



Large Biogas Plants in Denmark

-technology and operation experience

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Agenda



- NIRAS
- Large Biogas Plants in Denmark
- Large Biogas Plants concept and tour
- Input materials and gas production
- Economy

NIRAS Background



- Multi disciplinary Consultancy
- Since 1956
- 700 Employees , 2/3 hold academic degrees
- Turnover 49 million Euro (2002/2003)



Biogas Experience in NIRAS



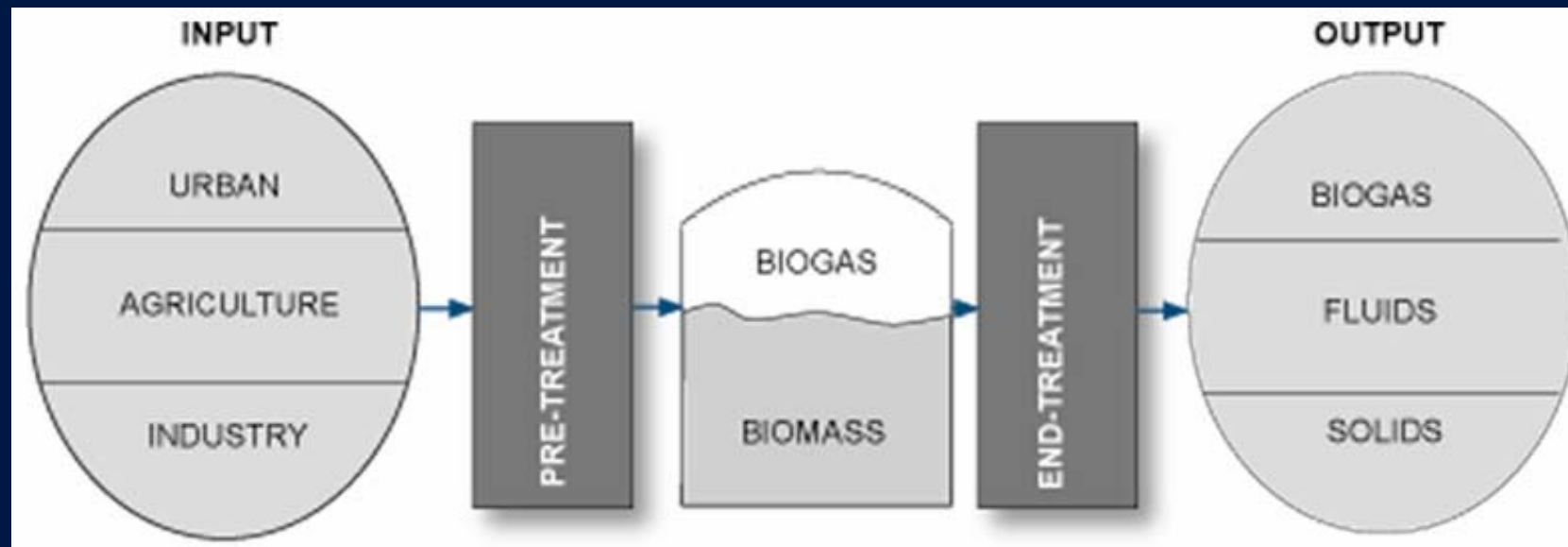
- Biogas Consultancy for 20 years
- Total 8 joint plants built in DK
- International activities
- Danish operations, upgrading and planning consultancy
- R&D Activities
 - Digestion of Grass
 - Restaurant waste
 - Odor control
 - Process control
 - Reject water handling
 - Pre-treatment



