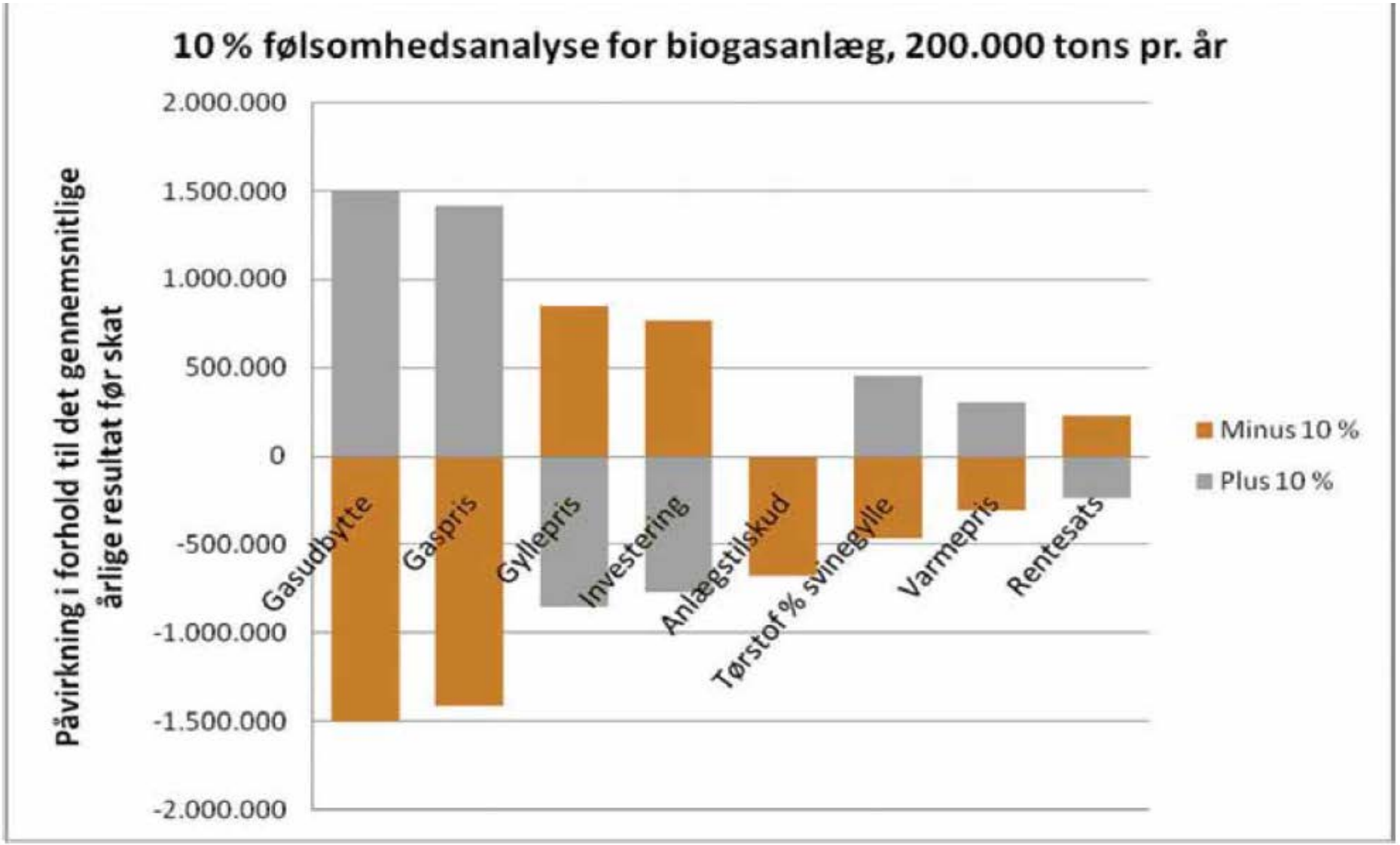
Cost example and sensitivity:

Example of medium scale plant Source: Tybirk, K. (red.) 2010. Kogebog for etablering af biogas med 12 faktaark. Agro Business Park/ Innovationsnetværket for Biomasse. November 2010

Biomassetype	TS %	Mængde (tons/år)	Andel af samlet grundlag(%)	Mængde (tons pr. dag)	Behandlingsgebyr/ indkøbspris (kr./t)
Blandet svinegylle	4,5	110.000	55 %	301,4	0
Blandet kvæggylle	8,0	60.000	30 %	164,4	0
Gyllefiber, svin, kemisk fældning	28,0	10.000	5 %	27,4	0
Gyllefiber, svin, dekantercentrifuge	30,0	10.000	5 %	27,4	0
Majsensilage	29	10.000	5 %	27,4	250
I alt		200.000	100 %	685	

Cost example and sensitivity:

Example of medium scale plant, Source: Tybirk, K. (red.) 2010. Kogebog for etablering af biogas med 12 faktaark. Agro Business Park/ Innovationsnetværket for Biomasse. November 2010



Figur 3. Illustration af 10% følsomhedsanalyse for biogasanlæg 200.000 tons/år

Planned biogas plant inputs

(Source: IFRO Rapport 220 , Biogasproduktion i Danmark – Vurderinger af drifts- og samfundsøkonomi , June 2013)

Tabel 2.3 Input til planlagte biogasanlæg

Input (%)	Gennem-snitsanlæg	Gennemsnit anlæg < 1000 tons input/dag	Gennemsnit anlæg > 1000 tons input/dag	Økologiske anlæg
Gylle	71,0	66,2	77,2	27,0
Separeret gylle og dybstrøelse	11,7	15,8	8,8	5,6
Prim. slam	1,8	0,3	3,0	
Industri	9,1	9,3	9,5	
Energiafgrøder	4,2	7,9	1,5	
Øvrige	2,3	0,5	0,0	67,4
Sum	100,0	100,0	100,0	100,0

