I/S SKIVE FJERNVARME

BIOMASS GASIFICATION

IEA Bioenergy Agreement:2010-2012 Task 33: Thermal Gasification of Biomass

Optimization of I/S Skive District Heating Biomass Gasification Plant

IEA – Thermal Gasification of Biomass

7th of October 2010

AAEN A/S

I/S SKIVE FJERNVARME

BIOMASS GASIFICATION

AAEN A/S
Consulting Engineers

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B.Sc. Elec. Eng.

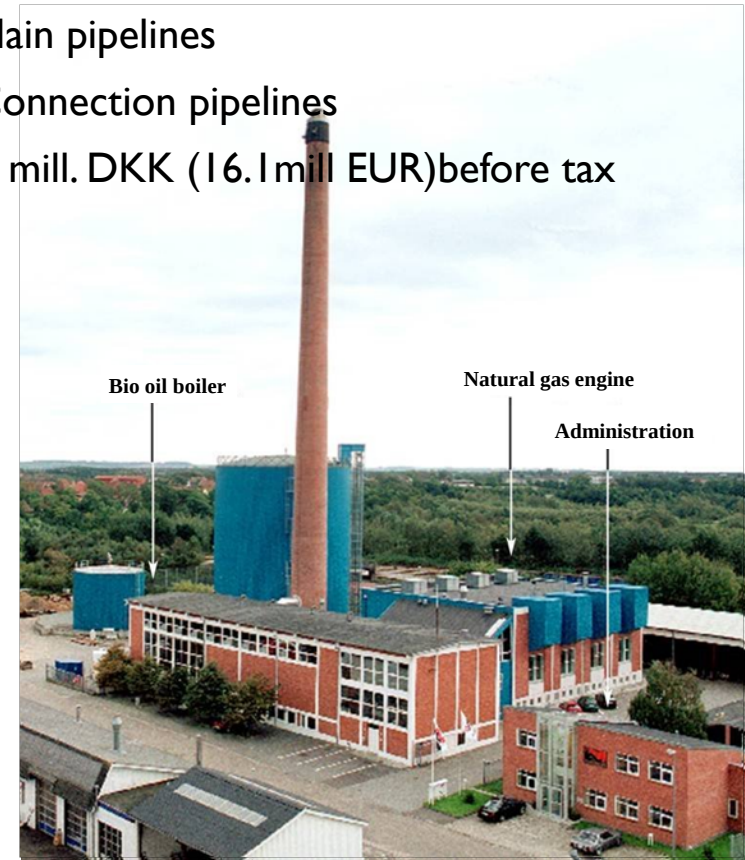
Graduate Certificate in Business Administration

Partner and project manager

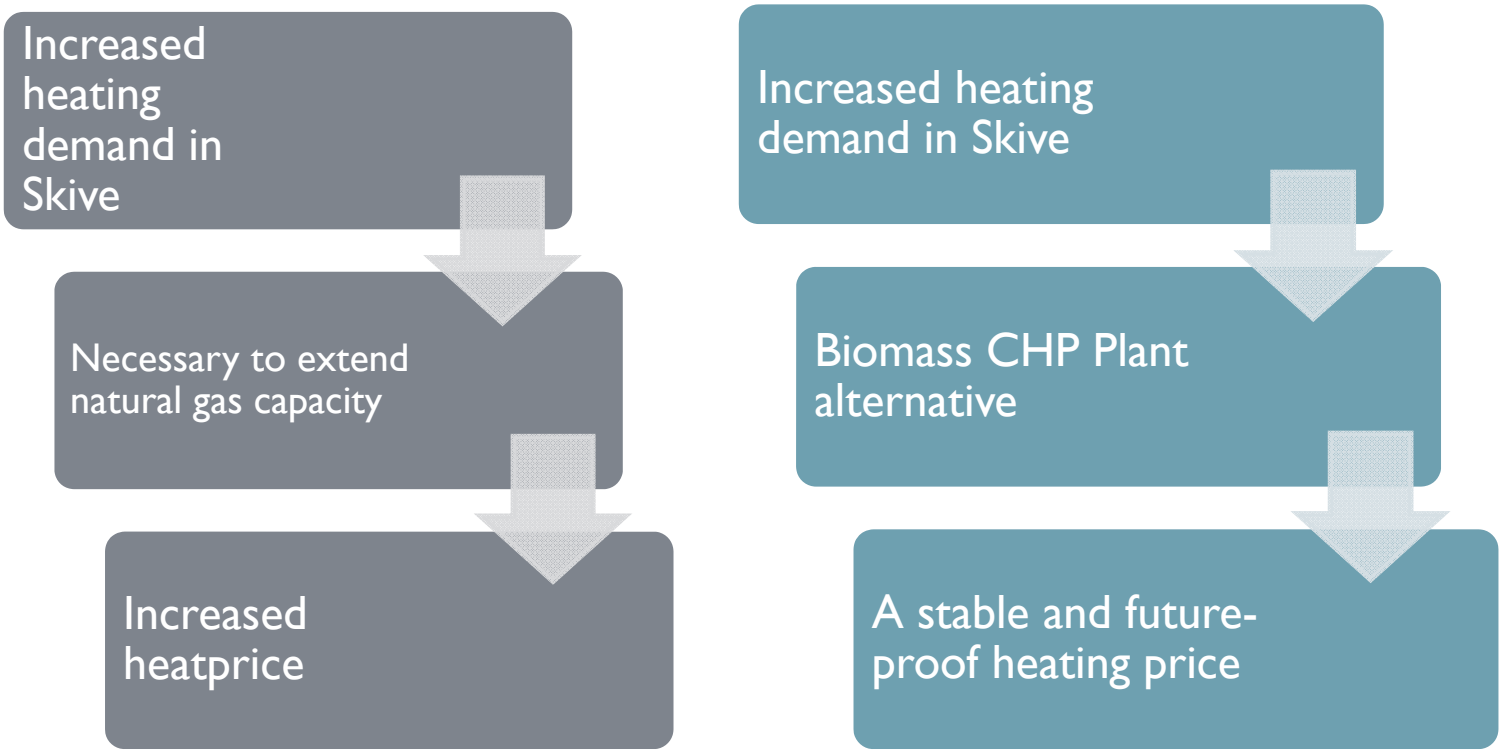
Building Consultant for Skive District heating Company

