

**IEA Bioenergy Agreement: 2010-2012**  
**Task 33: Thermal Gasification of Biomass**  
**Fifth Semi-annual Task Meeting, 2012**  
**Istanbul, Turkey**  
**Tue. 17 to Thu. 19 April 2012**

**Minutes**

Prepared by Dr. Jitka Hrbek, Task secretary, TUV, Austria

**Day 1, Tue April 17**

The list of attendees, for the Task Meeting include:

Name	Country	Affiliation	email
Reinhard Rauch	Austria	TUW	rrauch@mail.zserv.tuwein.ac.at
Jitka Hrbek	Austria	TUW	jhrbek@mail.zserv.tuwein.ac.at
Morten Tony Hansen	Denmark	FORCE	mth@force.dk
Ilkka Hannula	Finland	VTT	Ilkka.hannula@vtt.fi
Sanna Tuomi	Finland	VTT	Sanna.tuomi@vtt.fi
Ville Hankalin	Finland	Metso	Ville.hankalin@metso.com
Serhat Gül	Turkey	Tubitak	Serhat.gul@mam.gov.tr
Hakan Karatas	Turkey	Tubitak	Hakan.karatas@mam.gov.tr
Antonio Molino	Italy	ENEA	Antonio.molino@enea.it
H.J.M. Rian Visser	The Netherlands	ECN	h.visser@ecn.nl
Christiaan van der Meijden	The Netherlands	ECN	vandermeijden@ecn.nl
Bram van der Drift	The Netherlands	ECN	vanderdrift@ecn.nl
Roger Khalil	Norway	SINTEF	Roger.a.khalil@sintef.no
Lars Waldheim	Sweden	WAC	Lars.waldheim@waldheim-consulting.se
Martin Ruegsegger	Switzerland	ETECA	Eteca@gmx.ch
Richard Bain	USA	NREL	Richard.bain@nrel.gov

**Regrets for inability to attend** were received from: Thomas Kolb, KIT, Germany; Mayumi Morita and Tomoko Ogi, NEDO and AIST, Japan; Shusheng Pang, UoC, NZ

The Agenda of the Meeting was:

**Day 1, Tue, April 17**

**Meeting Location: Lares Park Hotel Taksim**

**Task Business Meeting**

- 1. Introduction of Task Members and Observers**
- 2. Review and Approval of Agenda**
- 3. Review and Approval of Minutes from First Semi-annual Task Meeting, 2011, October, Piteå, Sweden**
- 4. Discussion of IEA Bioenergy Conference 2012  
November 13 – 15, 2012**

**Vienna University of Technology**

**a) Task Plans for 2013-2015 triennium**

**Overall structure**

**Task website**

**Special Projects**

**Task Interactions**

**Member Country Summaries: *NTL's are being requested to provide executive summaries of the detailed country reports for the triennium, plus summarize the country gasifiers that are being used for the gasification project database***

1. Denmark, Morten Tony Hansen
2. Finland, Ilkka Hannula
3. Italy, Antonio Molino
4. The Netherlands, Bram van der Drift
5. Austria, Reinhard Rauch
6. Norway, Roger Khalil

**Day 2, Wed, April 18**

**Task Meeting and Workshop "Bed materials"**

**Meeting Location** Lares Park Hotel Taksim

7. Sweden, Lars Waldheim
8. Switzerland, Martin Rügsegger
9. Turkey, Hakan Karatas
10. USA, Richard Bain

**EERA bed materials workshop**

Speakers:

1. H.J.M. Rian Visser, EERA/ECN, the Netherlands
2. Christiaan M. van der Meijden, ECN, the Netherlands
3. Bram van der Drift, ECN, the Netherlands
4. Friedrich Kirnbauer, bioenergy 2020+, Austria
5. Husnu Atakül, ITU, Turkey

**Day 3, Thu, April 19**

**Site Visits**

Site Visit-1 to **Tubitak Gasification Facilities, Gebze**

Site Visit-2 to **Ekolojik Enerji Gasification Plant, Kemerburgaz**

## Country Updates on Biomass Gasification:

### Denmark, Morten Tony Hansen, FORCE Technology

A short introduction to FORCE Technology was given by Morten Tony Hansen, the new Task 33 NTL of Denmark.

FORCE is a non-profit company with unique combination of competencies within testing, technology development and consultancy. FORCE has 25 years of experience with biomass conversion and managed the Danish Centre for Biomass Technology 1986-2002. FORCE has produced the Danish National RD&D Strategy for Thermal Biomass Gasification and the D&D Action Plan on Solid Biomass CHP Technology. FORCE is active in public and commercial projects, provides fuel market analyses for Denmark and Europe as well as feasibility studies for pellet plants and CHP plants.

Further an overview on Danish gasification technologies and RD&D organizations was given.

Technology name	Stakeholders	Technology	Purpose	State	Plants	Hours	Time to c.
Alternating Gasifier	Ammongas, Vølund	Twin Bed Filter	Fuel (gas)	Pilot	1	50	40940
Vølund Updraft Gasifier	B&W Vølund	Updraft	CHP	Commercial	4	130000	0
CHP System of BioSynergi	BioSynergi	Open core dd	CHP	Pilot	1	6000	40970
Staged Down Draft Gasification	Weiss, DTU, Cowi	Multiple steps dd	CHP	Demonstration	2	4000	1
Pyioneer	DONG, DFBT, DTU	LTCFB	CHP	Pilot	4	700	>4
Close Coupled Gasification	EP Engineering	Vibrating grate FB	CHP	Pilot	1	1000	2
Sublimator	Frichs	CDP	CHP	Commercial	0	?	0
Catalytic Low Temp. Pyrolysis	Organic Fuel Tech.	Catalytic LT Pyrol.	Fuel	Pilot	1	300	40940
Up Draft Gasifier & Stirling Engine	Stirling DK	Updraft	CHP	Commercial	6	12000	0
BlackCarbon	Stirling DK	Pyrolysis	CHP	Demonstration	1	2400	2
Biomass Gasification Gas Engine	Carbona, Aaen	CFB	CHP, fuel	Demonstration	1	6500	40970
?	TK Energi	?	?	?	?	?	?