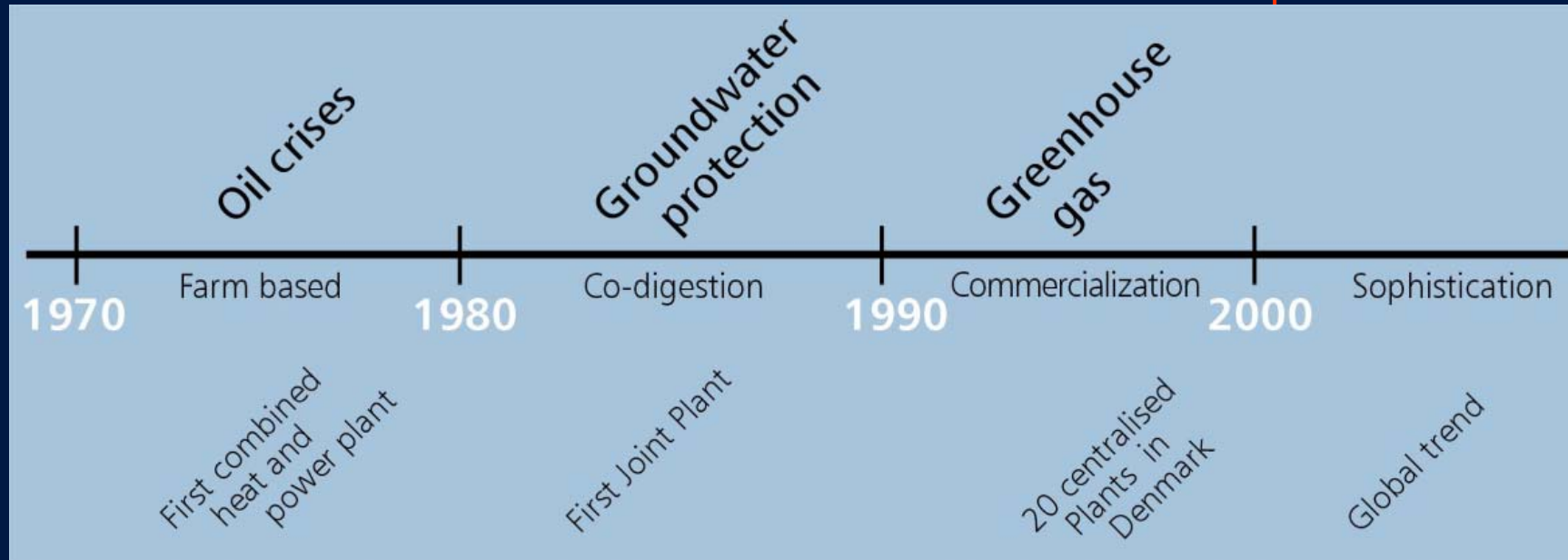
Biogas Concept



Anaerobic treatment = Biogas production



History of Biogas in DK



Biogas Plants in operation



m³ biomass processed at:

