

# The Swedish Centre for Biomass Gasification

Rikard Gebart, Luleå University of  
Technology

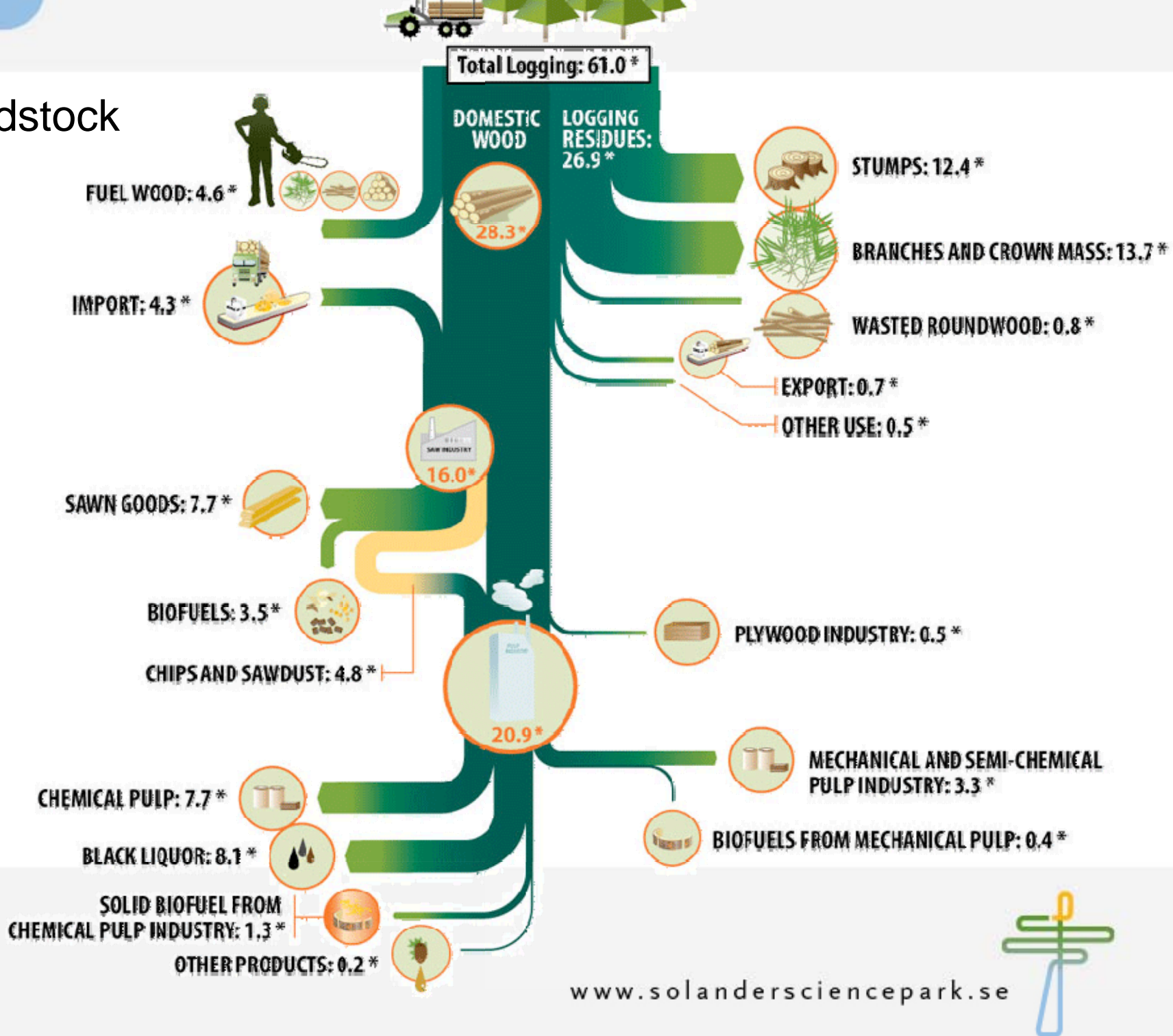
# Gasification

- Competence centre funded by the Swedish Energy Agency, Industry and academia
- Three host universities (LTU, KTH, Chalmers)
- Coordinated by LTU
- In total 25 companies, 9 universities and 2 institutes
- Initial budget 58.5 million SEK for a two year start-up period
- Annual budget 58.5 million SEK/year for the coming 8 years

