

Biomass Gasification with low tar production.

Staged gasification

Florianópolis Brasil June 2007

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Content of this presentation

- What is gasification?
- What is tar free gasification.
- The TK Energi process
 - Technical background for this process
 - Performance of this technology
 - Status for the technology
 - Economy of this technology

What is gasification ?

Gasification converts solid fuels into a gaseous fuels that consist of H_2 , CO , CO_2 , CH_4 , N_2 and H_2O .

Gasification does not produce energy.

Gasification converts low quality energy to high quality energy

Why gasify?

- To produce more "high quality energy"
 - Electric efficiency 25-30 % on a 300 KW plant fuelled with wood chips
- To obtain better environmental performance
- To use "dirty" fuels
- To produce more "advanced energy" eg. methanol

Why not gasify?

- The technology is not 100 % mature.
- Fuel quality demands
 - Particle size
 - Moisture content
- Gas quality
 - Tar
 - Particles
- Plant maintenance
 - Hot elements

Gasification principles

Small scale – 1 stage cocurrent

Medium dirty gas –

- 0,5-5 gram tar/Nm³
- 0,5-5 gram particles/Nm³

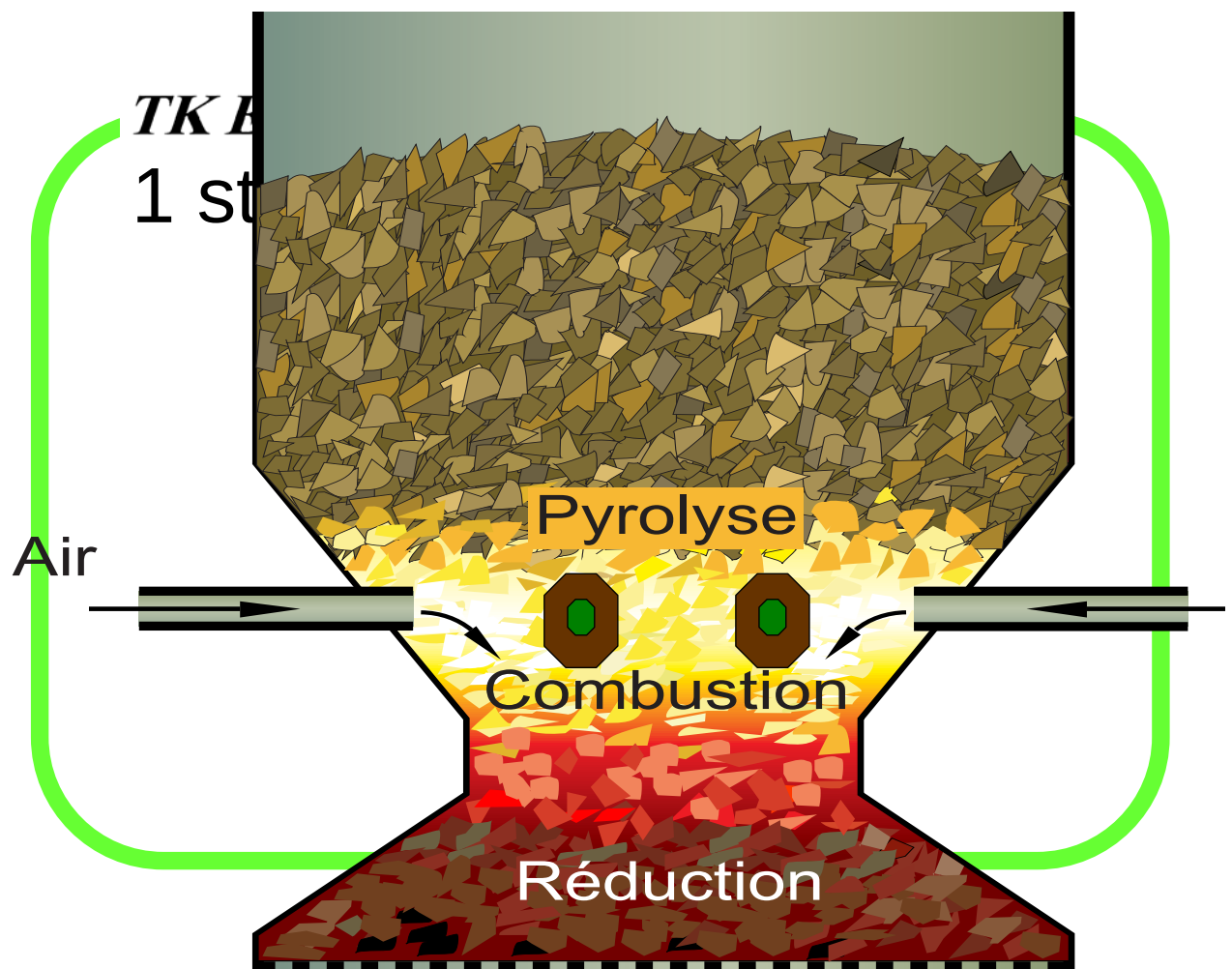
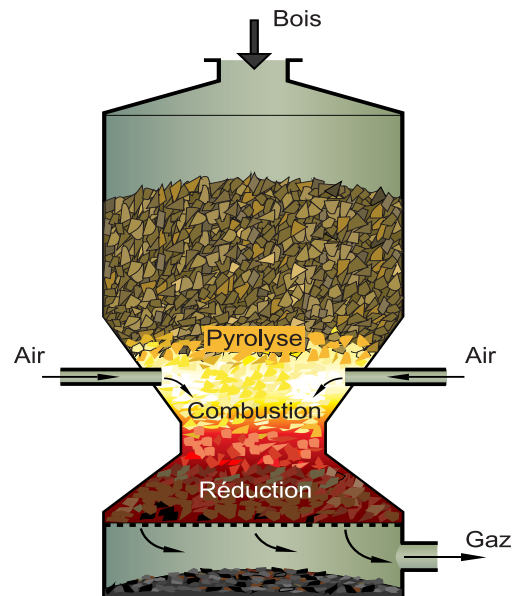
Fuel sensitive

