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Country Update Sweden

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Swedish Politics

A labour-green minority government supported by a leftist party since 2014.

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

New ”power tax” on nuclear power to finance decommissioning introduced in 2014.

The new governement has formed a ”broad” parliamentary energy commission with main focus on electrical power, to report in late 2017.

Transport biofuels tax exemption retained to 2018, biogas to 2020, after discussion on state aid with the EC.

Broad energy agreement in 2016 (excl. biofuels)

”Climate proposition expected in first half of 2017”

Swedish Politics

- Planning and investment decisions on reactors were taken in the 1960's
- Referendum to phase out reactors by 2010 in 1981
- The reactor program of 12 plants fully attained in 1985
- The two reactors at Barsebäck were closed in 1999 and 2005
- The reactor development law (SFS1984:3) revoked in 2012
- Up to 10 new replacement reactors on present sites??????

Due to the new "Power Tax" on nuclear energy Vattenfall in April 2015 announced the premature stop of two reactors in 2018 and 2020 for "commercial reasons", and EON has in September decided to phase out yet two reactors due to post-Fukushima investments and taxes.

Energy agreement decision to gradually phase out the "power tax" to 2017 causes power companies to reconsider three premature reactor shut-downs.

Energy Agreement 2016

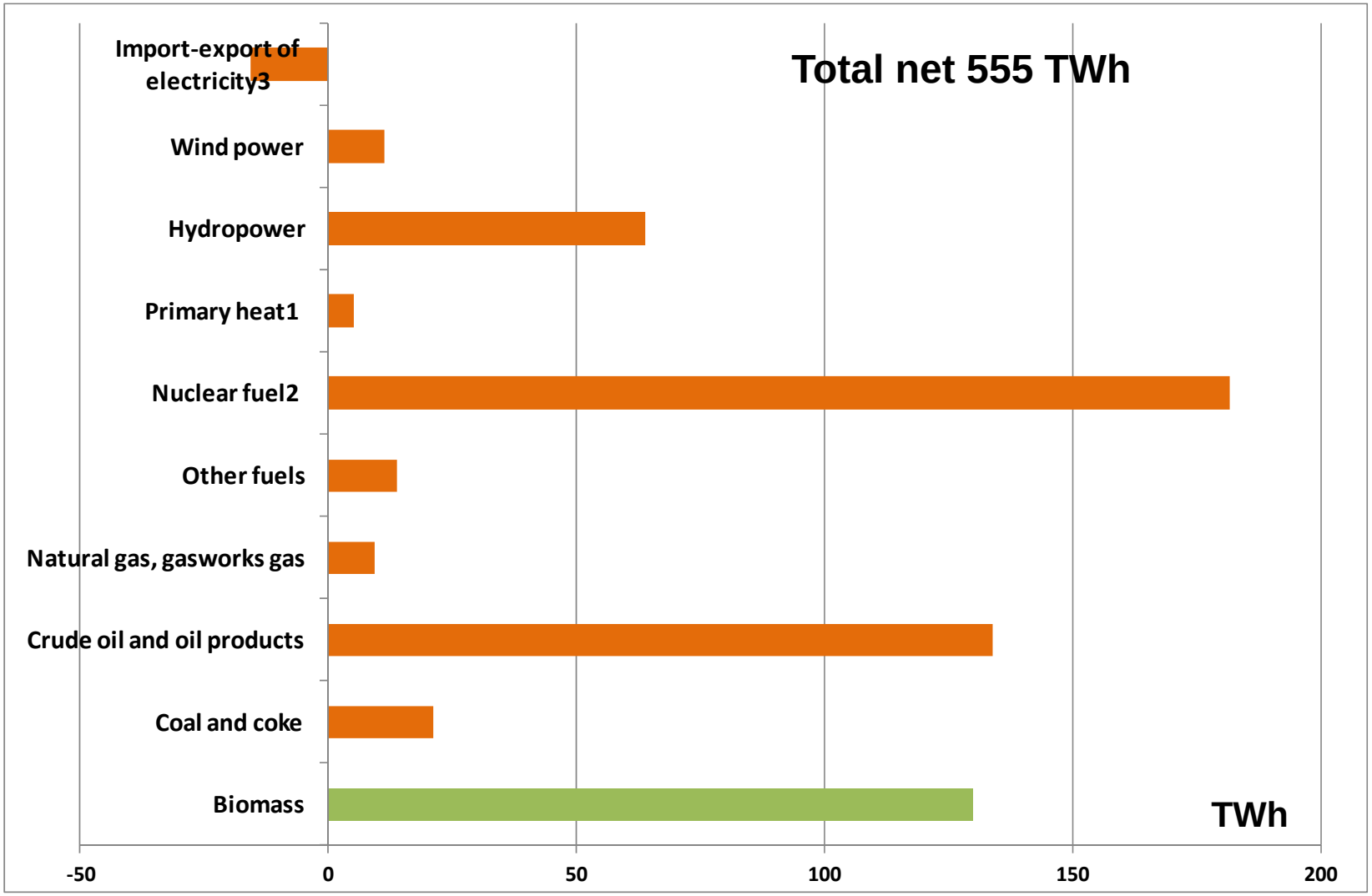
Goals

- Sweden should have no net GHG emissions by 2045, and achieve negative GHG emissions after this date.
- Sweden should have 100 % RE prower after 2040. This is a goal and not an ultimate stop date prohibiting nuclear power or implies a decommissioning of nuclear power by political decision”

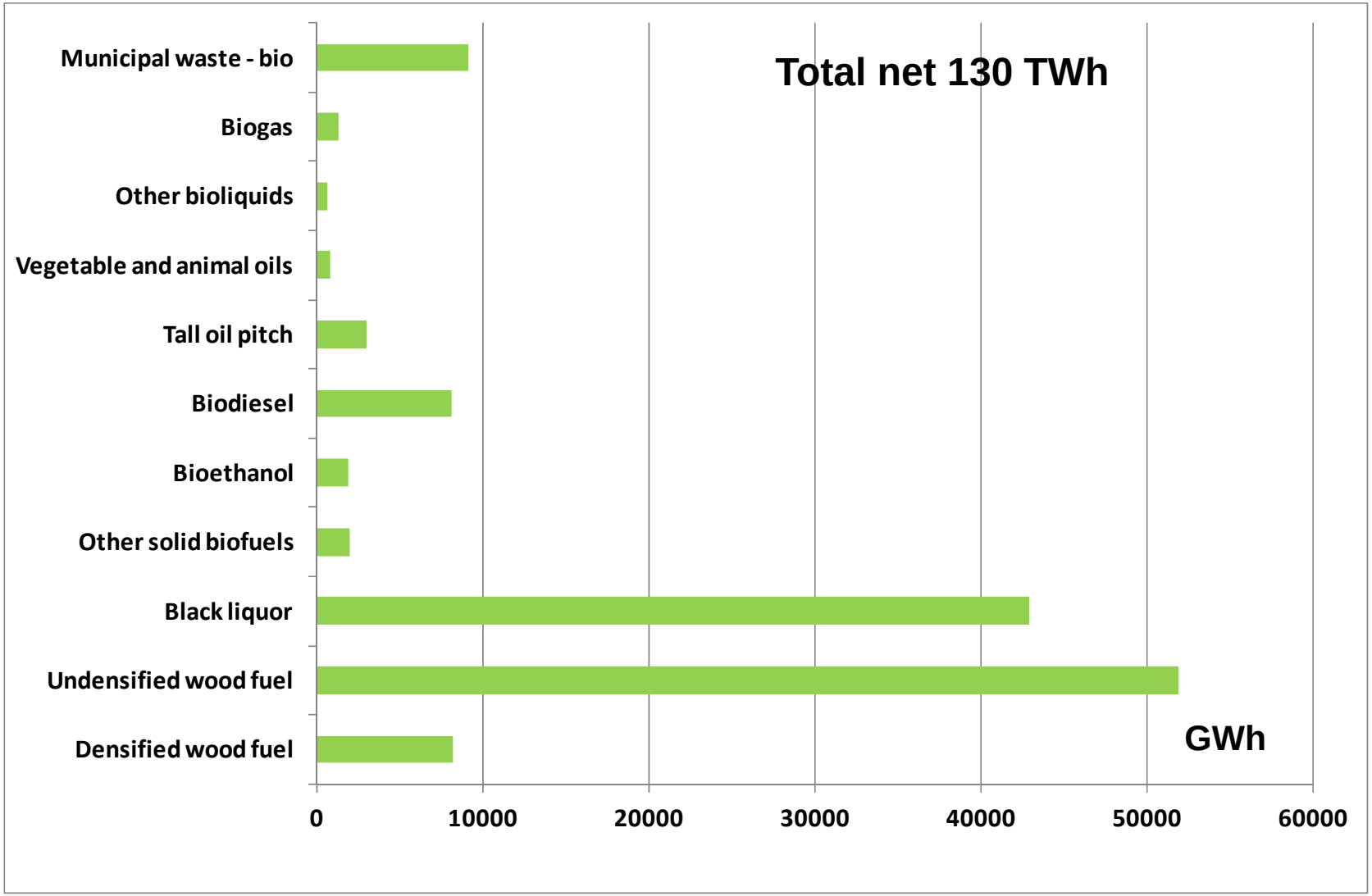
Actions

- Decision to gradually phase out the ”power tax” to 2017
- Expand the SE RE Certificate target by 18 TWh to 2030

