Symposium on using bioliquids in engines and turbines in CHP applications
Brussels, Belgium

Welcome to

SMALL SCALE CHP PLANTS BASED ON STIRLING ENGINES

Technology and Development

STIRLINGDK

Overview

- Introduction
- Stirling technology
- Burner for bio liquids
- Current and new installations
- Conclusions

Introduction on Stirling DK

Our mission:

- Conversion of low-value biomass/fuel into high-value CO2 neutral electricity and heat
- Plant sizes up to maximum 300kW electrical power output

Our delivery:

- Complete CHP plant (including updraft gasifier for wood chips)
- Combustion chamber with Stirling engine for special applications
- Stand alone engines (OEM-solutions)

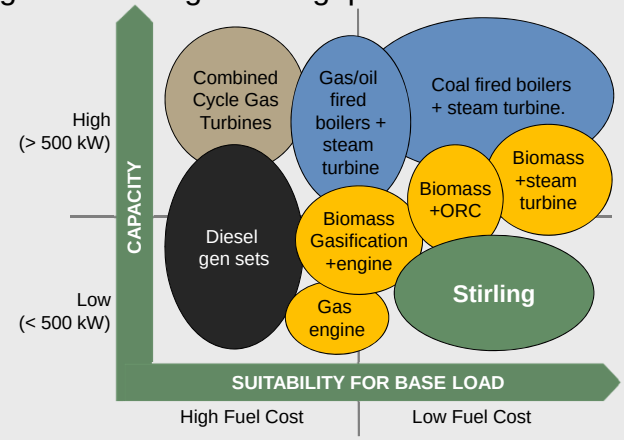

Biomass

district heating
processe heat

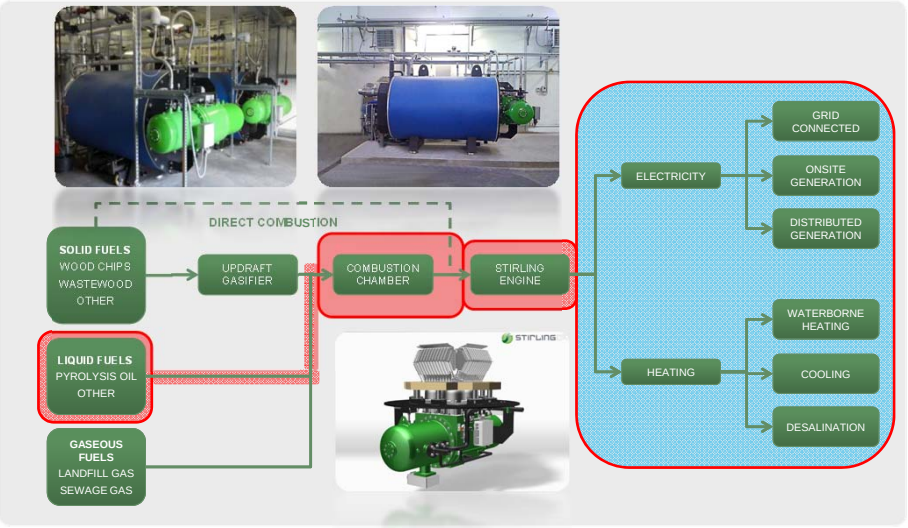
electrical power for
grid or local use

Why CHP based on Stirling engine ?

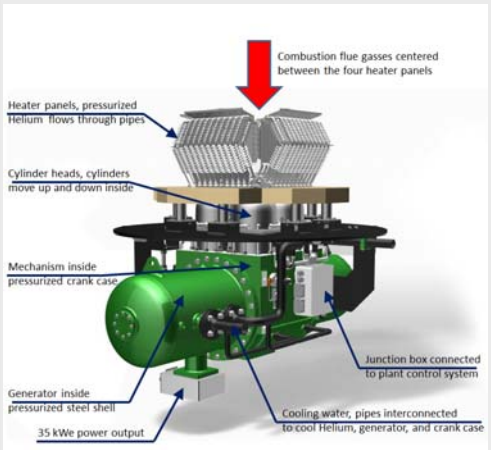
Stirling DK fills a significant gap in biomass CHP