- Large uniform particles
- Low moisture
- High ash melting point

Not upscaleable to more than 1 MWth

TK Energi AS

1 stage co-current gasifier

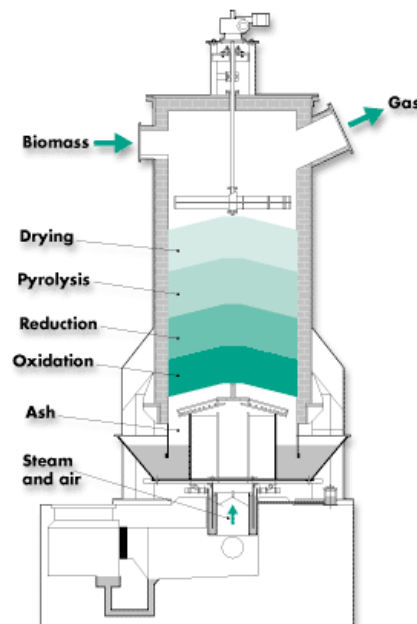


Gasification principles

Small scale

- **1 stage counter current**
 - Dirty gas – 10-100 gram tar/Nm³
 - Fuel tolerant
 - Upscalable to 10-25 MWth

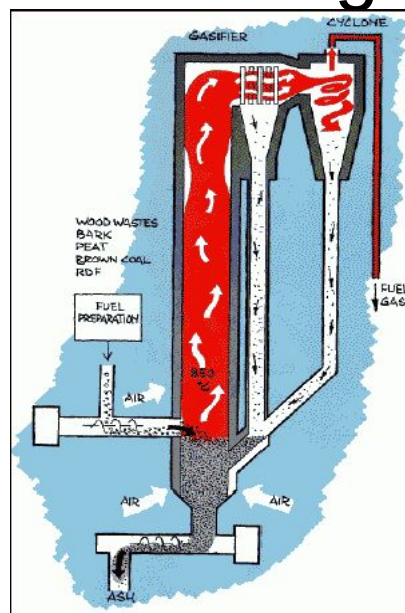
Updraft gasifier



Large scale

- **Fluidised bed gasifiers**
 - Not economical below 10-20 MWth
 - Dirty gas – 5-25 tar/Nm³
 - High maintenance cost if used for advanced applications

Fluidised bed gasifier



Large scale

Entrained flow gasifiers

- LARGE many hundreds of MW – GW
- For advanced plants for chemical industri or synfuels production
- Commercial for coal gasification

Gasification principles

The staged gasifier

3 stages:

