

**IEA Bioenergy Agreement: 2010-2012**  
**Task 33: Thermal Gasification of Biomass**  
**Second Semi-annual Task Meeting, 2010**

**Skive and Copenhagen, Denmark**

**Tue. 5 to Thr. 7 October 2010**

**Minutes**

**Day 1, Tuesday 5. October 2010**

**The list of attendees**, for the Task Meeting include: Henrik Flyver Christiansen, DAE, D, Mayumi Morita and Tomoko Ogi, NEDO/AIST, Japan, Thomas Kolb, KIT, Germany, Reinhard Rauch and Jitka Hrbek, TUV, Vienna, AT, Bram van der Drift and L.P.L.M. Rabou, ECN, NL, NZ, Martin Rügsegger, ETECA, CH, Hakan Karatas, MRC, TR, Jingge Li, UoC, NZ, and Richard Bain, NREL, USA,

**Others:** as observer Lars Waldheim, W.Cons., Sweden, Mehri Sanati, Lund University, Sweden

**Regrets for inability to attend** were received from: Giuseppe Fiorenza, ENEA, IT, Ilkka Hannula, VTT, FI

The Agenda of the Meeting was:

**Day 1, Tue, Oct 5**

1. Welcome:
2. Introduction of Task Members and Observers
3. Review and Approval of Agenda
4. Review and Approval of Minutes from First Semi-annual Task Meeting, 2010, June, Helsinki, Finland
5. Country Updates on Biomass Gasification: Detailed Highlights with Technical Information
6. (Country updates will be 25 min + 5 min for questions)
  - a) Austria, Reinhard Rauch
  - b) Netherlands, Bram van de Drift
  - c) Italy, Giuseppe Fiorenza , ENEA
  - d) Denmark, Henrik Christiansen, DEA
  - e) Japan, Tomoko Ogi, AIST
  - f) Norway, Rainer Backman, SINTEF
  - g) Switzerland, Martin Rügsegger, ETECA GmbH
  - h) Germany, Thomas Kolb, ITC-TAB
7. Short Updates
  - a) Finland, Ilkka Hannula, VT
  - b) Turkey, Hakan Karatas, MAM
  - c) New Zealand, Jinnge Li, Univ of Canterbury
  - d) USA, Richard Bain, NREL
8. Discussion on 2011 – 2012 Meetings and workshops

**Day 2, Wed Oct 6**

Meeting Location: Plant Visits: I/S Skive Fjernvarme (Andritz-Carbona gasifier CHP plant) and Weiss Hadsund plant (Viking gasifier CHP plant)

**Day 3, Thu, Oct 7**

Expert workshop on “Small scale biomass co-generation; Technology status and market opportunities”

## **Country Updates on Biomass Gasification:**

### **Austria, Reinhard Rauch, TUV:**

Policy targets in Austria such as green house gas reduction, increase of efficiency, increase of renewables (actually 29%, 34% by 2020) and use of biofuels for transportation (actually 5,9% biodiesel and ethanol, 10% by 2020) were presented. Also targets of the energy strategy, such as security of energy supply and innovation oriented modification of the energy system were introduced.

Further Austrian research organizations and their activities were introduced: Graz University of Technology, Joanneum Research Graz, MCI, Vienna University of Technology, Bioenergy 2020+, FJ-BLT Wieselburg

#### **Graz University of Technology – Institute of Thermal Engineering**

- Heat pipe reformer
- Distributed SNG production
- Health, safety and environmental issues for gasification systems

#### **Joanneum Research Graz – Department of Energy Research**

- Life Cycle Assessment
- Microchannel FT technology

#### **MCI – University of Applied Sciences for Environmental-, Process- and Biotechnology, Innsbruck**

- Multistage fixed bed gasification systems

#### **Bioenergy 2020+**

- Pressurized gasification (in cooperation with TUV)
- Usage of product gas from biomass CHP Güssing in a SOFC
- Production of FT liquids (in cooperation with TUV)
- Production of hydrogen
- Waste gasification in FICFB gasifier

