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IEA Bioenergieprogramm 2010-2012 Task 33: Thermische Vergasung von Biomasse

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Berichte aus Energie- und Umweltforschung

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IEA Bioenergieprogramm 2010-2012 Task 33: Thermische Vergasung von Biomasse

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Wien, März 2013

Ein Projektbericht im Rahmen der Programmlinie

IEA FORSCHUNGS KOOPERATION

Impulsprogramm Nachhaltig Wirtschaften

Im Auftrag des Bundesministeriums für Verkehr, Innovation und Technologie

Vorbemerkung

Der vorliegende Bericht dokumentiert die Ergebnisse eines Projekts aus dem Programm FORSCHUNGSKOOPERATION INTERNATIONALE ENERGIEAGENTUR. Es wurde vom Bundesministerium für Verkehr, Innovation und Technologie initiiert, um Österreichische Forschungsbeiträge zu den Projekten der Internationalen Energieagentur (IEA) zu finanzieren.

Seit dem Beitritt Österreichs zur IEA im Jahre 1975 beteiligt sich Österreich aktiv mit Forschungsbeiträgen zu verschiedenen Themen in den Bereichen erneuerbare Energieträger, Endverbrauchstechnologien und fossile Energieträger. Für die Österreichische Energieforschung ergeben sich durch die Beteiligung an den Forschungsaktivitäten der IEA viele Vorteile: Viele Entwicklungen können durch internationale Kooperationen effizienter bearbeitet werden, neue Arbeitsbereiche können mit internationaler Unterstützung aufgebaut sowie internationale Entwicklungen rascher und besser wahrgenommen werden.

Dank des überdurchschnittlichen Engagements der beteiligten Forschungseinrichtungen ist Österreich erfolgreich in der IEA verankert. Durch viele IEA Projekte entstanden bereits wertvolle Inputs für europäische und nationale Energieinnovationen und auch in der Marktumsetzung konnten bereits richtungsweisende Ergebnisse erzielt werden.

Ein wichtiges Anliegen des Programms ist es, die Projektergebnisse einer interessierten Fachöffentlichkeit zugänglich zu machen, was durch die Publikationsreiche und die entsprechende Homepage **www.nachhaltigwirtschaften.at** gewährleistet wird.

Dipl. Ing. Michael Paula
Leiter der Abt. Energie- und Umwelttechnologien
Bundesministerium für Verkehr, Innovation und Technologie

Inhaltsverzeichnis

Kurzfassung

Das Ziel von IEA Bioenergy Task 33 „Thermische Vergasung von Biomasse“ ist es, Informationen über die Erzeugung von Heizgasen aus Biomasse für den Einsatz in umweltverträglichen, energieeffizienten und wirtschaftlich konkurrenzfähigen Energiebereitstellungssystemen auszutauschen. Dabei wird besonders auf den Informationsaustausch über die F&E Programme im Bereich Biomasse- und Reststoffvergasung, die kommerziellen Anlagen und die Marktchancen für Biomassevergasungssysteme Wert gelegt, um technische und nicht-technische Hürden zu identifizieren und zu beseitigen.

Österreich hat im vergangenen Triennium als Subtask Leader bei folgenden Projekten aktiv mitgearbeitet:

- Country Reports
- Analysenmethoden zur Charakterisierung von Synthesegas
- Betriebserfahrungen von Biomassevergasungsanlagen
- Workshop Beiträge zum ausgewählten Thema
- Neugestaltung und Wartung der Task 33 Webseite
- Regelmäßiges Update der Task 33 Datenbank
- Task 33 Newsletter Beiträge

Zusätzlich ist Österreich noch aktiv an folgenden Projekten beteiligt, wie die Erstellung von Berichten über die Entwicklung der Biomassevergasung in den einzelnen Mitgliedsstaaten, der Standardisierung von Teer Messungen, der Produktion von Wasserstoff und Wasserstoff reichem Gas aus der Biomassevergasung sowie der Betrachtung von Biomassevergasungsanlagen aus dem Blickwinkel Gesundheit, Sicherheit und Umweltverträglichkeit.

Die Tasks in IEA Bioenergy sind in Triennien organisiert und die Arbeiten des Task 33 finden in Form von Meetings statt wobei im letzten Triennium (2010-2012) 6 Meetings und 5 Workshop zu einem spezifischen Schwerpunkt abgehalten wurden. Die Minutes der Meetings sowie Workshop-Reports, Country Reports und Workshop Vorträge sind auf der Homepage zu finden: http://www.ieatask33.org.

In diesem Triennium werden folgende technische Schwerpunkte behandelt:

- Bed materials in fluidised bed gasification
- Product gas cleaning and usage
- Tar formation, analysis and removal
- Small scale fixed bed gasification
- Analysis & measurements (trace components)
- Sustainability
- Fuel pre-treatment, demands of gasifiers on fuel quality
- Drop in fuels

Die Mitgliedschaft in einer Organisation wie der IEA Bioenergy ist was den wissenschaftlichen Nutzen betrifft sehr wertvoll für den gegenseitigen Austausch von aktuellen Informationen im Bereich der Biomassevergasung. Aus diesem Grund ist eine weitere Mitarbeit in der IEA unumgänglich, vor allem wenn sich Österreich

weiter unter den führenden Nationen in der Nutzung alternativer Energieträgern behaupten will, zu denen die Biomassevergasung ohne Zweifel gehört.

Summary

The scope of the work for Task 33 is the organization of semi-annual Task Meetings to exchange and review global R&D programs and projects to identify barriers to commercialize biomass gasification process (BMG). Use the survey information to prepare and update Country Reports and R&D needs and to make them available to national team leaders to aid in the development of their respective national BMG and bioenergy plans. Conduct subtask studies including focused technical workshops, with industrial and academic experts to address the key barriers to advancing BMG. Wherever possible, conduct joint studies with related tasks, annexes, and other international activities to pursue mutually beneficial investigations.

In Triennium 2007-2009 there were 6 meetings hold, including a workshop on a defined topic. The Meeting Minutes can be found on homepage **www.ieatask33.org**.

Austria worked up following Task Projects as a subtask-leader (2010-2012):

- Country Reports
- Analytical methods for characterisation of synthesis gas
- Operating experience of biomass gasifications systems
- Workshop contributions related to specific topic
- New design of Task 33 website and maintenance
- Regular update of Task 33 database
- Newsletter contributions

In addition Austria is active in the projects such as Standards of tar measurement, Biomass gasification for production of hydrogen and hydrogen-rich gas and last but not least Health-, safety- and environmental aspects of biomass gasification plants. Furthermore a Newsletter as an important information source for Austrian Industry about the highlights in biomass gasification area in Task 33 member countries is published twice a year.

Within this Triennium there are following topics for workshops planed:

- Bed materials in fluidised bed gasification
- Product gas cleaning and usage
- Tar formation, analysis and removal
- Small scale fixed bed gasification
- Analysis & measurements (trace components)
- Sustainability
- Fuel pre-treatment, demands of gasifiers on fuel quality
- Drop in fuels

The information exchange and activities of the Task 33 are very valuable for Austria as a member country, because several commercial and demonstration projects are currently underway. The experiences of projects in other countries can be applied to these projects.

Einleitung

Thermische Biomassevergasung ist ein Prozess, bei dem die Biomasse (Holz, Stroh, usw.) mit Hilfe der zugefügten Wärme und eines Vergasungs- oder Oxidationsmittels (meist Luft**,** Sauerstoff**,** Kohlendioxid oder Wasserdampf) in ein Produkt- oder Brenngas umgewandelt wird. Da sowohl historisch, als auch aktuell, vor allem Holz als Biomasse zum Einsatz kommt, spricht man in der Regel auch von Holzvergasung.

Über die Vergasung kann die als Festbrennstoff vorliegende Biomasse in einen gasförmigen Sekundärbrennstoff umgewandelt werden, der in verschiedenen Nutzungsoptionen wie bsp. der Stromerzeugung oder als Kraft- und Treibstoff (Brenngas) oder für die Nutzung als Synthesegas für die chemische Synthese und somit z.B. eine Produktion der flüssigen Biotreibstoffen effizienter eingesetzt werden kann.

Den Vergasungsprozess kann man als Allothermal- oder Autothermalprozess betrachten. Bei der Allothermalvergasung ist die benötigte Vergasungswärme von außen dem Vergaser zur Verfügung gestellt, bzw. zugefügt. Bei der Autothermalvergasungsprozess ist die Wärme

Die Biomassevergasung findet in einem Vergaser statt. Es gibt viele verschiedene Vergasertypen, die können aufgrund Designs in drei Gruppen geteilt werden: fixed bed (Festbett-), fluidized bed (Wirbelschicht-) und entrained flow (Flugstromvergaser). Eine graphische Darstellung finden Sie im folgenden Bild.

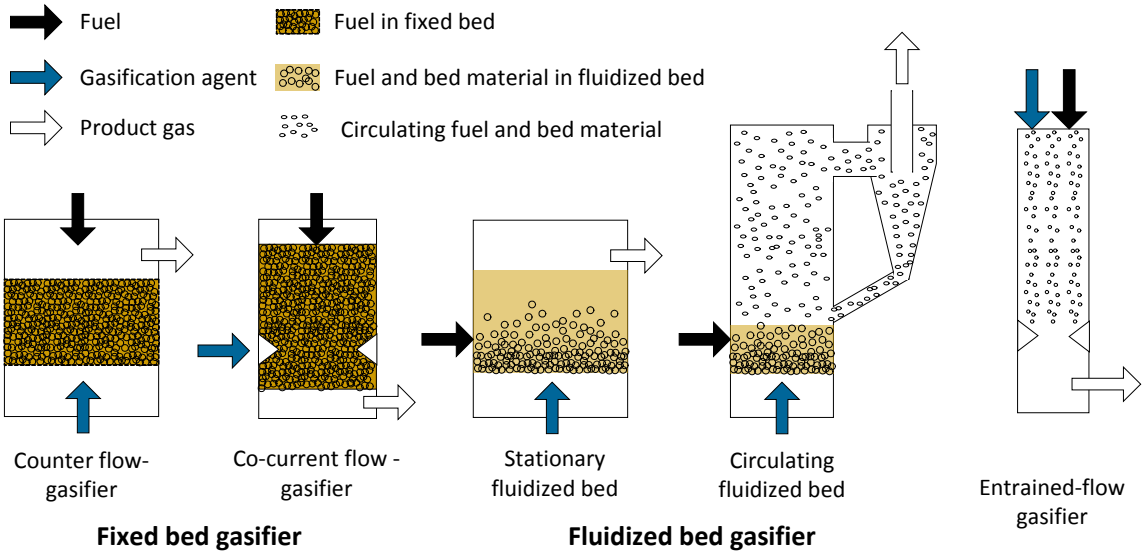

Bild 1: Biomassevergaser – Einteilung nach dem Design

Nicht nur Design sondern auch Temperatur, Druck, Brennstoffqualität, Vergasungsmittel und weitere Parametern bestimmen die Qualität und Menge des Produktgases. Folgende Tabelle bietet einen Überblick über die

Produktgaszusammensetzung bei der Biomassevergasung mit Sauerstoff und Dampf.

Chem. Verbindung		**O_2-Vergasung**	**Dampfvergasung**
CO	Vol. %	40-60	20-25
CO_2	Vol. %	10-15	20-25
H_2	Vol. %	15-20	30-45
CH_4	Vol. %	0-1	6-12
N_2	Vol. %	0-1	0-1
LHV	MJ/Nm^3	10-12	10-14

Tabelle 1: Produktgas-zusammensetzung

Produktgasnutzung

Durch die thermische Nutzung von Biomasse zur Erzeugung von Strom, Wärme, Treibstoffen und Chemikalien wird ein wesentlicher Beitrag zur Minimierung von Treibgasen geleistet. Zusätzlich werden die wertvollen fossilen Rohstoffe eingespart.
Die Produkte der thermischen Vergasung sind einerseits Strom und Wärme oder auch Treibstoffe und Chemikalien.
Bei der Produktion von Strom und Wärme wird bei der Vergasung bereits bei kleinen Anlagen ein hoher elektrischer Wirkungsgrad erreicht, bei gleichzeitigem hohem Wärmeoutput. Dies ist ein wesentlicher Vorteil der Vergasung gegenüber der Verbrennung, was besonders angesichts limitierter Ressourcen wichtig ist.
Bei der Produktion von Treibstoffen über die Vergasung werden Reststoffe oder lignozellulose Biomassen eingesetzt, womit keinerlei ethischen Probleme im Gegensatz zu den jetzigen Biotreibstoffen entstehen.

Die politische Entwicklung und die fast ausgebrauchte fossile Brennstoffe sind der Grund, warum ist die Produktgasnutzung auf die Biotreibstoffe in der letzten Jahre so intensiv fokussiert.

Zu den bedeutendsten Verfahren für die Produktgasnutzung sind zurzeit Fischer-Tropsch Synthese, Produktion von Wasserstoff, Methanol, gemischten Alkohole und Bio-SNG.

Fischer Tropsch Synthese

Hochwertige Kohlenwasserstoff-Kraftstoffe können aus Biomasse über den Weg der Vergasung und Fischer-Tropsch Synthese hergestellt werden (z.B. schwefel- und aromatenfreier Diesel-Kraftstoff). Dabei handelt es sich um eine Katalytische Umwandlung des Produktgases bei erhöhte Temperatur und Druck.

Als Nebenprodukte fallen sauerstoffhaltige Kohlenwasserstoffe wie Ethanol und Aceton sowie Ethen**,** Propen und höhere Olefine an. Als Quellen für die Synthesegaserzeugung stehen neben Kohle auch Erdgas und Biomasse zur Verfügung.

Das Verfahren wurde von Franz Fischer und Hans Tropsch in 1925 entwickelt.

Diese mehrstufige Umwandlung bedeutet im Vergleich zur Gewinnung entsprechender Kraftstoffe aus Erdöl einen erhöhten technischen, energetischen und ökonomischen Aufwand was der wahrscheinliche Grund für keine Produktion im großen Maßstab bis jetzt wurde.

Wasserstoff

Wasserstoff könnte in Zukunft ein wichtiger Energieträger sein, heute wird er jedoch vor allem als wichtiger Einsatzstoff für industrielle Produktionsprozesse eingesetzt - unter anderem in Raffinerien. Für die Herstellung von Wasserstoff werden in der Regel fossile Rohstoffe wie Rohbenzin oder Erdgas verwendet, derzeit ist die Verwendung von Wasserstoff daher noch keine nachhaltige Technologie. Setzt man hingegen nachwachsende Rohstoffen für die Herstellung von Wasserstoff ein, können fossile CO_2-Emissionen vermieden werden.

Derzeit scheint jedoch die Vergasung von Biomasse der kostengünstigste Weg für die Herstellung von Wasserstoff aus erneuerbarer Energie zu sein.

Methanol

Methanol, auch bekannt als Methylalkohol, oft bezeichnet als MeOH kann von fossilen oder erneuerbaren Brennstoffen hergestellt werden. Es könnte im Transportsektor oder für Produktion der weiteren Kohlenwasserstoffen verwendet werden.

Aus Produktgas von der thermischen Biomassevergasung könnte Methanol via katalytische Umwandlung hergestellt werden.

$$CO + 2H_2 \leftrightarrow CH_3OH$$

$$CO_2 + 3H_2 \leftrightarrow CH_3OH + H_2O$$

Als Katalysator werden Kupfer-oxide, Zink-oxide und Chrom-oxide verwendet.

Gemischte Alkohole

Die Bedeutung der katalytischen Umwandlung vom Produktgas zu den gemischten Alkoholen nimmt heutzutage zu. Die gemischten Alkohole können als Additive zu Treibstoffen verwendet werden, was die Oktannummer erhöht und gleichzeitig wegen der Reinheit die Umwelt schont.

Bio-SNG

Synthetisches Erdgas (Sy, das bei der thermischen Biomassevergasung hergestellt werden kann ist nicht nur CO_2 neutral aber spart das fossile Erdgas.

Das Synthesegas wird nach einer Reinigung von Partikeln, Kohlendioxidanteilen und Schwefel- und Chlorverbindungen einer anschließenden Methanisierung zugeführt. Diese erfolgt exotherm und findet bei Temperaturen von 300 bis 450 °C und einem Druck zwischen einem und fünf bar in Anwesenheit eines geeigneten Katalysators statt.

Ausgangssituation/Motivation des Projektes

Österreich ist seit 1978 Mitglied im Bioenergy Implementing Agreement der Internationalen Energieagentur (IEA Bioenergy). Die Ziele des Bioenergienetzwerks sind die Förderung des Einsatzes umweltverträglicher und konkurrenzfähiger Bioenergie auf der Basis einer nachhaltigen Nutzung und die Bereitstellung eines substanziellen Beitrags für eine zukunftsfähige Energieversorgung.

Das Ziel von Task 33 „Thermische Vergasung von Biomasse“ ist es, Informationen über die Erzeugung von Heizgasen aus Biomasse für den Einsatz in umweltverträglichen, energieeffizienten und wirtschaftlich konkurrenzfähigen Energiebereitstellungssystemen auszutauschen. Dabei wird besonders auf den Informationsaustausch über die F&E Programme im Bereich Biomasse- und Reststoffvergasung, die kommerziellen Anlagen und die Marktchancen für Biomassevergasungssysteme Wert gelegt, um technische und nicht-technische Hürden zu identifizieren und zu beseitigen.

Beschreibung des Standes der Technik im Forschungsgebiet

Auf dem Gebiet der Vergasung von Biomasse hat in den letzten Jahren eine intensive Forschungs- und Entwicklungstätigkeit stattgefunden, wobei die Zielrichtung eindeutig im kleinerem Bereich die Kraft-Wärme-Kopplung war, bei größeren Anlagen wurde die Forschung neben der Stromerzeugung auch auf Synthesgasanwendungen fokussiert. Im kleinen Leistungsbereich (< 2 MW_{el}) wurde insbesondere die Festbettvergasung untersucht, wogegen im großen

Leistungsbereich (> 2 MW_{el}) der Wirbelschicht- oder Flugstromvergasung der Vorzug zu geben ist.

Sowohl in Europäischen Ländern (Fin, D, DK, S, I, A, CH) als auch in den USA und Japan entstanden bzw. entstehen Demoanlagen, an denen unterschiedliche Technologien zur kommerziellen Reife herangeführt werden sollen. Besonders erwähnenswert sind folgende Anlagen:

- Neste Oil, Finland: Herstellung von flüssigen Biotreibstoffen
- Choren, Deutschland: Herstellung von FT-Diesel
- Chemrec, Schweden: effiziente Vergasungstechnologie mit BioDME Erzeugung
- Lahti, Finnland: Müllvergasung mit 2*80MW zur Strom und Wärmeerzeugung

In Österreich konnte in den letzten Jahren die Wirbelschicht-Dampfvergasung mit einem Gasmotor zur Stromerzeugung erfolgreich etabliert werden. Hier laufen seit längerem Arbeiten, um das Produktgas auch als Synthesegas zu verwenden. Derzeit werden verschiedene Produkten aus dem Synthesegas hergestellt, wie zB. BioH2, FT Diesel, SNG und Gemischten Alkohole.

Im Bereich der kleineren Leistungsbereiche arbeitet die TU Graz (Heat Pipe Reformer) und die Fachhochschule Innsbruck. Es sind auch zahlreiche Firmen, wie z.B. Urbas, CleanstGas, GET im Bereich Vergasung zur Kraft-Wärmekopplung aktiv.

Hintergrundinformation zum Projektinhalt

Im IEA Bioenergy Task 33 arbeiteten bisher 8-13 Länder und die Europäische Kommission mit. Im vergangenen Triennium haben sich folgende Länder beteiligt:

- ✓ Österreich
- ✓ Dänemark
- ✓ Finnland
- ✓ Deutschland
- ✓ Italien
- ✓ Japan
- ✓ Niederlande
- ✓ Schweiz
- ✓ USA
- ✓ Türkei

- ✓ Neuseeland
- ✓ Schweden
- ✓ Norwegen

Die teilnehmenden Länder gestalten den Task wesentlich mit. Die Mitarbeit beinhaltet Entscheidung über das geplante Arbeitsprogramm, die Länderberichte, die Mithilfe bei der Organisation der Workshops und auch den Input zur Task Webseite.

