From the Task by Jitka Hrbek

During the last Triennium **2010 – 2012** there were 13 participating countries in the Task 33.

Following table shows the member countries and their National team leaders as well as Task 33 management.

<table>
<tr><td colspan="4">Task leader: Richard Bain, NREL, CO, USA
Assistant Task leader: Reinhard Rauch, VUT, Austria
Operating agent: Paul Grabowski
Task secretary: Jitka Hrbek, VUT, Austria</td></tr>
<tr><th>Member country</th><th>National team leader</th><th>Member country</th><th>National team leader</th></tr>
<tr><td>Austria</td><td>Reinhard Rauch</td><td>New Zealand</td><td>Shusheng Pang</td></tr>
<tr><td>Denmark</td><td>Morten Tony Hansen</td><td>Norway</td><td>Roger Khalil</td></tr>
<tr><td>Finland</td><td>Ilkka Hannula</td><td>The Netherlands</td><td>Bram van der Drift</td></tr>
<tr><td>Germany</td><td>Thomas Kolb</td><td>Sweden</td><td>Lars Waldheim</td></tr>
<tr><td>Italy</td><td>Antonio Molino</td><td>Switzerland</td><td>Martin Ruegsegger</td></tr>
<tr><td>Japan</td><td>Mayumi Morita</td><td>Turkey</td><td>Serhat Guel</td></tr>
<tr><td>USA</td><td>Richard Bain</td><td></td><td></td></tr>
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I would like to thank all the Task 33 representatives for their excellent cooperation and effort during the last Triennium.

Within that 3 years period some significant changes were made.
One of the most important items is a new, clear and informative website, which provides an overview of thermal biomass gasification process, the Task work, participants, and country reports and informs about the last and future Task meetings and workshops.

A major deliverable for the last triennium is also development of an interactive gasification facility database. The database is available on the Task 33 website at http://www.ieatask33.org/ and it is updated regularly. At the moment there are 120 gasification facilities from the entire world registered in the database. A list of all facilities can be found at attachment of this newsletter.

This newsletter reviews the highlights of the Triennium 2010 -2012. Information about workshops, IEA Bioenergy conference and Task 33 website and database is presented here.

SUMMARY

This newsletter reviews the highlights of Triennium 2010-2012.

- **Workshops - topics**
  1. Advanced biofuels
  2. Small scale biomass co-generation technology, status and market opportunities
  3. Gasification and alternative fuels
  4. Biomass gasification opportunities in the forest industry
  5. Bed materials
- **IEA Bioenergy conference**
- **Task website and database**

There were 6 Task meetings and 5 workshops held during the Triennium 2010-2012. The topics of the workshops dealt with the most important issues in the thermal biomass gasification area.

WORKSHOPS

Advanced biofuels are also known as second generation biofuels. In general, advanced biofuels are produced from cellulosic materials (lignocellulosic feedstock), such as agricultural and forestry residues or wastes, or energy crops.

On this workshop, which was held in June 2010 in Helsinki/Espoo participated the companies and institutes from Finland, the Netherlands, Austria, USA and Turkey, which are active in the area of biomass gasification and production of synthetic biofuels. There were 9 interesting presentations given, for the details see the following table.

Small scale biomass co-generation technology, status and market opportunities; This workshop on recent developments in small scale power production from solid biomass was jointly organised by Task 32 and Task 33 and held in October 2010 in Copenhagen.

It covered the development status of a wide variety of power technologies for solid biomass, based on both gasification and combustion and made a good comparison possible of the technologies available, given figures of the efficiencies, reliability, operational experience and costs.

Gasification and alternative fuels was the topic of the workshop which was held in New Zealand in April 2011. Biomass gasification experts from USA, Austria, Australia and New Zealand presented the latest progresses in biomass gasification R&D as well as commercialisation. 40 people from universities, research institutes, energy industry, wood processing industry and engineering consultancy companies attended the workshop.

During the workshop with topic **Biomass gasification opportunities in the forest industry,** which was held in November 2011 in Piteå, Sweden**,** highlights of the thermal biomass gasification in Sweden, Finland, Austria and USA were presented. The workshop was a very informative appointment for all workshop participants. More than 30 experts from the biomass gasification area and forest industry had a possibility to exchange the important information in RD&D of thermal biomass gasification process and the new opportunities for forest industry.

In conjunction with the First Semi-Annual Meeting 2012 of IEA Bioenergy Task 33, a workshop of **Bed materials** was held on 18 April 2012 in Istanbul, Turkey. The workshop was organized with cooperation of EERA (European Energy Research Alliance). The influence of the bed materials on the product gas quality during the thermal biomass gasification was confirmed in different projects and scientific studies.

EERA is an initiative by 10 (+5) leading European R&D institutes. The aim of this initiative is to accelerate development of new energy technologies, expand and optimize research capabilities and harmonize national and EC programs.

IEA BIOENERGY CONFERENCE

In November 2012 IEA Bioenergy conference was held in Vienna. 235 Task members, students and experts participated on the conference. 49 speakers from 16 states presented to stakeholders in R & D, industry and policy an insight into the recent research and market developments in bioenergy. The conference included all topics dealt with by IEA Bioenergy as well as by partner organizations like FAO, GBEP and UNDP.

The presentations have been addressed to all stages in bioenergy systems: from growth of biomass, to conversion to energy carriers and, to use for energy services. Cross cutting topics like sustainability (GHG emissions), socio-economy and trade have been also discussed. Policy makers benefited from the latest conclusions on policy recommendations based on a global scientific energy technology network.

TASK WEBSITE AND DATABASE

A new version of the Task 33 webpage was activated already in July 2011 (www.ieatask33.org). The aim was to create a new, clear and informative webpage on thermal gasification of biomass, not just for task members, but also for all specialists in the gasification area, stakeholders and involved public.

As a part of the IEA Bioenergy Task 33 webpage a new interactive online database with the biomass gasification facilities worldwide, based on Google maps, was created.

The database is compatible with the database of IEA Bioenergy Task 39 (Liquid Biofuels) and it is planned in the future to join these databases into one.

At the moment there are 120 gasification facilities registered in the database (a list of all registered facilities can be found in attachment of this newsletter) and they can be further sorted based on technology of the process, type of gasifier and status of the facility.

The webpage provides a good summary about the activities in the Task, informs about the workshops and meetings in form of Meeting minutes and Workshop reports as well as about the future Task meetings and workshops.

The interactive online database provides an overview about gasification facilities not only in member countries but worldwide. The database is updated regularly.

WORKSHOPS

Workshop 1: "Advanced biofuels"

02.06.2010, Helsinki/Espoo, Finland

Advanced biofuels also known as second generation biofuels are fuels which can be manufactured from various types of biomass. The biomass is mostly lignocellulosic one but it can also include animal materials.

Following table summarizes the workshop presentations.

Bram van der Drift, ECN, the Netherlands	**BioSYNGAS and BECCS**
Kari Salo, ANDRITZ Carbona, Finland	**Carbona Pressurized Gasification Technologies**
Reinhard Rauch, VUT, Austria	**Products from Synthesis Gas of Steam Gasification**
Tuula Mäkinen, VTT, Finland	**Liquid Biofuels for Transportation in Finland**
Tiina Räsänen, StoraEnso, Finland	**Development of BTL Technology for Woody Biomass**
Richard Bain, NREL, USA	**Techno-economics of the Production of Mixed Alcohols from Lignocellulosic Biomass via High-Temperature Entrained Flow Gasification**
Serge Biollaz, PSI, Switzerland	**Techno-economics of Biofuel Processes for Synthetic Natural Gas (SNG) Production**
Serhat Gül, TUBITAK MAM, Turkey	**Simulation Studies for BTL**
Esa Kurkela, VTT, Finland	**Large-scale CFB and BFB Gasification from Power & Heat to Syngas Applications**

On this workshop participated the companies and institutes from Finland, the Netherlands, Austria, USA and Turkey, which are active in the area of biomass gasification and a production of synthetic biofuels.

BioSYNGAS and BECCS
Bram van der Drift, ECN, the Netherlands

ECN from the Netherlands informed about BioEnergy Carbon Capture and Storage (BECCS). BECCS research is multidisciplinary collaboration between different units:

- Biomass, coal & environmental research
- Hydrogen & clean fossil fuels
- Policy studies

Today, fossil fuel fired power plants with CCS ultimately only mitigate 80-90% of current CO_2 emissions and BECCS offers opportunities for net atmospheric CO_2 reduction. CCS can be combined with production of 2nd generation biofuels (BioSNG, FT diesel, Bio-ethanol from lignocellulose)to increase the efficiency of the process.

Carbona Pressurized Gasification Technologies
Kari Salo, ANDRITZ Carbona, Finland

Andritz CARBONA presented the delivery portfolio for gasification. Carbona is a biomass gasification technology based company supplying plants for various applications. From 2006 acquired Andritz OY the ownership in Carbona Inc. Andritz is on the leading supliers in P&P industry and has also biomass CFB gasification background from 1980´s as Ahlstrom Machinery Oy, Pyroflow. Carbona has developed BFB biomass gasification technology since 1996.

Andritz Carbona now offers plants on combined ANDRITZ Carbona technology, for BFB and CFB gasification technologies mainly based on lignocellulosic fuels.

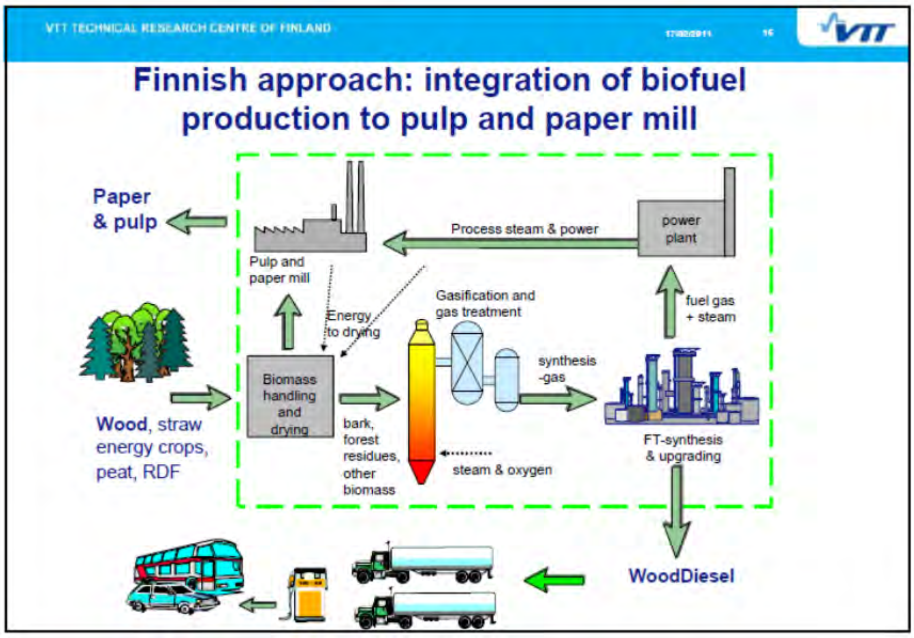
It was presented the operational experiences from different gasification plants owned by ANDRITZ Carbona, also a short overview on the future projects was given.