Large plants 2002

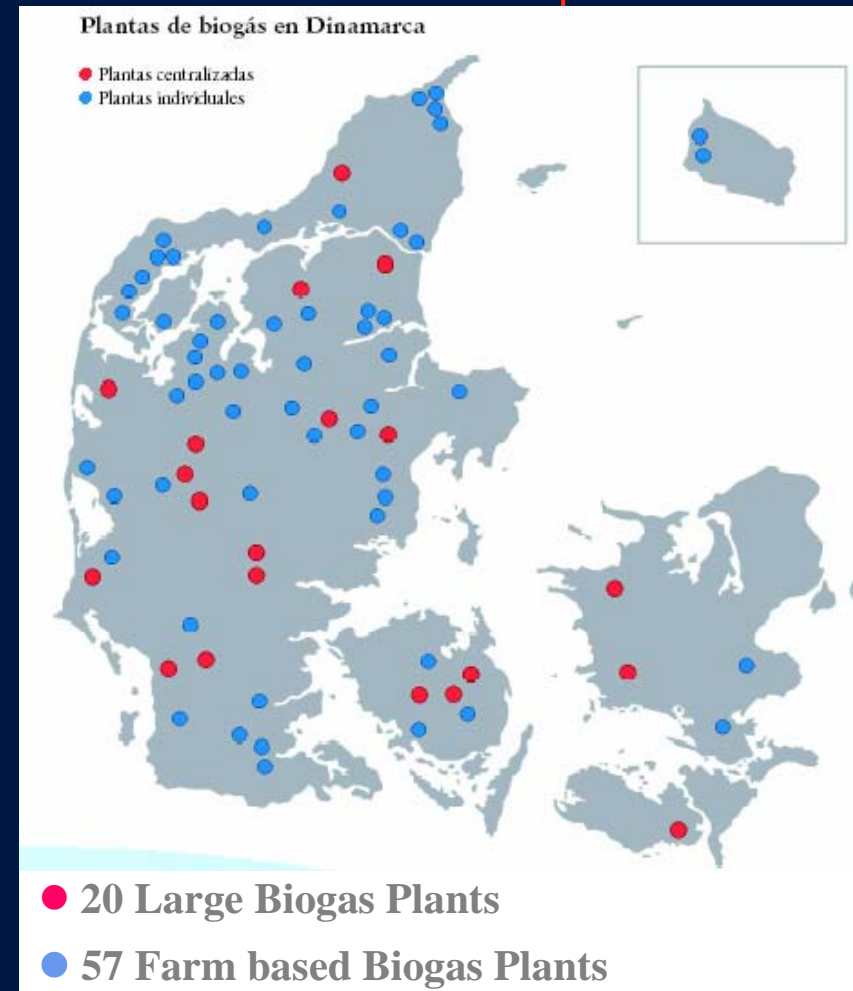
Animal manure 1.105.000

Organic waste 375.000

Total 1.480.000

Farm Plants 300.000

New projects app. 15



Snertinge Biogas Plant



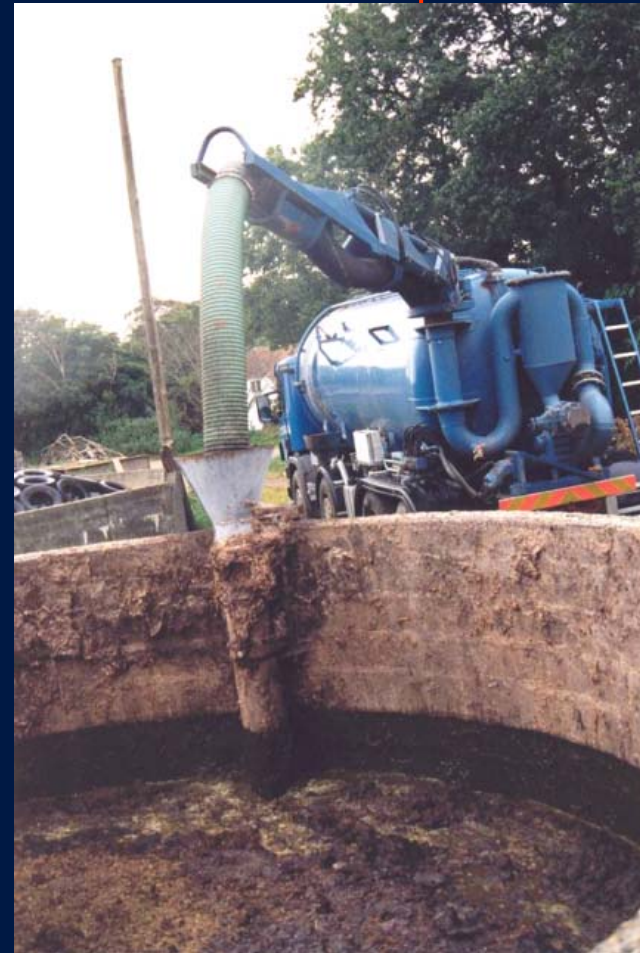
BIOGAS PLANT



Waste Collection



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



Pre-Treatment: Hygienisation / sterilization



- Hygienic step if recycling nutrients
