CHALMERS
UNIVERSITY OF TECHNOLOGY

SFC

Status of Gasification in Europe

Professor Henrik Thunman

Chalmers University of Technology

Project within Europe aimed for SNG

GoBiGas 20 MW (mothballed) + (100 MW cancelled)
Demonstration/Commercial

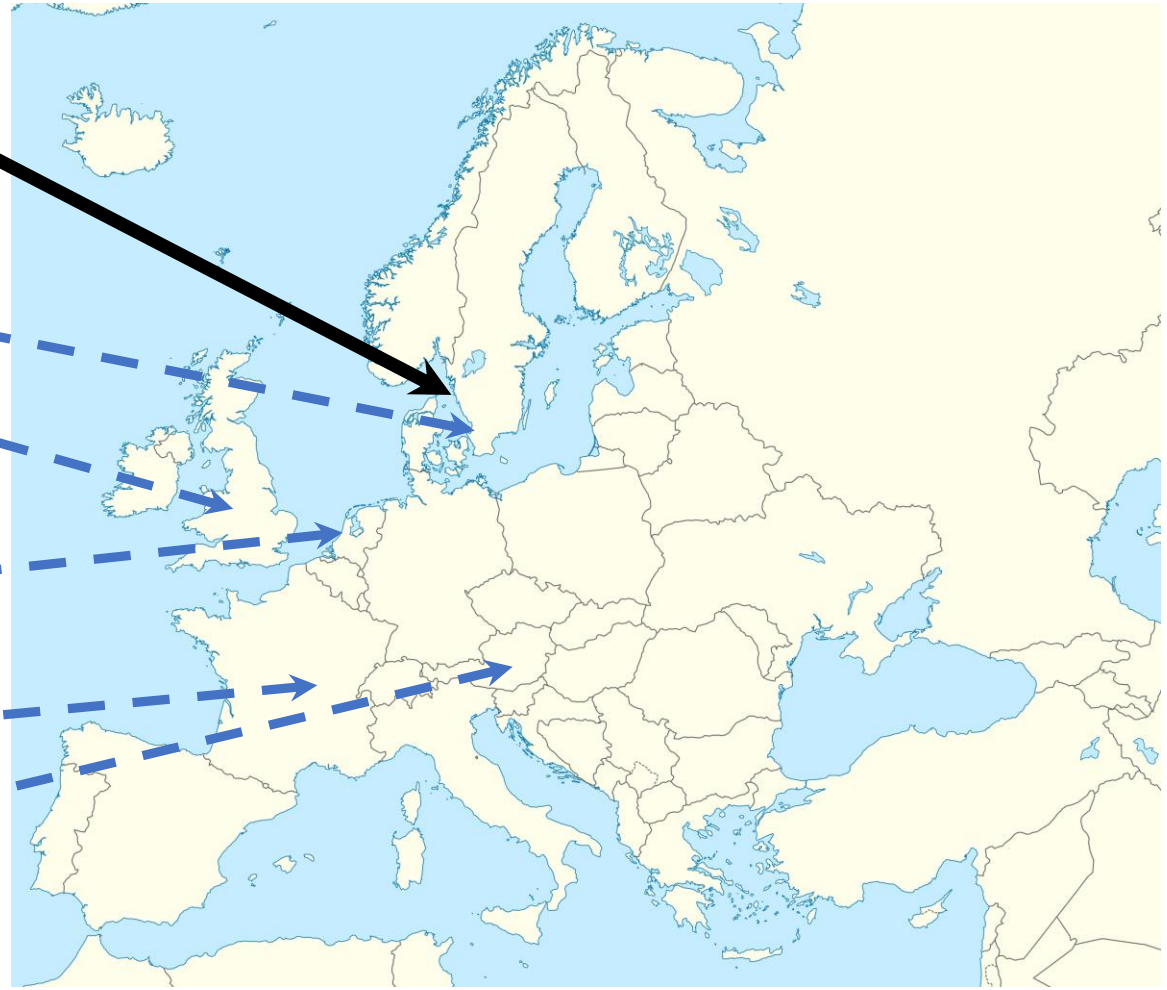
Bio2G 200 MW (cancelled)
Commercial

GoGreenGas ~0.08 MW + (3 MW under construction)
Demonstration

AMBIGO Project 2.8 MW (waiting contracts and permits)
Demonstration
SWC System modules of 1 MW (under commissioning)

