

IEA Bioenergy Agreement: 2007-2009

Task 33: Thermal Gasification of Biomass

First Semi-annual Task Meeting, 2009

Karlsruhe, Germany

Wed. 13 to Fri. 15 May 2009

Day 1, Wednesday, 13 May 2009

The list of attendees, for the Task Meeting 13 to 15 May, 2009 include: Lars Waldheim, TPS, SE, Thomas Kolb, FZK, Germany, Reinhard Rauch, TUV, Vienna, AT, Bram van der Drift, ECN, NL, Giuseppe Fiorenza, ENEA, IT, Henrik Christiansen, DEA, DK, Ilkka Hannula, and Esa Kurkela, VTT, FI, Shu-sheng Pang, UofC, NZ, Ruedi Buhler, U+E and Serge Biollaz, PSI, CH, Fernando Preto NRCAN, CA, Richard Bain, NREL, [Vann Bush \(for May 13 & 14\) and Suresh Babu, GTI, USA](#).

Others: Invited speakers for the 14 May WS: Raw Gas Clean-up, Gas Conditioning, and Synthesis Gas Conversion, include **Esa Kurkela, VTT, Ekkehard Schwab, BASF SE, John Bøgild Hansen, Haldor Topsøe, Olaf Schulze, CHOREN, Olaf von Morstein, Uhde, Rikard Gebart, ETC, Georg Schaub, EBI-gek, Univ Karlsruhe, Ulrich Arnold, ITC-CPV, FZK, and Hans Liebold, FZK - ITC-TAB, FZK**

Observers: Lee Bannon & Steve Spence, IBT Bio, UK & USA

Regrets for inability to attend were received from: Philippe Schild, EC, BE and Mehri Sanati, LTH, SE

The **Agenda** was reviewed and approved. The final Agenda is shown in Attachment 1.

The **minutes from the second semi-annual Task Meeting of 2008** held from October 15-17, 2008 in Montreal, Canada were approved and posted on the Task 33 website.

Review of Task Deliverables for 2007-2009:

WS 2: Report on Procedures/Guidelines for **Synthesis Gas Characterization** is available on the Task 33 website. Further work on development of a Guideline will be explored in discussions between NREL, TUV, PSI, ECN, VTT, and GTI. Follow-up on resources and commitments will be explored by the Task during the 2010-2012 triennium.

WS 3: **HSE progress report:** With lead from M/S Ruedi Buhler U+E, CH & Harry Knoef, BTG, NL the interim guideline, posted at www.gasification-guide.eu will be the working document until resources from IEA Task 33 and the European partners become available to incorporate any additional feedback that may become available from industrial partners.

WS:4 A Case for Biomass Gasification : Under preparation

WS:5 Biomass Derived Raw Gas Clean-up, Gas Conditioning, and Synthesis Gas Conversion:
Under preparation

Country Updates on Biomass Gasification:

Richard Bain, NREL, USA: The USA national bioenergy situation and implementations are posted under Richard Bain's Country Update presentations on the Task website at www.ieatask33.org. The significant bioenergy (biomass gasification) technology demonstration projects include Abengoa (Taylor BMG technology), New Page (TRI gasification technology), Flambeau River Biofuels LLC (FTL), Carbona, Range Fuels (1st Stage Auger Pyrolysis reactor followed by steam reforming/gasification of devolatilized products and synthesis gas clean-up), NEXTERRA at University of South Carolina, PRIME Energy, GulfCoast Energy Inc EtOH project, Pearson technology in Mobile, AL, Coskata project (based on Prof. Gaddy's synthesis gas conversion to EtOH), and Emery Gasification project.

Other bioenergy projects that utilize BMG include Frontline Bioenergy LLC, Ames, Iowa (Bubbling FB, gasification with air/O₂/steam, 5 bar pressure, with HGCU+Tar Reforming). This project is proceeding with design of a 70 MWth (300 TPD) plant. TRI is building a new indirectly heated gasifier with pulsed combustion 4 TPD PDU, in Durham, NC. University of California, Davis has built a 5 TPD, Dual Fluidized bed, PYROX type gasifier type, with plans for technology demonstration in Japan. UPM and Andritz-Carbona /GTI are conducting advanced gas clean-up and synthesis R&D at GTI, in support of biodiesel production.

A DOW-NREL CRADA is investigating the development of Co-Mo modified FTL catalysts for producing mixed alcohols using synthesis gas. Another investigation worth tracking is the high-pressure total dissolution of biomass with Fe catalysts.