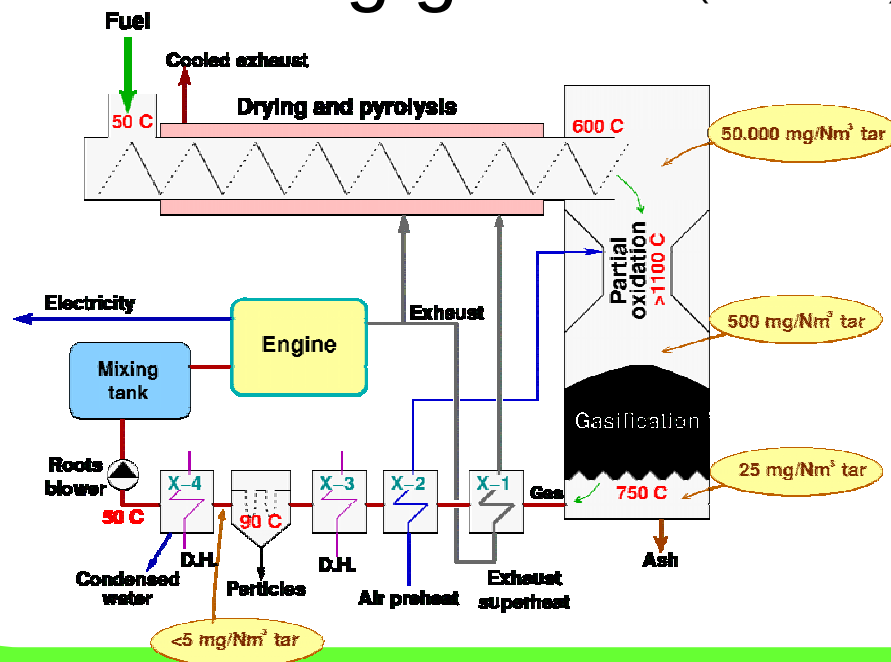
Pyrolysis

Combustion

Char reduction

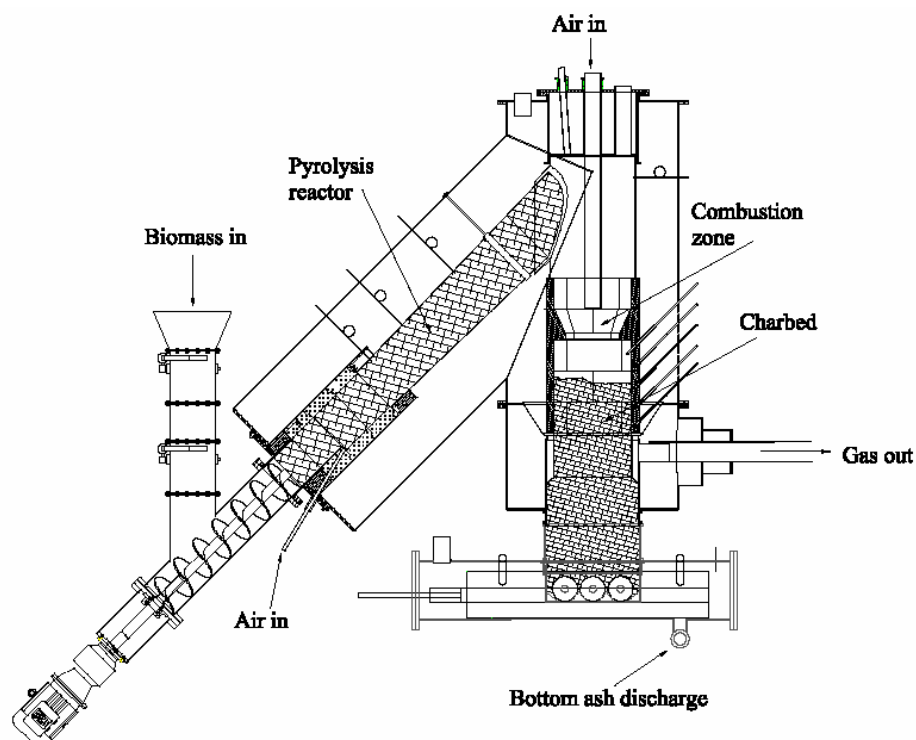
TK Energi AS

The Viking gasifier (70-80 kwth)