Also, an overview on Danish energy policy along with a vision for the Danish energy system in 2050 was presented.

### Finland, Ilkka Hannula, VTT

Characteristics of the energy sector in Finland were presented.

An overview on gasification of biomass and waste in Finland was given.

Commercial lime-kiln gasifiers were constructed in 1980's by Ahlström, new development by Foster Wheeler in 1990's for boiler applications.

Gasifiers in Finland now offered by Andritz-Carbona, Foster Wheeler and Metso Power in size range 15-150 MW.

VTT's role and activities in biomass gasification:

- IPR on gas reforming for clean gas applications
- Support for industrial projects
- R&D on gas filtration, heavy metal removal and fuel characterization

New CFB gasification plants, which are in commissioning/under construction were introduced.

- Metso: 2x80 MW at Lahti waste-to-energy plant
- Metso: 140 MW in Vaasa
- Andritz: lime kiln gasifier 48 MW at Joutseno (start up in summer 2012)
- Foster Wheeler: lime kiln gasifier 12 MW at Varkaus returned to air-blown operation mode

Metso gasification projects:

#### **Vaskiluodon Voima – Substituting Biomass for Coal in a PC boiler**

- 140 MW<sub>th</sub> gasifier adjoined to the existing 560 MW coal-fired power plant
- PC boiler in operation since 1982
- Coal consumption 400 000 – 500 000 t/y
- Enables biomass to replace up to 40% of coal
- Production capacity: 230 MW<sub>el</sub>, 170 MW<sub>th</sub>
- Total investment 40 mio. Euro

Metso scope:

- Fuel receiving and handling
- Drying
- Gasification
- Boiler modification
- Automation, electrification and instrumentation

#### **LahtiStreams IP (Advanced Integrated Waste Management and WtE Demonstration)**

(Lahti Energie/FI, VTT/FI, L&T/FI, Dong Energy/DK, FZK/D; total budget 23,5 M€)

- Demonstration of complete advanced waste management chain
- R&D of:
  - Improved hot gas cleaning
  - Waste processing and mat. recovery
  - Advanced ash treatment
  - New gasification based high efficiency WtE technologies

#### **Lahti Energia – Gasification Power Plant**

- 2x80 MW<sub>th</sub> gasifiers, waste-derived fuel, 50 MW<sub>el</sub>, 90 MW<sub>th</sub>

Metso scope:

- Start up April 2012
- Total investment 157 mio. Euro

#### **High-Efficiency Power from Biomass**

IGCC based on press. Fluidized-bed gasif. and hot gas filtration

- Pilot scale by VTT 30-150MWe (1990's)

Gasification coupled to engines for small-scale plants 0,1-5 MWe

- VTT's Novel gasifier devel. In early 2000
- Gas reforming know-how licenced to Carbona and Skive plant
- Support to SME companies in "farm-scale" power

SME companies are developing small-scale gasifiers for gas engines in Finland (100-500kWe)

New R&D project at VTT with 5 SME companies is planned for 2012.

Gasification based small scale CHP development in Finland (downdraft, gas purification, gas engine)

- Gasek (50 kWe, 100kWth)
- Volter (30 kWe, 80 kWth)

Biorefinery BTL Demo plants in Finland

- 3 consortiums are planning sec. gen. BTL biorefineries
- Planned capacities 100 000-200 000 t/a of diesel
- EU NER300 funding expected end of 2012
- Investment 400-800 M€

Biomass-to-Syngas R&D at VTT:

- 2G 2020 BIOFUELS
- Production of SNG of H<sub>2</sub> from biomass
- US-cooperation project on evaluation of gasification-based systems
- Nordsyngas
- Gasification reactivity

## Italy, Antonio Molino, ENEA

ENEA's activities regarding biomass:

- Biomass combustion
- LCA – Anaerobic digestion
- Biodiesel from algae
- WEB Geographic Information System of Biomass Energy Crops
- Biofuels 2<sup>nd</sup> generation

The policy and current status of biomass gasification were presented.

PLANT	POWER (kWe)	MANUFACTURER OF THE SYSTEM	CHARACTERISTICS OF THE PLANT
Belluno(BL)	1000	GAS-1000 MODEL	The plant is fed with 8500t/a of wood
Parma	1000		The plant produces 7.5GW <sub>he</sub> 15GW <sub>ht</sub> and it is powered with 9000 t/a of kenaf
Gadesco Pieve(CR)	960	Agroenergia	The pyrogasificator is fed with chopped or chipped vegetable biomass
Alessandria	640		The system is experimental and the process has been developed by poliTO; the plant is fed with 4100 t/a of biomass from forest
Vigevano(PV)	500	ModelloGAS-500	The plant produces 3.75GW <sub>he</sub> and 7.5 GW <sub>ht</sub> and it is powered with 4100 t/a of wood chips
Caluso(TO)	400	Autogas Nord	The plant is fed with residues of agricultural production, forest biomass, leaves, waste of food industry
Oltrepo Pavese(PV)	300	Bio&Watt	The plant uses an endothermic motor
Castel San Pietro(BO)	250	Bio&Watt	The pyrogasificator is fed with waste prunings, corn stalks, wood chips of poplar
Orzinuovi(BS)	250	Bio&Watt	The pyrogasificator is powered by biomass from forests
Verbania	250	CoVer Energy	The plant is classified as experimental

