

IEA Task 33 Meeting

Karlsruhe, Germany

2014-11-03

Country Update Sweden



Lars Waldheim

Alsätravägen 130

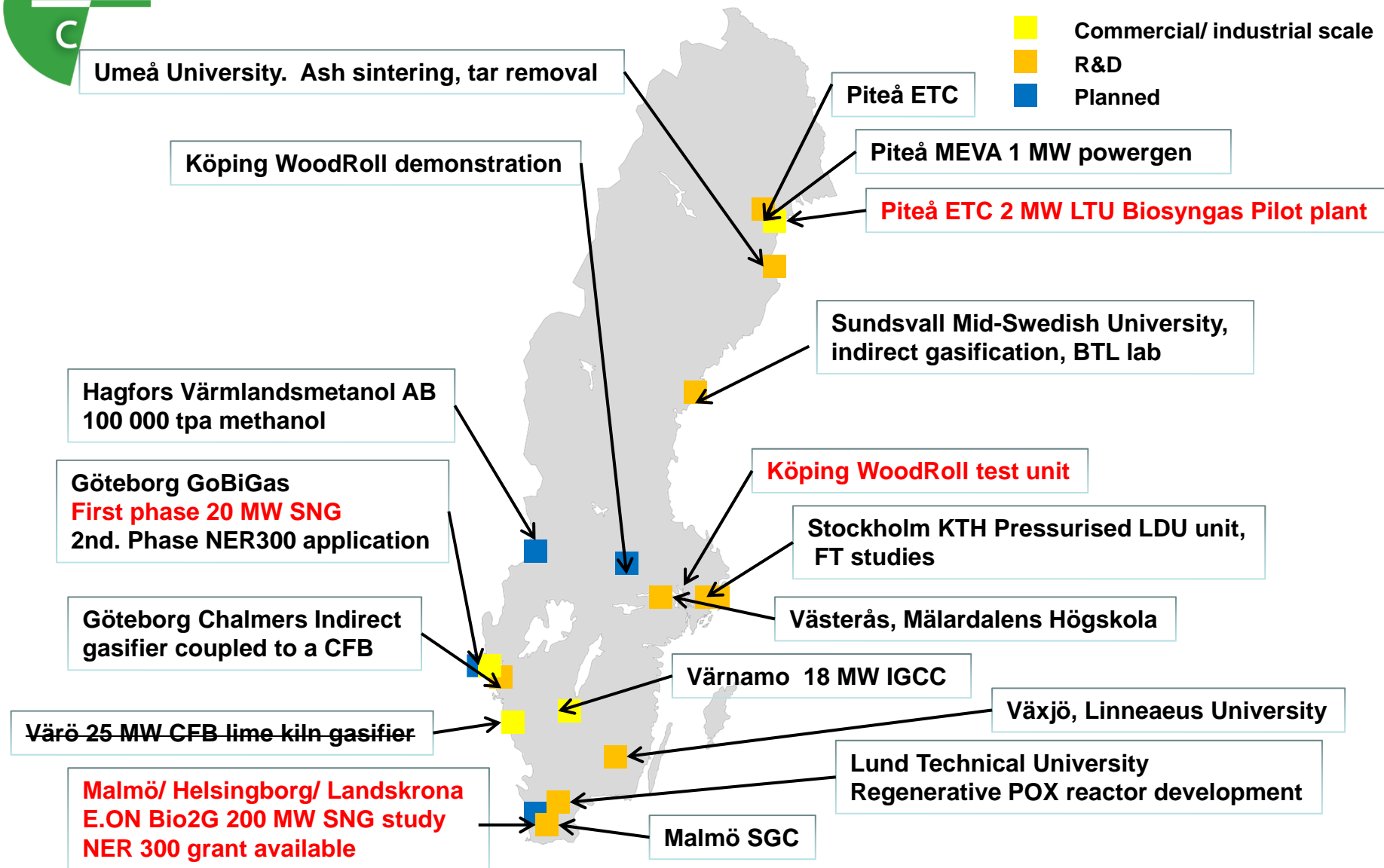
12736 SKÄRHOLMEN

lars.waldheim@waldheim-consulting.se

070 592 81 69



Biomass Gasification Sweden 2011





Swedish Politics

A labour-green minority government supported by a leftist party took over governing power from liberal-conservative 4-party coalition in October following a regular general election.

Impacts on energy policy is at present unclear.

Decision on any replacement of nuclear power plants is postponed beyond the mandate period of four years.

The new government has announced intentions to initiate a "broad" parliamentary energy commission.

But if opposition is going to participate will be based on a negotiation on the commission's instructions and mandate.



Swedish Energy Targets 2020

- Reduce GHG emissions 40 % by 2020 outside ETS sector
 - 20% done (rel. 1990), 30% by flexible mechanisms
 - Continued use of environmental taxation
 - Sweden independent of fossil transport fuels in 2030
- Follow EU ETS policies (now third phase)
- Minimum 50% Renewable Energy 2020
 - RE Certificate prolonged and coordinated with Norway
 - Target increased, +25 TWh rel. 2002
 - Wind power planning 20 TWh land-based+10 TWh sea-based
 - 10% renewable transport fuels
- Energy Savings Plan
 - 20% reduction of energy/GNP ratio by 2020, relative to 2008
- Nuclear power
 - The reactor development law (SFS1984:3) was revoked
 - *However, the new government has stopped planning by Vattenfall by an owner's directive*
 - *Up to 10 new replacement reactors can be accepted on present sites??????*



Renewable transport fuels

- **Present situation**

- 11.8 % RE transport fuels in 2012
- 5.9 % of all vehicles predominant RE fuels
- Energy taxes levied on low-level blends in gasoline and diesel as of 2013 to comply with EU state aid rules, but no CO₂ tax.
- Tax exemptions retained for high-level blends or neat fuels (e.g. E85, B100, CBG, but also for HVO < 15 % in diesel)
- Sustainability criteria to qualify as RE fuel and for tax exemptions

- **Future plans**

- Quota obligation rise proposal to increase RE fuels from 4.8 % was withdrawn for governance reasons in early 2014.
 - Parliamentary commission on fossil-free vehicle traffic was reported December 16, 2013.
 - Proposal for a price guarantee for second generation biofuels?
-



NER 300

–EU NER300: bioenergy 5 of 9 proposals, 3 retained

- **Pyrogrot Billerud** -Category: 40 kton/a pyrolysis oil or slurry project abandoned.
- **GoBiGas 2** -Category: 40 million Nm³/a SNG
Has grants from first round.
- **E.ON Bio2G** -Category: 40 million Nm³/a SNG
Received second round support decision in August 2014.

The deadline for initiating construction has been extended by 2 years. (GoBiGas 2, end 2016, Bio2G end 2020)



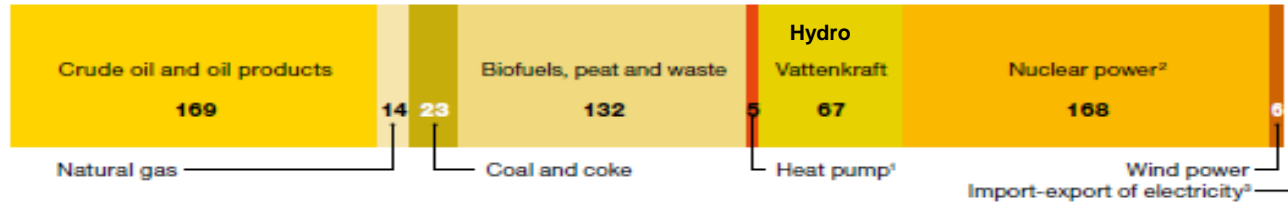
R&D and D

- Government Bill “A Boost to Research and Innovation” 2010 gives support to 20 identified “Strategic Areas of Research” in 43 groupings for 5+5 years, 3 energy related
 - Bio4Energy (UmU/LTU/SLU)
 - Biorefining of woody biomass 50 MSEK per year
 - Chalmers Energy Initiative (Chalmers, SP, Innventia)
 - Energy Combines, electricity propulsion systems and hybrid vehicles, large-scale renewable electricity generation and grid integration, technology impact assessment, 58 MSEK/year
 - STandUP (UU/KTH/LTU/SLU)
 - Mainly electrical grid and vehicle technology, but also RE power generation
- Swedish Centre for Renewable Fuels (f3) launched
- Swedish Gasification Centre launched



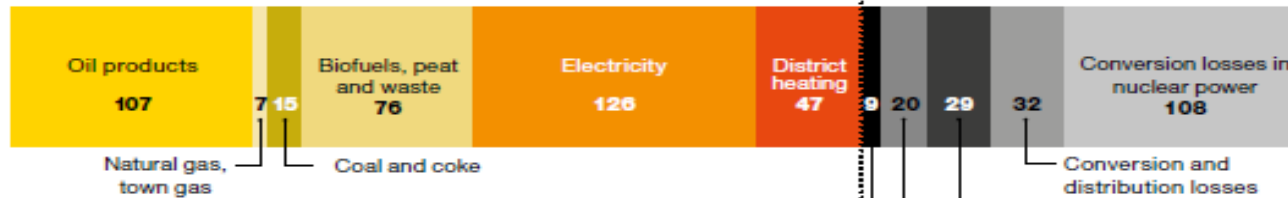
Energy balance 2011

Total energy supplied in Sweden in 2011, by energy carrier, 577 TWh

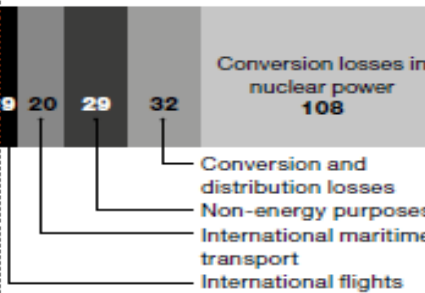


Conversion in power stations and heating plants, refineries, gasworks, coking plants and blast furnaces. Distribution of electricity and district heating, as well as international bunkering and supply of energy raw materials to the paint and chemicals industry, for example.

