

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

**Vienna, Austria**

**Mon. 12 to Fri. 16 November 2012**

**Minutes**

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

**Day 1, Monday November 12**

The list of attendees, for the Task Meeting include:

| Name               | Country         | Affiliation | email                                |
|--------------------|-----------------|-------------|--------------------------------------|
| Shusheng Pang      | NZ              | UoC         | Shushing.pang@canterbury.ac.nz       |
| Thomas Kolb        | Germany         | KIT         | Thomas.Kolb2@kit.edu                 |
| 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 Hiltunen     | Finland         | VTT         | Ilkka.hiltunen@vtt.fi                |
| Antonio Molino     | Italy           | ENEA        | Antonio.molino@enea.it               |
| Mayumi Morita      | Japan           | NEDO        | moritamym@nedo.go.jp                 |
| Tomoko Ogi         | Japan           | AIST        | t-ogi@aist.go.jp                     |
| Bram van der Drift | The Netherlands | ECN         | vanderdrift@ecn.nl                   |
| 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: Serhat Gül and Hakan Karatas, TUBITAK, Turkey, Roger Khalil, Sintef, Norway.

The Agenda of the Meeting was:

**Day 1, Monday, November 12**

**Site visits**

Visits of FICFB gasification plants in Oberwart and Güssing, Austria

**Day 2-4, Tuesday to Thursday November 13-15**

**IEA Bioenergy Conference**

**Meeting venue: Schönbrunn Palace Conference Center, Austria**

Schönbrunn Palace | Schönbrunner Schloßstrasse 47 | 1130 Vienna | Austria

Coordinates: [48.186657, 16.313215 / +48° 11' 11.97", +16° 18' 47.57"](#)

Detailed program of the conference at: <http://www.ieabioenergy2012.org/topics-programme.html>

**Day 5, Friday, November 16**

**Task 33 Meeting**

**Meeting venue:** Vienna University of Technology, Institute of Chemical Engineering  
Sem 166/1, Getreidemarkt 9/166, 1060 Vienna

Location: [http://www.vt.tuwien.ac.at/fileadmin/t/vt/Home/080328\\_tu\\_plan\\_print.pdf](http://www.vt.tuwien.ac.at/fileadmin/t/vt/Home/080328_tu_plan_print.pdf)

**09:00 - Task 33 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, 2012, April, Istanbul, Turkey
4. Task Plans for 2013-2015 Triennium
  - Overall structure
  - Special projects
  - Task interactions
  - Plans for 2013, Discussion
5. Technical tour at TUV

Day 1, Mon November 12

## Site visits to FICFB Güssing and Oberwart

### Güssing

In 2002 8 MW CHP FICFB steam blown gasifier producing heat and power (4.5 MWth, 2 MWe) with a gas engine started its operation in Güssing, Austria. Renet-Austria, a competence network on energy from biomass, consisting of experts from Universities and Industry started to develop this process further to a commercial stage.