General information about I/S Skive Fjernvarme

- Consumers — 3.294 energy meters (8000 – 9000 households)
- Annual sale of district heating: — 120.000 MWh
- Annual sale of electricity: — 22.000 MW
- District heating network — 67,1 km Main pipelines
  54,4 km Connection pipelines
- Annual turnover: — about 120 mill. DKK (16.1mill EUR)before tax
- Annual fuel consumption
  - Natural gas: — 4,5 mill. m^3
  - Bio oil: — 4.500 ton
  - Wood pellets: — 21.000 ton



Project background



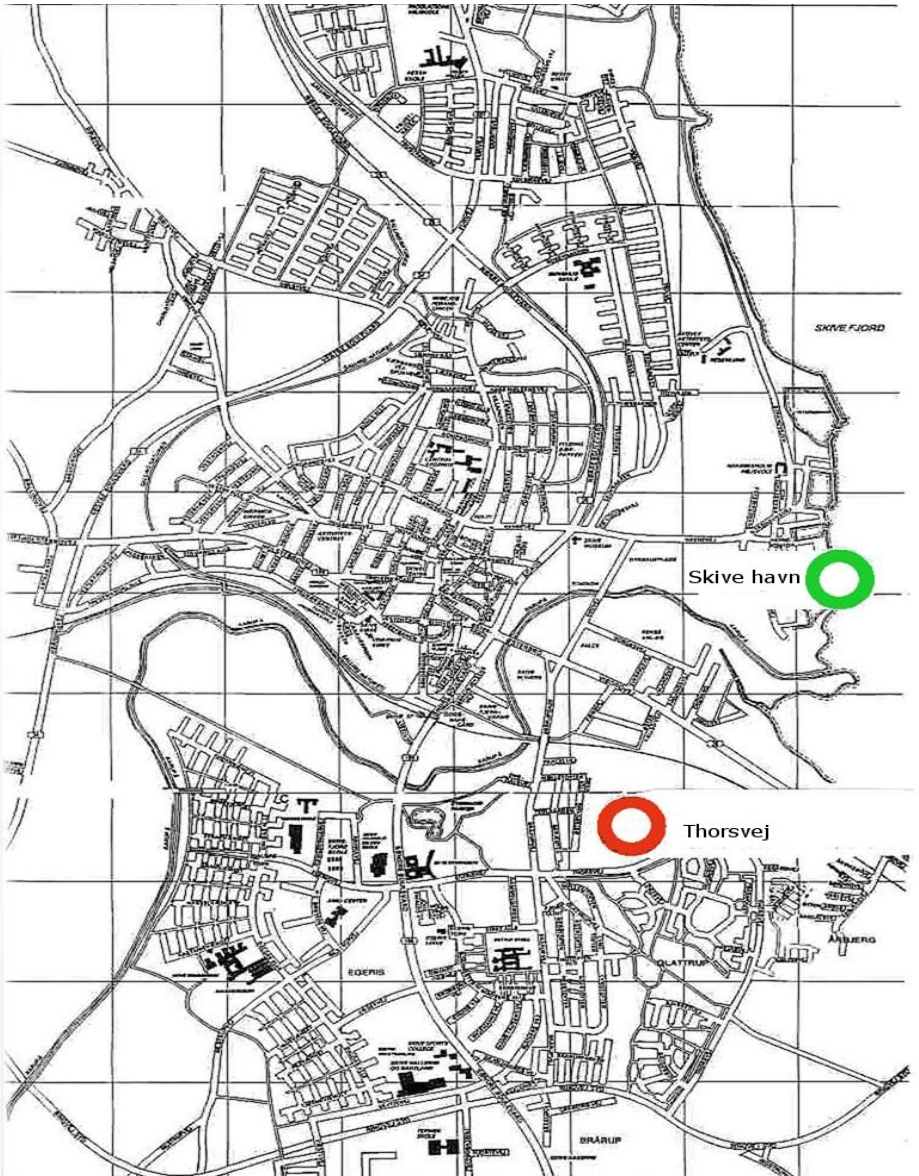
Wood pellets import

Wood pellet transport

- Transport distance is approximately 3 km.