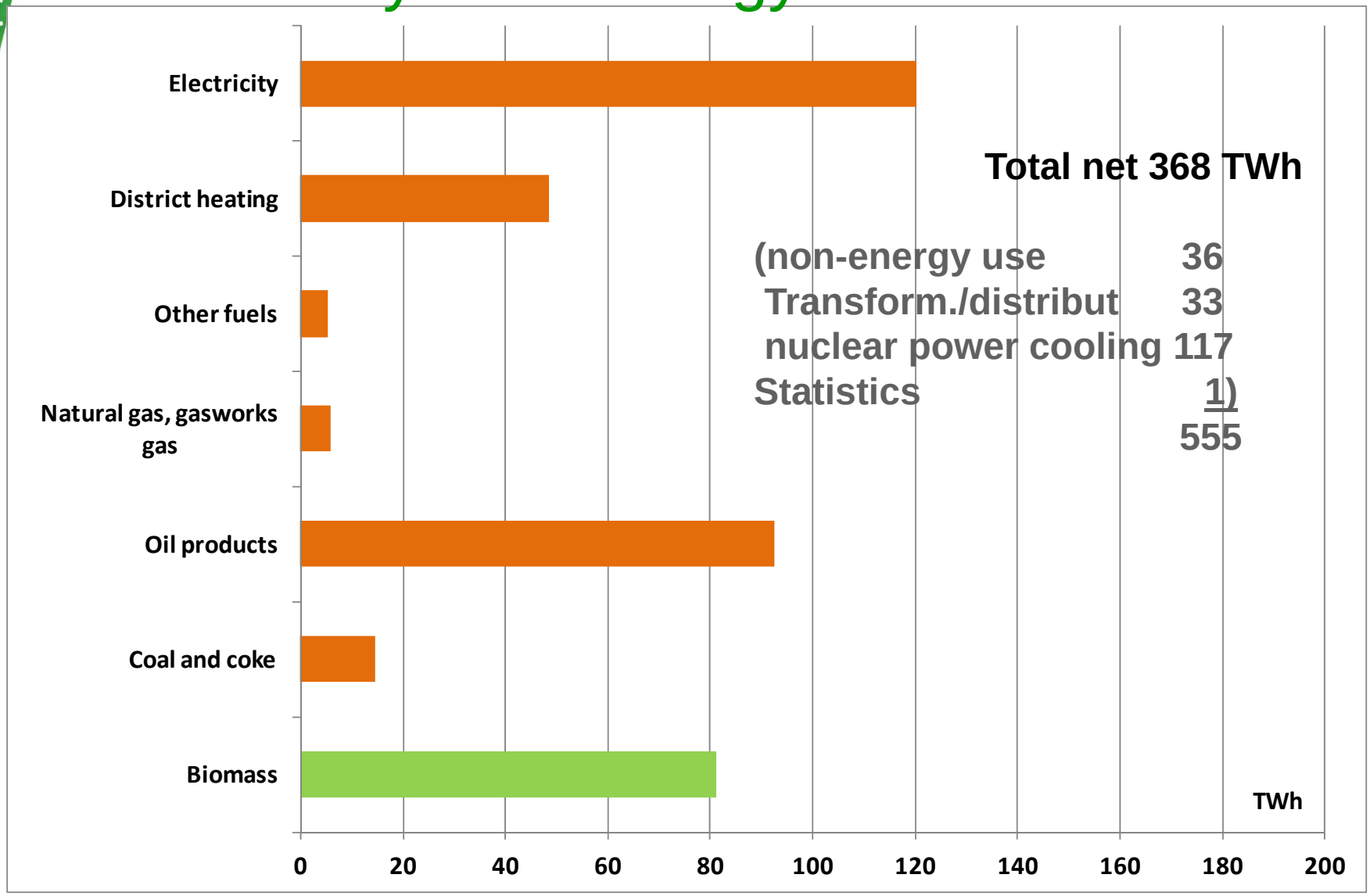
Primary Energy Supply 2014



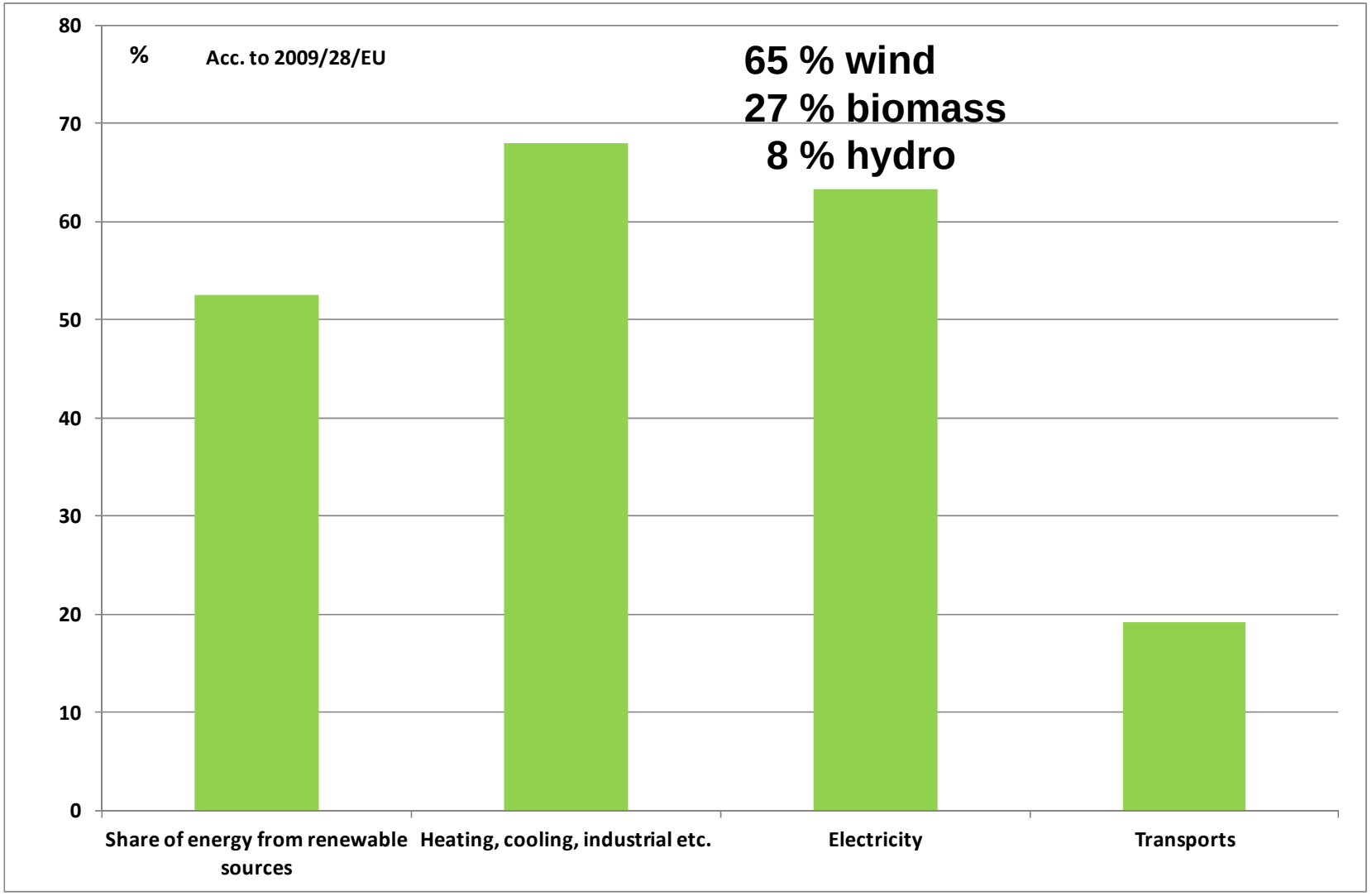
Biomass Energy Supply 2014



Primary Final energy Use 2014



Use of RE energy 2014



RE Promotion Green Certificates

2002 datum **6.7 TWh**
2002 target **+ 10 TWh 2010**
2006 target **+ 17 TWh 2016**
2009 target **+ 25 TWh 2020**

