Draft Minutes
IEA Bioenergy Agreement: 2007-2009
Task 33: Thermal Gasification of Biomass
(Northern Hemisphere) Spring Meeting - 2008
Day 1, Monday, 21 April 2008: TASK MEETING
Location: Hotel Savoyen Vienna, Rennweg 16, 1030 Wien
April 21-23, 2008

Prepared by
Suresh P. Babu, Task Leader
9 June 2008

The third Task Meeting for the 2007 to 2009 triennium was held from April 21 to 23, 2008 in Vienna Austria. The Agenda for the Task Meeting is shown in Attachment A. The twenty-six attendees for the Task Meeting on April 21 were:

Austria - Reinhard Rauch and Michael Fuchs, TUV
Canada - Fernando Preto, NRCAN, Ibrahim Karado, FP Innovations
Denmark - Erik Winther and Martin Wittrup-Hansen, Dong Energy, Louise Kristeine Mortensen, Volund, Henrik Christiansen, DEA,
European Commission - Philippe Schild, BE,
Finland - Ilkka Hannula, VTT
Germany - Thomas Kolb, FZK, Eberhard Oettel, FEE
Netherlands - Bram van der Drift, ECN
New Zealand - Shu-sheng Pang, Univ. of Canterbury
Sweden - Lars Waldheim, TPS, Mehri Sanati, VXU
Switzerland - Ruedi Bühler, Umwelt+Energie, Sandra Hermle, Bundesamt für Energie (BFE), Serge Biollaz, PSI
USA - Richard Bain, and Calvin Feike, NREL, and Vann Bush and Suresh Babu, GTI
Slovenia (Observer) - Jozef Viglasky, Technical University in Zvolen
United Kingdom (Observers) Fred Dumbleton and Dave Carless, Biojoule Ltd.

The **Agenda** was reviewed and approved as proposed. The **minutes from the (Northern hemisphere) Fall-2007 Task Meeting** in Bergen/Petten, NL were revised to show two corrections for spelling names. With these changes the minutes were approved.

Review of Task Deliverables for 2007-2009

1. Review Task Deliverables
    a. WS Report on Procedures/Guidelines for Synthesis Gas Characterization is available on the task website
    further work on development of a Guideline will be discussed between NREL, TUV, PSI, ECN, VTT, GTI
    b. Thermal Gasification Paper – work in progress

c. Country Reports –Publication with GasNet in 2008

Status of Country Report Updates: The detailed reports updating those posted on the Task website in 2004 have been received from AT, CH, FI, NL, SE, and UK. Other member countries, i.e., CA, DE, DK, NZ, and USA are requested to provide their inputs by May 31, 2008. GasNet has agreed to provide similar reports from other European countries that are not currently the members of Task 33.

Country Updates on matters related to bioenergy in general and thermal gasification of biomass in particular are included on the following paragraphs.

SWITZERLAND

First Industrial Project - Dasag: Dasag Renewable Energy AG (dasagren), as one of the engineers and suppliers of Biomass Gasification Power Plants, offers The Indian Institute of Science (IISc) open-top down draft gasifier, produced by Netpro, Bangalore, India. Several of these plants are in operation in India. A 450 kWe plant was sold in Switzerland to Woodpower, Wila incorporating waste heat utilisation. The feed biomass with 15% moisture is gasified and the producer gas is cleaned using cyclone separation, quenching, scrubbing and filtering. The cleaned fuel gas is fed to one Jenbacher engine. Plant commissioning started in January 2007 and the highlights of experience to date are summarized below:

operational problems due to wrong engineering design revised during 2007 and 2008
further changes / improvements were carried out by the owner, Woodpower, with support from IISc (Dasappa) and the former subcontractors of dasagren.
after solving the main problems, Woodpower is convinced that the commissioning problems could be attributed to deficiencies of the licensed manufacturer.
dasagren is now in "silent liquidation" and it could be activated later.

Second Industrial Project – Pyroforce: The features of the Pyroforce Gasifier offering are:

2-zone downdraft gasifier
gas cooler (to 150°C)
bag house filter with precoating adsorbants for contaminants and tar reduction
gas scrubbing column (water or solvent)
Jenbacher engine.

The specifications and performance of the Spiez Pyroforce project are:

200 kWe
more than 17,000 hours operation with engine at partial load
oil change less than once every 5000 hours
high operating availability, more than 6500 hours/year
wood: moisture content ≤ 15%

waste water free of contaminants

The standard size of Pyroforce commercial gasifiers are 150 kWel. The particulars of the commercial installation in Güssing are:

2 gasifiers of 300 kWe capacity and gas coolers
1 common baghouse filter for two gasifiers
1 Jenbacher engine
commissioned in 2007 and the two gasifiers are now in operation

The particulars of another commercial Pyroforce installation at Nidwalden, Switzerland, are given below:

1,200 kWe capacity provided by eight (8) gasifiers and gas coolers
2 baghouse filters
2 Jenbacher engines
commissioned in 2007 and at least one gasifier is in full operation

PYCON, which supplies the Pyroforce gasifiers gives warranties on efficiency, power and heat output, and availability.

USA

This update focuses on US government policy, US Department of Energy funded technology demonstrations, and studies at the National Renewable Energy Laboratory (NREL). Much additional privately-funded work has arisen in recent months, but that is not the focus of this update.

The current national commitment to advance bioenergy includes the following ambitious biofuels goals:

Production of cost-competitive cellulosic ethanol in the blend market by 2012
President's Vision on "20 in 10" (from the January, 2007 State of the Union address) which is targeted to reduce U.S. gasoline use by 20% by 2017 through…
- 5% reduction from enhanced efficiency standards (CAFÉ)
- 15% reduction from new Alternative Fuels Standard at 35 billion gallons/year (consistent with the current Renewable Fuels Standards (RFS)

The Energy Independence & Security Act of 2007 (EISA)
- annual production of 36 billion gallons renewable fuel by 2022, including 21 billion gallons/year of 'advanced' biofuels

President's Vision on "30 x 30" (from the January, 2008 State of the Union address) which includes
- longer-term biofuels goal
- ramp up the production of biofuels to 60 billion gallons/year
- displace 30% of U.S. gasoline consumption* (based on 2004 use) by 2030

The current goals for biofuels (EtOH and biodiesel) production are summarized below:

EISA RFS goals (in billion gallons/yr)

Year	Total	Conventional	Cellulosic	Biodiesel
2010	13.0	12.0	0.1	0.65
2012	15.2	13.2	0.5	1.0
2022	36.0	15.0	16.0	-

These goals are supported by the following provisions:

- proposed Senate version of Farm Bill which includes Volumetric Ethanol Excise Tax Credit (VEETC) extension and incentives for cellulosic feed stocks and biorefinery deployment
- approximately three fold increase, between 2006-2008, of DOE's overall biomass investment (not including loan guarantee program)
- negotiations by Office of Science and EERE for over $900 million in multiyear contracts/agreements (half of which are concluded to date). An additional $200 million is being sought to fund "10%-Scale" Biorefinery validation demonstrations

The current DOE-funded programs selected on a competitive basis include:

a. Under Solicitation 932, the US DOE's strategy is to invest and promote investments in cellulosic biofuels that should accelerate commercialization and help create a biofuels market based on non-food feedstocks. The selection involves six integrated commercial-scale biorefineries (up to $385 million) at a minimum of 700 TPD feed capacity to produce 130 million gallons of cellulosic ethanol in 5 years using a variety of conversion technologies and cellulosic feedstocks. A summary of the six selected demonstration projects is given in the following table:

Performers	Feedstock Type	Conversion Technology	Status of Project
Alico	Vegetative Waste Woody Waste	Gasification + Fermentation	Award pending negotiation.
Bluefire	Sorted MSW	Concentrated Acid Hydrolysis and Fermentation	Phase 1-Cooperative Agreement signed Sept. 2007.
Poet	Corn Cob Corn Fiber	Enzymatic hydrolysis and Fermentation	Phase 1-Cooperative Agreement signed Sept. 2007.

