BIOGAS DEVELOPMENT IN SWEDEN AND DENMARK: INTEGRATION PF PUBLIC PRIVATE AND ACADEMIC POLICIES

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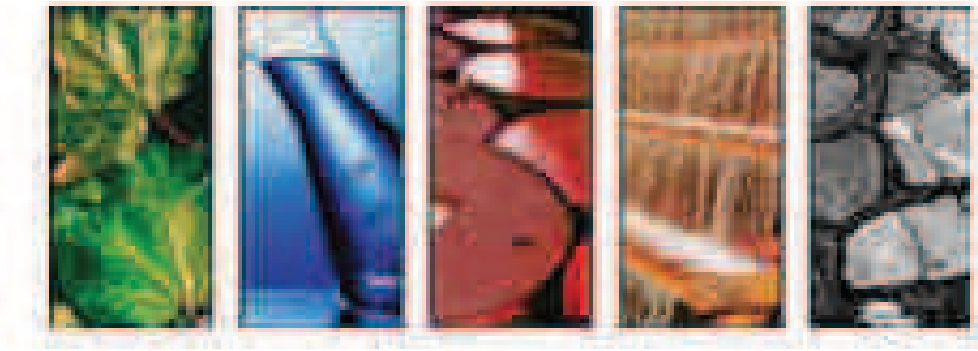
Talk lay-out

- Introduction – Denmark
- Energy policy in Denmark
- A typical Centralized Biogas Plant in Denmark
- Auto gas in Sweden

Where do I come from?

Technical University of Denmark (DTU)

And



INSTITUTE OF
ENVIRONMENT & RESOURCES

Northern Europe

DTU is in Denmark

The Technical University of Denmark

- Founded in 1829 by the Danish physicist Hans Christian Ørsted (discovered elctro-magnetism)
- The largest technical university in Northern Europe
- 10000 students
- 2000 Ph.D. students
- 1000 Faculty
- 3000 researchers
- 15 departments

Environmental Engineering
Technical University of Denmark

Department of Environmental Engineering

www.er.dtu.dk

EU Renewable Energy policy

- European leaders agreed in March 2007 to have 20% of their overall energy needs covered by renewables such as biomass, hydro, wind and solar by 2020
- If other countries will follow, the target will be increased to 30%

Energy sources in DK - SE

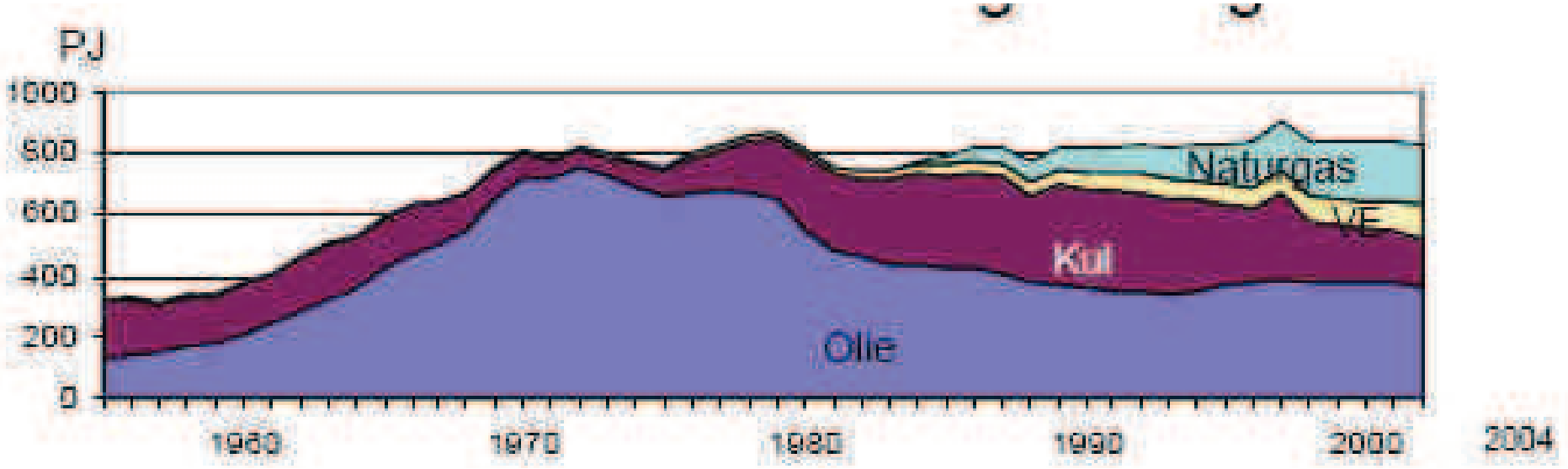
DK: Coal, oil, natural gas, renewable energy (16%) :

- Wood, straw, waste
- Wind

SE: Nuclear, oil, natural gas, renewable energy (26%) :