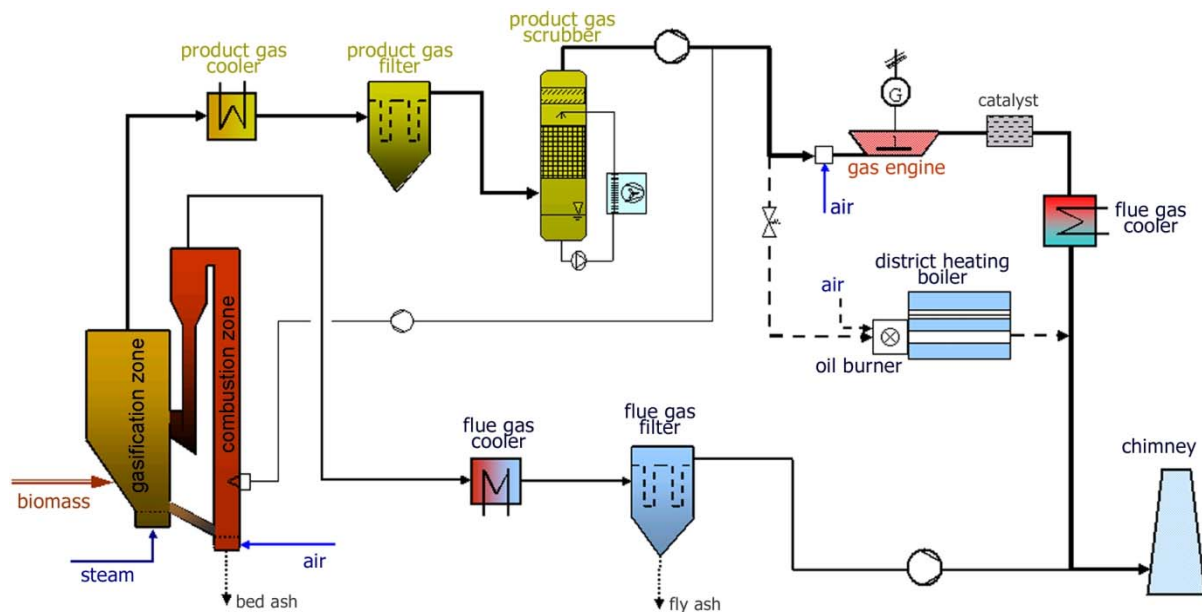


Figure: Güssing gasification plant – flow diagram

Due to the excellent performance that was reached during the last years and the optimal gas composition, several additional research projects could be started in Güssing.

The producer gas from the circulating allothermal fluidized bed gasifier is nearly free of nitrogen and has high hydrogen content. For this reason it is well suited for fuel cells as well as several synthesis products. Therefore, projects aiming at the development of processes for the production of BioSNG, Fischer Tropsch liquids, mixed alcohols and hydrogen are currently carried out.

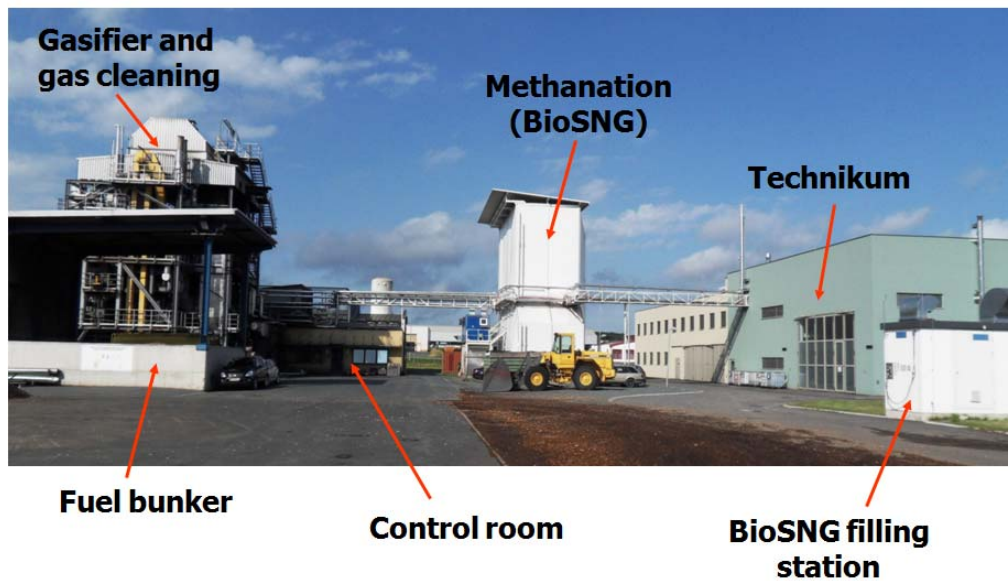


Figure: Synthesis platform in Güssing

## Oberwart

The biomass gasification plant in Oberwart ( $8.5_{\text{fuel}} / 2.8_{\text{el}}$ ) is based on the same FICFB technology as the plant in Güssing. The only difference is the dryer for the biomass feedstock and the ORC, which increases the efficiency of the process.