- Separate unit to guarantee 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%



3.4.4 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



3.2.9 Gas Storage



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



3.4.1 Gas Treatment



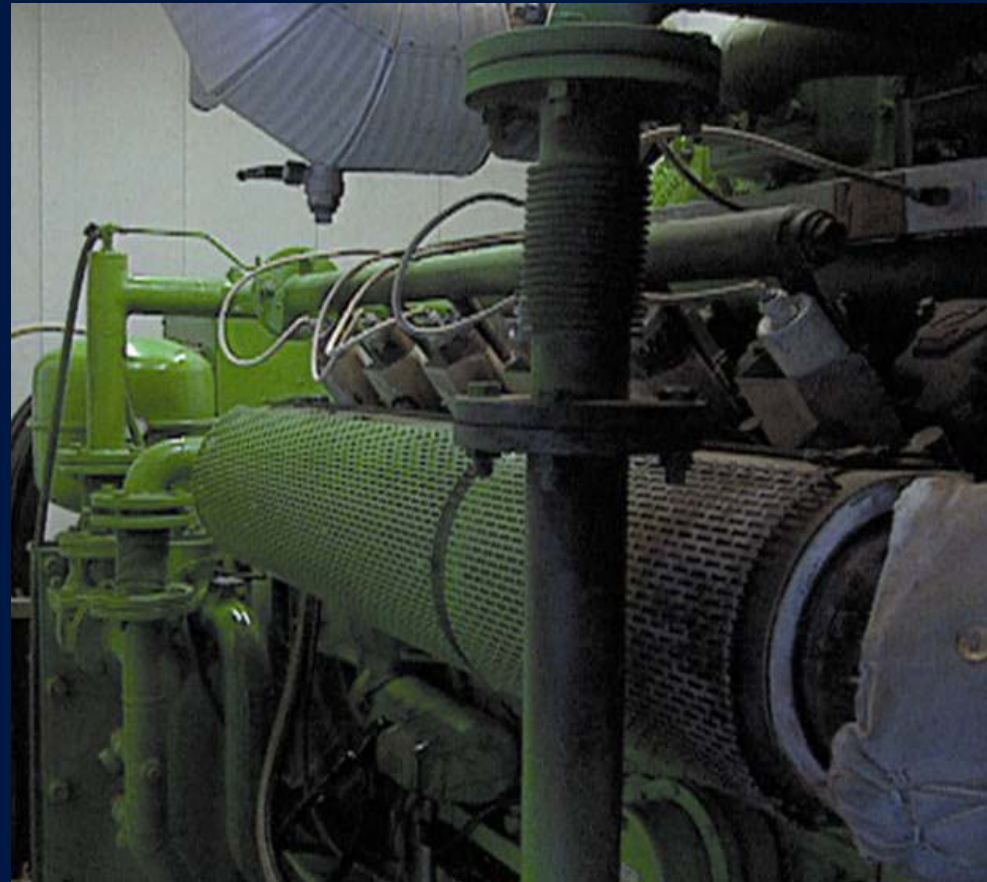
- Gas contains H₂S
- Can be removed biologically in
 - after storage
 - gas cleaning unit