Products from Synthesis Gas of Steam Gasification
Reinhard Rauch, VUT, Austria

Vienna University of Technology (VUT) has given a short overview about the Institute of Chemical Engineering and its activities. Also the gasification facilities in Güssing and Oberwart were presented. The Institute of Chemical Engineering is since 1990´s active in the field of biomass gasification and has also a good knowledge about advanced biofuels. There are research programs concerning the reforming, hydrogen production, mixed alcohols production and F-T diesel here. Most of projects are situated just in Oberwart and Güssing where the product gas from the commercial gasification plants can be used for further experimental work. More information about the actual projects can be found here:
http://www.vt.tuwien.ac.at/chemische_verfahrenstechnik_und_wirbelschichttechnik/synthetische_biotreibstoffe/

Liquid Biofuels for Transportation in Finland
Tuula Mäkinen, VTT, Finland

VTT (Technical Research Centre of Finland) presented the research on liquid biofuels for transportation in Finland. At the beginning of the presentation a short overview about bioenergy, policy and legislation was given. Biofuels are in Finland produced by Neste Oil by hydrogenation of vegetable oils and animal fats (NExBTL). Finnish approach is an integration of biofuel production to pulp and paper mill. Stora Enso & Neste Oil, UPM &ANDRITZ Carbona are working on the production of FT diesel for transportation. Fuel company Vapo searches the options to invest on BTL using peat and forest residues as a raw material.



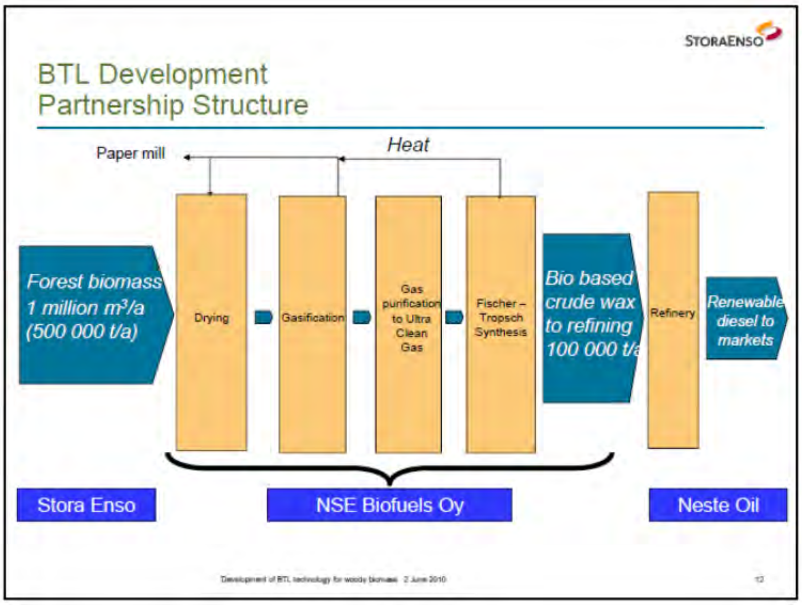
It was presented the program BioRefine concerning the new biomass products. Programme was scheduled to 2007-12. The goals of the programme:

- To develop innovative products, technologies and services based on biomass refining and biorefineries
- To expand existing biomass know-how in energy and forest industry to new areas
- To promote the co-operation between companies from different industrial clusters and sectors for innovation
- To promote the commercialisation of the developed products and technologies

Development of BTL Technology for Woody Biomass
Tiina Räsänen, StoraEnso, Finland

StoraEnso is a forest products company producing newsprints, magazines and fine papers, consumer boards, industrial packaging and wood products.

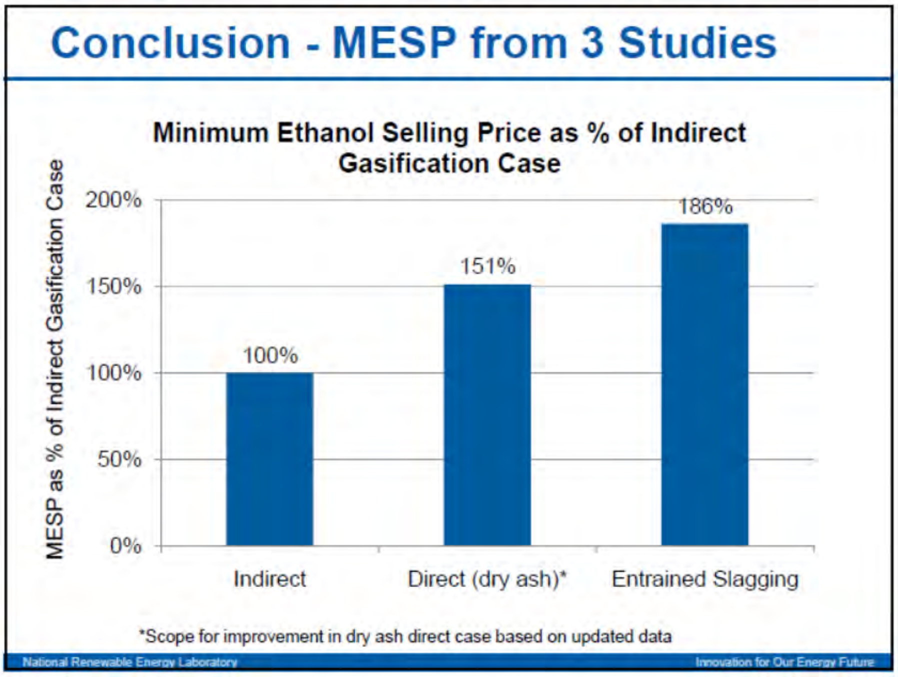
50/50 joint venture of Stora Enso and Neste Oil was presented. The aim was to first develop a technology and later produce next generation renwable diesel crude from wood and forest residues. The partners of the project were also VTT and Foster&Wheeler. BTL Development Partner Structure is showed in the following figure.



Techno-economics of the Production of Mixed Alcohols from Lignocellulosic Biomass via High-Temperature Entrained Flow Gasification
Richard Bain, NREL, USA

The DOE target was to produce a cost-competitive ethanol via thermochemical conversion at a pilot scale from Lignocellulosic biomass. Research targets primarily in the areas of syngas cleanup and alcohol synthesis. The comparison of high and low temperature gasification, different types of gasifiers and process parameters was given. It was summarized that:

- The main cost drivers in the process are:
    - Gasifier capital costs
    - Air separation costs
    - Feed preparation cost
- Advantage is to get relatively clean syngas with minimal downstream processing compared to lower temperature gasification
- Quantification of costs show that indirect gasification is economically favourable (see the following figure)



Techno-economics of Biofuel Processes for Synthetic Natural Gas (SNG) Production Serge Biollaz, PSI, Switzerland

Key technologies for SNG production at Paul Scherrer Institut (PSI) were presented. The different process technologies of the biomass gasification were compared (indirect CFB, BFB, CFB, and EF).

RD&D activities in Güssing on SNG production were introduced. First slip stream tests on 2 kW-scale were provided already in 2003.

Summary of the presentation:

- Energy and/or heat integration of SNG plants is much easier than for liquid biofuels value chains
- Scale for biomass-to-SNG plant is probably determined by biomass supply chain
- Analysis has shown that gasification technology is the most distinctive and critical choice that dominates the entire biomass-to-SNG process design
- The developed model of EPFL suggests that pressurised, steam/oxygen gasification outperforms allothermal gasification at ambient pressure with respect to efficency and investment cost.
- A 1 MW_{SNG} PDU has successfully been commissioned. There are strong evidences that fluidised bed methanation technology is quite robust towards bulk gas composition for SNG production

Simulation Studies for BTL

Serhat Gül, TUBITAK MAM, Turkey

The aim of the study was:

- To compare the different technologies with respect to performance of a CTL/BTL process
- To compare the different operational parameters with respect to performance of a CTL/BTL process
- To determine the mass & energy balance of the whole system with its subsystems, for pilot scale CTL/BTL plant that is designed and constructed at MRC

Simulation methods (gasifier):

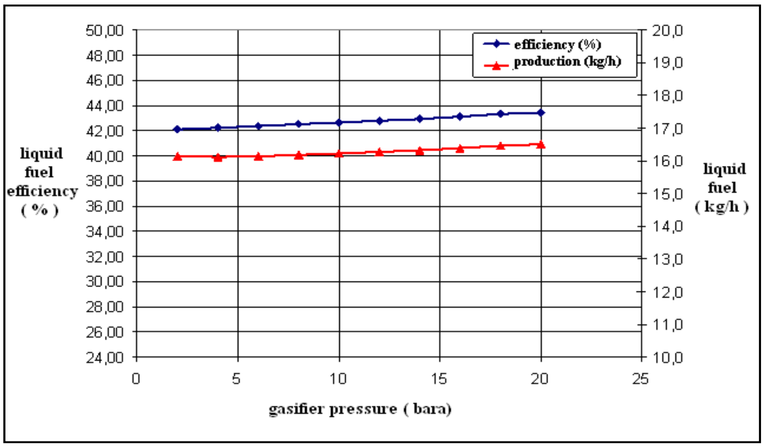
- For gasification process of selected fuel (Soma-Turkish Soma lignite), Gibbs reaction model has been used obtaining thermodynamic equilibrium conditions
- Heat loss was assumed as 3% of heat capacity of feeding fuel
- Carbon conversion rates have been assumed as 95 % and 98 % for fluidized and entrained bed gasification systems
- The set parameters considered in the simulations are the fuel feeding capacity, gasifier temperature and H2O/CO ratio of syngas
- Feeding rates of O2 and H2O have been adjusted according to the defined set parameters