This project started in 2004. The first test operation and power production started at the end of 2007. Since 2010 the plant is in operation and at the same year started also the R&D work. One of the R&D projects is "Simple SNG". The production of natural gas from wood has 2 main advantages against other conversion technologies:

- The energetic efficiency of the conversion is at about 60-70%, so this conversion has a very high efficiency compared to other conversion technologies
- For natural gas there exists already a well-developed infrastructure, the synthetic natural gas (BioSNG) can be produced decentral and be used for many applications (heat, electricity, chemistry, transportation fuels)

These advantages are the reason of many research projects for the production of BioSNG from biomass. All these projects uses catalysts on the basis of nickel, so the gas cleaning is difficult, as the used nickel catalysts are very sensitive to poisoning (sulphur, chlorine, aromatics, tars, etc.)

The aim of this project is to investigate previous found catalysts for methanation, which are resistant to sulphur poisoning. These are on basis of NiO/MoO and are used on commercial scale in refineries. This type of catalysts is used for hydration of heavy oil or sulphur components. So this catalyst is not only resistant to sulphur or chlorine, this type of catalysts could also hydrate tars and reduce in this way. The catalyst is obtained from a large catalysts manufacturer, with whom already a long cooperation exists.

In former work already successful short term tests and some parameter were varied. So the aim of this project is to complete the parameter variation and to investigate the long term stability of the catalyst.

Within the project a lab scale methanation unit is build up at the biomass CHP Oberwart, which will convert about 1Nm<sup>3</sup>/h of product gas to methane. The product gas will be taken either direct after the filter (contains all tars) or after the product gas scrubber (after tar removal), converted over the methanation catalyst and analysed. By adjusting the optimal parameters (temperature, steam carbon ratio) it will tried to optimise the conversion rate and also the long term stability. The long term aim of this research is to develop a simple robust methanation that natural gas from wood can be produced cost efficiently.

The second of the R&D in Oberwart is “Polygeneration”. The aim of the project is to separate only some compounds such as H<sub>2</sub>, CH<sub>3</sub>, etc. from the product gas.

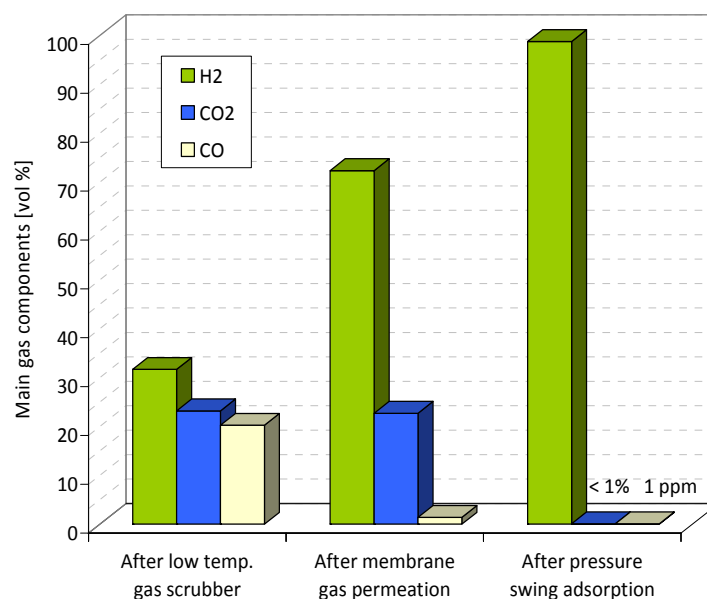


Figure: Polygeneration- results

## Day 2-4, Tue-Thu November 13-15

### The IEA Bioenergy Conference

[www.ieabioenergy2012.org](http://www.ieabioenergy2012.org)

- A total of 235 participants (49 speakers from 16 countries)
- 4 speakers from Task 33
- 2 whole days of presentations
- 1 day site visits

| Opening Plenary Session: Initial welcome and Introduction |             |  |   |
|---|-------------|--|---|
| Hall I - Maria Theresia                                   |             | Hall II - Sissi                                  |   |
| Tuesday   | Session I   | <i>Thermal Gasification of Biomass</i>           | Session II <i>Biorefineries: Co-production of Energy and Materials from Biomass</i> |
|   | Session III | <i>Sustainable International Bioenergy Trade</i> | Session IV <i>Biomass Combustion – Small Scale Systems</i>                          |
|   | Session V   | <i>Biomass Feedstocks for Energy Markets</i>     | Session VI <i>Socio-economic Drivers for Bioenergy Projects</i>                     |
| Wednesday   | Session VII | <i>Energy from Biogas</i>                        | Session VIII <i>Greenhouse Gas Balances of Bioenergy Systems</i>                    |
|   | Session IX  | <i>Commercializing Liquid Fuels from Biomass</i> | Session X <i>Integrating Energy Recovery into Solid Waste Management</i>            |
|   | Session XI  | <i>Cross-cutting Topics</i>                      | Session XII <i>Pyrolysis of Biomass</i>   |
| Closing Plenary Session: Conclusions and Perspectives     |             |  |   |