3.4.2 Gas Utilization



- Boilers
- Internal Combustion Engines
- Gas turbines
- CHP applications
- Fuel Cells



Input material



- Pre-conditions
- Gas potential (CH_4 = methan)
- Dry matter in manure
- Example of input from 7 plants

Pre-conditions



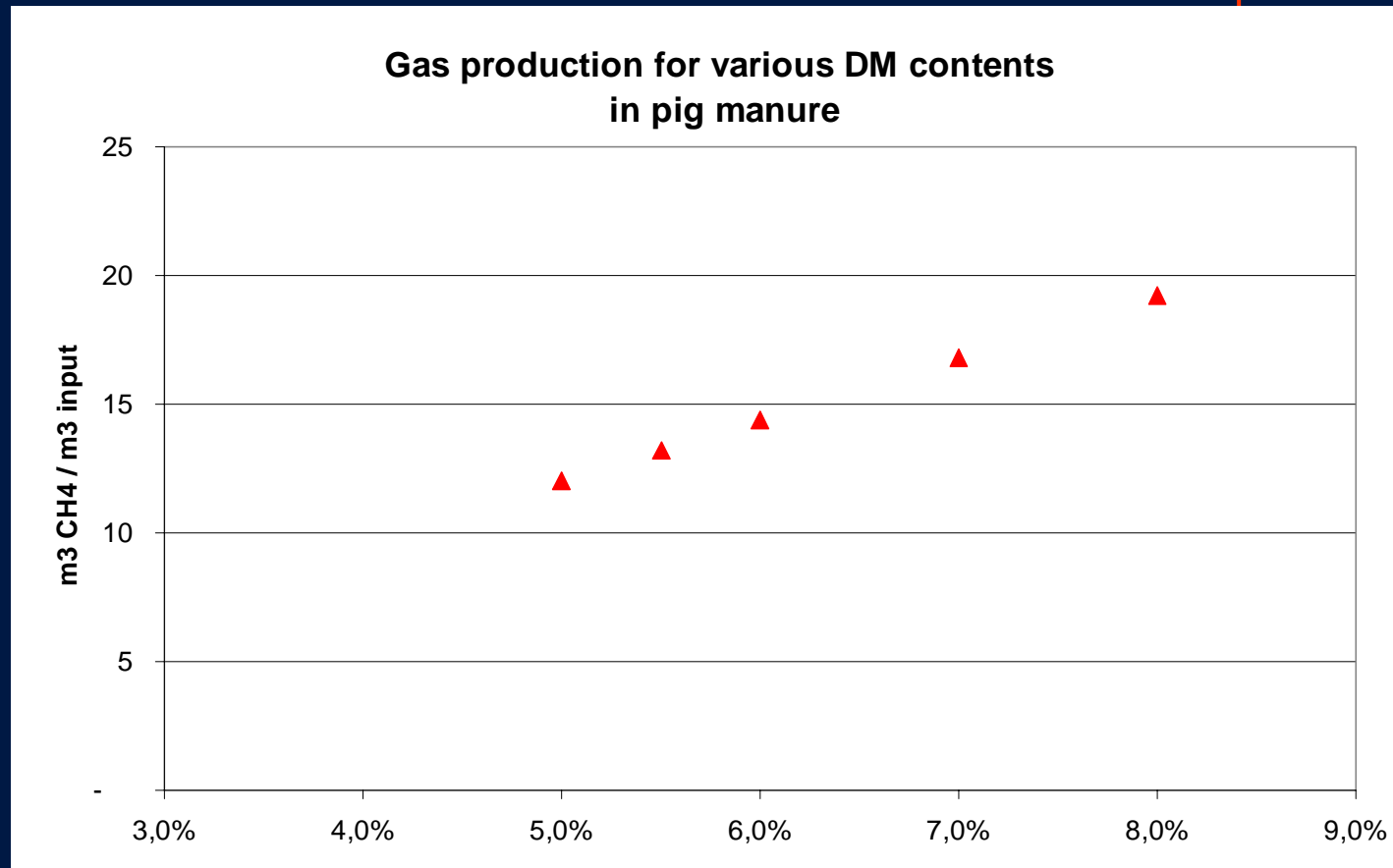
In principal all organic wastes that are:

- Free of substances that inhibit the biogas process
- Suitable DM content
- Free of environmental toxic substances
- Sufficient biogas production

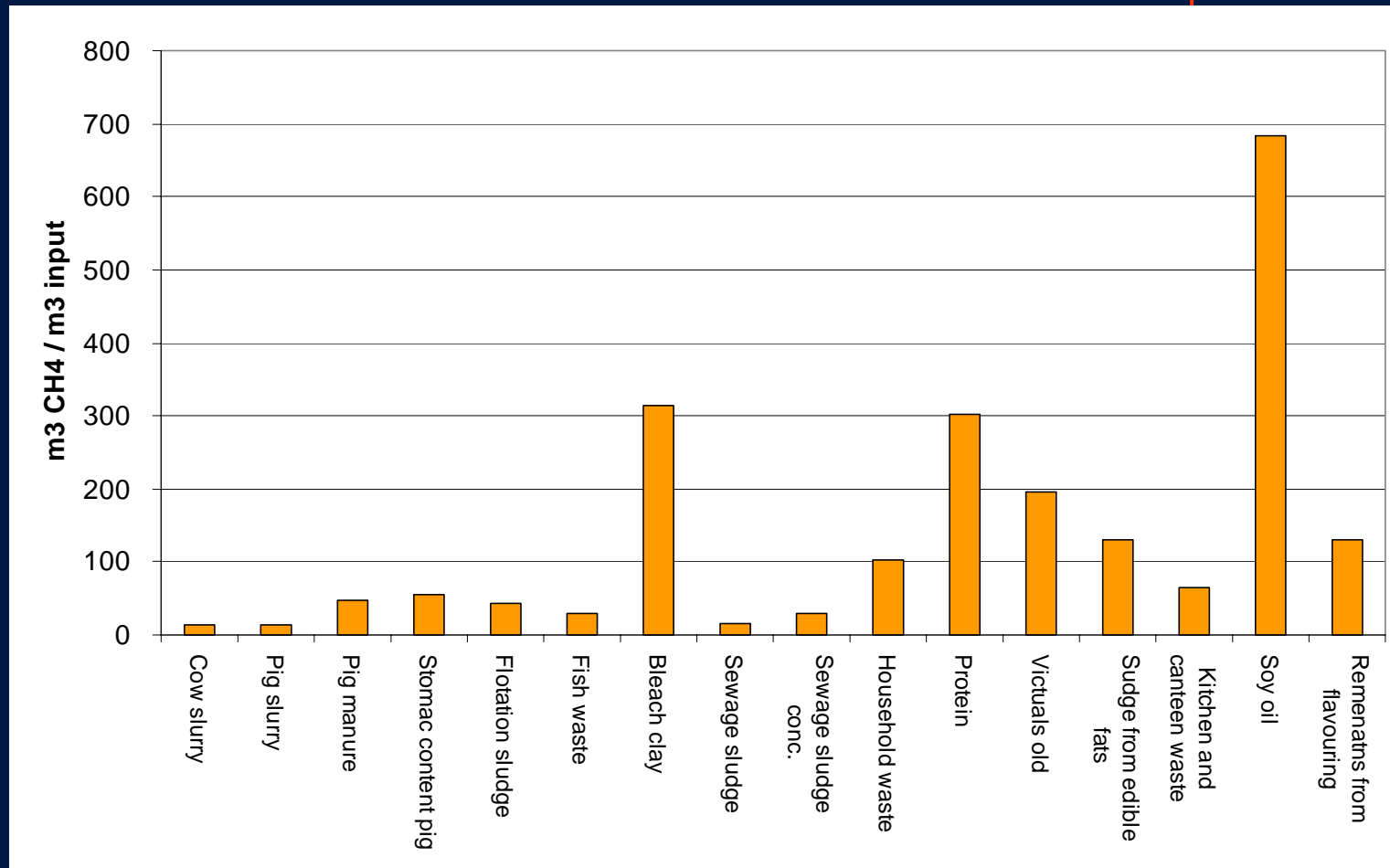
CH₄ production and DM%



- Pig slurry



CH₄ production capacity



Operational journal



Driftsstatus for december 2003

Afsnit 5.10

Side 1

Gasproduktion	638.000 Nm ³ ,	142 % af budgetteret produktion
Elproduktion	1.490.000 kWh,	på kraftvarmeværket i Lemvig
Energisalg	1.204.864 kr.,	129 % af budgetteret salg

Biomasse	Kvæggylle.....	5518 tons
	Svinegylle.....	4201 tons
	Minkgylle.....	32 tons
	Fast gødning, kvæg.....	96 tons
	Fast gødning, svin.....	12 tons
	Fast gødning mink/fjerkræ/hest.....	0 tons
	Mavetarmindhold fra slagteri.....	1103 tons
	Fedt- og flotations slam fra slagteri.....	8 tons
	Valle/vallekoncentrat.....	2656 tons
	Fiskeslam.....	95 tons
	Diverse industriaffald (fedt).....	139 tons
	Limlæder.....	30 tons
	Minkfoder spildevand.....	0 tons
	Slam, minkfoderproduktion.....	160 tons
	Protein/fiberslam.....	0 tons
	Flotations slam, fjerkræslagteri.....	630 tons
	Slam, rensningsanlæg.....	334 tons
	Tilført mængde ifølge opgørelse.....	15014 tons
	Tilført mængde ifølge flowmåler.....	14157 tons
	Gns. opholdstid i 7000m ³ tankvol.....	15,3 Dage

Gasudbytte	I forhold til biomasse mængde.....	45,1 Nm ³ /m ³ biomasse
	I forhold til 7000m ³ anlægsvol.	2,9 Nm ³ /(m ³ x dag)