IEA Bioenergy Task 33 ist als Netzwerk zum Informationsaustausch zwischen den einzelnen Mitgliedern aufgebaut. Der wesentliche Informationsaustausch findet bei den Task Meetings statt. Im Rahmen der Länderberichte präsentieren die Vertreter bei den Task Meetings den Status der politischen Rahmenbedingungen, aktuelle Entwicklungen und geplante Projekte in ihrem Land. Durch die Länderberichte wurde der Informationsaustausch wesentlich verbessert und deshalb wird bei jedem Task Meeting mindestens 1 Tag für diesen Informationsaustausch reserviert.

Das Ziel der Workshops ist es über spezielle Themen, die nicht oder nur ungenügend auf Konferenzen diskutiert werden zu behandeln. Die Themen der Workshops werden vor Beginn des Trienniums gemeinsam von allen Ländern festgelegt und die Organisation der einzelnen Workshops wird vom Land unterstützt, wo der Workshop abgehalten wird.

Ein wesentlicher Teil des Informationsaustausches ist auch die Besichtigung von Vergasungsanlagen. Bei jedem Workshop werden Vergasungsanlagen, bzw. Forschungsanlagen an Universitäten besichtigt. Diese Exkursionen werden auch von den teilnehmenden Ländern organisiert.

Beschreibung der Projektziele (bezogen auf das Kooperationsprojekt und auf das österrreichische Teilprojekt)

Die Ziele des Bioenergienetzwerks (IEA Bioenergy) sind die Förderung des Einsatzes umweltverträglicher und konkurrenzfähiger Bioenergie auf der Basis einer nachhaltigen Nutzung und die Bereitstellung eines substanziellen Beitrags für eine zukunftsfähige Energieversorgung.

Eine wichtige Aufgabe von IEA Bioenergy ist es, einen Beitrag zur Beseitigung von umweltbezogenen, institutionellen, technologischen und finanziellen Barrieren für den Einsatz von Bioenergietechnologien in der Zukunft zu leisten. Im Zentrum stehen dabei die Initiierung, Koordinierung und Förderung von Forschungs-, Entwicklungs- und Demonstrationsprojekten durch internationale Zusammenarbeit und der gezielte Informationsaustausch zwischen Experten aus Forschung, Industrie und Politik in den teilnehmenden Ländern. Diese Strategie soll dazu beitragen, die Entwicklung und Vermarktung von umweltfreundlichen, effizienten und kostengünstigen Bioenergietechnologien voranzutreiben.

Die Zusammenarbeit wird in Form von thematischen Netzwerken, den TASKS, durchgeführt und von einem Executive Committee geleitet, in das die teilnehmenden Länder einen Vertreter entsenden. Für die Periode 2010 bis 2012 stellte die österreichische Vertretung teilweise den Chairman im Executive Committee (Ao.Univ.-Prof. Dipl.-Ing. Dr. Josef Spitzer, Joanneum Research).

Im vergangenen Triennium basierten die Arbeiten teilweise auf der Fortsetzung von Aktivitäten aus dem vorigen Triennium, aber auch auf erkannte Chancen aus aktuellen Entwicklungen (z.B. Co-generation). Im vergangenen Triennium wurde besonderen Wert auf Informationsaustausch über nationale Arbeiten im Bereich der Biomassevergasung gelegt.

Ein weiterer Schwerpunkt war der Transfer der Webseite nach Österreich, die Zusammenstellung einer neuen Webseite und Online Datenbank von Biomassevergasungsanlagen.

Im vergangenen Triennium wurden folgende Schwerpunkte behandelt:

- Abhaltung von 6 Task meetings, zum Informationsaustausch und um nationale Entwicklungen zu präsentieren und zu diskutieren.
- Erstellen der Country Reports, wo nationale Rahmenbedingungen, aktive F&E Institutionen und Firmen und auch Projekte präsentiert werden.
- Durchführung von Studien und die Abhaltung von Workshops

Beschreibung der verwendeten Methodik, Daten und Vorgangsweise

Task 33 Meetings und Workshops

Task 33 Meetings sind zweimal im Jahr (6x im Triennium) organisiert und bieten einen Rahmen für Informationsaustausch zwischen den Experten aus Task 33 Mitgliedsländern im Bereich der Biomassevergasung.

Die Workshops werden im Rahmen der Task Meetings organisiert und es werden zusätzlich noch Experten aus Industrie und Forschung im Bereich der Biomassevergasung eingeladen, die die neuste Entwicklungen und Erfahrungsberichte präsentieren. Bei den Workshops wird darauf geachtet, dass keine thematischen Überschneidungen mit den verschiedenen Konferenzen im Bereich Biomassevergasung stattfinden.

Die Workshops sowie die Task 33 Meetings sind für Österreichische Beteiligte sehr nützlich, weil sie eine äußerst wichtige Informationsquelle darstellen.

Im vergangenem Triennium 2010 bis 2012 wurden wie geplant 6 Meetings und 5 Workshops zu einem Schwerpunkt abgehalten.

Die Auflistung der Meetings sind in der folgende Tabelle zu finden.

Datum, Ort	Workshop Thema
01.- 03.06. 2010, Helsinki, Finland	Second generation biofuels
05.- 07.10.2010, Skive/Copenhagen, Dänemark	Small scale biom. Co-generation techn. Status and market opportunities
12.-14.04. 2011 Christchurch, Neuseeland	Gasification and alternative fuels development
18.-20. 2011 Pitea, Schweden	Biomass gasification opportunities in the forest industry
17.-19.04 2012 Istanbul, Türkei	Bed materials
12.-16. 11 2012 Vienna, Österreich	IEA Bioenergy Konferenz

Tabelle 2: Auflistung der Meetings und Workshops

Im ersten Jahr des Trienniums fanden, wie geplant, zwei Taskmeetings jeweils mit einem Workshop statt.

Das erste Taskmeeting fand in Juni 2010 in Helsinki/Espoo, Finnland statt, wo ein Workshop zum Thema „Second-generation biofuels“ abgehalten wurde. Hier wurden die neusten Technologien für die Erzeugung den Flüssigen Biotreibstoffen neuer Generation vorgestellt.

Vorträge, die am Task 33 workshop ‘WS1: Second generation biofuels’ im Juni 2010 präsentiert wurden:

Bain, R. Technoeconomics of Ethanol Production
Biollaz, S. Technoeconomics of Biofuels Processes for Substitute Natural Gas
van der Drift, B. Biosyngas and BECCS
Gül, S. Simulation Studies for BTL
Kurkela, E. FTL and other BTL
Mäkinen, T. Liquid Biofuels for Transportation in Finland
Rauch, R. Products from Synthesis Gas of Steam Gasification
Räsänen, T. NSE Biofuels Project Activities
Salo, K Carbona Pressurized Gasification Technology

Die Minutes der Meetings, sowie alle Vorträge stehen auf **www.ieatask33.org** zur Verfügung. Der dritte Tag des Meetings wurde zu einer technischen Exkursion verwendet. Bei diesem Meeting hatten die Taskmitglieder die Möglichkeit die Labors und das Technikum des VTT zu besichtigen.

Das zweite Meeting fand in Oktober 2010 in Skive/Kopenhagen, Dänemark, statt. Am dritten Tag des Meetings wurde ein Workshop zum Thema „State-of-the-art

technologies for small biomass co-generation“ zusammen mit Task 32 „Biomass combustion and co-firing“ veranstalltet.

Folgende Vorträge wurden beim Workshop mit dem Tittle ‘State-of-the-art technologies for small biomass co-generation’ gehalten:

Augustin T. Steam Engines
Bini R. State-of-the-art of ORC Technology
Boisen A. Upscaling the LTCFB Gasifier
Christiansen H.F. Perspectives to data collected through the Danish follow-up program for biomass CHP
Gemperle H. Downdraft Gasifier with Gas Engine
Heeb R. Updraft Gasifier with Gas Engine
Jagd L. Gasification in Stirling Engine Application
Grøn M. Staged Gasification with Gas Engine, the Viking Gasifier
Moser W. Next Generation of Pellet Combustion with thermoelectric Power Generation
Rauch R. Indirect Gasifier
Schenk R. Steam Turbines
Skjoldborg B. The Skive Plant

Ein Teil von dem Task Meeting ist die Besichtigung von den Biomassevergasungsanlagen. In Dänemark hatten die Vertreter der Mitgliedsländer eine Möglichkeit drei Anlagen zu besichtigen.

Die erste Anlage in Skive, Andritz-Carbona KWK Vergaser ist ein stationärer Luft-Wirbelschichtvergaser mit 20MW_{th} und 6$MW_{el.}$ Holz Pellets werden als Brennstoff verwendet. Das Bettmaterial wurde vor kurzen von Dolomit zu Olivin umgeändert.

Die zweite Vergasungsanlage Babcock&Wilcox Vølund ist in Harboøre situiert. Es handelt sich um ein Fest-Bett Gegenstrom Vergaser. Hier werden Holzhackschnitzel als Brennstoff verwendet. Die Leistung sind 3.5 MW_{th}/1MW_{el}. Inbetriebnahme war in 1996 und 2000 wurde der Gasmotor installiert. Der Anlagenbetrieb ist problemlos, die aktuelle Leistung sind mehr als 500 MWh pro Monat.

Die dritte Anlage in Hadsund der Firma Weiss A/S ist eine zweistufige (Pyrolyse, Vergasung) Versuchsanlage mit integrierter Brennstofftrocknung. Die Holzhackschniztel, die als Brennstoff verwendet werden kommen zuerst in den Trockner, wo die Feuchtigkeit wesentlich reduziert wird. Dann wird der getrocknete Brennstoff in einen Pyrolysereaktor eingebracht, wo eine Zersetzung in gasförmige und feste Bestandteile stattfindet. Die gasförmigen Bestandteile (Pyrolyseöle und Gase werden nachher im Vergasungsreaktor vergast.

Die Vorteile der zweistufigen Vergasung sind:

- Niedriger Teergehalt im Produktgas(<5 mg/Nm^3)
- Stabiler Betrieb ohne Bedienungspersonal
- Hoher Kaltgaswirkungsgrad (>95%)
- Umweltfreundliche Technologie

Im zweiten Jahr des Trienniums fanden, wie geplant, zwei Taskmeetings jeweils mit einem Workshop statt.

Das erste Taskmeeting in 2011 fand in April in Christchurch, NZ statt, wo ein Workshop zum Thema "Gasification and alternative fuels development" abgehalten wurde. Hier wurde der Status der Biomassevergasung in NZ, Australien, USA und Österreich vorgestellt und alternative Bio-Treibstoffe präsentiert.

Vorträge, die am Task 33 workshop ‘WS: "Gasification and alternative fuels development" im April 2011 präsentiert wurden:

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

Die Minutes der Meetings, sowie alle Vorträge stehen auf **www.ieatask33.org** zur Verfügung. Der zweite Tag des Meetings wurde zu einer technischen Exkursion verwendet. Bei diesem Meeting hatten die Taskmitglieder die Möglichkeit das Labor der Universität of Canterbury zu besichtigen.
Weiter wurden die Nature´s flame wood pellet plant, Solid Energy Renewables, Rolleston and SRS Sawmill Rolleston. besucht.

Das zweite Meeting im Jahr 2011 fand in 18.-20. Oktober in Piteå, Schweden statt. Am ersten Tag, wie üblich, wurden die Highlights im Bereich der Biomasse Vergasung in Task 33 Mitgliedsländer präsentiert. Am zweiten Tag des Meetings wurde ein Workshop zum Thema „Biomass Gasification Opportunities in Forest Industry“ veranstalltet.

Folgende Vorträge wurden beim Workshop gehalten:

R.Bain,NREL,USA: Climate change and the P&P industry, the IPCC SRREN report
R.Gebart,ETC,Sweden: Swedish BLG R&D program
R.Stare,Chemrec,Sweden: Chemrec pilot DP1 and BioDME, industrial developments
J.Otterstedt,Sveaskog,Sweden: Forest owners perspective on bioenergy
R.Gebart,ETC,Sweden: Swedish research, the Gasification Centre
E.Kurkela,VTT,Finland: Finish research
R.Bain, NREL,USA: BMG in N.America
R.Rauch,TUV,Austria: BMG based cogeneration
T.Honkola,Metso,Finland: Metso gasification
K.Salo,Andritz/Carbona,Finland: BMG in paper industry
V.Jokela,NSE,Sweden: NSE gasification
L.Waldheim,WAC,Sweden: Workshop-summary

Ein Teil von dem Task Meeting ist die Besichtigung von den Biomassevergasungsanlagen. In Schweden hatten die Vertreter der Mitgliedsländer eine Möglichkeit folgende Anlagen zu besichtigen.

In ETC Labor handelte sich um die BLG Pilotanlage DP1 mit einem Flugstromdruckvergaser. Die DP-1 Anlage ist für Forschung und Demonstration bestimmt. Bei der Temperatur von 1000°C und Druck von 30 bar wird Schwarzlauge in Synthesegas umgewandelt und dieses anschließend gereinigt. Aus dem synthesegas wird über den Methanolweg schlußendlich DME erzeugt, dass in LKWs verwendet wird. An dem Projekt sind Forschung, Industrie und Öffentlichkeit beteiligt (Triple Helix).

Bei der Firma MEVA wurde 1 MW_{el} **–** Vergaser präsentiert. MEVA Innovation AB spezialisiert sich auf Forschung, Entwicklung und Verkauf von den Vergasungsanlagen.

Weiter wurden die Smurfit Kappa Kraftliner Piteå Sägemühle und SunPine Biodieselanlage besichtigt.

Erstes Task Meeting in 2012 wurde am 17.-19. April in Istanbul, Türkei abgehalten. Im Rahmen des Workshops wurde das Thema „Bettmaterialien“ behandelt.
Folgende Vorträge wurden bei dem Workshop gehalten:

Hüsnü Atakül, ITU, Turkey: Hot gas clean-up with dolomite

Friedrich Kirnbauer, Bioenergy 2020+, Austria: Chemistry of olivine and its influence on biomass gasification

H.J.M. (Rian) Visser, ECN, the Netherlands: The requirements and main themes

on bed materials

Christian van der Meijden, ECN, the Netherlands: Milena gasification and bed materials

Bram van der Drift, ECN, the Netherlands: Tar dew point

Am dritten Tag des Meetings wurden die Vergasungs- und Verbrennungsanlagen in TUBITAK-MAM und Ekolojik Energy besichtigt.

Im Rahmen der Workshops wurden folgende Schlüsselthemen der Biomassevergasung behandelt: „Advanced biofuels“, "Small scale biom. co-generation techn., status and market opportunities", "Gasification and alternative fuels development", "Biomass gasification opportunities in the forest industry" and „Bed materials“.
Seit 2011 wurden alle Workshop Vorträge in Workshop-Reports zusammengefasst, die einen guten Überblick über das Thema des Workshops bieten. Workshop-Reports sowie alle Workshop Vorträge stehen online unter **www.ieatask33.org** zur Verfügung.

IEA Bioenergy Konferenz
Am 13.-15. November 2012 hat die IEA Bioenergy Konferenz in Wien stattgefunden. Nähere Informationen sind unter **www.ieabioenergy2012.org** verfügbar.
Bei der Konferenz waren insgesamt 235 Teilnehmer anwesend davon 49 Vortragende aus 16 Ländern.
Task 33 hat mit 4 interessanten Präsentationen beigetragen. Folgende Tabelle bietet einen Überblick über die Task 33 Vorträge.

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

Tabelle 3: Task 33 Vorträge bei der IEA Bioenergy Konferenz

Eine Zusammenfassung über die Konferenzbeiträge wurde in Form des Newsletters an die Beteiligte Firmen und Instituten gesendet.

Webseite

Im Jahr 2011 wurde die schon bestehende Task 33 Webseite neugestaltet. Es wurde eine neue übersichtliche und informative Internetseite des Tasks 33 zusammengestellt und eine online Datenbank über Vergasungsanlagen zugefügt. Diese neue Internetseite bietet seit diesem Zeitpunkt einen guten Überblick über die Task 33 Aktivitäten nicht nur für die Task 33 Mitglieder, sondern für alle, die im Bereich der Biomassevergasung aktiv sind. Die interaktive Online-Vergasungsanlagendatenbank ist ein ausgezeichnetes Werkzeug für die weltweite Suche nach Biomassevergasern und deren Betreiber.

Die Webseite sowie die online Datenbank werden regelmäßig aktualisiert. Zurzeit sind mehr als 100 Vergasungsanlagen weltweit in der Datenbank enthalten.

Task 33 Newsletter

Einmal pro Jahr wurde einen Newsletter auf der Webseite des Task 33 veröffentlicht. Hier wurden die wichtigsten Aktivitäten des Tasks 33 präsentiert, wie z.B. kurze Workshops Zusammenfassungen, Site Visits Beschreibungen und Neuigkeiten vorgestellt (neue Webseite) usw.

Ergebnisse des Projektes

Anstatt des sechsten Workshops haben die Task 33 Mitglieder an der IEA Bioenergy Konferenz in Wien im November 2012 teilgenommen. Die Beiträge zur Konferenz können Sie in der Tabelle 2 finden.

Zu jedem Task 33 Meeting wurde ein österreichischer Country Report Update in Form einer Präsentation vorbereitet und vorgetragen. Nach jedem Task 33 Meeting und Workshop sind die Task Meeting Minutes und Workshop-Report zusammengestellt. Diese sind nach der Zustimmung aller Task 33 Mitglieder online verfügbar.

Nationaler Newsletter

Jedes der Workshop Themen sowie die Konferenzvorträge haben größte Relevanz für österreichische Spezialisten im Bereich der Biomassevergasung und sind ein großer Informationsbeitrag für die F&E in Österreich, deswegen wurde nach jedem Meeting/Workshop ein Newsletter in Deutsche Sprache publiziert und unter: **http://www.nachhaltigwirtschaften.at/iea/results.html/id1976** abrufbar. Zusätzlich ist der Newsletter per Emailverteiler direkt an die Österreichische Firmen, die im Bereich der Biomassevergasung tätig sind zugeschickt.

Nationaler Workshop

Im Rahmen des 16. Österreichischen Biomassetages wurde am 18. November 2011 in Wieselburg ein nationaler Task 33 Workshop zum Thema: „Thermische Biomassevergasung in Österreich, Stand der Technik und Entwicklungsbedarf“ veranstaltet.
An dem Workshop haben 9 österreichischen Firmen und Forschungsinstitute aus dem Bereich der Biomassevergasung und 2 Task 33 Delegierte teilgenommen. Es wurde ein Überblick über die Aktivitäten des Task 33 präsentiert, sowie die neue Webseite und online Datenbank. Das Ziel des Workshops wurde die Schwerpunkte des Biomassevergasungsprozesses feststellen, wo noch ein Forschungsbedarf nötig ist und diese in Form eines K-Projektes zu bearbeiten und zu lösen. Dabei wurden die wichtigsten Themen der Biomassevergasung diskutiert und wichtige Informationen ausgetauscht.

Highlights der Bioenergieforschung

Das BMVIT organisiert gemeinsam mit JOANNEUM RESEARCH die Veranstaltungsreihe „Highlights der Bioenergieforschung“, die sich jeweils auf ein Schwerpunktthema konzentriert, zu dem Arbeiten und Ergebnisse aus den IEA Bioenergy-Tasks und österreichische Projekte aus Forschung und Praxis präsentiert werden. Am 30. und 31. März 2011 fand bereits zum fünften Mal die Veranstaltung Highlights der Bioenergieforschung an der FH Wiener Neustadt/Wieselburg statt.

Mit über 150 TeilnehmerInnen war die Veranstaltung ein voller Erfolg und dient der weiteren Verbreitung der nationalen und internationalen Ergebnisse der österreichischen Forschungsgemeinschaft zu den IEA Schwerpunkten.

"Nachwachsende Rohstoffe"

In der Zeitschrift "Nachwachsende Rohstoffe" wird in enger Zusammenarbeit mit M. Wörgetter (FJ-BLT Wieselburg) im Sonderteil IEA Bioenergy regelmäßig über die österreichischen Aktivitäten in IEA Bioenergy berichtet. Abwechselnd werden die aktuellen Arbeiten in den einzelnen Tasks präsentiert. Im Jahr 2010 wurde ein Bericht über Aktivitäten in Task 33 veröffentlicht (Ausgabe Nr. 58, Dezember 2010). Ergänzend wurden über Österreich relevante Inhalte von IEA Bioenergy informiert wie Ergebnisse aus den ExCo-Meetings oder Ankündigung von Workshops und Meetings sowie neue Publikationen.