#### **Vienna University of Technology (TUV) – Institute of Chemical Engineering**

- R&D in dual FB steam gasification
- Production of FT fuels
- Production of BioSNG
- Production of mixed alcohols
- Scientific partner in Bioenergy 2020+
- Representative of Austria in Task 33

#### **FJ-BLT Wieselburg (HBLFA)**

- 1. and 2. Generation biofuels
- Representative of Austria in task 39

#### **Austrian companies active in biomass gasification:**

- Austrian Energy&Environment – actually no activities, but has still patent of FICFB
- AGT Agency for Green Technology – low temperature conversion=thermo-catalytic decomposition process operating without air supply
- Austrian Enviro Technologies
- GE Jenbacher
- Ortner Anlagenbau – builds FICFB for CHP applications

- Repotec – builds FICFB gasifiers for CHP, SNG and other synthesis
- Syncraft Engineering GmbH
- Urbas – fixed bed gasification
- Xylogas - fixed bed gasification

### Implementation:

#### Biomassekraftwerk Güssing GmbH:

- Type, Capacity: FICFB, 2MW<sub>el</sub>
- Feed: wood chips
- In operation

#### BioSNG Demonstration:

- Type, Capacity: Methanation, 1MW<sub>SNG</sub>
- Feed: product gas from biomass CHP Güssing
- Status unclear

#### Pyrotherm Kraftwerk Güssing GmbH:

- Type, Capacity: Pyroforce, 350 kW<sub>el</sub>
- Feed: waste wood
- Status unclear, optimization work necessary

#### Energie Oberwart:

- Type, Capacity: FICFB, 2.7 MW<sub>el</sub>
- Feed: wood chips
- In operation

### Commercial FICFB gasifiers in Austria:

Location:	Güssing	- el. Production using gas engine -8.0 MW <sub>fuel</sub> , 2.0 MW <sub>wl</sub> -start up in 2002, in operation
	Oberwart	-gas engine/ORC -8.5 MW <sub>fuel</sub> , 2.8 MW <sub>wl</sub> -start up in 2008, in operation
	Villach	- gas engine -15.0 MW <sub>fuel</sub> , 3.7 MW <sub>wl</sub> - in commissioning
	Klagenfurt	-gas engine -25.0 MW <sub>fuel</sub> , 5.5 MW <sub>wl</sub> -start up in 2011, now detailed engineering

### Commercial FICFB gasifiers in Germany:

Location:	Ulm	-gas engine/ORC -15.0 MW <sub>fuel</sub> , 5.3 MW <sub>wl</sub> -under construction
	Geislingen	-AER process/gas engine/ORC -10.0 MW <sub>fuel</sub> , 3.3 MW <sub>wl</sub> -now detailed engineering

The further topic of the presentation was “hydrogen from biomass”. The aim is to separate hydrogen directly from the product gas of the biomass CHP Oberwart, which is done by membrane technology. First results are quite good (~75% H<sub>2</sub>, the rest is mainly CO<sub>2</sub>).

Also “FT synthesis” in Austria was presented. Nowadays 2 FT syntheses are in operation at biomass CHP plant in Güssing: 5kg/day lab scale based on slurry FT (by TUV and Bioenergy 2020+) and 1bpd pilot scale based on microchannel technology (by SGC Energia).