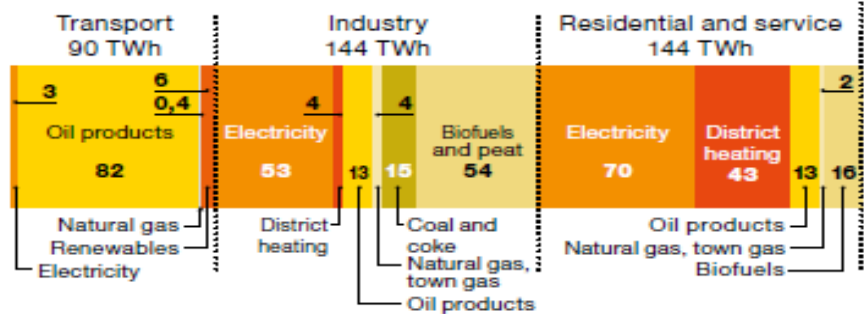
Total final energy use, by energy carrier, 379 TWh



Losses and use for non-energy purposes, 198 TWh

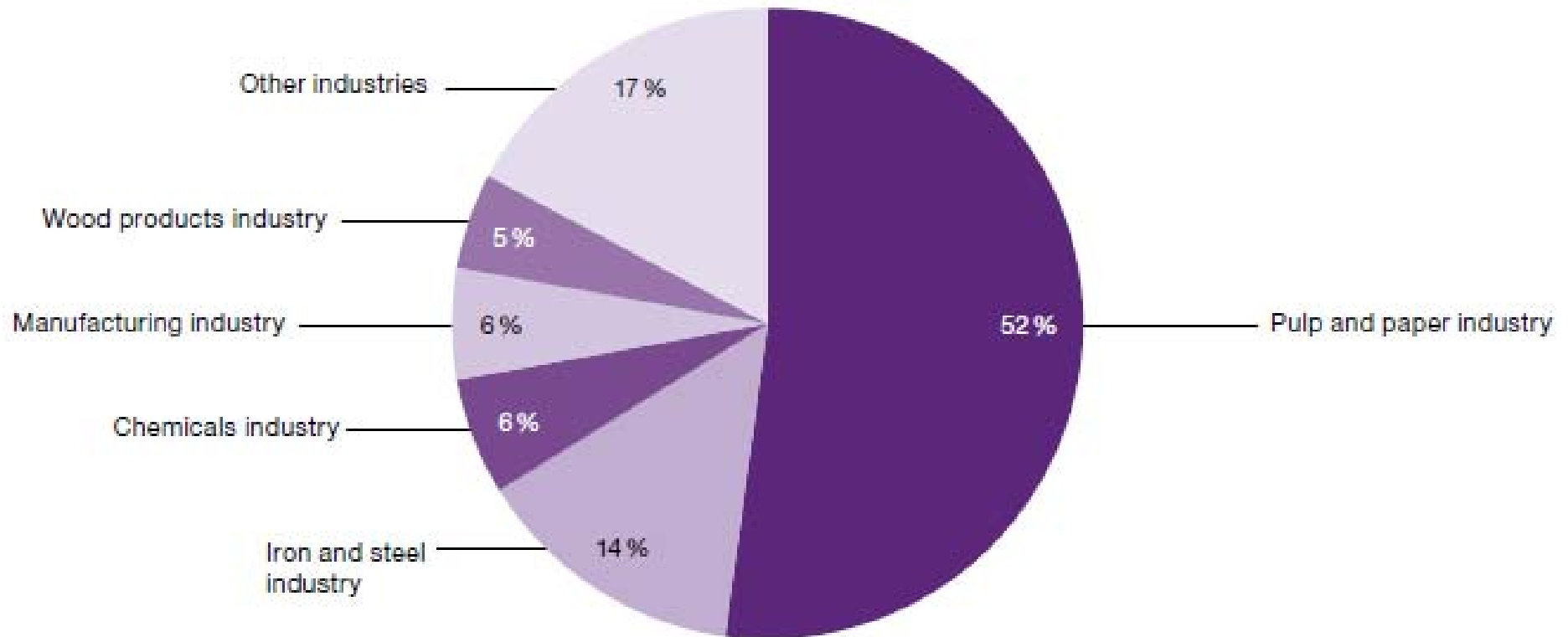


Total final energy use, by sector, 379 TWh



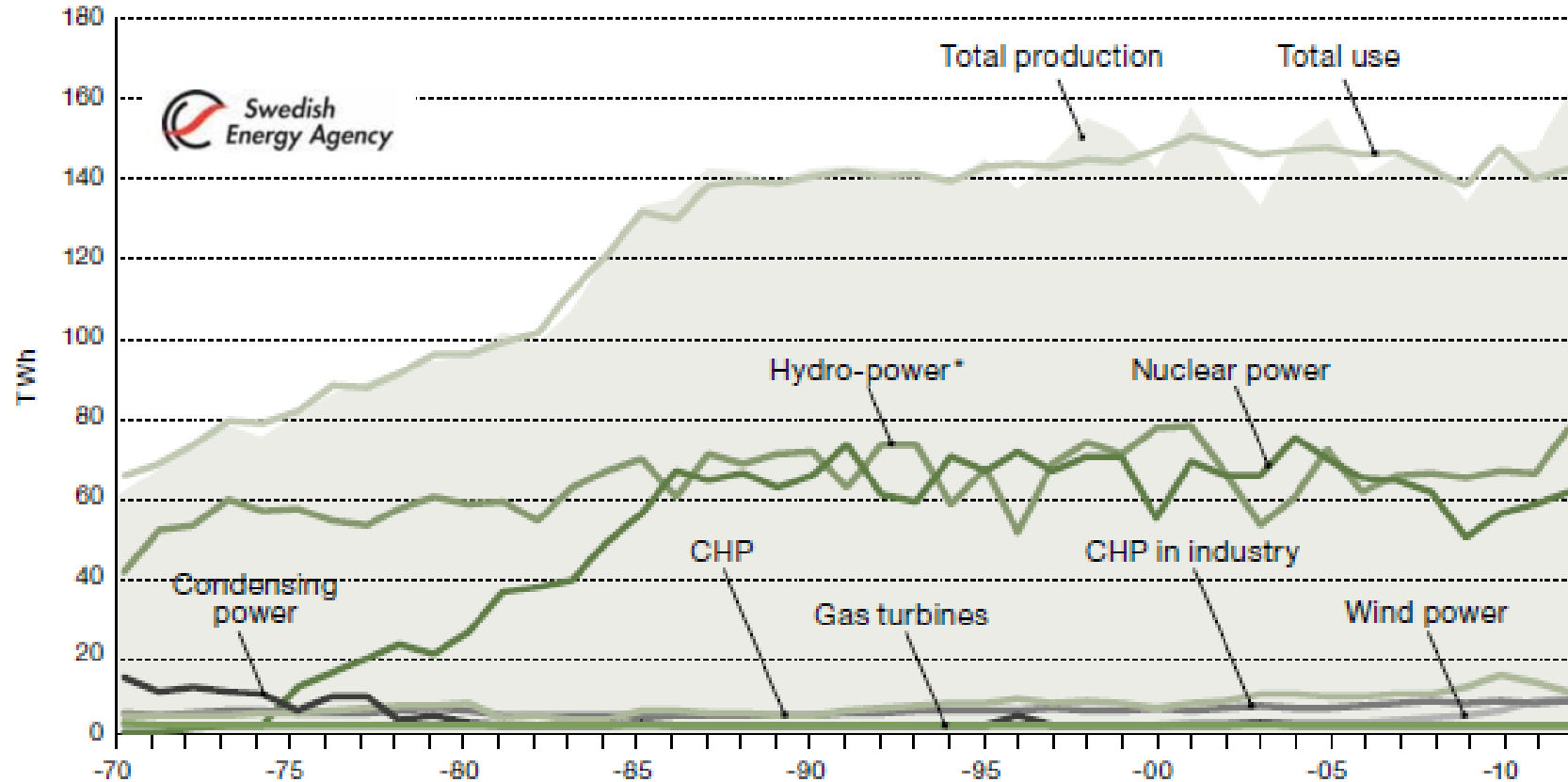


Energy Use in Industry 2012



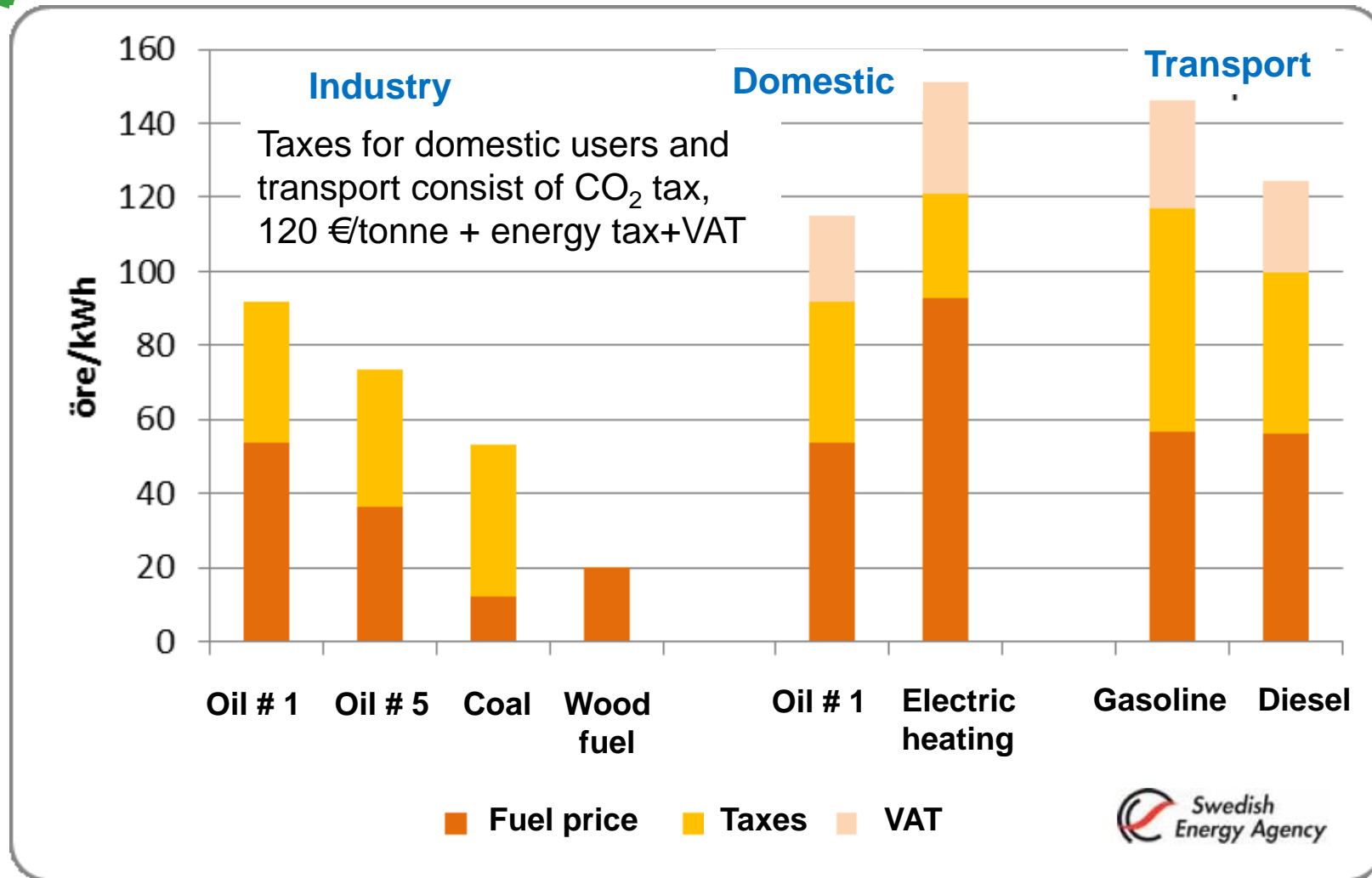


Power production 2000-2012



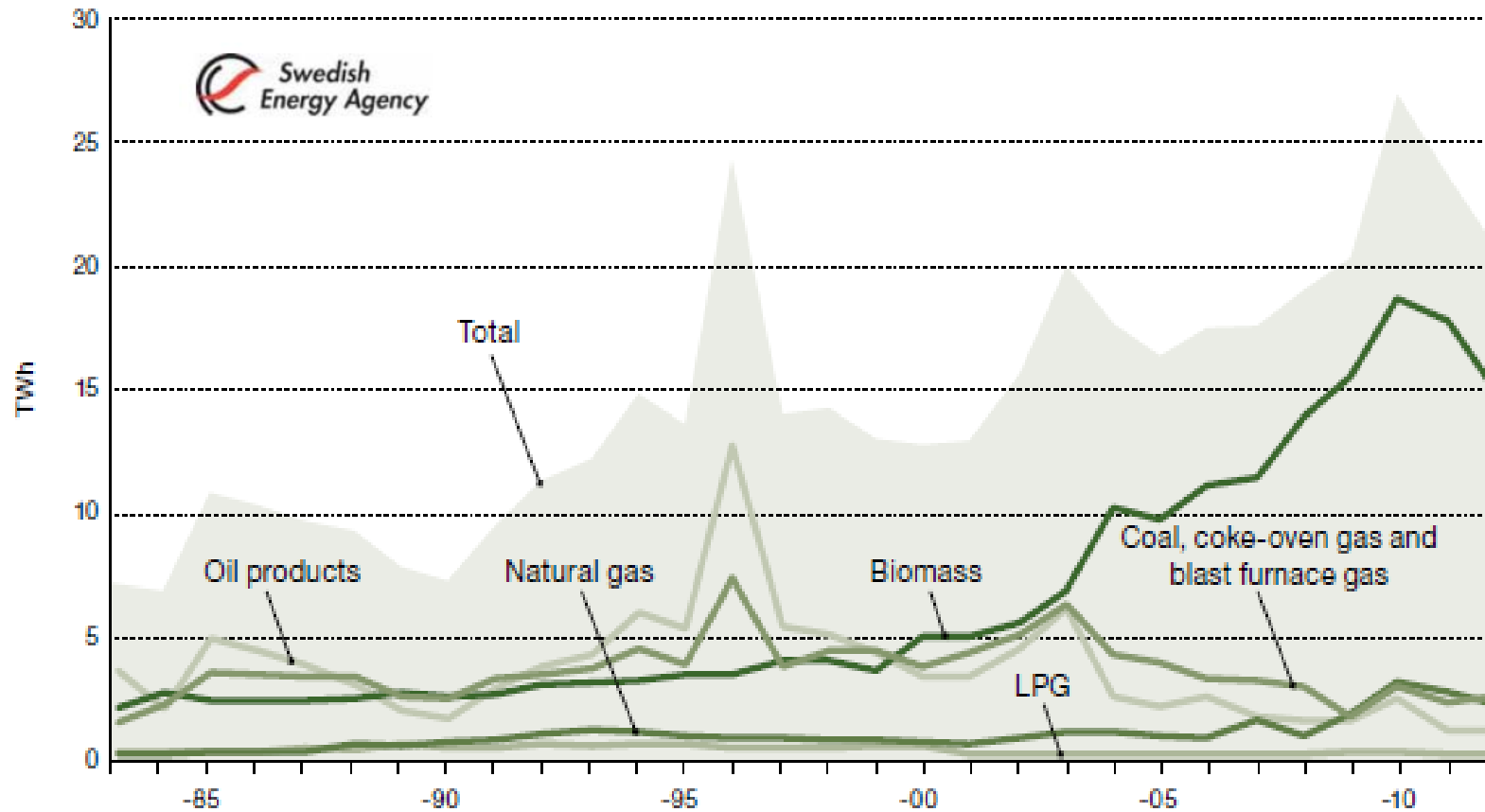


Fuel prices and taxation 2010