Webseite und online Datenbank

Im Jahr 2011 wurde die Task 33 Webseite nach Österreich transferiert und vom österreichischen Delegierten neu gestaltet. Eine online Datenbank über die Vergasungsanlagen wurde hinzugefügt. Die Webseite sowie die online Datenbank werden regelmäßig aktualisiert. Zurzeit sind mehr als 100 Vergasungsanlagen weltweit in der Datenbank enthalten.
Für die Aktualisierung sowie für die Verwaltung der Webseite und Datenbank ist Österreich seitdem zuständig.

Wertschätzung der österreichischen Arbeiten

Dr. Reinhard Rauch wurde im vergangenen Triennium als Co-Task Leader und Dr. Jitka Hrbek als Task Secretary tätig. Diese Funktionen bleiben im nächsten Triennium gleich, was die hohe Wertschätzung der österreichischen Arbeiten zeigt. Zusätzlich ist der Transfer des „Operating Agent“ auf Österreich in Diskussion, was wiederum den hohen Stellenwert der österreichischen Arbeiten bestätigt.

Veröffentlichte Ergebnisse

Art	Titel	Synopsis	Quellenangabe
Meeting Minutes	Meeting Minutes Helsinki	Meeting Minutes sind eine Zusammenfassung des Task Meetings, inklusive Country Reports Updates, Site Visits und Workshops.	http://www.ieatask33.org/app/webroot/files/file/minutes_and_presentations/Helsinki_Jun2010/Helsinki_Minutes.pdf
	Meeting Minutes Copenhagen		http://www.ieatask33.org/app/webroot/files/file/minutes_and_presentations/Skive_Oct2010/Skive_Minutes.pdf
	Meeting Minutes Christchurch		http://www.ieatask33.org/app/webroot/files/file/minutes_and_presentations/Christchurch%20April%202011/Minutes/Christchurch_Apr2011.pdf
	Meeting Minutes Pitea		http://www.ieatask33.org/app/webroot/files/file/2011/Pitea_Task_33_Minutes.pdf
	Meeting Minutes Istanbul		http://www.ieatask33.org/app/webroot/files/file/minutes_and_presentations/Istanbul_Apr_2012_Minutes.pdf
	Meeting Minutes		Noch nicht

	Vienna		veröffentlicht
Workshop Reports	Workshop Report "Biomass gasification opportunities in the forest industry"	Im Workshop Report sind die wichtigsten Informationen, die beim Workshop präsentier wurden zusammengefasst.	http://www.ieatask33.org/app/webroot/files/file/2011/Workshop-report/Pitea-workshop-report.pdf
	Workshop Report "Bed materials"		http://www.ieatask33.org/app/webroot/files/file/2012/WS-Report/WS-Report.pdf
Newsletter	Newsletter Vol.1/2011	Newsletter bietet ein Überblick über die Tätigkeiten des Task 33	http://www.ieatask33.org/app/webroot/files/file/Newsletter/Newsletter_Volume1.pdf
Landesbericht Österreich	Country Report Österreich	Im jedem Triennium wird der Country Report aktualisiert.	http://www.ieatask33.org/app/webroot/files/file/country_reports/Austria.pdf
Newsletter Österreich	Newsletter Vol 1/2012	Newsletter Österreich ist ein Überblick über die Highlights des Task 33 in Deutsch	http://www.nachhaltigwirtschaften.at/iea_pdf/newsletter/task33_newsletter2012_vol1.pdf
	Newsletter Vol. 2/2012		http://www.nachhaltigwirtschaften.at/iea_pdf/newsletter/task33_newsletter2012_vol2.pdf
Zeitschriften Artikel	Nachwachsende Rohstoffe, 58 (2010), S. 17	Beschreibung der Aktivitäten des Task 33 und Biomassevergasung-Highlights	http://www.blt.bmlfuw.gv.at/vero/mnawa/nr58.pdf

Tabelle 4: Publikationen Task 33

Innerhalb nächsten Wochen wird eine weitere Ausgabe des Task 33 Newsletters Vol. 2/2012 auf der Task 33 Webseite veröffentlicht.

Die Meeting Minutes Vienna 2012 werden nach dem Meeting in May 2013 nach der Genehmigung von allen Taskmitgliedern veröffentlicht.

Detailangaben in Bezug auf die Forschungskooperation Internationale Energieagentur (IEA)

Darstellung der österreichischen Zielgruppe, für die die Projektergebnisse relevant sind

Wie wurden die relevanten Stakeholder in das Projekt eingebunden?

Die Projektergebnisse sind nicht nur für TU Wien interessant, sondern für alle Österreichische Firmen, die im Bereich der Biomassevergasung tätig sind. Deswegen werden nach jedem Task 33 Meeting die neuste Informationen in Form eines Newsletters für österreichische Firmen in Deutsche Sprache zusammengefasst, Onlinegestellt und zusätzlich per Email zugeschickt.

Hiermit erhalten die Österreichischen Stakeholders einen Zugang zu aktuellsten technischen Entwicklungen und die Möglichkeiten der Entwicklung weltweiter Kooperationen.

Durch die Teilnahme an Task 33 werden ermöglicht:

- Intensiver Kontakt mit Forschungsinstitutionen anderer Länder (auf weltweiter Basis) durch direkte Zusammenarbeit im Rahmen bestimmter, im Task-Arbeitsprogramm definierter Schwerpunkte, die für Österreich von Relevanz sind.
- Informations- und Erfahrungsaustausch auf internationaler Basis.
- Repräsentanz und Verbreitung österreichischer Forschungs- und Entwicklungsaktivitäten auf internationaler Ebene.
- Möglichkeit von Projektanbahnungen auf internationaler Basis (z.B. bzgl. EU-Projektanträgen und Forschungsaufenthalten).
- Schaffung von für die Industrie relevanten Kontakten bzw. Informationen über interessante Marktpotentiale für österreichische Firmen in anderen Task-Mitgliedsländern.
- Schaffung von Informationsvorsprüngen und leichtere Anbahnung von Technologietransfers für heimische Firmen auf internationaler Basis.

Ins besonders die Verbreitung von Forschungsergebnissen und die Kooperation mit einschlägigen Industrieunternehmen kann durch die Teilnahme an IEA Bioenergy auf internationaler Ebene intensiviert und verbessert werden. Dies fördert die effiziente und rasche Umsetzung bzw. Weiterentwicklung von Forschungsergebnissen weltweit. Österreichische Firmen erhalten Zugang zu aktuellsten technischen Entwicklungen und die Möglichkeiten der Entwicklung weltweiter Kooperationen.

Schlussfolgerungen zu den Projektergebnissen

In dem Projekt gewonnenen Erkenntnisse für das Projektteam (fachliche Einschätzung)

In Österreich konnte in den letzten Jahren die Wirbelschicht-Dampfvergasung mit einem Gasmotor zur Stromerzeugung erfolgreich etabliert werden und auch andere Wege der Nutzung vom Synthesegas wurden untersucht. In Bezug auf Synthesegas handelt sich um einen sehr kostbaren Stoff, der in verschiedenen Gebieten eine Verwendung finden kann. Deswegen laufen seit längerem Arbeiten, um das Produktgas auch als Synthesegas zu verwenden. Derzeit werden verschiedene Produkten aus dem Synthesegas hergestellt, wie zB. BioH2, FT Diesel, SNG und Gemischten Alkohole. Damit ist auch das Testen von verschiedenen neuen Katalysatoren und deren Resistenz gegen Schadstoffe verbunden.
Mit den beiden Biomassevergasungsanlagen in Oberwart und Güssing ist es gelungen in Österreich eine international beachtete Plattform für eine effektive und innovative Nutzung von Synthesegas zu errichten.
Im Rahmen von Task 33 wird hier die Information weitergegeben und auch zukünftige Kooperation (z.B. US DOE) vorbereitet.

Die Teilnahme an den Task 33 Meetings bietet einen guten Überblick über die Vergasungsanlagen in den anderen Mitgliedsländern. In den folgenden Tabellen sind alle wichtigsten kommerzielle Biomasse Vergasungsanlagen in Mitgliedsländern, die zurzeit im Betrieb sind aufgelistet.
Die Anlagen können in folgenden Technologien eingeteilt werden: Co-firing, KWK, Synthesen und andere innovative Technologien.

Co-firing

Technologie/ Betreiber	Standort	Reaktor	Leistung/ Kapazität	Inbetriebnahme
Essent	Geertruidenberg Niederlande	CFB	30 MW_{el}	2005
Foster Wheeler	Lahti Finnland	CFB	40-90 MW_{th}	1998
Foster Wheeler	Varkaus Finnland	BFB	50 MW_{th}	2001
Metso	Värö Schweden	CFB	30 MW_{feul}	1987
NUON/ Vattenfall	Buggenum Niederlande	IGCC EF	250 MW_{el} 30 MW_{el}	2002

Kraft-Wärme-Kupplung

Technologie/ Betreiber	Standort	Reaktor	Leistung/ Kapazität	Inbetriebnahme
FICFB/Repotec	Güssing Österreich	FICFB	2 MW_{el} 8 MW_{th}	2002
FICFB/Ortner	Oberwart Österreich	FICFB	2,8 MW_{el} 8,5 MW_{th}	2008
FICFB/Ortner	Villach Österreich	FICFB	15 MW_{fuel} 3.7MW_{el}	2010
Urbas/ Fernwärme Neumarkt	Neumarkt Österreich	downdraft	0,240 MWel 0,580 MWth	2008
Urbas/ CHP Urbas Sulzbach-Laufen	Sulzbach-Laufen Deutschland	downdraft	0,130 MWel; 0,280 MWth	2009
Urbas/ Holzstrom	Neukirchen Österreich	Downdraft	0,3 MW_{el} 0,66 MW_{th}	2011
B&W Volund	Harboøre Dänemark	Updraft moving bed	1,4 MW_{el}	2000

B&W Volund	3 in Japan	Updraft moving bed	8-12 MW_{th}	2007-2009
HS Energieanla-gen gmbh	Neufahrn Deutschland	FB	0,5 MW_{th}	2012
FICFB/ Stadtwerke Ulm	Ulm Deutschland	FICFB	4,6 MW_e 15 MW_{th}	2012
Bio&Watt	Oltrepo Pavese Italy	Pyro-gasification	0,3 MW_{el}	2010
Centro Cisa	Castel D´Aiano, Italy	updraft gasifier+Stirling engine	35 kW_{el} 140 kW_{th}	2008
Guascor Italia	Rossano Calabro, Italy	updraft gasifier	4,2 MW_{el}	2003
Andritz/Carbona	Skive Dänemark	BFB	11 MW_{th} 5,5 MW_{el}	2008
Metso	Lahti Finnland	CFB	160 MW_{fuel}	2012
Pyroforce/ Holzstrom	Stans Switzerland	2 zone-downdraft	2x690 kW Jennbacher 1,2 MW distr.heating Boiler 1,6 MW	2007

Anlagen für die Synthesen

Technologie/ Betreiber	Standort	Reaktor	Leistung/ Kapazität	Inbetriebnahme
Enerkem	Pontotoc, Missisippi, USA	BFB	28000 gal/d	2010
Foster Wheeler Energia Oy	Varkaus Finland	BFB	14 aluminium t/d; 50 MWth	2009
Range Fuels, Inc.	Soperton, Georgia, USA	Staged gasification	ethanol; methanol 300000 t/a; 100 mmgy	2010 (gestoppt und von LanzaTech übernommen)
Carbo V / Choren Industries	Freiberg Deutschland	Staged gasification	45 MW_{th} BtL production	2012 (gestoppt)
Bioliq/ KIT	Karlsruhe Deutschland	Entrained flow with decentral pyrolysis	5 MW_{th} MtG production	2012
GoBiGas	Göteborg Schweden	DFB	BioSNG 20 $MW_{biomethane}$	2013

Andere innovative Technologien

Technologie/ Betreiber	Standort	Prozess	Leistung/ Kapazität	Inbetriebnahme
BioMCN	Farnsum Niederlande	Glycerin zu Methanol	200 000 t/a	2009

Zusätzlich bieten die Meetings auch einen guten Überblick über interessanten geplannten, laufenden oder abgeschlossenen Projekten im Bereich der thermischen Biomassevergasung in anderen Mitgliedsländern.
Zurzeit sind viele Vergasungsanlagen weltweit geplant oder in Ausbau, manche sogar schon in Genehmigungsphase.

Dänemark

Technologie/ Betreiber	Standort	Reaktor/ Prozess	Leistung/ Kapazität	Inbetriebnahme
Stirling	6 Anlagen	Updraft+Stirling Motor	CHP	

Deutschland

Technologie/ Betreiber	Standort	Reaktor/ Prozess	Leistung/ Kapazität	Inbetriebnahme
Wärmeversorgung Großenhein	Großenhein	FB, air	21 MW_{th} 6 MW_{el}	In Planung
BtL/ Choren, Carbo-V	Freiberg ß-plant	EF	45 MW_{th}	gestoppt

Finnland

Technologie/ Betreiber	Standort	Reaktor/ Prozess	Leistung/ Kapazität	Inbetriebnahme
Biorefinery BtL	Demoplants	FT Synthese	100 000-200 000 t/a Diesel	?

Italien

Technologie/ Betreiber	Standort	Reaktor/ Prozess	Leistung/ Kapazität	Inbetriebnahme
Gas 1000	Parma	Downdraft	1MW_{el} 2MW_{th}	?

Niederlande

Technologie/ Betreiber	Standort	Reaktor/ Prozess	Leistung/ Kapazität	Inbetriebnahme
HEVESKES	Delfzijl	Production of SNG	10 t/h fuel (RDF+biomass)	2014
HVC		MILENA	50-100 MW	Ende 2013
HoSt		3 ton/h paper-rejects plant		Ende 2013
Essent/RWE		CFB gasifier on waste wood for indirect co-firing into 600 MWe coal-fired power plant,	80 MW	feed-in tariff will stop end-2013, exploring ways to continue operation
BioMCN			150 kton/y bio-methanol	?

Österreich

Technologie/ Betreiber	Standort	Reaktor/Prozess	Leistung/ Kapazität	Inbetriebnahme
Ortner	Klagenfurt	FICFB	$25MW_{fuel}$ $5.5MW_{el}$	?
OMV	Wien	Wasserstoff-synthese	$50MW_{fuel}$ $30MW_{hydrogen}$	gestoppt

Schweden

Die Biomassevergasungstechnologie in Schweden befindet sich auf sehr hohem Niveau. Die Gründe dafür liegen an der hohen Verfügbarkeit von Biomasse und förderlichen politischen Rahmenbedingungen in Schweden. Folgender Bild bietet ein guter Überblick über die Anlagen in Schweden. In der Planung sind zurzeit 8 Vergasungsanlagen.

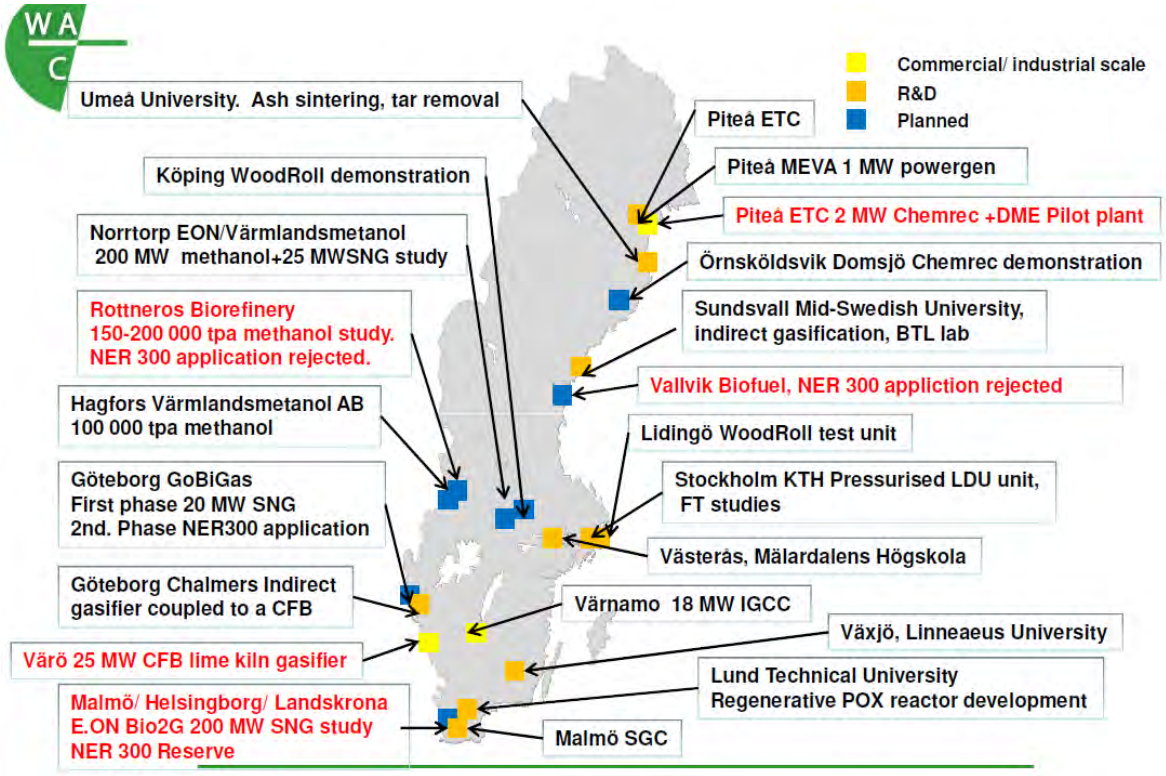

Bild 2: Biomassevergasungsanlagen in Schweden

Schweiz

Technologie/ Betreiber	Standort	Nutzung	Leistung/ Kapazität	Inbetriebnahme
EMPA EAWAG	Dübendorf	CHP	2x350 kW_{el}	Im Bau
Spanner	Luzern	CHP	45 kW_{th}	Planung

USA

Technologie/ Betreiber	Standort	Prozess	Leistung/ Kapazität	Inbetriebnahme
Fulcrum	City of McCarran	Ethanol Synthese	30 000 gal/d	Im Bau
Clear Fuels Rentech	Commerce City, Colorado	Synthese	240 gal/d	Im Bau
Clear Fuels	Collinwood Tennessee	FT liquids	6-8 MW_{el} 55 000 gal/d	In Planung
Coskata	Clewiston, Florida	Ethanol	300 000t/a	In Planung

Die Projektergebnisse sind nicht nur für TU Wien interessant, sondern für alle Österreichische Firmen, die im Bereich der Biomassevergasung tätig sind. Deswegen werden nach jedem Task 33 Meeting die neuste Informationen in Form eines Newsletters für österreichische Firmen in Deutsche Sprache zusammengefasst, Onlinegestellt und zusätzlich per Email zugeschickt.

Hiermit erhalten die Österreichischen Stakeholders einen Zugang zu aktuellsten technischen Entwicklungen und die Möglichkeiten der Entwicklung weltweiter Kooperationen.

Wie arbeitet das Projektteam mit den erarbeiteten Ergebnissen weiter?

- **Internationale Ebene**

Nach jedem Task Meeting/Workshop werden die Task Minutes sowie ein WS-Report online gestellt. Zusätzlich wird einmal im Jahr ein Newsletter (in Englisch) ausgegeben und an der Task Webseite veröffentlicht. Auf der Grundlage der Country Reports und Input der Taskmitglieder wird die online Datenbank aktualisiert.

Im Rahmen von Subtasks werden Berichte zu Task 33 relevanten Themen, teilweise auch in Kooperation mit anderen Tasks erstellt. Diese Berichte werden auf der Task Homepage und auch auf der nationalen Homepage „nachhaltig wirtschaften“ verfügbar gemacht.

- **Nationale Ebene**

Nach jedem Task meeting wird einen Newsletter (in Deutsch) an die österreichischen Stakeholder per Email-Verteiler zugeschickt. Sie werden über Task Tätigkeiten sowie über Workshop Highlights informiert.

Zusätzlich ist es geplant 1-2 mal pro Triennium einen Workshop zu organisieren, wo ein Informationsaustausch zwischen internationale und nationale Ebenen durchgeführt wird. Es ist auch geplant die internationalen Akteure (zB. Deutschland, Schweiz) zu einem nationalen Workshop einzuladen.

Zu jedem Workshop werden das bmvit und ExCo-Vertreter eingeladen und zusätzlich erhalten sie auch Newsletter per Email. In diesem Sinne kann auch ein regelmäßiges Abstimmen erfolgen.
Alle oben genannten Aktivitäten werden auch auf der nationalen Homepage „nachhaltig wirtschaften“ veröffentlicht.