## Netherlands, Bram van der Drift, ECN

Developments:

### HOST

- Netherlands: 3MW<sub>th</sub> CFB gasifier, boiler
- Portugal: 3MW<sub>th</sub> CFB gasifier, OLGA, gas engine
- Romania: 3MW<sub>th</sub>, CFB gasifier, boiler

### BioMCN (Methanol Chemistry Netherlands)

- Raw glycerine upgrading
- Now 30-40% glycerin in Natural Gas reformer (approx. 150MW<sub>bio-methanol</sub>)
- Looking for options to go to 100% bio-methanol gasification

### NUON

- 15% (energy) demolition wood direct co-firing in 250 MW<sub>el</sub> coal-based IGCC

### ESSENT

- CFB, cooler, cofiring, demolition wood
- Approx. 5000 h/year, cooling remains the biggest problem
- Subsidy scheme for this plant will end in 2013, then the future unclear
- Towards 50% biomass in Amer Power Plant

### ECN, Milena development

- Supporting 14 MW<sub>th</sub> CHP demo by HVC in Alkmaar
- Envisaged fuel: demolition wood
- Currently, tests with pilot-MILENA/OLGA, 150 kg/h

### ECN, Milena development: O<sub>2</sub>-transport

- O<sub>2</sub>-transport from combustor to gasifier
- Up to 0,3 wt% of O<sub>2</sub> in circulating olivine (ER up to 0,1)

24 h-test run using a demolition wood was realized. The gas composition was measured. CO (27-31 vol.%, dry), H<sub>2</sub> (18-20), CO<sub>2</sub> (13-16) and CH<sub>4</sub> (9-11).

### ECN, BioSyngas by entrained flow gasification:

- LCS: lab scale combustion and gasification simulator (conversion, slagging, fouling, emissions)
- Conversion of corn stover versus coal at 1300°C, ER=0,25, residence time 1800ms: corn conversion 100%, coal about 58%

### HVC, CHP- and SNG- developments:

- Basic engineering 14 MW CHP ready, permits granted, location selected, demolition wood
- Tests at ECN ongoing
- Investment decision 12/2010 or 5/2011

At the end of the presentation, a part of research work (provided at Universities in Netherlands), concerning partial combustion technology for tar removal, in-bed measurements to increase methane yield, producer gas cooling, self-gasification and catalytic oil gasification was presented.

## Denmark, Henrik Flyver Christiansen, DEA

" The Danish Commission on Climate Change Policy is to examine how Denmark can reduce and ultimately eliminate dependency on fossil fuels in the long term. The Climate Commission shall describe how to implement this long-term vision."

### The Commission's Results:

- Denmark can become independent of fossil fuels by 2050
- Even as the energy demand doubles
- The technology is available today, but more will become available
- Small additional cost as continued dependence on fossil fuels will become an expensive habit

### **Danish Follow-up Programme for Solid Biomass CHP Plants:**

- Skive gasification plant: wood pellets, 5 MW<sub>el</sub>
- Harboøre gasification plant: wood pellets, 0.85 MW<sub>el</sub>
- Græsted gasification plant: wood chips, 85 kW<sub>el</sub>
- Biosynergi pilot plant: 2 step down draft gasifier, wood chips, 85 kW<sub>el</sub>
- Weiss Project: 6\*Viking = 150kW<sub>el</sub> or 400kW<sub>th</sub>
- LT-CFB at DTU 2010 DONG Energy: pilot plant – 500kW, low temp. CFB, wood, straw and waste, scale up 5 MW, slurry fibre
- Svanholm Gods: in 2010: 4\*35 kW in UK and D

### **Japan, Tomoko Ogi, AIST**

Target for renewables energies in Japan was introduced. Also review of basic resource/energy policy and plan was presented. Energy security, Environment and Economic efficiency are the main programs.

#### **NEDO's Biomass and R&D projects:**

- Medium/long term technology development:
  - o Basic technology development expected to be commercialized in 2015-2030
  - o Gasoline and diesel as an alternative fuel

Accelerated technology development for biofuels (commercialization 2015-2020). Bio-ethanol production from lignocellulosic biomass.