ENEA's technological platform for the biomass gasification:

- Molten carbonate fuel cell 125 kWe
- JOULE plant-FICFB 500 kW<sub>th</sub>
- PI.GA.plant, fixed bed 30-80 kWe
- UNIQUE plant, Interconnected fluidized bed gasifier 1MW<sub>th</sub>
- PRAGA Plant, Countercurrent fixed bed gasifier 150 kW<sub>th</sub>

PI.GA – Downdraft gasifier

- 150-450 kW<sub>th</sub>
- Cleaning section: cyclone, scrubber, disk filter, sawdust filter

- Power generation: diesel engine modified to Otto cycle with gas feeding, coupled with alternator

PRAGA plant – Updraft gasifier

- 150 kWth
- Feeding: almond shells
- Gasif. medium: mix steam-air

JOULE plant – Steam gasification pilot plant FICFB

- 500 kWth
- In collaboration with VUT, University of L'Aquila, Louis Univ.

UNIQUE plant – FB with internal recirculation of 1 MWth

- Current activity: production of bio-SNG from syngas

ENEA's projects:

- SNG from biomass
- Supercritical water gasification
- BRISK (Biofuels Research Infrastructure for Sharing Knowledge)
- HY-Tractor (Tractor powered with a fuel cells)

## The Netherlands, Bram van der Drift

Modern industry policy in the Netherlands, more renewable energy ahead

**HoSt** (small CFB gasification for difficult fuels)

- Portugal: 3MW<sub>th</sub> CFB gasifier, OLGA, gas engine
  - Status: commissioning on wood and chicken manure
- 3 ton/h paper rejects plant in NL, gasifier, cooler, cyclones, boiler, steam
  - Start up: 2013

**BioMCN** (Methanol Chemistry Netherlands)

- The largest 2<sup>nd</sup> generation biofuels plant worldwide
- Now 30-40% glycerin in Natural Gas reformer (approx. 150MW<sub>bio-methanol</sub>)
- Planned: gasification (Siemens) of 1500 ktonne/y waste wood for 400 ktonne/y methanol

**NUON**

- 250 MW<sub>el</sub> coal-based IGCC, ability to co-fire biomass
- Biomass co-firing ongoing; significant extension of co-firing under investigation, implementation depends on government
- Test 70%: capacity drops to 170-200 MWe

**ESSENT (RWE)**

- **Amer-9 power station, Geertruidenberg**
- 600 MW<sub>el</sub> coal-fired PF boiler
- 36% w/w direct co-firing, will be increased to 50%
- Plus 5% e/e indirect co-firing by gasification of waste wood
- Approx. 5000 h/year, cooling remains the biggest problem

**DAHLMAN** – renewable energy ([www.dahlman.nl](http://www.dahlman.nl))

Became ROYAL DAHLMAN in Jan 2012

#### **HEVESKES ENERGY** ([www.heveskesenergy.nl](http://www.heveskesenergy.nl))

- Technology: oxygen driven JFE gasification technology, based on 3-years operational experience
- Feedstock: RDF
- Project Delfzijl: 10 ton/h RDF, start up 2013/2014

#### **SYNVALOR** ([www.synvalor.com](http://www.synvalor.com))

- New multi-stage low-tar concept for all, but more specifically difficult fuels
- Based on Vortex reactor designs
- Aimed at affordable (<2.50 €/kWe) and reliable technology
- CEO Jacques Poldervaart: history in Torbed gasification through Polow Energy Systems

#### **HVC**

- 12 MW (waste wood input) plant in preparation
- MILENA and OLGA based
- Phase 1a: heat production (first few years)
- Phase 1b: additional gas cleaning and SNG production (~850 Nm<sup>3</sup>/h)
- Start building 2012
- Phase 2: 50-100 MW plant

#### **ECN**

- Recent 500h test 0,8 MW MILENA-OLGA on wood were presented

### **Austria, Reinhard Rauch, VUT**

Policy targets, energy consumption and renewables in Austria were presented.

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

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

- Andritz (now also owner of the Austrian part of Austrian Energy & Environment)
- 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

#### **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 -SGC Energia finished successfully their demo
	Oberwart	-gas engine/ORC -8.5 MW <sub>fuel</sub> , 2.8 MW <sub>wl</sub> -start up in 2008, in operation



-operation difficulties and optimizations were presented  
 -project on polygeneration-production of valuable gases, electricity  
 and heat from biofuels was presented

- |            |  |
|------------|--|
| Villach    | - gas engine<br>-15.0 MW <sub>fuel</sub> , 3.7 MW <sub>wl</sub><br>- in commissioning                          |
| Klagenfurt | -gas engine<br>-25.0 MW <sub>fuel</sub> , 5.5 MW <sub>wl</sub><br>-planning                                    |
| Vienna     | -planning (decision end of 2012)<br>-hydrogen production<br>-50 MW <sub>fuel</sub> , 30 MW <sub>hydrogen</sub> |

**Commercial FICFB gasifiers abroad:**

Location:	Ulm (DE)	-gas engine/ORC -15.0 MW <sub>fuel</sub> , 5.3 MW <sub>wl</sub> -since 3/2012 in operation
-----------	----------	--

