

**IEA Bioenergy Agreement: 2013-2015**  
**Task 33: Thermal Gasification of Biomass**  
**Second Semi-annual Task Meeting, 2015**

**Berlin, Germany**  
**29 October 2015**

**Minutes**

Prepared by Dr. Jitka Hrbek, VUT, Austria

The list of attendees, for the Task Meeting includes:

Name	Country	Affiliation	email
<b>Task 33 members</b>			
<b>Kevin Whitty</b>	USA	UoU	kevin.whitty@utah.edu
<b>Reinhard Rauch</b>	Austria	VUT	rrauch@mail.zserv.tuwein.ac.at
<b>Jitka Hrbek</b>	Austria	VUT	jhrbek@mail.zserv.tuwein.ac.at
<b>Morten Tony Hansen</b>	Denmark	FORCE	mth@force.dk
<b>Berend Vreugdenhil</b>	The Netherlands	ECN	vreugdenhil@ecn.nl
<b>Martin Rügsegger</b>	Switzerland	Eteca	eteca@gmx.ch
<b>Mark Eberhard</b>	Germany	KIT	Mark.eberhard@kit.edu
<b>Lars Waldheim</b>	Sweden	WaC	lars.waldheim@waldheim-consulting.se

**Regrets for inability to attend** were received from: Antonio Molino, ENEA, Italy, Judit Sandquist, SINTEF, Norway, Ilkka Hannula, VTT, Finland.

**The Agenda of the Meeting was as following.**

- 14:00 Welcome and introductions
- 14:10 Updates on Special Projects for 2013-15 triennium
  - Status of biomass gasification report
  - Performance test protocol white paper
- 14:30 Report from ExCo76
  - 2016–18 triennium proposal
  - ExCo Strategic Projects
- 15:10 Country reports
- 15:30 Break
- 15:45 Country reports
- 17:15 Update on new Task website
- 17:30 Locations and dates of task meetings 2016
- 17:45 Wrap-up and meeting closure

## Discussion on actual and future projects

### Actual special projects

- **Status report on biomass gasification**  
- the representatives of the member countries were asked to provide an update on the database and country reports till 20. November to finish this report by Jitka Hrbek
- **Performance Test Protocol for Small Scale Gasifier**  
- a draft version was presented by Martin Rügsegger and Task members were asked to provide a feedback

### Future special projects

- **SP1: Gasification of waste (with Task 36)** (Lars Waldheim leads)
- **SP2: Protocol for tar sampling and analysis using SPA method** (Kevin Whitty leads)
- **SP3: Hydrogen production from biomass and its use** (the Netherlands, Sweden and Austria interested in leading)
- **SP4: Potential of biomass gasification to contribute to BECCS (with T38)**
  - Norway and Netherlands interested in leading
  - May also end up as strategic project
- **SP5: Gasification-based renewable energy hybrid systems**
  - Had been promoted by Ilkka Hannula
  - Now is also proposes as strategic project
- **SP6: Fuel pretreatment**
  - Strategic project
- **SP7: Status of biomass gasification** (Jitka Hrbek leads)
- **Other: Biomass success stories**
  - Strategic project with multiple involved

### Next Task Meeting

First Task meeting 2016 will be held probably in Norway in May 2016. Norway did not confirm this yet, decision until December. The second possibility, where the Task 33 meeting could take place is the Netherlands.

Second Task meeting 2016 will be held in Switzerland in late October. WS topic will be probably "Diagnostics and analytics on thermal gasification".

### Workshops 2016-18

- Diagnostics and analysis on thermal gasification
  - Switzerland Oct 2015
- Pretreatment of biomass for thermal conversion
  - joint with Tasks 32, 34, others
- Energy production through gasification of waste
  - joint with task 36 in 2017
- Fluidized bed biomass gasification of biomass and waste
  - joint with IEA FBC

### **Country participation 2016-2018**

Germany, Italy, the Netherlands, Norway, Sweden, Switzerland confirmed the participation in the next Triennium. The decision for Austria and Denmark should be met until Dec. 1.

There is also a possibility that France will join the Task for the next Triennium.

### **Task 33 Website**

A new design of the Task website was established with the aim to get a similar structure of the website as IEA Bioenergy homepage. The design of the website is much more attractive than of the old one. Anyway the database, which is collective for our and other 2 Tasks causes some problems.

## Country Updates on Biomass Gasification

### Austria, Reinhard Rauch, VUT

Statistics (energy demand and share of renewables, primary production of renewable energy in 2003 and 2013 and fuel consumption) were presented.

Austrian research organizations and their activities were introduced:

- Graz University of Technology
- Joanneum Research Graz
- MCI
- Bioenergy 2020+
- Vienna University of Technology

#### Austrian companies active in biomass gasification:

- Andritz (now also owner of the Austrian part of Austrian Energy & Environment)
  - No activities with FICFB, has still patent
- AGT Agency for Green Technology
- Cleanstgas
  - Not active any more
- GE Jenbacher
- Güssing Renewable Energy (GREG)
- Ortner Anlagenbau
- Repotec
- SynCraft Engineering GmbH
- Urbas
- Xylogas
- ZT Lettner

#### Commercial FICFB gasifiers

Location	Usage / Product	Fuel / Product MW, MW	Start up	Supplier	Status
Güssing, AT	Gas engine	8.0 <sub>fuel</sub> / 2.0 <sub>el</sub>	2002	AE&E, Repotec	Operational
Oberwart, AT	Gas engine / ORC / H <sub>2</sub>	8.5 <sub>fuel</sub> / 2.8 <sub>el</sub>	2008	Ortner Anlagenbau	Operational
Villach, AT	Gas engine	15 <sub>fuel</sub> / 3.7 <sub>el</sub>	2010	Ortner Anlagenbau	On hold
Senden/Ulm, DE	Gas engine / ORC	14 <sub>fuel</sub> / 5 <sub>el</sub>	2011	Repotec	Operational