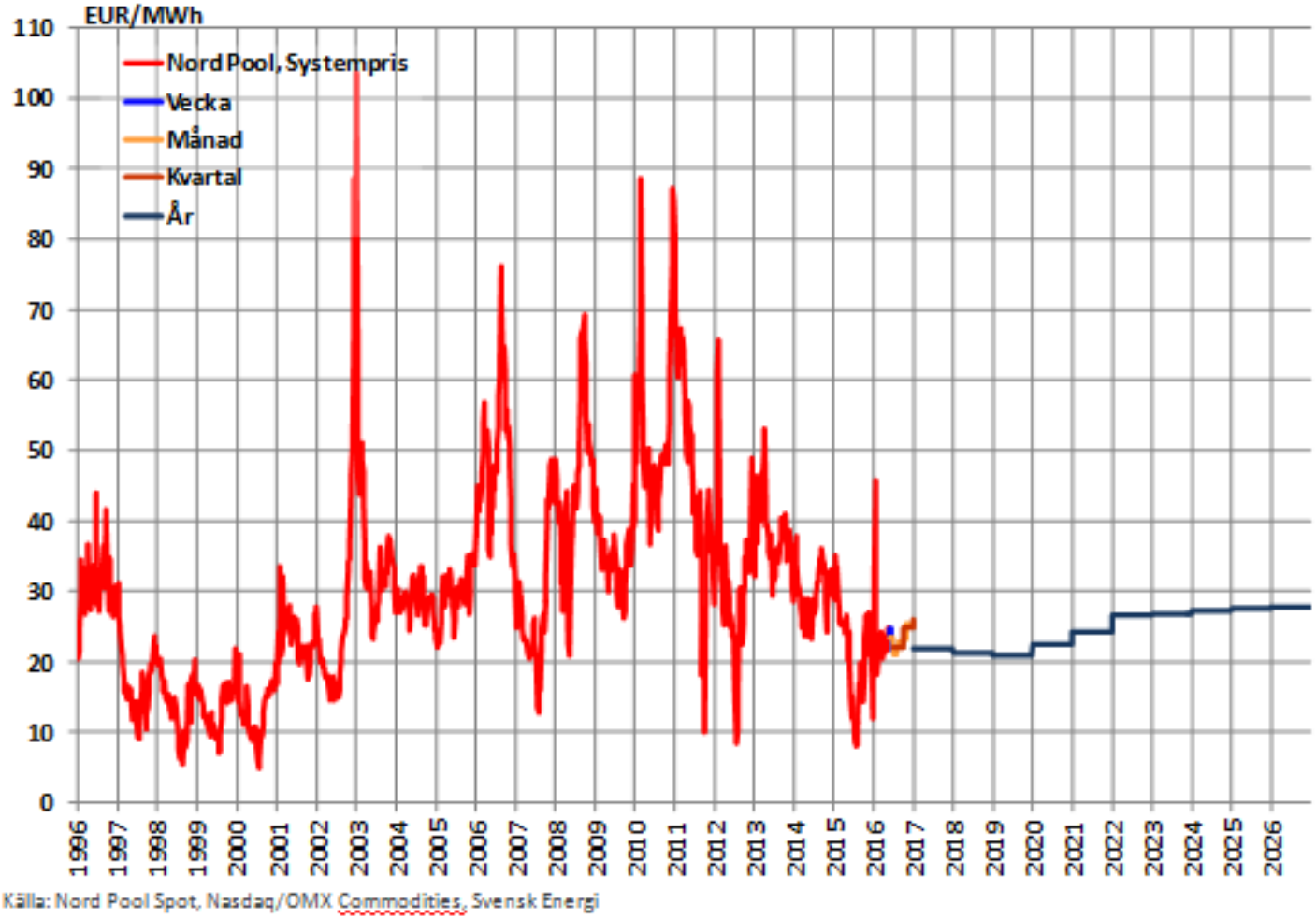
2012 SE+NO common target
SE **+ 13.2 TWh 2020** **to meet previous target**
NO **+ 13.2 TWh 2020**

2015 SE target **Increase 5 TWh to + 30 TWh 2020**

June 2016 SE target **Increase 18 TWh to + 48 TWH 2030**

(total final power usage in 2014, 120TWh)