There were 4 presentations given by Task 33 in Session I. Further information can be seen in the table below.

|  |   |
|--|---|
| Bram van der Drift (ECN, the Netherlands)<br>Serge Biollaz (PSI, Switzerland)<br>Lars Waldheim (WaC, Sweden)<br>Reinhard Rauch (VUT, Austria)<br>Chris Manson-Whitton (Progressive Energy, UK) | <b>Status and future of BioSNG in Europe</b>                                  |
| Morten Tony Hansen (Force Technology, Denmark)   | <b>Thermal biomass gasification for CHP. Danish success stories</b>           |
| Reinhard Rauch (Bioenergy 2020+, Austria)  | <b>Biomass steam gasification - A platform for synthesis gas applications</b> |
| Tomoko Ogi, Masakazu Nakanishi (National Institute of Advanced Industrial Science and Technology, Japan)<br>Kaoru Fujimoto (University of Kitakyushu, Japan)                                   | <b>I4. Synthesis of Bio-LPG from Biomass-derived Syngas</b>                   |

**All these presentations can be seen online at the Task 33 webpage.**

## Day 5, Fri November 16

### Task 33 meeting

The most important topic of the Task 33 meeting on Friday was a discussion on plans for the next Triennium.

Task Leader, Richard Bain, informed Task 33 members about the news from ExCo meeting and proposed studies for the next Triennium:

- Austria will be an Operating agent instead of USA
- Joined studies (database, feeding and fuel quality handbook) with other Tasks (32,39)
- Lessons learned report

Further the structure and content of Newsletter was discussed. It was suggested to publish twice a year a Newsletter with a specific topic related to thermal biomass gasification.

In 2013, two Task 33 meetings with site visits and 2 workshops are planned.

The first semi-annual meeting should be held in Italy at the beginning of May. The workshop topic chosen was "Feeding systems and fuel quality".

The second semi-annual meeting will be held in USA in October, the topic of workshop will be "Lessons learned".

On Friday, after the Task meeting the "Technikum" and laboratories at VUT, Institute of Chemical Engineering were also visited. Task members had a possibility to take a look at a 100kW FICFB gasifier, pressurized gasification unit, chemical looping facility, etc.

### Country Updates on Biomass Gasification:

#### Denmark, Morten Tony Hansen, FORCE Technology

A short oral presentation with highlights from the presentation given at the IEA Bioenergy 2012 conference: "Thermal biomass gasification for CHP - Danish success stories" and news from the most successful CHP plants.

The table contains a summary of the technologies in focus in Denmark based on information from the suppliers gathered for the industry's strategy for thermal biomass gasification in 2011.

| Technology name                     | Stakeholders            | Technology                 | Purpose    | State         | Plants | Hours  | Time to c. |
|-------------------------------------|-------------------------|----------------------------|------------|---------------|--------|--------|------------|
| Alternating Gasifier                | Ammongas, Vølund        | Twin Bed Filter            | Fuel (gas) | Pilot         | 1      | 50     | 1-2        |
| Vølund Updraft Gasifier             | B&W Vølund              | Updraft                    | CHP        | Commercial    | 4      | 130000 | 0          |
| CHP System of BioSynergi            | BioSynergi              | Open core down draft       | CHP        | Pilot         | 1      | 6000   | 2-3        |
| Staged Down Draft Gasification      | Weiss, DTU, Cowi        | Multiple steps dd          | CHP        | Demonstration | 2      | 4000   | 1          |
| Pyroneer                            | 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 Technology | Catalytic low temp. pyrol. | Fuel       | Pilot         | 1      | 300    | 1-2        |
| 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   | 2-3        |
| ?                                   | TK Energi               | ?                          | ?          | ?             | ?      | ?      | ?          |

Europe's largest gasification CHP plant in Skive (6 MWe) which is co-financed by DOE, Danish public funds and EU programmes, has - after changes in the plant to reduce dust and bed material to be carried out and after a new catalysator - been in unproblematic operation for 7-8 months.