Gaya project ~0.35 MW (under commissioning)
Demonstration

BioSNG 1 MW (closed)
Demonstration

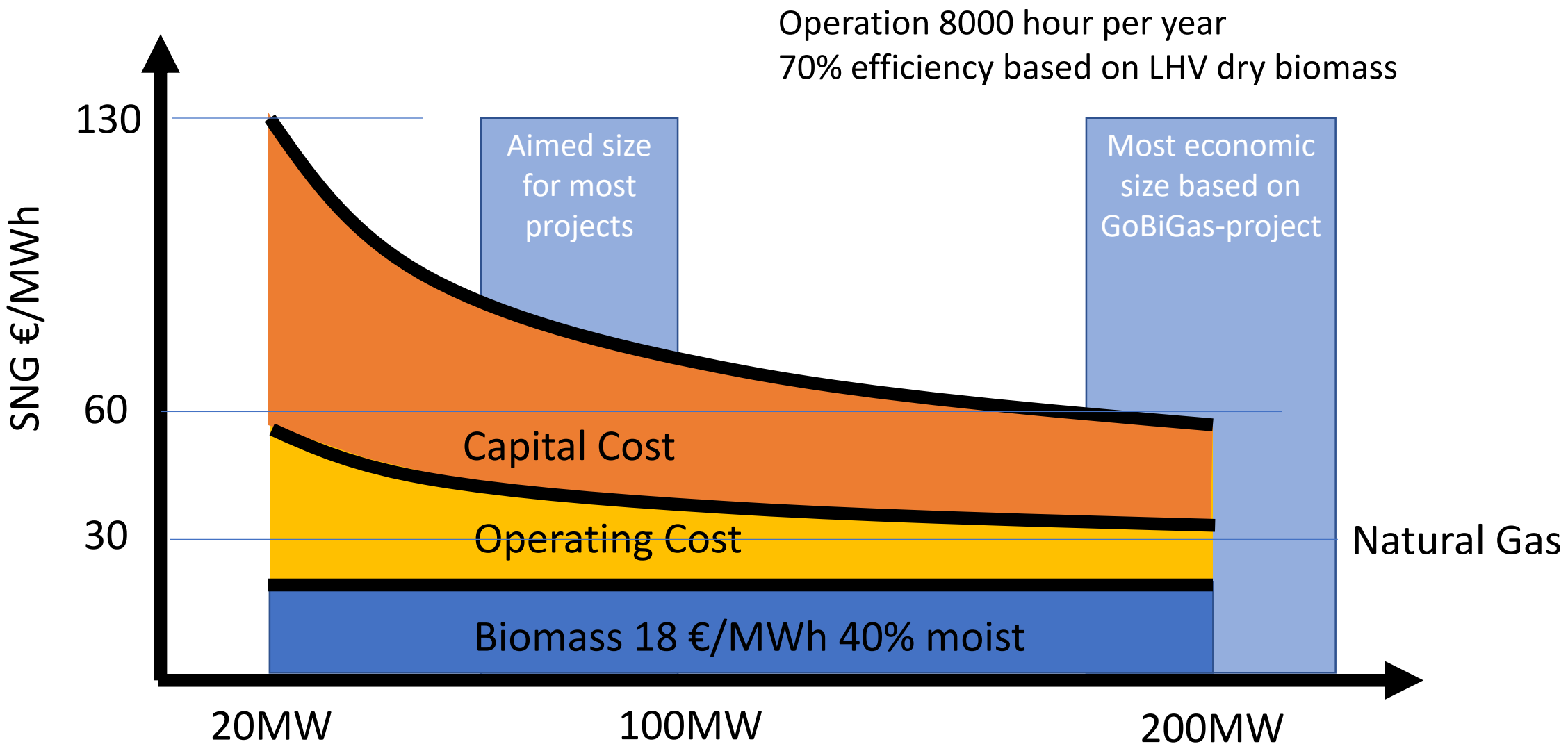


CHALMERS
UNIVERSITY OF TECHNOLOGY

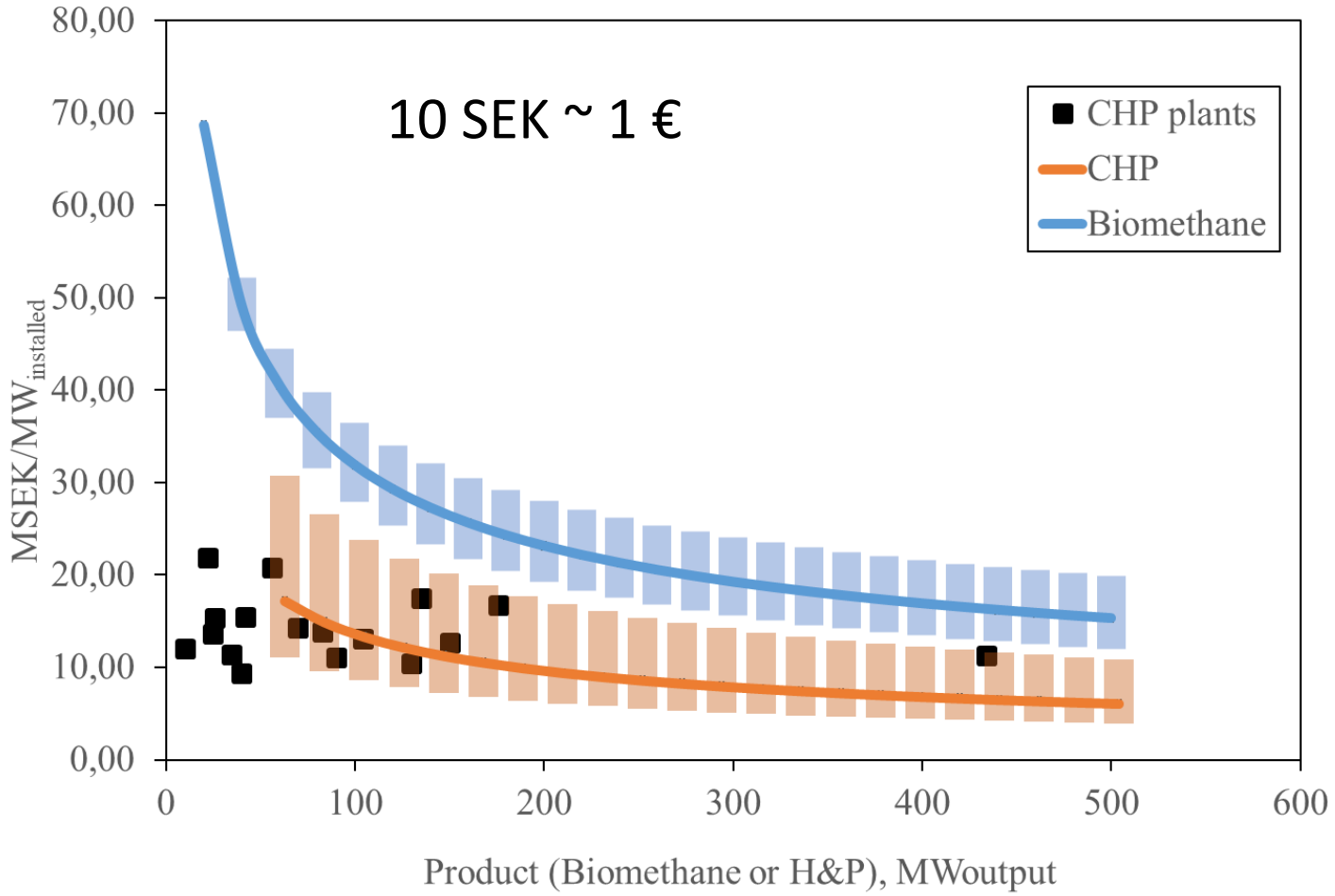
SFC