Iogen	Baled Barley Wheat Straw	Enzymatic hydrolysis and Fermentation	Award pending negotiation.
Range Fuels	Woody Waste	Gasification + Mixed Alcohol Synthesis	Phase 1 & 2-Technology Investment Agreement – Signed Nov. 2007 Ground Breaking Nov. 2007
Abengoa	Agricultural Residue	Biochemical + Gasification	Phase 1-Cooperative Agreement signed Sept. 2007

b. The "10%-scale" Biorefinery Validation at about 70 TPD feed capacity program includes up to $200 million over five years for development of small-scale cellulosic biorefineries in the United States. These are cost-shared, integrated biorefinery demonstrations using cellulosic feedstocks to produce fuels, chemicals, and substitutes for petroleum-based feed stocks and products at one-tenth projected scale for first-of-a-kind commercial facilities. A list of the selected projects are given below:

Projects	**Feedstock**	**Conversion**
ICM Inc.	Ag residues Energy Crops	Biochemical
Lignol Innovations	Hard and Soft Woods	Biochemical
Pacific Ethanol Inc.	Ag residues Wood residues	Thermochemical
New Page	Wood Residues	Thermochemical Fischer Tropsch

c. Ethanologen Solicitation (up to $23 million) which includes five selected research teams working on microorganisms

d. Enzyme Solicitation (up to $33.8 million) which includes creating commercially available, highly effective, inexpensive enzyme systems for biomass hydrolysis; second phase will target cellulase development with cost-sharing industry partners

e. Thermochemical Conversion (up to $7.75 million) for integration of biomass gasification and catalyst development

f. Joint DOE-USDA Solicitation ($18 million) for a variety of biomass R&D initiatives

SUMMARY OF USDOE BUDGET

Budget Area	FY06	FY07	FY08 Request
Thermochemical Conversion Platform (WBS 3.0)	$4,723,357	$14,145,153	$17,536,787
Feedstock Interface Total	$0	$0	$500,000
TC Processing Core R&D	$4,028,586	$11,216,114	$6,665,339
TC Process Integration Core R&D	$422,271	$1,880,000	$2,192,193
Solicitation Funding Opportunities	$0	$0	$4,064,255* $3,035,000† $7,099,255†
Platform Support (analysis)	$272,500	$1,049,039	$1,080,000

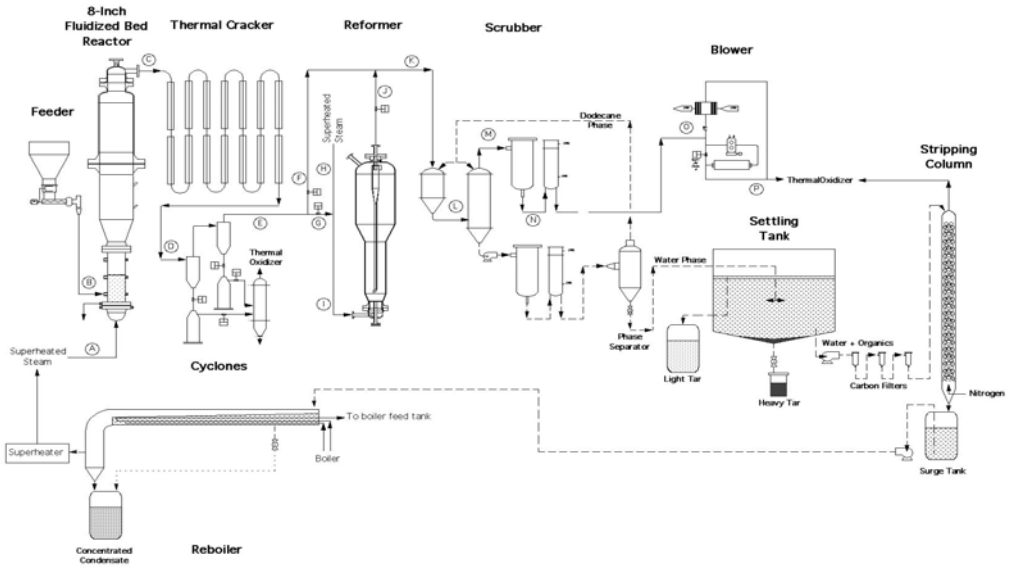
***** FY07 solicitation for syngas clean-up (without mortgages due to on-going projects)

† FY08 solicitations (without mortgages due to on-going projects)

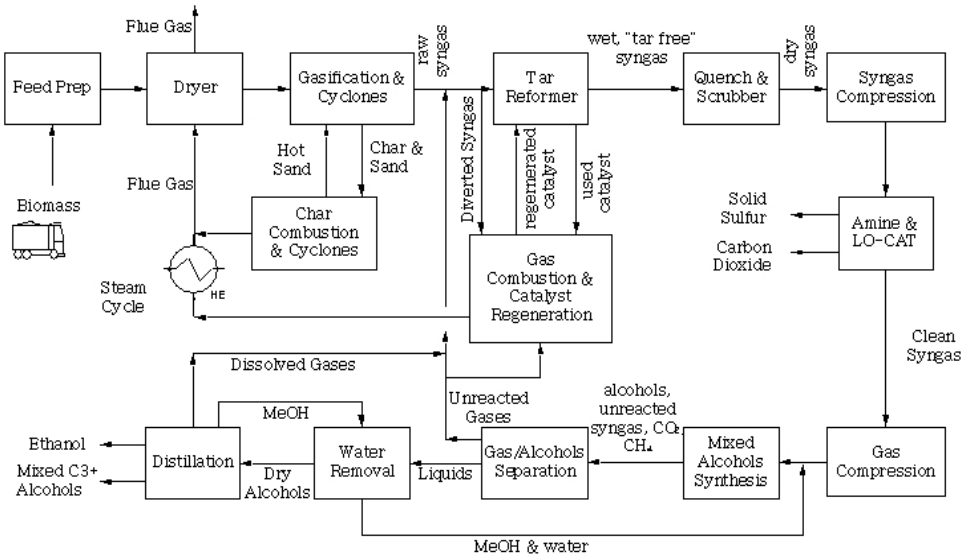
The reference for a recent NREL publication on Conceptual Design of a 2000 tonnes/day commercial plant, based on tests in NREL's 150 kWth Biomass Gasification and Thermochemical Process Development Unit (TCPDU) is given below:

Phillips, S.; Aden, A.; Jechura, J.; Dayton, D.; Eggeman, T. (2007). Thermochemical Ethanol via Indirect Gasification and Mixed Alcohol Synthesis of Lignocellulosic Biomass. 132 pp.; NREL Report No. TP-510-41168.

A general schematic of the NREL TCPDU is illustrated below:

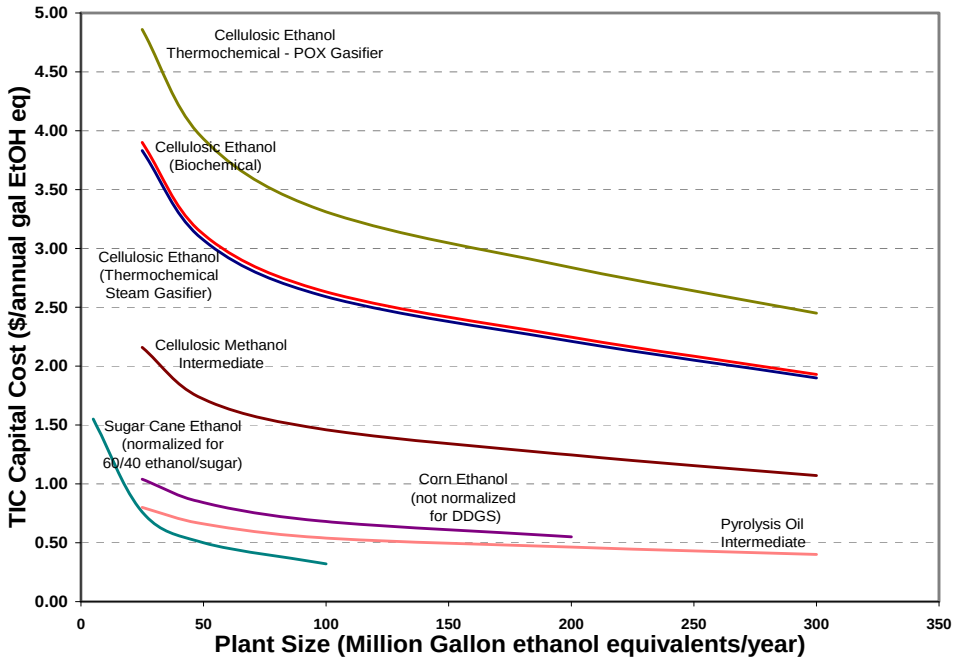


Results of this peer-reviewed study forms the basis for connecting R&D targets to cost targets. The following are the general project flow-sheet and an excerpt of a table on projected yields & carbon utilization taken from this publication:

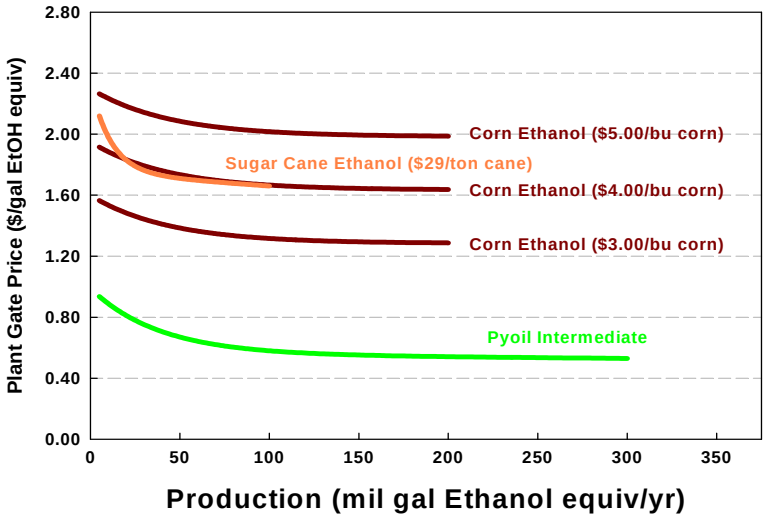


	Cellulosic Ethanol (BC)	Cellulosic Ethanol (TC) Steam	Cellulosic Ethanol (TC) POX	Ethanol Corn Dry Mill	Ethanol Sugar Cane	Pyrolysis Fuel Oil Intermediate	Methanol Intermediate
Yield							
gal/ton biomass	90	80	77	102	12.3	137	149
gal Ethanol eq/ton biomass	90	80	77	102	12.3	135	115
By-Product							
type	--	Higher Alcohols	Higher Alcohols	DDGS	Sugar	--	--
gal Ethanol eq/ton biomass	--	14	15	33wt%	5.7wt%	--	--
Electricity, kWh/ton	196	--	--	--	--	26	--
External Fuel							
Nat Gas, MMBtu/dry ton				1.13			
Process Efficency, HHV							
Overall %	48	47	46			68	55
Product %	44	40	37			67	55
Carbon Utilization							
Product %	31	27	26			59	35
By-Product %	--	6	5			--	0
Acid Gas/Fermentation CO2 %	16	15	24			--	0.3
Flue Gas CO2 %	53	52	36			41	47
Other %			8 - char				18