- Strategic development of next generation bioenergy utilization technologies (basic research BTL synthesis, bio-fuel from micro-algae, bio-butanol production)

#### **Gasification: CHP**

- More than 30 units in operation, most of them on demonstration stage (10-300 kW), except of few cases of 2MW for local distributed system. Gasifiers are mostly fixed bed and rotary kiln type. Electricity produced is consumed on site and/or bought by Buyback system

#### **Gasification: BTL**

- Only a few examples on demonstration stage (Mitsubishi Heavy Industries Co. Ltd., TAKUMA Co. Ltd)

#### **NEDO project: test (pilot) plant**

- Purpose: acquire properties of integrated system of BTL for commercialization
- Target: to run a test plant of complete system for synthesizing methanol with a self-heating, stand-alone gasifier
  - o Capacity: 2t/day
  - o Feedstock: cedar, driftwood
  - o Gasification: EF gasifier
  - o Catalyst for methanol synthesis: Cu/Zn (high pressure)
  - o Cold gas efficiency: 65% or more
  - o Methanol yield: 20% or more

Based on this pilot plant a commercial plant is planned.

#### **Present status of biomass gasification in Japan:**

- Only several years have been passed, since biomass was recognized as a “new sustainable energy” in Japan
- Gasification for CHP has been partially in practical application or demonstrated, but in small scale in most cases.
- Gasification BTL has been developed in bench scale. Now a few test plants in operation
- Bio-fuel for next generation is advocated, enforced as one of important and priority matters

## **Norway (there was no Task member personally present on the meeting):**

Biomass gasification has not a long history in Norway. University research, fundamental research is provided in some groups. In future industrial production of second generation biofuels via biomass gasification planned.

### **Gasification for Biofuels (GASBIO) – main objectives:**

- To develop Norwegian competence in the biofuels area
- To contribute to the reduction of biofuels production costs
- Norway has large unused biomass resources
- EU legislation mandates substantial increase in the use of biofuels
- Biofuels need intensive research to become competitive to fossil fuels on a large scale

### **Project overview – key data:**

- Project within thermochemical biofuels production, type: KMB
- Duration: 4 years
- Partners: SINTEF Energy research, Norske Skog, Xynergo, Metso, Statoil, NTNU-Education

### **STOP – Stable Operation conditions for biomass combustion plants.**

- The main focus of the project will be torrefaction. Pre-treatment fuel technologies can be beneficial for other thermal technologies than combustion, e.g. gasification
- Duration: 4 years

### **Industry – Xynergo**

- Long term objective is to produce high quality biodiesel, bio-jet fuel and bio-naphta based on sustainable, woody biomass
- A commercial scale biofuels production via biom. gasification is planned
- Full scale production in 2018
- Cooperation with Choren

### **Industry – Fiborgtangen Biokraft**

- Biomass gasification CHP plant based on biosyngas under planning (100 GWh power, 170 GWh heat)
- A side stream might be taken out for biofuels production
- Construction starts in 2011
- Planned start-up in 2012

## **Switzerland, Martin Rügsegger, ETECA GmbH**

Policy in Switzerland is made by Swiss Federal Office of Energy (SFOE), which provides strategy papers for biomass energy utilization and for energy use in general. Main strategy is high efficiency and increasing the part of renewable energy.

### **Programs:**

- REN-Projects by the Cantons
- Cost-covering remuneration for feed in the electricity grid
- + 5'400 GWh/a from renewable (10% of total) by 2030
- Biomass: large increase of power production with CHP

### **Research activities in thermal gasification of biomass:**

- PSI (Paul Scherrer Institut):

- gasification of dry biomass
- co-firing in NGCC
- high temperature fuel cells for CHP
- gas processing for SNG production
- gasification of moist biomass (for SNG production)

#### **Industrial gasification activities:**

- EKZ – supplier for turnkey biomass gasification plants (BMG technique similar to WILA Woodpower) and energy contracting for biomass cogenerating plants
- Pyroforce Energietechnologie AG – supplier for turnkey biomass gasifier plants
- XyloPower AG - supplier for turnkey biomass gasifier plants
- New Switzerland: Foster Wheeler AG in Baar and Foster Wheeler Management AG in Geneva

Thermal biomass gasification CHP-plants, which are in operation in Switzerland, were presented (Aerni in Pratteln, Holzstrom in Strans Nidwalden, Woodpower in Wila). The Pyroforce AMC Spiez is now out of operation.