Outlook on SNG production via Gasification based on the GoBiGas experiance

Cost for SNG via gasification as function of Scale



Comparision SNG-plant with CHP-plant

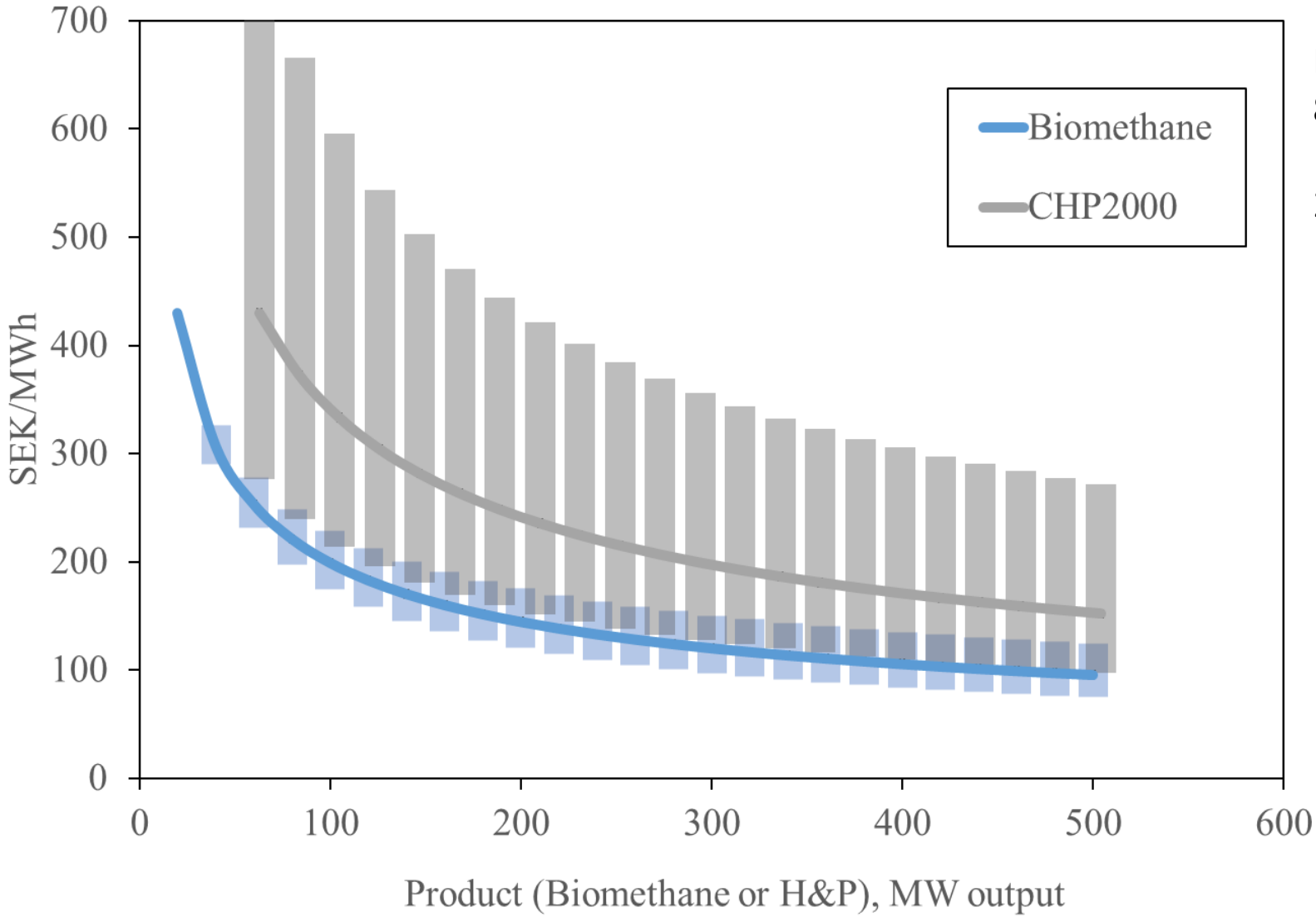