The cost analysis of ethanol or ethanol equivalent, as a function of commercial plant capacity is given in the following table and illustrations:

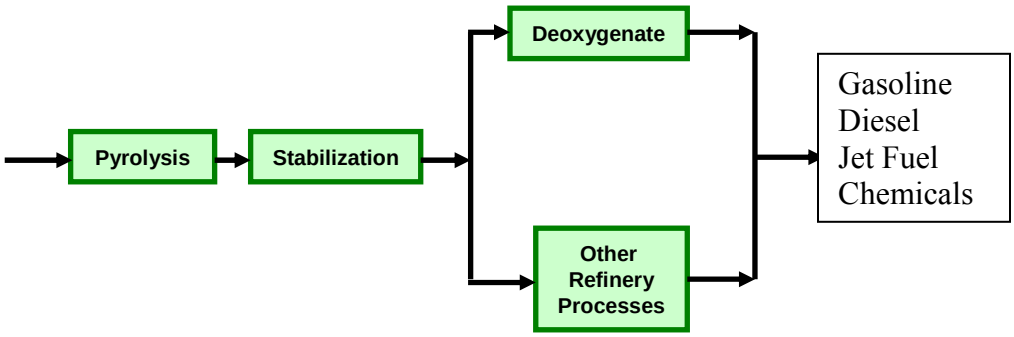


Cost component	Units	Cellulosic Ethanol (TC)	Cellulosic Ethanol (TC)	Cellulosic Ethanol (TC)	Cellulosic Ethanol (TC)
Year $	$	2007	2007	2007	2007
Plant Size	dry tonne/day	1,632	816	3,264	9,793
Feed Cost	USD/dt	**$ 45.90**	**$ 45.90**	**$ 45.90**	**$ 45.90**
Ethanol	gal/short ton	80.1	80.1	80.1	80.1
Mixed alcohols	gal/short ton	94.1	94.1	94.1	94.1
Ethanol	Mil Gal/YR	**50**	**25**	**100**	**300**
Capital Cost (million USD)					
Feed Handling & Drying		26.41	18.51	48.84	105.38
Gasification		14.68	8.43	25.57	61.57
Tar Reforming & Quench		43.71	26.91	71.01	153.22
Acid Gas & Sulfur Removal		16.51	9.16	29.75	75.70
Alcohol synthesis - Compression		18.21	11.61	28.58	58.37
Alcohol Synthesis - Other		5.24	3.34	8.22	16.78
Alcohol Separation		8.20	5.22	12.86	26.27
Steam System & Power Generation		19.12	11.77	31.07	67.03
Cooling Water & Other Utilities		4.10	2.52	6.66	14.36
Direct Fixed Capital (DFC), also called TIC		156.18	97.48	262.56	578.69
Engineering		18.74	11.70	31.51	69.44
Construction		20.30	12.67	34.13	75.23
Contractor & Legal		12.49	7.80	21.01	46.30
Process/Project Contingency		6.43	4.02	10.82	23.84
Total Plant Cost (TPC)		214.15	133.66	360.03	793.50
AFUDC					
Total Plant Investment (TPI)		214.15	133.66	360.03	793.50
Land		2.21	2.21	5.08	15.23
Startup		0.00	0.00	0.00	0.00
Total Capital Cost (TCC)		216.36	135.87	365.11	808.73
Working Capital		10.71	6.68	18.00	39.68
Variable Operating Costs (million USD/yr)					
Feed		28.65	14.33	57.31	171.91
Utilities		0.30	0.12	0.49	1.47
Other		1.00	0.50	2.00	6.00
Catalysts and Chemicals		0.70	0.35	1.40	4.20
Total		30.65	15.30	61.20	183.58
Fixed Operating Costs (million USD/yr)					
Labor		2.58	2.17	3.06	4.03
Maintenance (3% of A)		4.69	2.92	7.88	17.36
General Overhead (65% of labor + maint)		4.72	3.31	7.11	13.91
Direct Overhead (45% of Labor)		1.16	0.98	1.38	1.81
Insurance (0.5% of TIC)		1.08	0.68	1.83	4.04
Total		14.22	10.06	21.26	41.16
Capital Cost (TIC)	USD/annual gal	**3.12**	**3.90**	**2.63**	**1.93**

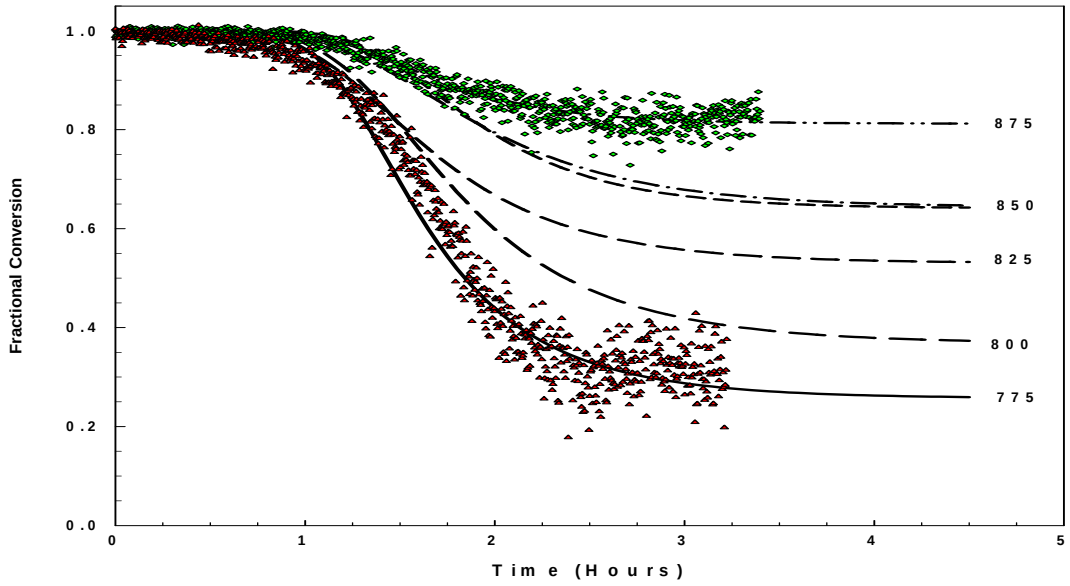


Bain, R. L. (2007). World Biofuels Assessment; Worldwide Biomass Potential: Technology Characterizations (Milestone Report). 164 pp.; NREL Report No. MP-510-42467.

A simplified process scheme for biomass pyrolysis and subsequent conversion to fuels and chemicals is illustrated below:



Another NREL study, "An Evaluation of Catalyst Deactivation During Catalytic Steam Reforming of Biomass-Derived Syngas," I&ECR, 44, p 7945-7956, (2005) by Bain, R. L., D. C. Dayton, D. L. Carpenter, S. R. Czernik, C. J. Feik, R. J. French, K. A. Magrini-Bair and S. D. Phillips, reports catalyst evaluation experiments carried-out to complete deactivation in order to gain insights about chemical mechanisms and to estimate reforming and deactivation kinetic rate constants and activation energies. A selected summary of the results is given in the following illustration:



The reforming of tar /light hydrocarbons is performed in a semi-batch fluidized bed reactor with multiple regenerations of a nickel/alkali catalyst. A summary of the reformer test results is given below. Detailed gas and tar analyses are used to estimate both initial and reformed product gas composition, and percent conversions of selected components during reforming of raw gases.

Run Order:	4	5	13	14
Run Code:	97095 OK_HY_97095	InDe1 OK_NREL32b_InDe1	97095b OK_HY_97095b	InDe2 OK_NREL32b_InDe2
H2	33.74	50.46	39.15	49.91
CO	24.45	12.18	18.37	13.95
CO2	19.93	23.64	23.45	24.25
CH4	12.59	4.62	11.06	5.84
N2	0.00	0.00	0.00	0.00
He (tracer)	1.86	1.07	1.69	1.15
C2H6	0.00	0.00	0.00	0.00
C2H4	2.12	0.17	1.66	0.14
C2H2	0.01	0.00	0.03	0.00
C3H8	1.25	0.07	0.99	0.00
C3H6	0.00	0.00	0.00	0.00
1-C4H8	0.00	0.00	0.00	0.00
2-cis-C4H8	0.00	0.00	0.00	0.00
2-trans-C4H8	0.02	0.00	0.00	0.00
COS	0.0000	0.0000	0.0291	0.0204
H2S	0.0058	0.0006	0.0040	0.0016
Closure	95.99	92.21	96.42	95.26
tar (mg/Nm3-wet)	reformer in	reformer out (initial)	reformer in	reformer out (initial)
benzene	7785	280	6874	245
toluene	393	0	326	0
phenol	46	29	39	0
cresols	0	0	0	0
naphthalene	2383	42	1834	39
phenanthrene	792	0	535	13
"other tar" (as 128)	2157	0	1691	0
"heavy tar" (as 178)	1417	0	824	0
"total tar" (minus 78)	7188	72	5250	52

DENMARK

There are several BMG projects in Denmark in various stages of development and demonstration in Denmark.