Burgeis, IT	Gas engine	2 <sub>fuel</sub> / 0.5 <sub>el</sub>	2012	Repotec, RevoGas	Operational
Göteborg, Sweden	BioSNG	32 <sub>fuel</sub> / 20 <sub>BioSNG</sub>	2013	Repotec/ Valmet	Operational
California	R&D	1 MW <sub>fuel</sub>	2013	GREG	Operational
Gaya, France	BioSNG R&D	0,5 MW <sub>fuel</sub>	2016	Repotec	Under construction
Thailand	Gas engine	4 <sub>fuel</sub> / 1 <sub>el</sub>	2016	GREG	Under construction

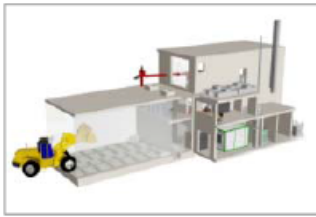
### Commercial CHP gasifiers

- Companies active in Austria

Company	Output kW el/th	Technology
Cristof Group REP	13/31 20/45	Fixed bed
Spanner RE <sup>2</sup>	20/48 30/73 45/108	Fixed bed
Syncraft	180/270 280/550	Staged gasification
Urbas	150/300 280/550	Fixed bed
Xylogas	50/105 220/410 440/870	Fixed bed
Holzenergie Wegscheid	125/230	Fixed bed
Fröling	50/107	Fixed bed
Burkhard	180/240	Fixed bed

## Syncraft

Technology and references presented



### CraftWERK / Innsbruck / AT

Currently under final approval together with 3 other plants in Austria. Commissioning 2016.



### CraftWERK / Dornbirn / AT

The plant in Dornbirn has been commissioned December 2014. In its first year of operation it is about to reach an availability of 87%.



### CraftWERK / Vierschach / IT

The plant in Italy has been our first commercial plant that has been added to an existing 1.2 MW biomass boiler in 2011/12. In commercial operation since April 2014.



### CraftWERK / Schwaz / AT

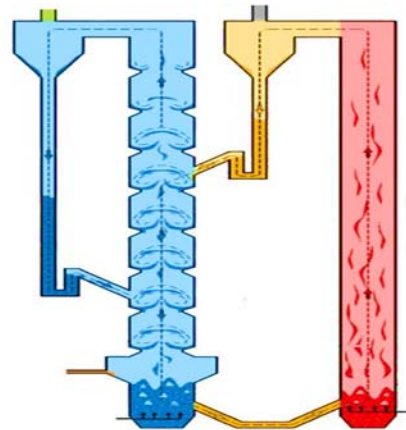
The Alpha plant has been built in 2009 on the site of the Stadtwerke Schwaz and is since then used as development platform for our technology.

## Vienna University of Technology (VUT)

### Project G-Volution

- no more limit in scaling-up, as there is no stationary fluidized bed anymore
- excellent gas-solids contact between catalytic bed material and product gas, so lower tar content
- increases of residence times for fuel particles as well as gases with regard to gas-solids interaction
- solids residence time distribution resembles a cascade of stirred vessels (dispersed downward movement of solids)
- 100 kW pilot plant at Vienna, University of Technology is in commissioning phase
  
- **Dual fluidized bed plant size:**
  - Height: 7.5 m
  - Base area: 35 m<sup>2</sup> per floor
- **Engineering:**
  - 70 Detailed design plans
  - 20 Lay-out plans
- **Measurements for PLC:**
  - 105 Temperatures

- 70 Pressures
- 13 Volume/mass flows
- 4 Level indicators
- 22 Values of gas analyses
- 5 Speeds of rotation
- 2 Measurements of weight



### Bioenergy 2020+ together with VUT

- Synthetic Biofuels (FT- Route) – Kerosene from wood
- Conversion of wind and photovoltaic to transportation fuels
- Slurry reactor – scaling up to 1 bpd
- Investigations on hydrodynamics

The Task members were invited to 8. International Conference on Applications of Biomass Gasification, which is organized by IEA Bioenergy Task 33 – Austria, FEE and MCI and will be held on the 2.nd December in Innsbruck, Austria. More information can be found at the Task 33 website (<http://www.ieatask33.org/news/view/1#1>).

### Germany, Mark Eberhard, KIT

#### Carbo-V process

February 2012	Linde Engineering Dresden GmbH acquires Carbo-V® IP
January 2013	Linde has elaborated numerous technical corrections of Carbo-V process design
	Linde and Forest BtL (Finland) sign agreement to apply Carbo-V process to provide Syngas for downstream Biodiesel and Naphta   Kemi, Finland
February 2014	ForestBtL / VAPO / NER300 canceled the project

#### BioTfuel-Project

- 8 years partnership to realize a RD&D programme to develop a complete B-XTL process chain
- Total Project Budget 180 M€ / Comissioning January 2017

#### BioTfuel demo plants:

- Two multiple scale demo plants will be located in France
- to get scale-up data
- to validate various scheme/configurations

### SWU Stadtwerke Ulm CHP Demo Plant

- Plant Constructor AGO and SWU settlement out-of-court
- Retrofit an additional gas cleaning to reduce nitrogen oxides in flue gas
- Commissioning in Mai 2014
- Plant is in operation still not full electrical power generation
- In 2014 average 300 h/month in operation
- In 2015 average 500 h/month in operation
- Plant design is 600 h/month

### bioliq®-Project

- Two measurement - campaigns in 2015
- 57 h operation with slurry in 3 week July campaign to review technical improvement
- Further optimization for November campaign
- 100h campaign for the process chain in summer 2016

### Industry Guide Thermochemical Biomass Gasification 2015

- > 400 plants in Germany, total installed capacity: 42 Mw<sub>el</sub>
- Total efficiency up to 85 % (combined heat and power generation)
- Capacity range: small scale plants of 15 kW<sub>el</sub> up to large scale plants of up to 5 Mw<sub>el</sub>