Zweimal im Jahr wird ein Newsletter in Deutsche Sprache online veröffentlicht und zusätzlich per Emailverteiler an die involvierten österreichischen Firmen und Forschungsinstitute zugesendet. Der Newsletter bietet eine Übersicht über die Aktivitäten des Task 33 und Highlights aus dem Bereich der Biomassevergasung, sowie weitere Links, die zu weiteren Informationen aus dem Bereich der Biomassevergasung führen.

Ausblick und Empfehlungen

Resümee hinsichtlich der Ziele, die in dem Projekt verfolgt wurden - Darstellung, ob und wie diese erreicht wurden

Im vergangenen Triennium wurden folgende Schwerpunkte behandelt:

- Abhaltung von 6 Task meetings, zum Informationsaustausch und um nationale Entwicklungen zu präsentieren und zu diskutieren.
- Erstellen der Country Reports, wo nationale Rahmenbedingungen, aktive F&E Institutionen und Firmen und auch Projekte präsentiert werden.
- Durchführung von Studien und die Abhaltung von Workshops
- Transfer und Neuaufbau der Task 33 Webseite
- Webseite Verwaltung und regelmäßiges Datenbank update

Das Projekt wurde wie geplant durchgeführt. Nähere Informationen können in Kapitel *Beschreibung der verwendeten Methodik, Daten und Vorgangsweise* gefunden werden.

Bei den Studien werden folgende Themen behandelt:

- Biomassevergasungssysteme, wo die verschiedenen Technologien, aber auch Firmen und existierende Anlagen beschrieben werden
- Report über „lessons learned“, wo erfolgreiche Umsetzungen von Biomassevergasungsanlagen, aber auch nicht erfolgreiche Anlagen beschrieben werden. Hier soll auch auf die Gründe für Erfolg oder Misserfolg eingegangen werden.

Für die Workshops wurden folgende Themengebiete ausgewählt:

1. Bed materials in fluidised bed gasification
2. Product gas cleaning and usage
3. Tar formation, analysis and removal
4. Small scale fixed bed gasification
5. Analysis & measurements (trace components)

6. Sustainability
7. Fuel pre-treatment, demands of gasifiers on fuel quality
8. Drop in fuels

Aus diesen Schwerpunkten werden die 6 wichtigsten ausgewählt und zu diesen jeweils ein Workshop abgehalten. Die Workshops werden im Rahmen der Task Meetings organisiert und es werden dazu Experten aus Industrie und Forschung eingeladen. Bei den Workshops wird darauf geachtet, dass keine thematischen Überschneidungen mit den verschiedenen Konferenzen im Bereich Biomassevergasung stattfinden.

Die Task Meetings finden 2-mal jährlich statt (jeweils Frühling und Herbst) und dabei wird der aktuelle Status (politische Rahmenbedingungen, F&E Projekte, Demonstrations- und kommerzielle Anlagen) der teilnehmenden Länder präsentiert. Weiter wird bei jedem Meeting auch eine oder mehrere Vergasungsanlagen besichtigt.

Der Task hat auch in der Vergangenheit eine Webseite (**http://www.ieatask33.org**) erstellt, in der Literatur zu Biomassevergasung, die aktuellen Länderberichte und die Ergebnisse der Workshops online verfügbar sind. Diese Webseite wurde im laufenden Triennium neugestaltet und eine online Datenbank über Vergasungsanlagen von Biomasse zugefügt. Es wurde auch die Verwaltung der Webseite nach Österreich transferiert. Im kommenden Triennium ist es wieder geplant die Webseite regelmäßig aktualisieren und mit neuen Daten und interessanten Informationen über der Biomassevergasungstechnologien zu befüllen.

Es ist geplant 1-2 pro Triennium ein Workshop auf nationale Ebene zu organisieren. Hier wird den österreichischen Firmen, Forschungsinstituten etc. der Stand der Technik in anderen Task Mitgliedsländer präsentiert. Zusätzlich werden die österreichische Firmen und Institute die in Biomassevergasung tätig sind über ein Newsletter (2 mal pro Jahr) informiert.

Darstellung, ob weiterführende nationale Forschungsprojekte bzw. IEA-Kooperationsprojekte im Themenbereich geplant sind bzw. schon durchgeführt werden.

Auch im Triennium 2013-2015 ist es geplant basierend auf den Ergebnissen von letztem Triennium im Task 33 weiterarbeiten.

Literatur-/Abbildungs- / Tabellenverzeichnis

Link zu Taskwebsite (Seite, auf der der gesamte Taskbericht veröffentlicht ist/wird)

Taskwebseite: www.ieatask33.org
Taskbericht: http://www.nachhaltigwirtschaften.at/iea/results.html/id1976

Auflistung von Publikationen des Task (Link zu Downloads)

Titel	Link zu Download
Meeting Minutes Helsinki	http://www.ieatask33.org/app/webroot/files/file/minutes_and_presentations/Helsinki_Jun2010/Helsinki_Minutes.pdf
Meeting Minutes Copenhagen	http://www.ieatask33.org/app/webroot/files/file/minutes_and_presentations/Skive_Oct2010/Skive_Minutes.pdf
Meeting Minutes Christchurch	http://www.ieatask33.org/app/webroot/files/file/minutes_and_presentations/Christchurch%20April%202011/Minutes/Christchurch_Apr2011.pdf
Meeting Minutes Pitea	http://www.ieatask33.org/app/webroot/files/file/2011/Pitea_Task_33_Minutes.pdf
Meeting Minutes Istanbul	http://www.ieatask33.org/app/webroot/files/file/minutes_and_presentations/Istanbul_Apr_2012_Minutes.pdf
Meeting Minutes Vienna	
Workshop Report "Biomass gasification opportunities in the forest industry"	http://www.ieatask33.org/app/webroot/files/file/2011/Workshop-report/Pitea-workshop-report.pdf
Workshop Report "Bed materials"	http://www.ieatask33.org/app/webroot/files/file/2012/WS-Report/WS-Report.pdf
Newsletter Vol.1/2011	http://www.ieatask33.org/app/webroot/files/file/Newsletter/Newsletter_Volume1.pdf
Country Report Österreich	http://www.ieatask33.org/app/webroot/files/file/country_reports/Austria.pdf
Newsletter Vol 1/2012	http://www.nachhaltigwirtschaften.at/iea_pdf/newsletter/task33_newsletter2012_vol1.pdf
Newsletter Vol. 2/2012	http://www.nachhaltigwirtschaften.at/iea_pdf/newsletter/task33_newsletter2012_vol2.pdf
Nachwachsende Rohstoffe, 58 (2010), S. 17	http://www.blt.bmlfuw.gv.at/vero/mnawa/nr58.pdf

Bild- und Tabellenverzeichnis:

Anhang

Meeting Minutes

- Helsinki 2010
- Copenhagen 2010
- Christchurch 2011
- Pitea 2011
- Istanbul 2012
- Vienna 2012

Workshop Reports

- "Biomass gasification opportunities in the forest industry"
- "Bed materials"

Newsletter

- Vol. 1/2011

Newsletter-Österreich

- Vol. 1/2012
- Vol. 2/2012

IEA Bioenergy Agreement: 2010-2012
Task 33: Thermal Gasification of Biomass
First Semi-annual Task Meeting, 2010
Helsinki, Finnland
Tue. 1 to Thr. 3 June 2010
Minutes

Day 1, Tuesday 1 June 2010

The list of attendees, for the Task Meeting include: Mayumi Morita and Tomoko Ogi, NEDO/AIST, Japan, Thomas Kolb, KIT, Germany, Reinhard Rauch and Jitka Hrbek, TUV, Vienna, AT, Bram van der Drift, ECN, NL, , Ilkka Hannula, Matti Nieminen and Tuula Mäkinen, VTT, FI, Chris Williamson, UofC, NZ, Serge Biollaz and Martin Rüegsegger, PSI/ETECA, CH, Serhat Gül, MRC, TR and Richard Bain, NREL, USA,

Others: Invited speakers for the 2nd June 2010 WS1: Advanced Biofuels: Esa Kurkela, VTT,FI, Kari Salo, Carbona Inc., FI; Tiina Räsänen, Stora Enso, FI.

Regrets for inability to attend were received from: Giuseppe Fiorenza, ENEA, IT; Henryk Flyver Christiansen, DEA, DK.

Country Updates on Biomass Gasification:

Finland, Ilkka Hannula, VTT: The waste gasification seems to be a good way of waste disposal and energy gain. It is also a cost-effective way to reduce CO_2 emissions of power plants. Review of existing plants was demonstrated. A CFB of 60 MW with 360 MW_{th} boiler is in operation since 1998. There were no commissioning problems. The gasifier is proposed to operate with a high fuel flexibility. Projects under consideration concerning a high efficiency boiler for waste or high alkali/chlorine biofuels: Mälarenergi (200MW, waste) and Lahti Energia (160 MW, waste).

Lahti Energia Waste Gasification Project: the ground construction has begun, in commission by April 2012. Capacity of 2*80MW. The fuel will be high quality SRF.

Atmospheric-pressure CFB/BFB gasification for kilns and boilers: commercial lime kilns gasifiers were constructed in 1980´s by Ahlström Oy. New development by Foster Wheeler in 1990´s for boiler application. Gasifiers in Finland now offered by Forster Wheeler, Carbona/Andritz and MetsoPower. Feasible in size range 15-150 MW.

VTT´s Ultra Clean Gas Project (UCG) proceeded in 2004-2007 was supported by VTT, TKK, Forster Wheeler, Neste Oil, Andritz, Vapo, PVO, UPM, StoraEnso, M-real and Botnia. The project was focused on pressurized gasification followed by catalytic reforming.

In 2010 VTT-UCG optimized syngas R&D PDU-scale development. First synfuel production plant with 200-250 MW feed capacity will start-up in 2012-2014. 105 000 tons/a diesel fuel should be produced. UCG Funda 2008-10: VTT, TKK an Abo Akademi, total budget 1,5 M €.

Stora Enso/Neste Oil joined Venture for F-T BTL diesel fuel. Currently building a 12 MW demoplant, to be in use in spring 2009.
International gasification R&D cooperation: Carbona with The Gas Technology Institute, Chicago, USA. The long term exclusive cooperation is planned concerning pressurized BFB gasification with biomass fuels, air and oxygen supply and gas cleanup system. As main product is bio-crude oil supposed.

Nord Syngas:
Participants: ETC and LTU Sweden, SINTEF Norway. The project duration 2010-13 and budget 2,3 M€. The objectives of the project:

1. To create new scientific knowledge on FB and EF gasification of biomass and black liquor in order to support the Nordic industrial development and demonstr. projects
2. To study the fate of alkali metals and other inorganic species
3. To create new data on fuel pyrolysis and reactivity

Mixed alcohols:
Project duration till 2011, budget 0,35 M€
Objectives: to assess and compare on-going North American and Finish R&D work on different BTL applications.

Germany, Thomas Kolb, KIT: The significant BMG activities in Germany are listed below:
Bioliq –fast straw pyrolysis, biosyncrude preparation, entrained flow gasifier. The product gas is cleaned and a biofuel is synthesized (DME, gasoline). The process is divided into 4 steps: fast pyrolysis, HP entrained flow gasification, gas cleaning and synthesis. The realization period is 2008-2011.

CHOREN
-beta-plant:
-fuel: wood (65 000 t ds/a)
-thermal load: 45 MW_{th}
-mechanical complementation in 2009, not in operation yet
sigma-plant:
-basic engineering
-site selection
-investment >500 M€
- no decision yet

BtL with CHOREN-Technology in France:
The French CEA and its industrial and financial partners are launching the first phase of construction of a pilot thermochemical BTL unit in northeastern France. The pilot plant will demonstrate a complete BTL production chain. It will use about 75,000 t of forest and agricultural residues/year to produce about 23,000 t of second generation biofuels (diesel, kerosene, naphta)/year. The 1st phase involves the design studies and is under contract with CNIM group (France) and in partnership with Air Liquide, Choren, SNC Lavalin, Foster Wheeler-France and MSW Energy. Air Liquide will coordinate some of technical engineering operations and provide oxygen and hydrogen. Choren is providing the gasification technology.

BMG – Artfuel, CUTEC:
Specifications: - CFB/steam-oxygen blown

-fuel: dry biomass (60-100 kg/h)
-thermal load: 400kW
-temperature: 900°C
-atm. Pressure
-F-T synthesis

Technology platform bio energy and methane, TBM
Location: Geislingen-Türkheim near Stuttgart

Objectives: - commercial operated biomass plant based on AER-Gas technology
-10MW_{th} gasifier (FB)
-1st step – power generation
-2nd step – methanation
-integration of other biomass conversion technologies
Time schedule: 01/2008 start of planning

Decision on erection is post phoned

BtL with UHDE Technology in France:
BioTfuel is a new BtL project with 5 French partners and UHDE. Syngas production is based on UHDE's PRENFLO-technology with Direct Quench PDQ. 2 pilot plants with total invest of 112,7 Mio € are planned.

KIC InnoEnergy
EU-project has started in 2010

Goal: foster SET-plan implementation
6 regional centers with different technical topics
CC BENELUX: Intelligent energy-efficient buildings and cities
CC IBERIA: Renewables (wind, CSP, photo voltaics, wave and tidal energy)
CC ALPS VALLEYS: Sustainable nuclear & renewable energy convergence
CC Sweden: European Smart Electric Grid and Electric Storage
CC POLAND PLUS: Clean Coal Technologies
CC GERMANY: Energy from Chemical Fuels

Turkey, Serhat Gül, MRC:

MRC - Marmara Research Centre is a government institution divided into 7 institutes, located nearby of Istanbul. Energy institute has 7 different research groups, one of them is "Gasification/combustion of biomass/coal" group with 19 researchers. The group started its activities in 2005 with EU project "BIGPOWER". In parallel to this project, nationally funded project has been started and laboratory scale and pilot scale test facilities has been constructed. The group is focused on the gasification and combustion of solid fuels. Auxiliary infrastructure for gasification has been developed and gas cleaning is developing. Power application is studied with the integration of gasifier unit with gas engine.
The annual biomass energy potential is estimated as 17 Mtoe. Turkey has about 21,7 mil. hectares forest area (about 27,2% of the country).
Turkey is an energy importing country, that is why biomass is a very attractive choice.
Gasification/combustion of biomass/coal group activities:
Current laboratory scale test facilities:

- BFB gasifier (20kW_{fuel})

- Fixed bed gasifier (40 kW_{fuel})
- CFB combustor (20kW_{th})
- CFB combustor (35 kW_{th})

Current pilot scale test facilities:

- BFB gasifier (450 kW_{fuel})
- Fixed bed gasifier (300kW_{fuel})

Under construction facilities:

- CFB combustor
- CFB gasifier (150kW_{fuel})
- Pressurized bubbling bed gasifier (150kW_{fuel})

Tringen-Liquid fuel production from coal/biomass mixtures is a nationally funded project. Its duration is 4 years (2009-2012). Project partners are: MRC, 2 Universities and 2 private companies. The aim of the project is to produce more economic, efficient and clean liquid fuels from coal and biomass, to enhance the utilization of the widespread national resources for sustainable development and energy security. Also to develop technologies to be used in industry and finally to demonstrate the outcomes in pilot scale.

Ongoing projects at MRC:

- Combustion of biomass and lignite in CFB, 2007-2010
- Liquid fuels production from coal and biomass, 2009-2013
- High added value materials from waste tyre gasification residues, 2009-2012
- Designing and manufacturing of 2 MW_e FB gasifier, 2009-2011

New Zealand, Chris Williamson, University of Canterbury:

Emissions Trading Scheme (ETS) is the government´s core price-based measure for reducing greenhouse gas emissions and achieving broader sustainability objectives in New Zealand.
Mid. 2009 government introduced a biodiesel subsidy of $NZ 0,425/litre for locally produced biodiesel. Latest figures show 6 producers and 75,000 litres produced.
In 2009 and extensive study into NZ bioenergy options completed → NZ could produce 100% of liquid fuel and heat from 3,3 Mha of forest.

Objectives of University of Canterbury:

- Optimization of biomass gasif. And co-gas. for clean and H_2 rich gas
- Gasif. of energy densified biomass slurry
- F.-T. synthesis for biodiesel
- $_{22New}$ biomass resources and feasibility studies for an integrated F.T. plant

FICFB lab scale gasifier used for investigations on gasification of industrial wood residue for CHP and liquid fuel synthesis.
Latest experiments to understand and optimize gasifier operations:

- Optimization the steam/biomass ratio by measuring the tar concentration, producer gas and carryover of bed material
- Optimization the bed depth in BFB by measuring the tar concentration, producer gas and the pressure differential across the chute
- Check for tar removal in the BFB cyclone system by measuring the tar content in the gas before and after cyclone

There are two projects concerning the tar removal and gas cleaning:

- Gerhom´s project – currently developing an automatic control system before relocation and integration with FICFB gasifier

- Jan´s project- gas cleaning, continuation of Gerhom´s project with further gas cleaning to remove NH_3, H_2S, HCl

At Uni of Cant. Gas composition vs. bed material studied:

- For the ratio of H_2:CO = 2:1 seems to be the best combination 50% of dolomite in olivine or 20% of magnetite and 20% of dolomite

Current/future experimental campaign:

- Bed materials: to lower tar and CO_2 and increase H_2:CO
- Coal-biomass blends: synergy with coal (Research NZ Ltd)
- Alternative biomass fuelstocks with non woody crops

New biomass resources:

- Field trials to grow perennial crops, summer and winter annuals
- 6 strong contenders identified to have dry biom. Yields of 12-26 t/ha

F.-T. fuel work:

- to develop a FT reactor and catalyst system
- ultimate goal – incorporate the FT process into the Univ. of Cant. gasifier to demonstrate a complete biomass to liquid fuel process

Commercial activities on biomass gasification:

- Fluidyne Gasification Ltd = mega class series of gasifiers ($300kW_e$-$2MW_e$) for CHP in Canada
- Alternative energy solutions – focus on small scale, transportable fast pyrolysis system producing bio oil-char and syngas

Switzerland, Martin Rüegsegger, ETECA GmbH:

Policy in Switzerland is made by Swiss Federal Office of Energy (SFOE), which provides high efficiency and increasing of renewable energy.