Stirling Engine: Wood based gasification with a 35 kWe Stirling engine at Ansager. Commissioned in 2007, reconstructed and recommissioned in 2008. Operation and evaluation are now in progress. A similar effort is underway at Svanholm with an 80 kWe Stirling engine.

Græsted Gasification plant. Wood based, 85 kWe, Thomas Koch's 3-stage down draft gasifier is in operation.The gas engine performance has improved with certain engine modifications, from 375 hours in 2006 to 2200 hours of engine operation, so far in 2008.

Danish Follow-up Biomass CHP Projects

a. Gjøl demonstration plant employing Thomas Koch's 3-stage down draft gasifier is a wood gasifier of 2 MWe capacity. Construction of the plant was completed under an EU project that has come to an end in August 2007. The future remains uncertain.

b. Skive wood pellet gasification plant: Carbona built the plant with a design capacity of 6 MWe plus 11 MWth, using wood pellets. The plant was

commissioned in 2007. Following the changes made to the flare to reduce noise, tests have resumed with focus on tar decomposotion on Ni-based monoliths stacked in a vessel immediately downstream from the FB gasifier. The product gas was initially used only in a boiler to produce steam/hot water, but commissioning of the Jenbacher reciprocating engines is under way.

c. Low Temperature-CFB gasification pilot plant: The 500 kWth gasifier employs straw, wood and waste at DTU. Most recently the plant was operated at 500 kWth capacity with pig manure.

d. DTU Viking Gasification plant. The wood chip fired 30 kWe, two-stage gasifier was operated for >3000 hours coupled to a gas engine in 2006. Subsequent tests included 150 hours with a fuel cell and test and evaluation of converting product gases employing Haldor-Topsøe catalysts into MeOH and DME. In 2008, the Viking Plant at DTU was recommissioned with cold and hot tests and efforts are now in progress to demonstrate power generation with an IC engine at >32% efficiency.

WEISS Industry is scaling-up the Viking system for 150 kWe or – 400 kWth capacity. It is anticipated that 35% electrical efficiency can be accomplished in these plants while the balance 65% of heat can be utilized for other applications.

AUSTRIA

A summary of Austrian research activities are given below:

Graz University of Technology – Institute of Thermal Engineering:

- Evaluation and optimisation of a fixed bed gasifier, gas cleaning system and gas engine
- R&D of a two staged gasification system
- Scientific partner in Austrian Bioenergy Centre
- Health, safety and environmental issues for gasification systems

Graz University of Technology - Institute for Apparatus Design, Particle Technology and Combustion Technology:

- Research on gasification and combustion in a fixed bed of solid fuel
- Fundamental research on biomass particles under gasification conditions

Joanneum Research in Graz - Department of Energy Research:

- Life Cycle Assessment

Vienna University of Technology, Institute of Chemical Engineering:

- R&D in dual fluidised bed steam gasification
- Production of Fischer-Tropsch fuels
- Production of BioSNG
- Use of product gas in fuel cells
- Scientific Partner in RENET Austria (Network of Competence for Energy from Biomass), Austrian Bioenergy Centre, and in Bioenergy 2020+

Austrian Bioenergy Centre:

- Pressurised gasification (in cooperation with Vienna University of Technology)
- Test and evaluation of SOFC at the Güssing, CHP plant

FJ-BLT Wieselburg (HBLFA):
- 1st and 2nd generation biofuels

The notable commercial project implementations in Austria are summarized in the following table:

Owner	**Type, Capacity**	**Biomass feed**	**Status**
Biomassekraftwerk Güssing GmbH &CO KG	FICFB, 2 MWe	wood chips	in operation
Pyrotherm Kraftwerk Güssing GmbH	Pyroforce, 350 kWe	waste wood	in operation
Energie Oberwart	FICFB, 2.7 MWe	wood chips	in commissioning

Further particulars of the two Pyroforce commercial gasifiers installed in Güssing are given below:

Owner:	Pyrotherm Kraftwerk Güssing GmbH
Constructed by	Pyroforce / CTU
Power production	350 kWe
Heat production (1) 70°C/90°C	437 kWth
Heat production(2) 115°C	140 kWth
Biomass type used	Clean waste wood from parquet floor industry
Hours of operation (gas engine) (6th March 2008)	540 h, commissioning was in Jan./Feb. 2008

Gas cleaning at this installation employs one set of bag filters for two gasifiers and an RME scrubber. The cleaned gas is fed to one GE Jenbacher 312 gas engine.

At the Güssing CHP plant a BioSNG pilot plant is currently under construction. This plant can process 1/8 of the total product gas stream to produce Bio-SNG. Start up of the BioSNG plant will be in summer 2008.

The particulars of the next FICFB commercial plant are summarized in the following table:

Owner:	Energie Oberwart GmbH
Constructed by	Ortner Anlagenbau
Power production	2750 kWe
Heat production	1500-6000 kWth
Biomass type used	Wood chips
Status:	In commissioning

The second FICFB biomass gasification based CHP plant is being built in Oberwart. The plant is similar to the Güssing biomass CHP, with a dual fluidised bed gasifier, gas cooling, and bag-house gas clean-up followed by a tar scrubber. The cooled and cleaned producer gas will be fed into two gas engines for power generation. In addition a biomass drying unit and an Organic Rankine Cycle (ORC) will be integrated with the gasification island to improve overall plant efficiency. The ORC utilizes all waste heat to produce additional electricity. Plant construction was completed in December 2007 and commissioning is in progress.

GERMANY

The German bioenergy policy is driven by "Roadmap Biofuel", dated Nov. 14th, 2007/BMELV, BMU which requires increasing biofuel blending in transportation fuels. An increase in EtOH blending from 5% to 10% (by Vol.) was rejected on Apr. 4th, 2008 due to the number of vehicles that would require retrofits. A goal to increase biodiesel blending from 5% to 7% (by Vol.) is in effect. The overall national goal is to increase biofuel share by 10% in 2020 and to reduce CO2 emissions at1% per year from 2011 to 2020. A certification system is being developed for sustainable biofuel production while increasing the efficiency of CO2 utilization. The support for 2nd generation biofuels comes in the form of tax reduction until 2015. Methods are developed to evaluate biofuels by efficiency of CO2 reduction.

BMG – Artfuel-Process by CUTEC; CUTEC is operating a 400kWth CFB BMG with 60 - 100 kg/h dry biomass, steam– oxygen gasification at a temperature of ~900°C, and at atmospheric pressure to produce synthesis gas for FTL. Current tests are focused on determining syngas quality for different feed stock and on additives to prevent slagging of the residual ash.

CHOREN Process: From CHOREN-presentation at DGMK-meeting in Vehlen, Germany it is reported specifications of the β – plant include: 2-stage gasifier, with a capacity of 65,000 dry TPY (45 MWth) of wood, producing FTS of 18,000 m^3/yr. Six bar operating pressure may require ~ 50 compressors to process synthesis gas conversion to FTL. The estimated investment for this plant is ~ € 100 million. Mechanical completion was reported in April 2008. CHOREN is now preparing to conduct demonstration tests. Plans are already underway for the

σ – plant. It has been announced the plant will be erected in Schwedt. Basic engineering work is in progress. Decision to proceed is announced for 2009 for this ~ € 500 million plant.

bioliq®-Process by FZK: This BtL process is designed to produce transportation fuel from biomass. It involves a fast pyrolysis step, incorporating mechanical mixing with hot sand at 500°C in a twin-screw reactor to produce a pumpable and transportable slurry, followed by entrained oxygen-gasification, at up to 80 bar pressure to produce a tar-free synthesis gas for e. g. methanol synthesis. A major feature of the process is the decentralized pyrolysis step with transportation of slurry to a centralized gasification / synthesis plant.

FZK is building up a 5MW pilot plant in Karlsruhe in cooperation with LURGI. The project is funded by Fachagentur Nachwachsende Rohstoffe (FNR). Plant commissioning and parametric tests for the pyrolysis plant were started in February 2008. The product from pyrolysis is a pumpable and stable slurry, with high char particle content of up to 40 wt. %. The gasification plant is based on "Lurgi Multi Purpose Gasification Technology" with the following technical features:

- cooling screen
- entrained gasification in slagging mode
- gasification with oxygen
- temperatures above 1200 °C
- pressure: max 80 bar

Support research for entrained flow gasification of highly viscous slurry (e. g. design of spray nozzle, basics on slurry gasification behaviour, syngas quality) is being conducted by FZK in cooperation with EBI, University of KA at the research entrained flow gasifier REGA (technical: thermal load = 60 kW; fuel flow rate = 10 kg/h; Tmax = 1400°C; adiabatic, atmospheric).

EUROPEAN COMMISSION:

The presentation on updates from European Commission covered

1. New Projects (FP7)
2. New Calls (2008)
3. New Policies
    a. New RES Directive
    b. SET-Plan Initiatives

The following table summarizes the distribution of selected projects under FP 6 to address various aspects of bioenergy. Individual project durations range from 3-5 year; 10-30 partners; last project due to end in 2011.