**Urbas gasifiers:**

- Ruden:
  - 150 kW<sub>el</sub>/300 kW<sub>th</sub> + 70 kW<sub>el</sub>/150 kW<sub>th</sub>
  - Development since 2001
  - 30 000 operating hours
- Eberndorf:
  - 20 000 oper. hours
  - 2x120 kW<sub>el</sub> + 70 kW<sub>el</sub>/650 kW<sub>th</sub>
  - Start up 2006-8
- Neumarkt:
  - 2x120 kW<sub>el</sub>/580 kW<sub>th</sub>
  - Start up 2008
  - 16 000 operating hours
- Sulzbach-Laufen, DE:
  - 130 kW<sub>el</sub>/280 kW<sub>th</sub>
  - Start up 2009
- Neukirchen:
  - 2x150 kW<sub>el</sub>/300 kW<sub>th</sub>
  - Start up 2011
  - 1000 operating hours
- Konstanz, DE:
  - 150 kW<sub>el</sub>/300 kW<sub>th</sub>
  - Start up end of 2011

**Cleanstgas (Clean Staged Gasification)**

- Biomass gasification plant in St. Margarethen/Raab
- System sizes available 125 or 250 kW<sub>el</sub>
- Fuel: wood chips
- Further planned projects were presented (start up in end of 2012 and 2013)

## Norway, Roger Khalil, SINTEF Energy

The structure of SINTEF was presented.

Energy research cluster: SINTEF + NTNU – focus on:

- Hydropower
- Solar cells
- Wind
- Bioenergy
- CCS - Carbon Capture and Storage
- Zero emission buildings
- Oil and gas exploration and production
- Energy systems

**STOP** – Stable Operating conditions for biomass combustion plants

- The main objectives in STOP is the development of new strategies for improved operating conditions control in biomass and biomass residues combustion plants

**Gasbio** – new project within thermochemical biofuels production (duration 4 years)

Partners: SINTEF, Norske Skog, Metso, Statoil, Avinor, NTNU

Objectives: to establish an internationally oriented solid Norwegian competence base within biomass gasification to produce biofuels.

- Main objectives:
  - To develop Norwegian competence in the Biofuels area.
    - Emphasis on large-scale production of suitable qualities of synthesis gas
  - To contribute to the reduction of Biofuels production costs.
    - Innovations in gasification processes
    - Focus on low-value biomass fractions

## LignoRef

Lignocellulosics as a basis for second generation biofuels and the future biorefinery

- Project type: KMB – Research Council of Norway
- Budget: 3 M€
- Duration: 4 years (2009 – 2012)
- Partners:
  - Coordinator: PFI (paper and fiber research institute)
  - Industry: Statoil, Borregaard, Weyland, Allskog, Cambi
  - Others: UMB, UiB, NTNU

## Biomass to liquid fuels

- Budget:
  - Norwegian Research Council: 50%
  - Industry: 50%
  - Total: 1 mil. Euro (2009-2011)
- Duration: 3 years
- Partners:
  - Coordinator – Project owner: NTNU – Dept. Chem. Eng.
  - Industry: Statoil
  - SINTEF Hydrocarbon Process Chemistry (Kincat Gemini center)

## New, innovative pretreatment of Nordic wood for cost-effective fuel-ethanol production” (2007-2010)

- Project type: Nordic Energy Research

- Budget:
  - Total: 1.6 mil. Euro
- Duration: 4 years
- Partners:
  - Coordinator: PFI
  - Industry: Statoil, Borregaard, Novozyme, SEKAB, Norske Skog, Skogeierforeningen
  - R&D: Innventia, Matis, VTT, SINTEF

### **SusBioFuel**

#### **Sustainable Biofuel: Innovations in Bioethanol Production Technologies**

- Project type: Nordic Energy Project
- Budget:
  - 1.6 mil. Euro
- Duration: 4 years (2010-2014)
- Partners:
  - Coordinator: SINTEF
  - Industry: Statoil, Weyland, Matis
  - Others: VTT, DTU, PFI, Innventia

### **The Biooil Refinery**

- Project type: BIP – research Council of Norway
- Budget:
  - Total: 1.5 mil. Euro
- Duration: 2 years
- Partners:
  - Coordinator: PFI
  - Industry: Statoil, Holmen, Södra, Trondheim Energi, Fiborgtangen vekst
  - Others: Aston University

### **PROFIT**

Profitable bioenergy and paper production through innovative raw material handling and process integration

- Project type: BIP – Research Council of Norway
- Budget:
  - Total: 4.5 mil. Euro
- Duration: 4 years (2009 – 2013)
- Partners:
  - Coordinator : VTT (Technical Research Center of Finland)
  - Industry: Total of 7 industry partners

Other: Chalmers, NTNU

### **AFORE**

Added-value from chemicals and polymers by new integrated separation, fractionation and upgrading technologies

- Project type: EU project
- Budget:
  - SINTEF: EUR 395 378

Total: EUR 10 901 431

- Duration: 4 years (2009 – 2013)
- Partners:
  - Coordinator : VTT
  - Industry: Södra Cell, Danisco, hte; Granit, NATEX, KCl.

- Other: total of 20 partners

### **EuroBioRef**

European multilevel integrated biorefinery design for sustainable biomass processing

- Project type: EU project
- Budget:
  - SINTEF: EUR 619 858
  - Borregaard: EUR 3 000 000

Total: EUR 38 174 053

- Duration: 4 years (2010 – 2014)
- Partners:
  - Coordinator : CNRS
  - Industry: Arkema, Borregaard, Novozymes, Topsøe, Merck, Metabolic explorer, Umicore.
  - Other: total of 28 partners

### **Sweden, Lars Waldheim, Waldheim Consulting**

Energy and climate bill and fuel prices and taxation in Sweden were presented.