# Background

- Swedish political decisions:
  - >50% of the total energy supply from renewables by 2020
  - 10% of the transport energy from renewables by 2020
  - 40% reduction of GHG emissions by 2020 (compared to 1990)
  - Vehicle fleet independent of fossil fuels by 2030
- European level political decisions:
  - 20% reduction of GHG emissions
  - 20% of the energy supply from renewable sources
  - 20% reduction of energy consumption

# Use of forest feedstock in Sweden



\*Million tons dry biomass

Source:  
Biomassafflöden i svensk  
skogsnäring 2004,  
Per Olov Nilsson.  
Rapport 23-2006  
Skogsstyrelsen  
ISSN 1100-0295

[www.solandersciencepark.se](http://www.solandersciencepark.se)

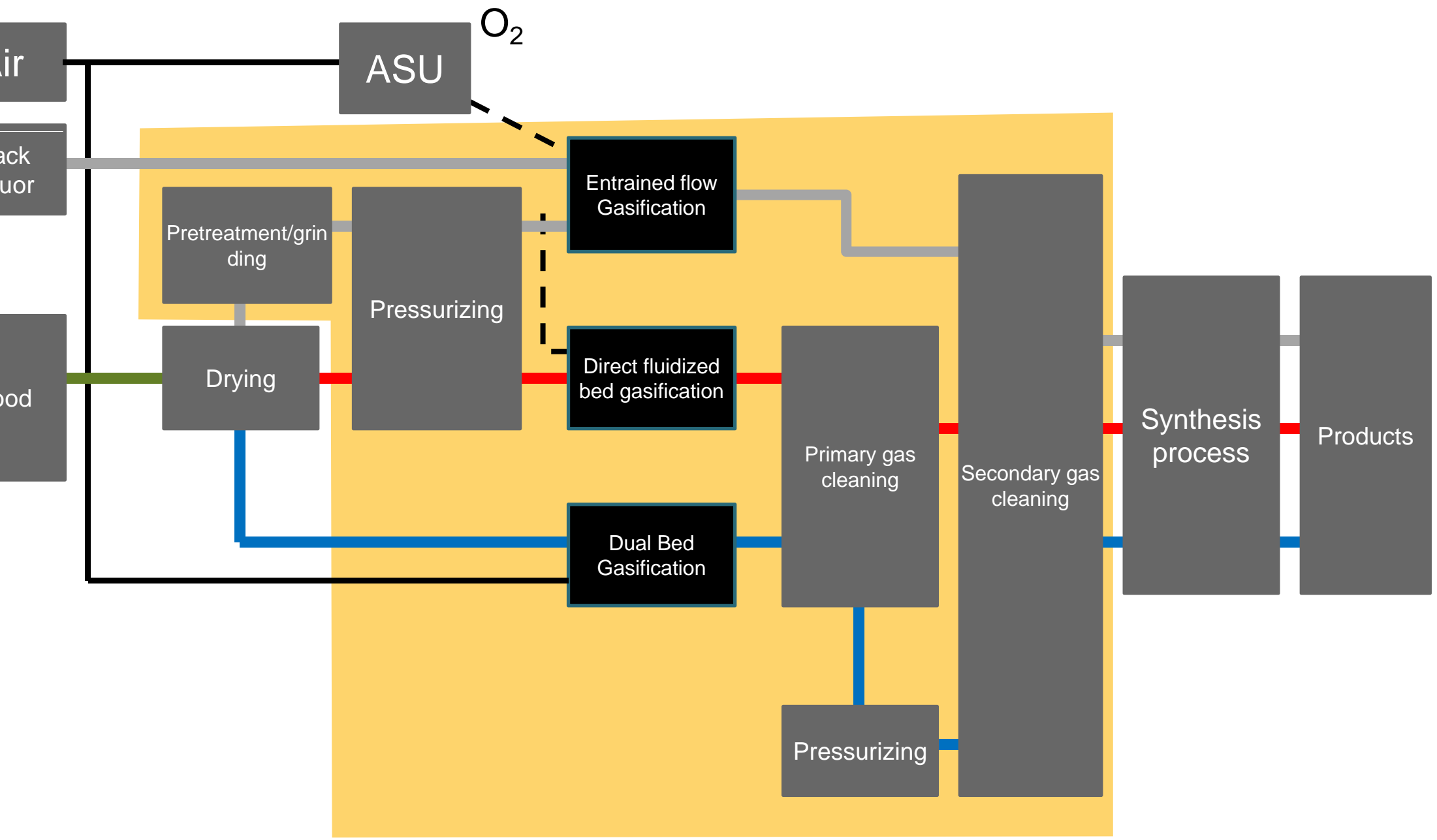


# Background

- Biomass gasification has a long tradition in Sweden
  - Gengas for vehicles
  - Black liquor gasification (Ortviken, Frövi, Skoghall, Piteå, ...)
  - Fluidised bed gasification (Värö, Studsvik, Värnamo, ...)
  - Dual bed gasification (Chalmers, ...)
- Thermochemical conversion of biomass
  - High efficiency
  - Fuel flexible
  - Multiple products
  - Good fit for Sweden – availability of feedstock and competence to meet national and EU targets

# Background

- Several large demo projects are partially funded:
  - e.g. Gobigas (SNG from wood chips)
- Many other projects are planned
  - e.g. Domsjö (methanol and DME from black liquor)
- Gasification is a key technology but need for more skilled people and improved research infrastructure



# Motivation for choice of technologies

- Each technology has its advantages and drawbacks
  - Entrained flow – high quality syngas, simple(r) gas cleaning but some material issues
  - Fluidised bed gasification – simple(r) pretreatment but more complex gas cleaning
  - Indirect gasification – simple(r) pretreatment, syngas suitable for SNG but more complex gas cleaning