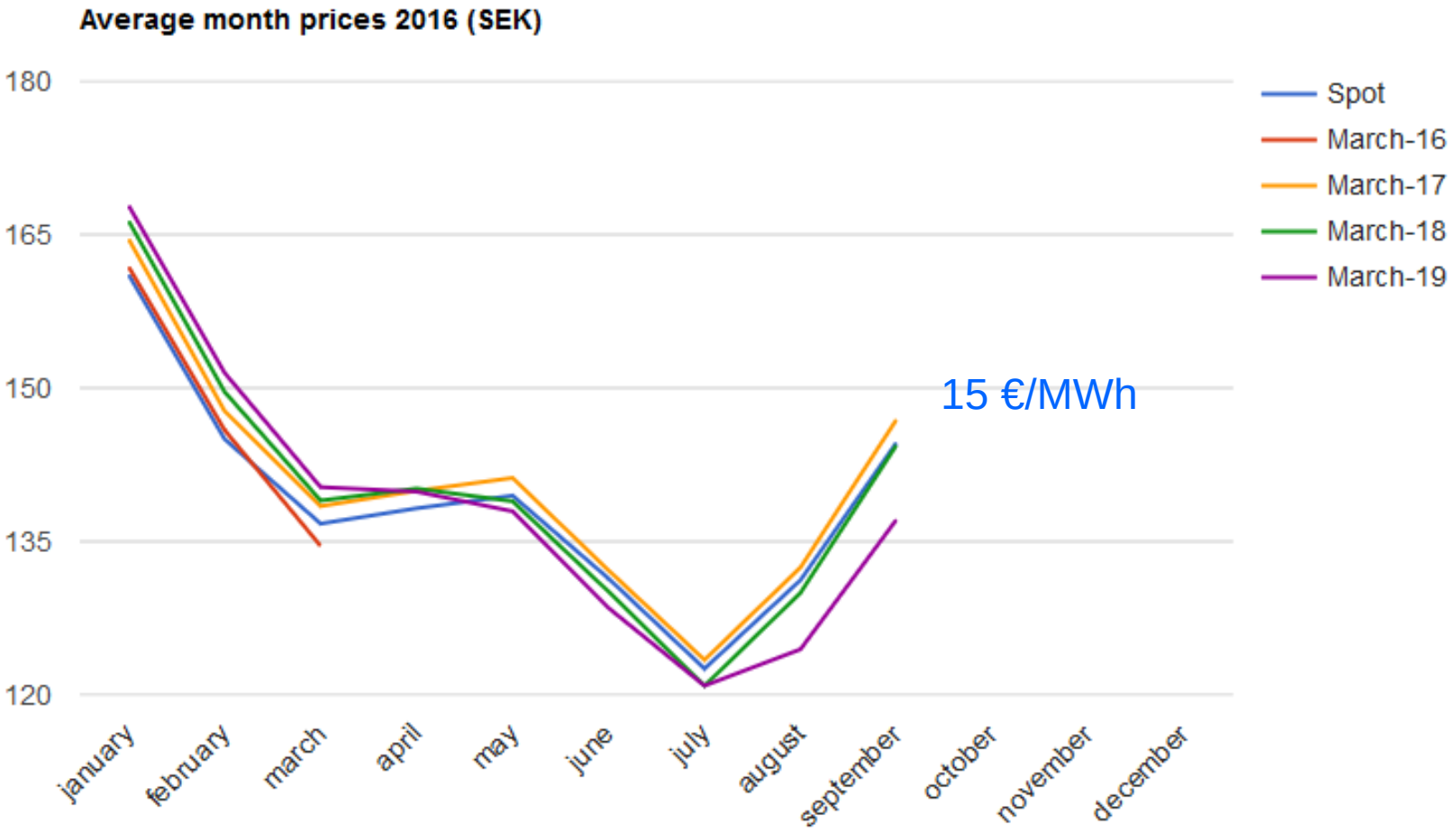
Noordpool spot



Källa: Nord Pool Spot, Nasdaq/OMX Commodities, Svensk Energi

RE Certificates 2006-2014

RE Certificates 2016



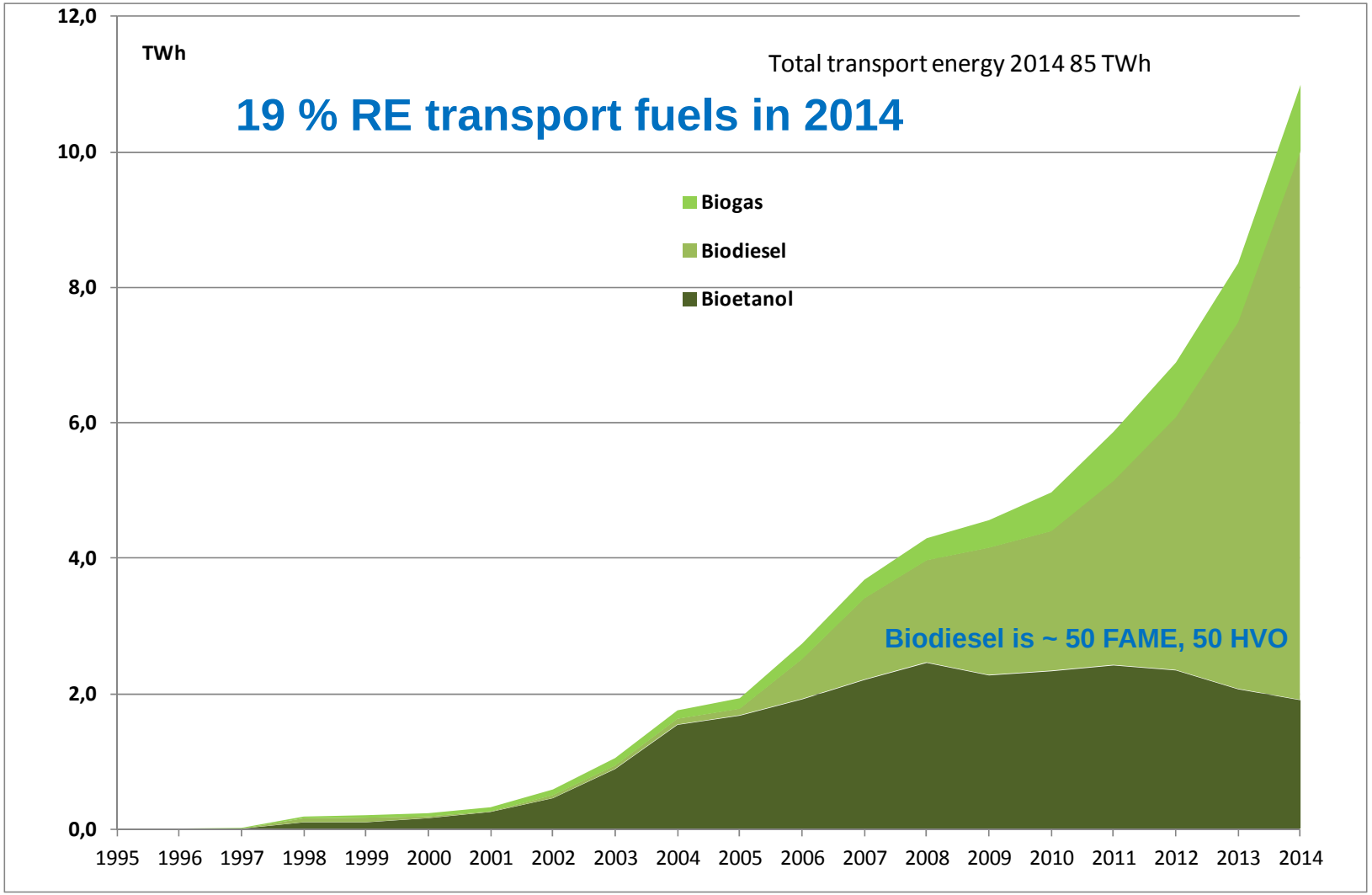
Renewable transport fuels

Present situation

- 19 % RE transport fuels in 2014
- 5.9 % of all vehicles predominant RE fuels in 2013
- Energy taxes levied on low-level blends in gasoline and diesel as of 2013 to comply with EU state aid rules, but no CO_2 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
- New support system in discussion since 2012. All options on the tabl
  - tax exemptions
  - quota obligation
  - GHG reduction obligation
  - the FFF committee proposal guarantee price rel. fossil fuel
  - Other?
- Present tax based system accepted by the EC to 2018 (biogas 2020)

Renewable Transport Fuels



Renewable transport fuel taxation 2015

Fuel type	Usage	Energy tax reduction %	CO2 tax reduction %	Notes
Ethanol ETBE	Low blend-in	(74) 88	100	Max. 5 % blend (10 % 2016)
Ethanol, Other biofuel	High blend-in	(73) 92	100	E85, No fossil component
Ethanol ED 95	High blend-in	100	100	No fossil component
FAME	Low blend-in	(8) 36	100	Max. 5 % blend
FAME	High blend-in	50 (63)	100	
HVO		100	100	
Biogas		100	100	To 2020

taxes changed twice in 2016 to avoid “over-compensation”

Tax exemptions and state-aid

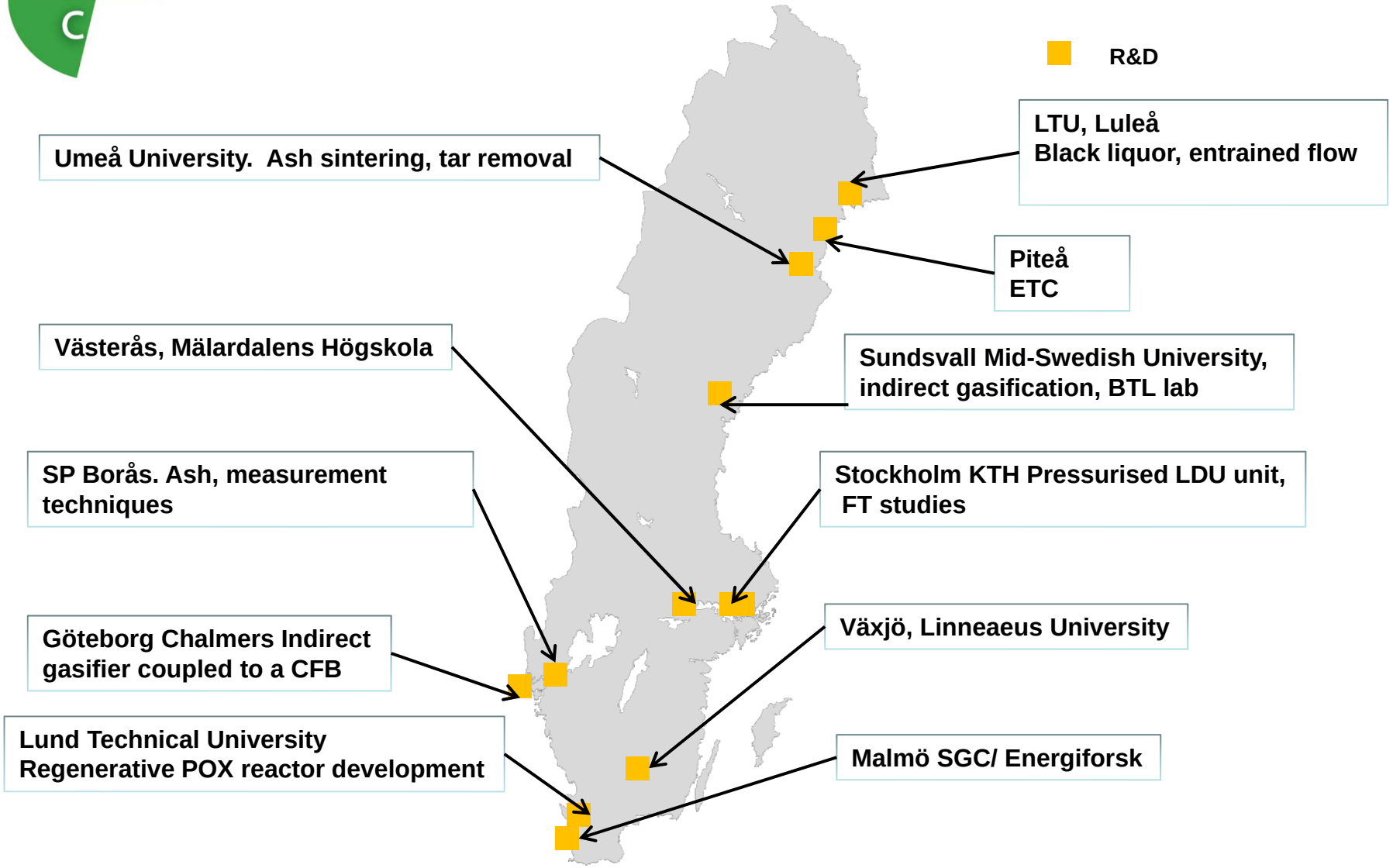
The EC view on support by tax exemptions

- cannot make biofuels cheaper than fossil fuels ("over-compensation").
- cannot apply to new plants (2014)
- cannot be applied to biofuels derived from food crops as of 2020
- cannot be combined with other policy measures such as a quota obligation
- CO2 tax not mentioned in tax directive
- CO2 tax requires differentiation on a fuel basis

SE government actions to avoid issues for enterprises

- More price supervision to avoid over-compensation.
- Stepwise increase in biofuels taxation to avoid over-compensation
- Differentiated taxation for different biofuels depnding on type and level of blend-in (even CO2 tax!)
- New tax conditions for new plants (after 2014)
- Proposal for new system in 2017 for implementation 2018

Biomass Gasification R&D Sweden



Swedish Research Program

SFC – Separate slide

LTU-Biosyngas centre- Separate slide

Energy gas program- Separate slide

f³- 65 million SEK, of which a part is a joint program of 44 MSEK, “Renewable transport fuels” 50% from energy agency

Thermochemical conversion- Biomass including lignin

Gasification, HTL, HTC, Pyrolysis, Hydrogenation, 80 MSEK 2015-2019 (allocations 40 MSEK in 2015, 20 MSEK in 2016)

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, Linneaeus Univ., Luleå Technical Univ., Lund Univ., Mid-Swedish Univ., Umeå Univ.

