

DRAFT MINUTES
IEA Bioenergy Agreement
Task 33: Thermal Gasification of Biomass
Fall 2006, Task Meeting, October 30 to November 2, 2006
Chicago, IL and Golden, CO
Prepared by
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The sixth and final Task Meeting for the 2004 to 2006 triennium was held from October 30 to November 2, 2007 in Chicago and Golden, CO, USA. The **Agenda** for the Task Meeting is shown in Attachment 1 and the list of **Task Meeting attendees**, including invited speakers and observers, for the one day workshop on, October 31, 2006 on “Biomass Gasification: Success Stories and Lessons Learned” is shown in Attachment 2. The **Task Member Unable to Attend**: Emanuelle Scoditti, Italy

On November 1, the Task Members visited the GTI FlexFuel Test Facility in Des Plaines, IL and on November 2, the team visited the National Biomass Energy Research Center, at the National Renewable Energy Research Laboratory in Golden, CO.

The **Agenda** (Attachment 1) was reviewed and approved as proposed. The **minutes from the Spring 2006 Task Meeting** in Dresden, Germany were also approved with minor changes

Country Report Updates: The detailed reports updating those posted on the Task website in 2004 have been received from FI, CH, NZ, IT, AT, NL and UK.

Monday, October 30, 2006 – COUNTRY REPORTS

Germany: The Agricultural ministry has entered into a partnership with Daimler-Chrysler to pursue the introduction of biofuels in Germany. For the short term, oil is expelled from rapeseed and processed further to produce biooil, which could be readily substitute for fossil fuels. Besides biooil, Germany’s goal is to introduce about 700,000 TPY of bioethanol during 2007. Tax incentives are necessary to offset the high cost of ethanol. In the overall scheme, Germany will use wheat to produce ethanol and the residues from biooil (i.e., residual cake and glycerin) and bioethanol production will be converted either a fuel gas or synthesis gas by thermal gasification. In general, the German focus is on producing synthesis gas, its conversion to biofuels or methanol. Methanol could be used as a fuel, H₂ carrier, or for producing chemicals. Since mid 2006, the German oil companies have been seriously pursuing the production of biooils and biofuels. Germany’s target is to ultimately produce 15 to 20% of its liquid fuels from biomass, which could be blended with gasoline in the 10-15% by volume range. Discussions are now in progress to develop the next generation of IC engines to efficiently handle the fuel blends.

For commercial production of biofuels, several scenarios are under consideration including integration of distributed biofuel intermediates, collected from 50 KM radius,

with existing refineries as central fuel processing plants. Sustec SVZ and CHOREN lead the major biofuels programs in Germany. These organizations are conducting demonstration projects in Schwarze Pumpe and Freiberg, respectively. In support of these efforts ITC is building a pyrolysis pilot plant in Karlsruhe and discussing partnership with Lurgi to adopt its twin-screw pyrolyzer. This will be ultimately scaled-up to a 20 TPH demonstration plant. Siemens is discussing partnership with Sustec to participate in the commercialization of the biofuels employing the GSP gasifier to produce synthesis gas, methanol, DME, and F-T liquids. Any surplus glycerin will be mixed with char as a slurry feed to the gasifier. Germany considers bioethanol as an interim solution to produce alternatives to fossil fuels. In the long run, synthesis gas derived fuels and chemicals should help meet Germany's RE targets.

It is estimated that in the overall biomass conversion process, about 6 to 7% of the total energy will be consumed to sustain the pyrolysis process step.

Switzerland: The next update will be provided at the Spring 2007 Task Meeting.

European Commission: The next update will be provided at the Spring 2007 Task Meeting.

Denmark: The next update will be provided at the Spring 2007 Task Meeting.

SWEDEN: Sweden's RE quota targets are 7% of total primary energy consumed in 2003, 17% in 2010 with a goal to produce 10 TWh by the same year. Tax exemptions for RE transport fuels are now valid until 2008, while the RE certificate trading, which started in 2003, is extended until 2030.