Ship load and depth

- Maximum ship load: 3000 tons
- Maximum ship depth: 4 meter



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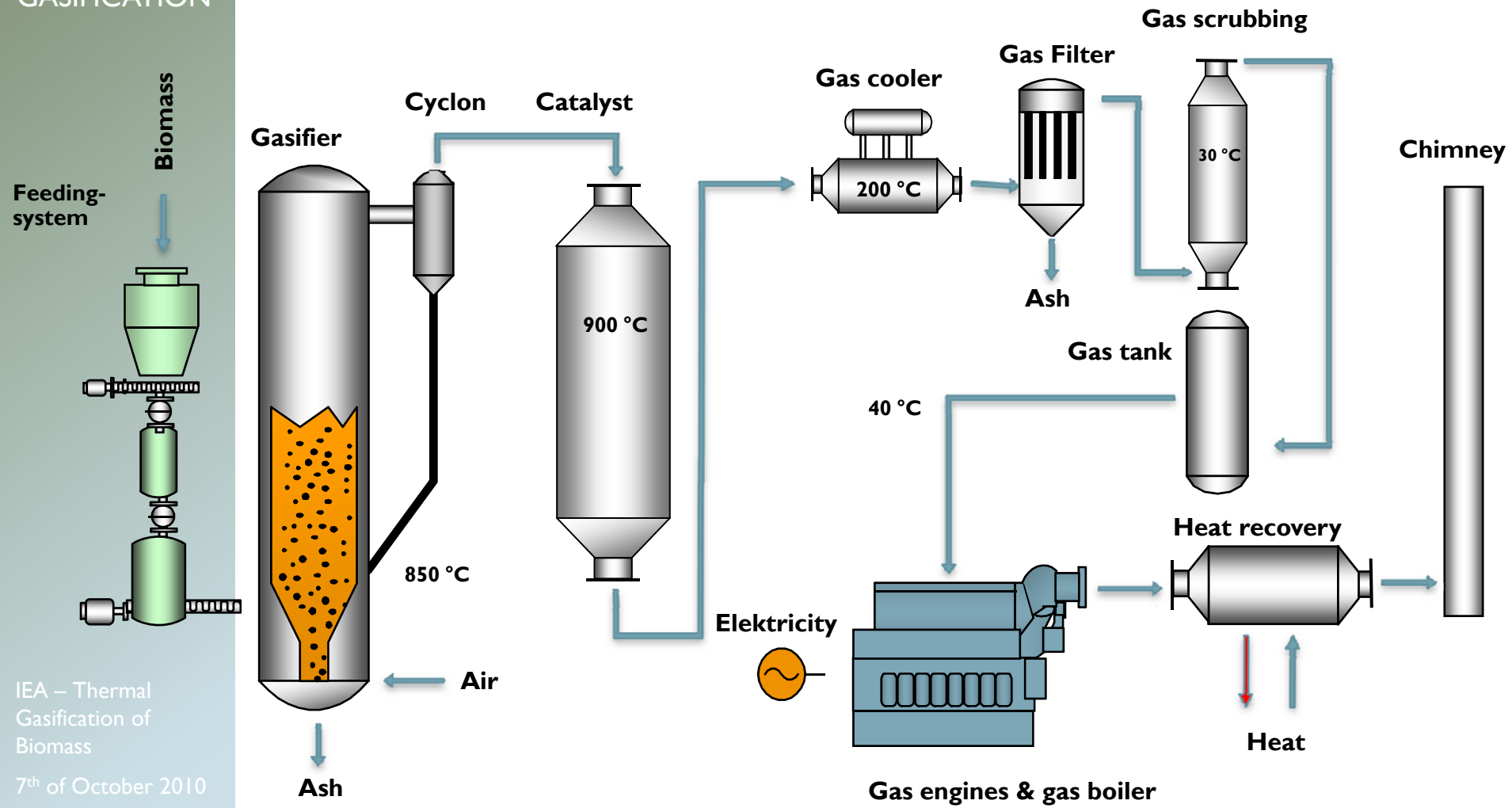
Gasification Plant