### Biomass gasification manufacturer

- |                                 |                               |
|---------------------------------|-------------------------------|
| ▪ BR Engineering                | ▪ Ettenberger                 |
| ▪ Burkhardt                     | ▪ KOPF SynGas                 |
| ▪ Holzenergie Wegscheid         | ▪ Wood Gasifier System Werner |
| ▪ ReGaWatt                      | ▪ Ligento green power         |
| ▪ Spanner Re <sup>2</sup>       | ▪ Meva Energy AB              |
| ▪ Stadtwerke Rosenheim SynCraft | ▪ Qalovis                     |
| ▪ Xyloenergy                    | ▪ URBAS Maschinenfabrik       |

### Biomass gasification plants

Manufaktur	Technology	Feedstock	Grid feeding plants	Note
BR Engineering GmbH (CH)	Fixed-bed process (optional: moving bed) in combination of cocurrent and countercurrent flow	Unadulterated wood, wood chips, other biomasses (among others hogged fuel)	2	<ul style="list-style-type: none"> <li>• Since 1997</li> <li>• Cold gas efficiency: up to 90%</li> <li>• Production of biochar</li> <li>• USP: proven for demolition wood/ ash free of char</li> </ul>
Burkhardt GmbH (D)	Fluidized bed process in cocurrent flow	Pellets	120	<ul style="list-style-type: none"> <li>• Since 2011</li> <li>• wood gas cogeneration plants</li> <li>• wood gasifier with downstream CHP</li> <li>• Electric efficiency of more than 30 %</li> </ul>
Holzenergie Wegscheid GmbH (D)	Fixed-bed process in cocurrent flow	Unadulterated wood, briquettes & maxi-sized pellets, wood chips	34	<ul style="list-style-type: none"> <li>• Distributing countries: D, A, CH, I, SLO, J, CDN, F, PL</li> </ul>
ReGaWatt GmbH	Fixed-bed in countercurrent flow	Wood chips from various sources up to 30 % bark and landscape management chips	4	<ul style="list-style-type: none"> <li>• Since 2010</li> <li>• Distributing countries: EU</li> </ul>



Manufakturere	Technology	Feedstock	Grid feeding plants	Note
Spanner Re <sup>2</sup> GmbH	Fixed-bed process in cocurrent flow	Unadulterated wood, forest chips (at 30 kW <sub>el</sub> ), wood chips	440	<ul style="list-style-type: none"> <li>Spanner Re<sup>2</sup> wood cogeneration plants</li> <li>Since 2008</li> <li>Distributing countries: D, A, CH, I, CZ, SLO, LV, CDN, GB, FIN, HR, J, PL</li> </ul>
Stadtwerke Rosenheim GmbH & Co. KG	Fluidized bed and tiered process, combination of concurrent and eddy flow (Rosenheimer Process)	Unadulterated wood, wood chips		<ul style="list-style-type: none"> <li>Since 2015</li> <li>Distributing countries: DE, AT, I</li> </ul>
SynCraft (A)	Tiered process in cocurrent flow (floating fixed-bed)	Unadulterated wood, tree and shrub cuttings, waste wood class A, wood chips	3	<ul style="list-style-type: none"> <li>By-product bio char</li> <li>Fuel flexibility</li> <li>No additives needed</li> <li>Electric efficiency 30 %</li> </ul>
Xyloenergy GmbH	Fixed-bed process in cocurrent flow	Unadulterated wood, wood chips	1	<ul style="list-style-type: none"> <li>capacity via 100 % diesel/ bio-diesel as well;</li> <li>utilization of waste wood</li> <li>Distributing countries: EU</li> </ul>

Manufakturere	Technology	Feedstock	Grid feeding plants	Note
Ettenberger GmbH & Co. KG	Tiered gasification process in combination	Unadulterated wood, wood chips, short rotation plants	3	
KOPF SynGas GmbH & Co. KG	Fluidized bed process	Sewage sludge (10 % moist. cont.)	2	<ul style="list-style-type: none"> <li>Since 2000</li> </ul>
Wood Gasifier System Werner	Fixed-bed process in cocurrent flow	Unadulterated wood, wood chips	1	
Ligento green power GmbH	Fixed-bed process in cocurrent flow	Unadulterated wood, residual wood from forestry, short rotation plants, wood chips	2	
Meva Energy (S)	Entrained flow in cocurrent flow	Unadulterated wood, wood chips, pellets, saw dust, husks, straw	1	
Qalovis GmbH	Fixed-bed process in cocurrent flow	Unadulterated wood, residual wood from forestry and landscape conservation, wood chips, pellets	1	<ul style="list-style-type: none"> <li>USP: no scrubbing of gas needed</li> </ul>
URBAS Maschinenfabrik GmbH (A)	Fixed-bed process in concurrent flow	Unadulterated wood, wood chips	14	<ul style="list-style-type: none"> <li>Since 2008</li> </ul>

#### Stadtwerke Rosenheim

- 95 kW<sub>th</sub>, 50 kW<sub>el</sub>
- Feedstock: wood chips
- Fluidized bed and tiered process, combination of concurrent and eddy flow
- Gas utilization: motor
- Since 2015