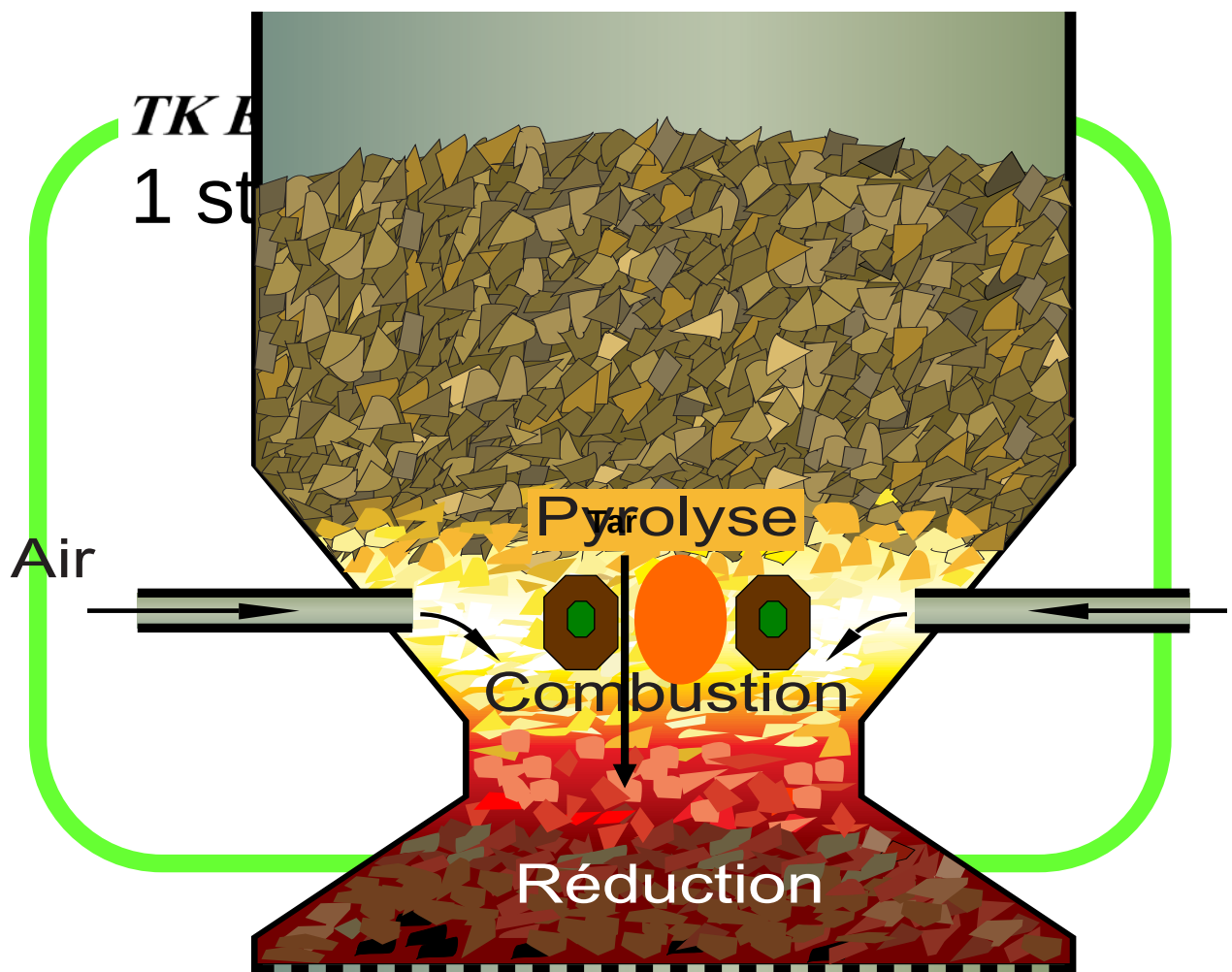
TK Energi AS

TK Energi's gasification principle



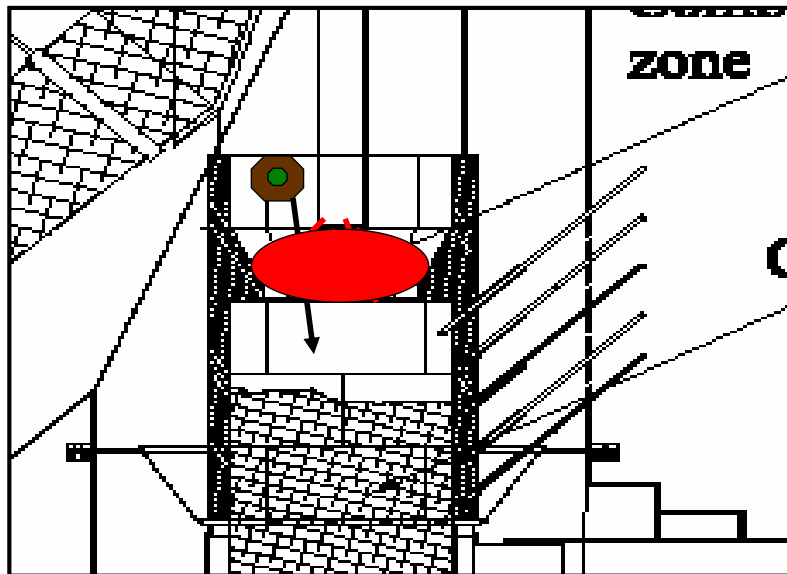
The combustion zone

Must take place in a char free space.