Companies E.ON, Valmet, Göteborg Energi, Mälarenergi, Cortus, Nynäs, EEM, Nordkalk , Sveaskog, Holmen, MEVA, Bioendev. Luleå Energi, Umeå Energi Pite Energi, LKAB, Akademiska Hus

2013-2017 activity, 58 MSEK/year

2017-2020 new phase in planning

Energiforsk *fka* Swedish Gas Centre

Four energi research organisations where merged to Energiforsk in January 2015

(Värmeforsk, Svenskt Gascentrum, Elforsk, Framsyn)

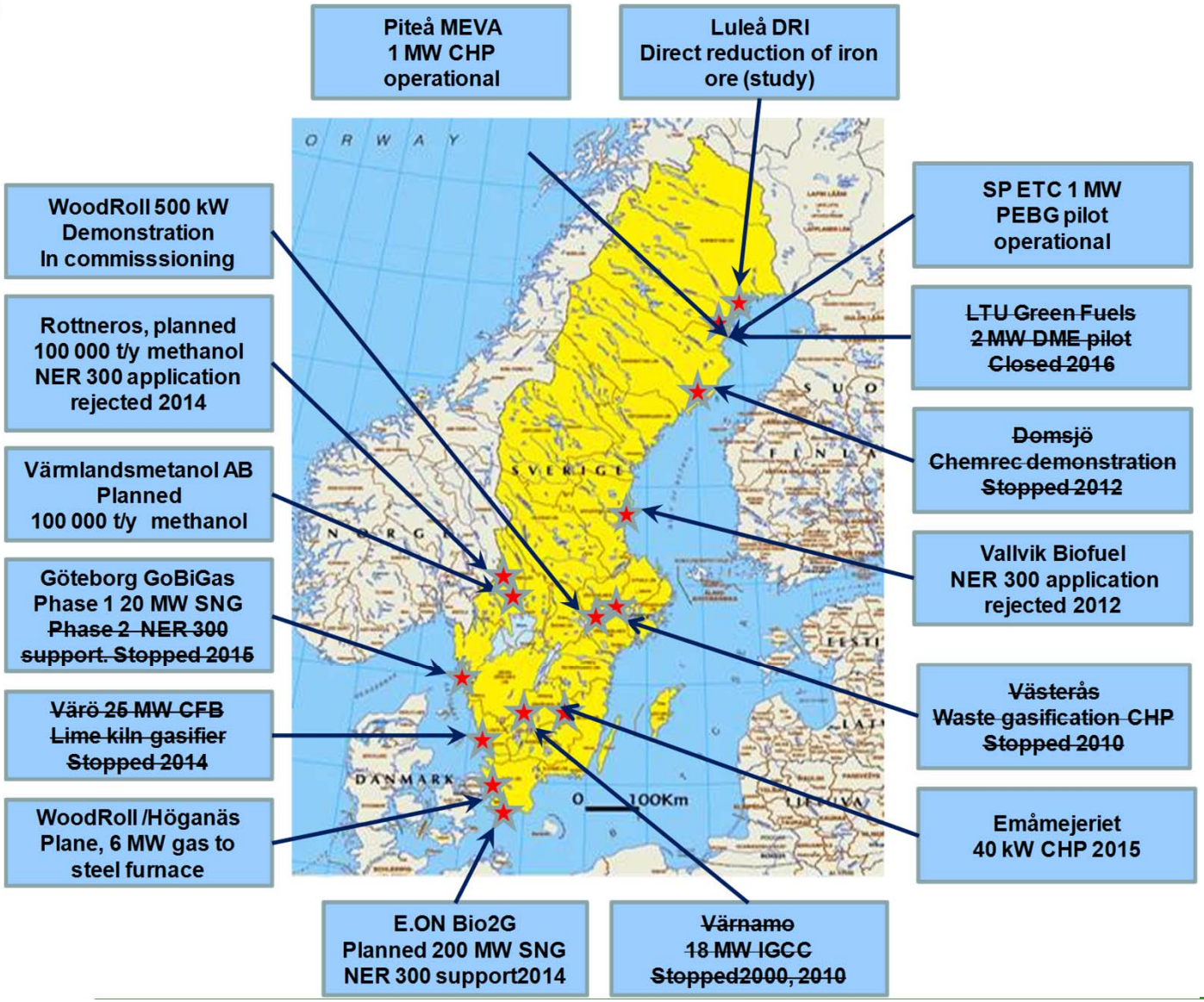
”Energy gas program”

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

A dozen projects approved in December 2014

- ***International Gasification Seminar, Malmö 2016***
- No continuation of program in the present form for institutional reasons