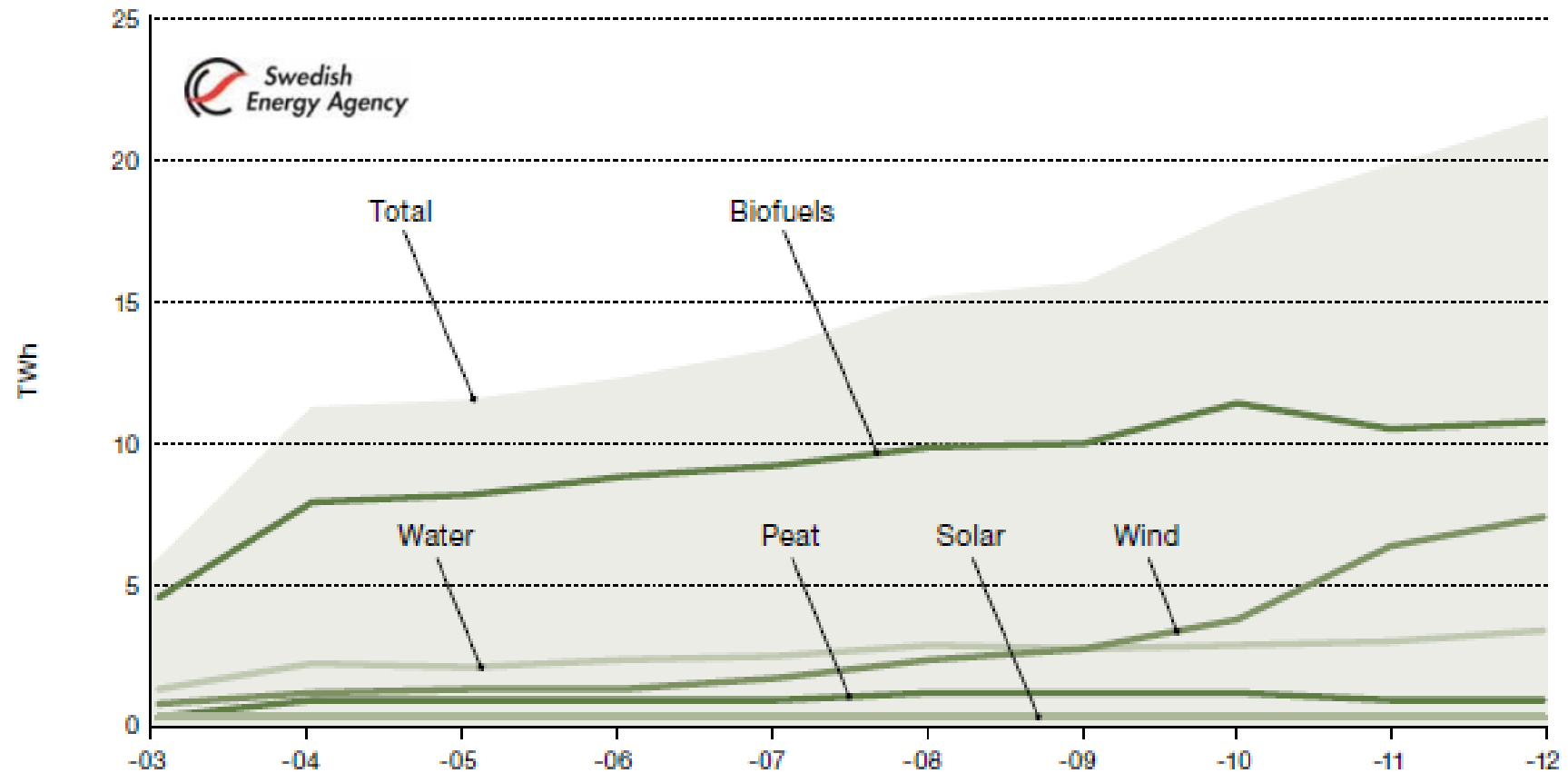


Fuel Use for Power 2000-2012



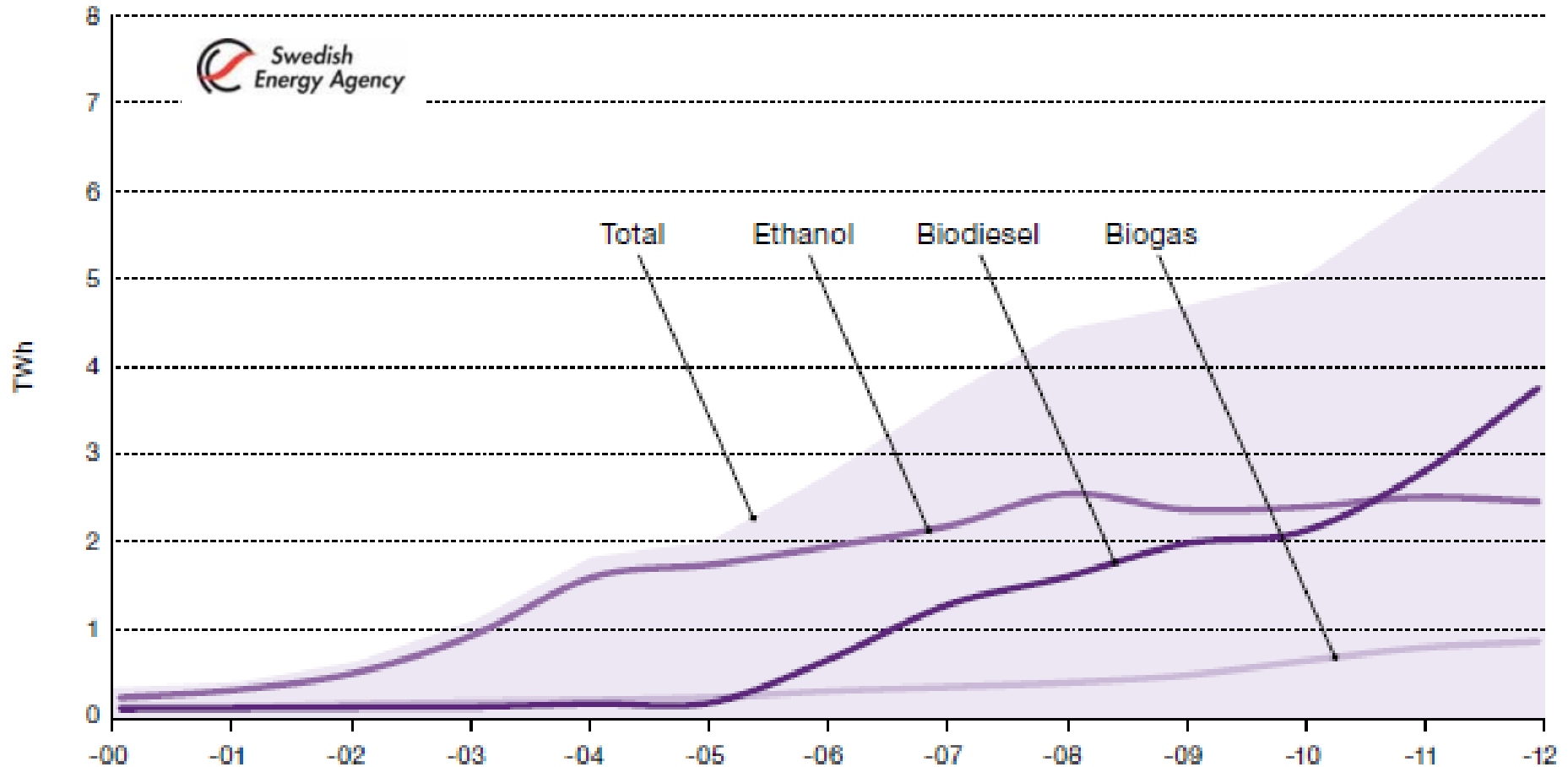


RE Power 2000-2012



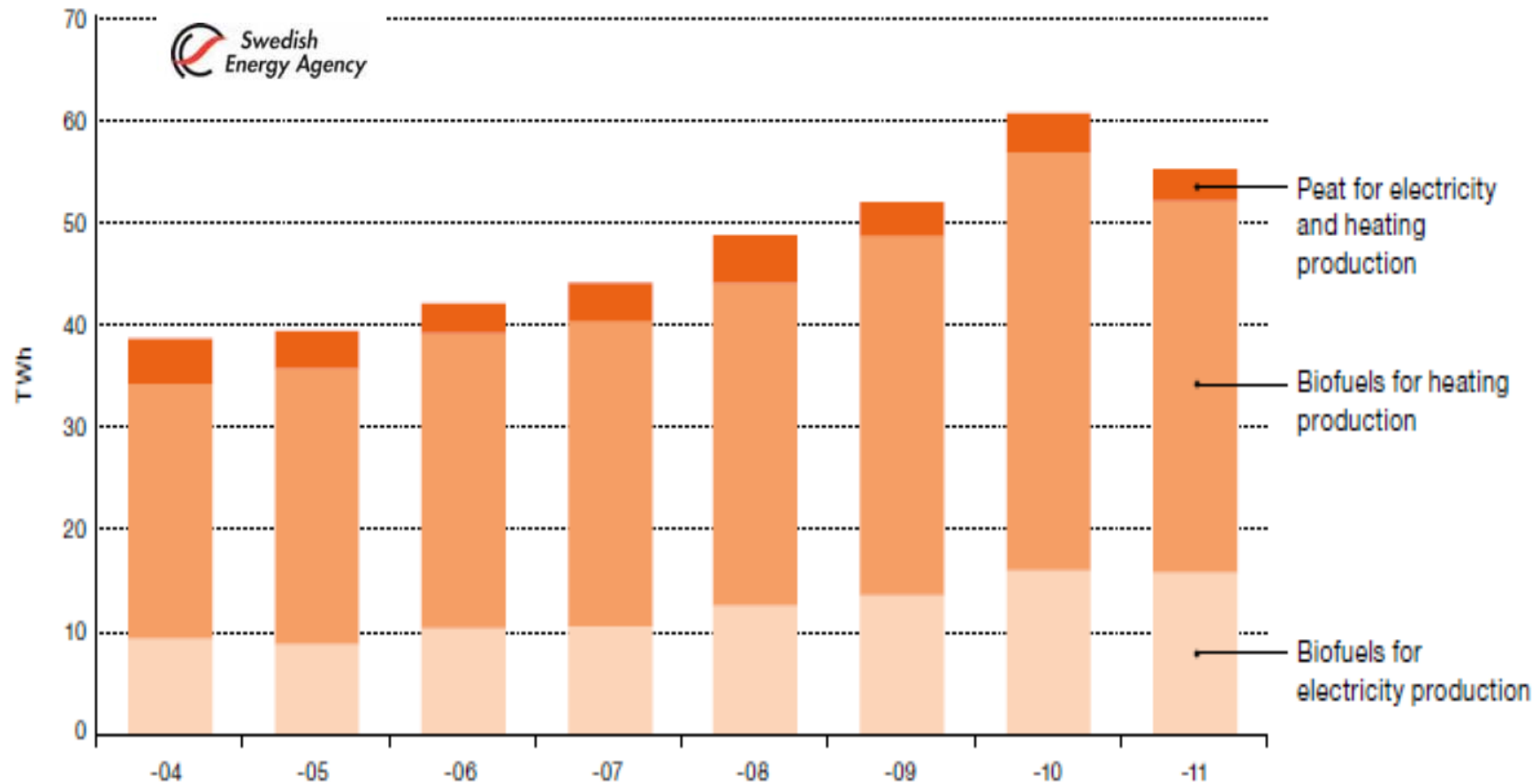


Biofuel Use 2000-2012





Fuels for heating 2000-2012





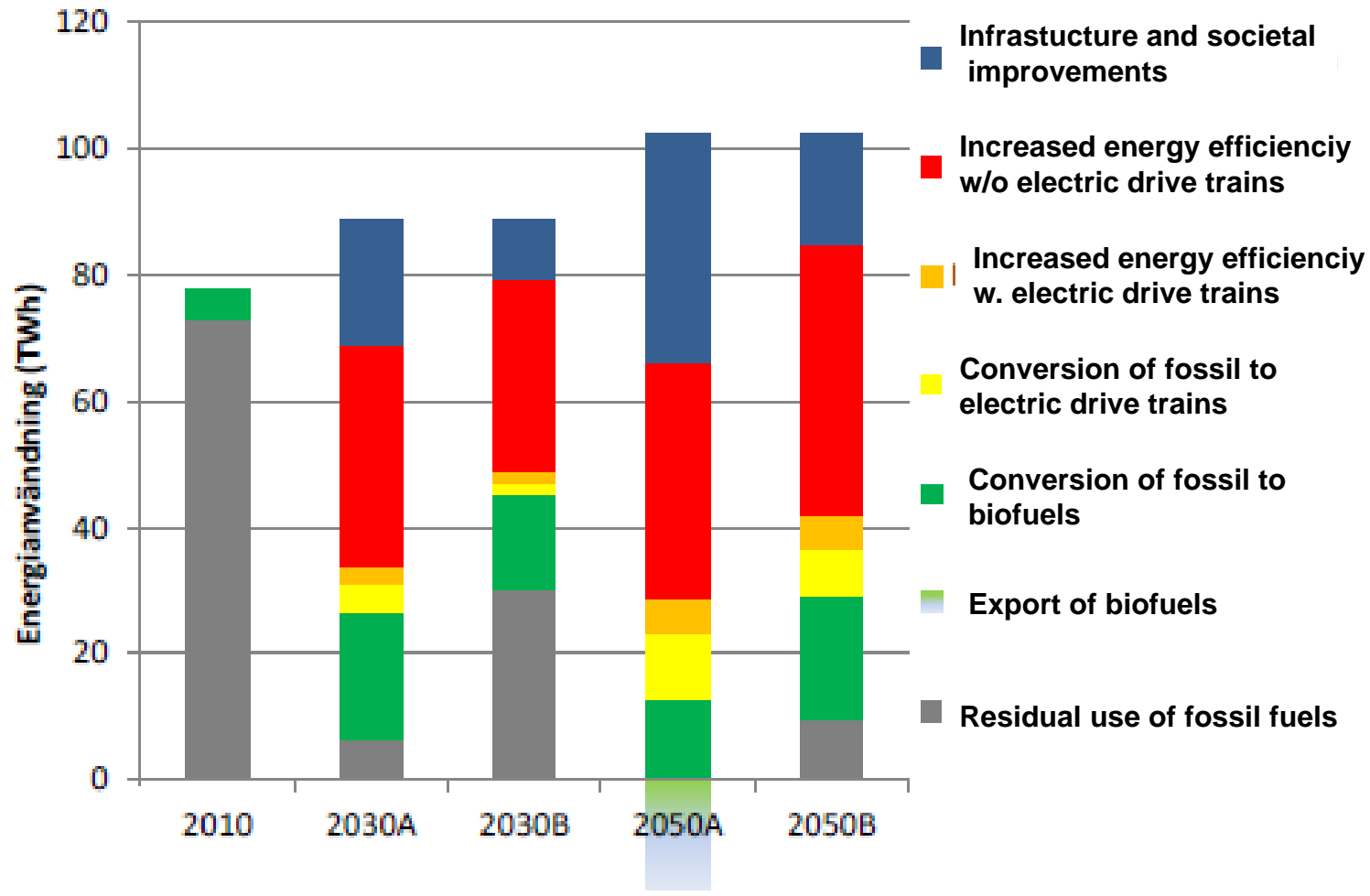
Parliamentary commission on fossil-free vehicle traffic 2013

- **Policy areas requiring to be addressed**
 - Urban and societal planning to reduce need and improve efficiency in transport,