It is clearly a success that technologies have been developed and plants are being built and remain in operation in Denmark. However, the technology still is maturing and even though some plants can be bought on commercial terms, it would be an exaggeration yet to regard Danish gasification a commercial success. The technologies still receive and need substantial development grants to get realized.

## **New Zealand, Shusheng Pang, UoC**

University of Canterbury, New Zealand, has performed extensive studies on co-gasification of blended lignite and wood sawdust at a 100 kW dual fluidised bed gasifier. A detailed mathematical model has been developed to simulate the co-gasification process. Professor Shusheng Pang's team is also building a 20 kW entrained flow gasifier for gasification of biomass pyrolysis liquid.

Windsor Engineering Group Ltd. and Waiariki are commissioning a 1 MW updraft gasifier in Rotorua, New Zealand, using Agder Biocom (Norway) technology.

## **Finland, Ilkka Hiltunen, 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

## **The Netherlands, Bram van der Drift**

A new government started on 5. November 2012. EU renewable target 2020 increased to 16%.

New innovation system: TKI's, being PPP's with industry in lead

## **NUON**

- 253 MW<sub>el</sub> coal-based IGCC, ability to co-fire biomass since 2002
- IGCC 253 MWe started in 1993, coal-fired
- Common is 15% biomass (m/m) co-firing and ramping up to 70%, recent tests done with torrefied wood
- Recent announcement: plant will be closed (actual date not yet published), it is too expensive for power production. Political protest: the plant is high-tech, low emissions and very low carbon

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

- Became ROYAL DAHLMAN in Jan 2012
- Synova LLC invests in Royal Dahlman, citations from press release:
- *–... worldwide development of waste-to-energy power plants ...*
- *–... enables Royal Dahlman to significantly accelerate its growth strategy in the field of renewable energy technology ...*
- *–... cooperation should result in a revenue growth of at least 30 percent within the next three years ...*
- •[www.synovapower.com](http://www.synovapower.com)

## **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
- Pilot plant constructed, 50 kWe engine coupled, first results good

## **TORRGAS** ([www.torrgas.nl](http://www.torrgas.nl))

- Technology for gasification of torrefied biomass
- Based on torroidal reactor design: Torbed technology

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

- Technology: oxygen driven JFE gasification technology, based on 3-years operational experience
- Feedstock: RDF and biomass
- 10 ton/h RDF, start of construction 2013, start of production 2014

## **HVC** ([www.hvcgroep.nl](http://www.hvcgroep.nl))

- 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

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

- 3 ton/h paper rejects plant in NL, gasifier, cooler, cyclones, boiler, steam
  - Start up: 2013/Q4

## **ESSENT (RWE)**

- Amer-9 power station, Geertruidenberg
- 80 MW CFB gasifier on waste wood or indirect co-firing into 600 MW<sub>el</sub> coal-fired PF boiler
- Feed-in tariff will stop end 2013, exploring ways to continue operation

### **BioMCN** (Methanol Chemistry Netherlands)

- 150 kton/y bio-methanol production from glycerin; additional 400 kton/y bio-methanol plant
- (“woodspirit”: wood torrefaction – Siemens entrained flow gasifier)
- 199 MEuro granted by NER300

### **ECN**

MILENA for low-grade coal gasification

- TARA technology for simpler gas cooling
- Benzene separation (bioBTX production) for added value and simpler upgrading and/or better emissions

### **CARLOS VILELA** *Technical University of Eindhoven, TU/e*

- Thesis on Primary methods for tar reduction
- Simple test facility where little biomass is quickly heated in fluidized bed, gases are analysed, solid C-rich remainder is quantified (“C combustion”)
- Variations of bed material, BET surface, temperature, steam, gas residence time, fuel (cellulose, lignin, xylan, wood)