Varmeforbrug	I alt.....	139,0 MWh
	Nettopvarmning af biomassen.....	8,5 °C

El-forbrug	I alt.....	109,0 MWh
	Pr. m ³ udrådnnet biomasse.....	7,7 kWh/m ³

Dieselforbrug	I alt.....	112,0 MWh
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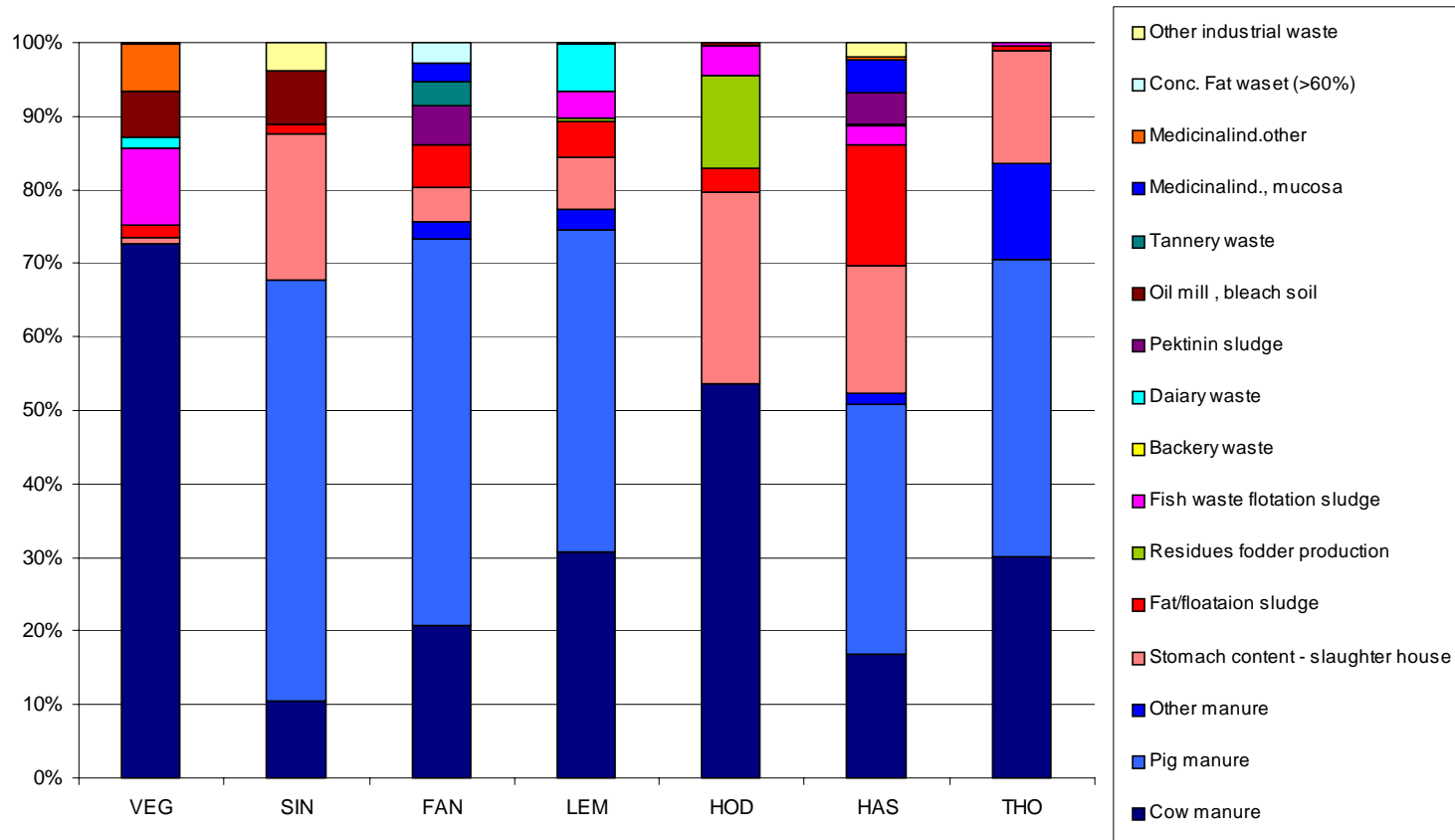
Supplerende oplysninger

Driften har været stabil i december måned.