Simulation methods (gas cleaning):

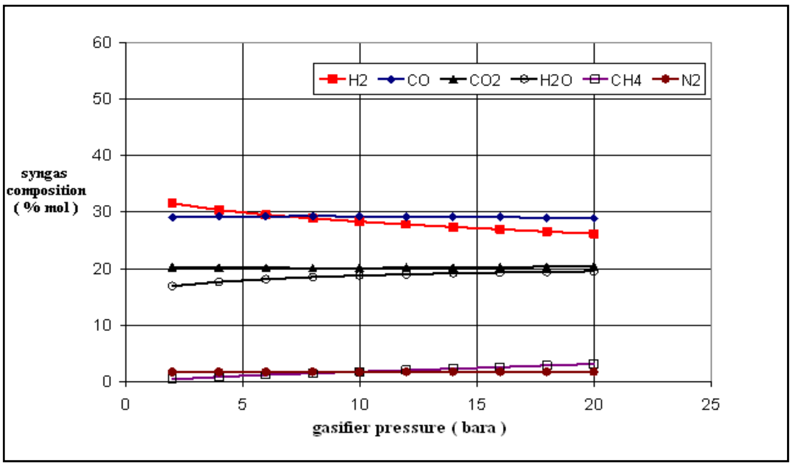
- At the gas cleaning stage, there are 5 different gas cleaning units which are the removal of H2S unit, cracking/reforming unit for tar and methane, HCl removal unit, particulate removal and finally H2S guard unit
- There is no need to define reaction mechanism for each gas cleaning reactor, because gas cleaning section does not have major effect on system performance (in terms of mass & energy balance)
- Impurities in the gas stream are removed with assumed percentage
- The temperature requirement of the gas stream is important and it has to be held at desired level for each gas cleaning reactor

Simulation results

- Liquid fuel efficiency



- Syngas composition



Workshop 2: "Small scale biomass co-generation technology, status and market opportunities"

07.10.2010, Copenhagen, Denmark

The presentations of the workshop are summarized in the following table.

W. Moser, Bioenergy 2020+, Austria	**Pellet combustion with thermoelectric power generation**
L. Jagd, Stirling.dk, Denmark	**Gasification in stirling engine application**
M. Grøn, Weiss AS., Denmark	**Vikinger gasifier**
T. Augustin, Spilling Energie, Germany	**Steam engines**
R. Bini, Turboden, Italy	**ORC for biomass plants**
H. Gemperle, Pyroforce, Switzerland	**Downdraft gasification**
R. Heeb, BaC-Volund, Denmark	**Updraft gasification**
R. Rauch, VUT, Austria	**Indirect gasifier**
A. Boisen, DONG Energy, Denmark	**Upscaling LTCFB gasifier**
B. Skjoldborf, AAEN, Denmark	**Skive plant**
R. Schenk, Siemens, Germany	**Steam turbines**
H.F.Christiansen, DAE, Denmark	**Summary**

Summary of this workshop was prepared by Task 32.

This workshop on recent developments in small scale power production from solid biomass was jointly organised by Task 32 and Task 33.
It covered the development status of a wide variety of power technologies for solid biomass, based on both gasification and combustion and made a good comparison possible of the technologies available, given figures of the efficiencies, reliability, operational experience and costs. The presentations are available online on the Task 33 website.
Based on the presentations, a summary matrix was presented of the various technologies.
From all technologies, steam engines, steam turbines and ORC's are currently most commonly applied for small scale power generation from solid biomass, with each technology applied several hundreds of times. Other technologies that have been implemented in fewer projects but have recently become commercially available are Stirling engines and gas engines with updraft or downdraught gasification (Pyroforce and Vølund) and indirect gasification (as applied in Güssing).

Several other technologies are currently in the demonstration stage, e.g. gas engines fuelled with gas from staged gasification (Weiss) or BFB gasification (as applied in Skive).
Thermoelectric conversion is currently in the experimental stage, much work needs to be done and this technology is expected to have a limited market potential in pellet boilers.
Electrical efficiencies to be expected vary from approx. 3% for thermoelectric generators to

10% for steam engines, 17-22% for the more or less proven ORC's, Stirling engines and Steam turbines and 23-28% for gasification base and power production. The low-temperature CFB based gasification process is attributed efficiencies over 40%, but that merely depends on the power plant where the produced gas is cofired.

Next Generation of Pellet Combustion with Thermoelectric Power Generation
Wilhelm Moser, Bioenergy 2020+, Austria

Wilhelm Moser presented the current status of the Thermoelectric Power Generation (TEG) technology, see Annex 2. This solid state semiconductor technology generates a voltage over a semiconductor junction when a temperature difference is applied. Prototypes based on Bismuth Tellmide have achieved electrical efficiencies of around 1-2 % at a temperature of approx. 250°C, which might go up to 7% in case of optimised application of another, new material that can withstand 400°C. If the technology is used in heat following mode however, such low efficiencies could still be justifiable. The main application foreseen is in automatic pellet furnaces to enable grid independent operation. The bottleneck for the further development is in the development of suitable materials, not the integration itself. If both the additional investment and fuel consumption are taken into account, the current electricity production costs of the tested prototypes are around 0,80 €/kWh. The aim is to reduce this by about 50%.

Gasfication in Stirling engine applications
Lars Jagd, Stirling.dk, Denmark

Lars Jagd of Stirling.DK explained the current status of the Stirling engine technology. This technology is based on a helium driven piston, where helium cycles between a high temperature of 700 °C on the hot side and a temperature of 60-80°C on the cold side.
Since the hot side of the stirling engine operates at around 700 °C, the remaining heat in the flue gases of the boiler is normally used to preheat combustion air up to around 400-500°C.
As of yet, 5 combustion based Stirling engines have been installed, with a total operation time of 40,000 hours. The maximum operation time of a single engine has been around 5000 hours.
In order to prevent ash related heat transfer problems for the hot side, the foreseen application strategy is by exposing the heat exchanger to a relatively clean flue gas, generated by burning a clean fuel from e.g. a fixed bed gasifier or flash pyrolysis, instead of flue gases from a biomass combustion system. Standard gasification based plants for 1-4 engines of 35 kWe have been developed.

Currently, 7 engines are operational based on gasification engines. There are however still some important challenges to be resolved before the technology can be sold as commercially proven, e.g. related to metal fatigue of some of the internal moving parts.
About 35-40 persons are now employed at Stirling DK. The aim is to commercialise the technology within 6-12 months as OEM through established biomass boiler manufacturers, such as Viessmann and Danstoker. The main market foreseen is small scale power production (30-500 kWe). The technology is characterised by relatively high investrnent costs (about 10.000 EurolkWc) and low O&M costs. Efficiencies to be expected are around 18%.

Staged gasification with gas engine, the Viking Gasifier
Morten Grøn, Weiss AIS, **Denmark**

Morten Grøn of Weiss A/S explained the technology of staged gasification for power production, such as first applied with the Viking gasifier (80 kWe). The technology can be regarded as in the demonstration stage, with around 5000 operating hours of experience and a few examples operational now (Hadsund, 200 kWe) or soon to be built (Hillernd, 500 kWe).
The gasification process starts with a drier for the fresh wood chips. Here, superheated steam produced by the waste heat of the gas engine is used to produce the superheated steam required. The dried wood chips enter a screw pyrolysis reactor, which is indirectly heated by the hot gases from a fixed bed downdraught gasifier, where both the pyrolysis products (char and pyrolysis gas) are further gasified at high temperature to produce a relatively clean gas.
The hot producer gas transfers heat to the pyrolyser and then preheats the gasification air. lt is then further cooled down and cleaned, before entering the gas engine.
Anticipated electrical efficiencies are around 30%, for a typical system size of 0.2-1 MWe.
Specific investment costs are in the order of 4-10 million Euro/MWe in the size of 0.2-1 MWe

Steam engines
T. Augustin, Spilling Energie GmbH, Germany

Spilling Energie GmbH can be regarded as the key producer or steam piston engines. About 200-300 plants on biomass are now in operation. The technology uses 6-60 Bar saturated steam (up to 40 tph) in 1-6 cylinders to produce 0 .15-1,2 MW of electricity in load following mode at about 10-15% electrical efficiency. Although this efficiency is relatively low in comparison to most of the other technologies available or under development, this technology has several advantages. It can be operated on saturated steam, has good part load behaviour (individual cylinders can be switched on or off), modest water requirements and that it can be maintained by local technical staff. lt can therefore be regarded as a relatively robust technology, with application potential in remote locations with little attention.

State-of-the-art of ORC technology for biomass plants
Roberto Bini, Turboden SRL, ltaly

Dr. Bini, general manager of Turboden SRL presented the current status of the ORC technology. Turboden started in 1987 with the development of biomass combustion based ORC technology, and can now be regarded as the key technology supplier for this application with 152 biomass fuelled

plants in operation or under construction (mainly in Italy, Austria and Germany). The technology is supplied on (multiple) skids for standard sizes of 0,2-3 MWe, eventually custom sizes are available.
In contrast to a conventional steam based Carnot cycle, the ORC technology is based on an organic medium (usually toluene). The operation is much simpler than a steam based cycle, with simple start-stop cycles, good part load efficiencies, high availabilities and low O&M costs.
Normally heat is transferred to an ORC system from a biomass boiler using thermal oil at a temperature of around 300 °C. This implies that a hot flue gas temperature remains after the thermal oil circuit. A recent innovation by Turboden is to apply a 'split system' in which part of the heat is supplied to the ORC at a lower temperature level. This results in higher boiler efficiencies, and thereby higher electrical efficiencies. The electrical efficiency can be further improved by reducing the condensing temperature. Electrical efficiencies are in the range of 16-20% depending on heat utilization.

Downdraft gasification with gas engine
Herbert Gemperle, Pyroforce, Switzerland

Pyroforce is a Swiss company, focussed for over 15 years on the development and commercialisation of a downdraught fixed bed gasification technology. A standard reactor has been developed that can feed a gas engine of 150-170 kWe after the gas has been cooled and cleaned using a dosing unit for calcium carbonate, baghouse filter and wet scrubber.
5 plants are now in operation with a total operating time of around 50,000 hours:

- Emmen 80 kWe, 3,500 hrs.
- Spiez 130 kWe, 17,000 hrs.
- Güssing 300 kWe, 6,000 hrs.
- Stans 1, 600 kWe, 7,500 hrs.
- Stans II, 600 kWe, 13 ,000 hrs

Investment costs are in the range of 3.5-4 million Euro/MWe for installations of a typical size of around 1 MWe. Typical electrical efficiencies are around 25%.