### **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<br>-8.0 MW <sub>fuel</sub> , 2.0 MW <sub>wl</sub><br>-start up in 2002, in operation<br>-SGC Energia finished successfully their demo   |
|           | Oberwart   | -gas engine/ORC<br>-8.5 MW <sub>fuel</sub> , 2.8 MW <sub>wl</sub><br>-start up in 2008, in operation<br>-operation difficulties and optimizations were presented<br>-project on polygeneration-production of valuable gases, electricity and heat from biofuels |
|           | Villach    | - gas engine<br>-15.0 MW <sub>fuel</sub> , 3.7 MW <sub>wl</sub><br>- in commissioning   |
|           | Klagenfurt | -gas engine   |

Vienna -25.0 MW<sub>fuel</sub>, 5.5 MW<sub>wl</sub>  
 -planning  
 -planning (decision end of 2012)  
 -hydrogen production  
 -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)**

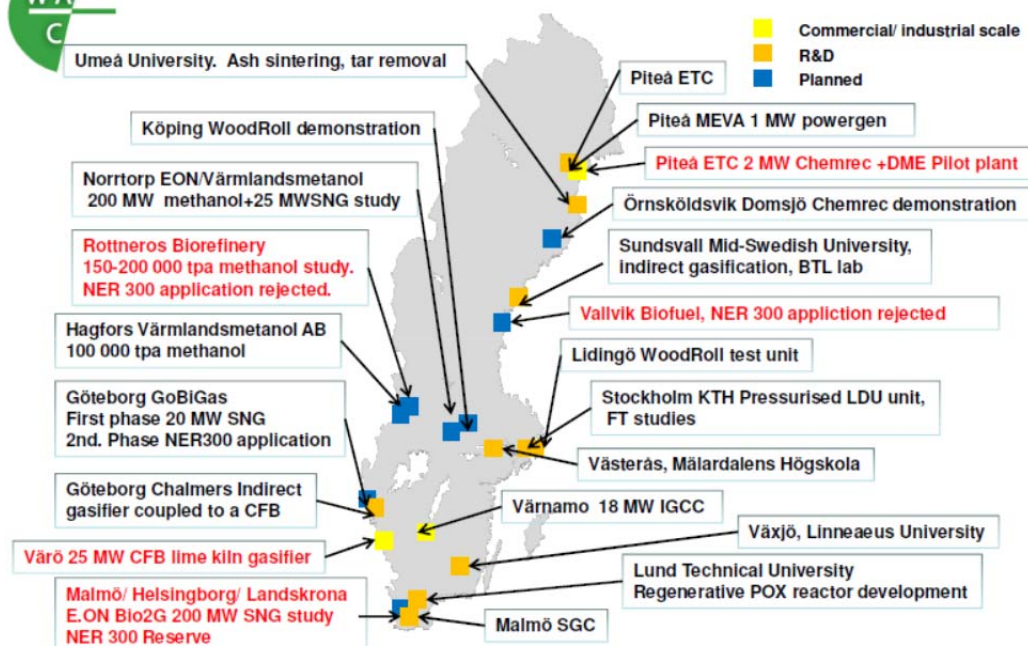
- Biomass gasification plant in St. Margareten/Raab
- System sizes available 125 or 250 kW<sub>el</sub>
- Fuel: wood chips
- Further planned projects were presented (start up in end of 2012 and 2013)

**Sweden, Lars Waldheim, Waldheim Consulting**

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



## Biomass Gasification Sweden 2011



### EU NER300: bioenergy 5 out of 9 proposals, 3 retained

- Pyrogrot Billerud- Category: 40 kton/a pyrolysis oil or slurry
- E.ON Bio2G – Category: 40 million Nm<sup>3</sup>/a SNG, reserve
- GoBiGas 2 – Category: 40 million Nm<sup>3</sup>/a SNG

New EC list by end of November.