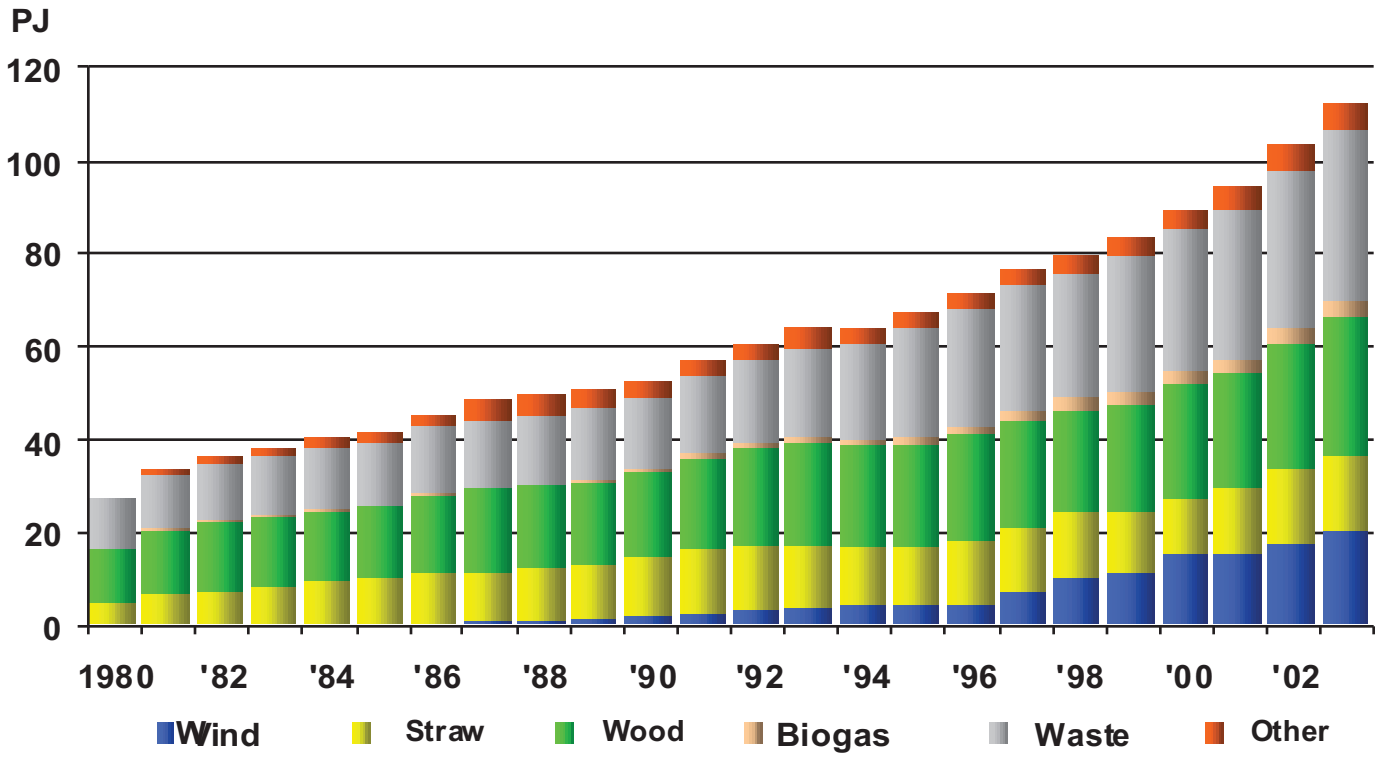
- Wood
- Waterfalls

Denmark's energy consumption

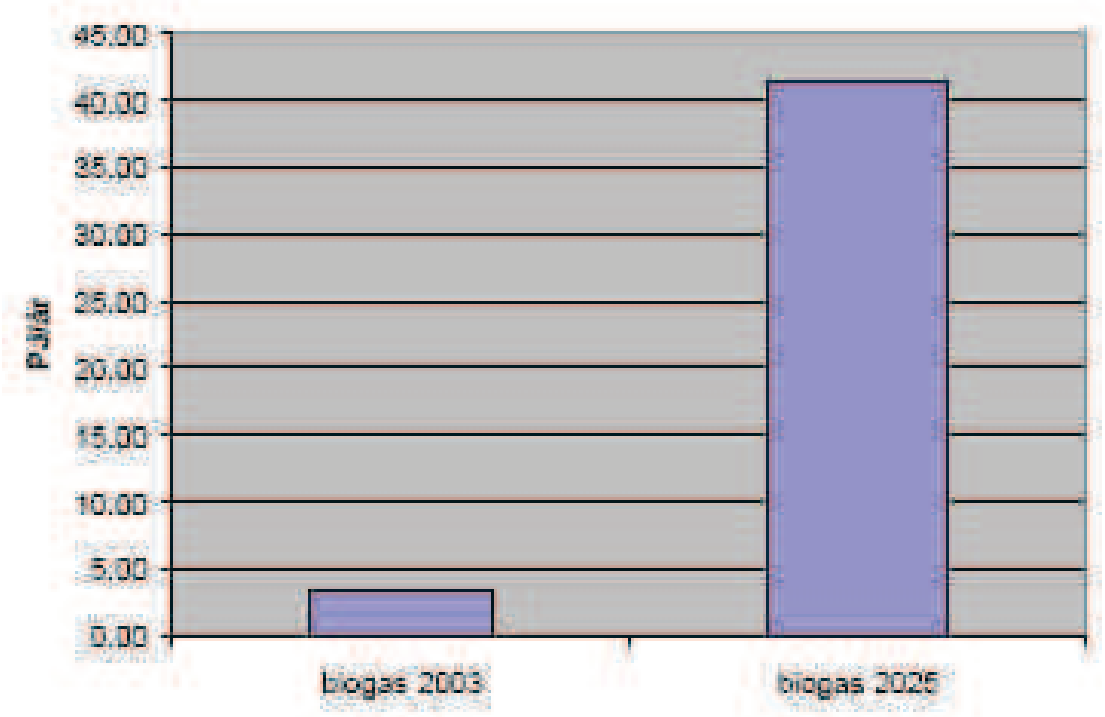


Energipolitik	Forsyningssikkerhed + Økonomi + Miljø + Klima		+ Beredskab
	Infrastruktur	Liberalisering	Organisation
Marked	Energi- og varmeplanlægning	Marked	+ Rammer
	National →		International
Selvforsyning	0 %		145 %
BNP	100		150
Fjernvarme	0,7 mio. boliger		1,5 mio. boliger

Energy from renewables in Denmark