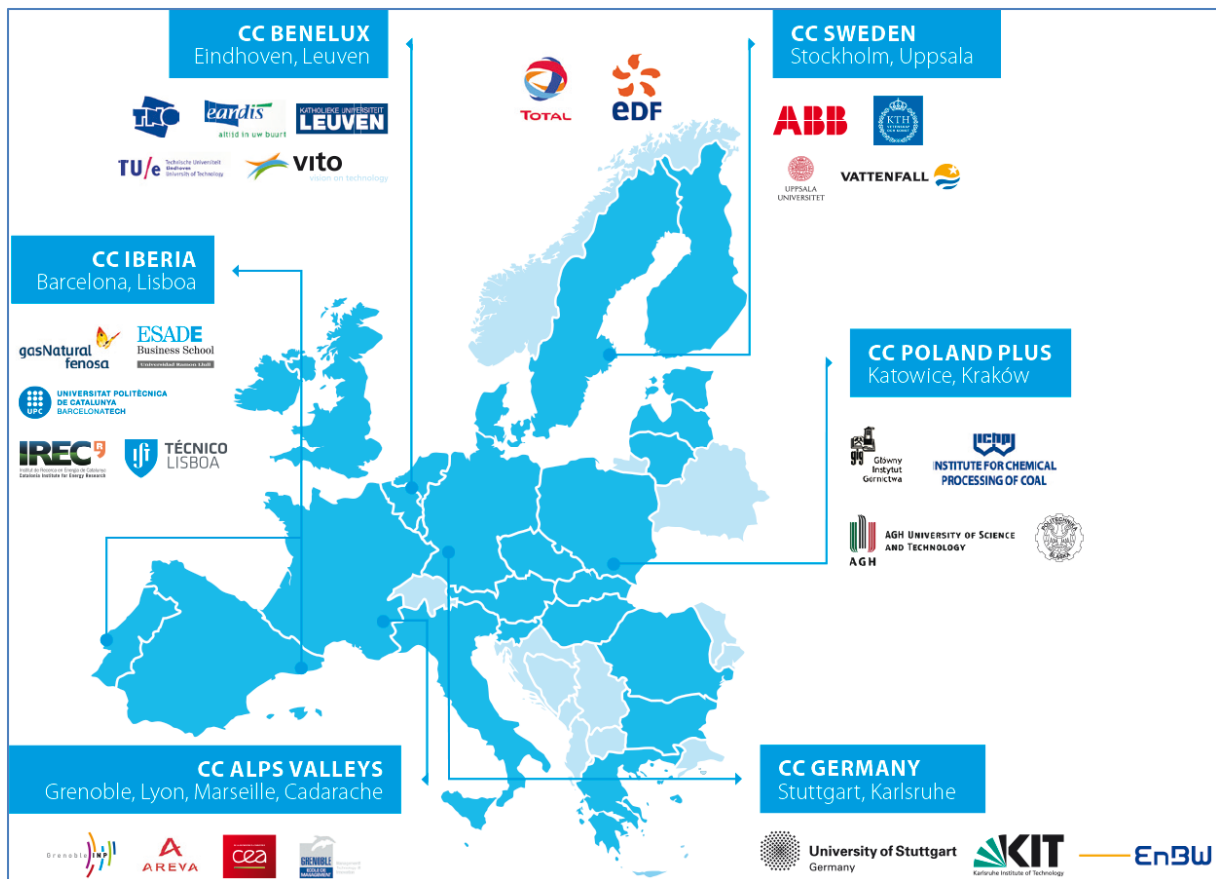
#### Knowledge and Innovation Community - KIC InnoEnergy

- innovative business ideas in the area of sustainable energy
- investment, financial support

- know-how transfer
- active support on the way to commercial success
- access to an international business network
- partnership, without any financial risk for the participants
- application-oriented education programmes for entrepreneurs in the energy market

3<sup>rd</sup> Energy from Chemical Fuels Conference

5<sup>th</sup> October 2015, Frankfurt am Main, Germany



## Switzerland, Martin Rügsegger, ETECA GmbH

General Swiss energy consumption, policy and programs as well as energy strategy were presented.

Federal office of Energy presents new **Energy strategy 2050**

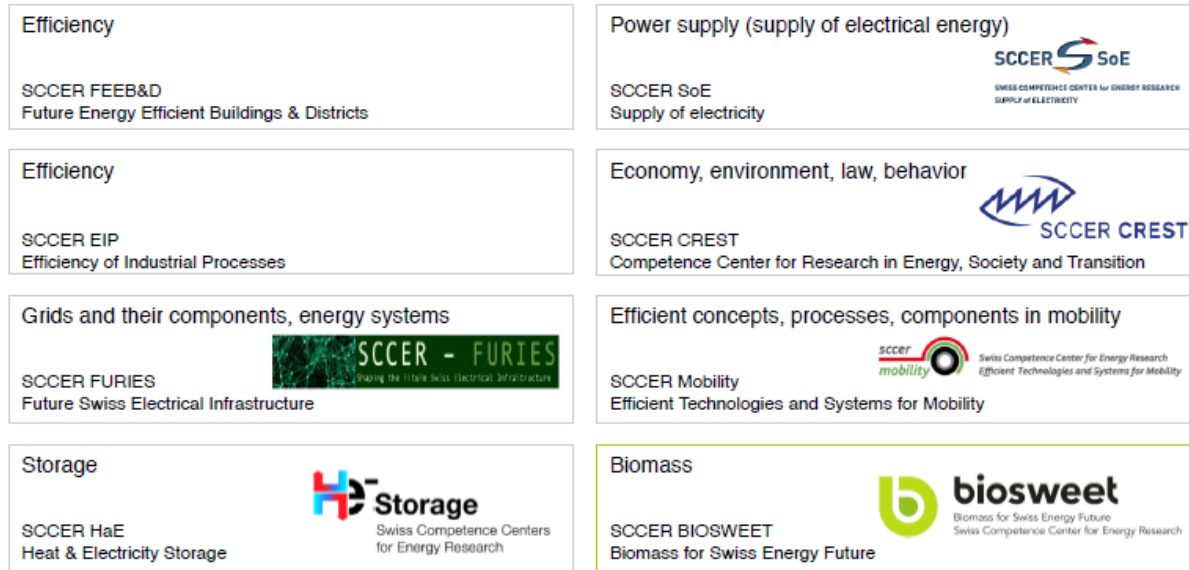
- “Change of Energy” = Energiewende (out of fossil and nuclear) →
- “Energierstrategie 2050” Political decisions 2018 expected
- “Energierstrategie 2050” without referendum in place 2018
- “Energierstrategie 2050” with referendum in place earliest 2020