 - Change in traffic modalities and infrastructure, i.e. more railway transports, improved railways etc.
 - Drive train efficiency improvements
 - Promote eco-driving
 - Increased use of biofuels
 - Introduce and deploy electric drive trains
- **Main recommendations for future policy actions**
 - Gradually increase the quota obligation to 2020
 - Biofuel price guarantee to make investments more bankable
 - Expand the use of electrical energy by charging infrastructure etc.
 - Bonus-malus policies to improve efficiency
 - Promote citizen change (from individual to collective transports, taxes, insurances, ecodriving etc.)
 - Infrastructure and urban planning actions



Parliamentary commission on fossil-free vehicle traffic

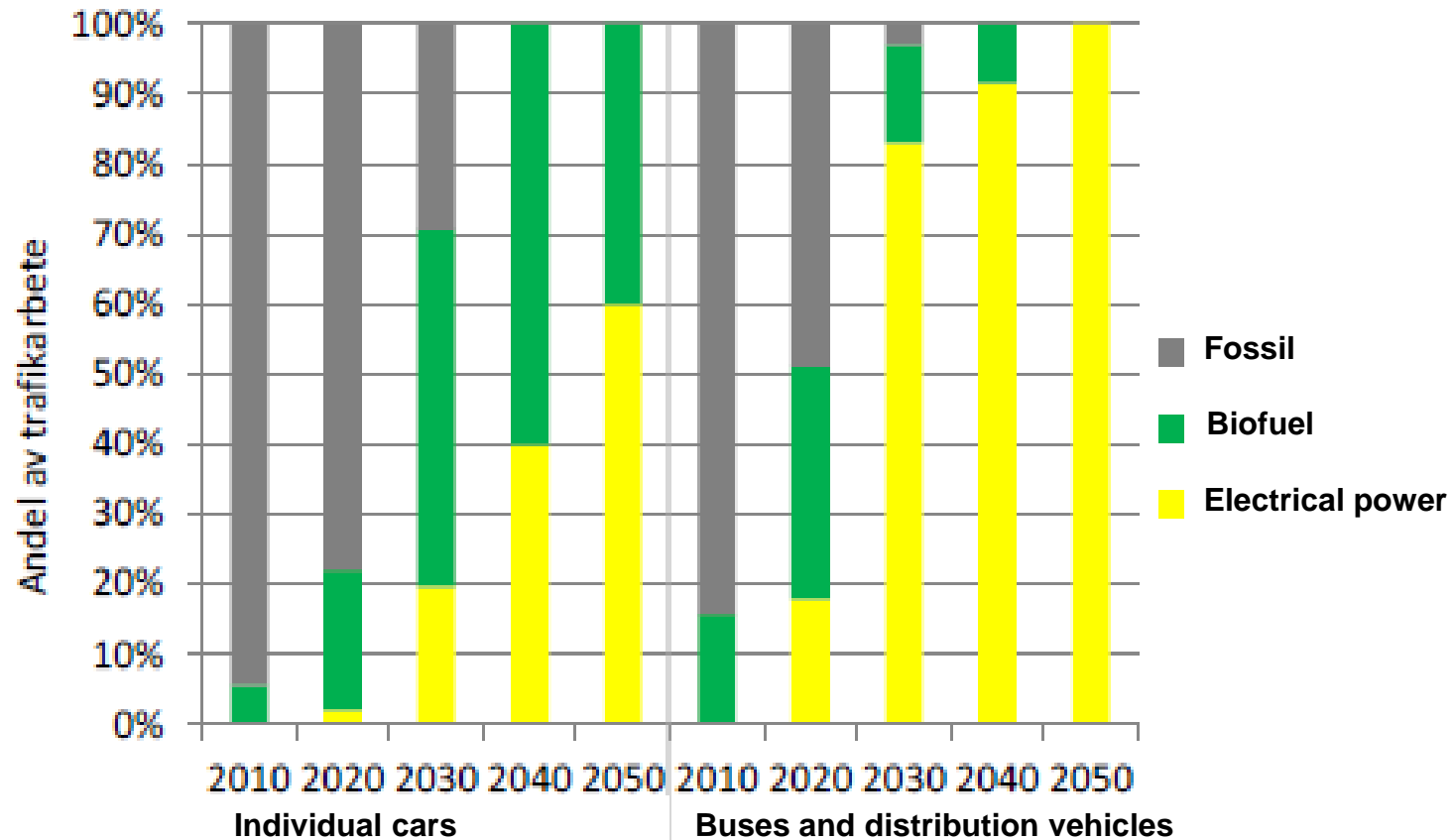
Energy for transports, TWh





Parliamentary commission on fossil-free vehicle traffic

Share of transport work %





Swedish Gasification Centre (SFC)