Strategy for energy from biogas



Complete utilisa-tion of the biogas potential

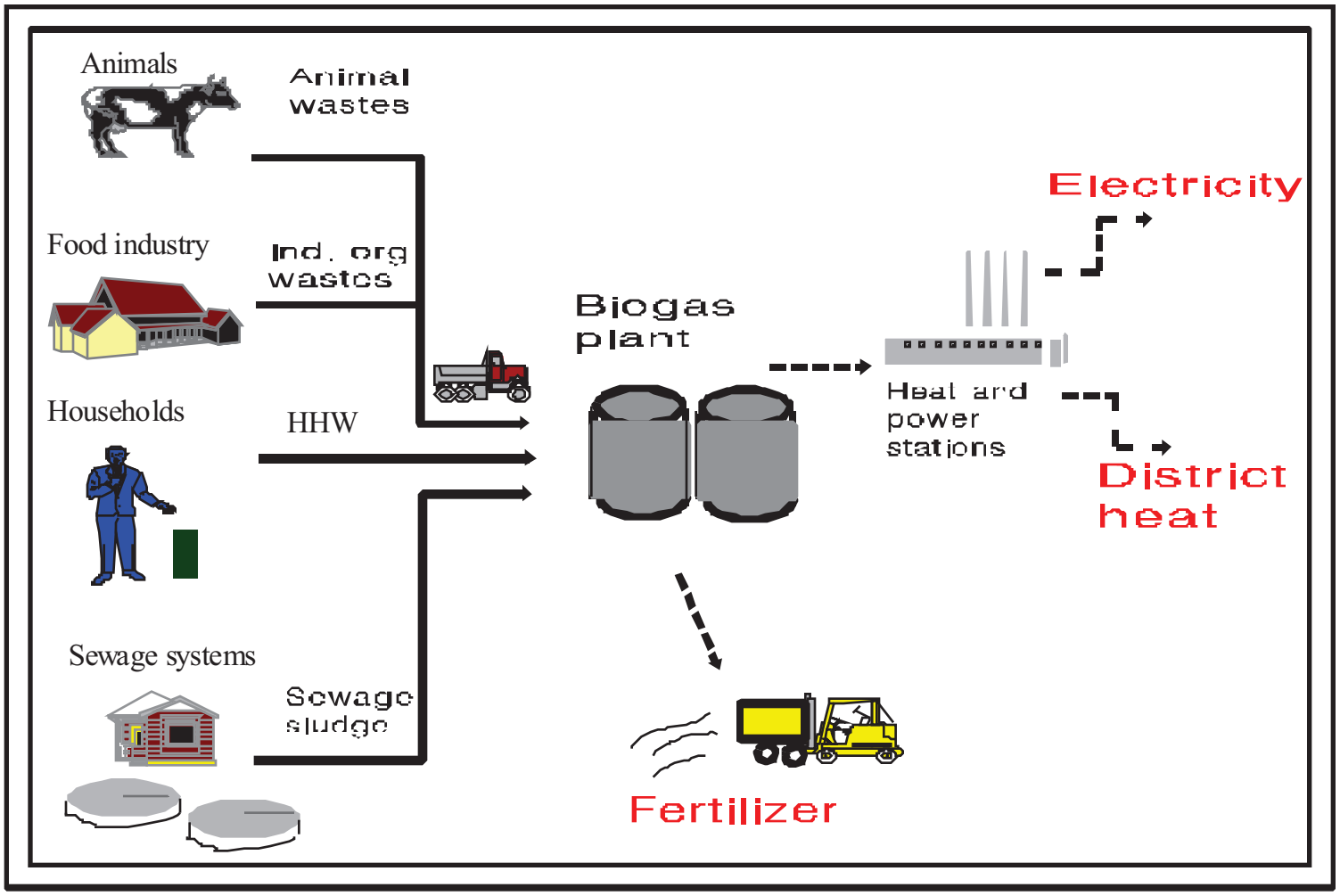
Conclusions

Advantages with Biogas Technology

- **Environmental protection**
  - Effective and cheap climate instrument
  - Protects drinking water and water enviroment
  - Odours reduction in local areas
- **Contributes to energy supply safety**
- **Local occupation and technology export**
- **Contributes to sustainable agriculture**