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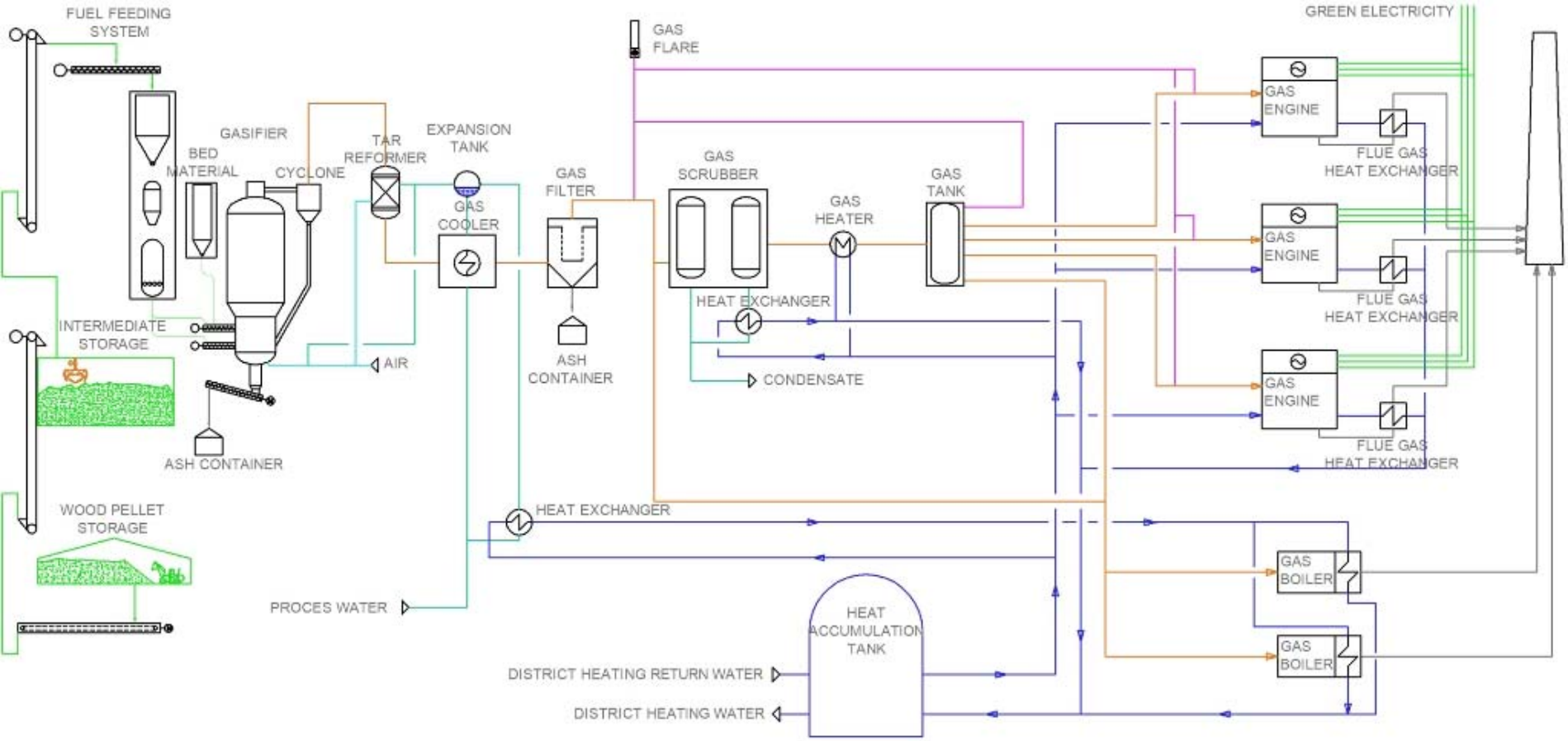
The Overall System



Authority Processing

The political handling of the project

- Preparation of a project proposal about biomass cogeneration plant – posted the 14th of May 2001.
- Approval of the heating plan on City Counsel Meeting on the 19th of September 2001.
- Preparation of district plan proposal for the new facility at Thorsvej. Consultation period was completed the 12th February 2003.
- There were objections to the project because of the location at the residential area.
- On a extraordinary general meeting at I/S Skive Fjernvarme, the 12th March 2003 the consumers was informed about the project.
- The district plan was finally adopted by Skive municipality at City Counsel Meeting 24th of June 2003.

The administrative handling of the project

Environmental Impact Assessment

- Viborg County's processing of the case was closed.
- The County's decision was complained to the National Nature Complaints Board
- The National Nature Complaints Board did on the 9th March 2005 agreed in the decision of the County.

Waste water approval

- Was published together with the environmental approval on the 26th March 2005.

Fire Protection Authority

- The prepared ATEX and HAZOP analyze was approved by the Fire Protection Authority in Skive with assistance from the Danish Technological Institute the 20thApril 2005.

Environmental approval

- The environmental approval was published on the 26th March 2005.

Building permission

- Building permission for the accumulation tank was granted the 19th October 2004.
- Excavating and casting permission for the CHP Plant was granted the 11th April 2005.
- Final building permission for the CHP Plant was granted the 5th September 2005.

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Above: On 19th April 2005 – Chairman of the Board Mr. Erik Nielsen from I/S Skive District Heating perform the first digging

Left: June 2005 – Accumulation tank completed

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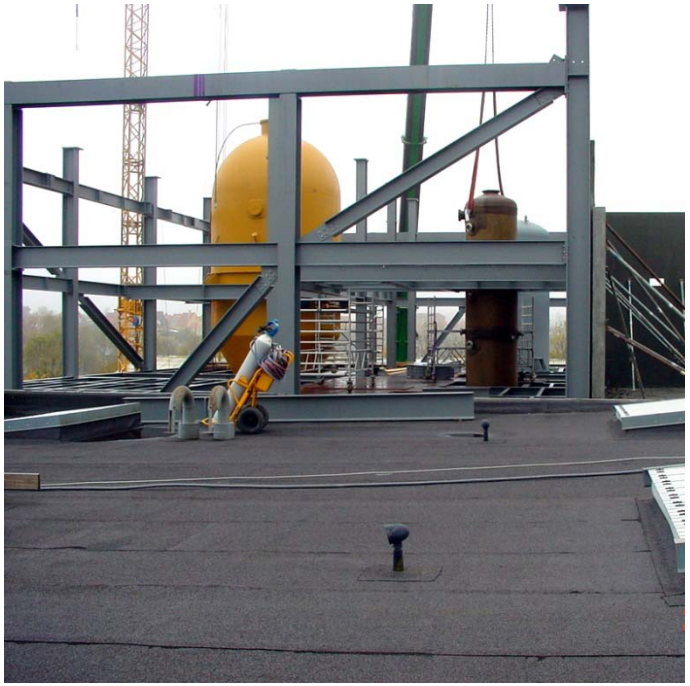
Gasifier unit produced in Finland while inside brickwork is performed by Finish and Danish Companies