R&D and D:

- Two gasification projects selected in the 2009 EOI for demonstration of 2<sup>nd</sup> generation biofuels and energy technologies (100 M€)
- Energy intensive industry program 8 M€
- Bioenergy fuels program
- 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
- STandUP (UU/KTH/LTU/SLU) - mainly electrical grid and vehicle technology, but also RE power generation
- Swedish Centre for Renewable Fuels (f<sup>3</sup>) launched
- Swedish Gasification Centre launched
- NER300: bioenergy 5 out of 9 projects proposed to the EU
- Demonstration and SET-plan budget reinforced for FY 2012
- Biorefinery Norrtorp pre-study initiated

An overview on biomass gasification in Sweden was given ( status 2011).

**Swedish Centre for Renewable Fuels (f<sup>3</sup>-fossil free fuels)** – 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

- Budget for 2011-13 (~3 mio. Euro)
- Project areas:
  - System-wide studies
  - Studies for renewable fuels
  - Analysis of synergies between plants and diff. technology platforms
  - Method development for interdisciplinary studies

**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)

## Chalmers

- Biogas production via thermal conversion (from lab-scale to 80 MW SNG)
- Indirect gasification: 2-4 MW<sub>fuel</sub> gasifier integrated on the return leg of Chalmers 12 MW<sub>fuel</sub> CFB boiler
- Goal of activity: to demonstrate
  - how an indirect gasifier could be built
  - a robust method for catalytic reformation of the gas to a syngas containing only CH<sub>4</sub>, H<sub>2</sub>, CO, CO<sub>2</sub>, H<sub>2</sub>O
  - an energy efficiency for dry biomass to clean syngas
- 22 researchers work at Chalmers, activity divided into:
  - Gasification process
  - Gas cleaning
  - High temperature corrosion

## Swedish Gas Centre

- Gasification and gasification database
- Co-production of SNG and FT diesel
- International Gasification Seminar
- Particulate contaminants from indirect gasifiers (in planning)
- Autothermal regenerative POX tar reactor (in planning, Lund Technical Univ)

## KTH School of Chemical Engineering

- Long experience of R&D within gasification. Activities started in 1970's.
- 75 kW pressurized (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
- Online alkali analyses
- Projects:
  - 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
  - DeMiTar: development and market implementation of PID and FID tar analyzers
  - HTAG – high temperature air gasification

## ETC

- Host for DP1: Chemrec black liquor, biomass
- VIPP gasifier: biomass, cyclone gasification, WESP, scrubber, engine CHP
- PEBG: pressurized entrained flow gasification, 1MW, 15 bar

## Värnamo – pressurized combined cycle:

- Supplier: Bioflow (Foster-Wheeler, Sydkraft)
- Fuel: 18 MW
- Power: 6 MW
- Heat: 9 MW
- 18 bar
- Typhoon GT

## VVBGC project status

- Engineering initiated in January 2010
- Project terminated in Feb. 2011 because of difficulties in attracting additional partners to close industrial funding targets

#### **GoBiGas**

- Biomass to biomethane 65 – 70 %
- Energy efficiency > 90%
- Phase 1:
  - Demo plant, 20 MW generating 160 GWh/y
  - In operation early 2013
  - Allothermal (in-direct) gasification
  - Gasification: cooperation between Metso Power and Repotec
  - Methanation: cooperation with Haldor Topsöe
- Phase 2:
  - 80-100MW generating 640-800 GWh/y
  - Technology not yet chosen

#### **Project status –October 2011**

- Funding: 222 MSEK granted for phase 1  
Project application for phase 2 sent to EiB for funding
- Investment decision – Dec. 2010 by Göteborg Energi
- Gasification – cooperation between Metso Power and Repotec
- Methanation – cooperation with Haldor Topsöe
- Phase in operation – early 2013

#### **Black Liquor Gasification Activities**

- Development plant for oxygen-blown high pressure BTL gasification (located at the Smurfit Kappa mill in Piteå, Sweden)
- 30bar
- Capacity 20 metric tons/day of black liquor solids
- Used for technical development and design verification
- Started up 2005, now in operation, more than 12 000 operating hours

#### **Black Liquor Demonstration Activities**

- Domsjö and Chemrec in collaboration
- Feed: 200 MW of sodium sulphite liquor
- Products: 100 000 t/y of DME or 140 000 t/y of methanol or a mixture of both

#### **E.ON**

- Biomass to SNG
- Bio2G

#### **Värmlandsmetanol**

- Permitting is on-going
- No grant financing requested
- Planned construction start “as soon as permits are in place”
- FBG, forest residues, 100 000 t/y of fuel grade, methanol plus district heating 15 MW<sub>th</sub>

#### **Rottneros Biorefinery AB**

##### **BioMethanol opportunities:**

- 150-200 kton BioMethanol via wood or blackliquor gasification
- Capital expenditure of 3 bill. SEK per project

## MEVA

- Test unit, 10 kW<sub>th</sub>, gas engine, in operation at ETC Piteå
- The first commercial unit, 1,2 MW<sub>el</sub> under commissioning at Horlax, Piteå
- Target market is co-gen. plant, 2-20 MW<sub>th</sub>, 1-10 MW<sub>el</sub>
- Hot commissioning started in April (some few hours of gasification has been achieved up to now)

## Cortus Wood Roll

- Indirectly heated gasification in industrial scale
- Successful syngas (CO/H<sub>2</sub>) production during autumn 2011
- Relocation to Köpling planned
- Demo plant:
  - Power: 5 MW (future 25 MW)
  - Fuel: 30 TPD DS of biomass
  - Product: 1550 Nm<sup>3</sup>/h synthesis gas
  - Investment 6,5 mill. Euro

## MiUn BTL Research Laboratory

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

## Switzerland, Martin Rügsegger, ETECA GmbH

Policy in Switzerland is made by Swiss Federal Office of Energy (SFOE)

### Policy & Programs:

#### Programs

- REN-Projects by the Cantons (CO<sub>2</sub>-contribution)
- Cost-covering remuneration for feed in the electricity grid
- Further info: [www.admin.bfe.ch](http://www.admin.bfe.ch)

