



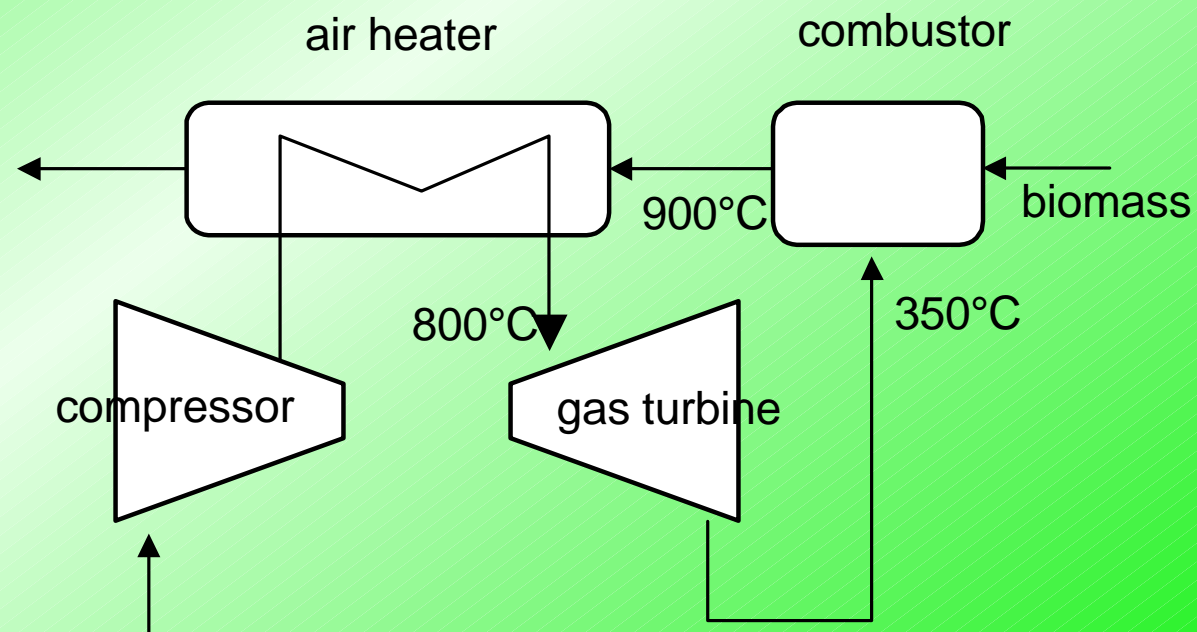
# Status of External Firing of Biomass in Gas Turbines

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# What is indirect firing ?



- ◆ Firing occurs externally, and heat is transferred into the GT cycle through heat exchange.



# *Why indirect firing ?*

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- ◆ It 'keeps the ashes out of the engine' : it is an indirect route to use biomass for power production

# *EFGT review papers (KTH, Sweden)*

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- ◆ Anheden and Alroth (1997)
- ◆ Yan (1998)
- ◆ Yan and Eidenstein (2000)
- ◆ Mainly devoted to coal

# Contents

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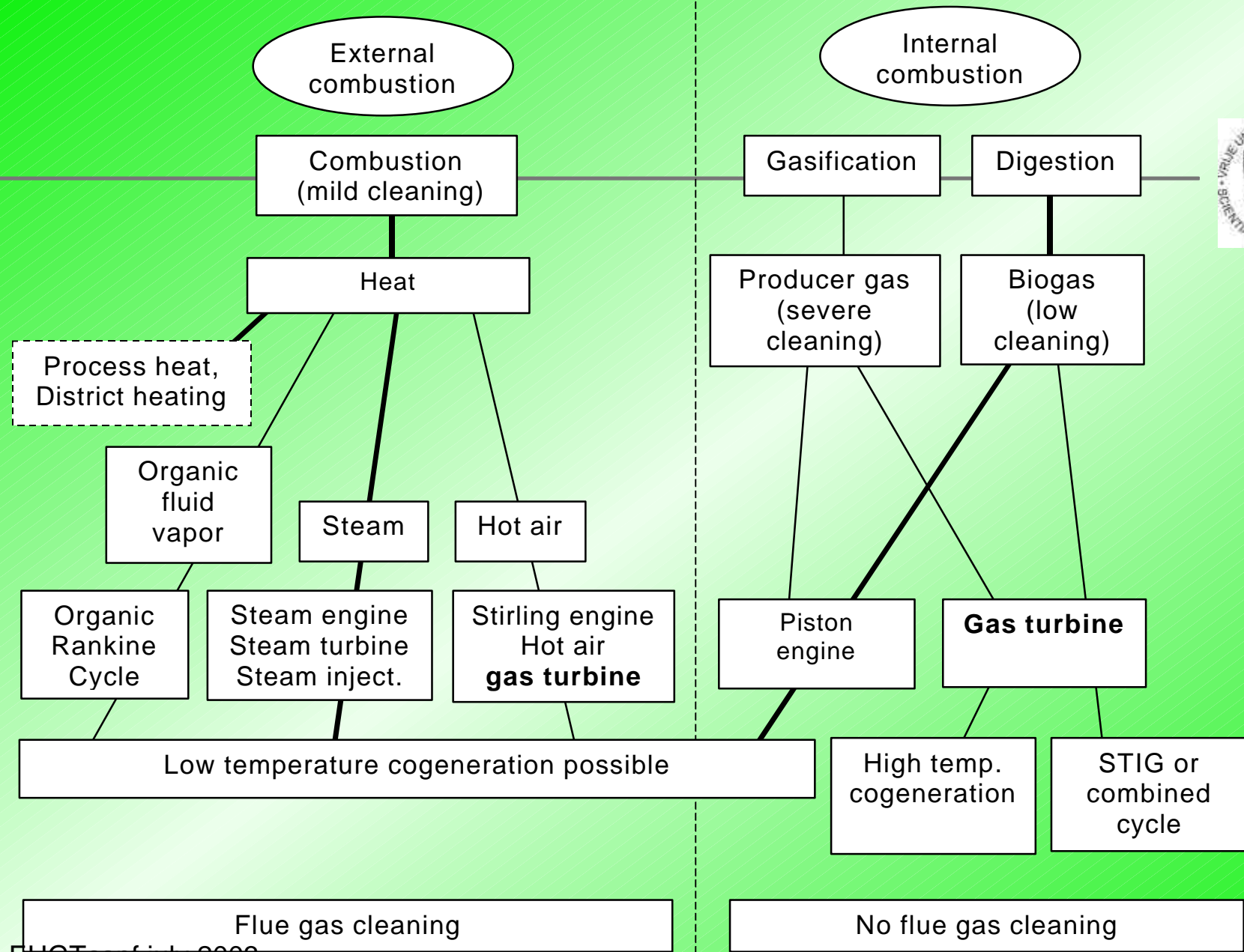
- ◆ What is the best way to use biomass ?
- ◆ Biomass EFGT investment costs
- ◆ Overall status of EFGT
- ◆ Biomass EFGT projects
- ◆ Outlook