TK Energi AS

TK Energi's gasification principle



TK Energi AS

The Charbed

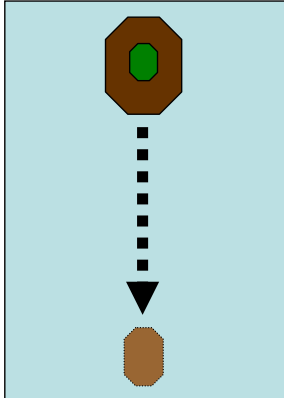
Crack remaining char

Chemical quench

Should not produce char or soot

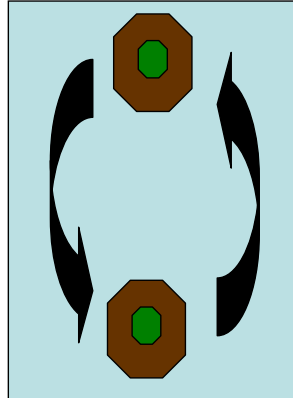
The stratified char bed

Stratified
fixed bed



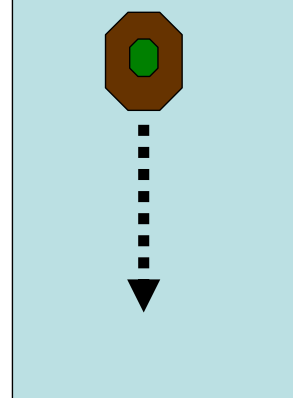
Hours

Fluid bed



Minutes

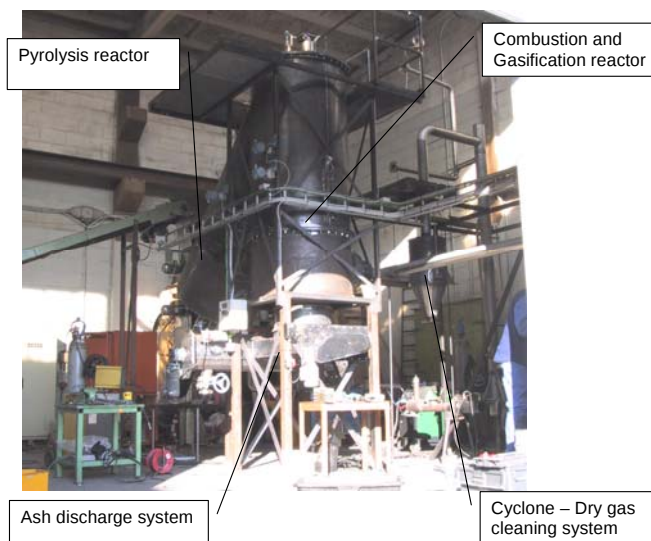
Entrained
flow



Seconds

3-stage Fixed Bed Gasification – New generation

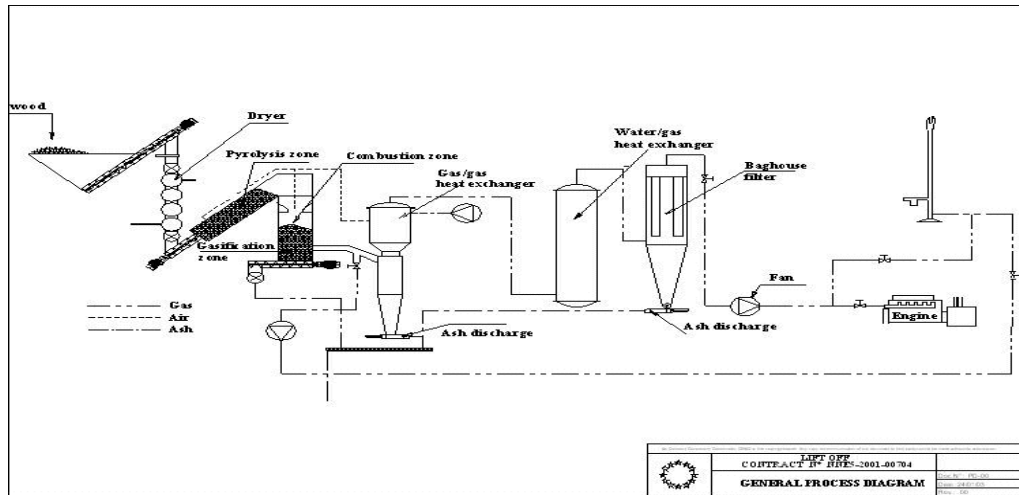
The No-Tar Gasifier



TKEs new generation gasifier only produces about 1-20 mg/Nm³ and is designed without any moving parts in the hot zones.