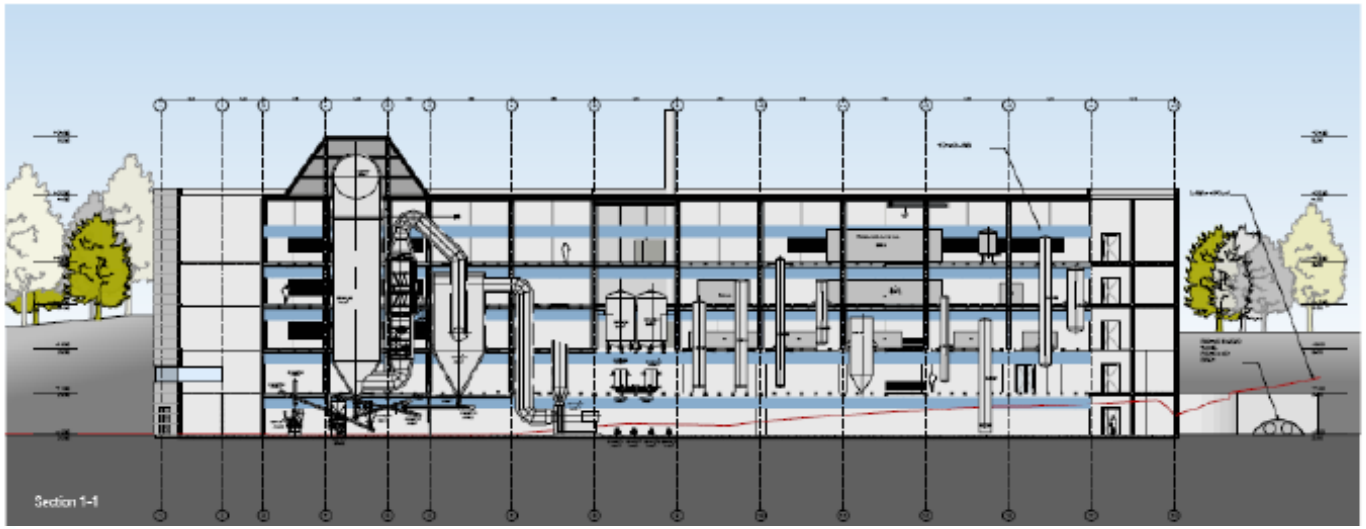
Biomass Gasification Developments 2010-



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

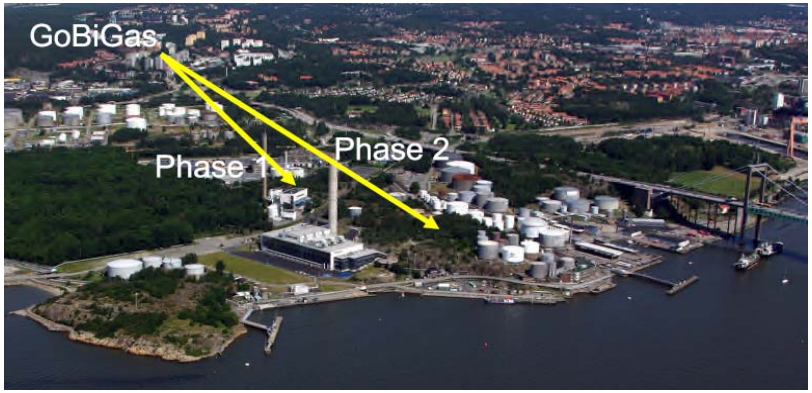


Göteborg Energi

Biomass to SNG: GOBIGAS

GoBiGas – step by step

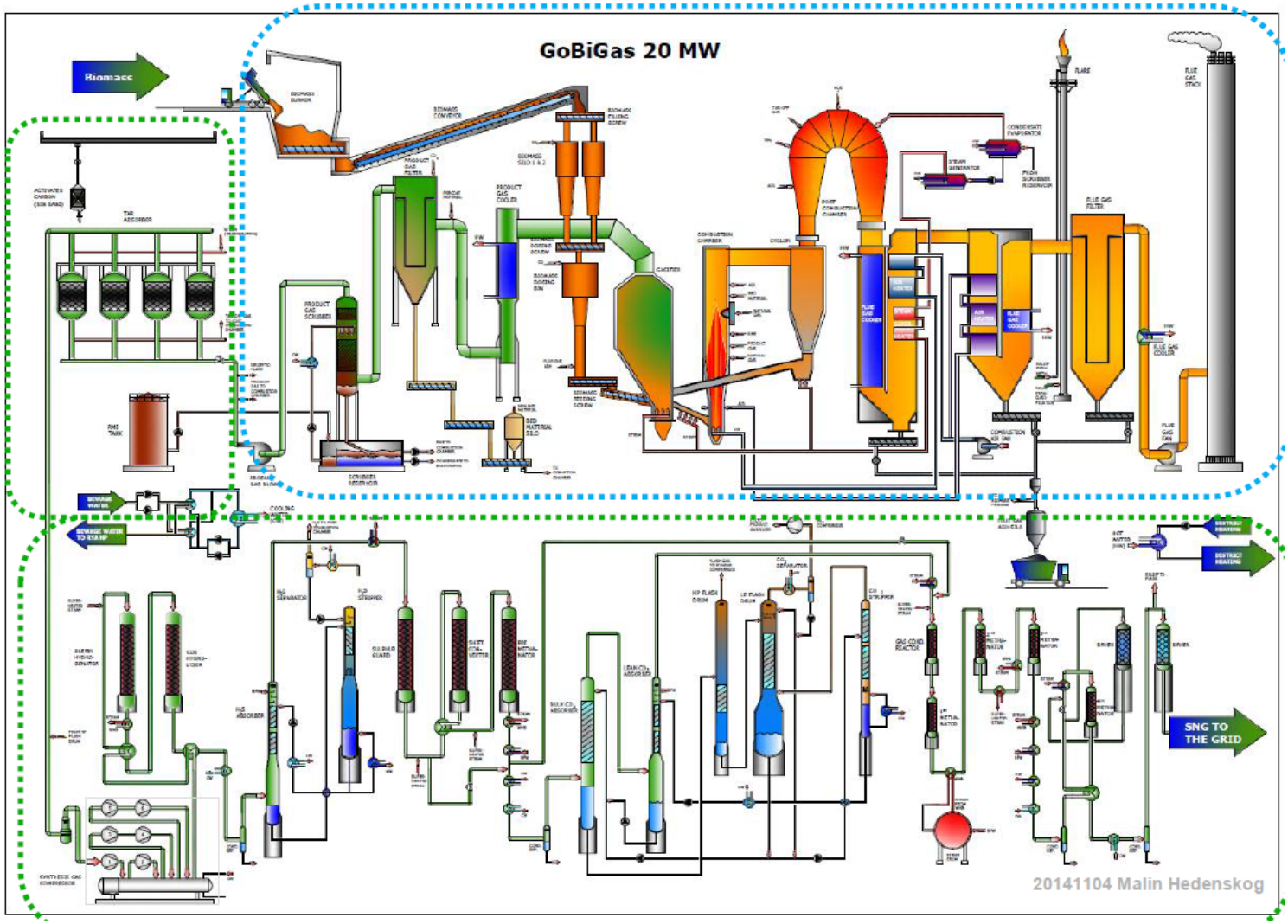
- **Performance goals:**
  - Biomass to biomethane 65 - 70%
  - Energy efficiency > 90%
- **Phase 1:**
  - Demonstration plant
  - Evaluation, R&D programme
  - 20 MW generating 160 GWh/year
  - In operation early 2013
  - Allothermal (in-direct) gasification
- **Phase 2:**
  - 80-100 MW generating 640-800 GWh/year
  - In operation after evaluation of Phase 1
  - Technology not yet chosen



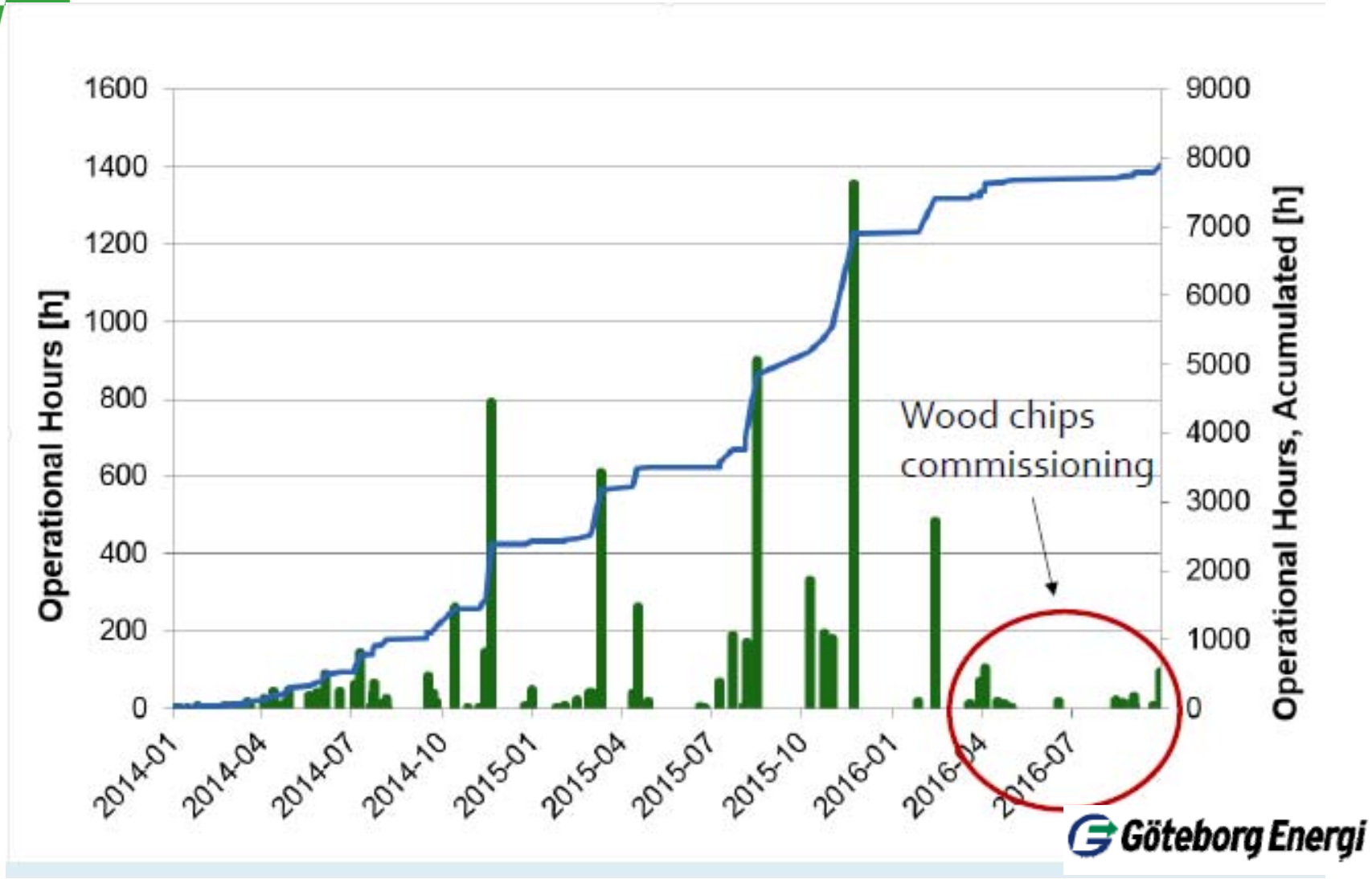
Official start-up October 28, 2013.