# *Biomass is not the same as coal*

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- ◆ The use of biomass is still challenging
- ◆ Often dirty, low energy and mass density, fuel handling difficult and costly
- ◆ Fuel properties quite variable
- ◆ Scale often limited, leads to cogeneration or heat-only production



# *Two routes for Air Heaters*

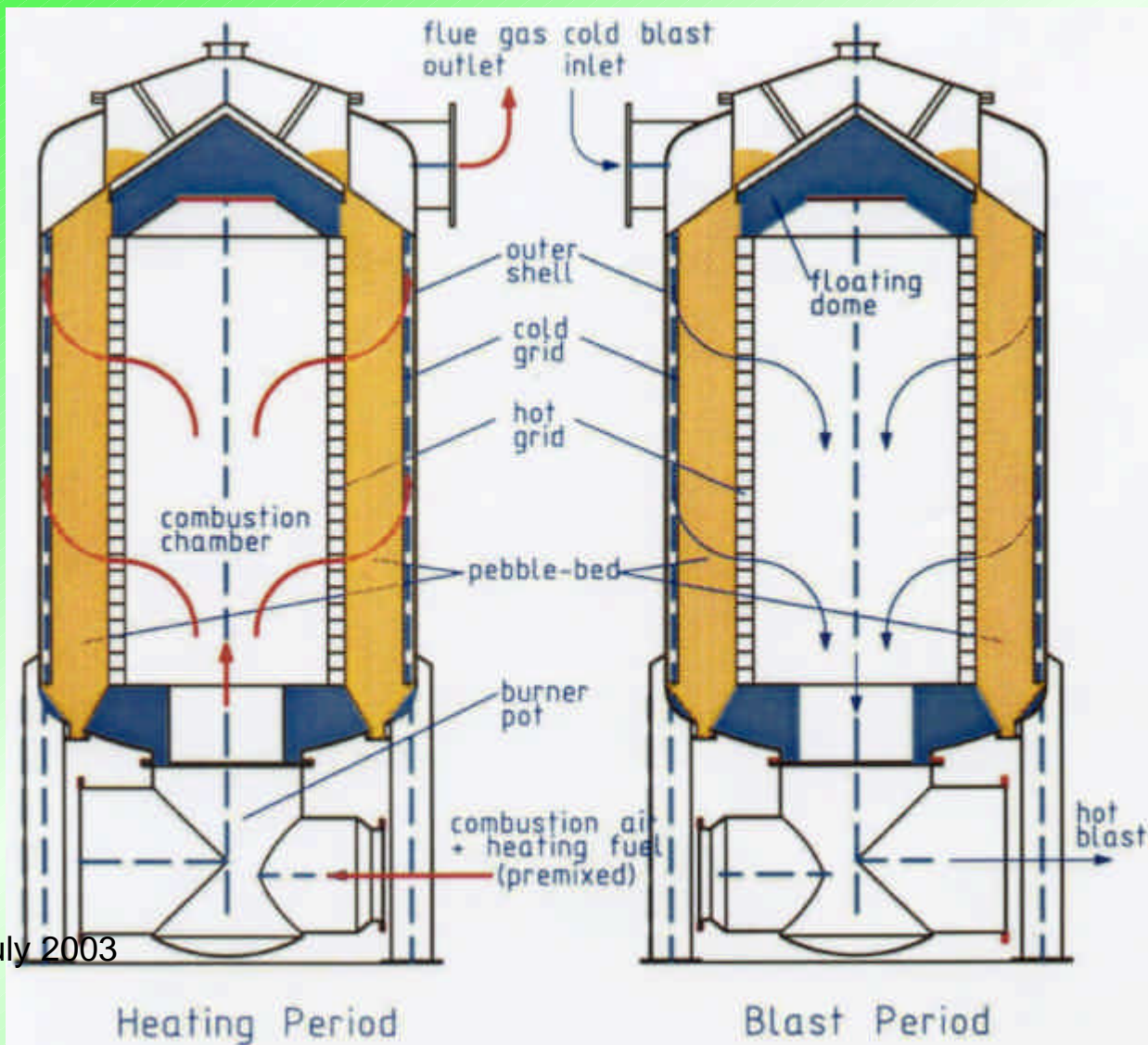
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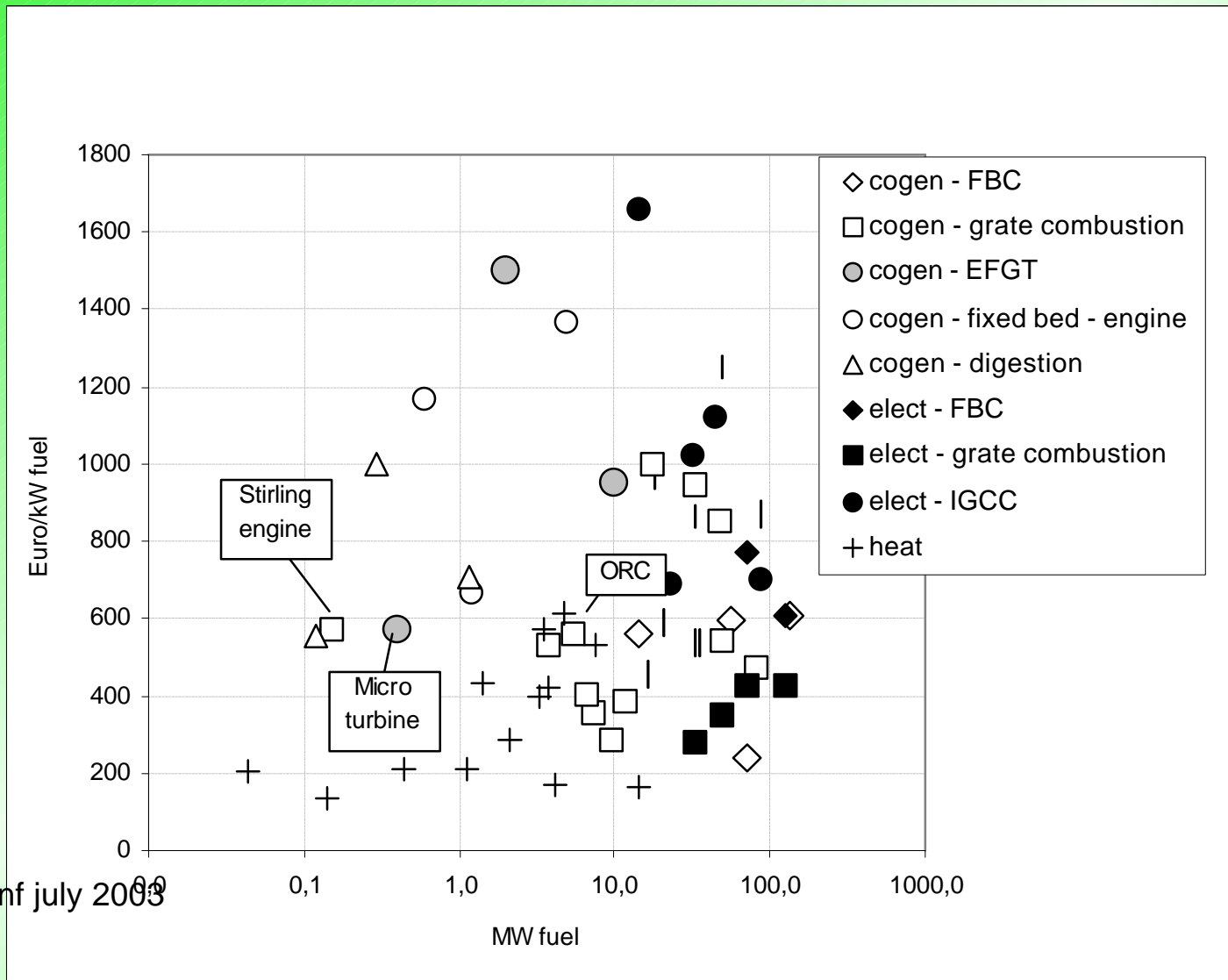
- ◆ Ceramic heaters :
  - High efficiency, large scale
  - Not yet available, in particular for biomass
  - Cost ??
  