To further support RE, the government has imposed a 30% increase on natural gas taxes and an increase of SEK65 /tonne on landfill taxes. Taxes on CO₂ from fossil fuels and nuclear power are continued along with phase out of the latter by about 2010.

The newly formed coalition government led by the Conservative Party, which includes the Liberal, Center and Christian Democratic Parties, is not proposing any major policy changes with regard to energy. The energy RD&D budget for 2006 – 2008 is about ~90 million €/year, with provision to support biomass RD&D programmes through process demonstration phase. The government policies and programs also show support for RE with an emerging interest in biogas and green SNG (as an energy carrier and for transportation applications), and a revival of interest in BIG-GT technologies. Along with these, the projected policy impacts on markets, there are several concerns about the fate of biofuels after 2008, biomass availability and productivity, and market acceptance of second generation biofuels.

The major R&TD effort is led by the CHRISGAS, or Clean Hydrogen-rich Synthesis Gas Project. The objectives and deliverables include production of hydrogen-rich gas from biomass fuels at the scale of 3500 Nm³/hr H₂ equivalent, within 3-4 years. The pressurized CHEMREC black liquor gasification pilot plant tests are in progress at Piteå.

NEW ZEALAND: The national mission is to increase RE consumption by 30 PJ, concurrently with a 20% improvement in economy-wide energy efficiency by 2012. The Kyoto Protocol signed with expected gain from carbon credits, is now expecting a large loss (approx. \$NZ 1 billion) and the carbon tax scheduled for 2007 (\$NZ 15/tonne) has been scrapped.

The leading BMG developer, Fluidyne Gasification (www.fluidynenz.250x.com), has entered into collaboration with a California forester to investigate the appropriate wood species for energy supply. The company has supplied and commissioned a 40-50 kWe Pacific Class downdraft gasifier in 2006. AB Powerhearth Ltd (www.3ialternativepower.com) is pursuing technology commercialization in USA. Alternative Energy Solutions (AES) is pursuing the commercialization of the Indian, Ankur Scientific Technologies downdraft gasifier. The 2 MWth capacity Page Macrae, updraft gasifier, is supplying gas to a boiler providing steam for a plywood manufacturing plant.

The University of Canterbury FICFB test gasifier has been commissioned and efforts are underway to provide more stable operation along with detailed characterization of gasification products. In the near future, research focus will be shifted to gas cleaning for engine operation, and system modeling.

UNITED KINGDOM: Current power production from biofuels is at about 5%, which could be raised to 10% by 2010, and 15% by 2015. The national aspirations are to produce 20% of electricity from renewables by 2020, to cut carbon dioxide emissions by 60% by 2050, and to introduce 5% bio-transport fuels by 2010. In support of these goals, One of the near term task is to produce nearly a million TPY of biooil and about ¼ million TPY of bioethanol. Given the past setback with the ARBRE biomass gasification project in UK and the present opposition to FERCO Silvagas project, importance is given to biomass based CHP projects. Most of the new bioenergy capacity build-up is with co-firing projects that do not require much capital investment. In April 2007, £8 million will be awarded to new CHP projects.

One of UK's challenges is the disposal or utilization of nearly 50 MMTPY of waste materials which are forbidden from landfills. It is anticipated that the landfill directive issue, could be addressed to some extent by offering the 10.3 Eurocents/kWh Renewable Obligation for power produced from wastes.

A major review of UK energy policy is now underway and it should not disadvantage biomass. As in the past, the major market driver is the renewables obligation of approximately €10.8 cent/kWh. This has helped installation of small CHP systems with modernised downdraft biomass gasifiers.

The current R & D is focussed on UK strengths in gas turbines and small CHP. All UK reports on biomass energy conversion are listed at: <http://www.dti.gov.uk/publications/>

Click on “Browse” then on [Energy - New and Renewable: biomass](#), and also the UK Country Report on Task 33 Web site.