Funding (EC Contribution) **(18 projects, not including demonstration actions)**	**€~81 million**

Bio-fuels for transport	34 %
Bio-refineries	18 %
Gasification and H2 production	23 %
Bio-residues and energy crops	5 %
Combustion	10 %
Others	10 %

The following table summarizes the distribution of selected projects (still in negotiation) under FP 7 to address various aspects of bioenergy. Individual project durations range from 3-4 year; 5-15 partners; last project due to end in 2011.

Funding (EC Contribution) (12 projects - not including demonstration actions)	**~27.1 M€**
Bio-fuels [3 CP & 2 SA]	10.0 M€
Gas cleaning [3 CP]	9.0 M€
Resource Assessment Methodology [2 CA]	3.2 M€
EU-Brazil [1 SA]	0.9 M€
RES Fuel [1 CP]	3.9 M€

The selected projects (still in negotiation) along with the level of funding are listed in the following table:

Acronym	Type	Title	Total Cost (M€)	EC (M€)
BIOREF-INTEG	SA	Development of advanced biorefinery schemes to be integrated into existing fuel producing complexes	1.00	1.00
BEE	CA	Biomass energy Europe	1.82	1.82
UNIQUE	CP	Integration of particulate abatement, removal of trace elements and tar reforming in one biomass steam gasification reactor	3.76	2.69
CEUBIOM	CA	Classification of European Biomass potential for bioenergy using terrestrial	1.34	1.34

		and earth observations		
BIOTOP	SA	Biofuel assessment on technical opportunities and research needs for Latin America	1.29	0.99
PROPANERGY	CP	Integrated bioconversion of glycerin into value added products and biogas at pilot scale plants	2.85	1.91
SOLARH2	CP	European Solar-Fuel initiative – Renewable hydrogen from sun and water. Science linking molecular biomimetics and biology	5.52	3.93
GLYFINERY	CP	Sustainable and integrated production of liquid biofuels, bioenergy and green chemicals from glycerol in biorefineries	5.23	3.94
SUSTOIL	SA	Developing advanced biorefinery schemes for integration into existing oil production/transesterification plants	0.99	0.99
SUPERMETHANOL	CP	Reforming of crude glycerin in supercritical water to produce methanol for re-use in biodiesel plants	3.07	2.19
HYPE	CP	High efficiency consolidated bioprocess technology for lignocellulose ethanol	5.43	3.66
GREENSYNGAS	CP	Advanced cleaning devices for production of green syngas	3.90	2.72
		SUM	36.20	27.18

The 2008 calls will be processed in two stages. The schedule for calls is given below:

1. FP7-ENERGY-2008-1 (26.3M€): Stage 1: Completed / Stage 2 in June
2. FP7-ENERGY-2008-FET (15M€): Stage 1: Completed / Stage 2 in June
3. FP7-ENERGY-NMP-2008-1 (25M€): Stage 1: Completed / Stage 2 in June
4. FP7-ENERGY-2008-RUSSIA (4M€): EC selection: Completed / Waiting for Russian evaluation

The schedule, vision, and mission for implementation of Biofuels Technology Platform are given below :

Launched on 8 June 2006 in Brussels
Strategic Research Agenda presented on 31 January 2008

Vision: “By 2030, the European Union covers as much as one quarter of its road transport fuel needs by clean and CO2-efficient biofuels”

Mission: "Contribute to the development of cost-competitive world-class biofuels technologies, to the creation of a healthy biofuels industry and to accelerate the deployment of biofuels in the European Union through a process of guidance, prioritisation and promotion of research, development and demonstration."

www.biofuelstp.eu

The new **Strategic Energy Technology** (SET) policy development was initiated with an EC Proposal on October 2007 that was approved by the European Council in March 2008.

The new **Renewable Energy Sources** (RES) directive proposal was submitted in January 2008 and the European Council is set to vote in May 2008, which will be followed by the European Parliament vote in October 2008.

The recently approved Policy Proposals include the January 2007 energy package which requires:

- 20-30% GHG reduction
- 20% energy efficiency improvement
- 20% renewable energy including 10% biofuels

was broadly endorsed by Member States (March 2007 European Council) and Parliament (Thomsen Report of September 2007)

The recent European Commission Proposals presented on 23 January 2008, requires

- A new EU emissions trading scheme with a European (not national) cap, auctioning of allowances: to generate reductions in GHG of 21%
- New national targets to achieve a 10% GHG reduction in non ETS sectors
- A framework to promote the development of CO2 capture and storage
- New guidelines on state aid for environmental protection
- An update on the implementation of the Energy Efficiency Action Plan
- New directive to reach the 20% renewable energy target and 10% biofuels target

A brief summary of the Renewables Directive is as follows:

- Sets mandatory national targets for renewable energy shares, including 10% renewable energy share in transport fuels, in 2020 (*Articles 3 and 5)*
- Requires national action plans *(Article 4)*
- Standardises "guarantees of origin" (certifying the renewable origin of electricity or heat) *(Articles 6, 7, 8 and 10)*

- Enables the transfer of guarantees of origin to give Member States flexibility to meet their targets by developing cheaper non domestic renewable energy *(Article 9)*
- Reforms, or requires reforms of administrative and regulatory barriers to the growth of renewable energy *(Article 12)*
- Requires improvements in provision of information and training regarding renewable energy *(Article 13)*
- Improves renewables' access to the electricity grid *(Article 14)*
- Creates a sustainability regime for biofuels *(Articles 15-18)*

As a part of the Target Setting Methodology Member States are required to share the 11.5% increase amongst them. The particulars of the methodology are given below:

2005 is the base year for the whole energy package
2005 share is modulated to reflect national starting points: a third of national growth between 2001 and 2005 is deducted from the 2005 actual share for those Member States whose growth over the period exceeded 2%
5.5% is added to the modulated 2005 share of renewable energy for every Member State
The remaining effort is weighted by a GDP/capita index, to reflect different levels of wealth across Member States, and multiplied by each Member State's population
These two elements are added together to derive the full renewable energy share of total final energy consumption in 2020.
A cap is imposed to ensure that no Member State faces a target of 50% or more.

The National Renewables Targets sets mandatory national targets for renewable energy shares, including 10% biofuels share, in 2020: from 8.5% to 20% for the EU overall.

To comply with these targets, The National Action Plans should -

- Set sector targets by Member States
- Measures adequate to achieve the targets including planned development of biomass resources
- Provide policy stability for investment

The standards for "guarantees of origin" (certifying the renewable origin of electricity or heat) builds on the framework created by 2001/77/EC which standardises information requirements, issuing, transfer and cancellation procedures, and requires the nomination of an independent competent body to manage GOs.

The related Administrative Reforms requires reforms of administrative and regulatory barriers to the growth of renewable energy, simplification and streamlined procedures, planning authorities to consider renewable energy and district heating and cooling systems, minimum levels of renewable energy in building codes for new or refurbished buildings, promotion of energy efficient renewable energy, and certification regimes for installers with mutual recognition

Grid Access improves renewables' access to the electricity grid and it is the same access conditions given in 2001/77/EC. Member States are required to provide priority access to the grid system for electricity from RES, to develop grid infrastructure, and to review cost sharing rules.

The Sustainability criteria for biofuels (liquid and gas) and for bioliquids (used for heat and power) requires:

- A minimum of 35% GHG savings
- No use of raw material from undisturbed forests, bio-diverse grassland, nature protection areas (unless taken out harmlessly)
- No conversion of wetlands and continuously forested areas for biofuel production (to protect carbon stocks)
- All EU biofuels must meet "cross compliance" environmental rules

The consequences of not meeting the criteria include:

- Biofuels do not count towards targets
- Not eligible for national biofuel obligations
- Not eligible for tax exemptions and similar financial support

The verification of compliance is the responsibility of Member States. To reduce the administrative burden, the European Commission can decide on "certification schemes" giving reliable proof of compliance, which the Member States have to accept as compliance certificates.

Other measures (Article 18) to promote biofuels include introduction of diesel blends with 7% biodiesel by 2010) and 10% biodiesel by 2014. The limit today is only 5%.

In their respective biofuel obligations, Member States should give a bonus to biofuels from wastes, residues, cellulosic and ligno-cellulosic materials.

These measures when implemented should positively impact the use of Sustainability regime as summarized below:

- The *scheme* should increase annual GHG benefits by at least 7MtCO2eq
- Total biofuels use would thus reduce emissions by at least 83Mt

- Annual administrative costs should be approximately €15M.
- The scheme ensures that the EU only supports biofuels with a clearly positive lifecycle GHG benefit and whose growth has not jeopardised biodiversity.

The European Union will closely monitor the progress and developments of implementing these policies.

In view of growing international competition, The SET Plan was developed so that Europe should lead the world with mastery of technology that is vital to competitiveness. Thus, time is of the essence. Decisions taken now will have lasting consequences and cost of inaction will be much higher in the long run

The underlying mission is to use the ambition and the targets of the Energy Policy for Europe to create a new European policy for energy technology

SET Plans/Initiatives should include European industrial initiatives and advancement of European energy research capabilities.