Research activities in Switzerland:

- PSI (Paul Scherrer Institut): -gasification of dry biomass (for CHP, SNG production)
  -gasification of moist biomass (for SNG production)
- EKZ – supplier for turnkey biomass gasification plants and energy contracting for biomass cogenerating plants
- Pyroforce Energietechnologie AG – supplier for turnkey biomass gasifier plants
- XyloPower AG - supplier for turnkey biomass gasifier plants
- PYCON (Pyroforce and CTU) – was formed for project “Stans Nidwalden” will disappear
- CTU – renaming (Conzepte Technik Umwelt AG → Clean Technology Universe AG)
- DASAGREN – is no longer active, 2 collaborators today with XyloPower

BMG Stans Nidwalden – main features:

- 8 gasifier Pyrforce
- Feed: wood chips
- 2x690 kW_{el} Jennbacher with waste heat utilization 2.2 MW for distr. heat
- Distr. heating max. 5,4 MW
- 2007 commissioning
- Actual in revision for new process control system

BMG Wila – main features:

- Modified dasagren: IISc-Nepro gasifier with coal production
- Feed: waste wood with 15% of moisture

- Producer gas cleaning system with cyclone separation, quenching, scrubbing and filtering
- 350 kW_{el} with Jennbacher
- Waste heat utilization 425 kW
- Investment 4.8 Mio CHFr
- Commissioning in January 2007
- 2500 running hours till end of April 2010

BMG Pratteln – main features:
- Gasifier type Kuntschar
- Feed: wood chips with 10-15% of moisture
- Gas cleaning with cyclone separation
- Waste heat for district heating
- Commissioning January 2009
- Investment 4,5 Mio CHF

Bio Coal Production Facility –main features:
- "Pyreg" low temperature gasifier for bio coal production
- Feed: wood chips
- Syngas used for production process only
- Gas cleaning over "Flox-burner"
- Waste heat actually not used
- Output 1t coal per day
- Commissioning in April 2010
- Coal used for agricultural purpose "Terra Preta"

New BMG Projects in Switzerland
- EMPA Dübendorf calls 2010 for offers for BMG 1MW_{el}
- Delinat will multiply the bio coal production, 5 new facilities are planed including waste heat utilization
- Research SNG gasifier facility in discussion

Austria, Reinhard Rauch, TUV:

Austrian research organisations: Graz University of Technology, Joaneum Research Graz, MCI, Vienna Univerzity of Technology, Bioenergy 2020+, FJ-BLT Wieselburg

Graz University of Technology – Institute of Thermal Engineering
- Heat pipe reformer
- Distributed SNG production
- 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 gasif. conditions

Joaneum Research Graz – Department of Energy Research
- Life Cycle Assessment
- Microchannel FT technology

MCI – University of Applied Sciences for Environmental-, Process- and Biotechnology, Innsbruck

- Multistage fixed bed gasification systems

Vienna University of Technology (TUV) – Institute of Chemical Engineering
- R&D in dual FB steam gasification
- Production of FT fuels
- Production of BioSNG
- Production of mixed alcohols
- Scientific partner in Bioenergy 2020+
- Representative of Austria in Task 33

Bioenergy 2020+
- Pressurized gasification (in cooperation with TUV)
- Usage of product gas from biomass CHP Güssing in a SOFC
- Production of FT liquids (in cooperation with TUV)

FJ-BLT Wieselburg (HBLFA)
- 1. and 2. Generation biofuels
- Representative of Austria in task 39

Austrian companies active in biomass gasification:
- Austria Energy&Environment – actually no activities, but has still patent of FICFB
- AGT Agency for Green Technology – low temperature conversion=thermo-catalytic decomposition process operating without air supply
- Austrian Enviro Technologies
- GE Jennbacher
- Ortner Anlagenbau – builds FICFB for CHP applications
- Repotec – builds FICFB gasifiers for CHP, SNG and other synthesis
- Syncraft Engineering GmbH
- Urbas – fixed bed gasification
- Xylogas - fixed bed gasification

Implementation
Biomassekraftwerk Güssing GmbH:
- Type, Capacity: FICFB, 2MW_{el}
- Feed: wood chips
- In operation

BioSNG Demonstration:
- Type, Capacity: Methanation, 1MW_{SNG}
- Feed: product gas from biomass CHP Güssing

Pyrotherm Kraftwerk Güssing GmbH:
- Type, Capacity: Pyroforce, 350 kW_{el}
- Feed: waste wood

Energie Oberwart:
- Type, Capacity: FICFB, 2.7 MW_{el}
- Feed: wood chips
- In operation

Commercial FICFB gasifiers in Austria:

Location:	Güssing	- el. Production using gas engine
		-8.0 MW_{fuel}, 2.0 MW_{wl}
		-start up in 2002, in operation

	Oberwart	-gas engine/ORC
		-8.5 MW_{fuel}, 2.8 MW_{wl}
		-start up in 2008, in operation
	Villach	- gas engine
		-15.0 MW_{fuel}, 3.7 MW_{wl}
		- start up in 2010, now construction finished
	Klagenfurt	-gas engine
		-25.0 MW_{fuel}, 5.5 MW_{wl}
		-start up in 2011

Commercial FICFB gasifiers in Germany:

Location:	Ulm	-gas engine/ORC
		-15.0 MW_{fuel}, 5.3 MW_{wl}
		-start up 2010
	Geislingen	-AER process/gas engine/ORC
		-10.0 MW_{fuel}, 3.3 MW_{wl}
		-start up 2010

Netherlands, Bram van der Drift, ECN

Developments:

HOST

- Netherlands: 3MW_{th} CFB gasifier, boiler
- Portugal: 3MW_{th} CFB gasifier, OLGA, gas engine

BioMCN

- Now 30-40% glycerin in Natural Gas reformer (approx. 150$MW_{bio\text{-}methanol}$)
- Looking for options to go to 100% bio-methanol gasification

NUON

- 15% (energy) demolition wood direct co-firing in 250 MW_{el} coal-based IGCC

ESSENT

- Approx. 6000 h/year, cooling remains the biggest problem
- Plans for second indirect co-firing system

ECN

- Tests ongoing to support basic engineering CHP-demo by HVC
- OLGA being improved ORS (oil recovery system) added for oil viscosity control, additional absorber for lower temperature gasification
- MILENA tests at lab-scale at low-temperatures

HVC

- Basic engineering 10MW CHP ongoing, permits granted, location selected, demolition wood

EDGaR (Energy Delta Gas Research)

- Supporting the energy transition related to the use of gases (no renewable energy)
- 42 Mio € for R&D
- Consortium
- 5 years programme
- 3 theme´s: monogas to multigas, future energy systems, changing gas markets

NL renewable energy subsidies:

Biomass:	11,4-19,3€ ct/kWh
Waste:	11,4-13,7
Biogas:	5,9-63,5

Japan, Tomoko Ogi, National Institute of Advanced Industrial Science and Technology

Nedo (New Energy and Industrial Technology Development Organization) is a funding agency AIST (National Institute of Advanced Industrial Science and Technology) is a research institute. Both are governed by cabinet office of prime minister of Japan.

Japan strategies policies relating to biomass energy:

- Promotion of utilization of organic resources originated from forestry, agriculture and fisheries as feedstock for biomass gasification
- Enhancement of energy supply social structure

Target of new energy introduction:

- Biomass: in 2010 – target scenario = 3,080 thousand kl COE
  In 2020 – target scenario = 3,300

According to the report, in Japan, now only three types of bio-fuels are accepted: bio-ethanol from sugar-cane (Brazil), from sugar beet (domestic), from scrap wood from houses.

Gasification status in Japan:

- CHP: developed at demonstration stage in a relatively small scale
- Liquid fuels: developed at bench scale

Gasification for CHP applications in Japan:
Nowadays there are 12 companies using wood, waste, agricultural residues and manure as a feedstock for gasification process. Capacity of plants varies from 10 kW to 300kW.

NEDO biomass R&D projects:

- Short term plan up to 2012: combustion, co-firing of biomass
  Bio-ethanol and bio-gasoline
- Mid/long term plan after 2012: development of biofuel production from lignocelluloses biomass
  Gasification for fuel/chemicals

Present status of biomass gasification in Japan:

- Only several years had been passed, since biomass was recognized as “New sustainable energy” in Japan
- Gasification process is not yet commercialized or be in practical application
- Gasification for CHP application has been partially in practical application or demonstrated, but in small scale
- Gasification for liquid fuels/chemicals synthesis has been developed at bench scale

U.S.A, Richard Bain, NREL:

Current biofuel status:

Biodiesel	-165 companies, 1.85 billion gallons/y capacity
Corn ethanol	-201 commercial plants
	-11.987 billion gallons/y capacity
	-additional 1.322 billion gal/y planned or under construction
Cellulosic ethanol	-projected commercial cost approx. 3.50/gge

Key DOE Goals:

- 2012 : cellulosic ethanol $1.31/ETOH gallon or approx. 1.96/gge
- 2022: 36 B gal renewable fuel, 21 B “Advanced renewable fuel”

- 2030: 60 B gal ethanol

Biopower status:
2009 capacity – 10.8 GW_e
2009 generation – 54.34 TWh
Cost - 0.08-0.10 USD/kWh

Biopower potential:
2022 – 22 GW
2035 – 48 GW
2050 – 91 GW
Major DOE biofuels projects are located on eastern part of USA.
DOE and the USDA Forest Service have supported development Community Power Corporation´s BioMax Modular Biopower System.
CPS Projects:
There are 18 BioMax sites in the USA.

Frontline Bioenergy, LLC, Ames, Iowa – commercial installation of BFB gasifier with air or oxy/steam supply. Pressure operation is up to 6 bar. Gas conditioning is providing using high efficiency filtration system with tar reforming. Capacity is up to 70MW_{th} per train.

Frontline system:
Bubbling fluidized bed
- Fuel flexibility: corn, stover, straw, grasses, tramp material
- Robust performance, isothermal

Moderate pressure operation
- Greater throughput: single unit, allows shop-built components
- Benefit for biomass-to-liquids: avoid first stage compression

Gas conditioning
- Novel filtration: removes alkalis and PM, protects downstream boilers and catalytic/biological processes
- Proprietary tar cleanup: allows multi-burner applications

Upgradeable for syngas production
- Add oxy/steam system for syngas production

Discussion on Scope of Work and Workshop Topics for 2010-2012: The next task meeting will be hold together with Task 32: Biomass Combustion and Co-firing. IDA Energy, a branch of The Danish Society of Engineers will be hosting the planned workshop in fall 2010.

The third meeting in this Triennium could be on the topic “sustainability issues”. The task leader will contact Task 38 to a possible joint workshop.

The task homepage will be transferred to Austria. The homepage will be also updated and modified. A description of basics of gasification will be included and also a database of existing gasifiers, similar to the database of task39 (http://biofuels.abc-energy.at/demoplants/projects/mapindex).

Next Task Meeting: tentatively scheduled for Week 40, 5.-7. October 2010. Denmark will host the second semi-annual meeting of the 2010-2012 Triennium. The meeting will take place in Copenhagen.

END

IEA Bioenergy Agreement: 2010-2012
Task 33: Thermal Gasification of Biomass
Second Semi-annual Task Meeting, 2010
Skive and Copenhagen, Denmark
Tue. 5 to Thr. 7 October 2010
Minutes

Day 1, Tuesday 5. October 2010

The list of attendees, for the Task Meeting include: Henrik Flyver Christiansen, DAE, D, Mayumi Morita and Tomoko Ogi, NEDO/AIST, Japan, Thomas Kolb, KIT, Germany, Reinhard Rauch and Jitka Hrbek, TUV, Vienna, AT, Bram van der Drift and L.P.L.M. Rabou, ECN, NL, NZ, Martin Rüegsegger, ETECA, CH, Hakan Karatas, MRC, TR, Jingge Li, UoC, NZ, and Richard Bain, NREL, USA,

Others: as observer Lars Waldheim, W.Cons., Sweden, Mehri Sanati, Lund University, Sweden

Regrets for inability to attend were received from: Giuseppe Fiorenza, ENEA, IT, Ilkka Hannula, VTT, FI

The Agenda of the Meeting was:

Day 1, Tue, Oct 5

1. Welcome:
2. Introduction of Task Members and Observers
3. Review and Approval of Agenda
4. Review and Approval of Minutes from First Semi-annual Task Meeting, 2010, June, Helsinki, Finland
5. Country Updates on Biomass Gasification: Detailed Highlights with Technical Information
6. (Country updates will be 25 min + 5 min for questions)
    a) Austria, Reinhard Rauch
    b) Netherlands, Bram van de Drift
    c) Italy, Giusseppe Fiorenza , ENEA
    d) Denmark, Henrik Christiansen, DEA
    e) Japan, Tomoko Ogi, AIST
    f) Norway, Rainer Backman, SINTEF
    g) Switzerland, Martin Rüegsegger, ETECA GmbH
    h) Germany, Thomas Kolb, ITC-TAB
7. Short Updates
    a) Finland, Ilkka Hannula, VT
    b) Turkey, Hakan Karatas, MAM
    c) New Zealand, Jinnge Li, Univ of Canterbury
    d) USA, Richard Bain, NREL
8. Discussion on 2011 – 2012 Meetings and workshops

Day 2, Wed Oct 6

Meeting Location: Plant Visits: I/S Skive Fjernvarme (Andritz-Carbona gasifier CHP plant) and Weiss Hadsund plant (Viking gasifier CHP plant)

Day 3, Thu, Oct 7

Expert workshop on “Small scale biomass co-generation; Technology status and market opportunities”

Country Updates on Biomass Gasification:

Austria, Reinhard Rauch, TUV:

Policy targets in Austria such as green house gas reduction, increase of efficiency, increase of renewables (actually 29%, 34% by 2020) and use of biofuels for transportation (actually 5,9% biodiesel and ethanol, 10% by 2020) were presented. Also targets of the energy strategy, such as security of energy supply and innovation oriented modification of the energy system were introduced.

Further Austrian research organizations and their activities were introduced: Graz University of Technology, Joanneum Research Graz, MCI, Vienna University of Technology, Bioenergy 2020+, FJ-BLT Wieselburg

Graz University of Technology – Institute of Thermal Engineering

- Heat pipe reformer
- Distributed SNG production
- Health, safety and environmental issues for gasification systems

Joanneum Research Graz – Department of Energy Research

- Life Cycle Assessment
- Microchannel FT technology

MCI – University of Applied Sciences for Environmental-, Process- and Biotechnology, Innsbruck

- Multistage fixed bed gasification systems

Bioenergy 2020+

- Pressurized gasification (in cooperation with TUV)
- Usage of product gas from biomass CHP Güssing in a SOFC
- Production of FT liquids (in cooperation with TUV)
- Production of hydrogen
- Waste gasification in FICFB gasifier

Vienna University of Technology (TUV**) – Institute of Chemical Engineering**

- R&D in dual FB steam gasification
- Production of FT fuels
- Production of BioSNG
- Production of mixed alcohols
- Scientific partner in Bioenergy 2020+
- Representative of Austria in Task 33

FJ-BLT Wieselburg (HBLFA)

- 1. and 2. Generation biofuels
- Representative of Austria in task 39

Austrian companies active in biomass gasification:

- Austrian Energy&Environment – actually no activities, but has still patent of FICFB
- AGT Agency for Green Technology – low temperature conversion=thermo-catalytic decomposition process operating without air supply
- Austrian Enviro Technologies

- GE Jenbacher
- Ortner Anlagenbau – builds FICFB for CHP applications
- Repotec – builds FICFB gasifiers for CHP, SNG and other synthesis
- Syncraft Engineering GmbH
- Urbas – fixed bed gasification
- Xylogas - fixed bed gasification

Implementation:

Biomassekraftwerk Güssing GmbH:

- Type, Capacity: FICFB, 2MW_{el}
- Feed: wood chips
- In operation

BioSNG Demonstration:

- Type, Capacity: Methanation, 1MW_{SNG}
- Feed: product gas from biomass CHP Güssing
- Status unclear

Pyrotherm Kraftwerk Güssing GmbH:

- Type, Capacity: Pyroforce, 350 kW_{el}
- Feed: waste wood
- Status unclear, optimization work necessary

Energie Oberwart:

- Type, Capacity: FICFB, 2.7 MW_{el}
- Feed: wood chips
- In operation

Commercial FICFB gasifiers in Austria:

Location:	Güssing	- el. Production using gas engine
		-8.0 MW_{fuel}, 2.0 MW_{wl}
		-start up in 2002, in operation
	Oberwart	-gas engine/ORC
		-8.5 MW_{fuel}, 2.8 MW_{wl}
		-start up in 2008, in operation
	Villach	- gas engine
		-15.0 MW_{fuel}, 3.7 MW_{wl}
		- in commissioning
	Klagenfurt	-gas engine
		-25.0 MW_{fuel}, 5.5 MW_{wl}
		-start up in 2011, now detailed engineering

Commercial FICFB gasifiers in Germany:

Location:	Ulm	-gas engine/ORC
		-15.0 MW_{fuel}, 5.3 MW_{wl}
		-under construction
	Geislingen	-AER process/gas engine/ORC
		-10.0 MW_{fuel}, 3.3 MW_{wl}
		-now detailed engineering

The further topic of the presentation was “hydrogen from biomass”. The aim is to separate hydrogen directly from the product gas of the biomass CHP Oberwart, which is done by membrane technology. First results are quite good (~75% H_2, the rest is mainly CO_2).

Also “FT synthesis” in Austria was presented. Nowadays 2 FT syntheses are in operation at biomass CHP plant in Güssing: 5kg/day lab scale based on slurry FT (by TUV and Bioenergy 2020+) and 1bpd pilot scale based on microchannel technology (by SGC Energia).

Netherlands, Bram van der Drift, ECN

Developments:

HOST

- Netherlands: 3MW_{th} CFB gasifier, boiler
- Portugal: 3MW_{th} CFB gasifier, OLGA, gas engine
- Romania: 3MW_{th}, CFB gasifier, boiler

BioMCN (Methanol Chemistry Netherlands)

- Raw glycerine upgrading
- Now 30-40% glycerin in Natural Gas reformer (approx. 150$MW_{bio\text{-}methanol}$)
- Looking for options to go to 100% bio-methanol gasification

NUON

- 15% (energy) demolition wood direct co-firing in 250 MW_{el} coal-based IGCC

ESSENT

- CFB, cooler, cofiring, demolition wood
- Approx. 5000 h/year, cooling remains the biggest problem
- Subsidy scheme for this plant will end in 2013, then the future unclear
- Towards 50% biomass in Amer Power Plant

ECN, Milena development

- Supporting 14 MW_{th} CHP demo by HVC in Alkmaar
- Envisaged fuel: demolition wood
- Currently, tests with pilot-MILENA/OLGA, 150 kg/h

ECN, Milena development: O_2-transport

- O_2-transport from combustor to gasifier
- Up to 0,3 wt% of O_2 in circulating olivine (ER up to 0,1)

24 h-test run using a demolition wood was realized. The gas composition was measured. CO (27-31 vol.%, dry), H_2 (18-20), CO_2 (13-16) and CH_4 (9-11).

ECN, BioSyngas by entrained flow gasification:

- LCS: lab scale combustion and gasification simulator (conversion, slagging, fouling, emissions)
- Conversion of corn stover versus coal at 1300°C, ER=0,25, residence time 1800ms: corn conversion 100%, coal about 58%

HVC, CHP- and SNG- developments:

- Basic engineering 14 MW CHP ready, permits granted, location selected, demolition wood
- Tests at ECN ongoing
- Investment decision 12/2010 or 5/2011

At the end of the presentation, a part of research work (provided at Universities in Netherlands), concerning partial combustion technology for tar removal, in-bed measurements to increase methane yield, producer gas cooling, self-gasification and catalytic oil gasification was presented.

Denmark, Henrik Flyver Christiansen, DEA

" The Danish Commission on Climate Change Policy is to examine how Denmark can reduce and ultimately eliminate dependency on fossil fuels in the long term. The Climate Commission shall describe how to implement this long-term vision."

The Commission´s Results:

- Denmark can become independent of fossil fuels by 2050
- Even as the energy demand doubles

- The technology is available today, but more will become available
- Small additional cost as continued dependence on fossil fuels will become an expensive habit

Danish Follow-up Programme for Solid Biomass CHP Plants:

- Skive gasification plant: wood pellets, 5 MW_{el}
- Harboøre gasification plant: wood pellets, 0.85 MW_{el}
- Græsted gasification plant: wood chips, 85 kW_{el}
- Biosynergi pilot plant: 2 step down draft gasifier, wood chips, 85 kW_{el}
- Weiss Project: 6*Viking = 150kW_{el} or 400kW_{th}
- LT-CFB at DTU 2010 DONG Energy: pilot plant – 500kW, low temp. CFB, wood, straw and waste, scale up 5 MW, slurry fibre
- Svanholm Gods: in 2010: 4*35 kW in UK and D

Japan, Tomoko Ogi, AIST

Target for renewables energies in Japan was introduced. Also review of basic resource/energy policy and plan was presented. Energy security, Environment and Economic efficiency are the main programs.

NEDO´s Biomass and R&D projects:

- Medium/long term technology development:
    - Basic technology development expected to be commercialized in 2015-2030
    - Gasoline and diesel as an alternative fuel

Accelerated technology development for biofuels (commercialization 2015-2020). Bio-ethanol production from lignocellulosic biomass.

- Strategic development of next generation bioenergy utilization technologies (basic research BTL synthesis, bio-fuel from micro-algae, bio-butanol production)

Gasification: CHP

- More than 30 units in operation, most of them on demonstration stage (10-300 kW), except of few cases of 2MW for local distributed system. Gasifiers are mostly fixed bed and rotary kiln type. Electricity produced is consumed on site and/or bought by Buyback system

Gasification: BTL

- Only a few examples on demonstration stage (Mitsubishi Heavy Industries Co. Ltd., TAKUMA Co. Ltd)

NEDO project: test (pilot) plant

- Purpose: acquire properties of integrated system of BTL for commercialization
- Target: to run a test plant of complete system for synthesizing methanol with a self-heating, stand-alone gasifier
    - Capacity: 2t/day
    - Feedstock: cedar, driftwood
    - Gasification: EF gasifier
    - Catalyst for methanol synthesis: Cu/Zn (high pressure)
    - Cold gas efficiency: 65% or more
    - Methanol yield: 20% or more

Based on this pilot plant a commercial plant is planned.

Present status of biomass gasification in Japan:

- Only several years have been passed, since biomass was recognized as a “new sustainable energy” in Japan

- Gasification for CHP has been partially in practical application or demonstrated, but in small scale in most cases.
- Gasification BTL has been developed in bench scale. Now a few test plants in operation
- Bio-fuel for next generation is advocated, enforced as one of important and priority matters

Norway (there was no Task member personally present on the meeting):

Biomass gasification has not a long history in Norway. University research, fundamental research is provided in some groups. In future industrial production of second generation biofuels via biomass gasification planned.