Stirling DK product portfolio



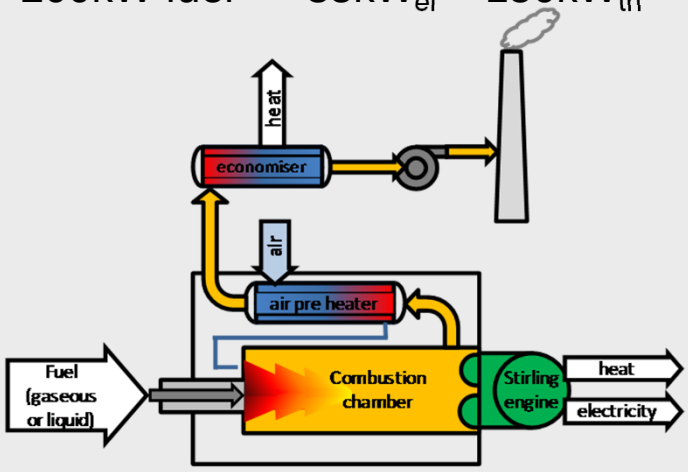
Stirling engine



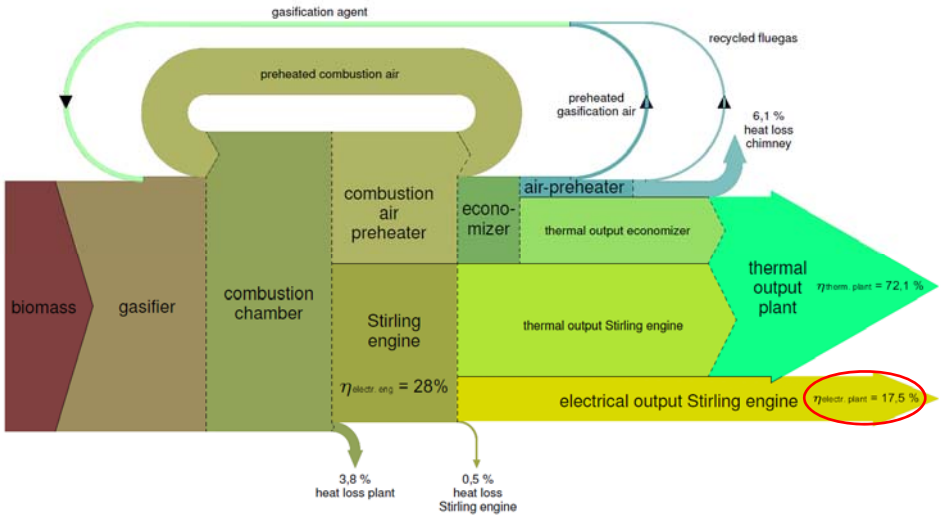
- Generates power through a closed cycle process
- Can be fuelled by any heat source / combustible material
- Heater design is able to cope with a considerable amount of depositions
- Optimised for low maintenance and long life span
- Stirling DK engine technology backed by 20-year research and development programme
- More than 40.000h of operation achieved on the engine