Updraft gasification with gas engine
Robert Heeb, Babcock & Wilcox Vølund A/S, Denmark

Babcock & Wilcox Vølund A/S is a company with 350 employees and a turnover of approx.
100 million Euro/year, focussed on WtE systems, biomass combustion and gasification systems. The company has performed R&D on updraft gasification using steam/air since 1988 and has provided an application license to a Japanese company. The 1 MWe, 3.5 MWth
Harboøre plant, commissioned in 1996 is a well-known example of the technology. 4 other installations are in operation in Denmark and Japan (8-12 MWth), with a total of 120,000 operating hours for the gasifiers.
In the gasification concept, tar is removed from the producer gas in a gas cooler/cleaner. From this process, tar is separated and used as a fuel. Washing water containing some organic components is thermally treated in a separate process step, named TARWATC. Clean producer gas is used in a gas engine.
While average annual efficiencies in 2006 experienced for the Harboøre plant were 23 % electricity, 57% heat and 13% tar (total 93%), today's knowledge makes it possible to apply the technology to

produce electricity at a net electrical efficiency of 28%. Eventually the tar can be burned to further heat up the gas engine flue gases before producing steam in a waste heat recovery boiler, to make extra electricity in a steam turbine (a combined cycle concept).
Specific investments are in the range of 4-6 million Euro/MWe for a 2 MWe system.

Indirect gasifier
Reinhard Rauch, TU Vienna, Austria

Dr Rauch of TU Vienna is involved in the development of an innovative gasification technology based on a combination of a circulating fluid bed steam gasifier and a bubbling fluid bed combustion system, where bed material for the gasification zone is heated in the combustor. This gasification concept was first applied in practise in Güssing, Austria. This installation has an electrical efficiency of 25% (2 MWe, based on 8 MW fuel input). Product gas is first cooled and then cleaned in a two stage gas cleaning system (pre-coated filter and RME scrubber) before it enters the gas engine. The resulting RME from the scrubber is burned in the combustion section. Slipstreams of the product gas are also used for various R&D projects on development on microgasturbines, fuel cells, methanisation, Fischer Tropsch synthesis, etc.
Other work is done on optimisation of the electrical efficiency, e.g. by adding an ORC to the engine waste heat. This can result in an efficiency exceeding 30%.
The plant has been operational since 2002 and has operated for approx. 7000 hours per year since 2005. It can therefore be regarded as highly successful. After Güssing, the plant in Oberwart was built in 2008, this plant is equipped with an ORC in addition to a gas engine and is now operational. In 2010 and 2011, four other plants of this concept are constructed in Germany and Austria and another 6 in the range of 2-5,3 MWe are in the planning phase.
Investment costs for Güssing and Oberwart are around 5 million Euro per MWe.

Upscaling the L TCFB gasifier
Anders Boisen, DONG Energy, Denmark

Anders Boisen ofDONG Energy (a large electricity producer in Denmark) elaborated on the Low Temperature Circulating Fluid Bed (LTCFB) gasification technology. This process has been developed by Danish Technical University and will be put into practice through a 6 MWth demonstration plant, to be built by Dong Energy at their coal fired power plant at Kalundborg, Sealand, Denmark.
Dry fuel is pyrolysed in a CFB reactor at 650 °C into a tar containing gas. Char residues and sand are separated from the gas in a cyclone, after which the char is burned in a separate reactor, thereby heating up the sand before it is rehIIned to the pyrolysis CFB. The final gas is cleaned in a second cyclone to remove the ash, before it can be used as a clean fuel for e.g. cofiring.

Since the produced gas is not directly burned in a gas engine, but burned to produce heat for a steam cycle, the process can be seen as a pretreatment step to reduce the logistical costs of biomass fuels while at the same time removing harmful alkaline fuel components before utilization in a conventional boiler. It is in this sense different from the other technologies presented in this workshop as it is not directly used for small scale power production.

The Skive plant (BFB gasification): status and perspectives

Bettina Skjoldborg, Aaen consulting and Henrik Flyver Christiansen, Danish Energy Agency

Bettina Skjoldborg presented the experience with the biomass gasification plant, which was installed and is now used at the district heating system of the Danish town.
This district heating system delivers 120 GWh of heat to 8000-9000 households through a network of 67 km of transportation pipelines and 54 km distribution pipelines. With the increasing heat demand there was a need to expand the heat generation capacity. Since it was expected that biomass could provide the perspective of a more stable heat price on the long term than natural gas, it was decided to install a wood pellet gasification plant.

The fluid bed gasifier produces 20 MW of wood gas. Tars are refo1med catalytically before the gas is cooled down, dedusted and washed to produce a clean gas that can be used to feed three gas engines with a total capacity of 6 MWe.
The building process started in 2005 and the plant was commissioned in 2008. There were several drawbacks in the project development and start up. The total project costs were about 50% higher than anticipated. The plant has resulted in 70% of the planned output, and 50% availability, while 100% output and 90% availability were expected. In addition to that the fuel cost has significantly risen. As a result of these factors, the total heat price now expected is at a level of 365 DKK/MWh, against a predicted value of only 278 DKK/MWh.

Steam turbines: what is the lower limit for feasibility, recent developments to reduce costs and increase efficiency in small/ steam turbine systems
Reiner Schenk, Siemens Frankenthal, Germany

Mr Reiner Schenk of Siemens Turbomachinery Equipment presented the current market application status of steam turbines for small scale power production from biomass combustion applications.
In 2006, Siemens acquired over 95% of the shares of the company KKK, which was specialised in the production of pre-designed small scale steam turbines (from 45 kWe up to approx 10 MW) which are of particularly interest in the market for many biomass combustion based CHP applications. Live steam pressures vary from 3-132 Bar, up to 530 °C.
Through the standard sizes and modular design, the specific costs can be kept at an acceptable level and different configurations can be made to tailor specific conditions. For example, different turbines can be arranged in twin order, as separate high pressure and low pressure turbines, or in tandem arrangement, where different turbines operating at the san1e inlet and outlet conditions drive the same generator through a mechanical gearbox. This has the advantage that individual turbines can be switched on or off to improve part load behaviour as compared to a single larger turbine. Isentropic efficiencies of these turbines are approx. 72%, and specific investment costs approx. 850 €/kWe for a 1 MWe system.

Summary of technology presentations: an attempt to present a comparable status of performance and economic data, application scale and technology readiness.
Anders Evald, Force Technology, Denmark

From all technologies, steam engines, steam turbines and ORC's are currently most commonly applied for small scale power generation from solid biomass, with each technology applied several hundreds of times. Other technologies that have been implemented in fewer projects but have recently become c01mnercially available are gas engines with downdraught or downdraught gasification (Pyroforce and Vølund) and indirect gasification (as applied in Güssing).
Several other technologies are currently in the demonstration stage, e.g. Stirling engines, gas engines fuelled with gas from staged gasification (Weiss) or BFB gasification (as applied in Skive). Thermoelectric conversion is now in the experimental stage, much work needs to be done and this technology is expected to have a limited market potential in pellet boilers.
Electrical efficiencies for small scale power production from solid biomass to be expected vary from approx. 1-2% for thermoelectric generators to 10% for steam engines, 17-22% for ORC's, Stirling engines and steam turbines and 23-28% for gasification based power production. The low-temperature CFB based gasification process is attributed efficiencies over 40%, but that merely depends on the power plant where the produced gas is cofired.

Perspectives to data col/ected through the Danish follow-up program for biomass CHP
Henrik Flyver Christiansen, Danish Energy Agency, Denmark

Henrik Flyver Christiansen of the Danish Energy Agency presented the results of an assessment made in Denmark on the performance of biomass based CHP plants. In 1993-2005, years, the energetic, environmental and financial perfo1mance of a large number of heat and CHP plants was monitored on a monthly basis. This yielded several interesting observations.
The average heat loss of the district heating network in the 189 district heating plants was 16%. Total operating hours per year varied from 4600-8700 hours, and efficiency from 68- 95%. The evaluation illustrated that the project complexity and technology and project risks are often underestimated, resulting in underperfo1mance and lower than expected efficiencies and plant availabilities. lt is also seen that over time, technology has substantially improved in reliability, efficiency and costs. As an example, steam pressure for straw fired boilers applied in practice has increased from 65 to 310 Bar in the 20 years period 1981-2001, resulting in increased efficiencies.

Visit to Stirling.dk
A field trip was made to the demonstration site of Stirling DK in Copenhagen. Here, the producer gas from a 200 kW fixed bed updraught gasifier is burned in a separate combustion chamber to produce the required heat for a 35 kWe Stirling engine. This demonstration plant has an electrical efficiency of approx. 17%. The heat is delivered to the neighbouring waste incinerator, which transfers it to the district heating network of Copenhagen.

Workshop 3: "Gasification and alternative fuels development"

14.04. 2011, Christchurch, NZ

Following presentations were given during the Workshop 3

R. Bain, NREL, USA	**Biomass gasification in North America**
J. Sanderson, Earth Systems, Australia	**Biomass gasification in Australia**
R. Rauch, VUT, Austria	**Steam biomass gasification**
D. Williams, Fluidyne, NZ	**The enigma of gasification**
S. Pang, UoC, NZ	**R&D at University of Canterbury**
T. Levi, CRL Energy Ltd, NZ	**Gasification of coal and biomass for purified hydrogen production**
S. Pearce, Solid Energy, NZ	**Underground coal gasification**
W. Saw, UoC, NZ	**Production of hydrogen rich gas using a dual fluidized bed gasifier**
C. Pennial, UoC, NZ	**Reactor and catalyst development for FT synthesis**

Summary prepared by Jingge Li, UoC, NZ

In conjunction with the First Semi-Annual Meeting 2011of IEA Bioenergy Task 33 (Thermal Gasification of Biomass), a workshop of Gasification and Alternative Fuels Development was held on 14 April in the Copthorne Hotel Commodore, Christchurch. It was organised jointly by Professor Shusheng Pang, University of Canterbury, and Dr Richard Bain, Leader of the IEA Bioenergy Task 33.