Today

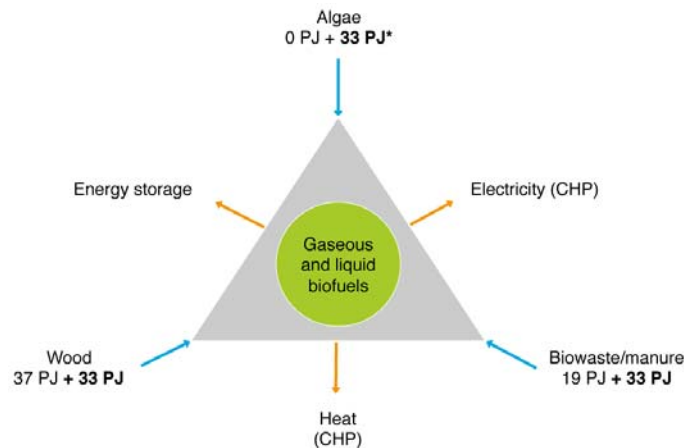
- In October 2015 after elections National Government shifted towards “right”

- 85% of Swiss people don't believe in "Change of Energy"
- In Switzerland KEV (Feed in tariff) for electric RE production since 2015
- To many RE-Projects, for KEF (Feed in) Budget  
=> Projects line up in a cue
- P+D contribution for "Lighthouse Projects"

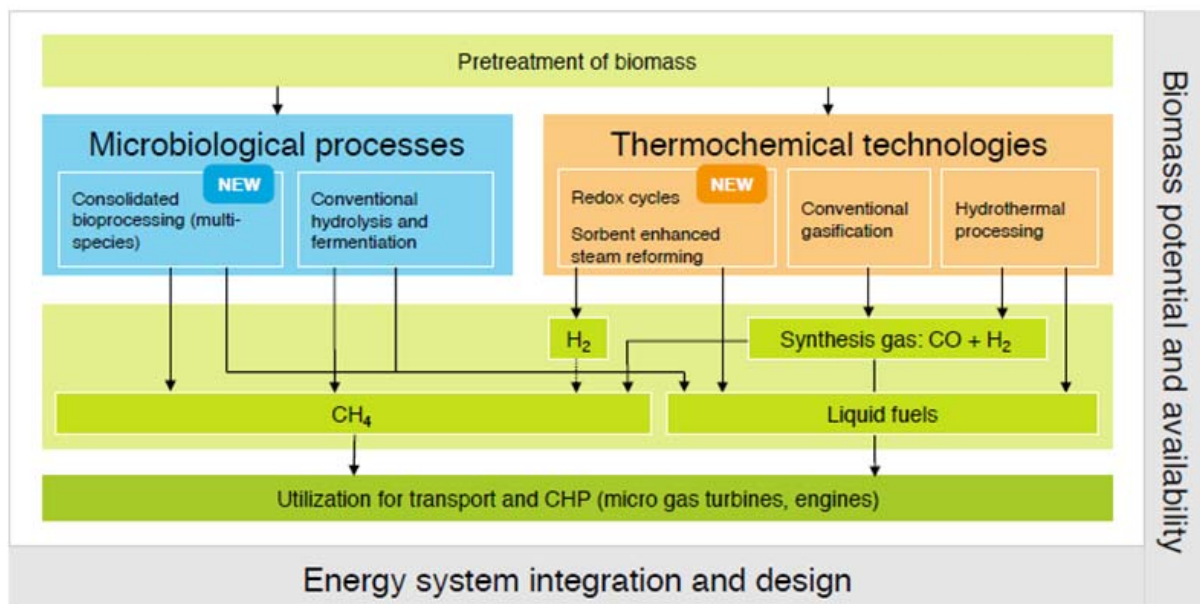
## SCCER Action Areas



### SCCER Biosweet



\*production mainly outside Switzerland



## Research activities

### - PSI

- Gasification of dry biomass (SNG, CHP)
  - Co-firing in NGCC for power generation
  - High & low temperature fuel cells for CHP
  - Gas processing for SNG production
- Gasification of moist biomass for SNG production
  - For SNG production
- EU Infrastructure Project, collaboration with: BRISK

### **CCEM Competence Center Energy and Mobility (PSI)**

- 3 Projects related to "Thermal Gasification of Biomass".
- ARRMAT (Attrition Resistant Reactive Bed Materials in Fluidised Beds)
- WOODGAS-SOFC II
- SYNGAS Diagnosis

NFP66 (National R Program) 3 Projects related to "Thermal Gasification of Biomass"

1. Hot gas cleaning of producer gas from wood gasification for production of bioSNG and electricity from wood (Hot gas cleaning wood gasification) (PSI) 2012-September 2015  
<http://www.nfp66.ch/E/projects/wood-source-energy/gas-cleaning-economical-energy-wood/Pages/default.aspx>
2. Predicting the complex coupling of chemistry and hydrodynamics in fluidised bed methanation reactors for SNG production from wood (PSI) (bio-SNG - fundamentals of methanation) Synthetic natural gas from wood — How can the synthesis be optimised? 2012-January 2016  
<http://www.nfp66.ch/E/projects/wood-source-energy/synthetic-natural-gas-wood/Pages/default.aspx>

3. Distributed production of ultra-pure hydrogen from woody biomass (ETHZ)  
 2012- December 2016  
<http://www.nfp66.ch/E/projects/wood-source-energy/production-ultra-pure-hydrogen-wood/Pages/default.aspx>