#### Facts:

- In 2009 56,15% of Sw. electricity production came from renewable

### Research activities

- PSI
  - Gasification of dry biomass (SNG, CHP)
  - Gasification of moist biomass for SNG production
  - EU Infrastructure Project, collaboration with: BRISK
  - CCEM Competence centre Energy and Mobility
    - 3 projects (ARRMAT, WOODGAS-SOFC II, SYNGAS Diagnosis)
    - NFP66 – 3 projects rel. biom. gasification
      - Hot gas cleaning for production of bioSNG and electricity
      - Prediction the complex coupling of chemistry and hydrodynamics in FB methanation reactors for SNG
      - Distributed production of ultra-pure hydrogen from woody biomass

### Swiss Industry

- EKZ (supplier for turnkey biomass gasification plants)
- Pyroforce (**out of business**)

- XyloPower AG (supplier for turnkey biomass gasification plants)
- Foster Wheeler (**only office in Switzerland**)
- EMPA EAWAG Dübendorf CHP gasifier plant (2x350 kWel)
  - Project in detail planning stage
- 3MW Gasifier Project for brick production in rotating furnace (**CANCELLED** – fin. reasons)
- PSI: Biomethane Development => 20-80 MW BM-to-SNG based on BFB methanation technology in discussion

#### **CHP plants - news**

- AERNI Pratteln: plant in modification
- Woodpower Wila: out of operation since 7/2011
- Woodpower EMPA: Approved project awaiting building permission

#### Facts today:

- 1 Plant in stable operation (Stans)
- 1 Project in waiting position for realization
- 1 Plant in modification

#### Facts of the past 3 years:

- 1 Plant closed down
- 3 Planned projects abandoned
- 1 Main supplier out of business

#### Politics:

Visions clearly for Renewable Energy

#### Reality:

- Cost-covering remuneration (KEV) for new projects pending
- Thermal gasification is technically complex (higher costs)
- Risk investments for biomass-energy projects not existing
- CO<sub>2</sub> -certificates, -contributions and -compensations unsecure in the future
- Public and private frames not in line with political visions
- Volatile biomass-fuel-price

## **Turkey, Serhat Gül, Tubitak – MAM**

Energy consumption, biomass potential and policy in Turkey was presented.

### **TUBITAK**

#### **Current Laboratory Scale Test Facilities;**

- Bubbling fluidized bed gasifier ( 20 kWfuel )
- Fixed bed gasifier ( 40 kWfuel )
- Circulating fluidized bed combustor ( 20 kWth )
- Circulating Fluidized bed combustor ( 35 kWth )
- Circulating Fluidized bed gasifier ( 150 kwfuel ) – problems and solutions presented

#### **Current Pilot Scale Test Facilities;**

- Bubbling fluidized bed gasifier ( 450 kWfuel )
- Fixed bed gasifier ( 300 kWfuel )
- Circulating Fluidized bed combustor ( 750 kWth )

#### **Under construction test facilities;**

- Pressurised bubbling bed gasifier (1100 kwfuel, 11 bar)

### **Biomass gasification activities in MRC**



### **1) Trigen - Liquid Fuel Production from Coal/Biomass Mixtures**

- Project Duration: 4 Years (2009 – 2013)
- Supporting bodies: Nationally Funded
- Project partners : MRC, 2 Universities, 2 private company

#### **Aim Of The Project**

- to produce more economic, efficient and clean liquid fuels from coal and biomass
- to enhance the utilization of the widespread national resources for sustainable development and energy security
- to develop technologies to be used in industry
- to demonstrate the outcomes in pilot scale

### **2) Pressurised bubbling bed gasifier (1100 kwfuel, 11 bar)**

- now under construction
- fuel feeding: 250 kg/h
- diameter (cm): 30 bottom, 45 top
- height: 350 cm
- gasif. agent: O<sub>2</sub> + steam

### **USA, Richard Bain, NREL**

- Energy consumption in 2009 covered by 8% from renewable
- Electricity generation in 2009 – about 10,8% covered from renewable

#### **U.S. biodiesel production**

- 2,85 billion gallons/y
- 478,06 cents/gal (Mar 2011)

#### **U.S. corn ethanol production**

- 218 commercial plants
- 14.554 billion gal/year nameplate capacity
- 11.987 billion gal/yr. production<sup>2</sup>
- Additional 0.27 billion gal/yr planned or under construction
- Mar 2011 Rack Price – 270.48 cents/gal

#### **Biopower status**

2010 Capacity – 10.7 GW

- 5.8 GW Electric Power Sector
- 4.9 GW End Use Generators

2010 Generation – 56TWh

Cost – 0.08 – 0.12 USD/kWh

Biomass resources scenarios, supply curve (2005-2030) and an overview on U.S. biomass gasifier developers were presented.

#### **Nexterra**

- gasification system at University of South Carolina.
- start up was at the end of 2007
- the power is 1,38 MW<sub>el</sub> and capacity 60 000 lbs/hr of high pressure steam for district heating

- The biomass (wood residues, moisture 25-55 %) is converted to combustible gas with 3 gasifiers.

### **Enerkem**

The process converts waste and residuals into advanced biofuels

Enerkem promotes sustainable development and that is why it uses the non-recyclable portion of the waste and creates value from the forest and agricultural residues. From one ton of waste (dry basis) 360 liters of ethanol are produced. The process requires little use of water and allows for its reuse in a closed circuit.

### **GTI Biomass Gasification Activities**

Within the “2<sup>nd</sup> generation biofuels project”, there are provided laboratory and pilot-scale test for Andritz/Carbona and UPM F-T project. The maximum feed rate of biomass is 40 tons/day. The gasifier is pressurized (25 bar) oxygen blown.