Annual utilization pf plant

CHP-plant ~ 25%
SNG-plant ~ 90%

=> 3.5 times more utilization of a SNG-plant than a CHP-plant

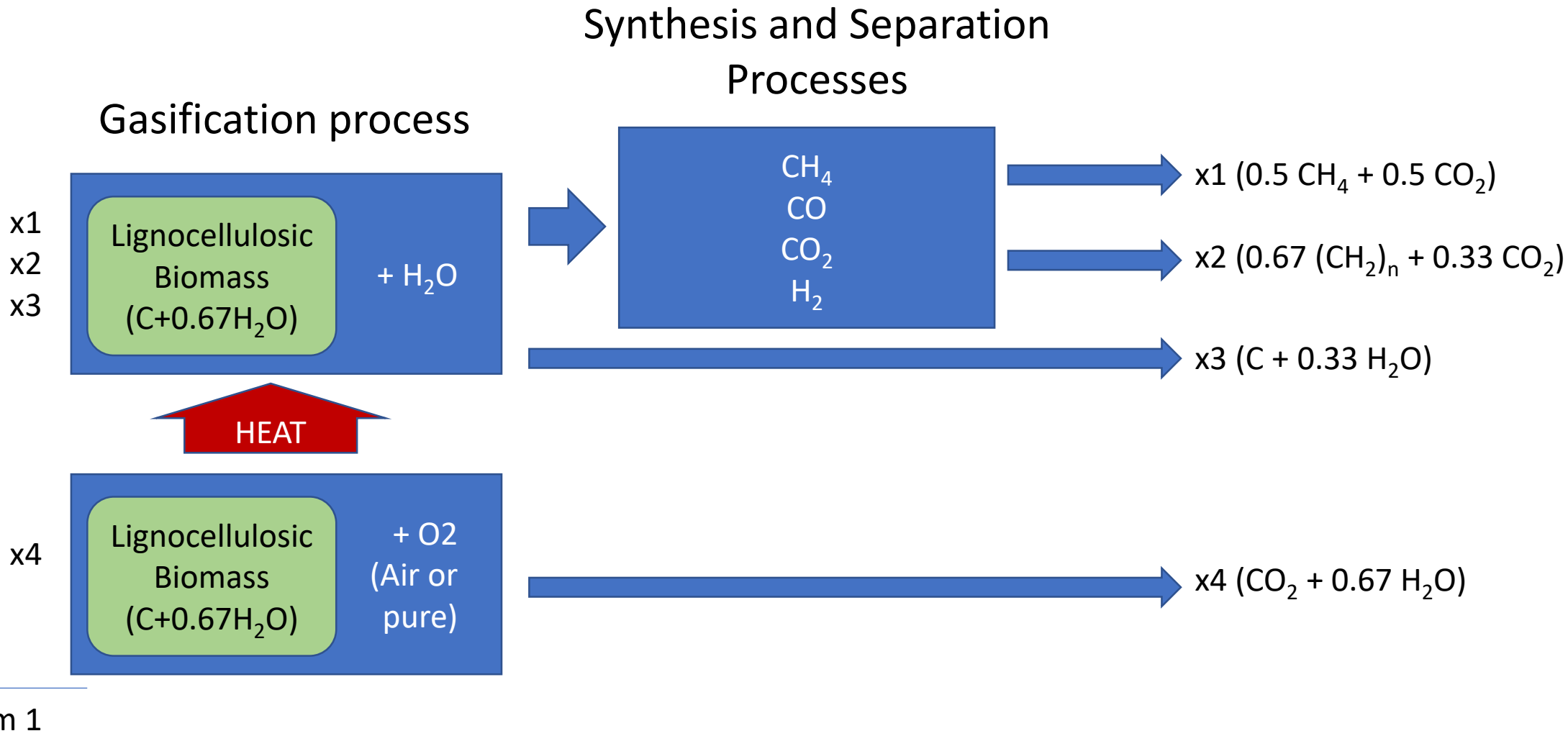
Investment cost comparison based on annual production