Göteborg Energi

Biomass to SNG: GOBIGAS



Biomass to SNG: GOBIGAS



Biomass to SNG: GOBIGAS

Gasification - Performance Test (Wood Pellets)

Flue gas emissions	Guarantee	Measured	
Dust (24 hr average)	10	< 1.4	mg/Nm³ @ 6% O2
CO (24 hr average)	500	109	mg/Nm³ @ 6% O2
NOx as NO2 (1 year average)	95	96	mg/Nm³ @ 6% O2
N2O (24 hr average)	20	3.2	mg/Nm³ @ 11% O2
NH3 (24 hr average)	10	4	mg/Nm³ @ 11% O2
Product gas	**Guarantee**	**Measured**	**Unit**
Capacity	24.3	23.5	MW
Flow	6890	6900	Nm³/h
CH_4	8.3-11.4	8.6	Vol-%
O_2	<0.1	<0.01	Vol-%
C_6H_6	<15	14.4	g/Nm³
N2	<0.85	0.3	Vol-%
Tar	<20	<10	mg/Nm³

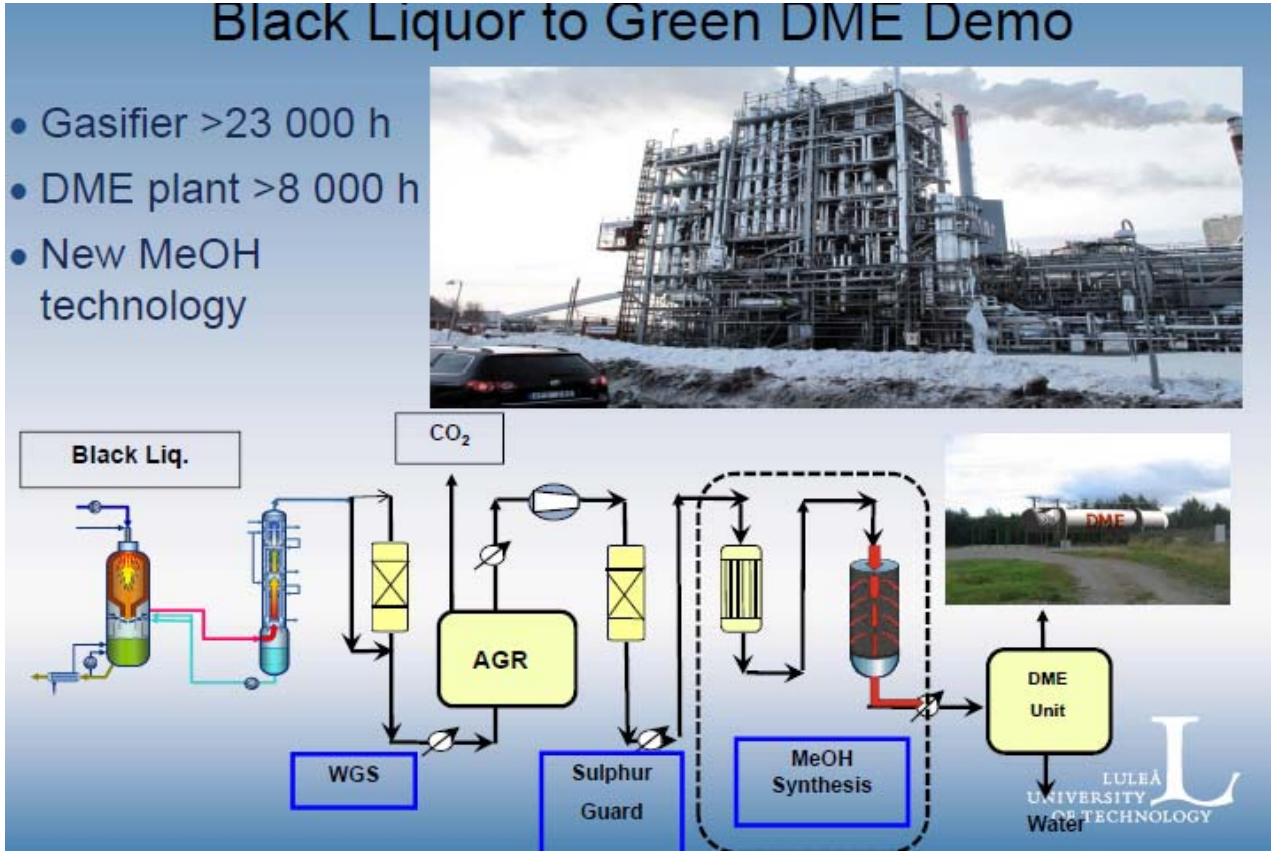
Göteborg Energi

Biomass to SNG: GOBIGAS

However, the City Council decided to discontinue plans for Phase II in December 2016.

The future of the Phase I plant after the evaluation phase uncertain

LTU Biosyngas program



Previously Chemrec BL pilot, bio-DME pilot

LTU Biosyngas program, approx. 160 MSEK, 2014-2016

Program ended in May and no additional funding secured

Mothballing (or decommissioning) decision is pending

Other Projects

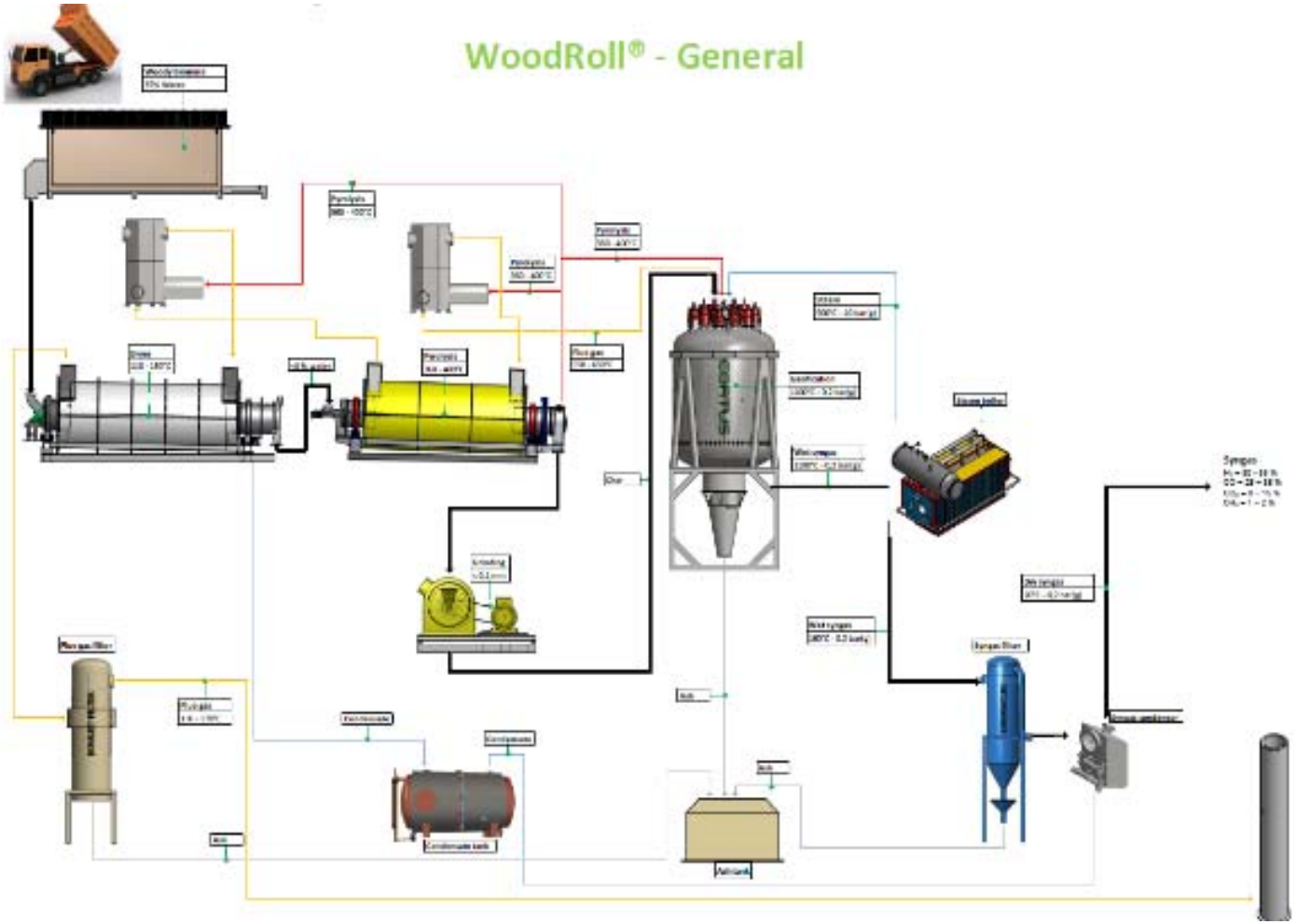
Other projects, no known development

- Bio2G, EON 300 MW SNG, S. Sweden

- Värmlandsmetanol, 100 000 tpa methanol, Värmland
  (New IPO on-going, 1.5 Millon €)