- ◆ Metallic heaters :
  - Available technology
  - Tested for biomass (FAIR-CT95-0291)
  - Applied in two biomass demonstration projects



# Regenerative air heater ?



# Biomass EFGT investment cost



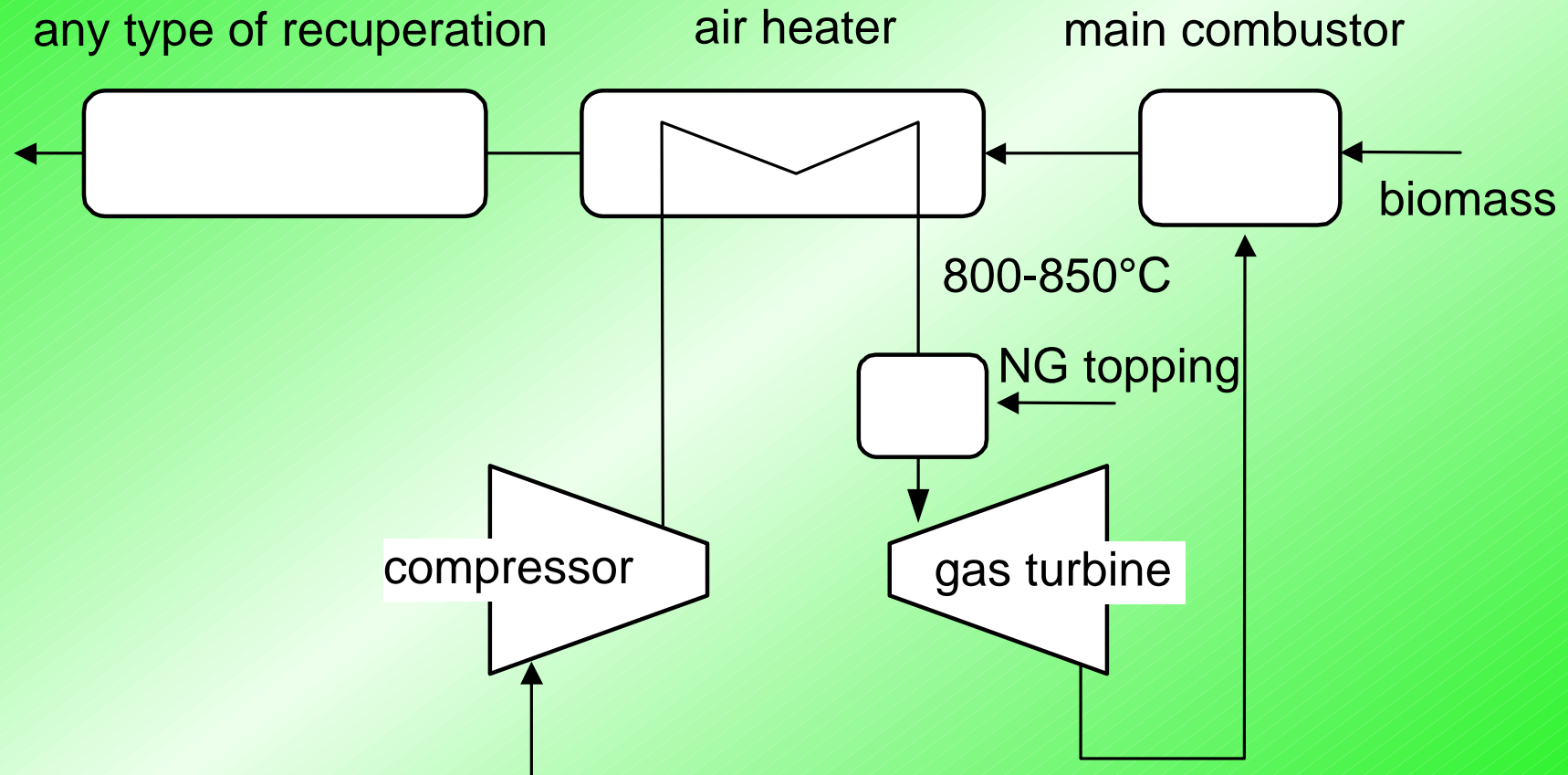
# *Biomass EFGT investment cost*

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- ◆ Should not exceed 600 Euro/kWth investment
- ◆ Market niche < 2-3 MWth
- ◆ CHP (heat driving component)
- ◆ Total energy usage most important

# Past experience : cycle layout



# *Past experience on Biomass EFGT*

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- ◆ Cogeneration : electric efficiency is less critical
- ◆ Simple cycle arrangements found to be the most economic
- ◆ No ceramic air heaters

# *Past experience on Biomass EFGT*

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FAIR-CT95-0291, 1995-1999, coordinated by Biomass Technology Group NL :

- ◆ Materials tested HR120, HR160, SS310
- ◆ Simple cycle, cogeneration, 250 kW<sub>e</sub>
- ◆ 19% Electric efficiency
- ◆ Conventional Shell and Tube air heater
- ◆ Low cost turbomachinery (marine tbchr)
- ◆ Meets 600 euro/kW<sub>th</sub> criterion

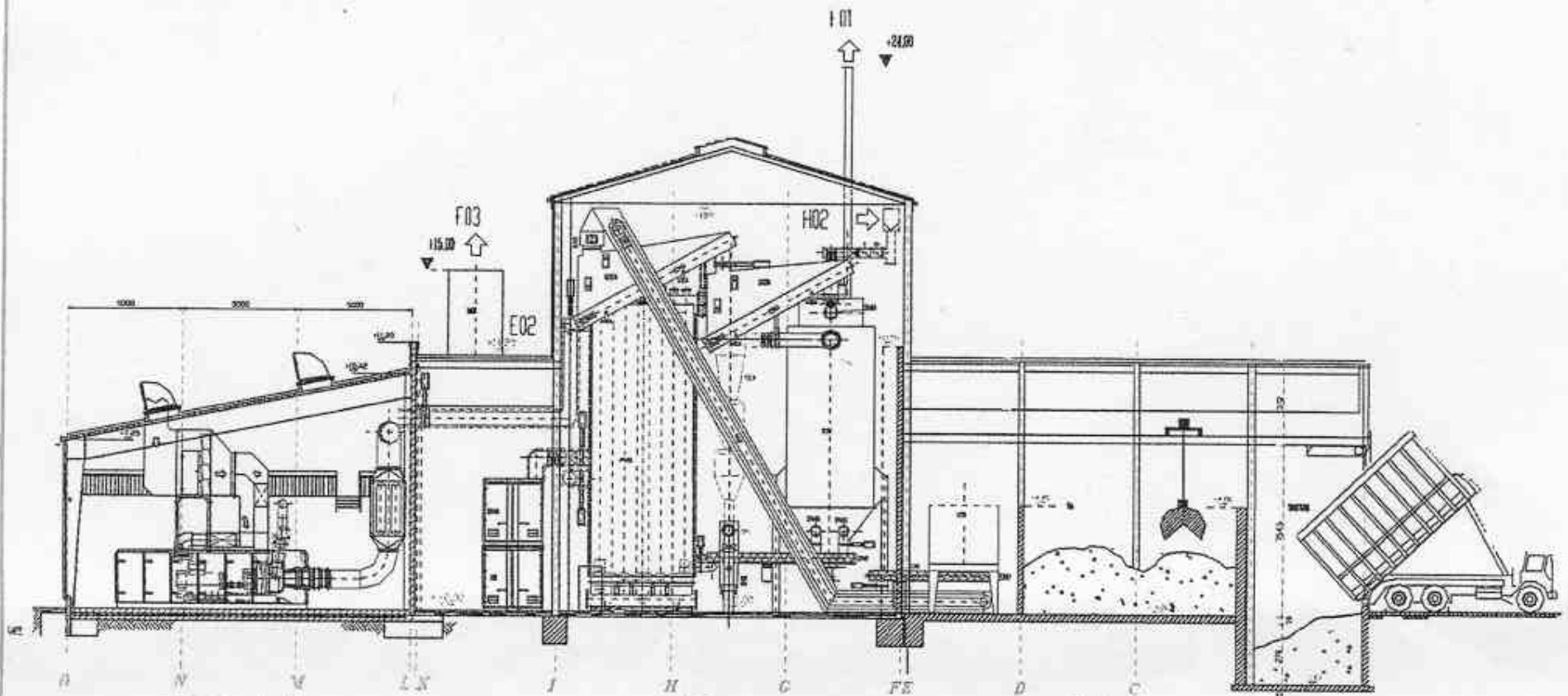
# *Past experience (Siebenlehn-Freiberg)*

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- ◆ About 3 MWe
- ◆ Largest fixed bed downdraft gasifier
- ◆ Metallic air heater
- ◆ Combined cycle/cogeneration
- ◆ 27% efficiency/23% efficiency-73% energy usage in cogeneration mode
- ◆ Has been in operation, continuation unclear