### **TRI Technology and Projects**

TRI’s core technology is deep fluidized bed, indirectly heated, steam reforming of biomass. TRI’s black liquor gasifier has been commercially operational for six years (Trenton, Ontario). Two separate DOE “Small-Scale Biorefinery Projects” are employing TRI technology:

- New Page, Wisconsin Rapids, WI; 500 dry tons per day biomass to FT fuels and tail gas. Class 10 study underway (\$30 million award, 2008)
- Flambeau River Biofuels, Park Falls, WI; 1000 dry tons per day biomass to FT fuels. Class 30 completed (\$30 million award, 2008)

### **ICM, Inc.**

ICM Inc.’s gasification technology has been successfully tested and supported at rates up to 250 tons per day by the Department of Energy. ICM currently offers three commercial-scale unit designs with feedstock processing ranges of 150-200 TPD, 300-350 TPD and 450-500 TPD.

ICM owns and operates a 200 ton per day commercial demonstration auger gasification unit in Newton, KS that was installed to process municipal solid waste from the Harvey County, KS landfill. Since commencing operations at the facility, ICM has tested more than a dozen feedstocks and amassed more than 2,100 hours of operation on the unit.

Projects: ReVenture Project, Charlotte, NC: ReVenture Park is a proposed waste-to-energy facility for Charlotte, NC. Forsite Development, the lead developer for the project, selected the biomass gasifier technology by ICM, Inc.

### **Coskata – Project Lighthouse**

The project is based on partnership between Coskata and Alter NRG. A semi-commercial demonstration, Westinghouse plasma gasifier is located in Madison, PA. The feedstocks are IEA Bioenergy Task 33, Workshop: “Biomass gasification opportunities in the forest industry” – Report page 28 Pine chips and capacity is 50 000 gal /year of ethanol. The successful start up was announced in October 2009.

### **University of California & West Biofuels**

Thermochemical conversion of biomass to mixed alcohols is provided using 5 ton/day dual fluidized bed gasifier based on “Pyrox Process”. The facility works under atmospheric pressure with air-blown combustor. It is now in start-up.

## Discussion on Scope of Work for 2013-2015

**Next Task Meeting:** together with the IEA Bioenergy ExCo conference in Vienna, 12<sup>th</sup> to 16<sup>th</sup> November 2012.

### Proposed programme:

- 12. November: **Site visits to Güssing and Oberwart**
- 13.-15. November **IEA Bioenergy ExCo conference**
- 16. November: **Task33 meeting and Site visits to VUT laboratories**

Each Task should prepare 5 abstracts for the IEA Bioenergy conference.

**Please, visit IEA Bioenergy Conference webpage for further information**

<http://www.ieabioenergy2012.org>

Proposed abstract for Task 33:

- Gasification overview (R. Bain)
- Gasification database and website (J. Hrbek)
- Gasification in Austria (R. Rauch)
- Danish Biomass Gasification for CHP (Morten Tony Hansen)
- Finland, VTT?
- The Netherlands, ECN?

### Task 33 Status

An overview on Task 33 activities presented by Richard Bain:

- Overview on Task 33 members - Executive Committee and Member Countries Representatives
- Last Task 33 workshops 2011 (Christchurch, Piteå)
- New Task 33 website including BMG database activated
- Task 33 budget status
- Task 33 continuation

### Work programme of Task 33

- Organize semi-annual Task Meetings to exchange and review global RD&D programs and projects to identify barriers to commercialize BMG
- NTLs will prepare and update Country Reports and RD&D needs and make them available for use by other NTLs and Executive Committee members to aid in the development of their respective national BMG and bioenergy plans
- Conduct subtask studies, including technical workshops, with industrial and academic experts to address the key barriers to advancing BMG on a country and global basis
- Conduct joint studies/workshops with related tasks, annexes, and other international activities to pursue mutually beneficial investigation

Proposed (not finalized yet) joined studies with other IEA Bioenergy Tasks

- Feed handling and feeder handbook (with 32 and 34)
- Project database (with 32 and 34)
- Lessons learned - Report

## Deliverables and Target Groups

- A biomass gasification summary report (jointly authored by Task Lead and NTLs) in 2014 addressing BMG basics, BMG applications, outstanding technical and sustainability issues, gasification specific policies in member countries, and a directory of gasifier developers in member countries (information will include company, development status, projects locations, gasifier type, primary products, patents, publications)
- A gasification lessons learned report (jointly authored by Task Lead and NTLs) in 2015. This report will serve as a success/failure analysis that will identify common characteristics of successful development and common characteristics of unsuccessful development)
- Two workshops with subsequent published proceedings (jointly organized with at least one other task)
- Three Task workshops in selected member countries focused on BMG development. The workshops will focus on local development issues and BMG applications, as well as member country BMG status and projects. Proceeding in the form of collated presentations will be made available to IEA Bioenergy and other parties on the Task 33 website
- Continued updates of Task website and BMG Database
- Updated Country reports from member countries summarizing the status of BMG, and providing detailed information on projects for inclusion into the BMG database (to be completed in 2014)

## Day 2, Wed October 19

### Expert workshop on “Bed materials”

Meeting Location: Lares Park Hotel Taksim

Table of presentations

H.J.M. Rian Visser, EERA, ECN, NL	
Husnu Atakül, ITU, Turkey	“Hot gas clean-up with dolomite”
Friedrich Kirnbauer, bioenergy 2020+	“Chemistry of olivine and its influence on biomass gasification”
Christiaan van der Meijden, ECN, NL	“MILENA gasification bed materials”
Bram van der Drift, ECN, NL	“Tar dew point”

All presentations can be found at [www.ieatask33.org](http://www.ieatask33.org)

The list of the workshop participants can be found at attachment I.