Biogas plants in Denmark

Codigestion concept



Gas yields from different types of organic industrial waste is shown

Type	Organic content	TS (%)	VS (%)	Biogas yield $m_3$biog./ton	Notes
Stomach/Intestine content	Carbohydrates, proteins, lipids		15-20	50-70	
Flotations sludge	65-70% proteins, 30-35% lipids		13-18	90-130	Process adaptation is needed
Bentonite bound oil	80% lipids, 20% other organics		40-45	350-450	Warning bentonite Process adaptation is needed
Fish oil	30-50% lipids		80-85	350-600	Process adaptation is needed
Whey	75-80% lactose, 20-25% protein	8-12	7-10	40-55	
Concentrated whey	75-80% lactose, 20-25% protein	20-25	18-22	100-130	
Size water	70% protein, 30% lipids		10-15	70-100	High N-content Process adaptation is needed
Marmelade	90% sugar, fruit organic acids		50	300	
Soya oil/margarine	90% vegetable oil		90	800-1000	Process adaptation is needed
Spiritus	40% alcohol		40	240	
Sewage sludge	Carbohydrate, lipids, protein		3-4	17-22	Sanitation, possibly heavy metals
Conc. sewage sludge	Carbohydrate, lipids, protein		15-20	85-110	Sanitation, possibly heavy metals
Source sorted household waste	Carbohydrate, lipids, protein	25-35	20-30	150-240	Sanitation Plastics and other particles

Co-digestion

- Cheaper than separate treatment systems
- Existing plants can be used
- Technical advantages: i.e. solid waste can be diluted in liquid waste
- Larger plants offer the possibility for organized distribution of the treated matter as fertilizer on the fields
- Waste management