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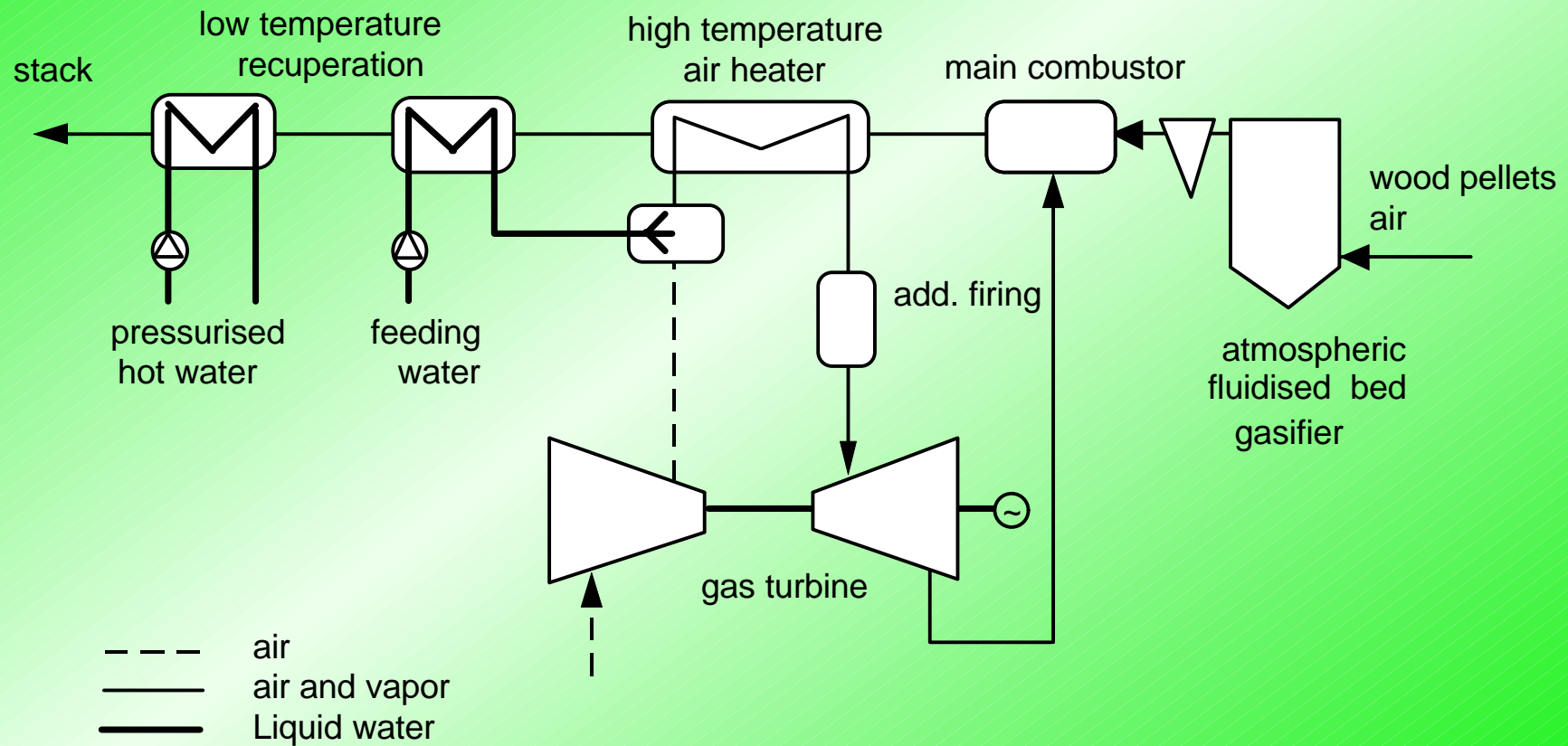
EUGTECH July 2003