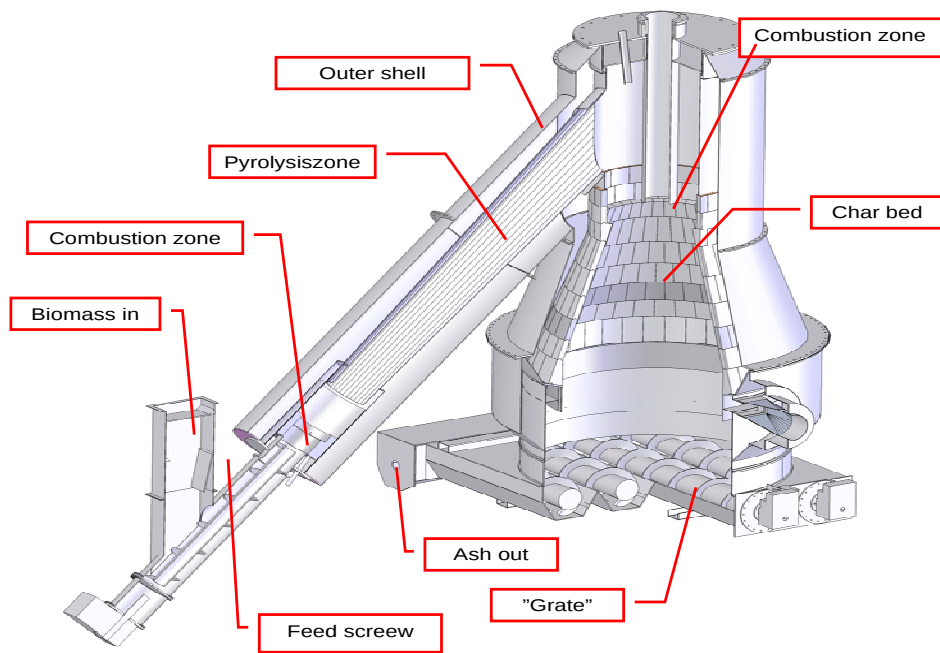
The plant offers a cold gas efficiency of 80% and low maintenance costs,

Principle of the gasification plant



The mechanical design

- No parts that are hot and moving
- A gas tight barrier in the insulation in the cold end of the bed