Input composition 2001



Input composition in Danish biogas plants 2001

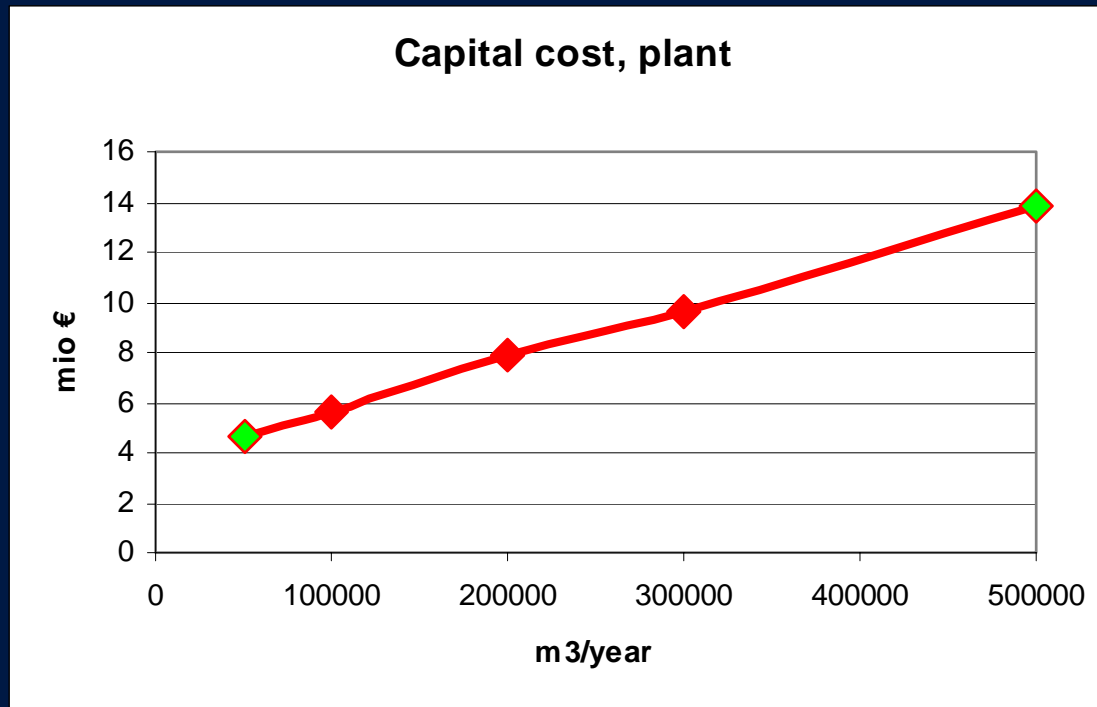


Economy: Income

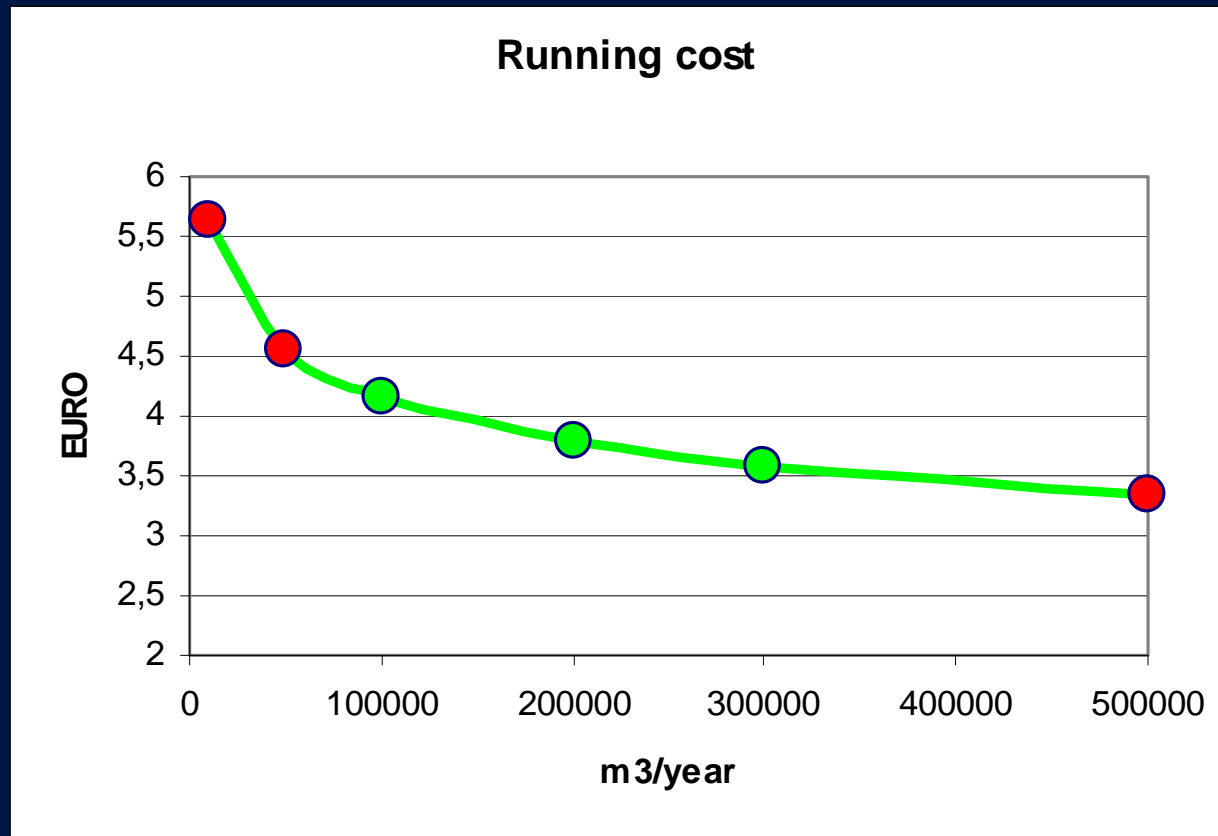


- Gate fees
 - Gate fees for organic waste
- Biogas
 - Electricity sale
 - Heat sale
- ? Fertiliser

Economy: Capital cost



Economy: Running cost



Trends in Denmark



- Increased gas production (~25%) per unit received material
- Increased reduction of solids
- Pre-treatment: Sterilisation at 70 and 133 °C
- Reduced retention time (4-6 days thermo-, 7-10 days mesophilic)
- Physical layout: 2 parallel lines, fewer pumps and moving parts
- Process monitoring and management
- Reduced capital cost

Land application/ after-treatment



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



Fertiliser effect



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





THANK YOU!

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