### Swiss Industry

- **BR Engineering GmbH** CH-6006 Luzern [www.br-engineering.ch](http://www.br-engineering.ch)  
 Engineering and commissioning of thermal Gasification plants and gasification components (involved with Holzstrom Stans)
- **Schmid Energy Solution** CH-8360 Eschlikon
  - Representation for Switzerland Burkhardt turnkey biomass gasifier plants (taken over from Öhlmühle Möriken)
- **XyloPower AG** [www.xylopower.com](http://www.xylopower.com)
  - Supplier for turnkey biomass gasifier plants (BMG Technique similar to WILA)
- **CTU** <http://www.ctu.ch/de/home.html>
  - Supplier for turnkey biomass gasifier plants
- **Foster Wheeler AG**
  - Foster Wheeler AG in Baar Switzerland
  - Foster Wheeler Engineering AG Basel

	Käser Gasel	Holzstrom in Stans	A. Steiner + Cie. AG	J. Bucher AG Escholzmatt
<b>Gasifier</b>	Ligento	8 Pyroforce	Spanner	Wegscheid
<b>Type</b>	downdraft	2-zone downdraft	downdraft	downdraft
<b>Gas engine</b>	1 x 140 kW	2 x 690 kW Jennbacher	45 kW el	140 kW
<b>Waste heat therm</b>	for drying	1,2 MW for district heating	district heating	district heating drying wood chips
<b>extra Boiler</b>		1,6 MW W'chips + 1,7 MW oil for district heating	yes	Yes
<b>Commissioning</b>	2015 November	2007	2012/2013	1.4.2015

Remarks	under construction	24h_7d p week operation	24h_7d p week operation	24h_7d p week operation
<b>Fuel</b>	Dry clean wood chips	Dry demolition wood/scrap wood chips	Dry waste wood chips	Dry waste wood chips G 30-100
<b>Moisture</b>		10%	Max 15%	<10%
<b>Operating hours last 6 months</b>		Block 1: 3567 Block 2: 1441	3819	2 900 h
<b>Total live time operation h</b>		BHKW 1: 38 764 BHKW 2: 44 789	11 342	3 500
Remarks	under construction	Plant in normal operation	Plant in normal operation	Plant in normal operation

**3 CHP gasifiers in stable operation**  
**1 CHP gasifier under construction**

#### CHP project news

- Gasifier 160 kW AEW Rheinfeldern CHP, unit for pellets => Ordered  
1 Burkhardt unit
- Gasifier 130 kW Bucher Eschholzmat, second unit => Decision 2015  
1 Wegscheidt
- Gasifier 220 kW Riggisberg CHP, unit for forest waste chip => building permission requested  
1 Xylogas
- Several small scale gasifier CHP offered from supplier, decisions pending  
Reason of activity: KEV (Feed in tariff) approx. 28 Eurocent per kWh

## The Netherlands, Berend Vreugdenhil, ECN

#### Policy

- NEV (National Energy Lookout) 2015 → Focus on 2023
  - 16% sustainable energy in 2023 achievable
  - 14% sustainable energy in 2020 achievable
- Methods used to achieve this
  - Closing down old coal fired power plants
  - Increase tax on natural gas
  - Using subsidy SDE+ (on solar, wind, geothermal and biomass)

- SDE+ 2015 3.5 billion € subsidy on
  - Renewable electricity
  - Renewable heat or CHP
  - Renewable gas
  - SDE+ 2016 8 billion € in two phases
- TKI (Top Consortia for Knowledge and Innovation)
  - Consists of nine different area's, one of which is Energy
  - Tool to realize innovations which couples green and growth
  - Goal is to strenghten our position internationally, create jobs and prosperity
- TSE (Top Sector Energy)
  - Different subsidy programmes
  - Covers range of wind, solar, biomass and build environment
  - Strong focus on cost price reduction of sustainable energy

#### Renewable energy in NL

- NL is third one at the bottom with 4.8%
- CBS gives three reasons
  1. NL has almost no hydro power
  2. NL has no wood based house hold heating system, but gas based. Competition is difficult
  3. NL governments has not fully committed to supporting alternatives, unlike Denmark, Spain and Germany

#### DEVELOPMENTS

##### RWE

- MEP subsidy ended in 2013
- Mixtures of RDF fluff and demolition wood tested in 2014
- Applied for SDE+, but not successful
- 2016 will apply for SDE+ again, if granted the installation will run from 2017 and onwards on mostly demolition wood and partly RDF

##### ESKA

- Eska Graphic Board, a manufacturer of graphic board with two plants in Hoogezand and Sappemeer, has signed a contract with Leroux & Lotz Technologies for the construction of a gasifier at its site in Hoogezand
- should come into operation in the second half of 2016

##### HoSt

- Successful duration test done in Portugal operating ~1000 hours on RDF.
- Accumulation of wires in the gasifier eventually causes problems.

##### ROYAL DAHLMAN

###### INDIA

- MILENA OLGA Gas Engine (4MW<sub>th</sub>/1MW<sub>el</sub>) currently in commissioning phase

###### NETHERLANDS

- SNG Demonstration 4 MW<sub>th</sub> / 2.8 MW<sub>SNG</sub> being developed

###### UK

- Finalist in the ETI tender. MILENA OLGA IGCC was regarded most efficient. Site selected and permitted. Financing of the project under evaluation
- Generation Park Norwich, selected MILENA OLGA. 24 MW<sub>th</sub> / 7 MW<sub>el</sub>. Fuel will be locally harvested straw  
<http://www.generationparknorwich.com>

#### South East Asia

- Multiple waste to energy projects under development
- Range from 24 – 60 MW<sub>th</sub> and 7 – 18 MW<sub>el</sub>
- Most projects in an early stage
- One project close to realisation

#### SYNVALOR

- Developing a project to produce 700 kW<sub>el</sub> and 1000 kW<sub>th</sub> for a nursery garden
- Company that will use the power and heat is also co-owner of the installation
- Currently in permitting phase
- Expected installation is mid 2016 and start up early 2017