CDGB - Centre for Direct Gasification of Biomass

CIGB – Centre for Indirect Gasification of Biomass

B4G – Biomass for Gasification, Entrained Flow Centre

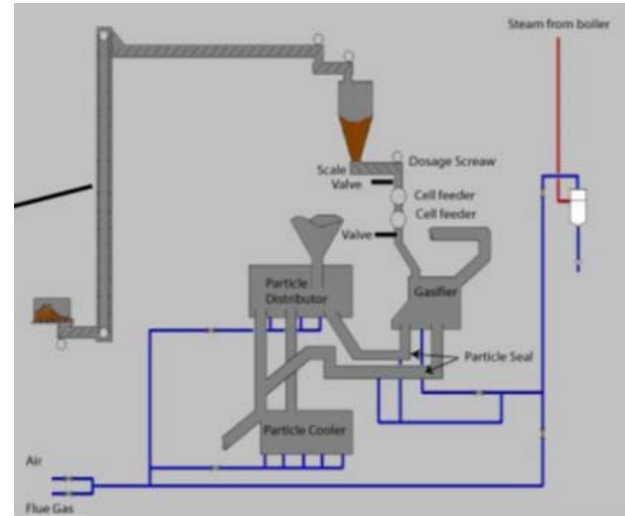
Academies Chalmers, Gothenburg Univ., KTH, Linnaeus Univ., Luleå Technical Univ., Mid-Swedish Univ., Mälardalen Univ., Umeå Univ.

Companies E.ON, Metso, Göteborg Energi, Fortum, Mälarenergi, Cortus, Nynas, Eskilstuna Energi och Miljö, Nordkalk

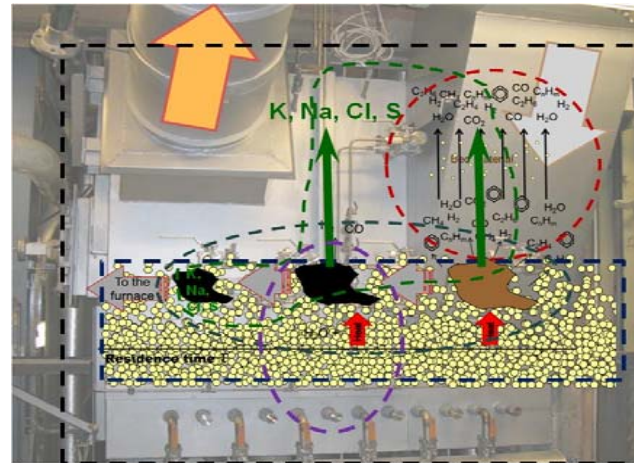
Application for 4 year activity, 58 MSEK/year 2013-2017 approved



Chalmers Indirect Gasification



Chalmers 2-4 MW_{fuel} gasifier integrated on the return leg of Chalmers 12 MW_{fuel} CFB boiler.
Accumulated operation time ~ 2 500 h whereof ~ 500 h experimental time with fuel gasification .



Focus in 2014 on bed materials, catalytic effects of bed material and support to GoBiGas



MiUn BTL Research Laboratory



150 kW ICFB gasifier.



- Integration of FT synthesis reactor
- Prove BTL integration
- System modelling
- Work on Fuel flexibility



Thermo-chemical Conversion of Biomass

- Long experience of R&D within gasification. Activities started in the 1970s.

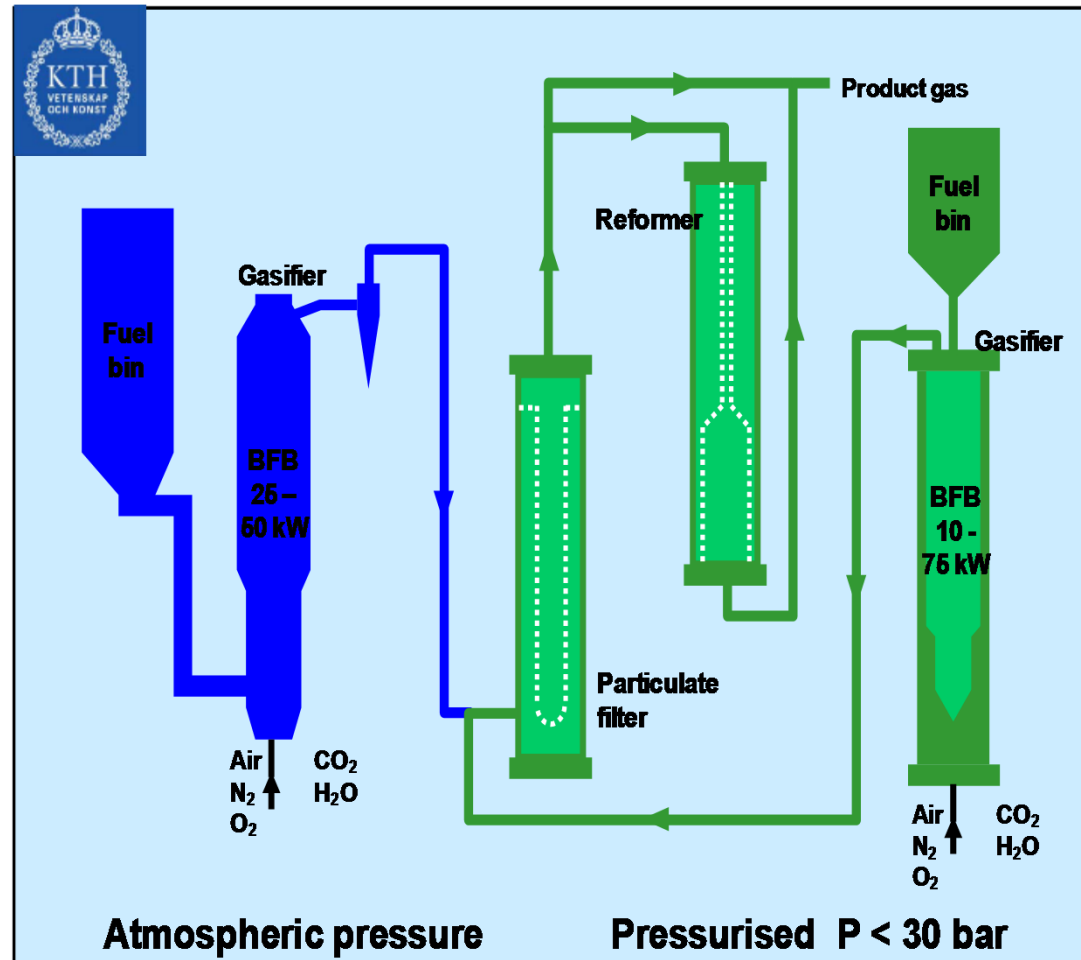
Technologies at KTH

- 75 kW pressurised (30 bar) & air & steam/oxygen FB gasifier with secondary reactor
- 50 kW air & steam/oxygen FB gasifier
- 5 kW air & steam/oxygen FB gasifier
- Test rigs for catalytic deactivation and particle separation concepts
- Tar analysis equipment, On-line alkali analyses
- **New major grant (500 000 €) for upgrading research infrastructure**



Projects

- HT-SNG: Demonstration of improved catalysts and reactor designs for the production of SNG
- SNG for smart gas grids
- SYNCON: Novel synthesis process concepts for efficient chemicals / fuel production from biomass (SYNCON)
- DeMiTar: Development and market implementation of PID and FID tar analyzers





ETC Gasification Activities

Host for DP1: LTU Biosyngas black liquor, biomass

VIPP gasifier: biomass, cyclone gasification, WESP, scrubber, engine CHP



Synthesis gas: zeolite membrane reactor/MeOH, one stage DME pilot





Swedish Gas Centre

”Energy gas program”