### 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)

New application for 4 year activity in March 2014

### 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 + 100MW<sub>fuel</sub>
  - 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 >85%

2012-13 season activity focused on bed materials and chemical looping reforming

### Swedish Gas Centre

- Gasification and gasification database
- Co-production of SNG and FT diesel (to be published in 2012)
- International Gasification Seminar (18-19 October 2012)
- Particulate contaminants from indirect gasifiers (ongoing)

- Autothermal regenerative POX tar reactor (ongoing, Lund Technical Univ)
- Online detection of water vapor (ongoing, Chalmers technical university)
- CO<sub>2</sub> removal in indirect gasification (ongoing, Lund Technical Univ, ECN)
- Fuel testing in 500 kW wood Roll prototype (ongoing, KTH, Cortus)

#### **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

New major grant (500.000 €) for upgrading research infrastructure

#### **Värnamo – pressurized combined cycle:**

- Supplier: Bioflow (Foster-Wheeler, Sydkraft)
- Fuel: 18 MW
- Power: 6 MW
- Heat: 9 MW
- 18 bar
- Typhoon GT
- Mothballed in 2000. > 8000 gasifier and 3600 hours of GT op.

#### **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
  - VVBGC has taken over Bioflow Oy and associated IPR
- Future: mothballing again

#### **GoBiGas**

- Biomass to biomethane 65 – 70 %
- Energy efficiency > 90%
- Phase 1:
  - Demo plant, 20 MW generating 160 GWh/y
  - In operation early 2013, agreement with Swedegas for pipeline transition of product gas
  - Allothermal (in-direct) gasification
  - Gasification: cooperation between Metso Power and Repotec
  - Methanation: cooperation with Haldor Topsøe
- 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 Topsøe
- Phase in operation – early 2013

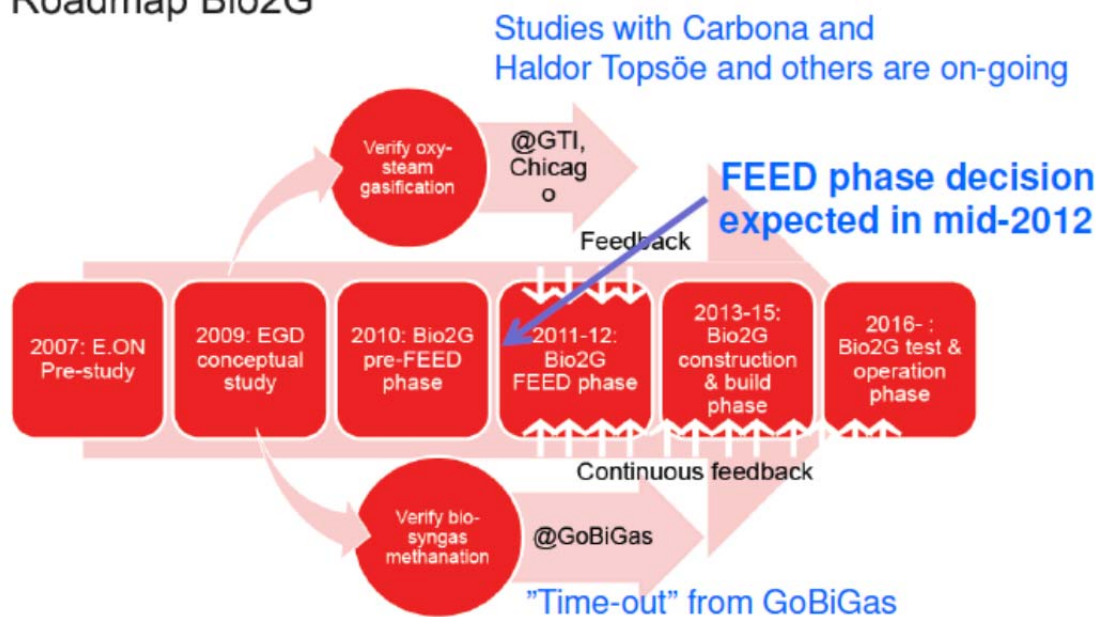
#### Black Liquor Gasification Activities

- 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
- Project end 2012, Staff have been given redundancy notice
- The Lulea Technical University is investigating take over and operation for R&D purpose