Biomass gasification experts from USA, Austria, Australia and New Zealand presented the latest progresses in biomass gasification R&D as well as commercialisation. 40 people from universities, research institutes, energy industry, wood processing industry and engineering consultancy companies attended the workshop. North America and Europe have been very active in R&D and commercialisation of biomass energy and bio-liquid fuel technologies. Numerous biomass gasification demonstration and commercialisation plants have been constructed and are in operation. Efforts now are on Fischer-Tropsch (FT) liquid fuels synthesis from biomass producer gas.

Biomass gasification in North America

R. Bain, NREL, USA

Dr Richard Bain, Principal Engineer of the National Renewable Energy Laboratory in US, presented an overview about the R&D status in North America. In US, the capacity of biodiesel is 11 billion litres, corn ethanol 55 billion litres, and biopower 10 GW. The Department of Energy has set up goals to increase the quantity and reduce the cost by 2030. Biomass gasification is one of the approaches to generate biopower and biofuels. There are about 50 biomass gasifier developers in the US which have been developing various types of gasifiers for diverse feedstock and energy products. Technical details were also presented by Dr. Bain for some successful biomass gasification projects and integrated biorefinery projects in US and Canada.

Steam biomass gasification
R. Rauch, VUT, Austria

Dr. Reinhard Rauch, the Head of the R&D Group of Synthesis Biofuels in the Vienna University of Technology and Co-Leader of the IEA Task 33, presented his first hand information on the well-known Güssing gasification plant in Austria. The Güssing biomass gasification plant uses a fast internal circulating fluidised bed (FICFB) gasifier with steam as the gasification agent developed by the Vienna University of Technology, which can generate a producer gas with high content of H2 and high calorific value. The project started as a CHP plant with 2MW electricity output, it now becomes a test facility for development of BioSNG, Fischer Tropsch fuels, mixed alcohols, and hydrogen.
Based on the successful operation of Güssing plant, the FICFB gasifier has been commercialized in six plants in Europe in stages of planning, construction or operation.

Biomass gasification in Australia
J. Sanderson, Earth Systems, Australia

Dr. John Sanderson from the Earth System in Melbourne gave a presentation on biomass gasification activities in Australia. Although no commercial biomass gasification plant is currently in operation in Australia due to limited funding in this area, it is recognized that a combination of avoided waste costs with income from energy production will be the key driver for bioenergy processes such as gasification in the near to medium term. Dr Sanderson hoped that a number of demonstration and test facilities associated with commercial entities will likely result in commercial biomass gasification plant installations in the near future. Five recently proposed gasification plants were detailed in the presentation as well as projects in biomass pyrolysis and BIGchar.

The enigma of gasification
D. Williams, Fluidyne, NZ

The IEA Workshop was also a showcase for New Zealand's work on biomass gasification. Doug Williams, a long time pioneer for development of downdraft gasifier and Director of Fluidyne Co., started his presentation with nice photos of Napier's 1930s gasifier plant with a gas engine. Then he showed the Fluidyne's recent project in California for commercialization of a 100kWe gasifier for generation of process heat and electricity. The emphasis of the technology has been to produce a clean gas free of condensable components and toxic particulates.

The Fluidyne gasifiers are also used to produce biochar for carbon sequestration and syngas for FT fuels. The Fluidyne gasifier is currently licensed for sale in Australia through Flow Force Technologies as shown in Dr Sanderson's presentation.

R&D at University of Canterbury
S. Pang, UoC, NZ

University of Canterbury has been very active in biomass gasification R&D. Professor Shusheng Pang has been leading a research programme of biomass gasification and bioliquid fuels. In collaboration with Vienna University of Technology, the research team has designed, constructed and commissioned a 100 kW FICFB steam gasifier and various biomass originated from NZ have been tested. The technology has been proved to be capable for generation of syngas suitable for synthesis of FT fuels. Professor Pang gave an overview on the current biomass to hydrogen-rich syngas and liquid flue (BTSL) research progress. The BTSL programme, funded by the Ministry of Science and Innovation (previously FRST) aims to reduce production costs and increase conversion efficiency. Technologies in development include biomass gasification, co-gasification of biomass and coal, co-gasification of biomass and sewage solid, gasification of biomass pyrolysis slurry, biomass pyrolysis, gas cleaning, and small scale FT reactor. Fundamental studies are also being carried out for operation optimisation and scale-up design.

Dr Woei-Lean Saw, a Research Fellow, presented latest trials on co-gasification of biomass and sewage solid.
Chris Penniall, a PhD student, showed his research on development of micro-channel FT reactor and catalysts.

Gasification of coal and biomass for purified hydrogen production
T. Levi, CRL Energy Ltd, NZ

Dr Tana Levi, Technical Manager in CRL Energy Ltd., talked about recent achievements in co-gasification of biomass and coal.

Underground coal gasification
S. Pearce, Solid Energy, NZ

Dr Steven Pearce, General Manager of Gas Developments in Solid Energy NZ Ltd, was invited to give a presentation on the Solid Energy's on-going project of underground coal gasification (UCG). The UCG operation works like a fixed bed gasifier and has a number of advantages such as extraction and conversion of coal to syngas in one step; elimination of mining and coal handling. The UCG technology provides access to deep and otherwise unmineable coal resources and also eliminates H&S risks associated with underground mining.

Workshop 4: "Biomass gasification opportunities in the forest industry"

20.10.2011, Piteå, Sweden

Presentations given on the workshop

Richard Bain, NREL, USA	**Climate change and the P&P industry, the IPCC SSREN Report**
Rikard Gebart, ETC, Sweden	**Swedish BLG R&D program**
Ragnar Stare, Chemrec AB	**Chemrec pilot DP1 and BioDME project and Chemrec industrial developments**
Jens Otterstedt, Sveaskog, Sweden	**A forest owner´s perspective on bioenergy**
Rikard Gebart, ETC, Sweden	**Swedish research, the Gasification Centre**
Esa Kurkela, VTT, Finland	**Fluidised-bed gasification R&D at VTT to support industrial development of BTL, SNG or bio-H2**
Richard Bain NREL, USA	**Biomass gasification Activities in North America**
Reinhard Rauch, TUV, Austria	**Gasification based co-generation**
Timo Honkala, Metso Power, Finland	**Metso gasification**
Kari Salo, Andritz Carbona Oy	**Biomass gasification in P&P industry**
Veikko Jokela, NSE Oy	**NSE gasification**

Summary prepared by Lars Waldheim, WAC, Sweden and Jitka Hrbek, VUT, Austria

The workshop **'Biomass gasification opportunities in the forest industry'** was held at the IEA Bioenergy Task 33 meeting, on the 19 October 2011 in Smurfit Kappa Kraftliner, 941 86 Piteå, Sweden. Highlights of the thermal biomass gasification in Sweden, Finland, Austria and USA were presented.

The forest industry was represented by Sveaskog, which is the leading forest owner in Europe with its base in the Swedish boreal forests. It owns about 600 million hectares, what is about 18% of the world forest land and 20 % of the world industrial timber. It is leading supplier of saw logs, pulpwood and bioenergy. The most important customers for Sveaskog were in the past sawmills and the pulp and paper industry. Based on new energy-political framework in Europe and growing demand of bioenergy, the new challenges and opportunities for forest industry occur and biomass gasification is being a very attractive process for the forest industry.

One of the most important Swedish projects is "Transportation Fuels from Forest Residues via PEBG". The project is scheduled from 2009-2012. Into the project research, industry and society sectors are involved. The project is based on pressurized entrained flow biomass gasification of low grade wood powder. The total funding of the project is 2,5 M€.

In Sweden, the black liquor production is concentrated at app. 20 pulp mills. Estimates have shown that about 25% of Sweden's use of gasoline and diesel can be replaced with synthetic fuels from black liquor. The Chemrec is one of the Swedish companies' active in R&D in the utilization of black liquor. The details of the Chemrec DP-1 gasifier were presented.

Further, Chemrec builds and operates the BioDME plant, based on Haldor Topsøe technology; Volvo Trucks develops, builds and places DME trucks with Delphi providing fuel injection system technology. ETC, the Energy Technology Centre in Piteå, contributes its technical expertise. The project duration is 48 months (till September 2012) and total budget is 28,4 M€.

NSE Biofuels Oy (Sweden) is owned by Neste Oil Oy and Stora Enso Oy. The current business is to produce syngas from woody biomass to be used as fuel in Stora Enso's Varkaus pulp mill lime kiln.

In Finland the technical research is concentrated at VTT (Technical Research Centre of Finland). During the workshop the actual projects such as the biomass to syngas process and the production of hydrogen and SNG were presented.

Further, Metso, a global supplier of sustainable technology and services, presented their CFB gasifier and their plans of modification of existing coal-fired plant (Vaskiluoto coal-fired plant in Vaasa) to biomass gasification facility. The benefits of the project should be relatively low investment cots, short delivery time and minimized production interference, integrated drying process and availability of storage capacity.

Andritz/Carbona reported on Metsä-Botnia Joutseno, gasification plant. The startup of the plant is scheduled to summer 2012). The targets are to replace 100% NG at lime kiln with gasification gas and utilize biomass side products from mill, further utilize waste heat available from mill for biomass drying and deliver whole line of Andritz products from fuel handling to lime kiln burner.

In Austria most R&D projects consists of a consortium, where scientific partners (Vienna University of Technology, Bioenergy 2020+, engineering partners (e.g. Repotec, TeconEngineering, Güssing Renewable Energy, etc.) and operators (e.g. Biomass CHP Güssing, Mondi, Begas Energie AG, OMV, etc.) work close together.

During the workshop it was reported on projects at VUT such as distribution of elements in the DFB gasifier, G-volution system, gasification and synthetic biofuels and mixed alcohols. This project is funded by "Klima und Energiefonds" and Bioenergy 2020+. Aim of this project is to get a fundamental know-how in the synthesis of mixed alcohols from biomass. The first experiments are already done and the first liters of mixed alcohols were produced and analysed.

The state of the art on thermal gasification in the USA and selected gasification technologies (Nexterra, Enerkem, etc.) and projects were presented.

Nowadays, corn ethanol is the most common biofuel in North America. There are 218 commercial plants there, with 14 554 billion gal/year nameplate capacity, the production of corn ethanol is about 12 000 billion gal/year and additional 0,27 billion gal/year are planned or under construction. The price for corn ethanol is about 270 cents/gal (status March 2011).
The capacity of biodiesel is about 2,85 billion gal/year (status April 2011).

The biofuels facilities in North America are situated mostly in Midwest part of the USA.