gasification part

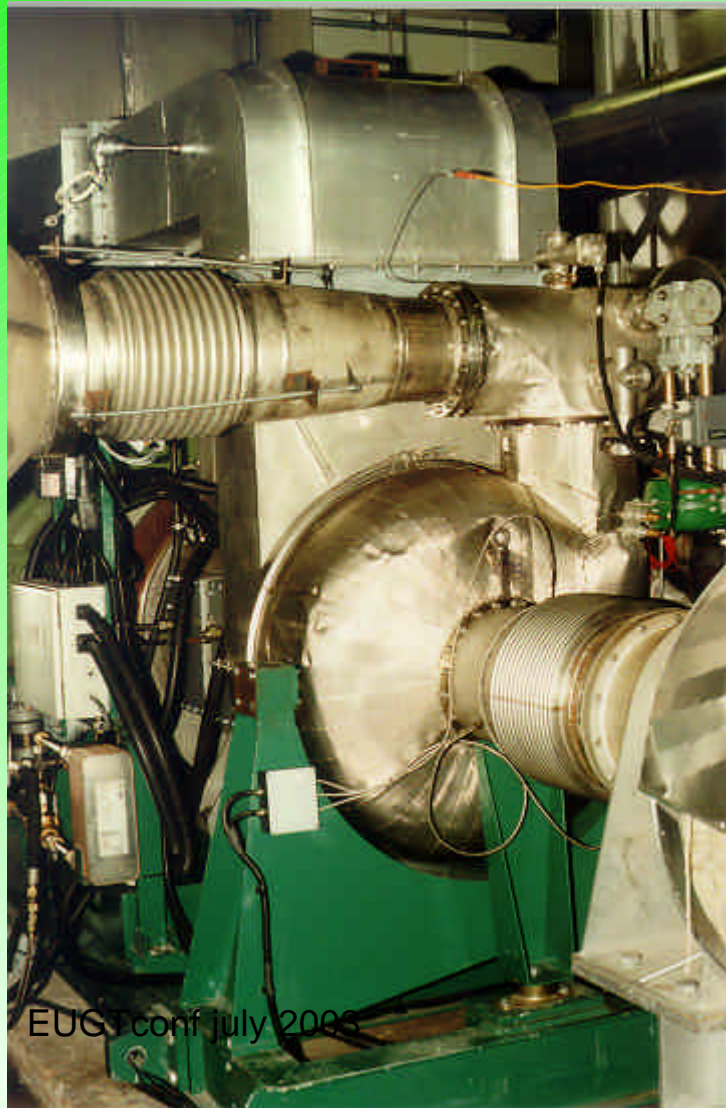
wood storage



# Past experience (Thermie, VUB, 1994-2002)



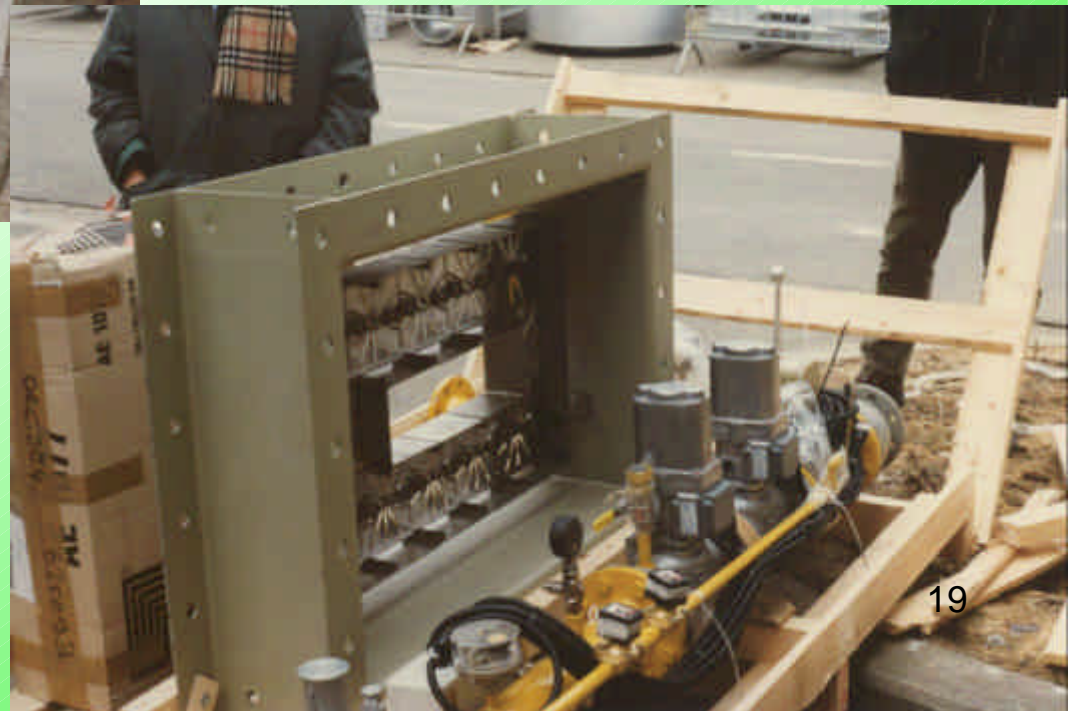
# *Past experience (Thermie)*



EUGTconf July 2006



# *Past experience (Thermie)*



EUGTconf july 2003

## *Past experience (Thermie, VUB)*

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- ◆ Lower specific engine cost
- ◆ Better to separate compressor and expander