USA: Recently, there has been a significant increase in non-USDOE EERE biomass projects. The highlights of the latest USA developments are listed below:

1. There is increasing interest in the developments at Biomass Resources Inc., (BRI) which has been developing fermentation of synthesis gas to ethanol. USDOE EERE reports that high rates of conversion and yields have been obtained with a biological conversion scheme.
2. Biomass Gas and Electricity, BG&E ((FERCO spin-off) has finalized and signed a 35 MWe power purchase agreement with City of Tallahassee, Florida. The 30-year contract for electricity sales is planned to start-up in 2010.
3. There is now a move by ethanol producers to use biomass gasifiers for CHP in corn ethanol facilities. Chippewa Valley Ethanol Company, with a capacity of 45 million gal/yr, has entered into an agreement with Frontline Bioenergy to support the installation of a prototype gasifier at the CVEC Benson, MN ethanol plant. The objective of this agreement is to replace all of the plant’s natural gas usage, thus saving \$20 million in fuel costs.
4. Primenergy has built a 280 TPD wood fired CHP plant at Central Minnesota Ethanol Cooperative, to produce 50,000 lb/hr steam and 35 MMBtu/hr thermal energy.
5. Tolko Industries and Nexterra, of Kamloops, British Columbia, Canada, is planning to build a 13,000 dry TPY updraft wood gasifier to produce fuel gas that can replace 250,000 GJ/yr of natural gas. Plant operations were expected to start in September 2006.
6. Kergy has acquired a CCT two-stage gasifier technology, which may be used for biomass gasification. An operating pilot plant is located in Broomfield, CO.
7. Pearson of Aberdeen, AL is structuring financing for mesquite to ethanol project in TX
8. Clear Fuels is also structuring financing for a Pearson ethanol project on Kauai, Hawaii
9. ORMAT is conducting tests with the beta version of a 4 kW gasifier for a close-loop organic Rankine cycle system.
10. USDOE in partnership with EC and Danish Energy Authority is participating in the demonstration of the CARBONA/GTI biomass gasification plant in Skyve, Denmark. The plant converts 110 TPD of wood pellets into 5.4 MWe and 11.5 MWth energy. As part of an EC supported project, tests were conducted with a proprietary tar cracking catalyst for over 3500 hours on a slipstream from a biomass gasifier. These results are used to design a high-temperature tar cracker installed in Skyve. Also, with EC support, tests were conducted on the Jenbacher gas engine to establish design of the fuel injection and turbocharger pressure ratios for the LCV biomass fuel gas. The projected efficiency of power generation is 30% (on LHV basis) with an overall thermal efficiency of 90%.

Austria: Austria derives 21-23% of its energy from renewable resources while biomass contributed roughly 12% (or 168 PJ or 0.16 Quads) of the primary energy demand. The national mission is to increase the production of electric power from renewables (hydro power not included) to 4 % and to have a share of 5.75% of renewable fuels in the transport sector by the year 2008.

The 8 MW_{th}, TUV FICFB CHP BMG plant in Güssing is in commercial operation. Several slipstreams studies are in progress to evaluate alternative uses for the synthesis product gas. The 2 MW_{th}, down draft fixed bed biomass gasifier at Wr. Neustadt is also in operation for local CHP applications. The Graz University of Technology, Institute of Thermal Engineering is continuing with the evaluation and optimisation of a fixed bed gasifier, gas cleaning system and gas engine, R&D of a two-staged gasification system in partnership with Austrian Bioenergy Centre, and also investigating the health, safety and environmental issues of biomass gasification systems. The Graz University of Technology, Institute for Apparatus Design, Particle Technology and Combustion Technology is conducting research on combustion of biomass fixed bed gasification, and fundamental research on fate of biomass particles during thermal conversion. Joanneum Research Graz, Department of Energy Research is continuing to work on the VIEWLS project for evaluation of biofuels. The Vienna University of Technology, Institute of Chemical Engineering is busy with several projects including the following activities:

- As a scientific Partner in RENET Austria (Network of Competence for Energy from Biomass)
- As a scientific Partner with Austrian Bioenergy Centre in the development of a pressurized biomass gasifier and to evaluate integration of biomass gasification with SOFC at the Guissing plant
- EZ-P4 (Polygeneration)
- EC-Project Renewable Fuels for Advanced Power Trains (RENEW)
- EC-Project BigPower
- EC-Project AER-Gas II
- EC-Project BioSNG

FINLAND: The 35 MW_{th} limekiln gasifier in Pietarsaari was shut down after 20 years of reliable operation. The plant was shut down because of certain plant modifications and system integration issues.

The construction of the he NOVEL gasifier at Kokemäki was completed in April 2005, following plant commissioning one of the 600 kWe Jenbacher gas engines went into operation in November 2005. The 7 MW_{th}, integrated updraft NOVEL gasifier, gas engine, and boiler are now operating as a system at Kokemäki. As the gasifier availability is progressively increased, two more Jenbacher gas engines will be brought on stream in 2008. At about the same time tests will begin on RDF and agro-fuels. The project is now in search of support for system optimization. In the absence of a gas storage facility, hot-water storage tanks will be used to meet the district heating needs. The Ni and ZrO₂ tar decomposition catalysts are working well and the product fuel gas meets the Jenbacher engine specifications.

The Kokemäki plant schedules and milestones are summarized below -

- Construction work: completed in April 2005
- Gasifier and the gas boiler started operation in 2005
- Start-up with one JMS 316 engine (600 kW) in November 2005
- Integrated gasifier operation with one engine demonstrated in June 2006

- Improvement of reliability and process optimisation scheduled for 09/06 to 12/07. This involves, improvement of automation and engine control, tests with different fuels, and optimisation of gas cleaning
- The 2nd and 3rd gas engines will be installed during 2008
- Slip stream testing of 2nd generation catalytic gas clean-up and scrubbing water recycling which started in Oct. 2005 will last until Sept. 2008
- Testing with waste-derived fuels and agro-biofuels will be scheduled in conjunction with other sponsored projects

The 60 MW_{th} CFB gasifier in Lahti has been in successful operation since 1998 and the 40 MW_{th} plastic waste CFB gasifier has been operating for the last 5 years (since 2001). The 160 MW_{th} CFB gasification system scale-up at Martinlaakso is in progress for co-firing applications. The scale-up project faced several non-technical hurdles although the technology was ready for industrial demonstration in 2002 – 03. Even though, Finnish authorities issued environmental permits within 6 - 12 months, complaints by environmental groups and organizations have delayed the projects by 2 - 3 years. All disputes are now resolved.

Other Finnish BMG activities include tests with the small-scale Puhdas Energia downdraft gasifier and the development of fluidised-bed gasifiers for boilers and kilns, under the EC TREN-IP project.

Other notable VTT R&D activities include, the development of the UltraClean Gas project (2004-07) and the development of a 500 kW-pressurised gasifier with catalytic reforming capabilities, which was started in November 2006.

NETHERLANDS: In 2006, fiscal incentives were introduced to promote up to 2% biofuels for vehicular applications. The goal is to build this up to 5.75% in 2010. In support of this mission, 60 million € funds will be provided until 2010 to promote innovation in second generation biofuels.

On August 18, 2006, the kWh feed-in tariffs for new projects set to zero. It is anticipated that the 9% goal for green electricity will be reached with existing projects by 2010.