#### **New projects – September 2010:**

EMPA EAWAG Dübendorf decided for CHP gasifier plant

- Supplier will be EWZ and Woodpower
- Wila-type gasifier
- 2x350 kW<sub>el</sub>

Delinat will multiply the bio coal production (Terra Preta)

- With low temp. gasifier (Pyrolyse)
- 5 to 10 new facilities are in construction including waste heat utilization

Energy Hub Baden CHP gasifier Facility including SNG research stream (in discussion only, concept available)

- SNG gasifier facility
- 7,5 MW fuel input
- 3,2 MW SNG
- 0,7 MW<sub>el</sub>/1,5 MW<sub>th</sub>

#### **Germany, Thomas Kolb, KIT:**

**Bioliq** –fast straw pyrolysis, entrained flow gasifier and biosyncrude preparation were presented.

- Fast straw pyrolysis:
  - o mechanical complementation in 2007
  - o function testing in 2008
  - o commissioning with biomass feed 2010
  - o production in 2010

**BMG-Choren, B-plant**, the plant is not in operation yet.

Choren moved in French area:

- BtL (Bure Saudron) – Design study:
  - o 75 kt/a forest and local agricultural residue
  - o 23 kt/a 2<sup>nd</sup> gen. biofuels

#### **Technology platform for bioenergy and methane:**

- Objective: the first commercially operated biomass gasification plant in Germany
  - 10 MW<sub>th</sub> gasifier (FB)

- 1<sup>st</sup> step: power generation
- 2<sup>nd</sup> step: methanation
- Integration of other biomass conversion technologies platform for R&D activities
- Preliminary planning finished, but problems with funding

#### **SWU Stadtwerke Ulm CHP demo plant:**

- Technology based on the FICFB Güssing (AT)
- Now under construction
- Feed: wood chips
- 15,1 MW<sub>th</sub>/4,55 MW<sub>el</sub>

#### **Blue Tower CHP and H<sub>2</sub> demo plant, Herten:**

- Gravity driven moving bed reactors
- Capacity: 13 MW<sub>th</sub>
- Allothermal/ceramic balls as a heat carrier
- Staged reforming/steam blown
- Construction start in 2009
- Total investment 24,6 Mio€

#### **Wood gas demo plant of Stadtwerke Düsseldorf, Arnsberg-Wildshausen:**

- Fixed bed air blown down draft gasifier, now in operation
- Built by Biomass Energiesysteme Dortmund with Stadtwerke Düsseldorf AG
- Feed: wood chips
- Thermal: 1MW, electric 270 kW<sub>el</sub>, heat 410 kW<sub>th</sub>

#### **KIC InnoEnergy**

EU-project has started in 2010

Goal: foster SET-plan implementation

6 regional centers with different technical topics

CC BENELUX: Intelligent energy-efficient buildings and cities

CC IBERIA: Renewables (wind, CSP, photo voltaics, wave and tidal energy)

CC ALPS VALLEYS: Sustainable nuclear & renewable energy convergence

CC Sweden: European Smart Electric Grid and Electric Storage

CC POLAND PLUS: Clean Coal Technologies

CC GERMANY: Energy from Chemical Fuels

#### **Turkey, Hakan Karatas, MRC:**

Gasification facilities in Turkey and the tests results were presented.

##### **Atmospheric Bubbling Fluidized Bed Gasifier: -test results**

- Feed: hazelnut shell (50kg/h)
- ER varied between 0.3-0.45
- CO, CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>, O<sub>2</sub>,N<sub>2</sub>, LHV, syngas flow rate, cold gas efficiency and carbon conversion were in focus of the tests

##### **Atmospheric Fixed Bed Gasifier: – test results (60 min)**

- Feed: wood chips and hazelnut shell
- Batch feeding



- Air gasification, ER=0.35
- Gas composition measured (CO, CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub>)

#### Laboratory scale – hot gas cleaning

- H<sub>2</sub>S removal on Turkish dolomite under simulated gasifier atmosphere

Mechanical construction of the pressurized bubbling fluidized bed gasifier (P-BFB-G) was accomplished.