SDKs
plant PI diagramm

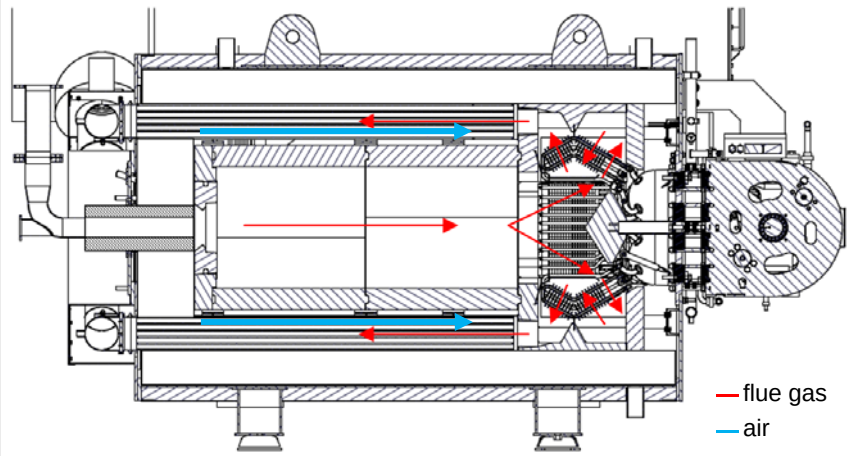
200kW fuel = 35kW$_{el}$ + 150kW$_{th}$



Energy flow



Combustion chamber
combustion chamber and burner



Syngas vs bioliquid
comparison

- What is the difference in running on syngas or bioliquids

  The Stirling engine actually doesn't care at all where he gets the heat from, only a high temperature flue gas is needed
- Corrosion issues

  The syngas from the updraft gasifier contains a lot of heavy liquid tars that have a low pH comparable to the low pH of pyrolysis oil
  Due to the fact that the engine heater only gets in contact with the flue gas there are no corrosion issues on the engine
- Ash depositions on the heater

  The heater is designed to cope with a considerable amount of depositions. The amount of solids in bioliquids as well as in the syngas are no problem for the Stirling engine

There is absolutely no doubt that this technology will work with bioliquids !

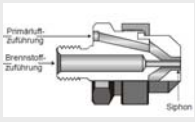
BUT .....there is no bioliquid burner available ....!

Bioliquid combustion
bioliquids and burner

- A wide range of bioliquids is possible, due to the utilization of preheated combustion air (450°C – 550°C):
  - Bioliquids with low heating values (below 16MJ/kg) can be used (3-5MJ/m³ it a typical HV of syngas from the gasifier)
  - High water contends in the oil can be accepted
  - No limitation on solid components or ash forming components
- Burner
  - Heating up of fuel due the position in COC (maybe cooling of fuel)
  - Utilisation of preheated combustion air (450°C-550°C)
  - For start up and pre heating of chamber a natural gas or oil burner is supplied within the standard configuration

Bioliquid Burner
technology investigations

- Technologies investigated:
  - Pressure atomisation / up to 30bar fuel pressure, fuel pump, corrosion,
  - Injector atomisation / simple injector, 10-20% of combustion air used
  - Rotating cup atomisation / problem with high air pre heating, not reasonable for small scale, moving parts
- Burner companies contacted:
  Oilon (Finnland); Riello (Italy); Weisshaupt, Dreizler, Düsen Schlick (Germany)
- There is no ready to market bioliquid burner available for 200kW fuel input and utilization of preheated air



Bioliquid Burner
development and partners

- Düsen Schlick:
  - Development of injector atomisation injector nozzle that can fullfill the demands of atomisation and combustion
  - Initial test on atomization system
  - A few hours of operation on pyrolysis oil (assisted by pilot burner)

- CanmetENERGY (Canada):
  - We are now about to establish a cooperation with CanmetENERGY. This company has a long history and a lot of experience in the development of bioliquid burners. They working together with ENSYN a producer of liquid fuels

Stirling DK
operating experience

- On bioliquids (pyrolysis oil):
  - Initial test on atomization system
  - A few hours of operation on pyrolysis oil (assisted be pilot burner)
- On wood chips (syngas from updraft gasifier):
  - More than 40.000h of operating experience on the Stirling engine

Current installations

Stirling engine on gaseous fuel (waste water treatment, Germany)

Current installations

single engine plant Technical University Denmark

Current installations
single engine containerised plant

New installations
4 engine installation Tabarz, Germany

Stirling DK
Conclusions

- Utilization of bioliquids on the Stirling engine is not a problem due to external combustion
- The Stirling engine in combination with the combustion chamber is a proven ready to market technology
- A burner that is able to fulfill the demands of the Stirling engine combustion chamber with the high air preheating is under development
- Currently SDK expects to have the technology for bioliquids fully developed until the end of 2012

Thank you for your attention and interest in **Stirling DK**

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