The Trans-European energy networks and systems of the future, driven by European industrial initiatives should strengthen industrial energy research and innovation by assembling and putting in motion the necessary critical mass of activities and actors such as

European Wind Initiative
Solar Europe Initiative
Bio-energy Europe Initiative
European CO2 capture, transport and storage initiative
European electricity grid initiative
Sustainable nuclear fission initiative

SWEDEN

The primary bioenergy policy of Sweden is driven by, security of energy supply in an economical way, 4% reduction of GHG emissions by 2012, and use of environmental taxation to fund programs. Sweden will follow EU policies in implementing:

- ETS system: Base case - 26 Mtonne CO2 (approx. 50% of total national GHG emission is covered by the ETS system)
- 2004-2007 - 23 Mtonne CO2 per year emission rights distributed in allocation plan
- 2008-12 - 20 Mtonne per year emission rights in allocation plan

For 2008-12 period no emission rights are for free, even for existing plants, the utility sector gets zero emission rights, and the industry gets a high percentage of their emissions rights

Energy Savings Plan

Statistics and information at: www. energimyndigheten.se
The results of present biofuels directive are:

- an increase in share of biofuels from 2.2% in 2005 to 3.1 % in 2006
- reduction in energy tax on biofuels of 9 billion SEK until the end of 2011
- removal of import duty on ethanol removed in 2008 (current EU duty 290 €/m3)

New RD&D Initiatives

- New black liqour R&D program initiated with 85 MSEK
- New biomass gasification R&D program initiated with 40 MSEK
- 2nd generation BTL pilot activities initiated with an extra of 150 MSEK during the period 2008-2010
- Establishment of financing for demonstration/industrial deployment of 2nd generation BTL plants stated as policy task in the financial plan for the 2008-2010 period Concretely, the FY 2009 budget allocates 875 million SEK for demonstration of second generation biofuels and other energy technologies for the period 2009-2011

Commercial Activities

Indirect co-firing, Varo Pulp Mill

Gasifier supplier: Götaverken
Fuel: Bark, wood wastes
Fuel capacity: 30 MWth
Gas usage: lime kiln
Commissioning: 1987
Notable Developments: Enriched air tests in 2003 to try to de-bottleneck lime kiln
the Foster-Wheeler CFBG unit at the Norrsundet mill will be closed in 2008, the Karlsborg unit is still there but not operated presently.

Varnamo demonstration

Gasifier supplier: Bioflow (Foster-Wheeler/Sydkraft)
Fuel capacity: 18 MWth
Power: 6 MWe
Heat: 9 MW th
18 bar pressure
Typhoon GT
Mothballed in 2000 after operation for > 8000 hours with gasifier and ~ 3600 hours of integrated operation with gas turbine

CHRISGAS Project

Project Team: Växjö University (co-ordinator), Växjö Värnamo Biomass Gasification Centre

(VVBGC), AGA-Linde, Catator, KS Ducente, Perstorp AB, Royal Institute of Technology (KTH), S.E.P. Scandinavian Energy Project, Södra skogsägarna, TPS Termiska Processer, (Valutec), and Växjö Energi.

Foreign participants:

Denmark: TK Energi, Finland: Valutec, Germany: FZ Jülich, Linde, Pall Schumacher, Italy: University of Bologna, ENI Netherlands: Technical University Delft, CCS Spain: CIEMAT

Budget 15.6 M€ + in kind cost sharing outside project
9.5 M€ EU grant
1.5 M€ STEM grant + 7 M€ grant outside project
Balance of financing of 28 M€ requested from STEM in 2006. 75% approved on condition that industrial consortium engages long-term and provide 25%.

Växjö Värnamo Biomass Gasification Centre

Non-profit, project-based public company, VVBGC AB
Large-scale gasification test platform for synthesis gas (CHRISGAS and others)
Biomass gasification centre on European scale
At present 8 employees, an additional 5-7 people on contract
Several have past work experience in the Värnamo demonstration plant for IGCC.

Gasification tests runs to train personnel and bring the plant from a mothballed state

Sep. 2007
Gas turbine operation (oil), 82 hrs
Combustion of biomass in gasifier at 950 ºC, 24 hrs
Gasification at 950 ºC and 17.5 bar, 13 hrs
Gasification at full load, 7.5 hrs
Wood chip/pellet feed rate: 4.5 ton/hr
Produced power, 304 MWh

Nov.-Dec. 2007
Gas turbine operation (oil), 84 hrs
Combustion of biomass in gasifier overnight
Gasification at 950 ºC and 17.5 bar, 46 hrs daytime
Gasification at full load, 26 hrs
Wood chip/pellet feed rate: 4.5 ton/hr
Produced power, 432 MWh

Status of CHRISGAS RTD & Demo : Since its inception in 2004 under the 6th Framework, with 9.5 M€ (88 MSEK) from EC and 75 MSEK from STEM, the

project is put on hold due to the need for additional funds to complete rebuilding the Varnamo plant and to resume tests. Discussions are on-going to form an industrial consortium that is willing to cost-share the project with STEM. In the meanwhile, a new Managing Director was appointed and efforts are underway to raise ~40 M€ based on a revised estimate from early 2008 to carry the project forward.

Status of CHEMREC BLG Activities: Nykomb Synergetics AB has new co-owners, namely, Volvo Technology Transfer and VantagePoint Venture Funds. With success at Piteå and New Bern, NC, USA, the CHEMREC process is viewed on one hand as a booster to debottleneck Kraft recovery boilers (such as those at Weyerhaeuser, New Bern, NC) and in its pressurised version developed at Piteå, also the ability to co-produce power and automotive (DME) fuels. The DP-1 plant at Piteå, 3MW fuel, will be extended to also include a one stage DME synthesis pilot to produce an estimated 3-4 tpd of fuel grade DME for use in 1 4trucks and as green LPG additive. This is part of a new EU project with a budget of 28 million € involving Chemrec, ETC, Total, Volvo, Topsoe, PREEM, Delphi and DuPont. A scale-up study is also in progress for 25000 tpa DME prototype BLG-BTL plant at Kappa Kraftliner. The other notable activity related to CHEMREC is the recent announcement of a 500 tDS/day plant project feasibility study for the New Page Escanaba mill, in Michigan, USA. See additional material on BLG in Lars Waldheim's presentation posted on the Task Website.

Other Industrial BMG Initiatives: M+W Zander FE GmbH, CTU - Conzepte Technik Umwelt, and Repotec are conducting a study on Biomass to SNG for GOBIGAS (Goteborg Energy) using the TUV-REPOTEC indirect gasification process. Decision will be made in summer 2008 to build a 100 MWth output plant that could start operations in 2012. KTH provides tar reforming support research.

Construction of two-100 MWth capacity co-firing plants is under consideration for MälarEnergi, in Västerås. The fuel includes assorted wastes and demolition wood. Subject to obtaining the necessary permits, plant construction could start in the next year, to retrofit existing 600 MW PF boilers that are currently using peat and coal. Project implementation includes major renovation of boiler and extension of flue gas cleaning to meet WID requirements.

Chalmers U of Technology Initiative: Efforts are underway to demonstrate co-gasification in a CFBC. There are more than 600 CFBCboilers with more than 100 GW capacity and they could be retrofitted to operate as CFBG plants. Chalmers U of Technology has demonstrated the concept on a 2 MWth capacity CFBC unit. About 80 hours of operation has been completed with wood chips and wood pellets. The observed dry gas composition with wood pellets is given below:

Hydrogen	23 %
Methane	17 %
Carbon Monoxide	41 %
Carbon dioxide	15 %

C2H4	~2.5 %
C2H6	0.5 %
Nitrogen	1 %

Calculated lower heating value = 14.3 MJ/nm3 or 15,6 MJ/kg

Other University Research Activities: The Mid Sweden University is conducting research to integrate fuel flexible BMG with FT synthesis and also on system modelling.

KTH (RIT), Stockholm, is developing high temperature pre-heated air gasification. Lund University has started work on a new FP 7 Project on Advanced Cleaning Devices for Production of Green Syngas.

FINLAND

The national bioenergy programs are consistent with EU's mission and to accomplish the following goals:

- Introduce 5.75 % of biofuels in transportation. fuels by 2010
- 20 % share of bioenergy of total energy consumption by 2020
- Implement feed-in tariff during 2008 for biogas plants under 20 MWth

The third nuclear reactor of 1600 MWe in capacity is estimated to start up in Olkiluoto by 2011. It is estimated, that this unit will lower the price of electricity in Northern Europe by 3 €/MWh.

The primary Finnish research activities are summarized below:

a. Fundamental research activities in 2008 - 2010: UCGFUNDA-project by VTT, Helsinki Univ.of Techn. and Abo Akademi University

- Ash behaviour and reactivity in syngas applications
- Fundamentals of catalytic reforming and hot gas filtration
- New gas sampling and analysis methods
- Evaluation of gasification based biomass to hydrogen processes

b. EC-BiGPower project from 2006 - 2008 (coordinated by VTT)

- Further refinements to the Novel gasification process
- Catalytic reforming and hot gas filtration
- Gasification coupled to second generation power production employing turbines and fuel cells

The industrial gasification activities in Finland include:

a. *The Lahti LahtiStreams IP/R&D activities* : CFB BMG plant is planned to be constructed in order to demonstrate high efficiency Waste-to-Energy conversion, production of clean gas from waste at 160 MW scale employing two gasifiers, two gas filters, a new boiler plant, and flue gas cleaning. The project is supported by the EU/TREN Integrated Project. The total cost estimate is approximately 150 million euro. The project co-ordinator is Lahti Energia. Further R&D on gas cleaning and ash utilisation is in progress at VTT. Although the Environmental License was granted on April 30, 2007, delays due to public hearings have caused significant increases in construction costs. Revised feasibility studies are now in progress.

b. *CHP by gas engines*: At the Novel Kokemäki demonstration, the latest test run ended on December 6, 2007. Although the technical readiness to proceed was recognized in February 2008, contract related negotiations have delayed resumption of plant testing and evaluation for the time being.