- Require capital and organization to establish large Centralized Biogas Plants

Ribe biogas plant

Lemvig biogas plant

Biomass truck

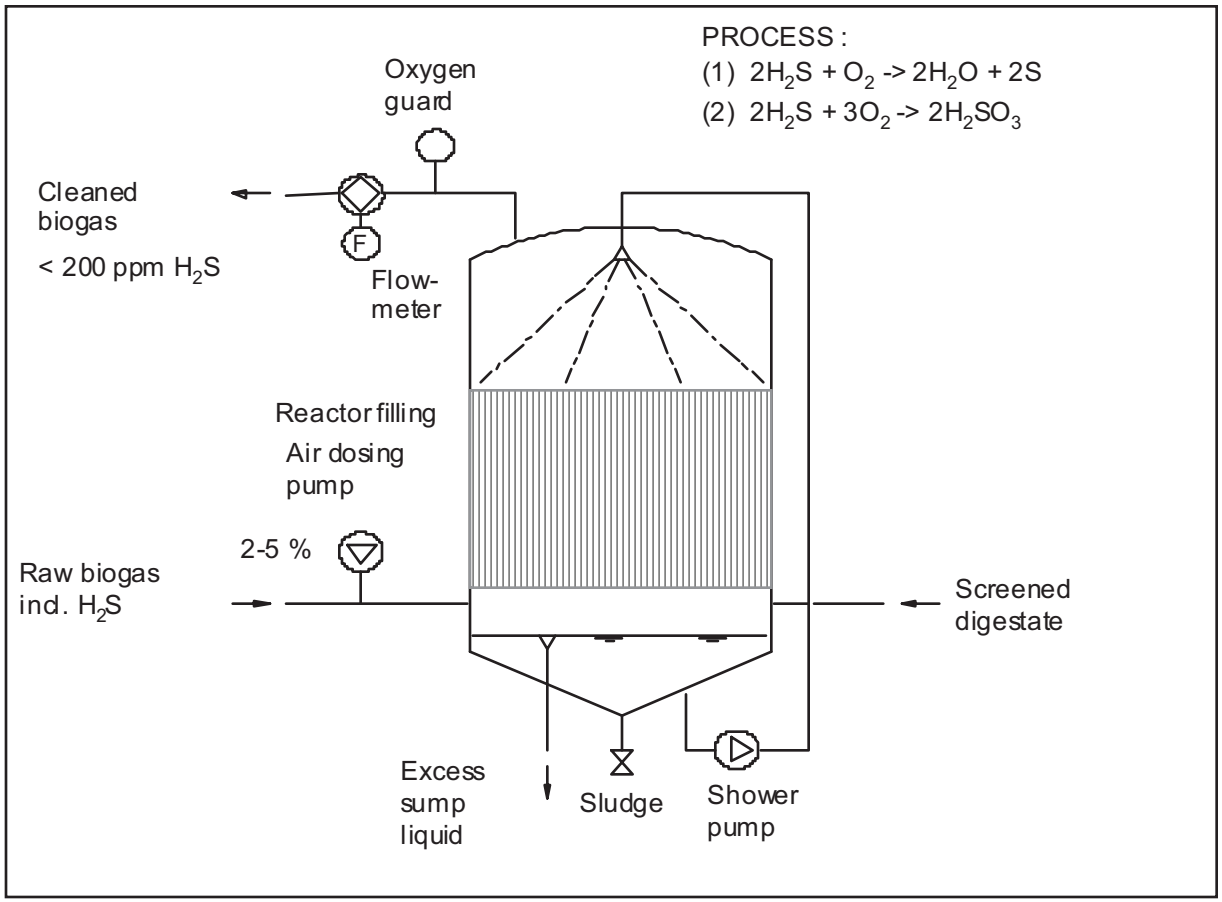
Thorsoe, 20 m^3, 32 ton gross weight

Receiving hall in Lemvig biogas plant

Thorsoe biogas plant

Heat exchangers in Ribe biogas plant

Schematic diagram of system for biological H_2S oxidation



Unit for biological H_2S reduction

Thorsoe Biogas Plant

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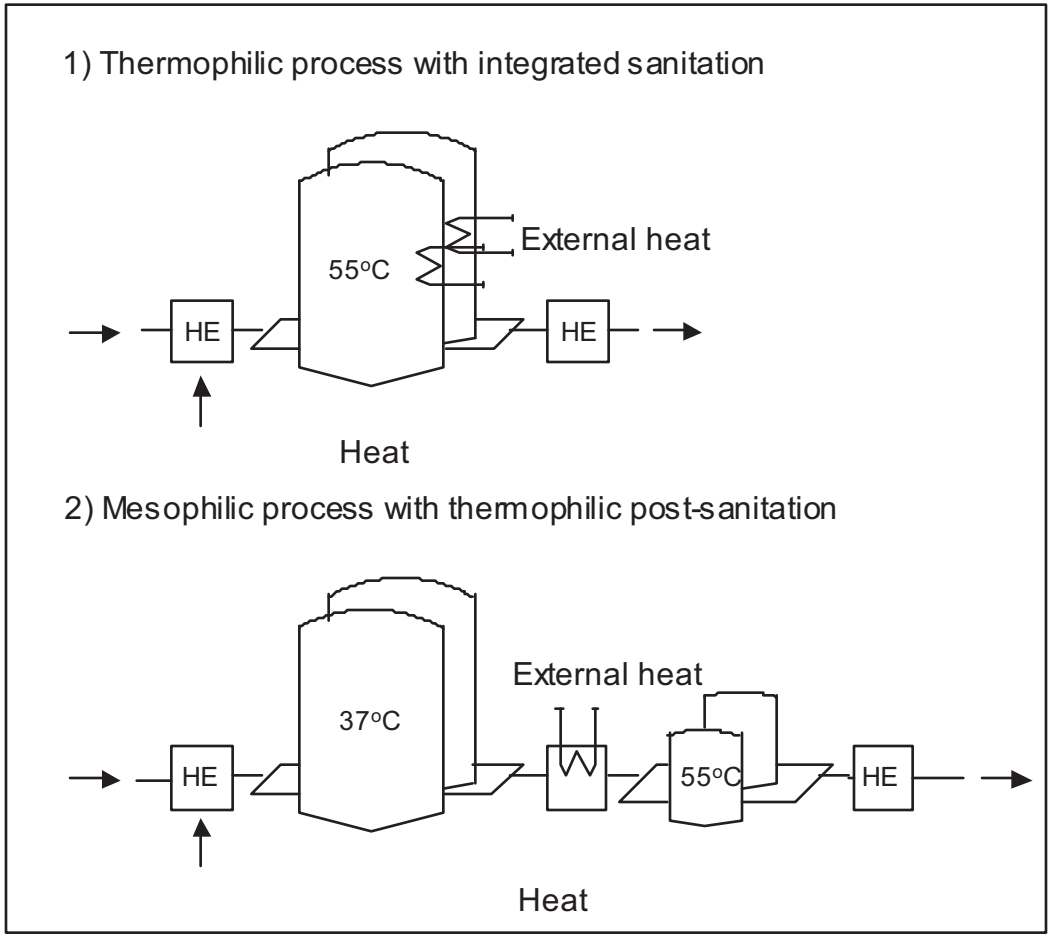
Biogas storage

Lemvig, 5000 m^3, 10 mbar-g

Sanitation of manure and organic waste in a biogas plants:

- Pathogenic reduction by thermal treatment
- Pathogenic reduction by anaerobic treatment
- Present rules

Process and Sanitation concepts



Biogas in the trasportation sector:
A success story from Sweden

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Natural gas net in South Sweden