Wood 150 kWth  
DME

Smolandsmetanol @  
Hagfors  
Wood 107 MWth  
1000 ton/y Methanol

SAKAB @ Kumla  
Wood 300 MWth(?)  
Methanol, SNG

Energi @ Göteborg  
Wood 20 □ 80 MWth  
SNG

Almers @ Göteborg pilot  
Wood 4 MWth

Södra @ Värö  
Bark 32 MWth  
substitution lime kiln

Eon @ Skåne  
Wood 200 MWth  
SNG



Black liquor 3 MWth  
DME 4 ton/day

IVAB @ Piteå pilot  
Forest residue 1 MWth

MEVA @ Piteå pilot  
Wood pellets 500 kWth

MEVA @ Hortlax demo  
Wood pellets 4 MWth  
CHP 1 MWeI

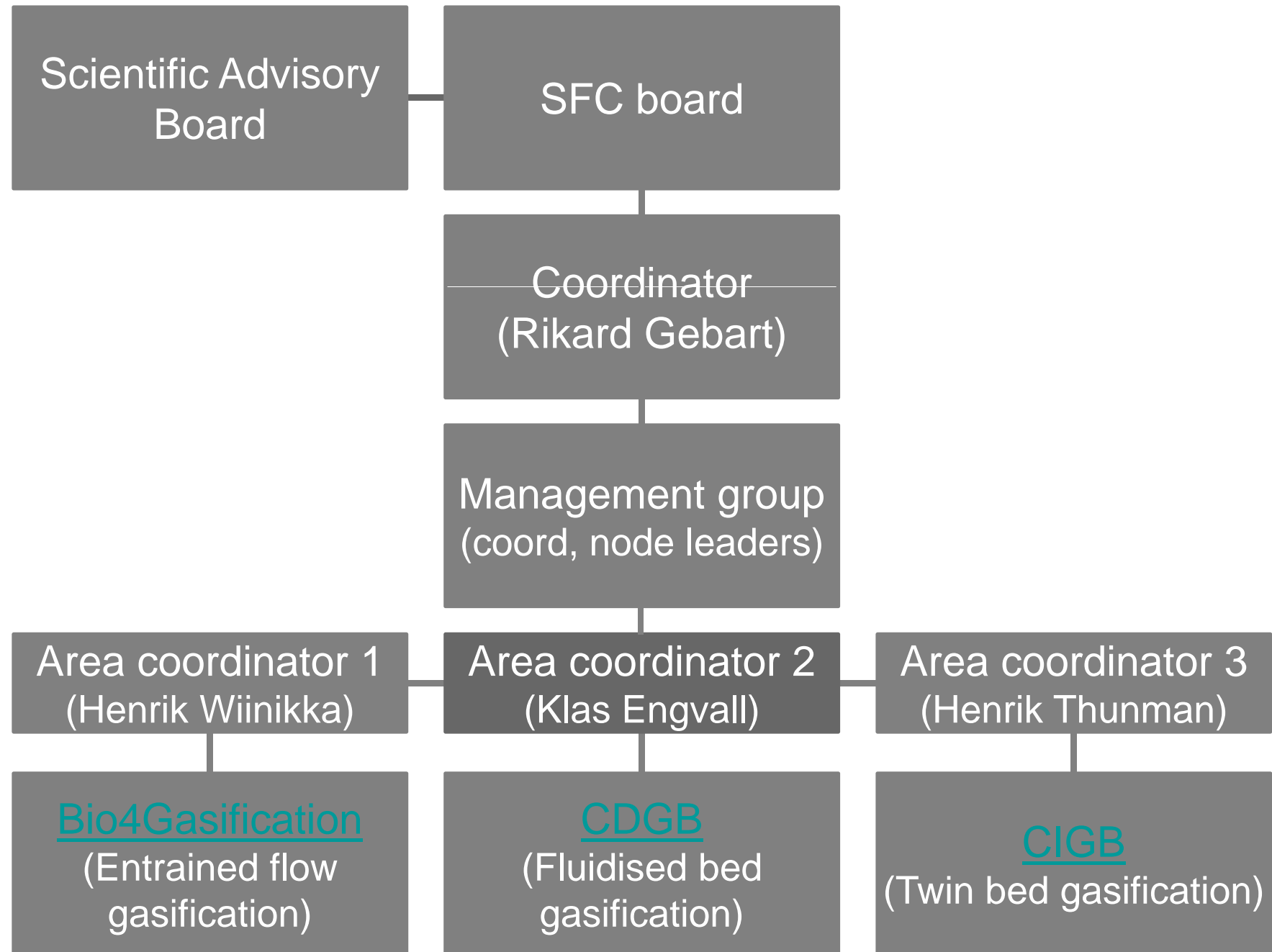
Domsjö @ Övik demo  
Black liquor 200 MWth  
DME/MeOH <280 ton/day

KTH @ Stockholm pilot  
Wood 800 kWth, CHP

VVBGC @ Värnamo  
Wood 18 MWth

(green = existing gasifier; ★ = fuel demo project)

# SFC)



# Conclusions

- About 45% of the Swedish consumption of gasoline and diesel can be replaced with synthetic fuels from the forest
- Strong research effort on three biomass gasification principles
  - Entrained flow
  - Fluidised bed
  - Dual bed
- Many exciting projects are planned, but many hurdles, both technical and political, must be overcome

Thank you!