The capacity of Biopower is about 10,5 GW (status 2010). The costs range between 0,08 – 0,12 USD/kWh. The Biopower plants are situated in the eastern part and western coastal parts of the USA. There are a lot of biomass gasifier developers in the USA. The complete table can be found in the workshop-presentation, given by R. Bain.

The workshop with a title “Biomass gasification opportunities in the forest industry” was a very informative appointment for all workshop participants. More than 30 experts from the biomass gasification area and forest industry had a possibility to exchange the important information in RD&D of thermal biomass gasification process and the new opportunities for forest industry.

The whole workshop report can be found at the Task 33 webpage in the section “Meeting minutes and presentations”.
(http://128.131.132.12/app/webroot/files/file/2011/Workshop-report/Pitea-workshop-report.pdf)

Workshop 5: "Bed materials"

18.04.2012, Istanbul, Turkey

Workshop presentations

Hüsnü Atakül, ITU, Turkey	**Hot gas clean-up with dolomite**
Friedrich Kirnbauer, Bioenergy 2020+, Austria	**Chemistry of olivine and its influence on biomass gasification**
H.J.M. (Rian) Visser, ECN, the Netherlands	**The requirements and main themes on bed materials**
Christian van der Meijden, ECN, the Netherlands	**Milena gasification and bed materials**
Bram van der Drift, ECN, the Netherlands	**Tar dew point**

In conjunction with the First Semi-Annual Meeting 2012 of IEA Bioenergy Task 33, a workshop of Bed materials was held on 18 April 2012 in Istanbul, Turkey. The workshop was organized with cooperation of EERA (European Energy Research Alliance).

EERA is an initiative by 10 (+5) leading European R&D institutes. The aim of this initiative is to accelerate development of new energy technologies, expand and optimize research capabilities and harmonize national and EC programs.

The synthesis gas from thermal biomass gasification process is an outstanding energy carrier.
It can be used as a standalone fuel for heat and power applications or it can be further treated and transformed into another energy source.
Nowadays, product gas is used not just for heat and power generation as in the last decades, but also for the transportation fuels production. That is why much more R&D work is performed and planned in this area.
The quality of the product gas from biomass gasification process plays an important role by the synthesis gas applications and it is influenced by many factors. One of the factors is the type and quality of bed material.
The most common bed materials used in commercial thermal biomass gasification facilities are silica sand, olivine and dolomite. Their influence on the quality of the product gas (especially tar content) was discussed during the workshop.

The requirements of bed materials for fluidized bed gasification are good fluidization behaviour of grains, attrition resistance, and relatively high melting temperature. Furthermore the bed material should be non-pollutant or hazardous and also cheap in use.
The choice of the right bed material can help to optimize the gas composition and avoid operational problems.

Figure: Olivine

The influence of the bed materials on the product gas quality during the thermal biomass gasification was confirmed in different projects and scientific studies. The most used bed materials are dolomite, calcite and olivine, because their catalytic activity is much higher than of silica sand. The most important factor, why to use the bed material with a catalytic activity is the tar reduction. Tars are higher hydrocarbons, which are formed during the thermal gasification and can cause serious technical problems during the process such as fouling and plugging.

The whole workshop report can be found at the Task 33 webpage in the section “Meeting minutes and presentations”.
(http://128.131.132.12/app/webroot/files/file/2012/WS-Report/WS-Report.pdf)

IEA BIOENERGY CONFERENCE

13.-15.11.2012, Vienna, Austria

On 13.-15.11 2012 IEA Bioenergy conference was held in Vienna. 235 Task members, students and experts participated on the conference. 49 speakers from 16 states presented to stakeholders in R & D, industry and policy an insight into the recent research and market developments in bioenergy. The conference included all topics dealt with by IEA Bioenergy as well as by partner organizations like FAO, GBEP and UNDP.

The presentations have been addressed to all stages in bioenergy systems: from growth of biomass, to conversion to energy carriers and, to use for energy services. Cross cutting topics like sustainability (GHG emissions), socio-economy and trade have been also discussed. Policy makers benefited from the latest conclusions on policy recommendations based on a global scientific energy technology network.

Topics of the IEA Bioenergy Conference

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<tr><td></td><td>Session III</td><td>Sustainable International Bioenergy Trade</td><td>Session IV</td><td>Biomass Combustion – Small Scale Systems</td></tr>
<tr><td></td><td>Session V</td><td>Biomass Feedstock to Energy Markets</td><td>Session VI</td><td>Socio-economic Drivers for Bioenergy Projects</td></tr>
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<tr><td></td><td>Session XI</td><td>Cross-cutting Topics</td><td>Session XII</td><td>Pyrolysis of Biomass</td></tr>
<tr><td colspan="5">Closing Plenary Session: Conclusions and Perspectives</td></tr>
</table>

Task 33 contributed with four interesting presentations to the section of biomass gasification. An overview can be found in the following table.

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

A part of the IEA Bioenergy Conference was a site visits day. The conference participants could take part on one these technical excursions:

Full day excursion (Tour 1)

Excursion to the Bioenergy 2020+ Research Facilities including pilot- and demonstration plants in Güssing and Oberwart (Burgenland).

The central part of this excursion was a visit at of the biomass gasification plants in Güssing and Oberwart.

The purpose of the Competence Centre Bioenergy2020+ is research, development and demonstration in the area of "Energetic use of Biomass". Research and services cover the entire bioenergy value chain.

In autumn 2006, the scientific proponents of the Knet-Networks of RENET Austria and the Kplus-Centre Austrian Bioenergy Centre, agreed upon a joint submission within the framework of the newly formed COMET Programme. In October 2007, concrete measures for the unification of both predecessor organizations could begin to form the K1-Centre BIOENERGY2020+.

Full day excursion (Tour 2)

Excursion to the IFA Tulln Biogas Research Facilities as well as the Vienna Biogas Plant (waste) and the Reidling Agricultural Biogas Plant (manure, energy crops)

IFA Tulln was founded in 1994 as a research institute focusing on biotechnology for agriculture. The institute is linked to three major Austrian Universities, namely the University of Natural Resources and Life Sciences, Vienna, the University of Veterinary Medicine, Vienna and the Vienna University of Technology. Today, more than 150 employees are working in 6 departments of IFA. The activities range from molecular genetics to innovative analytical methods, from environmental process development and biopolymers to animal and plant production. At the institute intensive research in the field of biogas is carried out together with Bioenergy2020+.

The municipality of Vienna opened a biogas plant in 2007. It is situated near a waste incineration plant and the central wastewater treatment plant of Vienna. In this biogas plant 17,000 tonnes of organic waste like leftovers from canteen kitchens and the waste from bio-waste collection are used to produce 1.7 million m3 of biogas per year. The biogas is burned in a boiler producing heat fed to the municipal district heating grid.

Reidling is a village in the region of Tullnerfeld in Lower Austria. Owner and operator of the biogas plant is Karl Pfiel, a farmer with approximately 5,000 pigs. Within one year 7,000 tonnes of pig manure and 11,000 tonnes of energy crops are used as substrate to produce biogas. The plant produces 12,000 m3 of biogas per day. The biogas is burned in two gas engines (CHP, GE Jenbacher) which have an installed electrical power of 500 kW each. The thermal energy is fed into a district heating network which is 4 km long and supplies 20 households, the kindergarten and the elementary school of Reidling with hot water.

Half day excursion (Tour 3)

Excursion to Europe's largest forest biomass power station operated by Wien Energie in Simmering

The power station was commissioned in October 2006. € 52 million have been invested in producing environmentally friendly energy, stimulating economic growth and safeguarding jobs. This power station supplies around 48,000 households in Vienna with electricity and 12,000 with district heating.

Figure: **Europe's largest forest biomass power station**

The forest biomass power station, located in Vienna's Simmering District, converts wood into electricity and heating, without having a negative impact on nearby forest recreational areas.

In Austria a target has been set to increase the share of electricity produced from renewable energy to 78.1 % by 2010. The biomass power station is an important part of the efforts to achieve this objective. Compared to a conventional thermal power station, the biomass power station in Simmering avoids around 144,000 tonnes of carbon dioxide each year.

Half day excursion (Tour 4)

Excursion to the "Hundertwasser" Waste Incineration Plant operated by Wien Energie in Spittelau

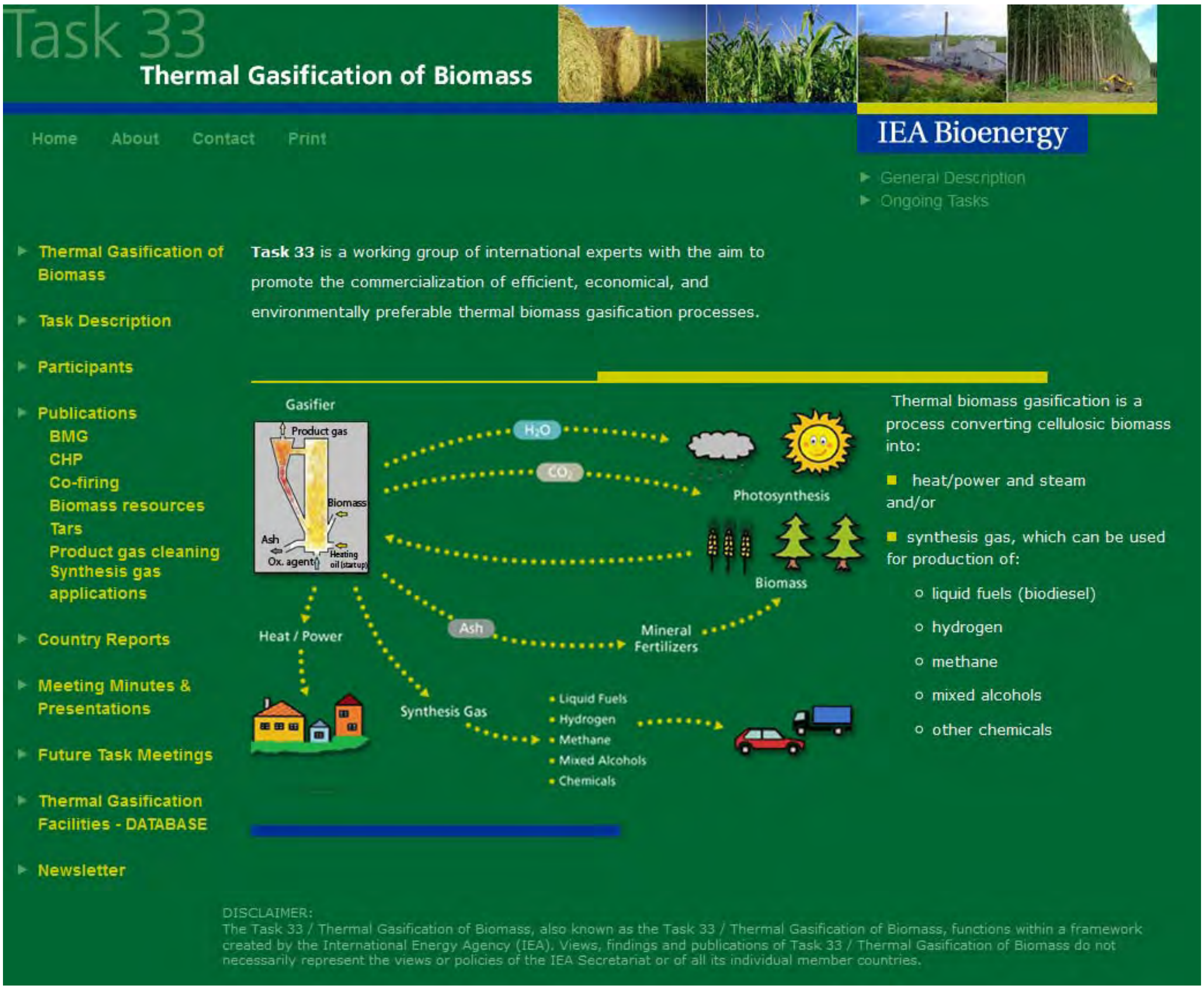
With a total installed electrical capacity of 400 megawatts and an output of 40 gigawatt-hours of electricity and 500 gigawatt-hours of heat, the Spittelau waste incineration plant is the second largest facility in Austria's district heating network. It supplies more than 318,000 homes and 6,200 business customers with heat and hot water. Today the subsidiary of Wien Energie ranks among Europe's largest district heating utilities thanks to a pipeline network of 1,153 kilometers.