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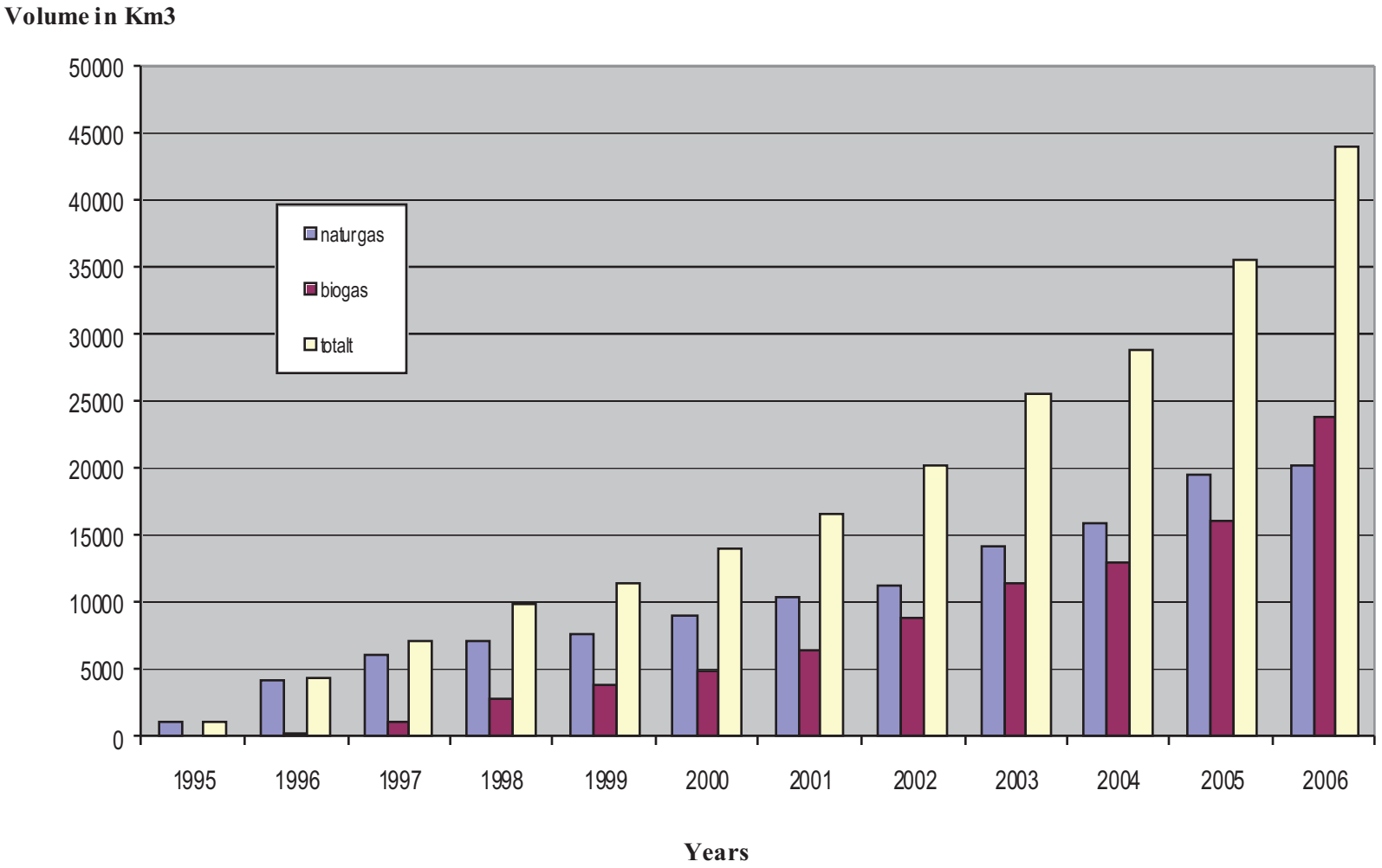