New project period 80 MSEK, 9 M€ for 2013-2015

On-going gasification related activities

- ***International Gasification Seminar***

Malmö, October 15-16, 2014, Stockholm Oct. 2015

- ***Particulate contaminants from indirect gasifiers***

- ***Autothermal regenerative POX tar reactor***

- ***On-line detection of water vapor***

- ***CO₂ removal in indirect gasification***

- ***Fuel tests in 500 kW Wood Roll prototype***

On-going, KTH, Cortus



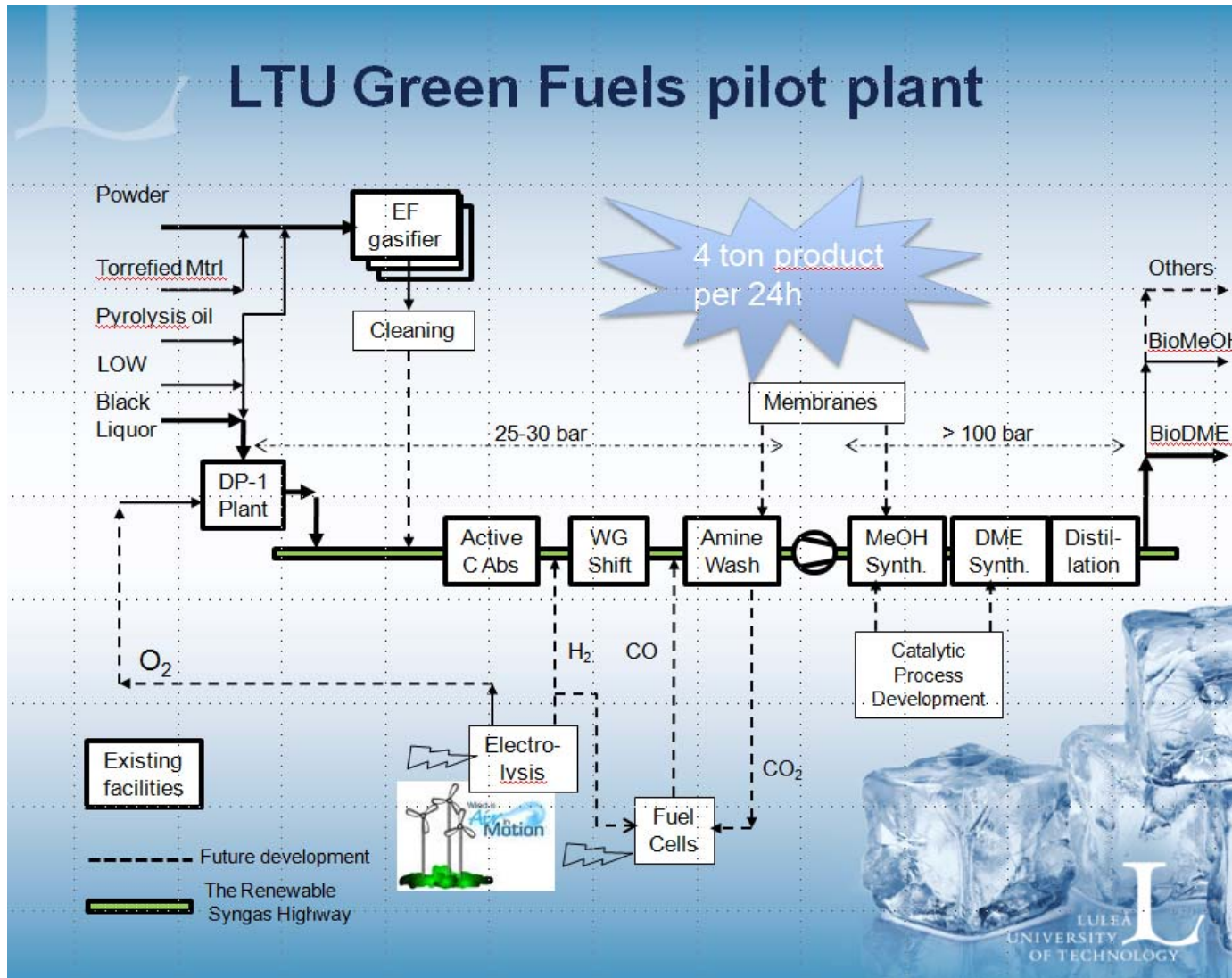


LTU Biosyngas program

- **The LTU Green Fuels (Luleå Technical University) has bought the Chemrec pilot plant and the bio-DME plant.**
- **Operating staff and some key Chemrec staff hired**
- **LTU Biosyngas program, approx. 250 MSEK, 2014-2016**
- **Objectives:**
 - DME fuel for truck tests, other test activities
 - catalytic gasification of liquids
 - Develop to solid fuel gasification
 - Gas cleaning developments
 - Development of catalytic synthesis reactions
- **See separate work shop presentation for details**



LTU Biosyngas program





Swedish Centre for Renewable Fuels (f³)



**Budget for 2011-17
44 million SEK**

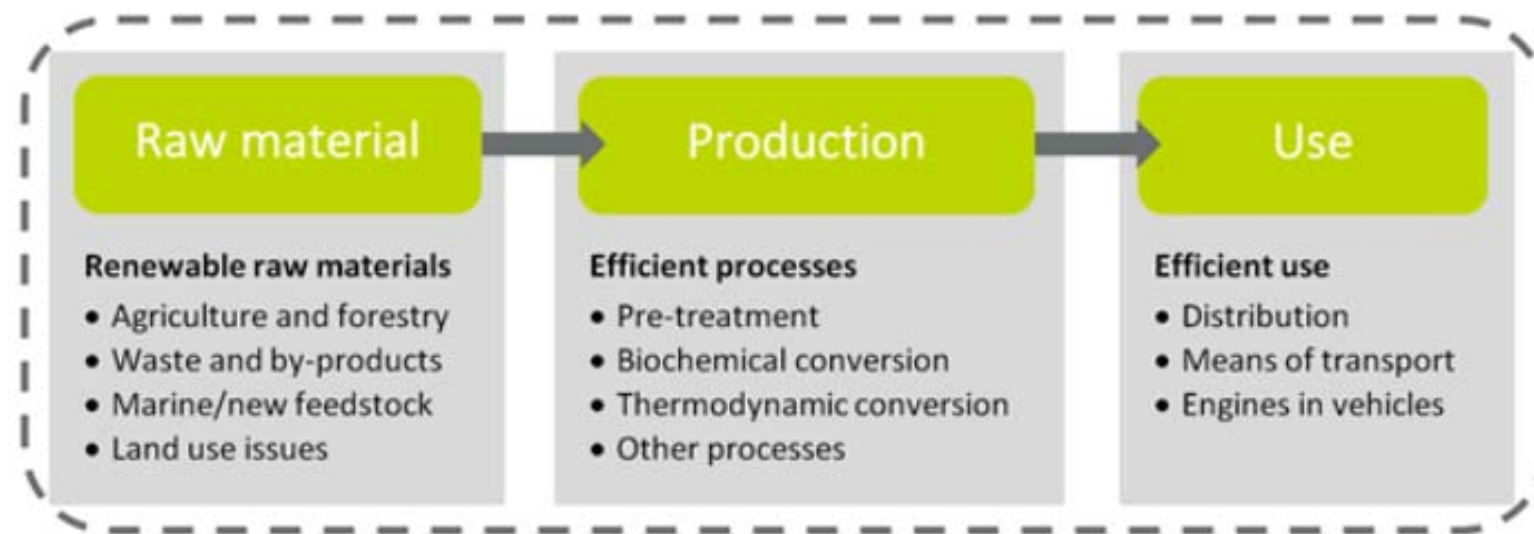
"f3 will be established as a nationwide knowledge platform and venue for cooperation in the production of renewable fuels and the related system aspects, with highest international credibility"



<http://www.f3centre.se/>



Swedish Centre for Renewable Fuels (f³)



All projects relate to the value chain and fall within one of five project areas:

1. Comprehensive technological, economical and/or environmental system studies
2. Stakeholder, policy and strategy studies
3. Comparative system studies of alternative process chains
4. Studies on process integration and efficiency improvement potentials
5. Syntheses of current knowledge status for specific areas or surrounding conditions of the value chain

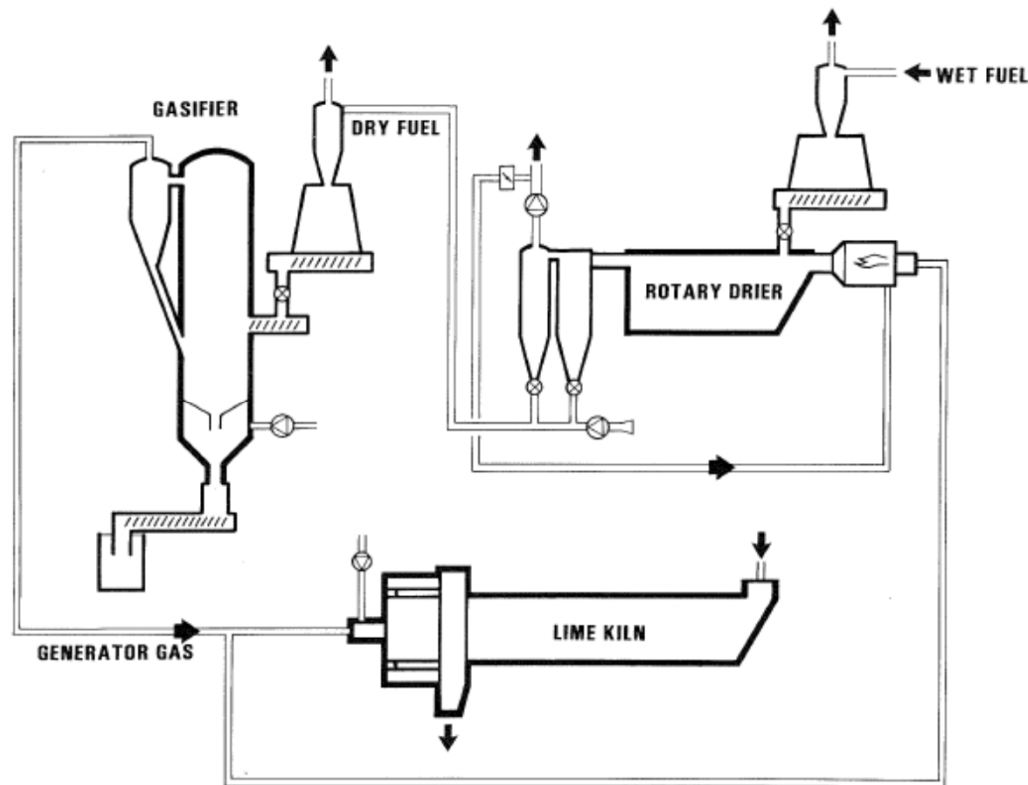




The Värö Gasifier

The gasifier at Värö was not stopped in 2013, it was operated until April 2014, longer than planned .