Figure: Incineration plant in Vienna by F. Hundertwasser

The plant built near the Danube Canal in Vienna's ninth district in 1971 had for a long time been referred to in common parlance as a "heavy polluter". To supply the New General Hospital (Europe's largest hospital) with energy, the waste treatment facility was built in this central location, which is only about two kilometres from the hospital. After a fire in 1987, then Mayor Helmut Zilk advocated the reconstruction and technological modernization of the plant. We owe it to his perseverance that the painter Friedensreich Hundertwasser turned the sober purpose-built facility into a unique piece of art. The Austrian artist and nature lover agreed to create the design of the façade and the chimney only after the City of Vienna pledged to equip the district heating plant with state-of-the-art emissions treatment technology. The successful and exemplary synthesis of technology, ecology and art even became a tourist attraction.

TASK WEBSITE

The new version of the Task 33 webpage was activated already in July 2011 (www.ieatask33.org). The aim was to create a new, clear and informative webpage on thermal gasification of biomass, not just for task members, but also for all specialists in the gasification area, stakeholders and involved public.



The homepage is composed of a schematic figure in the middle, where is the whole chain of the thermal biomass conversion process presented.

On the left side there are nine sections there:

- **Thermal Gasification of Biomass**
  - Describes the process of thermal biomass gasification, main gasification reactions and products, their utilization and synthesis gas applications
- **Task Description**
  - In this section the objectives of the Task 33 are presented, work scope, approach and industrial involvement
- **Participants**
  - The contact information about the Task 33 participants can be found in this section

- **Publications**
  - The most important publications about biomass gasification, combined heat and power production, co-firing, biomass resources, tars, product gas cleaning and synthesis gas applications can be found here
- **Country reports**
  - Each Task member country provides actual information on biomass gasification status in the country. This summary is published such as Country report at the website
- **Meeting Minutes & Presentations**
  - All Task 33 meetings are summarized in Meeting minutes and workshops in Workshop reports, which can be found in this section as well as all the presentations from Task meetings, workshops and eventually site visits
- **Future Task Meetings**
  - Actual information about next Task meetings and workshop topics are presented here
- **Thermal Gasification Facilities – DATABASE**
  - A new database with the biomass gasification facilities worldwide, based on Google maps, was created as a part of the IEA Bioenergy Task 33 webpage. This database is updated regularly and at the moment 120 gasification facilities are registered here
- **Newsletter**
  - Actual information about Task 33 activities are described in Newsletter, such as the highlights from biomass gasification research and developments

Thermal gasification facilities – DATABASE

A new interactive online database with the biomass gasification facilities worldwide, based on Google maps, was created as a part of the IEA Bioenergy Task 33 webpage.

The database is compatible with the database of IEA Bioenergy Task 39 (Liquid Biofuels) and it is planned in the future to join these databases into one.

At the moment there are 120 gasification facilities registered in the database (a list of all registered facilities can be found in attachment of this newsletter) and they can be further sorted based on technology of the process, type of gasifier and status of the facility.

Based on **technology** the facilities can be divided into:

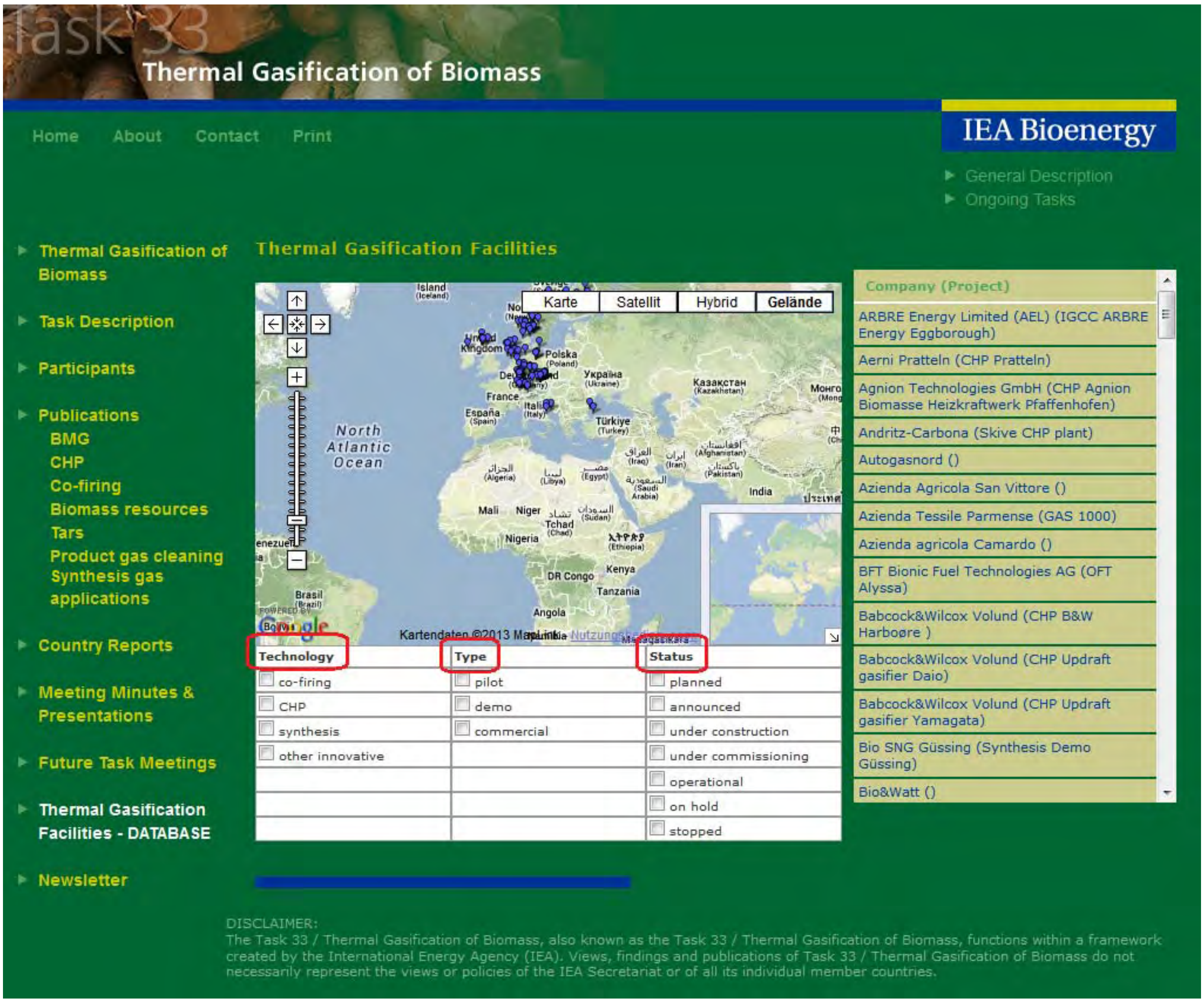
- Co-firing
- CHP
- Synthesis
- Other innovative (technology)

Based on **type**:

- Pilot
- Demo
- Commercial

Based on **status**:

- Planned
- Announced
- Under construction
- Under commissioning
- Operational
- On hold
- Stopped

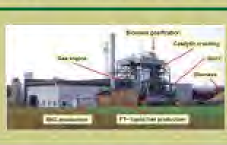
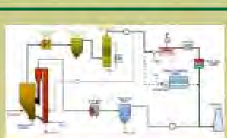


Which information can be found in the database?

The database provides very useful information about each gasification facility. There can be found data regarding the exact location, used technology and raw material, output, facility type, partners of the project, investment, status, start up, description of the process (technology brief), website of the company, related publication etc. in the database.

If there is some further data needed regarding the facility, there is information about a contact person responsible for the operation of the facility, which is able to provide the necessary data.

As an example FICFB gasifier in Güssing was chosen:

Data sheet:	
Coordinating Organisation/Company	FICFB Güssing
Project Name	FICFB Güssing
Location	Güssing, 7540, Austria
Technology	CHP conversion
Raw Material	lignocellulosics; wood chips
Input	3 t/h
Product	heat; power;
Output	4.5 MWth; 2.0 MWel
Facility Type	commercial
Partners	Austrian Energy
Status	operational
Start-Up	2002
Technology Brief	In Guessing a Biomass CHP with the concept of the FICFB gasification system was realised. The basic idea of the FICFB concept is to divide the fluidised bed into two zones, a gasification zone and a combustion zone. Between these two zones a circulation loop of bed material is created but the gases should remain separated. The circulating bed material acts as heat carrier from the combustion to the gasification zone. The fuel is fed into the gasification zone and gasified with steam. The gas produced in this zone is therefore nearly free of nitrogen. The bed material, together with some charcoal, circulates to the combustion zone. This zone is fluidised with air and the charcoal is burned. The exothermic reaction in the combustion zone provides the energy for the endothermic gasification with steam. Therefore the bed material at the exit of the combustion zone has a higher temperature than at the entrance. The flue gas will be removed without coming in contact with the product gas. With this concept it is possible to get a high-grade product gas without use of pure oxygen. This process can be realized with two fluidized beds connected with transport lines or with an internally circulating fluidized bed.
Contact Person	Ing. Reinhard Koch ; r.koch@eee-info.net
Picture	
Flow sheet	

The database is updated regularly and provides an actual overview about the gasification facilities worldwide.