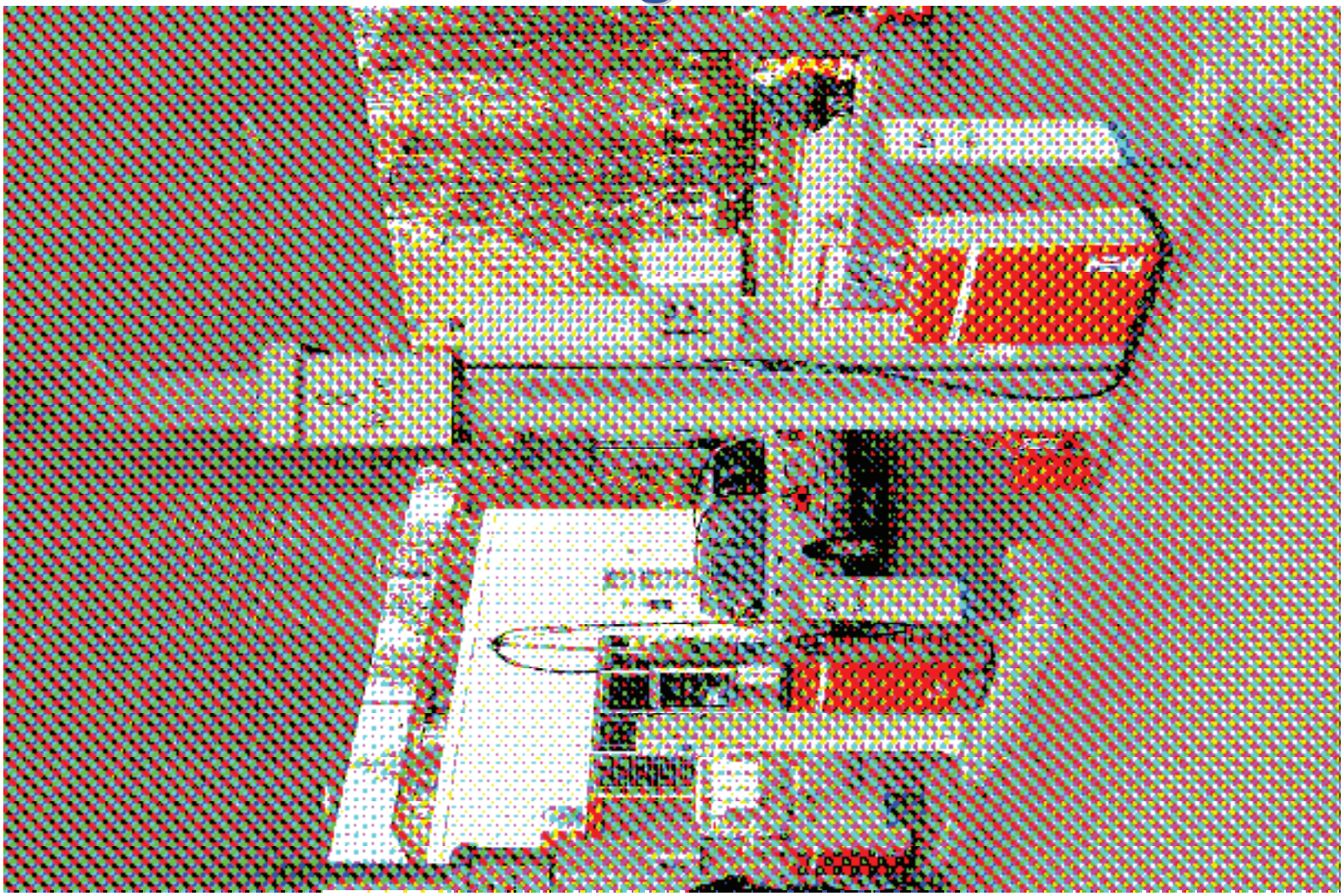
Autogas in Sweden