# The BIO4 Gasification Node

- Technology focus: Entrained flow
- Pilot scale experiments
  - Black liquor gasification 3 MW
  - Entrained flow gasification of powdered fuels 1 MW
  - Vortex gasification of powdered fuels 0.5 MW
  - Gas cleaning
- Modeling and Process development
- Experiment in demo plants when they become available
  - Vortex gasification for CHP 4 MW (1 MW el)
  - Black liquor gasification + methanol/DME 200 MW (Domsjö)
  - Black liquor gasification + methanol 40 000 m<sup>3</sup>/year (Vallvik)

# Planned projects

	<b>Black liquor gasification</b>	<b>Pressurised EF gasification</b>	<b>Cyclone gasification</b>
UP1: Thermo chemistry	X	X	X
UP2: Fuel conversion experiments	X	X	X
UP3: Modeling	X	X	X
UP4: Interaction with containment materials	X	X	X
AP1: Feeding, reactivity and ash behavior		X	X
AP2: Optimization of entrained flow reactors	X	X	
AP3: Process control	X	X	X
AP4: Cyclone gasification			X
PP1: Gas cleaning	(X)	(X)	X
PP2: ---			
PP3: ---			
PP4: ---			



are

1 MW flare

ETC Gasification  
Centre

Nitrogen

Oxygen

Chemrec DP-1

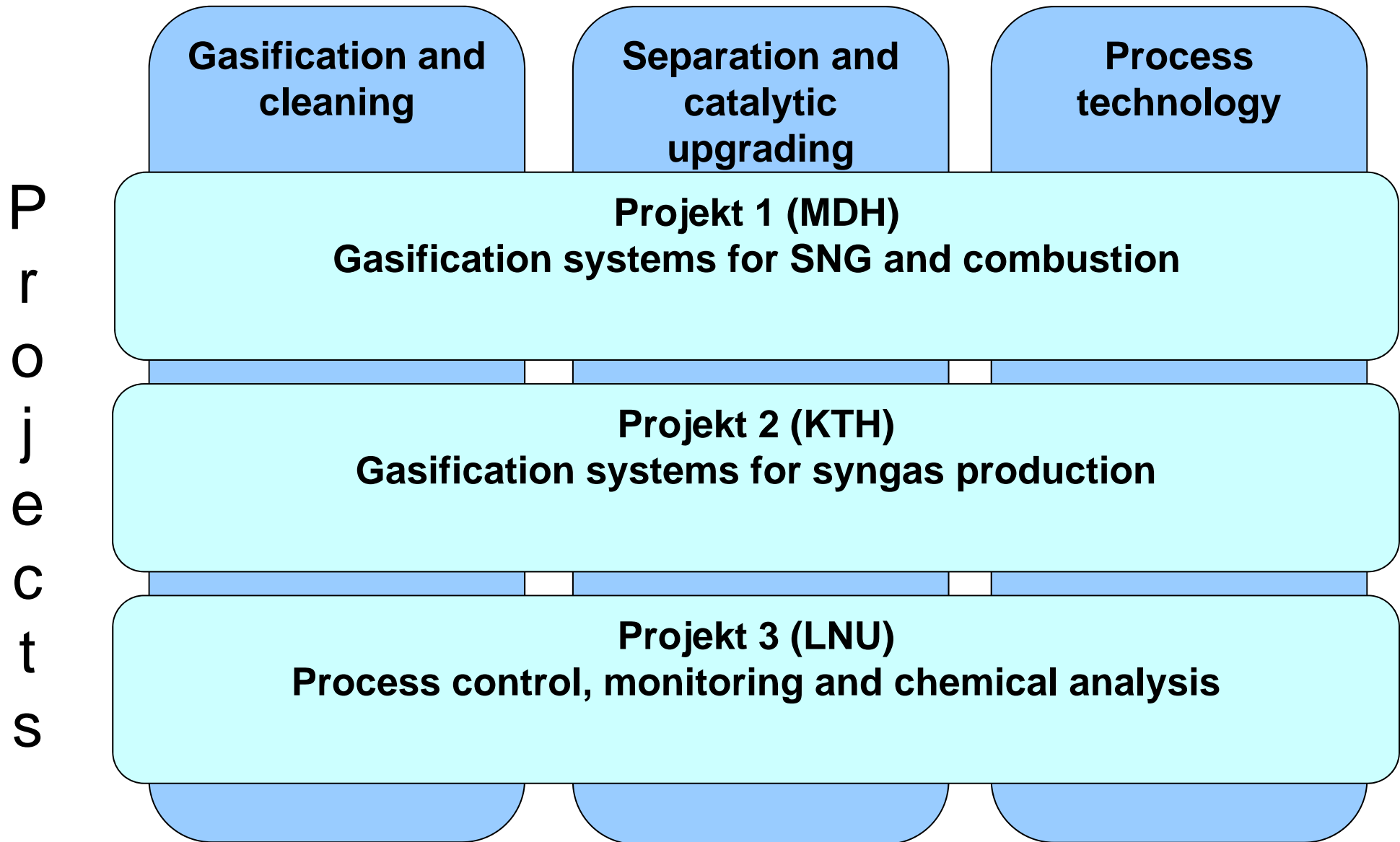
16 bar steam  
Black liquor

# The Centre for Direct Gasification Node

- Technology focus: Fluidised bed gasification
- Pilot scale experiments
  - 3 fixed bed gasifiers 0.5 MW
  - Lab scale fluidised bed gasifier
- Modeling and Process development
- Experiments in demo plants when they become available
  - Värnamo ?