#### TORRGAS

- Physical: applying homogenous, pulverisable, moisture free torrefied bio-fuel.
- Technical: creating a tar and nitrogen free drop-in syngas without slagging.
- Economical: splitting biomass in high value biocarbon and high grade syngas and thus maximizing the value creation

##### **0.7 MW demonstration in Groningen**

- Drop-in properties: 12 MJ/kg, nitrogen and tar free syngas meets requirements for direct mixing without major burner modifications
- Skid mounted bio-syngas generator: upto 15 MW<sub>th</sub> feed capacity can be installed on portable skid due to high volumetric reactor output
- Limited logistic handling: torrefied biomass handling is far less complicated and space intensive than untreated biomass

#### CCS

currently supporting these projects

##### **BMC (Zutphen) / BAVIO (Oss)**

- 14 MW<sub>th</sub> wood to SNG plant
- Repeat to reduce costs, 4 environmental permits granted
- SDE<sup>+</sup> subsidy granted for the project in Zutphen and Oss
- Status: Under development

##### **Alkmaar demonstration**

- 4 MW<sub>th</sub> MILENA OLGA ESME
- Consortium of Gasunie, Dahlman and ECN
- 300 Nm<sup>3</sup>/h of bioSNG production
- Operational in 2017/2018
- Production subsidy has been granted

#### SYNOVA

- Synova develops waste to energy projects: [www.synovapower.com](http://www.synovapower.com)



- Takes care of contracting, financing, permitting and financial and operating partner of the plant
- Synova focuses on gasification technology
- Works with several suppliers of gasification technology
- Invested in Dahlman and its OLGa technology to remove tars: [www.dahlman.nl](http://www.dahlman.nl)
- See movie at [www.fullcyclefund.com](http://www.fullcyclefund.com)
- Offices in Netherlands, Thailand, Philippines, Hongkong, US, UK

## Sweden, Lars Waldheim, Waldheim Consulting

An overview on biomass gasification in Sweden was given, as well as policy and Swedish energy targets.

- A labour-green minority government supported by a leftist party took over governing power from liberal-conservative 4-party coalition in October 2014 following a regular general election.
- Decision on any replacement of nuclear power plants is postponed beyond the mandate period of four years.
- The new government has formed a "broad" parliamentary energy commission with main focus on electrical power, to report in late 2017.
- Transport biofuels tax exemption retained to 2017, due to discussion on state aid with the EC.
- New tax on nuclear power to finance decommissioning

### Nuclear power in Sweden – history

- Planning and investment decisions on reactors were taken in the 1960's
- Referendum to phase out reactors by 2010 in 1981
- The reactor development law (SFS1984:3) was put in force prohibiting building of nuclear power plants and the development of novel reactor technologies
- The reactor program of 12 plants fully attained in 1985
- The two reactors at Barsebäck were closed 1999 and 2005
- The reactor development law (SFS1984:3) was revoked in 2012
- Up to 10 new replacement reactors can be accepted on present sites?????
- However, the new government has stopped planning by Vattenfall by an owner's directive in late 2014

*However, Vattenfall in April 2015 announced the premature stop of two reactors in 2018 and 2020 for "commercial reasons and E.ON has in September decided to phase out yet two reactors.*

Fuel prices taxation and RE power production 2002-2013 were presented.

Renewable transport fuels – future plans

- Quota obligation proposal was withdrawn for governance reasons in early 2014
- Increase of energy tax on low-level blends and also CO<sub>2</sub> tax resulting from state aid consultations with the EC
- Tax exemption retained until 2017 to conclude the EC discussion, a new package expected to be decided in parliament to be in force by 2018.

Biomass to SNG:

### **GoBiGas**

Actual status

- Gasifier operation approx. 9 000 hours
- MCR load proven on pellets
- Gas quality (relative to design values) good
- Pellets are very clean and generate certain specific issues
- Bed material activation has been a learning experience
- SNG product in a longer campaign in December 2014
- In 2015 periods of grid supply (days) on some occasions
- 60-70 % of design capacity
- 900 hours continuous run in August-September at 80 % load
- Biogas quality better than design spec.
- Overall efficiency during the long run close to target
- Present situation is finding and overcoming bottlenecks limiting capacity or limiting duration

Plans for 2015-16

- Continuous operation period from to December
- Installation of chip feeding equipment on-going
- Expected switch from pellets to chips early 2016
- The second phase is studied technically but still decision requires evaluation of first phase operation and also clarification on policies, commercial conditions etc.

Other projects, no known development

- **Bio2G, EON 300 MW SNG, S. Sweden**
- **Värmlandsmetanol, 100 000 tpa methanol, Värmland**
- **Rottneros biorefinery, 150- 200 000 tpa methanol, Värmland**

### **Cortus Wood Roll, Köping**

- 500 kW integrated plant
- Fully integrated production of clean syngas from biomass
- Investment 1,2 Mio €
- Six months work finalized shortly
- All safety functions
- Six screen Siemens control system
- Remote operation as an overall goal

### **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.

### **Swedish Research Program**

-new: Thermochemical conversion- Biomass including lignin

Gasification, HTL, HTC, Pyrolysis, Hydrogenation, 80 MSEK 2015-2019 (40 MSEK in first call)

### **Swedish Gasification Centre (SFC) – 8 Academies and 9 companies**

- CDGB (Centre for Direct Gasification of Biomass)
- CIGB (Centre for Indirect Gasification of Biomass)
- B4G (Biomass for Gasification, Entrained Flow Centre)

Application for 4 year activity, 58 MSEK/year 2013-17 approved

### 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

### KTH School of Chemical Engineering

- New transportable autothermal reformer housed in a transportable container

#### Features

- 5 Nm<sup>3</sup>/hr
- pressurised (30 bar)
- air or steam/oxygen
- partial oxidation burner
- catalyst beds
- gas analysis
- SPA tar sampling
- other analyses possible
- first test in March 2015