Kilde: Egen analyse

Cost data from modelling of Maabjerg:

Master project thesis: **Optimisation of Biogas Production A Socio Economic Value Chain Evaluation**
Lau Linnet. August 2013

Table 6.4: Transport economy

	Amount		Price w. NTF [kr/unit]	Total cost w. NTF [kr]	Annualised cost [kr]
Truck	5	trucks	*2.295.000* [a]	11.475.000	811.876
Reinvest	5	trucks		11.475.000	548.474
Distance driven	270.735	km			
Number of trips	14.229	trips			
Diesel use, w. annuity price	94.757	l	*6,77* [b]	641.857	641.857
Time use	10.159	hr	*243* [c]	2.468.552	2.468.552
Time use offloading & filling	4.744	hr			
Time use driving	5.415	hr			
Truck maintenance	270.735	km	*1,82* [d]	493.415	493.415
Pipeline investment	20,00	km	*945.000* [c]	18.900.000	1.337.207
Electricity use - pumpwork	850	MWh	*753* [c]	640.454	640.454
Total				46.094.278	6.941.834
Transport cost manure	445.000	tonne	10,96	kr/tonne	
Transport cost Industry and slurry	170.000	tonne	11,63	kr/tonne	
Transportcost average	615.000	tonne	11,14	kr/tonne	
Transport cost manure gas	9.684.979	m^3	0,50	kr/m^3	
Transport cost industry, slurry gas	7.044.123	m^3	0,28	kr/m^3	
Total cost average	16.729.102	m^3	0,41	kr/m^3	
Average transport distance	19,03	km			

Quite low

[a] An assumed value based on [19] and information from Grontmij
[b] Annualised value from[4]
[c] [19]
[d] [35]

Support incentives at end-use level for biogas

- **Investment support (30%)**
  - Primarily for biogas plant
  - Limited opportunities at farm site
  - No CHP or (upgrading) part
- **Production support**
  - Biogas production : No
  - Biogas use: Yes - implies that biogas price indirectly should reflect the support
  - Support financed by *PSO payments from consumers* (electricity-CHP and natural gas - upgrading)
- **Tax exemptions**
  - Only for heat related to CHP (else no difference to competing fuel)

Alternatives for biogas end-use in DK

Upgrade cost?	Upgrade cost 12-25 DKK/GJ?	CHP	Industry
Transport	Upgrading to gas grid	Support fixed 80+26+10 øre/kWh premium 43,8+26+10 correspond to 115 DKK/GJ	Support 75 DKK/GJ
Support 75 DKK/GJ	Support 115 DKK/GJ		
Fuel tax exemption = No	Fuel tax exemption = No	Fuel tax exemption = Yes	Fuel tax exemption = Yes for the process end use, same as nat gas No for heating

+

Investment grant for *biogas plant*

30 %

Change in contribution from treated secondary biomass (waste)

(Source: IFRO Rapport 220 , Biogasproduktion i Danmark – Vurderinger af drifts- og samfundsøkonomi, June 2013**)**

"I 2002 blev der typisk opnået et modtagergebyr på *63 kr. pr. m3* alternativ biomasse, som udgjorde næsten 30 % af det samlede input. Set i forhold til den samlede behandlede biomasse udgjorde modtagergebyret i alt 17 kr. pr. m3. Det er denne indtægt, der i det store hele i dag er bortfaldet."

Organisk affald til biogas?

Afgifter

- Deponeringsafgift (forbud)
- Afgift ved brug til energi:
  - CO2 afgift (150 kr/t CO2)
  - Affaldsvarmeafgift (52 kr/GJ varme)
  - Tillægsafgift (27 kr/GJ varme)

Politiske mål

- Udkast til ressourceplan
  - 50% genanvendelse af husholdningsaffald (træ, pap, papir, plast, metal, glas, organisk affald)
  - Ikke specifikke mål for organisk affald

Risk and distribution of risk is an important element for value and incentives

- **Input costs –** long term contracts for supply (volume and price for manure)
  (including treatment service)

  → Risk reduction for risk averse farmers and biogas plant

- **Input costs -** flexible input mix of biomass crops/waste (volume and price)

  → More flexible inputs (technology+potentials) reduce risk to biogas plant

- **Output biogas–** long term contracts for supply to CHP/upgrading plant or gas grid (volume and/or price)

  → Reduce risk to biogas plant if price and volume risk covered – risk reduction for CHP only for price contract

- **Output biogas–** long term alternative option for use (access to variable volume - local heat)

  → Diverse distribution/use channels reduce risk to biogas plant

- **Output –** fertiliser (value) price will be determined by competitive alternative

  → Risk reduction (volume) for biogas plant

Organisation and incentives

Alternative organisational setup can change incentives and may reduce risks

- Assumption 3 independent entities – farmers – biogas plant – CHP/heat plant

- Integrated biogas plant – CHP
  - optimise the use of the biogas resource (fixed flow)
  - optimise a short term biogas storage with power prices
  - reduce the volume risk for biogas demand (biogas plant part)

- Integrated biogas plant – suppliers/farmers
  - farmers and biogas plants eliminate the conflicting price incentive from the input manure price
  - volume risk for manure supply reduced

- Integrated biogas plant, farmers + local heating plant (district or CHP) demand
  - reduce the price conflict between entities and reduce heat demand uncertainty
  - reduce uncertainty on future heating supply costs