Gas cleaning equipment inserted – 27th October 2005

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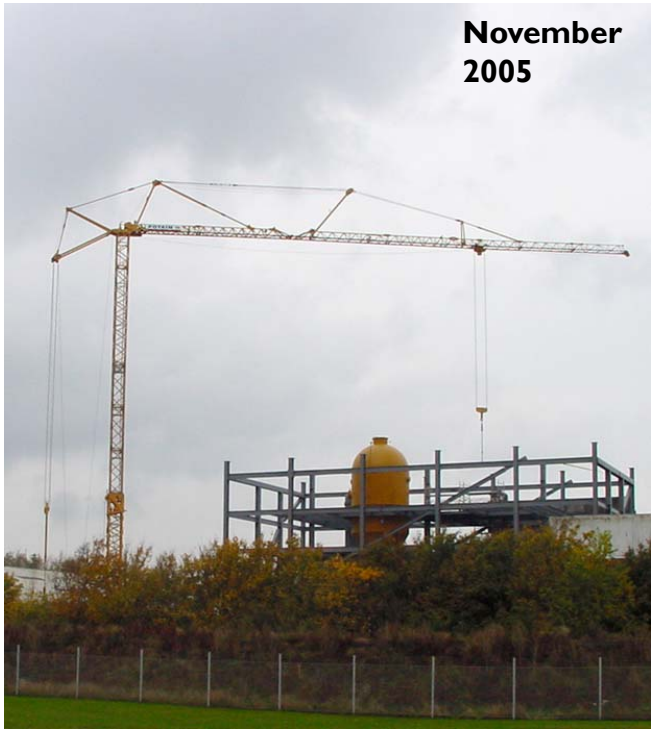
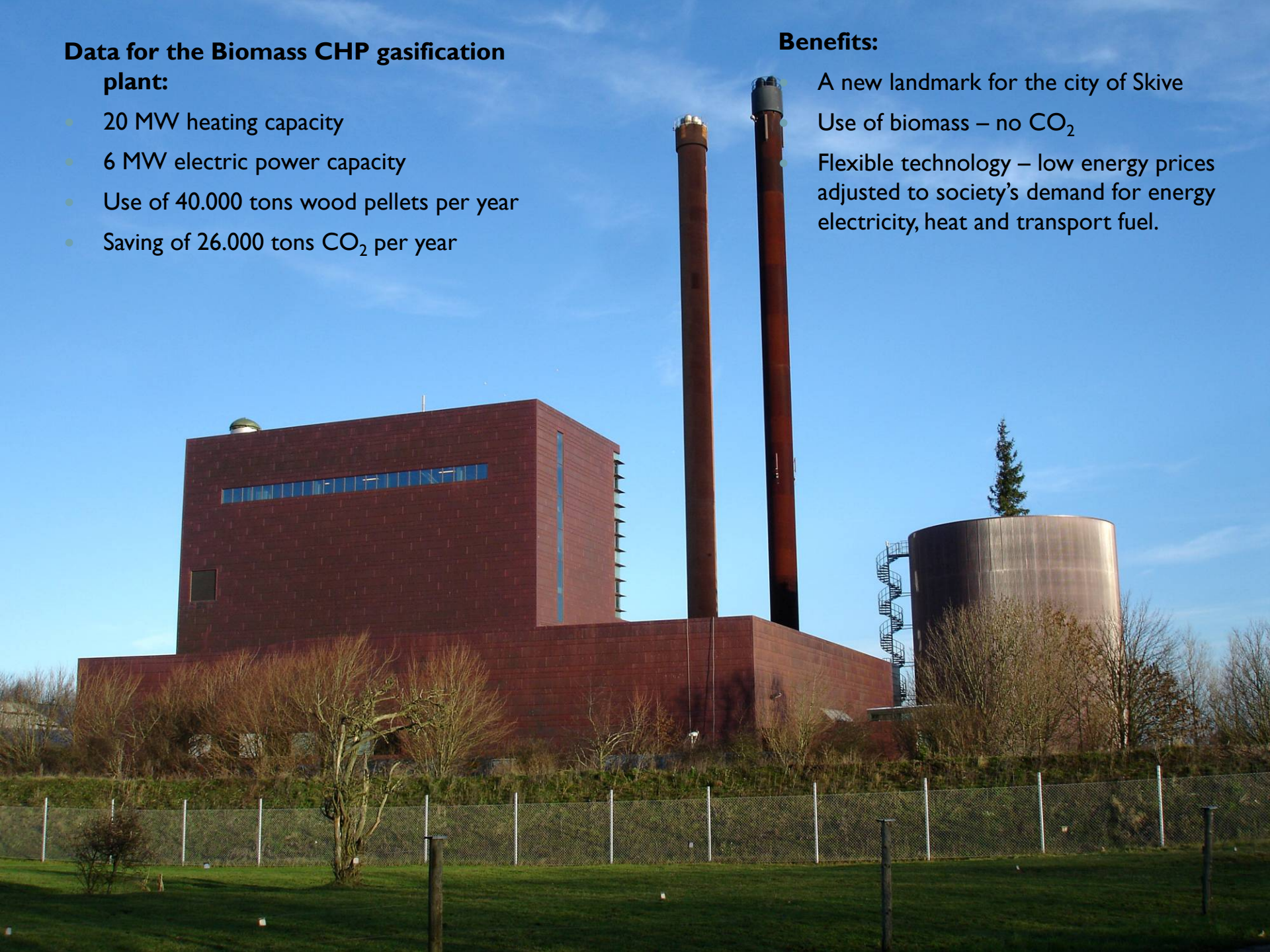


Operation and Commissioning

- 20 MW wood-gas is produced on the gasfier
- Analysis of the wood-gas show quality according to expectations
- 4 operators day and night during operation
- Noise problem from Flare
- The equipment in some areas has been too highly classified(ATEX)
- Too many assumed operation parameters in the SCADA system
- The first engine delivered 10 MWh 2nd June 2008
- Engine two and three were starting up between weeks 35 and 41 2008.