This was due to delays in the installation of the new lime kiln.





E.ON Bio2G

Bio2G – A reference plant in Sweden for production of bio-SNG by thermal gasification

Facts

- Production capacity 200 MW_{bio-SNG} (1,6 TWh/yr) + heat & electricity
- Forest residues as feed stock
- To be located in Malmö/Landskrona
- Awarded for NER300 support; 203 M€ available

Technology

- Pressurized O₂-blown gasification (Andritz, FI)
- Gas cleaning and methanation, (Haldor Topsoe, DK)



Project is awaiting decisions on the long-term policy instruments for biofuels





E.ON Bio2G

GTI test facility – an integrated biorefinery pilot plant



HALDOR TOPSOE

gti

ANDRITZ CARBONA

Successful testing of gas filtering (as well as gasification and tar reforming) at GTI in Chicago – two viable technical options for gas cleaning at hand
Experimental results from GTI have brought a better understanding of alkali behaviour and are important for further design considerations. It will also support further modelling work planned at SFC.



gti

4

=> Test facility for TIGAS production of gasoline from biomass



6 SGC International Seminar on Gasification 2014 - Bio2G October 15

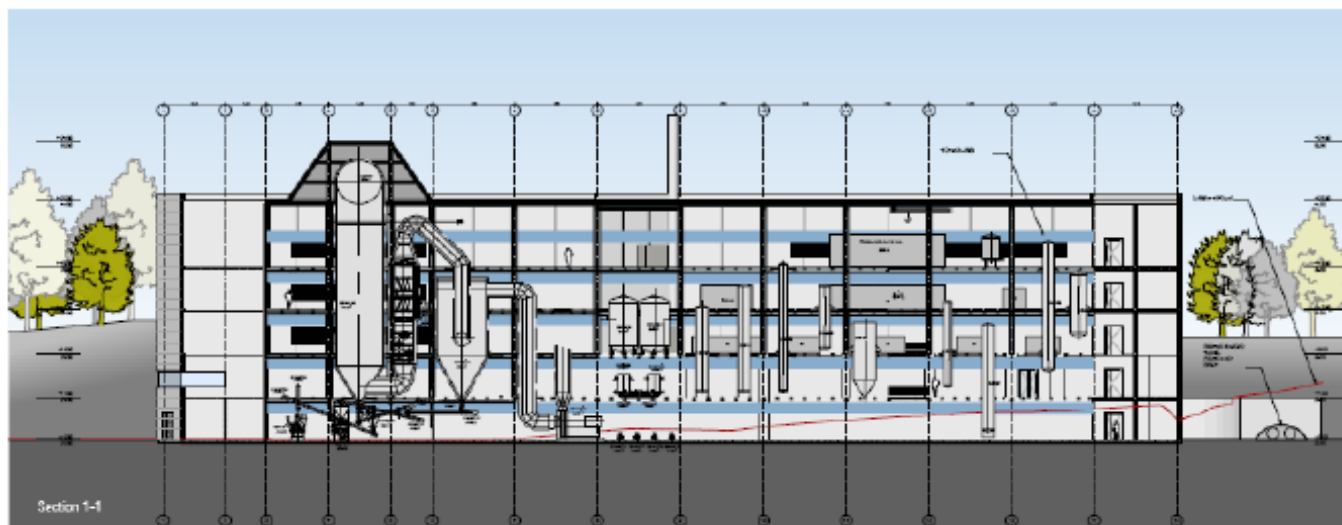
Tests and results from Chicago was presented at SGC International Seminar on Gasification
Presentation can be found at www.sgc.se



Biomass to SNG: GOBIGAS

GoBiGas – phase 1

Production:		Consumption:	
Bio-SNG	20 MW	Fuel (pellets)	32 MW
District heating	4 MW	Electricity	2,5 MW
Heat to heat pumps	8 MW	RME (bio-oil)	0,5 MW



 Göteborg Energi



Biomass to SNG: GOBIGAS

GoBiGas – step by step

- **Performance goals:**

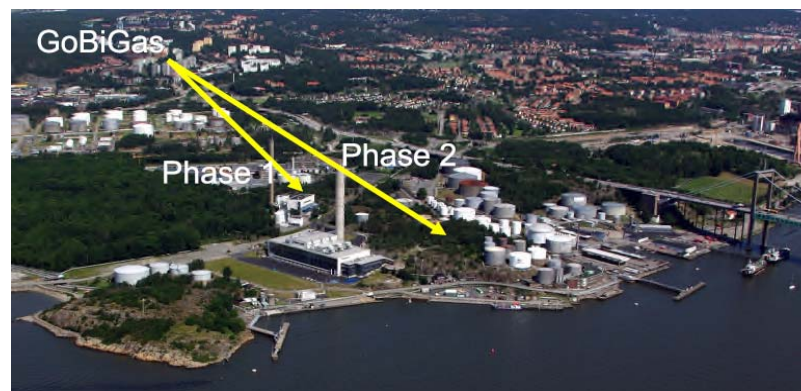
- Biomass to biomethane 65 - 70%
- Energy efficiency > 90%

- **Phase 1:**

- Demonstration plant
- Evaluation, R&D programme
- 20 MW generating 160 GWh/year
- In operation early 2013
- Allothermal (in-direct) gasification

- **Phase 2:**

- 80-100 MW generating 640-800 GWh/year
- In operation after evaluation of Phase 1
- Technology not yet chosen



**Official start-up
October 28, 2013.**



Further details in work shop presentation



Värmlandsmetanol

Permitting is on-going. No grant financing requested.
Private investors and public IPO expected to raise 3 000 MSEK (330M€)
Planned construction start "as soon as permits are in place".

VärmlandsMetanol, Sweden HTW Biomass to Methanol Project

- Uhde selected as technology supplier and EPC contractor
- **Plant Capacity:**
100,000 t/a of fuel grade methanol + district-heating 15 MW_{th}
- **Feedstock:**
Domestic forest residue, ~25 t/h
- **Process:**
Fluidized bed gasification (HTW)
(eq. 111 MW_{th})



Flygfoto: Lars Nilsson Montage: Strömer

VärmlandsMetanol AB

Uhde



ThyssenKrupp



MEVA Innovation AB

A first unit, 1.2 MWe has started operation at Hortlax, Piteå.
Target market is co-gen plant, 2-20 MW heat, 1-10 MWe.

VIPP-VORTEX®, Gasification system

VIPP Cyclone
Gasifier

VORTEX INTENSIVE
POWER PROCESS



VIPP-ECP®, Gas cleaning system

Multistage cleaning

- cyclone
- gas cooling
- RME scrubber
- WESP

Gas engine

Cooperation on specially designed gas engines with supplier Cummins Power Generation Ltd., UK.

In operation this heating season
According to company representatives





Cortus Wood Roll

Saxlund International / Opcon AB	Torkapparater AB	KTH Royal Institute of Technology	Sandvik Heating Technology AB – Kanthal	ÅF	Calderys AB	Siemens
Saxlund International / Opcon delivers biofuels feeding equipment to the WoodRoll® process	Torkapparater delivers dryer and pyrolysis equipment to the WoodRoll® process	KTH has provided equipments and facilities for Cortus to run tests on over 20 different fuels	Kanthal delivers radiation tube burners for indirect heating to the WoodRoll® process	ÅF provides Computational Fluid Dynamics modeling for system optimization	Calderys delivers refractory materials to the gasification reactor in the WoodRoll® process	Siemens delivers Control systems and instrumentation





Cortus Wood Roll, Köping

500 kW integrated plant

- ❖ Fully integrated production of clean syngas from biomass
- ❖ Investing 1 200 000€
- ❖ Six months work will be finalized shortly
- ❖ All safety functions
- ❖ Six screen Siemens control system
- ❖ Remote operation as an overall goal





Cortus Wood Roll