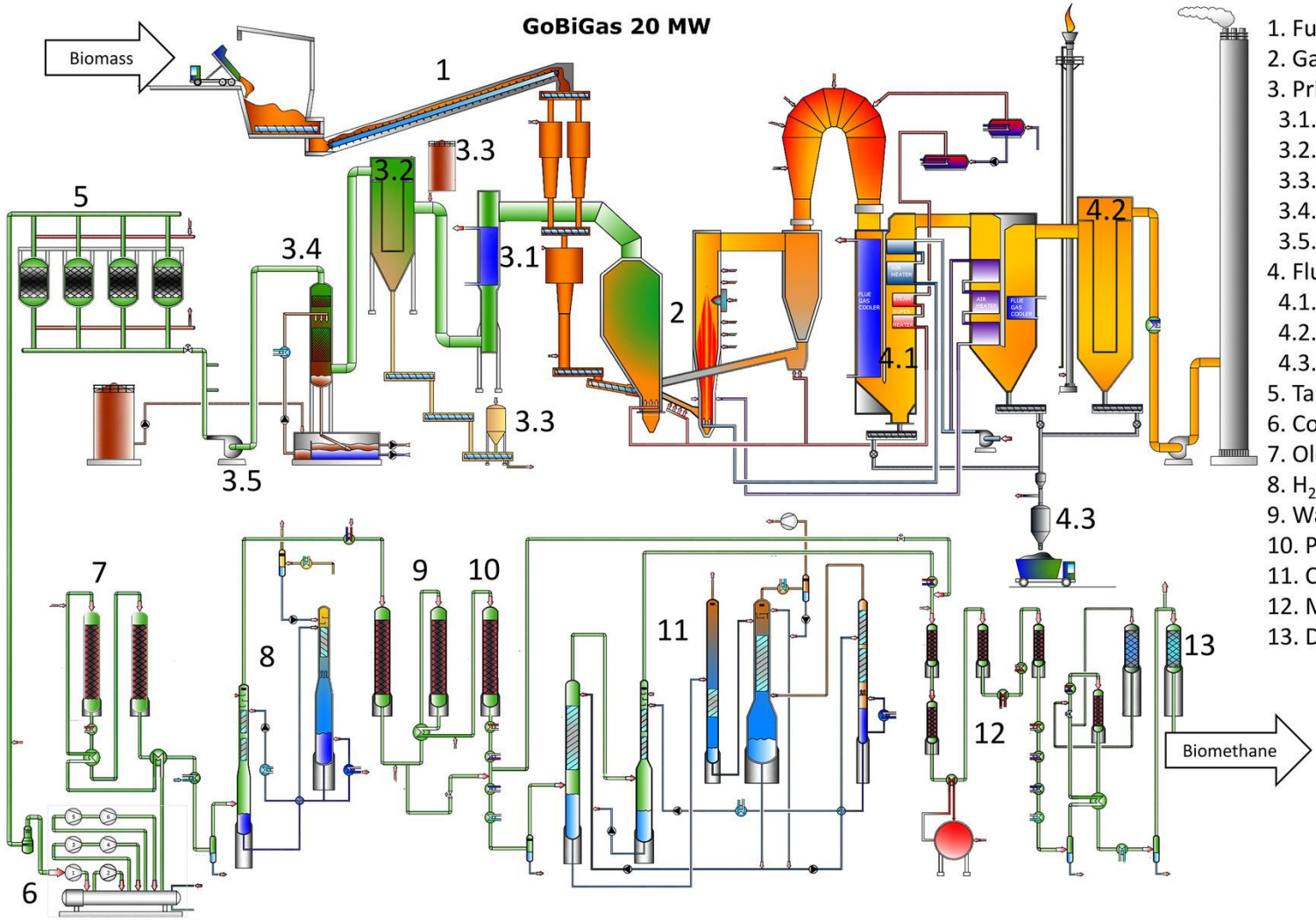
Full load hours
8000 h

2000 h

Process


Synthesis and Separation Processes
Gasification process
x1
x2
x3
Lignocellulosic Biomass (C+0.67H2O)
+ H2O
CH4
CO
CO2
H2
x1 (0.5 CH4 + 0.5 CO2)
x2 (0.67 (CH2)n + 0.33 CO2)
x3 (C + 0.33 H2O)
HEAT
x4
Lignocellulosic Biomass (C+0.67H2O)
+ O2 (Air or pure)
x4 (CO2 + 0.67 H2O)
Sum 1

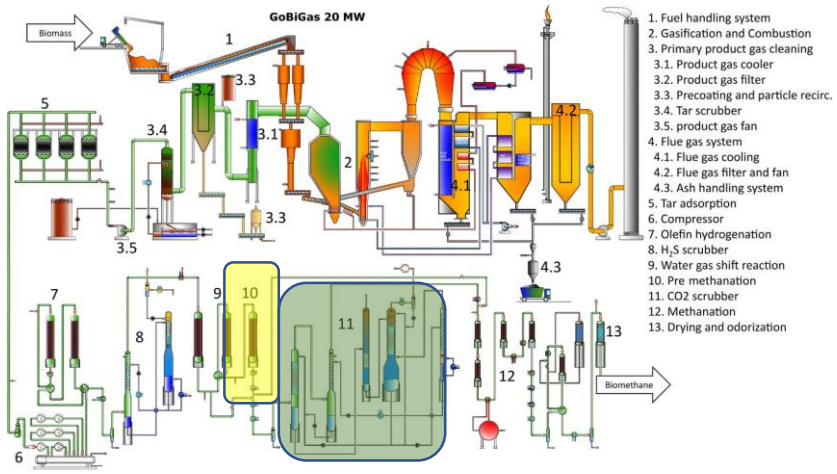
SNG –process and possible simplifications