Gasification for Biofuels (GASBIO) – main objectives:

- To develop Norwegian competence in the biofuels area
- To contribute to the reduction of biofuels production costs
- Norway has large unused biomass resources
- EU legislation mandates substantial increase in the use of biofuels
- Biofuels need intensive research to become competitive to fossil fuels on a large scale

Project overview – key data:

- Project within thermochemical biofuels production, type: KMB
- Duration: 4 years
- Partners: SINTEF Energy research, Norske Skog, Xynergo, Metso, Statoil, NTNU-Education

STOP – Stable Operation conditions for biomass combustion plants.

- The main focus of the project will be torrefaction. Pre-treatment fuel technologies can be beneficial for other thermal technologies than combustion, e.g. gasification
- Duration: 4 years

Industry – Xynergo

- Long term objective is to produce high quality biodiesel, bio-jet fuel and bio-naphta based on sustainable, woody biomass
- A commercial scale biofuels production via biom. gasification is planned
- Full scale production in 2018
- Cooperation with Choren

Industry – Fiborgtangen Biokraft

- Biomass gasification CHP plant based on biosyngas under planning (100 GWh power, 170 GWh heat)
- A side stream might be taken out for biofuels production
- Construction starts in 2011
- Planned start-up in 2012

Switzerland, Martin Rüegsegger, ETECA GmbH

Policy in Switzerland is made by Swiss Federal Office of Energy (SFOE), which provides strategy papers for biomass energy utilization and for energy use in general. Main strategy is high efficiency and increasing the part of renewable energy.

Programs:

- REN-Projects by the Cantons
- Cost-covering remuneration for feed in the electricity grid
- + 5´400 GWh/a from renewable (10% of total) by 2030
- Biomass: large increase of power production with CHP

Research activities in thermal gasification of biomass:

- PSI (Paul Scherrer Institut):
  - -gasification of dry biomass
  - -co-firing in NGCC
  - -high temperature fuel cells for CHP
  - -gas processing for SNG production
  - -gasification of moist biomass (for SNG production)

Industrial gasification activities:

- EKZ – supplier for turnkey biomass gasification plants (BMG technique similar to WILA Woodpower) and energy contracting for biomass cogenerating plants
- Pyroforce Energietechnologie AG – supplier for turnkey biomass gasifier plants
- XyloPower AG - supplier for turnkey biomass gasifier plants
- New Switzerland: Foster Wheeler AG in Baar and Foster Wheeler Management AG in Geneva

Thermal biomass gasification CHP-plants, which are in operation in Switzerland, were presented (Aerni in Pratteln, Holzstrom in Strans Nidwalden, Woodpower in Wila). The Pyroforce AMC Spiez is now out of operation.

New projects – September 2010:

EMPA EAWAG Dübendorf decided for CHP gasifier plant

- Supplier will be EWZ and Woodpower
- Wila-type gasifier
- 2x350 kW_{el}

Delinat will multiply the bio coal production (Terra Preta)

- With low temp. gasifier (Pyrolyse)
- 5 to 10 new facilities are in construction including waste heat utilization

Energy Hub Baden CHP gasifier Facility including SNG research stream (in discussion only, concept available)

- SNG gasifier facility
- 7,5 MW fuel input
- 3,2 MW SNG
- 0,7 MW_{el}/1,5 MW_{th}

Germany, Thomas Kolb, KIT:

Bioliq –fast straw pyrolysis, entrained flow gasifier and biosyncrude preparation were presented.

- Fast straw pyrolysis:
  - mechanical complementation in 2007
  - function testing in 2008
  - commissioning with biomass feed 2010
  - production in 2010

BMG-Choren, ß-plant, the plant is not in operation yet.

Choren moved in French area:

- BtL (Bure Saudron) – Design study:
  - 75 kt/a forest and local agricultural residue
  - 23 kt/a 2nd gen. biofuels

Technology platform for bioenergy and methane:

- Objective: the first commercially operated biomass gasification plant in Germany
  - 10 MW_{th} gasifier (FB)
  - 1st step: power generation
  - 2nd step: methanation
  - Integration of other biomass conversion technologies platform for R&D activities
- Preliminary planning finished, but problems with funding

SWU Stadtwerke Ulm CHP demo plant:

- Technology based on the FICFB Güssing (AT)
- Now under construction
- Feed: wood chips
- 15,1 MW_{th}/4,55 MW_{el}

Blue Tower CHP and H_2 demo plant, Herten:

- Gravity driven moving bed reactors
- Capacity: 13 MW_{th}
- Allothermal/ceramic balls as a heat carrier
- Staged reforming/steam blown
- Construction start in 2009
- Total investment 24,6 Mio€

Wood gas demo plant of Stadtwerke Düsseldorf, Arnsberg-Wildshausen:

- Fixed bed air blown down draft gasifier, now in operation
- Built by Biomass Energiesysteme Dortmund with Stadtwerke Düsseldorf AG
- Feed: wood chips
- Thermal: 1MW, electric 270 kW_{el}, heat 410 kW_{th}

KIC InnoEnergy

EU-project has started in 2010

Goal: foster SET-plan implementation
6 regional centers with different technical topics
CC BENELUX: Intelligent energy-efficient buildings and cities
CC IBERIA: Renewables (wind, CSP, photo voltaics, wave and tidal energy)
CC ALPS VALLEYS: Sustainable nuclear & renewable energy convergence
CC Sweden: European Smart Electric Grid and Electric Storage
CC POLAND PLUS: Clean Coal Technologies
CC GERMANY: Energy from Chemical Fuels

Turkey, Hakan Karatas, MRC:

Gasification facilities in Turkey and the tests results were presented.

Atmospheric Bubbling Fluidized Bed Gasifier: -test results

- Feed: hazelnut shell (50kg/h)
- ER varied between 0.3-0.45

- CO, CO_2, CH_4, H_2, O_2,N_2, LHV, syngas flow rate, cold gas efficiency and carbon conversion were in focus of the tests

Atmospheric Fixed Bed Gasifier: – test results (60 min)

- Feed: wood chips and hazelnut shell
- Batch feeding
- Air gasification, ER=0.35
- Gas composition measured (CO, CO_2, CH_4, H_2, O_2,N_2)

Laboratory scale – hot gas cleaning

- H_2S removal on Turkisch dolomite under simulated gasifier atmosphere

Mechanical construction of the pressurized bubbling fluidized bed gasifier (P-BFB-G) was accomplished.
Assembly of main components and pipelines of the circulating fluidized bed combustor (A-CFB-C) was performed.

New Zealand, Jingge Li, University of Canterbury:

Government strategies and initiatives in New Zealand were introduced.

Status of commercial biomass gasification:

- **Fluidyne Gasification Ltd**: is active overseas with its downdraft process (100kWe-2MWe)
- **Alternative Energy Solutions Ltd**: representative for Ankur in Australasia, but focusing now on a screw type fast pyrolysis system (biomass 1t/day) with Ernslaw One Ltd
- **Page Macrae Engineering Ltd**: the 2MWth updraft gasification plant has been shut down as the user, CHH plywood mill, was closed last year. A similar gasifier is to be installed with Windsor's timber dryer next year
- **Ethanol from whey**: 20 million L/yr produced by Anchor Ethanol, a subsidiary of Fonterra. Only 2 million L/yr is consumed in NZ, about 0.06% of petrol sales.
- **Biodiesel from used cooking oil and rape seed oil**: 1 million L/yr by Biodiesel NZ, Solid Energy; expanding to 70 million L/yr in 2011.
- **Biodiesel from tallow**: two pilot plants in Auckland respectively by BioDiesel Oils NZ and Ecodiesel. Ecodiesel is to complete a production facility for 40 million L/yr this year.

Status of research on bioliquid fuels:

- Thermal chemical conversion
- Biological conversion
- Biodiesel from algae by NIWA and Aquaflow

Status of R&D on biomass gasification:

- **University of Canterbury**: the program **"Biomass to syngas and liquid fuels"** (BTSL)
    - **Objectives:** Obj. 1: Optimisation of biomass gasification and co-gasification for clean and H_2 rich syngas.
      Obj. 2: Gasification of energy-densified biomass slurry (pyrolysis and gasification).
      Obj. 3: Fischer-Tropsch synthesis for biodiesel.
      Obj. 4: New biomass resources and feasibility studies for an integrated F-T plant.
    - **Optimization of the FICFB gasifier**, improvements in producer gas composition, improvements of energy efficiency

- **Cold model of circulating fluidized bed** which will be used as a operational map for CFB
- **Gas cleaning**: One unit for the removal and recovery of tars
  Regeneration of scrubbing liquid, biodiesel
  Tars recycle to the gasifier for energy recovery
  Up to 79% tar removal efficiency, 62% tar stripping efficiency
- **Co-gasification** of biomass (wood pellets) and coal: bench scale FB gasifier
- **F.-T. synthesis** of bio-diesel:
  - Microchannel reactor
    - heat and mass transfer rates are orders of magnitude greater than traditional reactors.
    - excellent in highly exothermic catalytic process.
    - easy scalability and better economics at smaller scale than traditional technology.
  - Catalyst
    - cobalt on titania and alumina.
    - the challenge is to develop methods to incorporate catalyst with the reactor.

U.S.A, Richard Bain, NREL:

Current biofuel status:

Biodiesel	-173 companies, 2.69 billion gallons/y capacity
Corn ethanol	-201 commercial plants
	-13.138 billion gallons/y nameplate capacity
	-11.987 billion gal/y production
	-additional 1.322 billion gal/y planned or under construction
Cellulosic ethanol	-projected commercial cost approx. 3.50/gge

Key DOE Goals:

- 2012 : cellulosic ethanol $1.31/ETOH gallon or approx. 1.96/gge
- 2022: 36 B gal renewable fuel, 21 B “Advanced renewable fuel”
- 2030: 60 B gal ethanol

Biopower status

2009 Capacity – 10.8 GW

Potential – Electric Sector

- 2022: 22 GW
- 2035 : 48 GW
- 2050: 91 GW

DOE (Department of Energy) IBR (Integrated Baseline Review) project details:

Haldor Topsoe, Range Fuels, Renewable Energy International, Enerkem, Clear Fuel-Rentech, Flambeau River and New Page project details concerning products, feeds, size and product rate were presented.

Coskata – Project Lighthouse

- Semi-commercial demonstration plant
- Located in Madison, PA
- Partnership between Coskata and Alter NRG
- Technology
  - Gasification Westinghouse Plasma Gasifier
    - Now owned by Alter NRG
  - Coskata – Syngas fermentation to ethanol

- Scale – 50,000 gal/yr ethanol
    - 100 gal/ton
    - Pine chips
- Status – Successful startup announced (Oct 2009)

Sweden, Lars Waldheim, Waldheim Consulting: (Observer´s report)

An overview about fuel prices and taxation and energy and climate policy in Sweden were presented.

R&D and D

- Second black liquor program recentely finished
- 2nd. generation BTL pilot activities (150 MSEK extra in period 2008-2010)
- EoI for 875 (90 M€) million SEK in 2009 for demonstration of 2nd.generation biofuels and energy technologies (37 EoI applicants, 5 gasification applicants,5 selected projects)
- Two gasification projects selected
    - Black liquour demo at Mo och Domsjö
    - GoBigas in Gothenburg after second round of selection
- Energy intensive industry program 8M€
- Bioenergy fuels program

Budget limitations stops program/project launches in 2010

Co-gasification in Utility CFB Boilers

- CHALMERS Research-Gasifier was introduced
- Chemical looping reforming

KTH School of Chemical Engineering

- Pressurized LDU unit (10kg/h)
- High temperature air gasification (down-, updraft)

MiUn BTL Research Laboratory

- 150 kW ICFB gasifier:
    - Integration of FT synthesis reactor
    - Prove BTL integration
    - System modeling
    - Work on fuel flexibility

ETC

- Entrained flow gasification
    - Chemrec black liquor

Värnamo

- Pressurized combined cycle
- Supplier: Biofow (Foster-Wheeler, Sydkraft)
- Fuel 18 MW, power 6 MW, heat 9 MW
- 18 bar pressure

VVBGC Project (Växjö Värnamo Biomass Gasification Centre)

- Objectives:
    - Rebuild of and Tests in the demonstration plant
    - Generate and compile IPR
    - Establish long term research platform
- Status:
    - Engineering and procurement on-going since January 2010
    - Vattenfall, EON, AGA-Linde and SGCE stakeholders
    - Expected full project agreement and start Q1 2011

- Budget 50 M€

Mälarenergi, Västerås

- Capacity: 2*100 $MW_{th,}$
- Fuel: Assorted wastes

- Application: Co-firing of cleaned gas into existing 600 MW PF boiler using peat and coal
- Status: Permit granted mid-2009 Tendering process in 2010
- Result of tendering led to decision to reoriented project towards conventional technology

Biomass to SNG: GOBIGAS

- Project status presented (funding, gasification, methanation, ground work and engineering, investment)

Biomass to SNG: E.ON

"The company's target is to develop and exploit technology for thermal gasification of biomass in order to produce combustible gases, power and heat".

- Target: 200 MW SNG plant in operation 2015

Black liquor gasification activities (Örnsköldsvik, Sweden)

- Products: DME and methanol
- Capacity 95 000 t DME or 132 000 t methanol/year
- Planned production start: 2013

Discussion on Scope of Work and Workshop Topics for 2011-2012: The next task meeting, the third in this triennium 2010-2012 will be probably held at University of Canterbury in New Zealand. The Workshop topic is not already specified and it is depended on the interest of industry sector in New Zealand. The forth meeting is tentatively planned in Sweden. In year 2012 is the meeting planned in Turkey. The workshop topics are not fixed yet.

The task homepage will be transferred to Austria. The homepage will be also updated and modified. A description of basics of gasification will be included and also a database of existing gasifiers, similar to the database of task39 (**http://biofuels.abc-energy.at/demoplants/projects/mapindex**).
The new homepage with a database will be presented on the next Task meeting.

Next Task Meeting: tentatively scheduled for April 2011.

Day 2, Wed Oct 6

Meeting Location: Plant Visits: I/S Skive Fjernvarme (Andritz-Carbona gasifier CHP plant), B&W Vølund in Harboøre and Weiss Hadsund plant (Viking gasifier CHP plant).

The second meeting day was devoted to visiting three gasification plants.
The first one in Skive was not in operation at that time, but here is a short overview and technical data:
Andritz-Carbona gasifier CHP plant is a bubbling fluidized bed gasifier with $20MW_{th}$ and $6MW_{el}$, air is used as a fluidizing agent. Wood pellets are used as a feedstock (40.000 t/year). The dolomite was

changed to olivine as a bed material. The building of the plant was started in 2005. Investment 248 mill. DKK (33.3 mill. Euro). Write-0ff period about 20 years. Annual sale of district heating is 120.000 MWh and electricity 22.000 MW.

The second gasification plant we visited was situated in Harboøre. An overview about the plant operation was given by project manager Mr. Robert Heeb (roh@volund.dk). A short survey can be found below.

Babcock&Wilcox Vølund gasifier

- Updraft gasifier (Dr. Gratzke)
- Feed: wood chips (moisture 35-55%)
- 3.5 MW_{th} /1MW_{el}
- Commissioned in 1996
- CH capability added in 2000
- Originally designed for district heating
- Gasifier operated for more than 120.000 h
- Gasifier engine more than 80.000 h
- Present power production more than 500 MWh/month

The gasification plant was in operation. There were no operational problems mentioned. It was possible to go through the plant and follow up the whole gasification process with feed storage at beginning and gasifier engines on the end.

The last gasification unit we visited on the 6th October was a pilot plant in Hadsund.

Weiss A/S

A pilot plant of the two-stage gasification process is being established at the factory of Weiss A/S. In the two-stage gasification process, the pyrolysis and the gasification process are separated into two different zones. In between the pyrolysis and the gasification zones, the volatiles from the pyrolysis are partially oxidized. Hereby, most of the tars are decomposed into gas. To enable high energy efficiency, the thermal energy in the gasification gas and the exhaust gas is being used for drying, air preheating and for pyrolysis.

The two stage gasification process has successfully demonstrated that the process offers

· Low tar content in gas (<5 mg/Nm3)

· Stable unmanned operation

· High coldgas efficiency (>95%)

· Low environmental impact (clean condensate, high carbon conversion)

The process verification and documentation has been performed in small scale, and in order to manufacture economical actractive plants the process is now being upscaled. The two-stage gasification process is modified, so the drying is separated from the pyrolysis unit. The drying agent is steam and produced steam from the dryer is lead to the pyrolysis-gasification reactor, and hereby soot production is reduced and char reactivity is increased.

However, the pilot plant was not in operation during our visit.

Day 3, Thu, Oct 7

Expert workshop on “Small scale biomass co-generation; Technology status and market opportunities”

The workshop was hold together with Task 32 “Biomass combustion and cofiring”. All presentations from the workshop can be found at **http://www.ieabcc.nl/**

A short report from the workshop will be delivered by this Task.

END

IEA Bioenergy Agreement: 2010-2012
Task 33: Thermal Gasification of Biomass
Third Semi-annual Task Meeting, 2011
Christchurch, New Zealand
Tue. 12 to Thu. 14 April 2011
Minutes

Day 1, Tuesday 12. April 2011

The list of attendees, for the Task Meeting include: Shusheng Pang and Jingge Li, UoC, NZ, Berend Vreugdenhil, ECN, NL, Reinhard Rauch and Jitka Hrbek, TUV, Vienna, AT, Martin Rüegsegger, ETECA, CH, Serhat Gül, MRC, TR and Richard Bain, NREL, USA.

Regrets for inability to attend were received from: Mayumi Morita and Tomoko Ogi, NEDO/AIST, Japan, Thomas Kolb, KIT, Germany, Ilkka Hannula, VTT, FI, Lars Waldheim, SWE,
From Norway, Denmark and Italy no NTL is nominated. Richard Bain will contact the ExCo representative of these countries, so that as soon as possible a new NTL will be nominated.

The Agenda of the Meeting was:
Day 1, Tue, April 12

9. Welcome:
10. Introduction of Task Members and Observers
11. Review and Approval of Agenda
12. Review and Approval of Minutes from Second Semi-annual Task Meeting, 2010, October, Skive, Finland
13. Country Updates on Biomass Gasification: Detailed Highlights with Technical Information
    a) New Zealand, Shusheng Pang, Univ of Canterbury
    b) Netherlands, Berend Vreugdenhil
    c) Turkey, Serhat Gül, MAM
    d) Switzerland, Martin Rüegsegger, ETECA GmbH
    e) Austria, Reinhard Rauch
    f) USA, Richard Bain, NREL
14. Discussion on 2011 – 2012 Meetings and workshops

Day 2, Wed, April 13
Site visits: Christchurch, New Zealand, University of Canterbury (UoC): presentations on actual work on UoC gasifier and gas cleaning, cold model gasification plant and FT-reactor, visits of the laboratory of gas cleaning and FT reactor.
Nature´s flame wood pellet plant, Solid Energy Renewables, Rolleston and SRS Sawmill Rolleston.

Day 3, Thu, April 14
Expert workshop on “Gasification and Alternative Fuels Development”

Country Updates on Biomass Gasification:

New Zealand, Shusheng Pang, University of Canterbury:

Government strategies and initiatives in New Zealand:

- The biodiesel grant scheme
- The emissions trading scheme
- NZ BioEnergy strategy: proposed by Bioenergy Association in corporation with industry
- Targets: by 2040 biomass energy will contribute 25% of national consuming energy

Status of commercial biomass gasification:

- **Fluidyne Gasification Ltd**: is active overseas (California) with its downdraft process (100kWe-2MWe)
- **Windsor Engineering Ltd.** (drying kilns, building 1,5 MW gasifier in Norway, commissioning June/July 2011)
- **Alternative Energy Solutions Ltd**: representative for Ankur in Australasia, but focusing now on a screw type fast pyrolysis system (biomass 1t/day) with Ernslaw One Ltd
- **Page Macrae Engineering Ltd**: the 2MWth updraft gasification plant has been shut down as the user, CHH plywood mill, was closed
- **CRL Energy Ltd**.: R&D on coal gasification for hydrogen production, 200kW FB gasifier constructed, cooperation with UoC

Status of R&D on biomass gasification:
University of Canterbury:

Bench scale gasifier:

- Tests to determine reactivity of biomass, coal and their blends

100kW dual fluid bed (DFB):

1) Trials for different bed materials (greywacke sand, olivine, calcite, dolomite, magnetite)
- Gasification temperature 700-800°C
- Wood pellets (feeding rate 15-20kg/h)
- Steam/feedstock ratio 0,3-0,7

→ using olivine as bed material, lowest conc. of NH_3 and H_2S in product gas

2) Gasification of bio-solid (dried sewage sludge)
- 720°C
- greywacke sand
- feedstock: wood pellets, biosolids and their blends (15,5 kg/h)
- steam/feedstock 0,7

3) An advanced gas cleaning system and steady state operation map of CFB presented.