-Rottneros biorefinery, 150- 200 000 tpa methanol, Värmland

Cortus Wood Roll



Cortus Wood Roll, Köping

500 kW integrated plant

Fully integrated operation has been achieved

Some re-engineering requirements have been identified and are being addressed

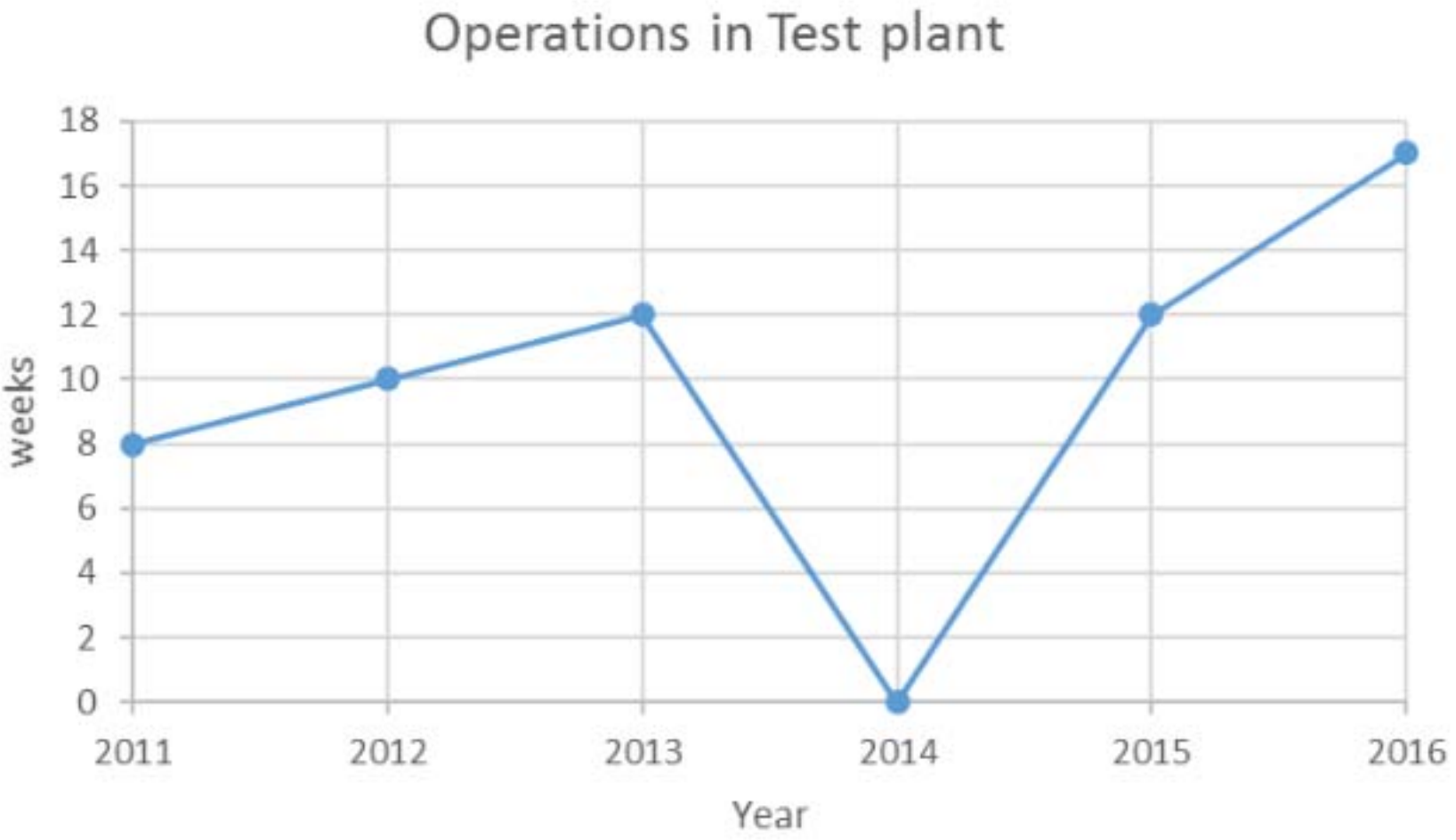
Firing pyrolysis gas in gasifier works

Stable product gas composition without any tar

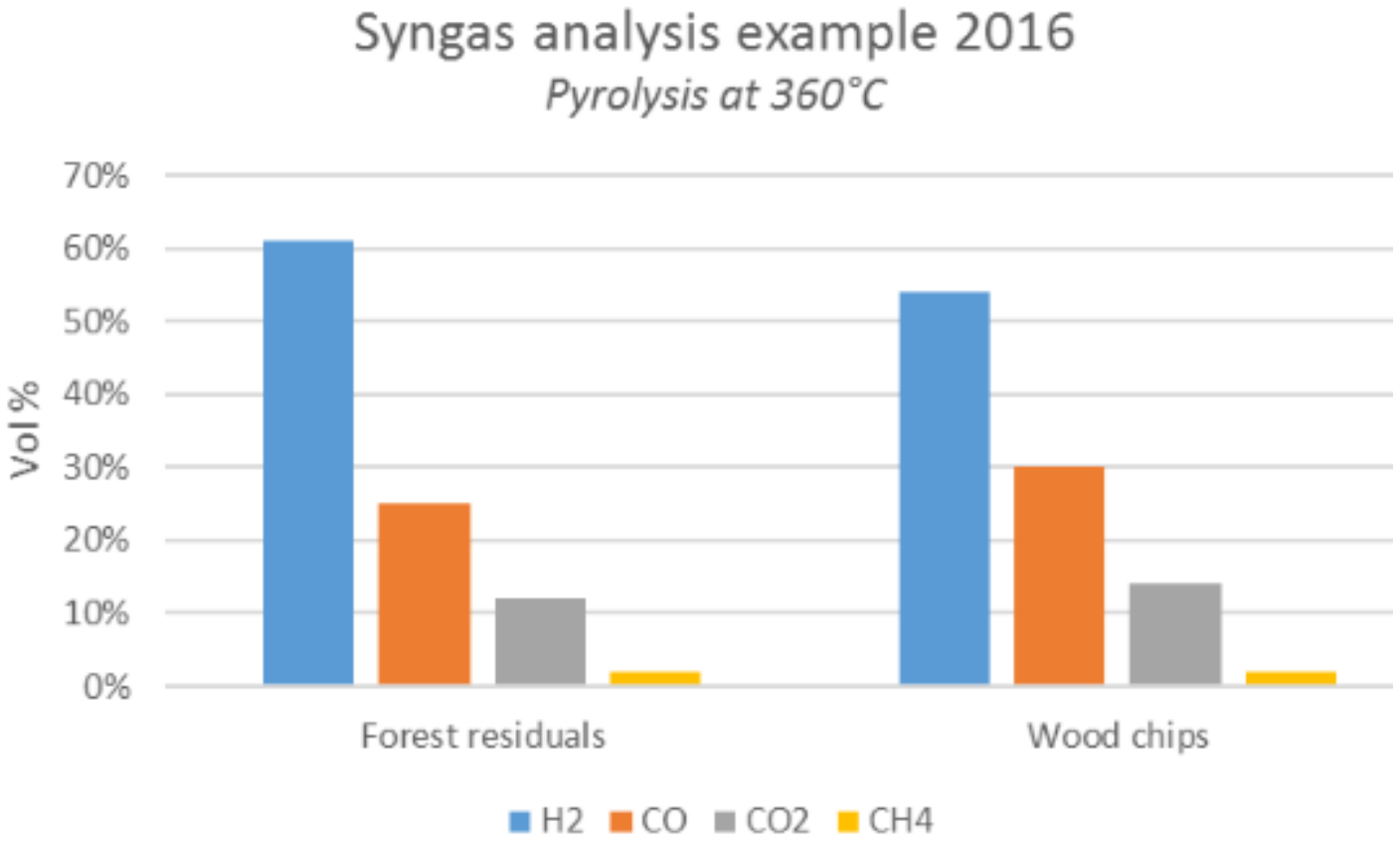
Work with HTAS on catalytic tar treattment in pyrolysis gas

CORTUS

Cortus Wood Roll



Cortus Wood Roll



Cortus Wood Roll, Köping

KIT Mobile SNG unit to initially tested at the Köping site.
A project cooperation within KIC Innoenergy.

Prospects:
- Höganäs 6 MW in stell furnace
- Forest Energy, Japan 2 MWe 2017 (pot. 20 plants)
- CHP study in California target 2017
- LPG replacement in a paper industry dryer
- 3 units in Italy awaiting new RE support policy decision

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
VORTEX INTENSIVE POWER PROCESS

Cyclone Gasifier

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 according to company representatives (1 000 hrs gasifier, 300 hrs integrated mode

MEVA INNOVATION AB