CPC Biomax Modular Bioenergy systems has now deployed 18 CHP type projects that includes walnut shell gasification plant in California.

USA's present mission is to increase the present 10 bn gal/yr EtOH to 40 bn gal/yr by 2020 with a target price of \$1.81 – 2.08 / gal.

Finland, Ilkka Hannula, VTT: VTT completed the EU sponsored BIGPower project ended in 2008. The final report is under review. The Ultra Cleangas fundamental studies for synthesis gas applications involving VTT, TKK, Abo Akademi (U of Tech) is financed (1.5 MM Euros for 2008-2010) by TEKES Biorefine. The participating industrial partners include Carbona, Foster Wheeler, METSO Power, Neste Oil, Stora Enso, & Vapo. Research scope includes pressurized steam-oxygen gasification, ash behavior, filter blinding, catalyst deactivation, tar reactions in catalytic and non-catalytic processes, system studies on BTL applications and hydrogen production, analytical methods for measuring tar and other contaminants, and participation in IEA BMG Task and Hydrogen Implementation Agreement.

METSO Power is offering high-efficiency boilers involving CFBG for waste or high-alkali and high chlorine biofuels. Waste gasification projects are under consideration for Malerenergie (200 MWth, waste) and for Lahti (160 MWth, waste). METSO is also searching for biorefinery projects. In this regard, METSO is initiating gas cleaning R&TD at Varo, Sodra Cell plant in Sweden. SEK 10 MM is supported by Swedish Energy.

Based on its past success with CFBG Foster Wheeler now offers boilers integrated with BMG in the range of 15-150 MW, preferably with dried fuels to achieve required boiler flame properties and certain emission requirements.

The Finnish biodiesel ventures are summarized below:

- a. Stora ENSO & Neste (50/50) JV to start demonstrating (in 2009) biocrude production at Stora Enso's Varkaus plant. A 12 MW CFBG unit will be operated with steam-oxygen gasification to test gas cleaning on 5 MW slip-stream while using the synthesis gas to fire a lime kiln.
- b. UPM Andritz-Carbona-GTI of USA team is developing BMG-IGCC & FTL processes incorporating high-temperature gas cleaning. Based on the current research UPM will decide in 2010 on building commercial plants in 3 locations, for 100,000 TPY of FTL and 250 MWth IGCC plants.
- c. VAPOIL is in early stages of project development to convert wood, peat, and Reed Canary grass (employing ultraclean gas) to liquid fuels.

In support research, VTT determined that isopropanol is a reasonably good substitute for dichloromethane for rapid on-line tar sampling and measurement.

New Zealand, Shu-sheng Pang, U of Canterbury (U of C): In 2008, the ruling National Party has removed the bio-oil obligation but introduced tax incentives. Emission trading scheme is promoted to reduce greenhouse gas emissions. Funding for bio-energy R&D was also increased. New Zealand's national policies are posted under Shu-sheng Pang's Country Update presentation on the Task website at www.ieatask33.org

In 2008, the 10-years old U of C bioenergy R&D has embarked on a 6 year BTL R&D program involving BMG, co-gasification of wood and coal, pyrolysis of biomass, synthesis gas conversion to liquid fuels, and related LCA studies. The FICFB BMG research unit is in active use for the last 2 years. Tests with olivine showed higher hydrogen yields and lighter tars compared to experiments with sand. Up to 42% H₂ was produced with 50% calcite and 50% olivine as bed material. Future studies will include co-gasification with sewage sludge. In addition to gasification, research is in progress with low-cost BM drying: packed moving bed dryer, rotary dryer, pneumatic dryer, FB dryer, supercritical steam drying w/condensation. Others conducting bioenergy R&D include CRL Energy, Crop (co-gasification of biomass with low-rank coal and fuel cell grade H₂) & Food Research Institute Ltd., Methanex Ltd., Solid Energy Ltd., and three forestry companies.

The commercial players include - Page McRae, with a 1.7 MWth UD BMG for thermal application in a plywood mill; Alternative Energy Solutions developed a high-temperature gas conditioning filter and marketing Ankur Gasifier from India for 30 kW to 5.5 MW for power generation; FLUIDYNE deploying small-scale DD gasifiers in Australia, Canada, Chile, & California, USA. FLUIDYNE is working with University of Ulster, No. Ireland for biomass gasification applications; and Windsor Engg. a new Co., is importing a 1-5 MWth range EU gasifier.