4) FT synthesis of biodiesel – microchannel reactor, catalyst Co on Ti and Al

5) New biomass resources:
- field trials to grow perennial crops
- system modeling and feasibility studies
- LCA analysis for energy, carbon and exergy flows and efficiencies through the process

The Netherlands, Berend Vreugdenhil, ECN

Heading for 14% of renewable energy in 2020 (3,9% in 2010)
Political developments: new government: EU targets, econ. developments and "green jobs" leading

Developments:
HoSt – small CFB gasification technology for difficult fuels
- Portugal: 3MW_{th} CFB gasifier, OLGA, gas engine
    - Commission on wood and chicken manure
    - Plan: 1 ton/h RDF plant, 3 ton/h paper-rejects plant

BioMCN (Methanol Chemistry Netherlands)
- The largest 2nd generation biofuels plant worldwide
- Now 30-40% glycerin in Natural Gas reformer (approx. 150$MW_{bio\text{-}methanol}$)
- Planned: gasification (Siemens) of 1500 ktonne/y waste wood for 400 ktonne/y methanol

NUON
- 250 MW_{el} coal-based IGCC, ability to co-gasify biomass

ESSENT
- 600 MW_{el} coal-fired PF boiler
- Approx. 5000 h/year, cooling remains the biggest problem
- Subsidy scheme for this plant will end in 2013

Heveskes – waste gasification
- High temp. technology available
- Plan for syngas production in Delfzijl (2013 start up)

Synvalor
- offers gasifier technology
- co-operation with Dordtech

HVC
- original plan: CHP – demo as intermediate step toward larger SNG-demo
- MILENA and OLGA based
- Less for power, more for SNG
- New plan: SNG-demo in Alkmaar, CHP-demo possibly abroad

ECN
- 8 mill. Euro less → subjects stopped: hydrogen, fuel cells, energy in buildings, smart grids
- Biomass unit expanded with carbon capture technologies
- Pressurized gas cleaning lab-scale under construction for SNG developments
- EERA on thermochemical conversion, 2 groups on biomass gasification initiated, bed material research, pressurized FB gasification

Turkey, Serhat Gül, MRC:

Energy consumption profile and resources presented.
MRC laboratory and pilot scale facilities were revised.
Pressurized BFB gasifier (1250 kW_{fuel}) under construction.

Ongoing projects:
- Combustion of biomass and lignite in CFB
- Liquid fuels production from coal and biomass
- High added value materials from waste tire gasification residues

- Designing and manufacturing of 2 MW_{el} FB gasifier

Policy:
- New regulations allow the small scale electricity cogeneration for local applications and increases the usage of biomass

Switzerland, Martin Rüegsegger, ETECA GmbH

Policy in Switzerland is made by Swiss Federal Office of Energy (SFOE)
Policy & Programs:
- Approved action plans by Swiss Federal Council 2008
- 2010-2020 maximum 5% increase of electricity consumption

Facts:
- In 2009 56,15% of Sw. electricity production came from renewable

Research:
- PSI

Industrial gasification activities:
EKZ, Pyroforce, Energietechnologie AG, Xylopower AG and Foster Wheeler AG

Thermal gasification plants:
- Aerni in Pratteln
- Holzstrom in Stans
- Woodpower in Wila
- Woodpower EMPA (approved project in planning)

News:
- EMPA EAWAG Dübendorf decided September 2010 for CHP gasifier Plant
  - Supplier: EWZ and Woodpower
  - Wila-type gasifier
  - 2 x 350 kW_{el}
- Delinat will multiply the bio coal production (Terra Preta)
  - with low temp pyrolysis (CH, BRD, AUT) and gasifier (eastern Europe)
  - new facilities are in construction including waste heat utilisation
    - Lausanne plant emissions legal approved
    - Commissioning in 2011 on several location in Europe
- Energy Hub Baden Project is cancelled 31.1.2011 due to missing investors
- 3 MW fuel gas produced by wood gasifier shall replace fossil fuel for brick production in rotating furnace. The fuel gas will be produced by 3 gasifier units each 1 MW.
  (Above mentioned CO_2 reduction concepts in discussion for several brick production plants)

Switzerland, Serge Biollaz (presented by Martin Rüegsegger), ETECA GmbH

Possible contribution of bioenergy till 2050 was outlined.

Objectives of EIBI (European Industrial Bioenergy Initiative)
- Enabling commercial availability of advanced bioenergy at large scale by 2020, including advanced biofuels covering up to 4 % of EU transportation energy needs by 2020

EIBI thermo-chemical value chains:

- Synthetic fuels via biomass gasification
- Bio-methane via biomass gasification
- High efficiency power generation via biomass gasification
- Bioenergy carriers via other thermochemical processes

Targets in EU concerning biofuels production in 2007-2020 were presented.

Austria, Reinhard Rauch, TUV:

Policy targets in Austria were presented.

Austrian research organizations and their activities were introduced: Graz University of Technology, Joanneum Research Graz, MCI, Vienna University of Technology, Bioenergy 2020+, FJ-BLT Wieselburg

Austrian companies active in biomass gasification:

- Andritz (now also owner of the Austrian part of Austrian Energy & Environment)
- AGT Agency for Green Technology – low temperature conversion=thermo-catalytic decomposition process operating without air supply
- Austrian Enviro Technologies
- GE Jenbacher
- Ortner Anlagenbau – builds FICFB for CHP applications
- Repotec – builds FICFB gasifiers for CHP, SNG and other synthesis
- Syncraft Engineering GmbH
- Urbas – fixed bed gasification
- Xylogas - fixed bed gasification

Commercial FICFB gasifiers in Austria:

Location:	Güssing	- el. Production using gas engine
		-8.0 MW_{fuel}, 2.0 MW_{wl}
		-start up in 2002, in operation
	Oberwart	-gas engine/ORC
		-8.5 MW_{fuel}, 2.8 MW_{wl}
		-start up in 2008, in operation
	Villach	- gas engine
		-15.0 MW_{fuel}, 3.7 MW_{wl}
		- in commissioning
	Klagenfurt	-gas engine
		-25.0 MW_{fuel}, 5.5 MW_{wl}
		-planing
	Vienna	-planing

Commercial FICFB gasifiers abroad:

Location:	Ulm (DE)	-gas engine/ORC
		-15.0 MW_{fuel}, 5.3 MW_{wl}
		-under construction
	Geislingen (DE)	-AER process/gas engine/ORC
		-10.0 MW_{fuel}, 3.3 MW_{wl}
		-now detailed engineering
	Göteborg (SW)	-planning

New G-volution system was introduced

- Gasification reactor is divided in several zones with catalytic active material (olivine, dolomite, etc.) for more intensive gas-solid contact and better product gas quality.

FT synthesis

- 2 FT synthesis units are in operation in CHP plant Güssing
- Results on engine tests with 20% blends presented

Mixed alcohols

- Funded by "Klima und Energiefonds" and Bioenergy 2020+
- Aim: to get fundamental know-how in the synthesis of mixed alcohols from biomass
- Advantage: very simple gas cleaning due to sulphur-resistant catalyst

Biohydrogen for refineries

- Coordinator OMV
- 50 MW_{fuel} plant
- Basic engineering of the gasifier and other sub units
- Optimal use of by-product

U.S.A, Richard Bain, NREL:

- Energy consumption in 2009 covered by 8% from renewable
- Electricity generation in 2009 – about 10,8% covered from renewable

U.S. ethanol production – about 50 billion liters in 2010
U.S. biodiesel production – since 2008 decreases and in 2010 was about 1,25 billion liters

Biomass resources scenarios and supply curve were presented.

NREL biofuels platform-goals:

- Near term: to demonstrate a modeled, cost competitive, biomass-derived ethanol price by 2012
- Long term: other biofuels technologies, that can contribute to larger volume EISA targets

NREL thermochem. platform:

- Gasification
- Pyrolysis
- Syngas cleanup
- Fuel synthesis (mixed alcohols)
- Process integration
- Process analysis & modeling

Different types of gasifiers for fuel synthesis were introduced → indirect gasifier is one of the lowest cost options.

Biomass syngas cleaning strategies were presented.

Tar reforming: - Ni-impregnated olivine gasif. catalyst prepared in house
-10% less tar forms at 650°C with catalyst than at 800°C without catalyst
-70% less tar forms at 800°C with catalyst than without it

Syngas cleanup: continous reforming/regeneration

- Industrial collaborator (Rentech) evaluated NREL catalyst for 100 h of tar reforming, simulated syngas containing H_2S and SO_2 → CH_3 conversion maintained at > 92% under recirculating/regenerating conditions → process intensification

National advanced biofuels consortium:

- Project objective – to develop cost-effective technologies that supplement petroleum-derived fuels with advanced "drop-in" biofuels, that are compatible with transportation infrastructure and are produced in sustainable manner
- ARA funded – 3 years effort, $ 46,3 M USD

Discussion on Scope of Work and Workshop Topics for 2011-2012:

The next task meeting, the fourth in this triennium 2010-2012 will be held 18.-20.10.2011in Pitea in Sweden. Workshop topic: "Forest Product Industry Gasification Opportunities". In year 2012 are the meetings planned in Turkey and probably in Austria. The workshop topics are not fixed yet.

Webpage of our Task

The actual status of the webpage was presented. As the programming from GTI was not compatible to other webservers, the complete website had to be reprogrammed.
In this frame also a simplification of the website was done, e.g. only one page for participants and national experts.
The introduction page was done new and here the logo of gasification was discussed. The agreement was, that an animated gif, where fixed bed, fluidised bed and entrained flow gasifiers are show, will be used.
The main work was the implementation of the database of gasifiers. Here all NTLs should give an input for the different gasifiers, based on their country reports.
The next step will be to implement a test server, where the NTLs can check the new homepage and when all agree on the content, the old one will be replaced by the new homepage. The address **http://www.ieatask33.org** will be the same after changing to the new homepage.

Next Task Meeting: 18.-20. October 2011

Day 2, Wed April 13

Meeting Location: College of Engineering, University of Canterbury, Christchurch
Nature´s flame wood pellet plant, Solid energy renewable, Rolleston
SRS Sawmill, Rolleston

College of Engineering, University of Canterbury, Christchurch

Three interesting presentations on biomass gasification and gas cleaning, cold model gasification plant and FT reactor were given by Woei-Lean Saw, Mook Tzeng Lim and Chris Penniall. These presentations will be posted on **www.ieatask33.org** as soon as possible.

The gas cleaning and FT reactor laboratories were visited (the gasifier lab could not be accessed due to its close location to another building which had just been identified high risk in the event of another earthquake).

Nature´s flame wood pellet plant, Rolleston

Nature's Flame is a business of **Solid Energy New Zealand Ltd**, a state owned enterprise. Alongside its coal business, Solid Energy is developing some of the promising energy solutions that will help to power New Zealand's future and help the country in its transition to clean, affordable and renewable energy forms.

In New Zealand and internationally, Nature's Flame aims to grow the wood pellet market for both home heating and industrial energy and to further develop innovative biomass energy solutions.

SRS Sawmill, Rolleston

In 2001 a new sawmill was built at Rolleston on the outskirts of Christchurch capable of producing more than 100 m^3 of sawn timber per hour, requiring the equivalent of a truck and trailer load of logs every 8 minutes. By using the latest technology only two operators are required for the entire milling process.

Reprocessing and manufacturing facilities at Rolleston include kiln drying, machining, sawing, and assembly lines for pallets, bins and cable drums.

All logs are sourced from local radiata pine plantations. Bark is removed prior to milling and sold for use in gardens and mulch. Chip from the mill is sold for the manufacture of MDF and sawdust is used as boiler fuel to heat the kilns.

Timber for packaging and furniture is shipped to most Asian countries or assembled into pallets, bins and cable drums for the domestic market.

All timber is completely chemical free. By ensuring all timber is kiln dried within 5 days of production there is no need for anti sap stain chemicals or other treatments.

Day 3, Thu, April 14

Expert workshop on “Gasification and Alternative Fuels Development”

Table of presentations

Richard Bain, NREL, USA	“Biomass Gasification R&D Activities in North America”
John Sanderson, Earth Systems, Australia	“Biomass Gasification in Australia”
Reinhard Rauch, TUV, Austria	“Conversion of Biomass over Steam Gasification to Biofuels and Chemicals – Actual Status of Work”
Doug Williams, Fluidyne Co., New Zealand	“The Enigma of Gasification (Cinderella or Princess)”
Shusheng Pang, UoC, New Zealand	“R&D Activities on Biomass Gasification for Syngas and Liquid Fuels at the University of Canterbury”
Tana Levi, CRL Energy Ltd., New Zealand	“Thermo-chemical Conversion R&D Activities at CRL Energy including the Gasification of Coal and Biomass for Purified Hydrogen Production”
Steve Pearce, Solid Energy, New Zealand	“Underground Coal Gasification (UCG) – A Transformational Technology”
Woei-Lean Saw, UoC, New Zealand	“Production of Hydrogen-Rich Syngas from Steam Gasification of Blend of Biosolids and Wood using a Dual Fluidized Bed Gasifier”
Chris Penniall, UoC, New Zealand	“Reactor and Catalyst Development for Fischer-Tropsch Synthesis Applicable to Small Scale Wood Processing Plants in New Zealand”

All presentations from the workshop can be found at **www.ieatask33.org** as soon as possible.

END

IEA Bioenergy Agreement: 2010-2012
Task 33: Thermal Gasification of Biomass
Fourth Semi-annual Task Meeting, 2011
Piteå, Sweden
Tue. 18 to Thu. 20 October 2011

Minutes

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

Day 1, Tue October 18

The list of attendees, for the Task Meeting include:

Name	**Country**	**Affiliation**	**email**
Reinhard Rauch	Austria	TUW	rrauch@mail.zserv.tuwein.ac.at
Jitka Hrbek	Austria	TUW	jhrbek@mail.zserv.tuwein.ac.at
Eric Winther	Denmark	FLS	Erwin@flsmidth.com
Esa Kurkela	Finland	VTT	Esa.Kurkela@vtt.fi
Ilkka Hiltunen	Finland	VTT	Ilkka.Hiltunen@vtt.fi
Thomas Kolb	Germany	KIT	Thomas.Kolb2@kit.edu
Bernd Zimmerlin	Germany	KIT	Bernd.zimmerlin@kit.edu
Mayumi Morita	Japan	NEDO	moritamym@nedo.go.jp
Tomoko Ogi	Japan	AIST	t-ogi@aist.go.jp
Jingge Li	New Zealand	UoC	Jingge.Li@canterbury.ac.nz
Bram van der Drift	The Netherlands	ECN	vanderdrift@ecn.nl
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Lars Waldheim	Sweden	WAC	Lars.waldheim@waldheim-consulting.se
Martin Ruegsegger	Switzerland	ETECA	Eteca@gmx.ch
Richard Bain	USA	NREL	Richard.bain@nrel.gov
Eva-Katrin Lindman	Sweden	Fortum	Eva.katrin.lindman@fortum.com

Regrets for inability to attend were received from: Hakan Karatas, MRC, Turkey and a representative from Italy

The Agenda of the Meeting was:

Day 1, Tue, October 18

15. Welcome:
16. Introduction of Task Members and Observers Review and Approval of Agenda
17. **Review and Approval of Minutes from First Semi-annual Task Meeting, 2011, April, Christchurch, New Zealand**
18. **Discussion of Task Member Deliverables**
    a. Country reports
    b. Gasification project database

Discussion on 2012 Meetings and workshops

19. **Country Updates on Biomass Gasification: Detailed Highlights with Technical Information**
    a. Sweden, Lars Waldheim, WAC
    b. Finland, Esa Kurkela, VTT
    c. Norway, Judith Sandquist, SINTEF
    d. Netherlands, Bram van der Drift
    e. Austria, Reinhard Rauch, TUW
    f. Germany, Thomas Kolb, ITC-TAB
    g. Switzerland, Martin Ruegsegger, ETC
    h. New Zealand, Jingge Li, Univ. Canterbury
    i. Japan, Mayumi Morita, NEDO
    j. Japan, Tomoko Ogi, AIST
    k. Denmark, Erik Winther, FLS

Day 2, Wed, October 19

Expert workshop on "Biomass Gasification Opportunities in the Forest Industry"

Day 3, Thu, April 14

Site visits: ETC Laboratories, BLG Pilot plant, EF Gasifier, VIPP Pilot plant, DME Pilot plant, MEVA Gasifier + ICE CHP plant, Smurfit Kappa wood intake and wood yard, SunPine tall oil biodiesel plant

Country Updates on Biomass Gasification:

Sweden, Lars Waldheim, Waldheim Consulting:

Energy and climate bill and fuel prices and taxation in Sweden were presented.
R&D and D:

- NER300: bioenergy 5 out of 9 projects proposed to the EU
- Demonstration and SET-plan budget reinforced fo FY 2012
- Biorefinery Nrrtorp pre-study initiated

Swedish Centre for Renewable Fuels (f^3-fossil free fuels) – will be established as a nationwide knowledge platform and venue for cooperation in the production of renewable fuels and the related system aspects, with highest international credibility

- Budget for 2011-13 (~3 mio. Euro)
- Project areas:
    - System-wide studies
    - Studies for renewable fuels
    - Analysis of synergies between plants and diff. technology platforms
    - Method development for interdisciplinary studies

Swedish Gasification Centre (SFC) – 8 Academies and 9 companies

- CDGB (Centre for Direct Gasification of Biomass)
- CIGB (Centre for Indirect Gasification of Biomass)
- B4G (Biomass for Gasification, Entrained Flow Centre)

Chalmers

- Biogas production via thermal conversion (from lab-scale to 80 MW SNG)
- Indirect gasification: 2-4 MW_{fuel} gasifier integrated on the return leg of Chalmers 12 MW_{fuel} CFB boiler
- Goal of activity: to demonstrate
    - how an indirect gasifier could be built
    - a robust method for catalytic reformation of the gas to a syngas containing only CH_4, H_2, CO, CO_2, H_2O
    - an energy efficiency for dry biomass to clean syngas
- 22 researchers work at Chalmers, activity divided into:
    - Gasification process
    - Gas cleaning
    - High temperature corrosion

Swedish Gas Centre

- Gasification and gasification database
- Co-production of SNG and FT diesel
- International Gasification Seminar
- Particulate contaminants from indirect gasifiers (in planning)
- Autothermal regenerative POX tar reactor (in planning, Lund Technical Univ)

KTH School of Chemical Engineering

- Long experience of R&D within gasification. Activities started in 1970´s.
- 75 kW pressurized (30 bar) air & steam/oxygen FB gasifier with secondary reactor
- 50 kW air & steam/oxygen FB gasifier
- 5 kW air & steam/oxygen FB gasifier
- Test rigs for catalytic deactivation and particle separation concepts
- Tar analysis equipment
- Online alkali analyses
- Projects:
    - Demonstration of improved catalysts and reactor designs for the production of SNG
    - SNG for smart gas grids
    - SYNCON: Novel synthesis process concepts for efficient chemicals/fuel production from biomass
    - DeMiTar: development and market implementation of PID and FID tar analyzers
    - HTAG – high temperature air gasification

ETC

- Host for DP1: Chemrec black liquor, biomass
- VIPP gasifier: biomass, cyclone gasification, WESP, scrubber, engine CHP
- PEBG: pressurized entrained flow gasification, 1MW, 15 bar

Värnamo – pressurized combined cycle:

- Supplier: Bioflow (Foster-Wheeler, Sydkraft)
- Fuel: 18 MW
- Power: 6 MW

- Heat: 9 MW
- 18 bar
- Typhoon GT

VVBGC project status

- Engineering initiated in January 2010
- Project terminated in Feb. 2011 because of difficulties in attracting additional partners to close industrial funding targets

GoBiGas

- Biomass to biomethane 65 – 70 %
- Energy efficiency > 90%
- Phase 1:
    - Demo plant, 20 MW generating 160 GWh/y
    - In operation early 2013
    - Allothermal (in-direct) gasification
    - Gasification: cooperation between Metso Power and Repotec
    - Methanation: cooperation with Haldor Topsöe
- Phase 2:
    - 80-100MW generating 640-800 GWh/y
    - Technology not yet chosen

Black Liquor Gasification Activities

- Development plant for oxygen-blown high pressure BTL gasification (located at the Smurfit Kappa mill in Piteå, Sweden
- 30bar
- Capacity 20 metric tons/day of black liquor solids
- Used for technical development and design verification
- Started up 2005, now in operation, more than 12 000 operating hours

Black Liquor Demonstration Activities

- Domsjö and Chemrec in collaboration
- Feed: 200 MW of sodium sulphite liquor
- Products: 100 000 t/y of DME or 140 000 t/y of methanol or a mixture of both

E.ON

- Biomass to SNG
- Bio2G

Värmlandsmetanol

- Permitting is on-going
- No grant financing requested
- Planned construction start “as soon as permits are in place”
- FBG, forest residues, 100 000 t/y of fuel grade, methanol plus district heating 15 MW_{th}

Rottneros Biorefinery AB

BioMethanol opportunities:

- 150-200 kton BioMethanol via wood or blackliquor gasification

- Capital expenditure of 3 bill. SEK per project

MEVA

- Test unit, 10 kW_{th}, gas engine, in operation at ETC Piteå
- The first commercial unit, 1,2 MW_{el} under commissioning at Horlax, Piteå
- Target market is co-gen. plant, 2-20 MW_{th}, 1-10 MW_{el}

Cortus Wood Roll

- Indirectly heated gasification in industrial scale
- Successful syngas (CO/H_2) production during autumn 2011
- Relocation to Köpling planned
- Demo plant:
    - Power: 5 MW
    - Fuel: 30 TPD DS of biomass
    - Product: 1550 Nm^3/h synthesis gas
    - Investment 6,5 mill. euro

Finland, Esa Kurkela, VTT:

Syngas route to biofuels was studied in VTT in UCG-project during 2004-2007.