1. Fuel handling system
2. Gasification and Combustion
3. Primary product gas cleaning
   - 3.1. Product gas cooler
   - 3.2. Product gas filter
   - 3.3. Precoating and particle recirc.
   - 3.4. Tar scrubber
   - 3.5. product gas fan
4. Flue gas system
   - 4.1. Flue gas cooling
   - 4.2. Flue gas filter and fan
   - 4.3. Ash handling system
5. Tar adsorption
6. Compressor
7. Olefin hydrogenation
8. H_2S scrubber
9. Water gas shift reaction
10. Pre methanation
11. CO2 scrubber
12. Methanation
13. Drying and odorization

SNG – process reactor system costs (20 MW SNG)

1	Fuel handling system	5 040
2	Gasification and Combustion	2 949
3	Primary product gas cleaning	2 378
4	Flue gas system	1 893
5	Tar adsorption (AC filter)	1 062
6	Compressor	3 459
7	Olefin hydrogenation	906
8	H2S scrubber	915
9	Water-Gas Shift reaction	529
10	Premethanation	515
11	CO2 scrubber	1 757
12	Methanation	1 941
13	Drying and odorization	497
	TOTAL COST, PROCESS SYSTEMS, k€	23 841



This reactor determine end product SNG or FT-crude, if pressure is increased methanol, DME, mixed alcohols.
~2% of reactor system costs

If hydrogen is added to the process from electrolysis the CO2 will be converted to end product and the scrubber can be removed

SNG – process auxiliary equipment and project costs 20 MW SNG

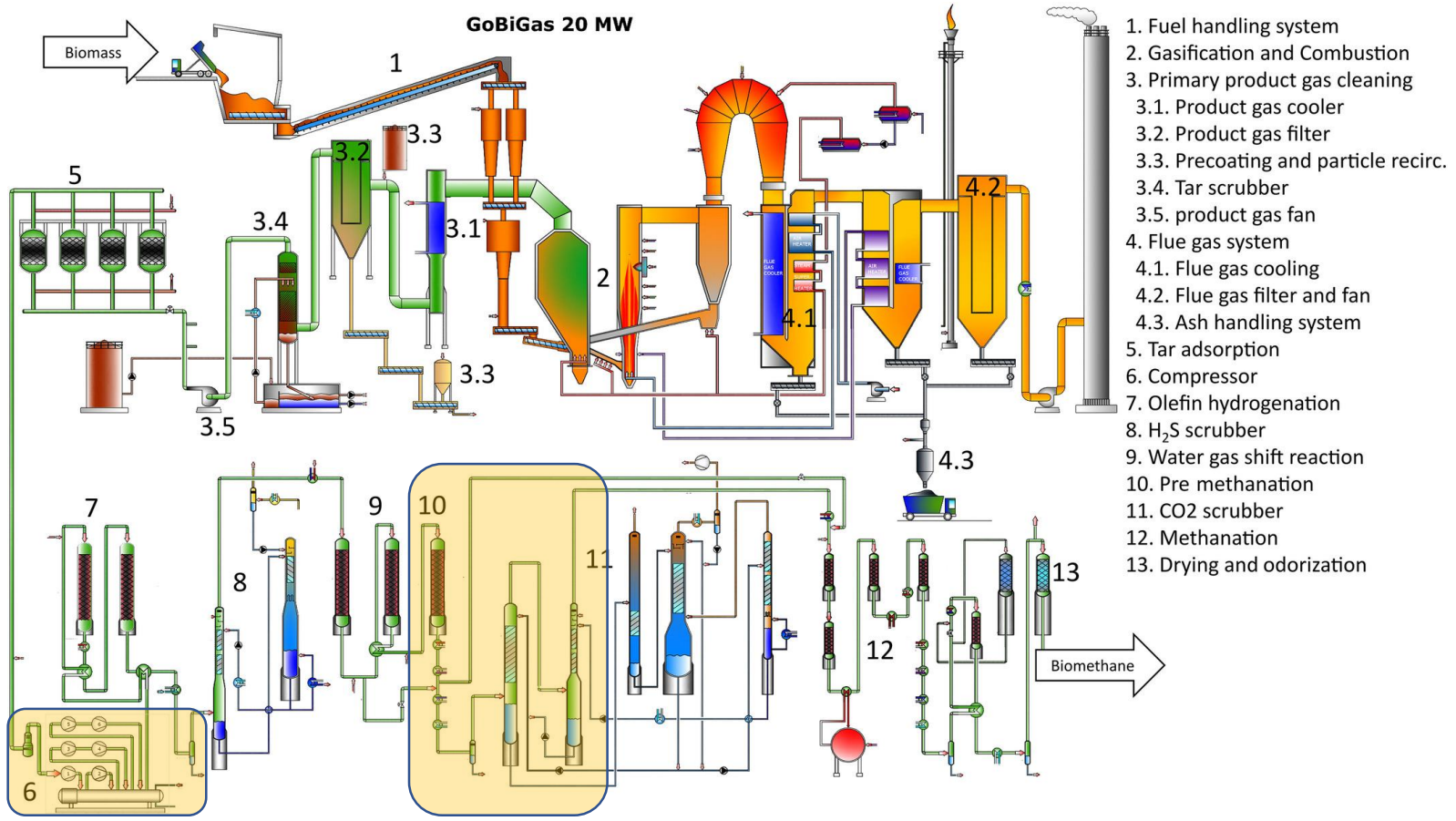
		GoBiGas	Reduced costs learning
A	Auxiliary equipment	14 652	
B	Civil	21 991	17 896
C	Structural steel	4 800	
D	Piping. Mechanical equipment, and insulation	26 664	21 331
TOTAL COST, AUXILIARY EQUIPMENT AND PROJECT COSTS		**114 140**	**95 506**
TOTAL COST, PROCESS SYSTEMS		**23 841**	**23 841**
TOTAL PROJECT COSTS K€		**137 981**	**119 347**