Switzerland, Ruedi Buhler, U+E: The status of industrial projects is summarized as follows:

Dasagren: One 450 kWe plant, with the Indian Institute of Science (IISc) gasifier, produced by Netpro in Bangalore, India was sold to Woodpower, Wila. Due to lack of demand for the technology, the company is now in silent insolvency.

Woodpower Wila: Commissioned the 450 KWe gasification system mentioned above. The system uses wood with 15% moisture, cyclone, quench, scrubbing, and one Jenbacher engine to produce power. Recent problems with fire in control panel & high-temperature ash/charcoal disposal units were attributed to inadequate engineering services provided by the licensed Indian manufacturer, Netpro.

Pyroforce: PYCON, is demonstrating in Guissing, AT two (350 kWe) cross-flow, 2-zone DD gasifier equipped with one gas cooler (to 150 C), bag-house filter employing pre-coating to absorb contaminants and reduce tar, a washing column all integrated with an Jenbacher engine. The plant has been shut down for several months and restarted after replacing the control system in 3/09, with a total of 1400 hrs of operation. In 2007, Pycon has commissioned in Stans, near Lucerne, CH a total of 8 gasifiers in to generate 1200 kWe employing 2 Jenbacher gas engines. In 2008, these gasifiers have produced 2100 MWh. Several operational problems were encountered due to changes in quality of demolition wood that led to redesigning the upper part of the gasifier and replacing the gas cooler and control system. PYCON provides performance guarantee for gasifier availability and efficiency.

Switzerland, Serge Biollaz, PSI: PSI's strategy for bioenergy is targeted to develop BMG coupled with synthesis gas conditioning and methanation to produce SNG (or RNG) at 25-70 bar and hydrothermal gasification of high moisture biomass wastes (including algae) to produce SNG. The former is being demonstrated at Guissing, AT, where 1/8th of the total product gas from the TUV/REPOTEC CHP plant is converted to SNG. In the latter program, 60% water slurries of manure (or 70% water slurry of waste wood such as saw dust) are subjected to catalytic hydrothermal conversion at 500 C and 35 MPa to produce SNG. In both instances CO₂ can be separated and recovered. At present hydrothermal gasification is conducted in a 1 kg/hour PDU (KONTI-2) at PSI. Furthermore PSI is also conducting R&TD to clean raw synthesis gas, rich in CH₄ from the TUV/REPOTEC indirect gasifier to remove contaminants such as tars, H₂S, COS, NH₃, HCN, K, Na, AS, Sb, P, Se, etc., to produce electricity in experimental SOFC modules. As a part of support research to explore biomass utilization, PSI has built a 1 kg/hour BFBG with

advanced on-line analytical instrumentation. Tests are now being conducted with pelletized wood and grass.

Italy, Giuseppe Fiorenza, ENEA, IT: The Italian national policies and measures to promote bioenergy are posted under Giuseppe Fiorenza's Country Update presentations on the Task website at www.ieatask33.org. The significant BMG activities are listed below:

Triscia Research Center – the gasification platforms include 30-80 kWe DD gasifiers, 150 kWth UD gasifier, and a 500 kWth dual fluidized bed gasifier. A 1.3 MWth novel FB unit is now under construction. The DD gasifiers are being tested with enriched air to improve improved efficiency. The UD gasifier is the same as the Genova gasifier developed by Ansaldo Energia. The 500 kWth dual fluidized bed pilot plant was developed in cooperation with TUV. It will be used to test hot gas clean-up methods and to test and evaluate MCFC stacks. A BFB gasifier with internal circulation of bed material was patented by ENEA/University of L'Aquila. A 1 MWth air-blown rice husk gasifier was designed, built, and tested at Trisaia before transporting and installation in China. The novel FBG unit will use steam-oxygen gasification and catalytic ceramic candles for raw gas conditioning. A 100 We SOFC will be tested on a gasifier slip stream.

The major industrial companies promoting BMG include Ansaldo Energia and the Marcegaglia group. Both companies previously developed UD biomass gasification for large scale applications. However, recently their interest is being shifted toward coal and RDF gasification. Some small players in BMG include Eco Engg, bio & watt, Socoges, and Caema Engg with 250 to 1500 kW Ankur gasifiers. So far, two or three of such gasifiers have been built in Italy.