- April 2010:
  - Motor: 10.730 number of hours
  - Electricity: 15.257 MWh
  - Heat: 42.257 MWh

Status:
70% output and 50% availability
The objective:
100% output and 90% availability
Unmannered operation during the evening and nighttimes.



Data for the Biomass CHP gasification plant:

- 20 MW heating capacity
- 6 MW electric power capacity
- Use of 40.000 tons wood pellets per year
- Saving of 26.000 tons CO_2 per year

Benefits:

- A new landmark for the city of Skive
- Use of biomass – no CO_2
- Flexible technology – low energy prices adjusted to society's demand for energy electricity, heat and transport fuel.

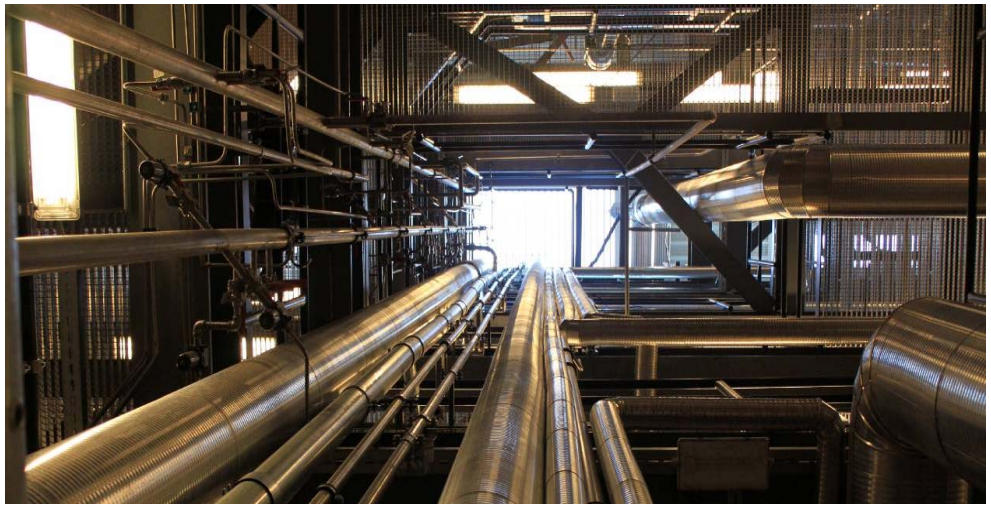
Experiences in General Terms

1. Comprehensive Regulatory and Permission procedures
2. The neighbours were scared of the new "gas factory"
3. The building must be constructed as a commercial CHP plant
4. 40 contracts with different suppliers
5. R&D projects takes a looong time

R&D Project

- The Danish Energy Agency:
- EU – 5th Framework Program
- DOE (Department of Energy) – USA

- 12 mill. DKK (1.6 mill. EUR)
- 12 mill. DKK (1.6 mill. EUR)
- 11 mill. DKK (1.5 mill. EUR)



Project Process

Situation	Reference 2005	Expectations today
• Investment:	• 161 mill. DKK (21.6 mill. EUR)	• 248 mill. DKK (33.3 mill. EUR)
• Operational cost:	• 153 DKK/MWh electricity	• 183 DKK/MWh electricity
• Assignment:	• Middel 2006	• Primo 2011
• Fuel price:	• 700 DKK/tons	• 1.200 DKK/tons
• Electricity transfer price:	• 600 DKK/MWh	• 745 DKK/MWh
• Interests:	• 3,5 % p.a.	• 4,5 % p.a.
• Write-off period:	• 12 year	• 20 year
• Heat price:	• 278 DKK/MWh	• 365 DKK/MWh