Reactor systems
~ 20% of total costs

SNG versus other alternative end products

- SNG
- Liquid fuel for land or sea transport
- Aviation fuel

- Other Petrochemical products

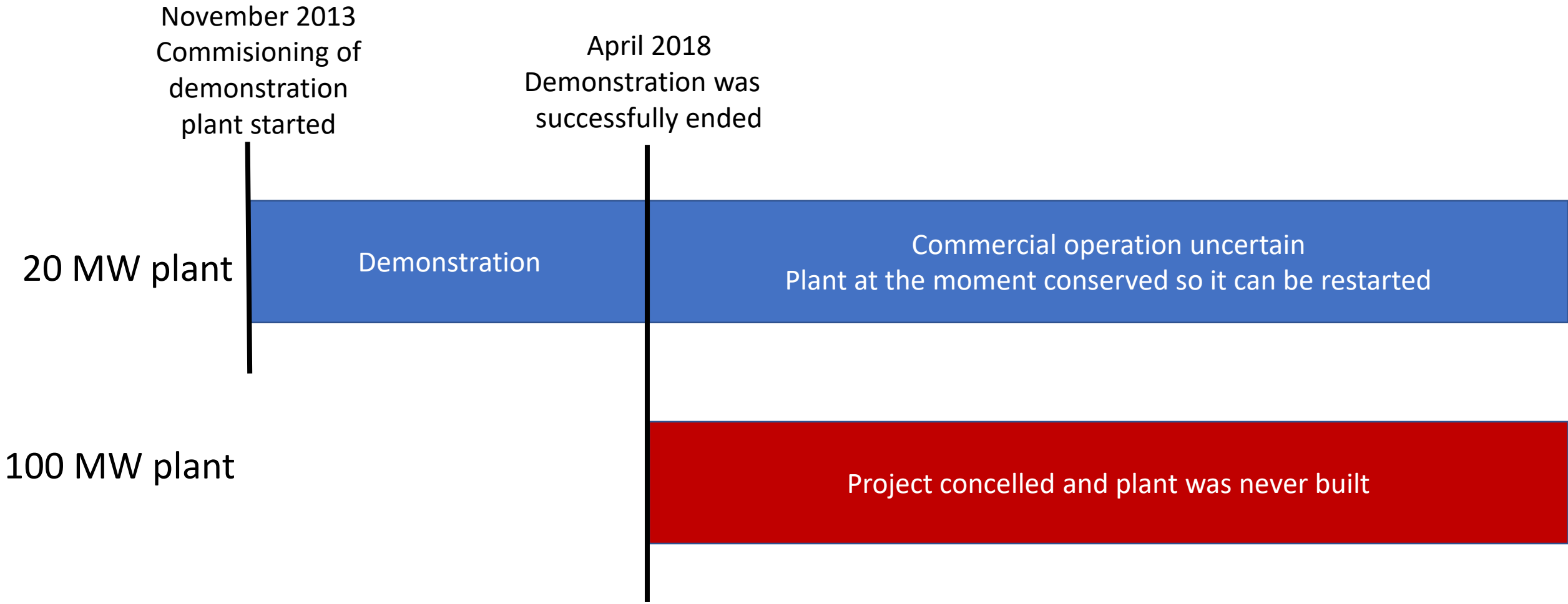


Main changas of process to produce various end products

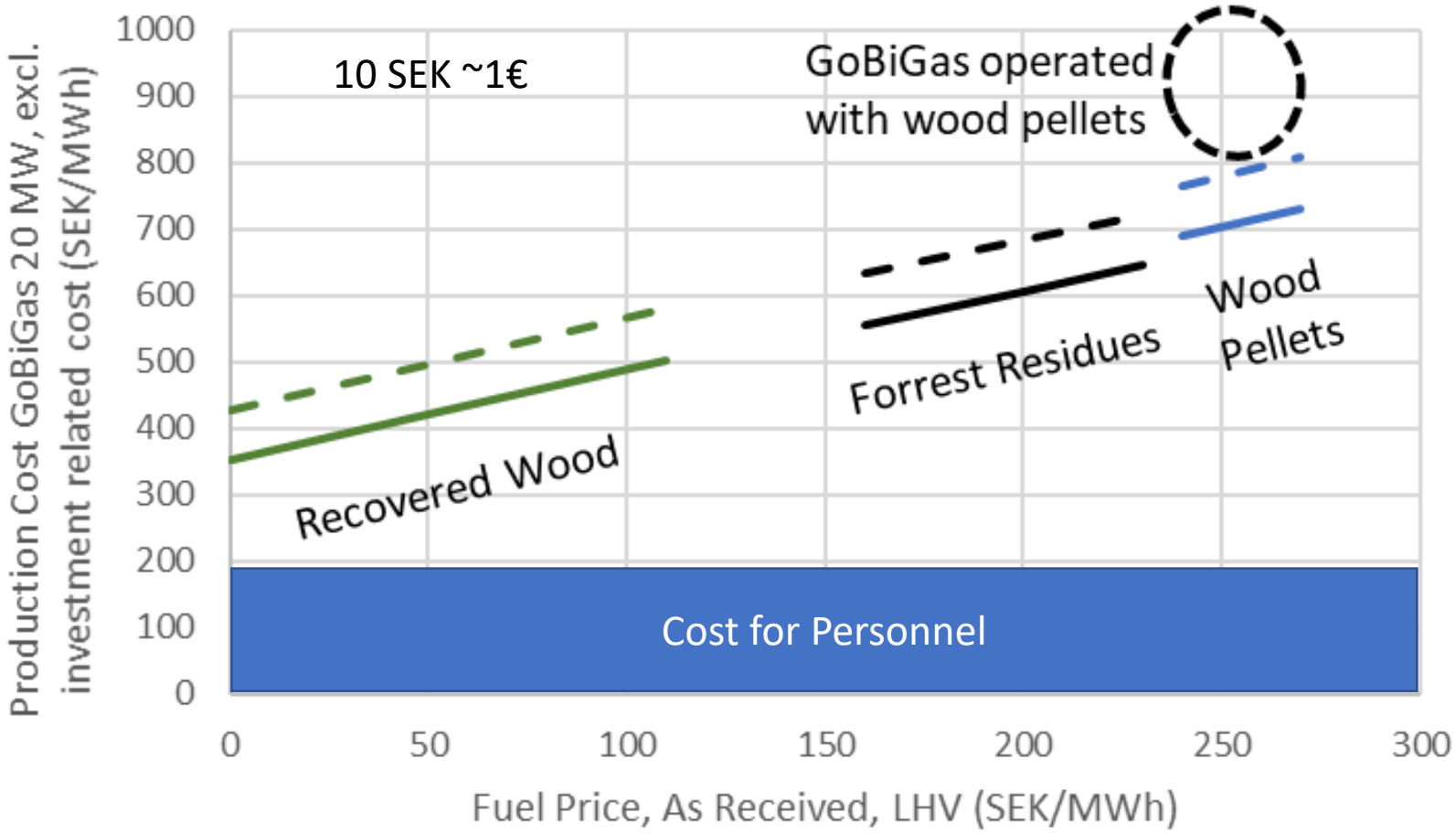
Technology status

- Next step is a fully commercial plant
- Synthesis processes are commercially available at large scale
- A commercial plant need to have parallel gasification units to match the availability of downstream synthesis process
- Moderate cost reduction due to learning can be expected
- State of the art efficiency for a SNG production is around 70% based on LHV of received biomass.

Status GoBiGas plant



Operating cost for demonstration plant



Dashed line present plant upgraded

Solid line new plant built based on experience from demonstration plant

Danish production support for gas fed to the gas grid ~490 SEK/MWh

Conclusion

- Large scale production SNG with high energy efficiency of via gasification has been proven technically feasible

- A large scale introduction of SNG produced via gasification in Europe will need directed political incentives, which favor SNG over other end-products that can be produced from syngas, for example aviation fuels

- Alternatively, the ability to store electrical energy in form of biomethane will give SNG an higher economic value then other advanced biofuels

- Smaller amount of SNG might be economically co-produced with other end products

Detailed information about the GoBiGas-project