Denmark, Henrik Christiansen, DEA: The Danish national policies and bioenergy drivers are posted under Henrik Christiansen's Country Update presentations on the Task website at www.ieatask33.org. Denmark's current policies provide a feed in tariff of 10 Eurocents/kWh for green electricity. DK has plans to use renewable energy for 100% of its primary energy needs. DK is preparing to host COP 15 in CPH in December 2009. The status of Danish demonstration programs are summarized below:

Skive demonstration with Carbona gasification technology encountered HEX problems in the district heating system where use of NH₃ for deflocculation has resulted in salt build-up at the high temperature end (250 to 750C). The plant has resolved issues with noise from flare in 2007 and noise from boiler in 2008. In, 2008, the plant was operated for about 2000 hours at half load with three Jenbacher engines (~ 2 MWe total capacity). High-tar & high dust content in raw gas remain as problems.

Graested demonstration plant – The two-step DD wood chips and pellet gasifier has been scaled up to 300 kWe. The plant has operated a gas engine with the resulting fuel gas for 1200 hours in 2007, 2200 hours in 2008, and 2600 hours in 2009.

Viking 2-stage Gasifier – the technology is scaled up to 150 kWe or 400 kWth. The technology claims an electrical efficiency in the range of 32 to 35% at 150 kWe during 250 hours of operation in 2009.

Gjol - The BMG project with the TKK 2-step DD gasifier has been completed. Plans are underway to utilize the gasifier for making glass wool from sewage sludge.

AMONGAS has built a twin bed BMG research facility.

LT-CFBG – The 500 kW pilot plant has been conducting gasification tests with straw, wood, and waste for Dong Energy.

The **Harboore Volund** plant (3.3 MWth capacity producing 0.85 MWe (capability to produce up to 1.3 MWe with wood chips) plus district heat) has been shut down after many years of successful operation. It was shown that the tar collected from the UD gasifier could be reformed to kerosene or gasoline.

Moving forward DK will promote decentralized biomass based CHP plants. Part of this effort is deployment of Stirling engines, at 35 kWe with 20% electrical efficiency. Stirling engines can use any type of feed with easy turn-down capability. Barritskov Aarsliderner is demonstrating Stirling engines to co-produce electricity and char as fertilizer (to replenish soil-carbon).

Sweden, Lars Waldheim, TPS: The Swedish national bioenergy policies and drivers are posted under Lars Waldheim's Country Update presentations on the Task website at www.ieatask33.org

Eric Rensfelt is appointed as the Managing Director of the Varnamo BMG Center. He will lead an industrial consortium to demonstrate biomass gasification for IGCC and to convert synthesis gas to SNG and biofuels. The initial program cost is 40 MM Euros. Other significant BMG activities are listed below:

CHEMREC – conducting black liquor, oxygen blown entrained biomass gasification tests to demonstrate MeOH production using a zeolite membrane reactor and DME. A cyclone gasifier is also under consideration for BMG.

Chalmers University – retrofitting the 8 MW CFB boiler with a 2 MW BMG. While banking the gasifier with hot sand, it can be brought back to full operation in about 10 minutes. A test unit is under construction to investigate chemical looping and down stream reforming of raw gases.

KTH – developing high-temperature gasification with preheated air for both DD and UD gasifiers to investigate its impact on gas quality and thermal efficiency.

Mitt Universitet – commissioning hot tests with a 150 kW integrated CFBG to produce FTL and BTL in general.

Gobigas – considering development of a 100 MW TUV/Repotec gasification process incorporating innovations from CHALMERS and KTH (tar reforming) to produce bio-SNG. The plant owners include Goteborg Energie (80%) and e-on (20%). e.on is pursuing development of a BMG plant producing 200 MW SNG by 2015.

Malarenergi – planning to build 2x100 MWth (waste and demolition wood) CFBG, similar to Lahti, for cofiring in a 600 MW pulverized peat and coal boiler, at about- 150 KM west of Stockholm.

Netherlands, Bram van der Drift, ECN: The Dutch national bioenergy policies are posted under Bram van der Drift's Country Update presentations on the Task website at www.ieatask33.Org. The significant BMG activities are listed below:

Essent – continuing operation of the 85 MWth CFBG (~30 Mwe) with demolition wood. The resulting product gas represents 5% of the heat input to the co-fired coal boiler.

NUON – the 85 MWth Shell gasification IGCC plant is operating with 15% of energy input by co-gasification with demolition wood. Vattenfall is considering taking over the NUON facility.