Carbona's CHP plant in Skive, DK was commissioned in 2007 and tests are now in progress. The demonstration process employs similar gas cleaning trains as the Novel Process in Kokemäki (monolith catalysts for tar decomposition) licensed by VTT.

c *Syngas for biorefineries*: Finnish forest industry could take advantage of the existing front-end biomass handling knowledge and benefit by readily implementing large-scale biorefineries. Stora Enso and UPM are evaluating commercial co-production of biopower, pulp and paper, biochemicals, and biodiesel including crude waxes.

The primary technology development activities in Finland include:

A. Initial R&D and concept studies were realised in VTT-led UCG-project in 2004-2007, Bio-syngas process tests with 0.5 MWth process development unit (PDU). This project was financed by Finnish governnment and a group of industrial companies: Neste Oil, Foster Wheeler, Andritz, Vapo, PVO, UPM, Stora Enso, M-Real, Metsä-Botnia
B. Demonstration of a bio-syngas process at ca. 15 MW scale at Varkaus by Neste Oil and Stora Ensa. Foster wheeler is supplying CFB gasification technlogy and VTT is acting as the main R&D partner in this project. The plant will be taken into operation in early 2009. Plant design studies already underway along with experimental research employing the flexible PDU at VTT. Upon demonstration of economic success, a pre-commercial plant of 200-300 MWth capacity is expected to be commissioned by 2013.
C. The UPM/Andritz/Carbona Co-operation project announced in June 2007 involves conducting pilot plant tests until the end of 2008 at the GTI Flex Fuel pilot plant, in Des Plaines, IL, USA at an estimated cost of 5 - 10 million euro. The pilot plant test results will form the basis for building the first commercial plant.

The Netherlands

With the termination of certain subsidies, the consumption of renewable energy (RE) dropped in 2007 compared to 2006. The national policies and developments, the reality and targets are summarized in the following table.

effect	2006	2007	2010	2020
RE (from 20% EU target)				14%
	2.8%	2.6%		
RE (national government)				20%
RE in power	6.5%	5.8%	9%	
RE in transport (biofuels)	0.4%	2%?	5.75%	
CO_2 (national government)	3%			30%

The following table illustrates a new subsidy scheme introduced on April 1, 2008.

	total price incl. subsidy	max. subsidy in contract period	contract period
wind on-shore	11 €ct/kWh	796 M€	15 years
biomass (<50 MW)	12 €ct/kWh	289 M€	12 years
waste	11.5-13.7 €ct/kWh [a]	187 M€	15 years
PV	56 €ct/kWh	46 M€	15 years
green gas [b]	27.7 €ct/m_n^3	16 M€	12 years

a: efficiency 22% to 31%

b: from digestion of sewage sludge/water treatment or landfill gas

According to AutoWeek nr. 6, 13 Feb. 2008, the network of CNG filling stations will be launched. This fuelling infrastructure could also use biomass derived SNG. (www.CNGnet.nl)

The particulars and status of the major biomass gasification plants are given below:

Essent Power Plant

- 85 MWth CFB gasifier operated on demolition wood, heat exchanger/cooler, cyclone, providing 5% of input energy to the 600 MWe coal-fired boiler, Amer-9 power station, in Geertruidenberg, NL
- Addition of clean wood pellets co-firing to provide 22 % of RE using dedicated milling and burners
- Operating hours : 3000 in 2007, 1000 in 2008 (boiler maintenance late March-June)
- Main problem: cooler fouling, after certain time pressure drop gets too high although cooling capacity is satisfactory

NUON Power Plant

- 2002: start of biomass co-gasification trials
- March 2006: official opening of biomass facilities for 30 wt % co-gasification, with a 1500 m3 wood silo, 400 m pneumatic transport to gasifier
- now: ~10 % energy from demolition wood. Wood contribution could be raised further but supply of pulverized demolition wood is a limiting factor
- 1% slip stream CO2-capture test planned, operational 2010/Q1
  - improved concept, low energy use
  - information useful for the Magnum project

NUON (Magnum) Power Plant

- Magnum will start as 1200 MWe NG-fired plant with dual-fuel turbines, Shell biomass gasifiers will be added in the next phase
- Carbon credit purchased
- CO2-capture work ongoing in Buggenum
- Process optimization:
  - lowering CAPEX
  - co-production of synthesis gas

HOST Chicken Manure Power Plant

- 3 MWth CFB gasifier, cooler, cyclone, boiler, steam turbine
- flue gas cleaning: bag house filter (carbon injection), non-catalytic deNOx
- 3500 hours in 2007 (due to limited supply of chicken manure), ash to fertilizer industry
- main problem: supply of *dry* manure
- test runs on RDF and MBM
- A 10 MWth chicken manure plant is planned for 2009

Other alternative and advanced energy projects:

a. BIO-MCN- former Methanor

- Capacity: demonstrated producing 900,000 tonnes/year of methanol from natural gas in two parallel lines
- Present owner: bio-MCN (Methanol Chemistry Netherlands) for bio-methanol production
- First feedstock option: glycerin from biodiesel production
- Start of successful operations: 30 March 2008 at 20,000 tonnes/year capacity
- Plans for expansion: 200,000 tonnes/year capacity in 2009/Q1 and 800,000 tonnes/year capacity in 2010
- Prices: fossil methanol: 250 €/ton, green methanol: 600 €/ton

b. ECN Olga-Dahlman Filter Technology

- interest from all over the world
- supplier Dahlman: 3 persons on OLGA
- technology can play a crucial role in biomass-to-SNG development at ECN
- adapted successfully to high concentrations from MILENA indirect gasifier
- work started to adapt OLGA for low-temperature gasifiers

c. ECN MILENA -Indirect Gasifier

- pilot plant of 160 kg/hour capacity installed in late 2007
- will be started in May 2008
- connected to existing OLGA
- gasifier reactor, flue gas filter

d. ECN-SNG

- focus on efficiency
- MILENA-OLGA is the basis for process design
- Process can now deal with: heavy tars, light tars, benzene, toluene, acetylene, ethylene, thiophenes, H2S, COS and chlorine.

e. ECN-SOFC

- January 2008: 30 cell SOFC stack (230 W) operated on wood for 200 hours without any problem as a part of the European project 'Green Fuel Cell'
- All gas cleaning operations above 350 C

f. ECN Torrefaction

- focus on high efficiency (>90%)
- torrefaction gas used for process heat generation
- integration with pellet production
- 50-100 kg/h pilot plant in operation: PATRIG with the following activities

  - validation of reactor and process concept
  - optimisation of process conditions with different types of biomass
  - industrial pelletisation tests
  - extensive evaluation of pellet quality
- Industrial partnership formed (BO2 Energy Concepts) with E-Concern and Chemfo aimed at technology demonstration and market introduction
- ECN provides IP& R&D
- E-Concern responsible for market introduction of BO2 pellets
- First commercial plant planned for The Netherlands, at approx. 70,000 tonnes/year, planned start-up late 2009
- Chemfo - Engineering and supply of commercial BO2 plants

Related References on/at:

- publications: www.ecn.nl/publications
- composition database: www.phyllis.nl
- tar dew point calculator: www.thersites.nl
- IEA bioenergy/gasification: www.ieatask33.org
- Milena indirect gasifier: www.milenatechnology.com
- OLGA: www.olgatechnology.com
- SNG: www.bioSNG.com and www.bioCNG.com

NEW ZEALAND

NZ Energy Policies, Strategies & Status Update
In late 2007, NZ Government issued three new policies and strategies:

a. Biofuel sale obligation bill: obligation for transport liquid fuel from renewable sources 0.53% in 2008, 3.4% by 2012;
b. Reduction of GHG emissions amounting to 50% of 2007 level by 2040;
c. 90% electricity generated from renewable sources by 2025.

In the meantime, Emission Trading Scheme was proposed, and the government provides more funding for bioenergy R&D:

- NZ$4.1 million per year for renewable energy from 1st Oct., 2008.
- $4 million per year for three years on low carbon energy technologies with emphases on demonstration projects of bioliquid fuels and bioenergy.

The NZ Emission Trading Scheme (ETS) promotes renewable energy and it is essentially a Carbon Tax, aimed at reducing liquid fossil fuels, natural gas and coal, primarily at refineries, ports, and mining. The scheme increases the price of diesel and electricity, and creates a payment mechanism to reward land owners who provide a range of environmental services by planting forest on grassland (typically hill country pasture in NZ context). Carbon Credits (a subsidy) come

with a clear liability to maintain Carbon on the land base. Participants face insurance, compliance (measurements & reporting) and land use opportunity costs.

NZ ETS provides incentives first to forest owners in 2008, followed by incentives for carbon reduction to oil companies in 2009, then coal, gas & geothermal energy in 2010. The agriculture section is proposed to implement this ETS by 2013.