## Day 3, Thu, October 20

### Site Visits

#### 1. TUBITAK

Gasification and combustion facilities at TUBTAK – MAM were visited

There are 2 atmospheric gasifiers (20 kW and 50 kW) and the third one, pressure gasifier is under construction.

Energy Institute MRC - projects:

- BRISK
- Energy storage
- Electric vehicles
- Distribution & efficiency of el. energy
- Vehicles & railways
- Fotovoltaics

Projects financed by government

## **2. Ekolojik Enerji**

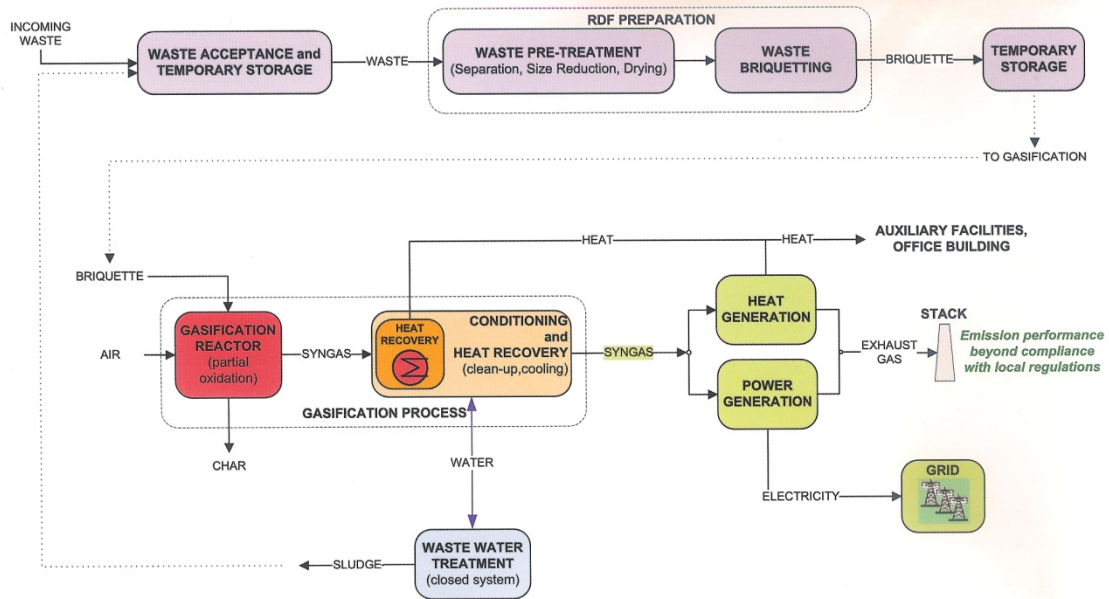
The Integrated Waste Management and Clean Energy Production Plant of Ekolojik Enerji Inc. consists of waste reception, RDF preparation, chemical/biological sludge drying, solid waste drying, evaporation, gasification, gas clean up mechanisms, energy recovery, energy production units and laboratories.

The integrated plant takes its origins from a successfully completed R&D project in Turkey, which was approved by the Scientific and Technological Research Council of Turkey. The project led the company to cooperation with Istanbul Greater Metropolitan Municipality for recovering energy from the municipal solid waste, which lasted approximately 7 months with a capacity of 50 tons/day.

Once the developmental stage was over Ekolojik Enerji Inc. has been approved with the Renewable Energy Production License. This was then followed by the Operational License; granted by the Ministry of Environment and Forestry with a supporting approval of Ministry of Finance. In addition to these the Category A Emissions License and HSE-Q Standards Certificate are also gained by the company.

## WASTE GASIFICATION and ENERGY RECOVERY PLANT

Figure 1. Overall Simplified Process Flow Diagram



**Abbreviations**  
 RDF : Refuse Derived Fuel (briquette or pellet)

Fig. Process diagram of waste handling in Ekolojik Enerji

## Attachment I

### Workshop participants list

Name	Country	Affiliation	email
Reinhard Rauch	Austria	TUW	rrauch@mail.zserv.tuwein.ac.at
Jitka Hrbek	Austria	TUW	jhrbek@mail.zserv.tuwein.ac.at
Morten Tony Hansen	Denmark	FORCE	mth@force.dk
Ilkka Hannula	Finland	VTT	Ilkka.hannula@vtt.fi
Sanna Tuomi	Finland	VTT	Sanna.tuomi@vtt.fi
Ville Hankalin	Finland	Metso	Ville.hankalin@metso.com
Serhat Gül	Turkey	Tubitak	Serhat.gul@mam.gov.tr
Hakan Karatas	Turkey	Tubitak	Hakan.karatas@mam.gov.tr
Antonio Molino	Italy	ENEA	Antonio.molino@enea.it
H.J.M. Rian Visser	The Netherlands	ECN	h.visser@ecn.n.
Christiaan van der Meijden	The Netherlands	ECN	vandermeijden@ecn.nl
Bram van der Drift	The Netherlands	ECN	vanderdrift@ecn.nl
Roger Khalil	Norway	SINTEF	Roger.a.khalil@sintef.no
Lars Waldheim	Sweden	WAC	Lars.waldheim@waldheim-consulting.se
Martin Ruegsegger	Switzerland	ETECA	Eteca@gmx.ch
Richard Bain	USA	NREL	Richard.bain@nrel.gov
Friedrich Kirnbauer	Austria	Bioenergy 2020+	Friedrich.kirnbauer@bioenergy2020.eu
Husnu Atakül	Turkey	ITU	atakul@itu.edu.tr

**END**