Assembly of main components and pipelines of the circulating fluidized bed combustor (A-CFB-C) was performed.

### New Zealand, Jingge Li, University of Canterbury:

Government strategies and initiatives in New Zealand were introduced.

#### Status of commercial biomass gasification:

- **Fluidyne Gasification Ltd:** is active overseas with its downdraft process (100kWe-2MWe)
- **Alternative Energy Solutions Ltd:** representative for Ankur in Australasia, but focusing now on a screw type fast pyrolysis system (biomass 1t/day) with Ernslaw One Ltd
- **Page Macrae Engineering Ltd:** the 2MWth updraft gasification plant has been shut down as the user, CHH plywood mill, was closed last year. A similar gasifier is to be installed with Windsor's timber dryer next year
- **Ethanol from whey:** 20 million L/yr produced by Anchor Ethanol, a subsidiary of Fonterra. Only 2 million L/yr is consumed in NZ, about 0.06% of petrol sales.
- **Biodiesel from used cooking oil and rape seed oil:** 1 million L/yr by Biodiesel NZ, Solid Energy; expanding to 70 million L/yr in 2011.
- **Biodiesel from tallow:** two pilot plants in Auckland respectively by BioDiesel Oils NZ and Ecodiesel. Ecodiesel is to complete a production facility for 40 million L/yr this year.

#### Status of research on bioliquid fuels:

- Thermal chemical conversion
- Biological conversion
- Biodiesel from algae by NIWA and Aquaflo

#### Status of R&D on biomass gasification:

- **University of Canterbury:** the program "**Biomass to syngas and liquid fuels**" (BTSL)
  - o **Objectives:**
    - Obj. 1: Optimisation of biomass gasification and co-gasification for clean and H<sub>2</sub> rich syngas.
    - Obj. 2: Gasification of energy-densified biomass slurry (pyrolysis and gasification).
    - Obj. 3: Fischer-Tropsch synthesis for biodiesel.
    - Obj. 4: New biomass resources and feasibility studies for an integrated F-T plant.
  - o **Optimization of the FICFB gasifier,** improvements in producer gas composition, improvements of energy efficiency
  - o **Cold model of circulating fluidized bed** which will be used as a operational map for CFB
  - o **Gas cleaning:**
    - One unit for the removal and recovery of tars
    - Regeneration of scrubbing liquid, biodiesel
    - Tars recycle to the gasifier for energy recovery
    - Up to 79% tar removal efficiency, 62% tar stripping efficiency
  - o **Co-gasification** of biomass (wood pellets) and coal: bench scale FB gasifier

- **F.-T. synthesis** of bio-diesel:
  - Microchannel reactor
    - heat and mass transfer rates are orders of magnitude greater than traditional reactors.
    - excellent in highly exothermic catalytic process.
    - easy scalability and better economics at smaller scale than traditional technology.
  - Catalyst
    - cobalt on titania and alumina.
    - the challenge is to develop methods to incorporate catalyst with the reactor.