A status report on major BMG projects are given below:

1. The 85 MW_{th} Essent CFB gasifier is operating with demolition wood, After gas cooling, dust removal with a cyclone, the product fuel gas is co-fired in the 600 MW_e coal-fired boiler at the Amer-9 power station, Geertruidenberg, NL. As per the EU legislation adopted by NL in Dec. 2005, the Amer-9 power station is considered a waste incineration plant with corresponding emission limits.
2. Since 2002, the 250 Mwe NUON POWER plant in Buggenum has been conducting biomass co-gasification tests. In March 2006, the biomass/waste handling system has been inaugurated to conduct co-gasification tests with up to 30-wt% of biomass/wastes. Investment decision will be made in mid-2007 to build the next generation NUON POWER plant project, called MAGNUM, with a capacity of 1200 MW_e. The fuel flexible plant will cost about ~1 billion € and it

- may use up to 50% biomass for co-gasification. The plant will be designed for CO₂ capture, and when approved in 2007, it should be ready for operation in 2011. The plant will be located at Eems-harbour (North-East), next to the 2400 MW_e NG-CC power plant.
3. The 3 MW_{th}, HOST CFB gasifier, cooler, cyclone, boiler, and steam turbine at HOST chicken manure gasification is now in being commissioned. The gasifier/boiler has operated successfully with dry manure. The emissions include 100-150 ppm NO_x (at 3% O₂) without any CO. Three options are considered for ash disposal, namely as a compost additive, as a construction material, and as a fertilizer. When fully operational in 2008, the plant is expected to run for 7000 hours/yr.
 4. The 3.5 MW_{th}, demolition wood (~ 1 cm), Polow gasifier based Torbed technology (see www.torftech.com) plant is being commissioned. The product fuel gas will be used for a variety of heating applications.
 5. The new owner, MCN (Methanol Chemistry Netherlands) METHANOR will produce 900 kton/y methanol from natural gas (in two parallel lines). The plant will blend glycerine from biodiesel production into the natural gas reformer. Plant start-up is scheduled for November 2006.
 6. The JRC (JOINT RESEARCH CENTRE) institute for energy supports EU policy development and legislation. It also supports international organisations (such as IEA Task 36 on waste, Task 37 on biogas/landfill gas, and others).

Other research in BMG is focused on fuel gas cleaning by Technical Univ. Eindhoven (with in-bed measures), pyrolysis of biomass, cold models for internal circulation fluidised beds (ECN), SNG by steam-oxygen gasification (ECN), indirect gasification with OLGA tar removal (ECN), construction of an 800 kW_{th} MILENA indirect gasifier for SNG.

ECN has also conducted a successful 700 hours test demonstrating the OLGA process in Jan/March 2006, at 0.5 MW_{th} scale. The first commercial OLGA plant, at 4 MW_{th} has been commissioned in August 2006, by ENERIA, France. Other ECN activities include torrefaction, with focus on high-energy efficiency, integration with gas combustion/heat generation, and pellet production. A 100 kg/h pilot plant called TOP should be available to test torrefaction during mid-2007. In developing SOFC for BMG systems, ECN has observed that C₂H₂/C₂H₄ and C₇H₈ contained in raw gases are readily converted in fuel cells. However, higher carbons (≥C₁₀) inhibit CH₄ reforming.

Other university research projects and those at BTG are listed below:

Eindhoven: plasma/corona, in-bed tar reduction, partial oxidation, cooler fouling

Twente: self gasification, steam/iron process with bio-oil, super critical water gasification (with BTG)

Delft: CFB-gasification (oxygen/steam), high-temperature filter (ceramic)

BTG: Supercritical water gasification is now “gasification in hot compressed water”

BTG: Gasification of pyrolysis products (no ash in oil is an advantage)

Italy: Not available.

Future Meetings: The first Task Meeting for the next triennium will include a workshop on “Situation Analysis and Role of BMG Technologies in Future Energy Needs.” The originally scheduled meeting from March 26-28, 2007 in London, UK has been moved to March 19-21, 2007 in Brussels. Dates, locations, and WS topics for subsequent task meetings will be deliberated at the Brussels Task Meeting.

END