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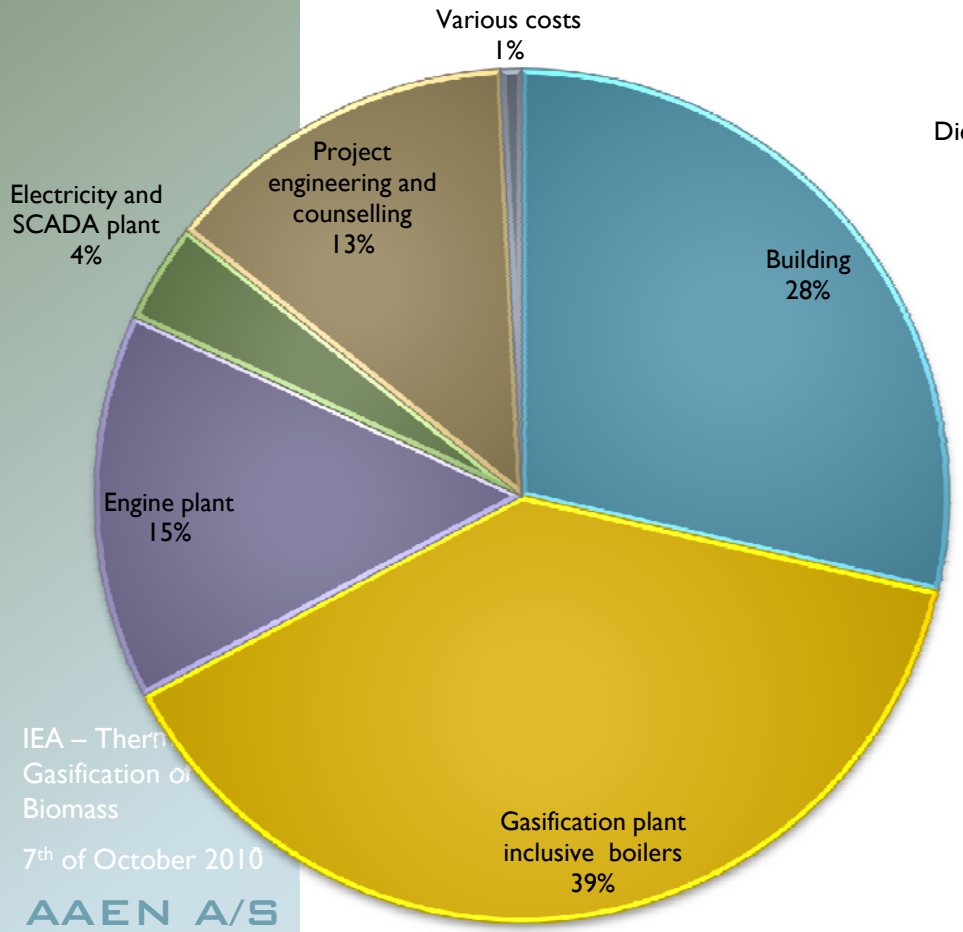
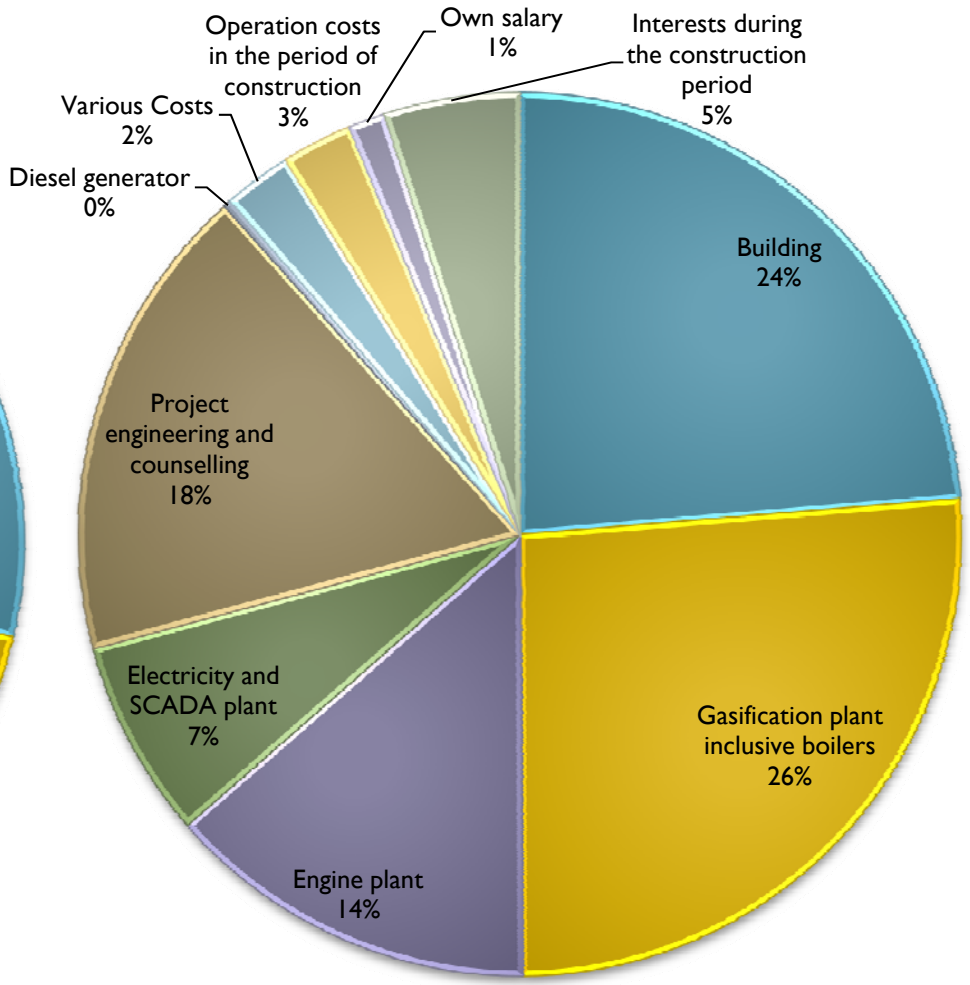
Construction Cost-sharing Reference