## **U.S.A, Richard Bain, NREL:**

### **Current biofuel status:**

Biodiesel -173 companies, 2.69 billion gallons/y capacity  
 Corn ethanol -201 commercial plants  
 -13.138 billion gallons/y nameplate capacity  
 -11.987 billion gal/y production  
 -additional 1.322 billion gal/y planned or under construction  
 Cellulosic ethanol -projected commercial cost approx. 3.50/gge

### **Key DOE Goals:**

- 2012 : cellulosic ethanol \$1.31/ETOH gallon or approx. 1.96/gge
- 2022: 36 B gal renewable fuel, 21 B “Advanced renewable fuel”
- 2030: 60 B gal ethanol

### **Biopower status**

2009 Capacity – 10.8 GW

Potential – Electric Sector

- 2022: 22 GW
- 2035 : 48 GW
- 2050: 91 GW

**DOE** (Department of Energy) IBR (Integrated Baseline Review) project details:

Haldor Topsoe, Range Fuels, Renewable Energy International, Enerkem, Clear Fuel-Rentech, Flambeau River and New Page project details concerning products, feeds, size and product rate were presented.

### **Coskata – Project Lighthouse**

- Semi-commercial demonstration plant
- Located in Madison, PA
- Partnership between Coskata and Alter NRG
- Technology
  - Gasification Westinghouse Plasma Gasifier
    - Now owned by Alter NRG
  - Coskata – Syngas fermentation to ethanol
- Scale – 50,000 gal/yr ethanol
  - 100 gal/ton
  - Pine chips
- Status – Successful startup announced (Oct 2009)

## **Sweden, Lars Waldheim, Waldheim Consulting: (Observer’s report)**

An overview about fuel prices and taxation and energy and climate policy in Sweden were presented.

#### **R&D and D**

- Second black liquor program recently finished
- 2nd. generation BTL pilot activities (150 MSEK extra in period 2008-2010)
- Eol for 875 (90 M€) million SEK in 2009 for demonstration of 2nd.generation biofuels and energy technologies (37 Eol applicants, 5 gasification applicants, 5 selected projects)
- Two gasification projects selected
  - Black liquor demo at Mo och Domsjö
  - GoBigas in Gothenburg after second round of selection
- Energy intensive industry program 8M€
- Bioenergy fuels program

Budget limitations stops program/project launches in 2010

#### **Co-gasification in Utility CFB Boilers**

- CHALMERS Research-Gasifier was introduced
- Chemical looping reforming

#### **KTH School of Chemical Engineering**

- Pressurized LDU unit (10kg/h)
- High temperature air gasification (down-, updraft)

#### **MiUn BTL Research Laboratory**

- 150 kW ICFB gasifier:
  - Integration of FT synthesis reactor
  - Prove BTL integration
  - System modeling
  - Work on fuel flexibility

#### **ETC**

- Entrained flow gasification
  - Chemrec black liquor

#### **Värnamo**

- Pressurized combined cycle
- Supplier: Biofow (Foster-Wheeler, Sydkraft)
- Fuel 18 MW, power 6 MW, heat 9 MW
- 18 bar pressure

#### **VVBGC Project (Växjö Värnamo Biomass Gasification Centre)**

- Objectives:
  - Rebuild of and Tests in the demonstration plant
  - Generate and compile IPR
  - Establish long term research platform
- Status:
  - Engineering and procurement on-going since January 2010
  - Vattenfall, EON, AGA-Linde and SGCE stakeholders
  - Expected full project agreement and start Q1 2011
  - Budget 50 M€

#### **Mälarenergi, Västerås**

- Capacity: 2\*100 MW<sub>th</sub>,
- Fuel: Assorted wastes

- Application: Co-firing of cleaned gas into existing 600 MW PF boiler using peat and coal
- Status: Permit granted mid-2009 Tendering process in 2010
- Result of tendering led to decision to reoriented project towards conventional technology

#### **Biomass to SNG: GOBIGAS**

- Project status presented (funding, gasification, methanation, ground work and engineering, investment)

#### **Biomass to SNG: E.ON**

“The company’s target is to develop and exploit technology for thermal gasification of biomass in order to produce combustible gases, power and heat”.