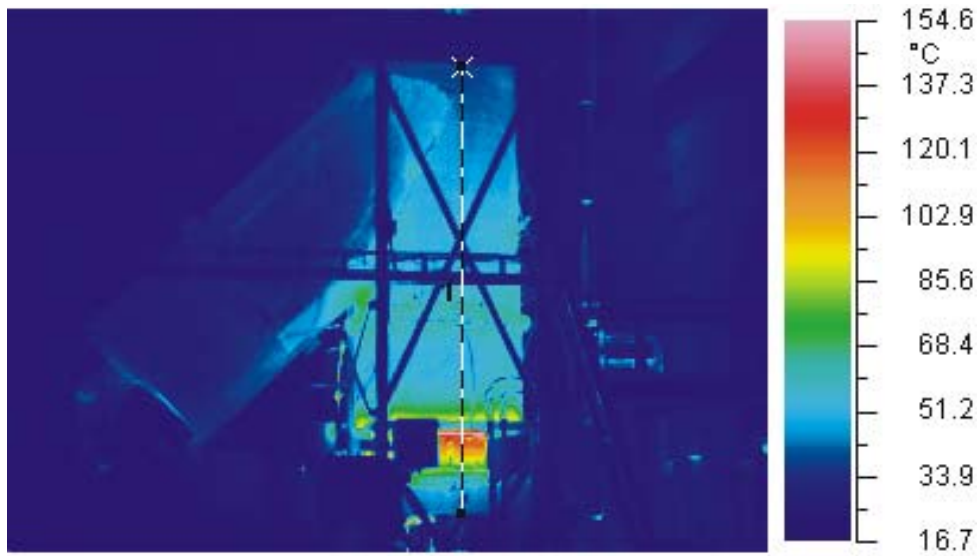


The fuel



TK Energi AS

The outside temperature



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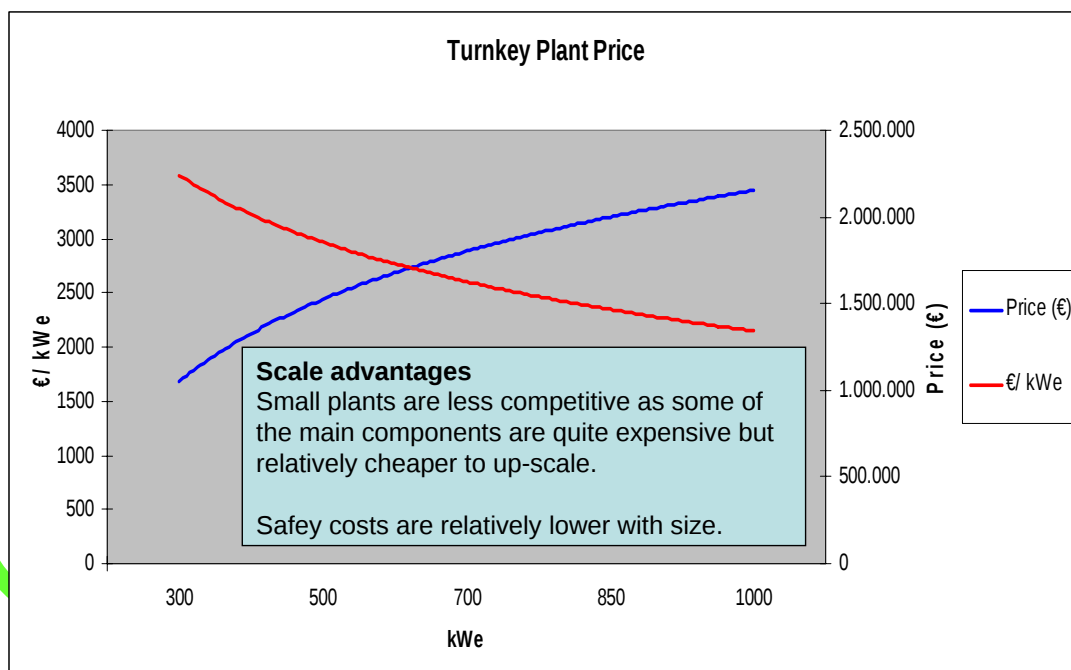
The inside of the gasifier