#### E.ON

- Biomass to SNG
- Bio2G

### Roadmap Bio2G



#### 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 of the complex coupling of chemistry and hydrodynamics in FB methanation reactors for SNG
      - Distributed production of ultra-pure hydrogen from woody biomass
- Engagement under EU SET-Plan (FP7-ERANET-2012-RTD) and European Industrial Bioenergy Initiative (EIBI) ERA-NET Plus BESTF Program supported by the Swiss Federal Office of Energy

### Swiss Industry

- EKZ (supplier for turnkey biomass gasification plants)
- Pyroforce (**out of business**)
- XyloPower AG (supplier for turnkey biomass gasification plants)
- 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)
- CTU Supplier for turnkey biomass gasifier plants <http://www.ctu.ch/de/home.html>
- Foster Wheeler (**only office in Switzerland**)

### CHP project news

- EMPA EAWAG Dübendorf CHP gasifier Plant  
Project is in the stage of detail planning and in construction  
Supplier will be EKZ Woodpower-type gasifier with 2 x 350 kW el
- Spanner thermal Gasifier 45 kW CHP Unit for District heating using waste wood of a sawmill (A. Steiner + Cie. AG Ettiswil /Luzern)
- PSI: Biomethane Development => 20-80MW BM-to-SNG plant in discussion based on BFB methanation technology

### CHP plants - news

- AERNI Pratteln: plant in modification
- Woodpower Wila: out of operation since 7/2011 (closed down)
- Holzstrom Stans Pyroforce Gasifier in continuous operation 20 000h/26 200h since start
- Woodpower EMPA: Approved project expected start of operation end of 2013

### Facts today:

- 1 Plant in stable operation (Stans)
- 2 Project in construction
- 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

## Italy, Antonio Molino, ENEA

### Policy

- Natural gas is still dominant, with a share of 42% in 2011, while the renewables are increasing their role, coal generation is quite steady in recent years, proving the 12% of the total
- The yearly growth of renewable energy power plant in Italy continues at very fast pace. In each of the past six years, their number doubled with respect to the previous year
- For the electricity sector, the target to be achieved by 2020 is 26.4% of electricity consumption from renewables. In 2011, Italy recorder 23.5%, surpassing by wide margins the 2011 intermediate target of 19.6%
- Bioenergy is produced by biomass (4,3 TW/h), biogases (3,2 TW/h) and bioliquids (2,6 TW/h)
- Combustion is by far the predominant energy conversion technology, almost all is based on the Rankine cycle coupling with the steam boiler grate
- The total gasification plants fuelled with biomass are corresponding to 10MWe

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 (PA)        | 1000        |                            | The plant produces 7.5GWhe 15GWht 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 (AL)  | 640         | nd                         | 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 3.75GWhe and 7.5 GWht 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 (VB)         | 250  | CoVer Energy   | The plant is classified as experimental   |
| Rossano (CS)          | 4200 | Guascor        | Commercial plant  |
| Castel D`Aiano (BO)   | 35   | Stirling       | Commercial plant  |
| Pomarico (MT)         | 300  | Bio&Watt       | Commercial plant  |
| Quingentole (MN)      | 70   | Caema          | Commercial plant  |
| Torre S. Susanna      | 500  | ICQ/SIAG/ERBA  | Experimental plant  |

ENEA's technological platform for the biomass gasification:

- Molten carbonate fuel cell 125 kWe
- JOULE plant-FICFB 500 kWth
- PI.GA.plant, fixed bed 30-80 kWe
- UNIQUE plant, Interconnected fluidized bed gasifier 1MWth
- PRAGA Plant, Countercurrent fixed bed gasifier 150 kWth

PI.GA – Downdraft gasifier

- 150-450 kWth
- 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)

Other research projects:

ENERPARK

- The project was funded by Basilicata Region with the EU Structural Funds PO FERS 2007-2013 through which the EU aims to strength then economic and social cohesion of its territory by correcting imbalances between the regions
- The project provides the construction of a gasification plant coupling with a methanation plant for increase the biomethane content in the syngas
- The biomass used for the process derive from the routine maintenance of the Gallipoli Cognato's forestry. A second step of the project provides the use of biomethane for the service cars for the workers in park

Industry/Companies

The whole list of the companies with detailed contact information can be found online at [www.ieatask33.org](http://www.ieatask33.org).

## **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.

**END**