- ◆ Topping combustion is a must
- ◆ Complete separation of biomass island, much less integration
- ◆ Shut down, mainly for economic reasons

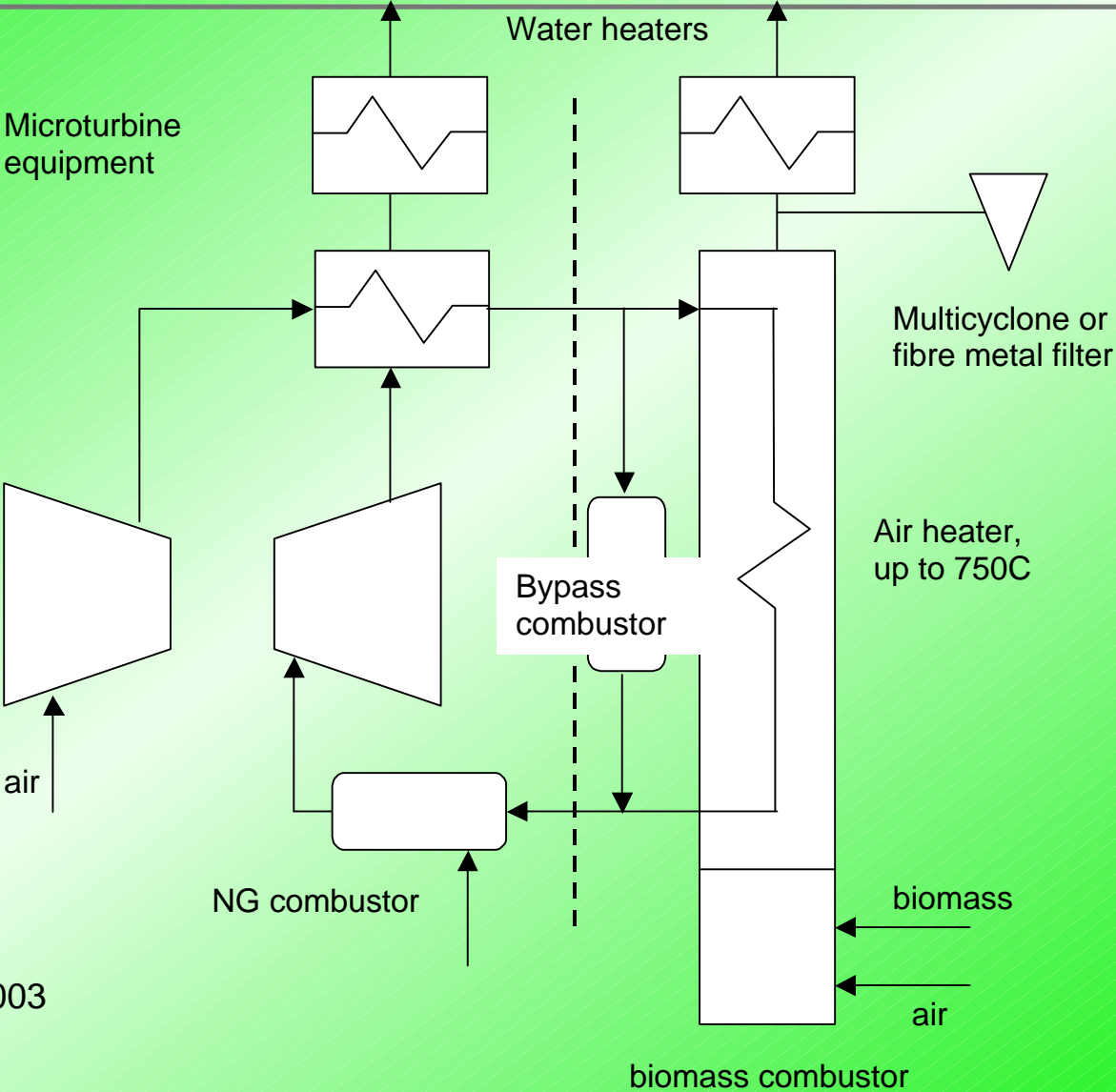
# *New project, new approach*

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- ◆ Should not exceed 600 Euro/kWth
- ◆ Use of a microturbine meets the requirements, niche biomass market
- ◆ Based on combustion rather than gasification
- ◆ Co-utilisation biomass-natural gas