  - Mälarenergi ?



# Planned projects





Batch type  
downdraft  
slag HTAG



Continuous  
downdraft  
slag HTAG



Continuous  
updraft non-  
slag HTAG

# The Centre for Indirect Gasification Mode

- Technology focus: Dual bed gasification
- Pilot scale experiments
  - 3 MW dual bed gasifier
  - 150 kW dual bed gasifier
  - Chemical looping reforming reactor
- Modeling and Process development
- Experiments in demo plants when they become available
  - Gobigas demo 1 for SNG 20 MW
  - Gobigas demo 2 for SNG 80 MW

# Planned projects

	Modellering och utvärdering av den indirekta förgasningsprocessen	Reaktorutveckling / fluidynamik	Experimentell processutvärdering	Gasrening och restproduktshantering	Grundläggande omvandlingsprocesser	Diagnostik
Projekt 1 Projektledare: David Pallares	1.a	2.a				
Projekt 2 Projektledare: Martin Seemann			3.a, 3.b			6.b
Projekt 3 Projektledare: Britt-Marie Steenari			3.b	4.d		
Projekt 4 Projektledare: Wennan Zhang			3.c	4.c		
Projekt 5 Projektledare: Henrik Leion				4.a		
Projekt 6 Projektledare: Nicolas Berguerand				4.b	5.a	
Projekt 7 Projektledare: Kent Davidsson					5.b	6.a

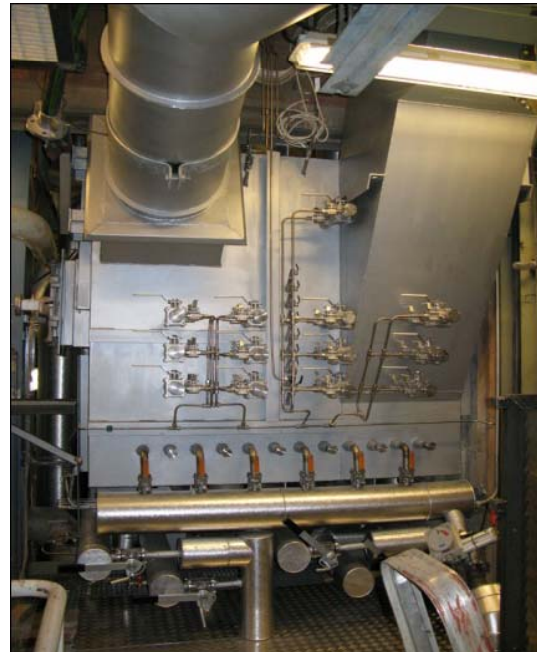
# gas production via gasification

## D&D

Chalmers  
reaktor



Chalmers 2-4 MW  
pilotanläggning



2008

GoBiGas fas 1 Hisingen  
20 MW SNG  
demonstrationsanläggning  
Göteborg Energi och E.ON



2012

Hisingen  
80 MW SNG  
Kommers  
anläggning  
Gbg Energi e



2016