The impact of ETS as direct cost to NZ households is illustrated in the following table (Peter Weir, 2008, cited from Castalia, 2007, NZ Government Regulation Impact Statement).

Scenarios	**1**	**2**	**3**	**4**
Carbon Price (t CO2e)	NZ$10	NZ$25	NZ$50	NZ$100
Average household expenditure	$100 - $200 pa	$170 - $330 pa	$330 - $660 pa	$660 - $1320 pa
Increase petrol price per litre (incl GST)	3.7c	6.1c	12.2c	24.4c
Increase wholesale electricity price per kWh	0.7c	1.4c	2.9c	5.8c
Increase in retail electricity price per kWh	1c	2c	4c	8c

Energy Price Scenarios 2025 based on carbon price of NZ$300/tonne CO2e is illustrated in the following table (Peter Weir, 2008, cited from Infometrics, 2008, using NZ Government Emissions Trading Group model)

	2007	**Increase**	**Price**
Coal ($/GJ)	$5.00	$30.00	$35.00
Gas ($/GJ) - Business - Household	$6.40 $22.70	$16.30	$22.70 $39.00
Petrol ($/litre)	$1.56	$0.89	$2.55
Electricity (/kWh) – Business – Household	8.7c 18.7c	18c	26.2c 36.7c

Biomass Gasification Suppliers in NZ:

- Fluidyne Ltd provides gasification technologies to a number of overseas biomass gasification projects.
- Alternative Energy Solution (AES) is the representative for Ankur gasifiers from India, in Australasia. Products range from 30kw-5.5MW with electricity generation modules. Working with Ankur, AES has developed a high temperature gas conditioning filter (HTF) which has passed prototype tests and was commercially released in 2007.
- Page MaCrea Engineering Ltd continues to operate the 1.7 MWth updraft gasifier in a plywood mill using:

- Plywood chip at 11% moisture content wet basis,
- Veneer trim (green wood waste) at 45% moisture content,
- Debarked waste (mixture of bark and green wood waste) at 42% moisture content.

Progress of Biomass Gasification at University of Canterbury is summarized below:

- 100 kW Fast Internal Circulating Fluidised Bed (FICFB) gasification system has been constructed and tested in cold and hot conditions.
- On-line gas analysis, gas sampling and scrubbing system have been developed and installed.
- A comprehensive safety review has been conducted and safeguards are implemented.
- Two master students have graduated. Six new postgraduate students are working on various projects in this area. So far studies have been conducted to investigate: i). Effect of gasification temperature on producer gas composition (650-800°C) and ii). Effects of steam/biomass ratio (0.35 to 0.77).

Summary of Best Results Achieved

The aim has been to maximise the calorific value of the producer gas for CHP applications while minimising the formation of tars (Jock Brown, 2006; Doug Bull, 2008).

	2006	Feb 2008
Gasification Temperature °C	750	730
H2 [%]	21.7	23.5
CO [%]	28.4	34.3
CO2 [%]	17.4	18.9
CH4 [%]	11.6	14.0
Ethene [%]	3.5	4.4
Ethane [%]	0.5	0.8
N2 [%]	16.9	3.8
He (tracer gas) [%]	0	0.4
Lower Heating Value (LHV) [kJ/Nm³]	10,300	13,500
Producer Gas Generation Rate [Nm³/h]		16.8
Cold Gas Efficiency [%]		44

Other progress in University of Canterbury's BMG Studies:

- New gas cleaning technology to recycle the tar removed back to the combustion column and reuse the scrubbing solvent.
- Feasibility studies on construction of a pilot scale biomass gasification plant in a wood processing plant.

In last two years, two rounds of comprehensive HAZOP reviews were conducted at the University of Canterbury for the 100 kW FICFB gasifier following IEC 61511 International Functional Safety Standard for the process industry and to employ a performance-based (not prescription) process to manage risks. The HAZOP review process involved:

- Analyse the system to understand the risks;
- Specify any additional safety measures needed to manage risk;
- Design safety measures to meet specifications;
- Test the safety system;
- Monitor operations and manage changes to keep risks low;
- Define safety lifecycle objectives;
- Build safer systems that do not experience as many of the problems of the past;
- Build more cost effective systems that match design with risk;
- Eliminate "weak link" designs that cost much but provide little;
- Provide a global framework for consistent designs;
- Develop an example of Safety Review Form.

Next Task Meeting:
Dates: October 15 to 17, 2008.
Location: Montreal, Canada. Details to be developed with Dr. Fernando Preto.
Work Shop Topic: "A Case for Thermal Gasification of Biomass", with presentations from Task Members. Task Leader will prepare a preliminary report on the subject by June 30, 2008 which could be used by Members to present their individual views.

Attachment A

IEA Bioenergy Agreement: 2007-2009
Task 33: Thermal Gasification of Biomass
First Semi-annual Task Meeting, 2008
21 to 23, April 2008, Vienna, Austria
Draft Agenda

Day 1, Monday, 21 April 2008: TASK MEETING
Location: Hotel Savoyen Vienna, Rennweg 16, 1030 Wien
Tel.: +43 (1) 206 33-0 Fax: +43 (1) 206 33-9210
http://www.austria-trend.at/sav/ e-mail savoyen@austria-trend.at

09:00- Welcome: Suresh Babu/Reinhard Rauch

2. Introduction of Task Members and Observers
3. Review and Approval of Agenda
4. Review and Approval of Minutes from Second Semi-annual Task Meeting, 2007, 24 to 26, October 2007, The Netherlands
5. Review Task Deliverables
    a. WS Reports
    b. Thermal Gasification Paper
    c. Country Reports –Publication with GasNet in 2008
6. Country Activities and Reports on Biomass Gasification (30 Minutes/Country):
    a. USA, Richard Bain, NREL
    b. Finland, Illka Hannula, VTT
    c. Sweden, Lars Waldheim, TPS
    d. European Commission, Philippe Schild, EC

12:30 to 13:30: LUNCH

    e. Germany, Thomas Kolb, ITC-TAB
    f. Denmark, Henrik Christiansen, DEA
    g. New Zealand, Shu-sheng Pang, Univ. of Canterbury
    h. Canada, Fernando Preto, NRC
    i. Netherlands, Bram van der Drift, ECN
    j. Austria, Reinhard Rauch, TUV
    k. Switzerland, Ruedi Bühler,U+E
    l. Slovakia, Jozef Viglasky from Technical University in Zvolen
    m. Spain, Soria Santiago from GUASCOR S.A
7. Discussion
8. Next Task Meeting: Any 3 days between Oct 13 to 17 or 20 to 24, 2008, Location: Ottawa/Montreal, Canada??, WS Topic: TBD???
9. OPEN/Wrap-up
10.

17:00 to 17:30: Wrap-up and Action Items for the Day
(Note: Coffee breaks at 10:30 and 15:30, for 15 minutes)

Day 2, Tuesday, 22 April, 2008: Plant Visit

08:15 Departure from Hotel Theresianum
08:30 Hotel Savoyen
10:30 Arrival in Güssing
Visit CHP Plant
Visit BioSNG demonstration plant (construction site)
Visit BioFiT pilot plant
12:00 Lunch break Gasthaus Walits-Guttmann
13:30 Plant Visit - Continued
Biopowerplant
Pyroforce plant
Biogas Steam Reforming plant (Strem)
18:30 Return to Vienna

Day 3, Wednesday, 23 April, 2008***

HSE Workshop: "On the Way to safe and eco-friendly Biomass Gasification"

Location: Hotel Savoyen Vienna, Rennweg 16, 1030 Wien

Tel.: +43 (1) 206 33-0 Fax: +43 (1) 206 33-9210

http://www.austria-trend.at/sav/ e-mail savoyen@austria-trend.at

08:30 Registration

09:00 Opening and Welcome: Hermann Hofbauer, TU Vienna

09:05 Introduction and History: Ruedi Bühler, Umwelt + Energie

09:15 Presentation of HSE Project: Harrie Knoef, BTG

09:45 Draft Guideline Overview (Target, Background and content): Friedrich Lettner,

TU Graz

10:15 Coffee Break

10:45 Draft Guideline Legal framework: Ulrich Seifert, Fraunhofer UMSICHT

11:15 Draft Guideline Risk assessment and software tool: Helmut Timmerer, TU Graz

11:45 Reflection on the Guideline by Manufacturer: Martin Schaub, CTU Pyroforce

12:05 Reflection on the Guideline: OPEN

12:25 Reflection on the Guideline by Engineer/Advisor: Thomas Otto, FEE

12:45 Lunch buffet

14:00 Keynote Speaker Good design practice (HSE) in France: Nicolas Millet, ENERIA

14:25 Keynote Speaker Good design practice: Jens Dall Bentzen, COWI

14:50 Keynote Speaker HSE Authority: Laurence Cusco, H&S laboratory

15:15 Panel discussion "On the Way to safe and eco-friendly Biomass Gasification"

Moderators: Suresh Babu, IEA and Ruedi Bühler, Umwelt+Energie

16:00 Coffee break

16:30 Panel discussion "On the Way to safe and eco-friendly Biomass Gasification"

Moderators: Suresh Babu, IEA and Ruedi Bühler, Umwelt+Energie

17:30 Summary

18:00 Closure of the workshop, Hermann Hofbauer, TU Vienna

******* - Program prepared by GasNet