Reference



70% load & 50% availability



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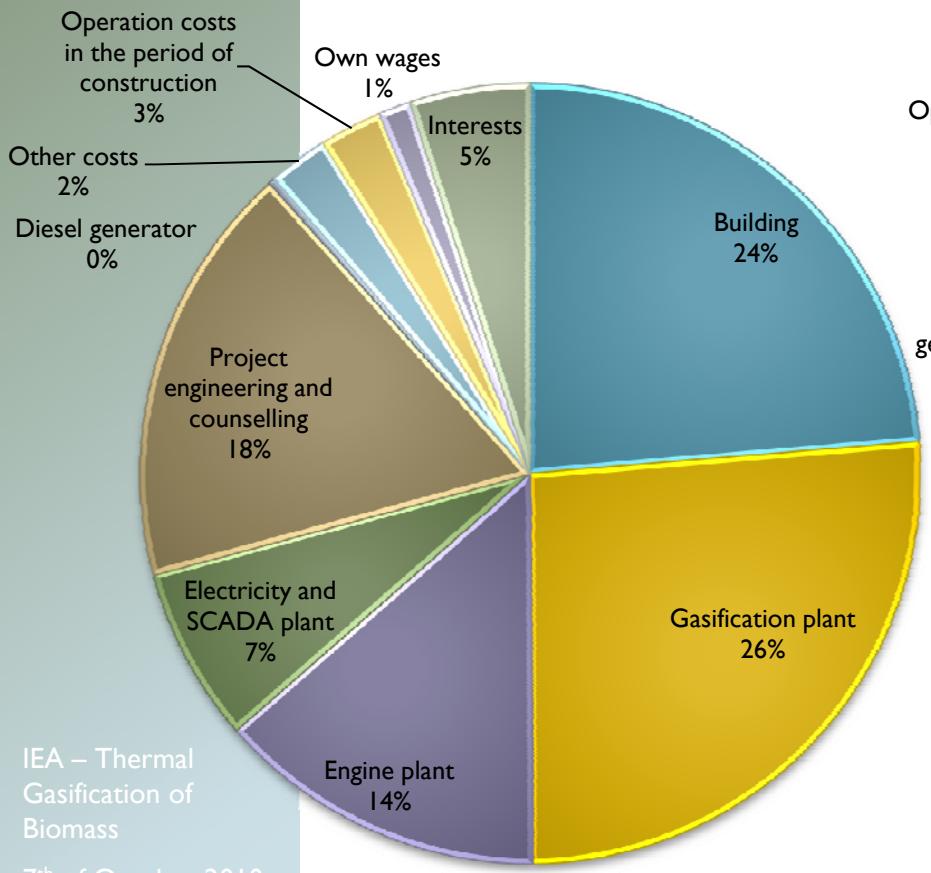
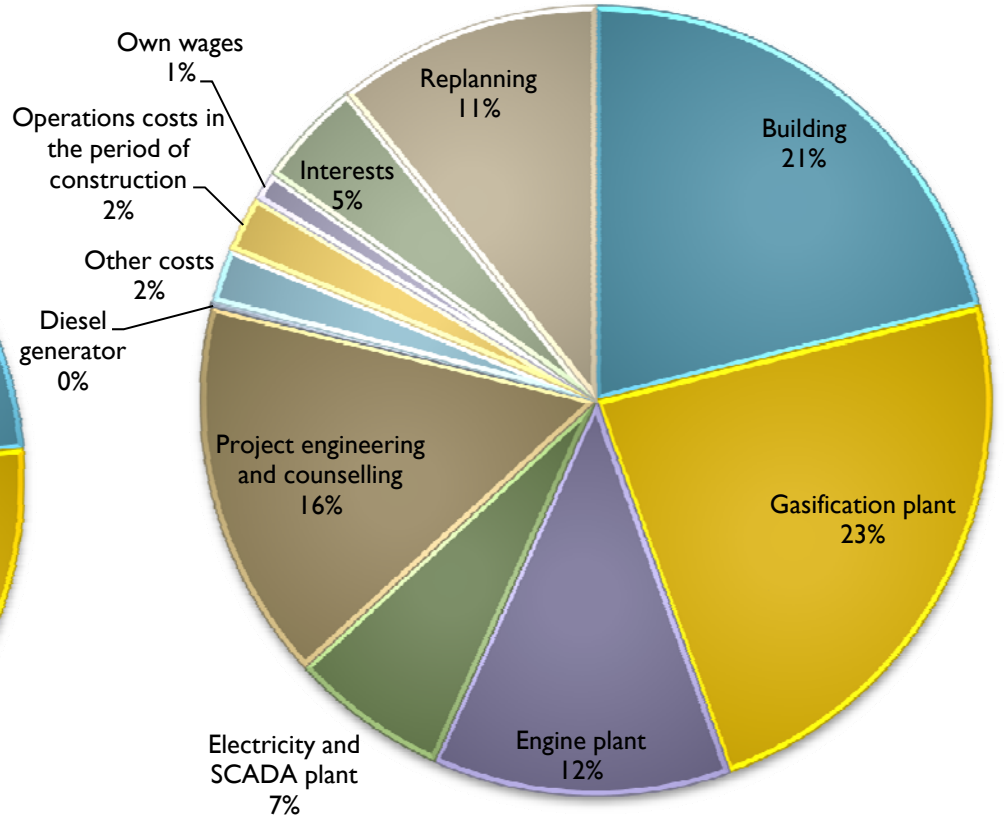
Construction Cost-sharing Expectation

70% load & 50% availability



100% Load & 90% availability



Perspectives

	Fuel MW	Electricity MW	Heat MW	Liquid MW	Costs Mio. DKK	Rate Mio. DKK/MW
Skive project	18	6	10	0	250	42
Skive optimised	28	9	16	0	288	32
Skive 2 + fuel	28	10	15		262	26
Skive 2 + liquid	28	10	15	18	302	30
Skive 2 + oxygen	78	28	41		380	14
Skive 2 pressurized + oxygen	98	43	43		608	14
Firing - Ad on gasification: Skive 2 model	28		Gas out =	25	194	
Straw combustion, 2002 costs; Sakskøbing – distant	39	11	23		252	22

Is it possible to bay a such a gasification plant?

What does a guarantee cost?

Will it work?