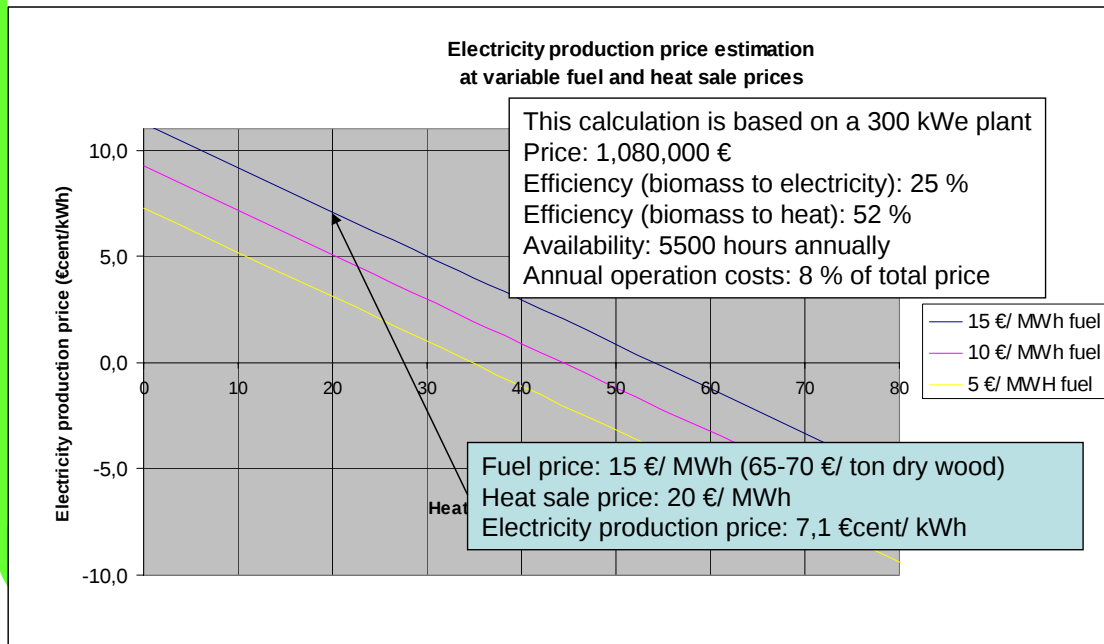
The fuel



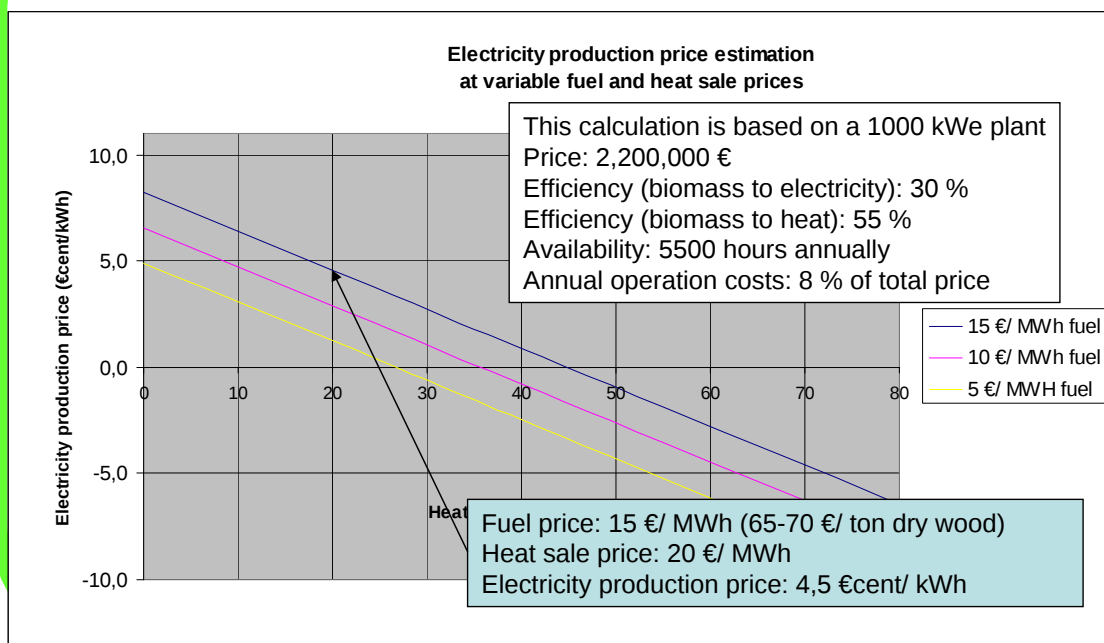
Turn Key Plant Price – Scale Advantages



Does it pay off to invest?



Does it pay off to invest?



Is it a fully Commercial Technology?

Not quite – TK Energi's gasifier cannot be considered a fully proven, standardised technology.

Mean time between failure is 800-1000 hours.

Char loss is still to big.

The investment is not completely risk free

Results from 3000 hours operation of this gasification plant in Denmark and Japan

- Low tar content in gas (10-80 mg/Nm³ with M above 69)
- Charloss from 2-10 %
- No sign of mechanical problems
- More fuel flexible than expected
- 22-26 % electric efficiency

Contact Information:

For visits and other information:

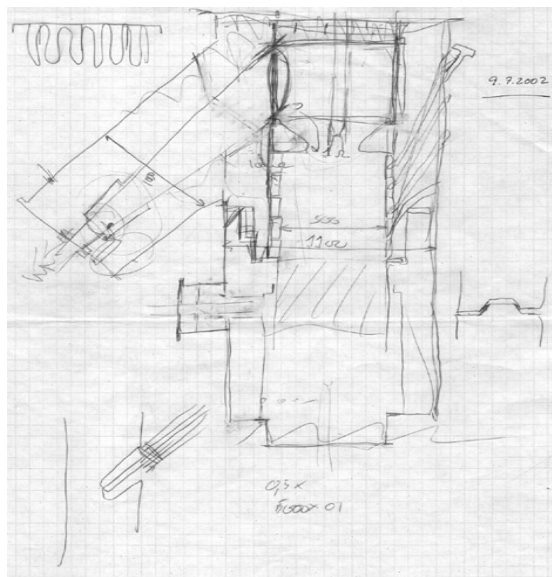
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Invent a gasifier



Gasifier No 1

- Air injection in the middle of the bed
- Biomass filter

What will happen if?

- Bridging and channeling in the bed
- Air inlet pipe in the middle will not last
- Biomass filter will start to pyrolyse

Gasifier No 2

- Cracking of tars with the heat from the hot zone in the gasifier.
- Holt cyclone followed by washing of the gas.

What will happen if?

- The heattransfer not sufficient to obtain tar cracking.
- It would work and produce waste water

Gasifier No 3

- A stage divided gasifier with dynamic separation of the reaction zones.

What will happen if?

- The gas transport pipes will corrode or melt.

Gasifier No 4

- A fluidbed with catalyst inside the primary reactor.

What will happen if?

- The catalyst will deactivate due to ash components.
- It would work and produce a gas