HoSt- operating the 3MWth chicken manure CFBG coproducing 0.25 MWe with a steam boiler.

BioMCN – considering co-gasification of glycerin and natural gas (on a 50/50 basis) in a natural gas reformer to produce 200, 000 TPY of bio-methanol.

Dahlman – A Portugese customer will use OLGA along with HoSt CFBG to produce ~1 MWe by the end of 2009.

HVC – cooperating with ECN to employ MILENA gasification and OLGA gas clean-up for CHP and SNG applications

ECN has published a report on the survey of producer gas clean-up which is posted at <http://www.ecn.nl/docs/library/report/2008/e08078.pdf>

Austria, Reinhard Rauch, TUV: Under Bioenergy 2020+, a new competence center was set-up by merging Austrian Bioenergy Center and Renet of Austria. Support research for BMG is continuing at Graz University, Joanneum Research, Vienna University of Technology (TUV), and FJ-BLT Wieselburg (HBLFA).

The TUV/REPOTEC demonstration at Guissing is continuing. At this facility, the first large scale demonstration of successful conversion of biomass to SNG is demonstrated at 100 cu.m/h (or 1 MWSNG). Further slip=stream tests will continue to investigate production of FTL and BTL. Energie Oberwert is now operating the TUV-FICFB process with wood chips at 30% electrical efficiency (employing gas engine supported by ORC) producing 2.7 MWe. The second large-scale TUV-CIFB plant was built and commissioned by Ortnet in Oberwart.

The two Pyroforce gasifiers with a total capacity of 350 kWe is operating to resolve design problems with heat exchanger and control panels.

Germany, Thomas Kolb, ITC-TAB

The German national strategy and investments for renewable energy development are posted under Thomas Kolb's Country Update presentations on the Task website at www.ieatask33.org. The significant BMG activities are listed below:

Artfuel CUTEC 100 kg/hr, steam/oxygen CFBG investigating additives to increase ash fusion temperature

University of Karlsruhe, operating the first 10 MWth, commercial fluidized bed BMG in Germany. Initial efforts to produce power are followed by methanation of synthesis gas. Future plans include R&D for integration of other conversion technologies with FBG. The technology platform for the integrated BMG+bioSNG+LNG production will be set-up at Geislingen-Turkheim near Stuttgart, 50 miles east of Karlsruhe. The planned platform construction in May 2009 is delayed. The facility will use a BMG similar to TUV/REPOTEC process. In these efforts regional energy suppliers, public services, and communes are partnering with University of Karlsruhe.

CHOREN – start-up of the 45 MWth (65,000 dry TPY) beta plant with wood chips at 6 bar, is delayed due to safety checks. The 2-stage gasifier will provide clean synthesis gas at 30 bar to produce 18,000 cu.m of FTL. The estimated plant cost is 100 MM Euros. Basic engineering work is in progress for locating the sigma plant at the Scwedt refinery. The decision to proceed with this >500 MM Euro facility will be made by the end of 2009.

bioliq – pyrolysis of straw (at ~500 C, at <10 seconds) was started at this KIT-Air Liquide/Lurgi facility in Nov 2008. The pilot plant capacity is 500 KG straw/hr which is equal to ~2 MWth. Upon successful operation of the pyrolysis plant the resulting char (40% char limit) plus liquid hydrocarbons will be gasified with oxygen at 80 bar, in the Lurgi MPG (2 or 3 burners) entrained gasifier at an estimated residence time of 3 seconds. The clean synthesis gas is suitable for producing fuels, H₂, chemicals and/or power. If required a flux could be added to lower ash softening temperature and to control ash viscosity which is critical for reliable gasifier operation.

Canada, Fernando Preto, NRC: The BMG projects In operation include the Nexterra BMG at Tolko to provide clean heat for wood drying kilns. The updraft gasifier with very low dust in raw gas can handle feed of -6+3 inches with about 7% moisture.

The Enerkem technology at Westbury is being commissioned to demonstrate conversion of negative-cost waste feed materials (ex: decommissioned power poles) to produce ~1.3 MM

gallons of catalytic EtOH per year. Future feeds will include wastes from pulp and paper mills and MSW.

When Plasco's 30,000 TPY capacity plasma gasification plant operates successfully near Ottawa, it will use the resulting fuel gas in IC engines to generate power. Plans are under consideration to build the a commercial plant in Red Deer, Alberta.