- Summery of the scientific evaluation and contribution see report:
  - GoBiGas demonstration – a vital step for a large-scale transition from fossil fuels to advanced biofuels and electrofuels
  - Search words: Thunman GoBiGas vital step
- Summery of project see report:
  - GoBiGas demonstration
  - Search words: Larsson GoBiGas Demonstration
- Detail of economics of equipment and operation see:
  - Economic assessment of advanced biofuel production via gasification using cost data from the GoBiGas plant
  - Search words: Thunman GoBiGas economics

Acknowledgement

The research and demonstration has been finically supported by the Swedish Energy Agency and most of the research has been conducted within the Swedish national competence center for gasification SFC

Detailed information about the GoBiGas-project

- Summery of the scientific evaluation and contribution see report:
  - GoBiGas demonstration – a vital step for a large-scale transition from fossil fuels to advanced biofuels and electrofuels
  - Search words: Thunman GoBiGas vital step
- Summery of project see report:
  - GoBiGas demonstration
  - Search words: Larsson GoBiGas Demonstration
- Detail of economics of equipment and operation see:
  - Economic assessment of advanced biofuel production via gasification using cost data from the GoBiGas plant
  - Search words: Thunman GoBiGas economics

Acknowledgement

The research and demonstration has been finically supported by the Swedish Energy Agency and most of the research has been conducted within the Swedish national competence center for gasification SFC