### SP ETC Gasification

SP (Technical Research Institute of Sweden) acquired ETC in January 2015

- 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

### 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

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

A dozen projects approved in December 2014

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- **International Gasification Seminar (Stockholm, Oct. 2016)**

## Denmark, Morten Tony Hansen, FORCE Technology

### Actual situation

- **Encouraging elements**
  - Some projects still ongoing
  - Energy planners emphasize importance of biomass gasification in the energy system
  - Partnership for Thermal Gasification ([www.forgasning.dk](http://www.forgasning.dk))
- **Disencouraging elements and political actions**
  - Promising projects closed down
  - Decreasing CO<sub>2</sub>-emission target (40 -> 37% reduction by 2020)
  - Abolishing NO<sub>x</sub> tax
  - "Independent", no longer "free from" fossil fuels (coal is OK)
  - Reducing energy RD&D programme (EUDP) to 1/8
  - "Green realism - no over-implementation"

### Energy agreement 2012

- 2020: Half of electricity demand covered by wind
- 2020: 35% of energy demand covered by RES
- Further general intentions

### Bioenergy analysis in the DEA

- Part of 2012 Parliament energy agreement
- Four scenarios for fossil free 2050 outlined
- Sustainable solid biomass plays a major role
- Further analyses of this are on-going
- Decision on scenario to be taken in 2020

Current feed-in tariff: ~15 €/kWh<sub>e</sub>

- Related to the natural gas price

### Thermal gasification plants – actual status

#### Babcock & Wilcox Vølund - Harboøre Plant

- Updraft type, wood chip fired
  - 1 MW<sub>e</sub> (1.4 MW<sub>e</sub> installed)
  - Tar challenge turned into flexibility advantage - bio oil
- 22 years of gasifier operation
  - CHP operation for 15 years
  - Operated 100% by heat demand
- The host is very happy
- BWV would like new demo plant
  - Feed in tariff challenging in DK
  - Preferences of plant owners in DK
  - Heat of low value in foreign markets

#### Biosynergi - Hillerød Plant

- Demonstration CHP plant under construction in Hillerød
  - 300 kW<sub>e</sub> / 750 kJ/s heat
  - Wet forest wood chips

- Open core downdraft type
- Status
  - CHP operational on natural gas
  - Gasifier in operation
  - Very close to intended operation

#### **Weiss - Hillerød plant**

- CHP plant in Hillerød
  - 500 kW<sub>e</sub> / 1000 kW<sub>heat</sub>
  - Fuel: Wood chips
- Staged down draft Gasifier
  - Developed and patented by DTU
  - Scale-up by Weiss and DTU
  - Licensed by COWI
- Design for unmanned operation
- Continuous operation pending

#### **DONG Energy Pyroneer - Kalundborg plant**

- Low temperature CFB
  - Developed by Peder Stoholm/DTU
- Pilot plant in Kalundborg
  - 6 MW<sub>th</sub> (product gas: ~650°C)
  - Loose wheat straw
  - Tested with various fuels
  - Gas co-fired into coal boiler
  - Stable and safe operation demonstrated
  - Ash used for fertiliser field tests
- Pyroneer project mothballed
  - Technology not sold
  - Plans for 60 MW<sub>th</sub> terminated
  - Staff moved/fired/quit

#### **Andritz/Carbona - Skive plant**

- Europe's largest for CFBG CHP
  - 28 MW<sub>fuel</sub> - 6 MW<sub>el</sub>
  - Wood pellets
  - Pressurized CFBG, Carbona
- Co-financed by the DoE/EU/DK
- Stable operation
  - Fuel quality improved
  - Availability 90%
- Liquid fuel generation project
  - Further investments are made
  - TIGAS process from Haldor Topsøe is being tested

## **USA, Kevin Whitty, University of Utah**

U.S. bio power, renewable energy consumption, availability of forest and agricultural biomass, federal policy and incentives for biomass technologies were presented.

### State policies in support of bioenergy

- Less than 15 states have policies specifically incentivizing biomass usage
- Most common types of incentive: incentives, tax credits, rebates
- Policies encourage:
  - Use of biomass in heating (excluding wood)
  - Industry production/collection of biomass
  - Funding of equipment, businesses, or homes using biomass
  - Installation of biomass CHP plants
  - Agricultural production for use in electrical generation
- Plant Construction or Equipment Incentivized
  - New Mexico
  - South Carolina
  - Illinois
  - New Jersey
  - Michigan

### **Fulcrum Bioenergy**

#### **Sierra Biofuels Plant**

- Waste to FT fuels
- 200,000 t/y MSW
- Designed for 10 million gallons syncrude
- TRI gasifier
- Agreement with United Airlines
- Startup expected late 2017

### **Red Rock Biofuels**

- Biomass to FT fuels
- Lakeview, Oregon
- TCG Global gasifier
- Veolocys for FT
- Targeting jet fuel
- Target completion 2016
- \$182 million investment

### **LanzaTech Freedom Pines Biorefinery**

- Biofuel production through LanzaTech's syngas fermentation technology
- Concord Blue chosen as gasification technology provider. Gasifier installation began 2014
- Target to combine gasifier and fermentation in 2015
- No new news

### **INEOS Indian River Bioenergy Center**

INEOS Bio, Vero Beach, Florida

- Feedstock: Vegetable and yard waste, MSW
- Products: Ethanol and power
- Scale: 300 tons feed/day
- Gasification technology: Proprietary oxygen-blown
- Cost: More than \$130 million
- Stopped in early 2015 to address technical issues
- No new updates since May

**Phoenix Energy**

- Provides on-site biomass power plants
- Small plants: 1-3 MW
- Based in San Francisco, California
- Facilities:
  - Lake Tahoe, NV
  - North Fork, CA
    - Expected operation end of 2016

**END**