Nexterra is planning to build a 1.4 MWe, \$25 MM cogeneration system at University of South Carolina, USA (which is projected to save \$2-3 MM/yr); 2 MWth district heating plant in Docks Green in Province of Victoria, Canada; a 60,000 lbs/hr steam plant at ORNL, Oak Ridge, TN, USA (at a projected annual saving of \$4MM/year); a 40,000 lb/hr steam plant at Kruger tissue mill in BC, Canada; a \$15 MM central heating plant at University of British Columbia (with a projected GHG reduction of 4000 TPY at an annual saving of ~ \$700K); and a 100,000TPY plant in Edmonton, Canada. Canada has several on-going biological conversion projects for producing methane and pathogen destruction from residential wastes. Nexterra is conducting R&TD to develop the next generation BMG for power at < 10 Mwe capacity. Part of this effort is a proprietary raw gas conditioning method. A 2 Mwe demonstration plant is planned at the end of CY 2009. GE Jenbacher gas engines are included in future applications.

Province of Alberta has announced building 3 large gasifiers (>\$100 MM) at Otoka Energy (EPI BFB gasifier), Millarv Western (Taylor Biomass Energy's BCL/FERCO/Sylvagas gasifier), and at Edmonton EWMC (Enerkem's greenfield EtOH plant).

The primary Canadian bioenergy research activities are being conducted at FP Innovations/Paprican and CANMET Energy (with a 6 TPD dual FB pulp mill residue gasifier), at NRCAN, in Ottawa, University of Saskatchewan (Fundamental FTL leading to demos), University of BC, Vancouver (reactivation of 76 mmID pressurized CFBG), Lakehead University in cooperation with CanmetEnergy (100 kWth air blown BFB with tar decomposition bed material), University of Northern BC (Nexterra heating plant as a research facility), and Nexterra Kamloops PDU (for lime kiln applications).

Discussion on Scope of Work and Workshop Topics for 2010-2012 : Copies of the proposed scope of work & workshop topics prepared by Reinhard Rauch & Rich Bain were distributed and the Task Members were requested to send-in their review comments etc., to the prospective Task Leaders Reinhard Rauch & Rich Bain by **Friday, 13 June, 2009.**

Next Task Meeting: 2 to 5 November, 2009 at Breda, NL. The planned WS Topic is 'BMG Operating Experience & RD&D Needs.' A tentative list of prospective contributors include representatives from Repotec, Carbona/Andritz/GTI, Babcock VÖlund, Foster Wheeler, CHEMREC, METSO (Götaverken), NUON, ESSENT, Biomass Engg, PYROFORCE/CTU, Nexterra, & others.

WS:5 Biomass Derived Raw Gas Clean-up, Gas Conditioning, and Synthesis Gas Conversion:
The WS presentations listed below are posted on the Task 33 website at www.ieatask33.org:

Presentation	Presenters, Affiliation
Fuel Production from Biomass-derived Syngas within the Bioliq[®]-process	Dr. Ulrich Arnold, <i>ITC-CPV</i>
Overview of 2nd Gen Biofuels	Dina Bacovsky, <i>Bioenergy 2020+</i>
Syngas Cleanup at NREL	Richard Bain, <i>NREL</i>
Two Worlds Meet	Bram van der Drift, <i>ECN</i>
Gasification and Syngas Upgrading Projects at ETC	Rikard Gerbart, <i>ETC</i>
Syngas Conditioning and Conversion	John Bogild Hansen, <i>Haldor Topsoe</i>
Syngas Conditioning by Lurgi Rectisol	Matthias Kasper, <i>Lurgi GmbH</i>
Gas Cleaning R&D at VTT	Esa Kurkela, <i>VTT</i>
Dry HTHP Syngas Cleaning - Status and Results	Hans Leibold, <i>ITC-TAB</i>
Applied Technologies	Olaf von Morstein, <i>Uhde</i>
Latest developments in FT Synthesis and Methanation at the Gussing biomass CHP Plant	Reinhard Rauch, <i>TUV</i>
Hydrocarbon Synthesis Research (pdf 861 KB)	Georg Schaub <i>Engler-Bunte-Institut</i>
Advanced Gas Cleaning for Biomass Gasification	olaf Schulze, <i>CTO</i>
BASF - Technologies for Syngas Purification	Ekkehard Schwab, <i>BASF SE</i>

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