OUTLOOK

For the Triennium 2013-15 there are 6 Task 33 meetings and workshops planned.

Workshop topics for the next Triennium (2013-2015) will be chosen from these:

1. Bed materials in fluidised bed gasification (update of Workshop 2012)
2. Product gas cleaning and usage
3. Tar formation, analysis and removal
4. Small scale fixed bed gasification
5. Analysis & measurements (trace components)
6. Sustainability
7. Fuel pre-treatment, demands of gasifiers on fuel quality
8. Drop in fuels

Further, the Task 33 website and BMG database will be updated regularly.

Task members will provide their Country report update summarising the status of biomass gasification in their country together with detailed information on projects for inclusion into the BMG database.

There are also planned joint studies and special projects together with Task 34 (Techno-economic study) and Task 39 (Database of BMG facilities).

Attachment

Gasification facilities registered in the database Task 33 (status July 2013)

1. ARBRE Energy Limited (AEL) (IGCC ARBRE Energy Eggborough)
2. Aerni Pratteln (CHP Pratteln)
3. Agnion Technologies GmbH (CHP Agnion Biomasse Heizkraftwerk Pfaffenhofen)
4. Andritz-Carbona (Skive CHP plant)
5. Autogasnord ()
6. Azienda Agricola San Vittore ()
7. Azienda Tessile Parmense (GAS 1000)
8. Azienda agricola Camardo ()
9. BFT Bionic Fuel Technologies AG (OFT Alyssa)
10. Babcock&Wilcox Volund (CHP B&W Harboøre)
11. Babcock&Wilcox Volund (CHP Updraft gasifier Daio)
12. Babcock&Wilcox Volund (CHP Updraft gasifier Yamagata)
13. Bio SNG Güssing (Synthesis Demo Güssing)
14. Bio&Watt ()
15. BioMCN (BioMCN Farmsum)
16. Biomass Engineering Ltd. (CHP Biomass Engineering Culcheth)
17. Biomass Engineering Ltd. (CHP Biomass Engineering Cumbria)
18. Biomass Engineering Ltd. (CHP Biomass Engineering Preston)
19. Biomass Engineering Ltd. (CHP Mossborough Biomass Engineering)
20. Biowärme Eberndorf (CHP Urbas Eberndorf)
21. CHOREN Fuel Freiberg GmbH & Co. KG (Synthesis CHOREN beta plant Freiberg)
22. CHOREN Industries GmbH (Synthesis CHOREN alpha plant Freiberg)
23. CHOREN Industries GmbH (Synthesis CHOREN sigma plant Schwedt)
24. Centro Cisa (Castel D´Aiano)
25. Chalmers Technical University (Centre for Indirect Gasification of Biomass)
26. Chemrec AB (Synthesis Chemrec Domsjoe)
27. Chemrec AB (Synthesis BioDME Pitea)
28. Ciamber ()
29. Cleanstgas GmbH (Demo-Cleanstgas 150/1)
30. ClearFuels Technology, Inc. (High Efficiency Hydrothermal Reformer (HEHTR) ClearFuels Collinwood,Tennessee)
31. Comune Quingentole ()
32. Cortus (WoodRoll Demonstration)
33. Coskata (Coskata Clewiston)
34. Coskata (Coskata Pilot Warrenville)
35. Coskata (Coskata Project Lighthouse Madison)
36. Cutec (Synthesis Cutec Clausthal-Zellerfeld)
37. Duchi Fratelli Societa Agricola/Agroenergia ()

38. E.ON Gasification Development AB (Bio2G)
39. ECN (Synthesis HVC Alkmaar)
40. ECN (Synthesis MILENA gasification Petten)
41. EMPA Duebendorf (CHP Dübendorf)
42. EP Engineering ApS (Helufsholm CCG - phase A)
43. ETC (MEVA VIPP Pilot, PEGB Pilot)
44. Enerkem (Synthesis Demonstration Plant, Westbury)
45. Enerkem (Synthesis Enerkem Alberta)
46. Enerkem (Synthesis Enerkem Sherbrooke)
47. Enerkem Corporation (Synthesis Enerkem Pontotoc)
48. Essent (CFB Geertruidenberg)
49. FICFB Güssing (FICFB Güssing)
50. FICFB Oberwart (FICFB Oberwart)
51. Fernwärme Neumarkt Biowärme – Öko Strom Ges.m.b.H. & Co.KG (CHP Urbas Neumarkt)
52. Flambeau River Biofuels Inc. (Project Trixie synthesis Park Falls)
53. Foster Wheeler Energia Oy (Synthesis Varkaus gasification)
54. Friedrich Wahl GmbH & Co. KG (CHP Urbas Sulzbach-Laufen)
55. Fulcrum BioEnergy's Sierra Biofuels Plant (Synthesis Fulcrum BioEnergy City of McCarran)
56. GTI Gas Technology Institute (GTI gasifier Des Plaines)
57. Græsted Fjernvarme (CHP BioSynergi pilot plant)
58. Guascor Italia (Rossano Calabro (CS))
59. Göteborg Energi (GoBiGas)
60. H2Herten GmbH (Blue Tower Technology Herten)
61. HEH Holzenergie (CHP Pfalzfeld)
62. HS Energieanlagen GmbH (CHP Heatpipie Reformer Neufahrn bei Freising)
63. Hilleroed Bioforgasning P/S (BioSynergi CHP demonstration plant)
64. HoSt (CFB Tzum)
65. Holzstrom GmbH (CHP Urbas Neukirchen)
66. Holzstrom aus Nidwalden (CHP Pyroforce Nidwalden)
67. ICM, Inc., Colwich, Kansas,USA (Cofiring ICM Inc. Auger Gasification Technology Newton)
68. ICQ/SIAG/ERBA ()
69. INEOS New Planet BioEnergy (Synthesis INEOS Plant Vero Beach)
70. InEnTec, LLC (Integrated Environmental Technologies, LLC) (Cofiring InEnTec® Plasma Enhanced Melter® (PEM) Reno, Nevada)
71. Iowa State University (BioCentury Research Farm)
72. Karlsruhe Institute of Technology (KIT) (Synthesis bioliq - process Karlsruhe)
73. Klagenfurt (FICFB Klagenfurt)
74. Kokemäki (CHP Condens Oy Kokemäki)
75. Kungliga Tekniska Högskolan (Royal Institute of Technology) (Centre for Direct Gasification of Biomass)
76. Lahti Energia Oy (Cofiring Foster Wheeler Lahti)
77. MEVA Innovation (VIPP Demonstration)

78. NSE Biofuels Oy, a Neste Oil and Stora Enso JV (Synthesis NSE Biofuels Oy)
79. NUON/Vattenfall (Wood co-gasification in IGCC)
80. Newpage Corp., formerly Stora Enso (Project Independence)
81. Organic Fuel Technology A/S (OFT Randers)
82. PoliTO (Wood Gasifier)
83. Pyroneer - DONG Energy Power A/S (Pyroneer Demonstration Plant)
84. Range Fuels, Inc. (K2A Optimization Plant)
85. Range Fuels, Inc. (Synthesis Range Fuels Soperton)
86. Research Triangle Institute (Synfuel Research Triangle North Carolina)
87. Rottneros AB (Rottneros Biorefinery)
88. Rottneros AB (Vallvik Biorefinery)
89. SAKAB AB (Bioraffinanderi Norrtorp)
90. STADTWERKE KONSTANZ GmbH (CHP Urbas Konstanz)
91. Southern Research Institute (Synthesis thermochemical Durham)
92. Southern Research Institute (technology development laboratory - hybrid)
93. Stadtwerke Duesseldorf (CHP Arnsberg-Wildhausen)
94. Stadtwerke Ulm/Neu-Ulm (CHP Stadtwerke Ulm/Neu-Ulm)
95. Steiner A. & Cie AG ()
96. Stirling DK (Barrit)
97. Stirling DK (Carlow)
98. Stirling DK (DTU)
99. Stirling DK (Flensburg)
100. SynGest Inc. (SynGest Menlo BioAmmonia)
101. Synthesis Scanarc Plasma Technologies AB (Scanarc/Pyroarc (plasma) process Hofors)
102. Södra Cell Värö Pulp Mill (CFB Metso Värö)
103. Tembec Chemical Group (Synthesis Tembec Chemical Quebec)
104. TÜBİTAK MRC - ENERGY INSTITUTE - TURKEY (Synthesis TRIGEN Gebze)
105. TÜBİTAK MRC - ENERGY INSTITUTE - TURKEY (Synthesis TÜBİTAK MRC Kocaeli)
106. University of Toledo (Synthesis Thermo Technologies Toledo)
107. Updraft gasifier, Waiariki (Windsor Engineering Group)
108. VVBGC AB (Växjö Värnamo Biomass Gasification Center)
109. Vienna University of Technology / BIOENERGY 2020+ (FT pilot Guessing)
110. Villach (FICFB Villach)
111. VärmlandsMetanol AB (Värmlandsmetanol Hag fors)
112. Waermeversorgung Grossenhain /POW AG (CHP Großenhain)
113. Weiss (500 kWe twostage gasifier in Hillerød)
114. West Biofuels (LLC Thermal Reformer Synthesis West BiofuelsWoodland , CA)
115. Woodpower in Wila (CHP Wila)
116. ZeaChem (ZeaChem Pilot Boardman)
117. co-Ver Energy Holding (Lake Maggiore Tecnoparco)
118. l'Azienda Tenca dei Fratelli Zanotti/AB energy (Orzinuovi)
119. urbas Energietechnik (CHP Demonstrationsanlagen URBAS)

120. urbas Energietechnik (CHP Demonstrationsaussenanlagen URBAS)