- Target: 200 MW SNG plant in operation 2015

#### **Black liquor gasification activities (Örnsköldsvik, Sweden)**

- Products: DME and methanol
- Capacity 95 000 t DME or 132 000 t methanol/year
- Planned production start: 2013

**Discussion on Scope of Work and Workshop Topics for 2011-2012:** The next task meeting, the third in this triennium 2010-2012 will be probably held at University of Canterbury in New Zealand. The Workshop topic is not already specified and it is depended on the interest of industry sector in New Zealand. The fourth meeting is tentatively planned in Sweden. In year 2012 is the meeting planned in Turkey. The workshop topics are not fixed yet.

The task homepage will be transferred to Austria. The homepage will be also updated and modified. A description of basics of gasification will be included and also a database of existing gasifiers, similar to the database of task39 (<http://biofuels.abc-energy.at/demoplants/projects/mapindex>). The new homepage with a database will be presented on the next Task meeting.

**Next Task Meeting:** tentatively scheduled for April 2011.

## **Day 2, Wed Oct 6**

Meeting Location: Plant Visits: I/S Skive Fjernvarme (Andritz-Carbona gasifier CHP plant), B&W Vølund in Harboøre and Weiss Hadsund plant (Viking gasifier CHP plant).

The second meeting day was devoted to visiting three gasification plants.

The first one in Skive was not in operation at that time, but here is a short overview and technical data:

**Andritz-Carbona gasifier CHP plant** is a bubbling fluidized bed gasifier with 20MW<sub>th</sub> and 6MW<sub>el</sub>, air is used as a fluidizing agent. Wood pellets are used as a feedstock (40.000 t/year). The dolomite was changed to olivine as a bed material. The building of the plant was started in 2005. Investment 248 mill. DKK (33.3 mill. Euro). Write-Off period about 20 years. Annual sale of district heating is 120.000 MWh and electricity 22.000 MW.

The second gasification plant we visited was situated in Harboøre. An overview about the plant operation was given by project manager Mr. Robert Heeb (roh@volund.dk). A short survey can be found below.

### **Babcock&Wilcox Vølund gasifier**

- Updraft gasifier (Dr. Gratzke)
- Feed: wood chips (moisture 35-55%)
- 3.5 MW<sub>th</sub>/1MW<sub>el</sub>
- Commissioned in 1996
- CH capability added in 2000
- Originally designed for district heating
- Gasifier operated for more than 120.000 h
- Gasifier engine more than 80.000 h
- Present power production more than 500 MWh/month

The gasification plant was in operation. There were no operational problems mentioned. It was possible to go through the plant and follow up the whole gasification process with feed storage at beginning and gasifier engines on the end.

The last gasification unit we visited on the 6<sup>th</sup> October was a pilot plant in Hadsund.

### **Weiss A/S**

A pilot plant of the two-stage gasification process is being established at the factory of Weiss A/S. In the two-stage gasification process, the pyrolysis and the gasification process are separated into two different zones. In between the pyrolysis and the gasification zones, the volatiles from the pyrolysis are partially oxidized. Hereby, most of the tars are decomposed into gas. To enable high energy efficiency, the thermal energy in the gasification gas and the exhaust gas is being used for drying, air preheating and for pyrolysis.

The two stage gasification process has successfully demonstrated that the process offers

- Low tar content in gas (<5 mg/Nm<sup>3</sup>)
- Stable unmanned operation
- High coldgas efficiency (>95%)
- Low environmental impact (clean condensate, high carbon conversion)

The process verification and documentation has been performed in small scale, and in order to manufacture economical attractive plants the process is now being upscaled. The two-stage gasification process is modified, so the drying is separated from the pyrolysis unit. The drying agent is steam and produced steam from the dryer is lead to the pyrolysis-gasification reactor, and hereby soot production is reduced and char reactivity is increased.

However, the pilot plant was not in operation during our visit.

### **Day 3, Thu, Oct 7**

Expert workshop on “Small scale biomass co-generation; Technology status and market opportunities”

The workshop was hold together with Task 32 “Biomass combustion and cofiring”. All presentations from the workshop can be found at <http://www.ieabcc.nl/>

A short report from the workshop will be delivered by this Task.

END