# New project layout



# Economic aspects



	units	reference	60% biomass EFGT
heat recovery	kW <sub>th</sub>	260	345
natural gas consumption	kW <sub>th</sub>	530	285
biomass consumption	kW <sub>th</sub>	-	345
global energy usage	%	78	79
net electric efficiency	%	26.5	22
investment all in	kEuro	190	360
specific investment	Euro/kW <sub>th</sub> input	360	575
O&M	% capital	1	4
natural gas rate	Euro/GJ	4	4
biomass cost	Euro/GJ	-	1
electric energy value	Euro/kWh <sub>e</sub>	0.08	0.10
heat value	Euro/GJ	7	7
run hours	Hours/year	5 000	5 000
natural gas cost	kEuro/year	38.2	20.5
biomass cost	kEuro/year	-	6.2
kWh <sub>e</sub> savings	kEuro/year	53.4	75.2
kwh <sub>th</sub> savings	kEuro/year	32.9	43.5
simple payback time	years	4.1	4.6

# *Project status*

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- ◆ +/- 250 000 euro funding from Electrabel
- ◆ T100 installed, will be operated in standard conditions during the warranty period
- ◆ Negotiations started with two potential air heater constructors

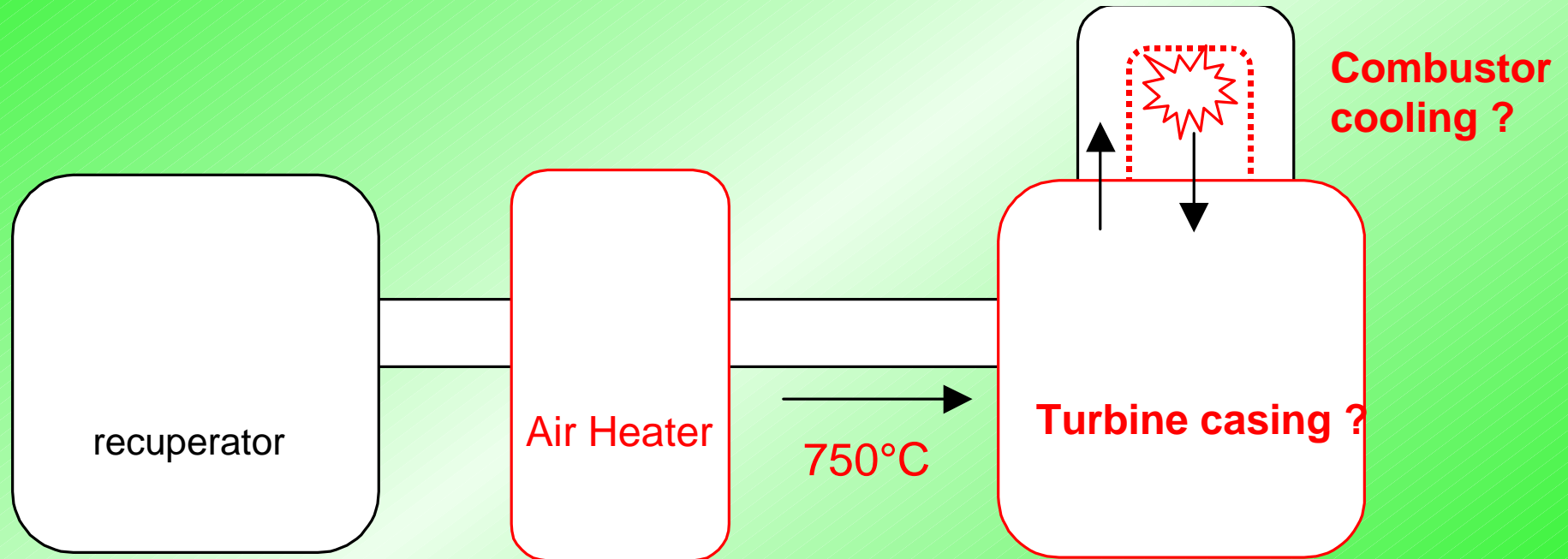


# *Project status*

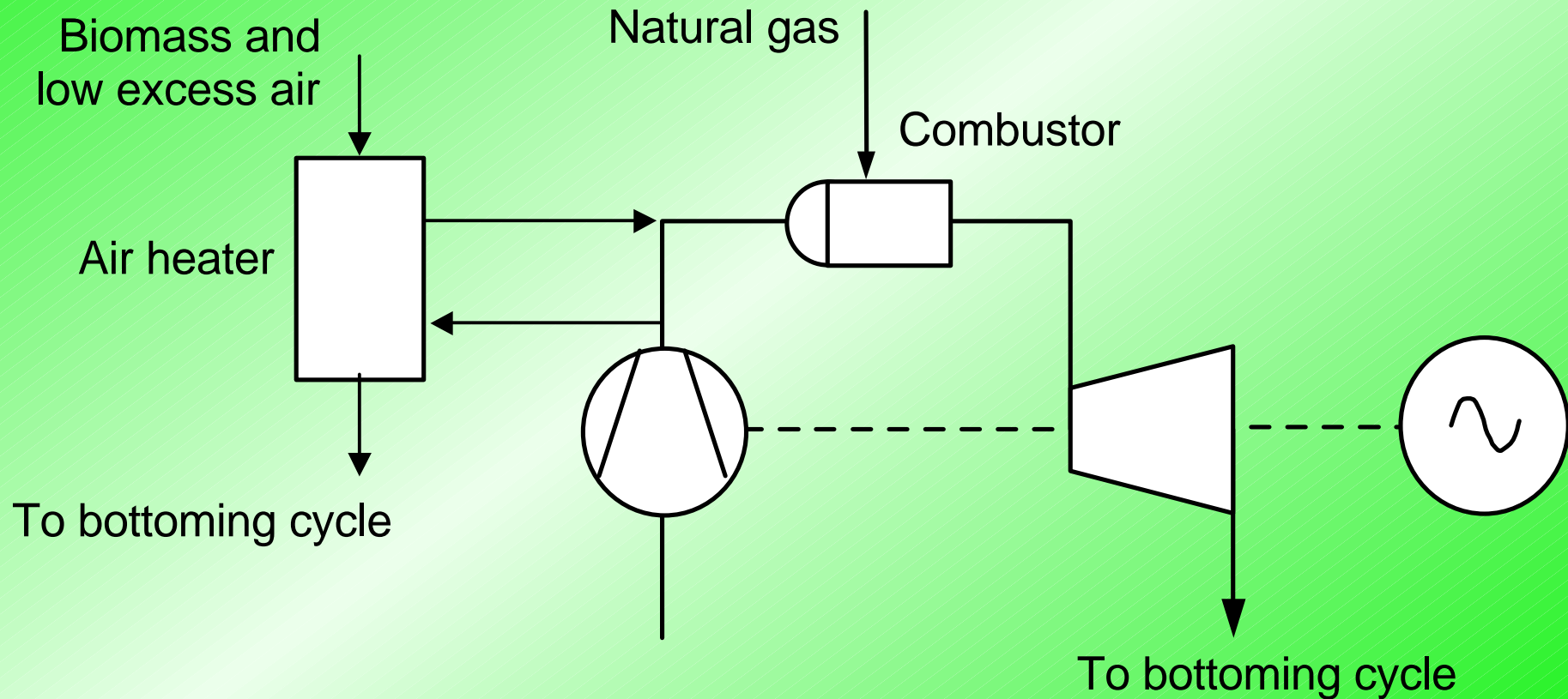


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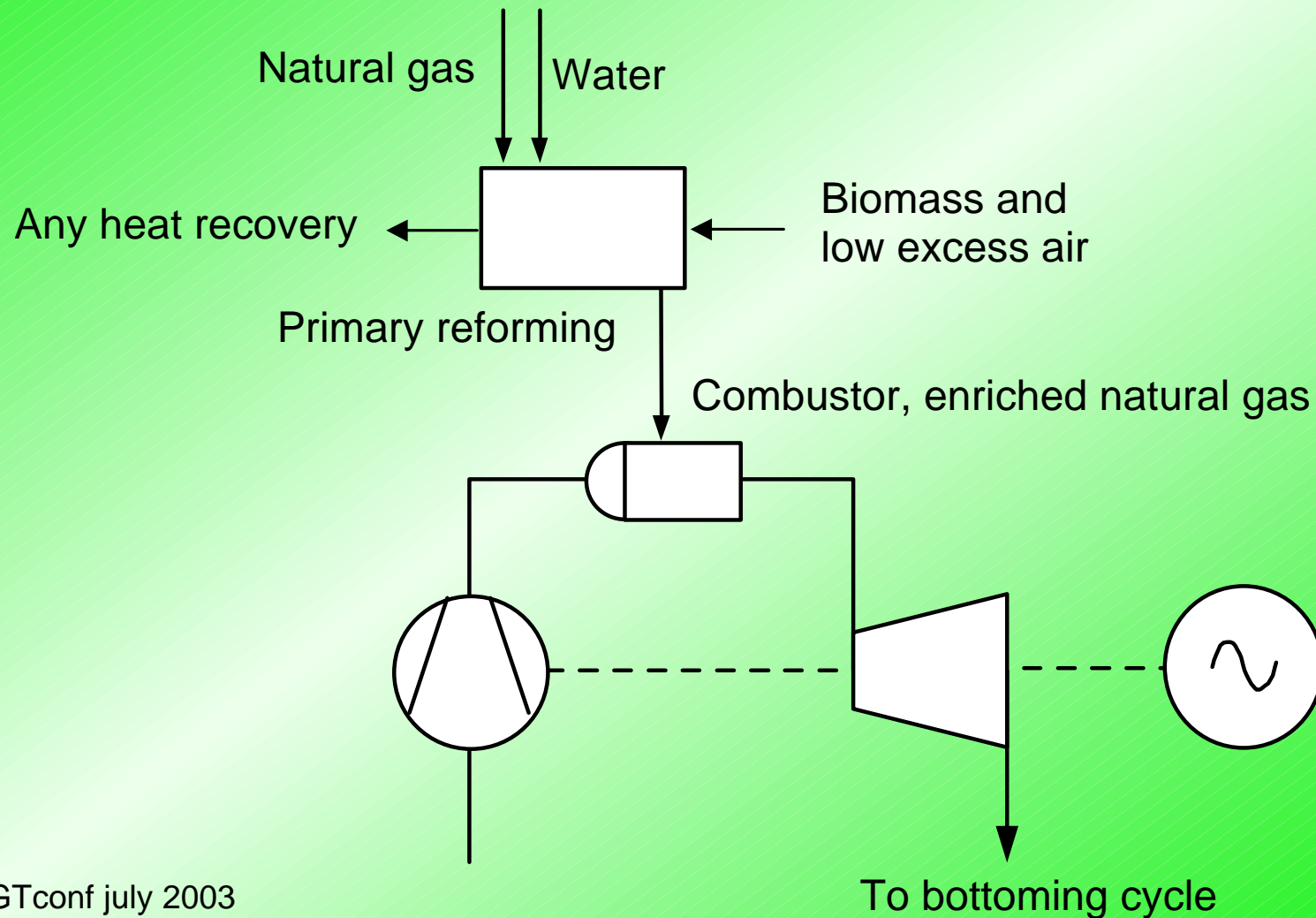
# Project status



# *Biomass co-utilisation in combined cycles ?*



# Biomass co-utilisation in combined cycles ?



# Conclusions

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- ◆ Biomass EFGT offers possibilities under certain conditions
- ◆ Metallic air heaters, topping combustion
- ◆ Small scale : simple cycle arrangements, low cost turbomachines, cogeneration critical, combustion
- ◆ Co-utilisation with natural gas : EFGT offers possibilities for use of biomass in combined cycles