Public stations for natural gas and biogas

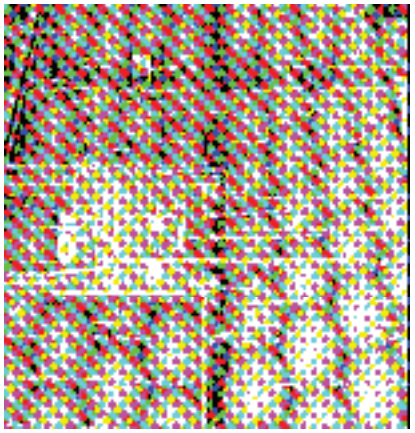


Biogas as vehicle fuel

Upgrading

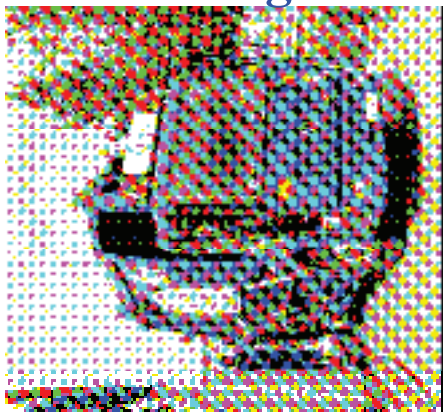
Compression

Storage



Dispenser

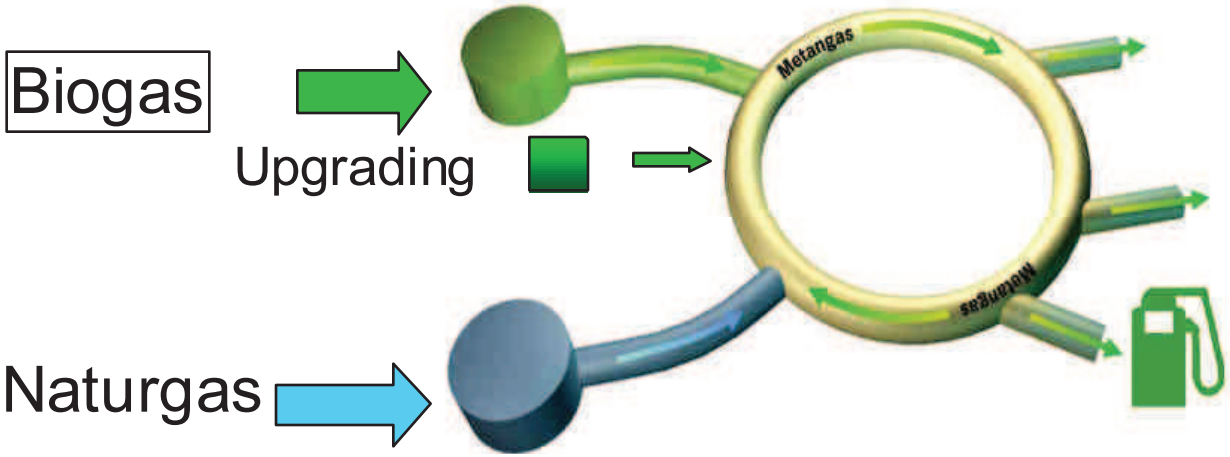
Refueling

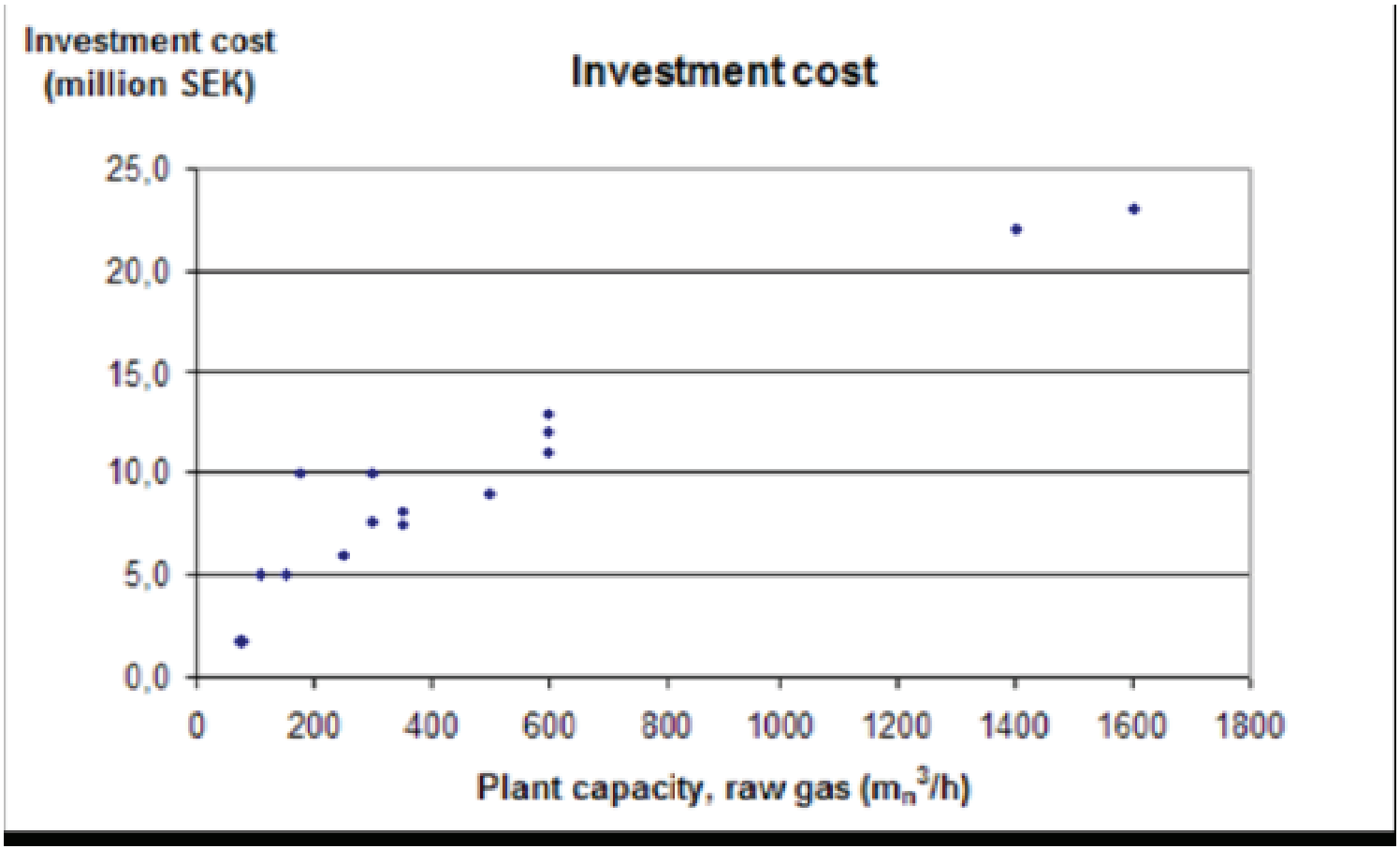


The Vision

Produktion af biogas where the biomass resouces are found (rural areas), upgrading and utilisation where the need is highst (cities)

Natural gas net is doing it possible




Investment cost
(million SEK)
Investment cost
25,0
20,0
15,0
10,0
5,0
0,0
0
200
400
600
800
1000
1200
1400
1600
1800
Plant capacity, raw gas (m_n^3/h)

Conclusions

Biogas is one of the most promising and sustainable energy sources as seen from Denmark and Sweden.

Many initiatives are taken:

DK: More focus in: utilisation of biogas in CPH

SE: More focus in: utilisation of biogas in transport