- Three consortiums are presently planning second-generation BTL biorefineries in Finland.
- The planned capacities are 100 000 – 200 000 ton/y of diesel.
- EU´s funding (NER300) has been applied, decisions at the end of 2012
- Investment euro 400-800 mio.

Gasification and gas cleaning process developed and tested at VTT on 1MW scale, 4000 operating hours with different wood residues:

- New innovative technology: -Gasifier targets:
    - no ash-related problems
    - Simple design and high reliability
    - High C-conversion to gas and tar
    - Low oxygen consumption
  - Gas cleaning targets:
    - Complete tar decomposition
    - 60-80 % methane reforming
    - H_2/CO ratios suitable to FT synthesis

Process chain of the Varkaus test plant and Andritz Carbona active projects were introduced.
Atmospheric-pressure CFB/BFB gasification for kilns and boilers:

- Commercial lime-kiln gasifiers constructed in 1980´s by Ahlström
- New development by Foster Wheeler in 1990´s for boiler applications

Gasifiers (15-150 MW) now offered by:

- Andritz Carbona
- Foster Wheeler
- Metso Power

New CFB gasification plants are in commissioning/under construction:

- 2 new gasifiers (2x80 MW) at Lahti (waste-to-energy plant) (Metso)

- One large gasifier (140 MW) in Vaasa (Metso)
- Lime kiln gasifier (48MW) at Joutseno (Andritz)
- Lime kiln gasifier (12 MW) at Varkaus was returned to air-blown operation mode after successful test campaigns for Neste Oil and Stora Enso (Foster Wheeler)

Metso gasification projects:

Vaskiluodon Voima – Substituting Biomass for Coal in a PC boiler

- 140 MW_{th} gasifier adjoined to the existing 560 MW coal-fired power plant
- PC boiler in operation since 1982
- Coal consumption 400 000 – 500 000 t/y
- Enables biomass to replace up to 40% of coal
- Production capacity: 230 MW_{el}, 170 MW_{th}
- Total investment 40 mio. Euro

Metso scope:

- Fuel receiving and handling
- Drying
- Gasification
- Boiler modification
- Automation, electrification and instrumentation

Lahti Energia – Gasification Power Plant

- 2x80 MW_{th} gasifiers, waste-derived fuel, 50 MW_{el}, 90 MW_{th}

Metso scope:

- Fuel handling
- Gasifier
- Gas cooling
- Gas filter
- Gas boiler and flue gas cleaning
- Start up April 2012
- Total investment 157 mio. Euro

SME companies are developing small-scale gasifiers for gas engines targeting to 100 – 500 kW_{el}.
New R&D project at VTT with 5 SME companies is planned for 2012.
Biomass-to-syngas projects at VTT in 2011 were presented:

- NEXTUCG (2007-11): proposal – large FT production unit
- Production of SNG or H_2 from biomass (2011-14)
- USA-cooperation project on evaluation of gasification-based systems (2011-2012) – co-utilization of biomass and coal for liquids and electricity and combinations of biotechnical and thermochemical routes
- NORDYNGAS (2010-2014): pressurized gasification, system studies related to integrated plants to pulp and paper industries
- GASIFICATION REACTIVITY (2011-2014): fundamental research with Åbo Akademi and Jyväskylä Univ.

LahtiStreams IP (Advanced Integrated Waste Management and WtE Demo)

- Waste processing and material recovery
- SRD/RDF production
- Advanced high efficiency WTE plant
- Further treatment of ashes

Norway, Judit Sandquist, SINTEF Energy:

Biomass gasification has not got a long history in Norway. There is fundamental research at Universities, applied research. Small scale waste-to-energy applications are being developed.

Energos Gasification Technology

Proven small-scale, energy from waste

- A two-stage thermal process enabled extremely good combustion control, eliminating the need for complicated and expensive flue gas treatments
- The plant was designed to minimize emissions:
  - Low carbon content in bottom ash
  - Simultaneously low and stable CO and NO_x emissions

There are 8 plants in operation (6 in Norway, 1 in Germany, 1 in UK) and 6 plants are under development.

Fiborgtangen Biokraft

Development of a renewable energy plant founded on local waste streams

Development is linked to existing industry, new developments and new business opportunities.

- Gasification plant producing a pure syngas
- CHP plant producing heat and power
- Linked to existing boiler house at Norske Skog Skogn
- Provisions for future renewable materials/chemicals/fuels
- Main study 2011, production 2014

Research in Norway:

- Norwegian Research Council RENERGI

Gasbio – new project within thermochemical biofuels production (duration 4 years)

Partners: SINTEF, Norske Skog, Metso, Statoil, Avinor, NTNU

Objectives: to establish an internationally oriented solid Norwegian competence base within biomass gasification to produce biofuels.

The Netherlands, Bram van der Drift:

Modern industry policy in the Netherlands, more renewable energy ahead

NL Renewable energy – **Green Deal** (between industry and government, 59 deals signed in Oct 2011

Green deals:

- Green gas (0,2 bcm in 2015, 0,5-0,75 bcm in 2020)
- Large-scale cofiring: keep 10% biomass in coal power plants unchanged till 2015

HoSt (small CFB gasification for difficult fuels)

- Portugal: $3MW_{th}$ CFB gasifier, OLGA, gas engine
  - Status: commissioning on wood and chicken manure
- 3 ton/h paper rejects plant in NL, gasifier, cooler, cyclones, boiler, steam
  - Start up: 2013

BioMCN (Methanol Chemistry Netherlands)

- The largest 2nd generation biofuels plant worldwide

- Now 30-40% glycerin in Natural Gas reformer (approx. 150$MW_{bio\text{-}methanol}$)
- Planned: gasification (Siemens) of 1500 ktonne/y waste wood for 400 ktonne/y methanol

NUON

- 250 MW_{el} coal-based IGCC, ability to co-fire biomass
- Biomass co-firing ongoing; significant extension of co-firing under investigation, implementation depends on government
- MAGNUM-project postponed, coal/biomass gasifiers

ESSENT (RWE)

- 600 MW_{el} coal-fired PF boiler
- Approx. 5000 h/year, cooling remains the biggest problem
- Subsidy scheme for this plant will end in 2013
- Small improvements being carried out
- Major changes depend on politics

DAHLMAN – renewable energy (www.dahlman.nl)
HEVESKES ENERGY (www.heveskesenergy.nl)

- Will construct syngas plant
- Technology: oxygen driven gasification technology by 7 Hills, based on 3-years operational experience
- Feedstock: RDF
- Project Delfzijl: 10 ton/h RDF, start up 2013

SYNVALOR (www.synvalor.com)

- New multi-stage low-tar concept for all, but more specifically difficult fuels
- Based on Vortex reactor designs
- Aimed at affordable (<2.50 €/kWe) and reliable technology
- Test facility erected in October 2011, first test results at the end of 2011

HVC

- 12 MW (waste wood input) plant in preparation
- MILENA and OLGA based
- Phase 1a: heat production (first few years)
- Phase 1b: additional gas cleaning and SNG production
- Start building 2012
- Phase 2: 50-100 MW plant

ECN

- Generating design data 12 MW HVC demo
- Forming the consortium for HVC-demo
- Preparing expert centre with TAQA
- Estimating costs of bioSNG plant (**www.sgc.se/gasification2011/programme.asp**)
- Long term CAPEX: 1000 $/kW
- Torrefaction deal closed, demo being build

Austria, Reinhard Rauch, TUV:

Policy targets, energy consumption and renewables in Austria were presented.

Austrian research organizations and their activities were introduced: Graz University of Technology, Joanneum Research Graz, MCI, Vienna University of Technology, Bioenergy 2020+, FJ-BLT Wieselburg

Austrian companies active in biomass gasification:

- Andritz (now also owner of the Austrian part of Austrian Energy & Environment)
- AGT Agency for Green Technology – low temperature conversion=thermo-catalytic decomposition process operating without air supply
- Austrian Enviro Technologies
- GE Jenbacher
- Ortner Anlagenbau – builds FICFB for CHP applications
- Repotec – builds FICFB gasifiers for CHP, SNG and other synthesis
- SynCraft Engineering GmbH
- Urbas – fixed bed gasification
- Xylogas - fixed bed gasification

Commercial FICFB gasifiers in Austria:

Location:	Güssing	- el. Production using gas engine -8.0 MW_{fuel}, 2.0 MW_{wl} -start up in 2002, in operation
	Oberwart	-gas engine/ORC -8.5 MW_{fuel}, 2.8 MW_{wl} -start up in 2008, in operation
	Villach	- gas engine -15.0 MW_{fuel}, 3.7 MW_{wl} - in commissioning
	Klagenfurt	-gas engine -25.0 MW_{fuel}, 5.5 MW_{wl} -planning
	Vienna	-planning -hydrogen production -50 MW_{fuel},30 $MW_{hydrogen}$

Commercial FICFB gasifiers abroad:

Location:	Ulm (DE)	-gas engine/ORC -15.0 MW_{fuel}, 5.3 MW_{wl} -under commissioning - Göteborg (SW) -planning

Urbas gasifiers:

- Ruden:
  - 150 kW_{el}/300 kW_{th} + 70 kW_{el}/150 kW_{th}
  - Development since 2001
  - 30 000 operating hours
- Eberndorf:
  - 20 000 oper. hours
  - 2x120 kW_{el} + 70 kW_{el}/650 kW_{th}
  - Start up 2006-8
- Neumarkt:

    - 2x120 kW_{el}/580 kW_{th}
    - Start up 2008
    - 16 000 operating hours
- Sulzbach-Laufen, DE:
    - 130 kW_{el}/280 kW_{th}
    - Start up 2009
- Neukirchen:
    - 2x150 kW_{el}/300 kW_{th}
    - Start up 2011
    - 1000 operating hours
- Konstanz, DE:
    - 150 kW_{el}/300 kW_{th}
    - Start up end of 2011

Germany, Thomas Kolb, KIT:

Choren Gasification Technology:

- ß-plant Freiberg – BTL production in semi industrial scale
    - commissioning end of 2009
    - test runs Oct 2010 at 41.4 MW_{th}
    - till June 2011: Low temperature gasifier – 2000 operating hours
        Carbo-V and endothermic quench 1000 h
        Gasification of residual coke 2000 h

Syndiese program:

Bure-Saudron BtL demonstrator, located in East of France,
1st demonstration, in France, of whole BTL chain
Project objectives:

- technological demonstration
- pre-industrial demonstration
- economic demonstration

Uhde: BioTfuel Project:

- 2 pilot plants being built in France, start up in 2012
- Life-cycle analysis for optimum equilibrium between technical-economical performance and environmental demands

Technology platform bio energy and methane:

Project cancelled in August 2011
Objective: first commercially operated biomass AER gasification plant in Germany (10MW_{th}, FB gasifier)

SWU Stadtwerke Ulm CHP demo plant:

- Wood chips
- 15,1 MW_{th}/4,55 MW_{el}
- Technology based on the FICFB Güssing (Repotec)
- Under construction

Agnion heat pipe reformer – allothermal biomass heatpipe-reformer

- Pilot facility in Pfaffenhofen (500kW$_{th}$)

The bioliq pilot gasifier

Technical:

- 5 MW thermal load
- Fuel: slurry
- Gasification with O_2
- Temperature 1200°C
- Pressure up to 80 bar
- Cooling screen
- Slagging mode
- Operational in 2012

R&D – Topics:

- Atomization of slurry
- Slurry-burn out
- Syngas quality
- Efficiency
- Process control
- Modeling/scale-up

Fast pyrolysis for slurry production:

Slurry: < 40% wt coke, viscosity < 3 Pas, particle size < 100 µm

Bioliq pyrolysis trial runs in 2011, achieved 24 h continuous operation by approx. 400 kg/h straw-input

Switzerland, Martin Rüegsegger, ETECA GmbH

Policy in Switzerland is made by Swiss Federal Office of Energy (SFOE)

Policy & Programs:

Kyoto protocol:

- Emissions reduction of 10% by 2010 – aim not fulfilled

Programs

- REN-Projects by the Cantons (CO_2-contribution)
- Cost-covering remuneration for feed in the electricity grid
- Further info: www.admin.bfe.ch

Facts:

- In 2009 56,15% of Sw. electricity production came from renewable

Research activities:

- PSI
    - Gasification of dry biomass (SNG, CHP)
    - Gasification of moist biomass for SNG production

Industrial gasification activities:

EKZ, Pyroforce, Xylopower AG and Foster Wheeler AG

Thermal gasification plants:

- Aerni in Pratteln
- Holzstrom in Stans

- Woodpower in Wila – out of operation since July 2011
- Woodpower EMPA (approved project in planning)

News:

- EMPA EAWAG Dübendorf decided September 2010 for CHP gasifier Plant
  - Supplier: EWZ and Woodpower
  - Wila-type gasifier
  - 2 x 350 kW_{el}
  - Now detailed planning, awaiting building permission

- 3 MW fuel gas produced by wood gasifier will replace fossil fuel for brick production in rotating furnace. The fuel gas will be produced by 3 gasifier units each 1 MW.
  - Test with 1MW unit gasifier estimated in the beginning of 2012

- PSI: Biomethane development: 20-80 MW BM-to-SNG, Pilot plant in discussion, based on BFB methanation technology

New Zealand, Jingge Li, University of Canterbury

Government strategies and initiatives in New Zealand:

- The government released the two strategies on 30 August 2011 to replace the 2007 version
- The goal: efficient use of the country´s diverse energy resources (hydro, geothermal, wind, biomass)
- The aim: to achieve a 50% reduction in GHG from 1990 by 2050
- Target: 90% of the electricity from renewables in 2050 (now 79%)
- Government joined the International Renewable Energy Agency on 1 May 2011

The biodiesel grants scheme (2009)

- Aims to start biodiesel production in NZ
- Grant up to 42,5 cents/l for biodiesel
- The grant is paid to NZ producers who sell 10 000 l or more biodiesel each month

Biomass energy strategy 2010

- It aims at economic growth by increasing production and use of biomass energy and biofuels in NZ
- Target is to increase bioenergy use from current 8,5% to 25% by 2040 including 30% of the country transport fuels
- Target will be implemented in three phases (till 2040)

Status of commercial biomass gasification:

- **Fluidyne Gasification Ltd**: is active overseas (California) with its downdraft process (100kWe-2MWe)
  - Gasifiers with outputs eq. to 250-500 kW_e are to be built with a change of design concept containing the oxidizing bed by 2013-15
- **Windsor Engineering Ltd.** (drying kilns),

- 1,5 MW gasifier in Rotorua in commissioning as a training facility for wood processing students at the WIT
- Updraft type
- Fuel: mixed shavings, hogging, sawdust and bark

Potential commercialization opportunity

- Gasification of demolished timber from the earthquake damaged buildings in Christchurch
- Proposal of UC collaboration with the city council (CHP)

CRL Energy Ltd.

- R&D on coal gasification for hydrogen production
- 200kW FB gasifier constructed, cooperation with University of Canterbury
- O_2 blown FB gasifier of 50 kW in construction

Status of R&D on biomass gasification:
University of Canterbury:

100kW dual fluid bed (DFB):

- Effect of gas contact time or BFB bed height (results presented, www.ieatask33.org)
- Effect of calcite catalytic bed material on producer gas composition (results presented)
- Now ready for demonstration in gasification of wood pellets for heat or CHP

A cold transparent DFB model for hydrodynamic study

- Objective: to develop design tools for scaling up of the DFB gasifier

Japan, Mayumi Morita, NEDO

Potential

- Forest residues (but problems with collection)
- Food waste (but development of drying technology necessary)

Policy

- Reduction of dependence on fossil fuels in the transportation by 80% by 2030
- Transportation: several eco-friendly technologies
- Bio-fuel technology innovation plan: bioethanol production to make prices competitive with gasoline prices in the medium to long term
- Cool-Earth 50 and Strategic Energy Plan – promote BTL technology

NEDO´s activities

- Innovative technology development
- System demonstration
- Development of production system for cellulosic bioethanol (2009-13)
- Development of technologies for high-efficiency conversion of biomass and other energy (2007-2012)
- Strategic development of next generation bioenergy utilization technologies (2010-2016)

Implementation

- Cogeneration
  - ChugaiRo Co
  - Tsukishima Kikai Co.

    - Kawasaki Heavy Industries
    - Shimizu Corporation
- Gasification for Liquid fuels
    - Mitsubishi Heavy Industries

Japan, Tomoko Ogi, AIST

After the earthquake, tsunami and radioactive catastrophe in March 2011 in Japan it is time to rethink the energy options.

- Enforcement of introduction of renewable energy
- Wood gasification for SNG production?

Gasification in Japan

- CHP developed at demonstration stage in a relatively small scale
    - Shimizu Corporation, Chugai Ro Co. Ltd.
- Liquid fuel synthesis developed at bench scale
    - Mitsubishi Heavy Industries Ltd.
        - Entrained flow gasifier (2t biomass/day)
        - Methanol synthesis device
    - TAKUMA Co. Ltd)

Discussion on Scope of Work and Workshop Topics for 2013-2015:

Newsletter

To promote the thermal biomass gasification and to inform the involved public, the newsletter will be published each year and can be found at **www.ieatask33.org**. The first issue will be finished at the end of the year 2011. The newsletter consists of short overview from the meetings and workshops, interesting information and news from the thermal biomass gasification area.

Workshop Topics:

For the next Triennium, following workshop topics were chosen:

- Bed materials in fluidized bed gasification
- Product gas cleaning and usage
- Tar removal, analysis and formation
- Small scale fixed bed gasification
- Analysis and measurements
- Sustainability
- Fuel pre-treatment, demands of gasifiers on fuel quality
- Drop in fuels

Webpage of our Task, Jitka Hrbek, TUV, Austria

Since the end of July, the new version of the webpage for the Task 33 was activated.

All task members had the opportunity to provide their feedback and to visit the new webpage before the site was activated. The aim was to create a new, clear and informative webpage on thermal gasification of biomass, not just for the task members but also for all specialists in the gasification area and involved public.

In Piteå, the actual status of the webpage was presented.

The webpage contains also the database of gasifiers worldwide. Now, a total of 87 biomass gasification facilities are registered in the database, 68 facilities in member countries.

The gasifiers can be divided by three parameters: technology (co-firing, CHP, synthesis, other innovative), type (pilot, demo, commercial) and status (planned, announced, under construction, under commissioning, operational, on hold).

Most of the gasification facilities, 44%, are used for CHP, 39% for synthesis and only 4% for co-firing. Other innovative technology is covered with 13% of all gasifiers.

There are 48% commercial gasifiers, 27% pilot plants and 25% demonstration plants for gasification facilities in the database. 59% of the gasifiers are in operation.

Next Task Meeting: 17.-19. April 2012 in Turkey
Topic of the workshop proposed: Status of Biomass Gasification Technologies

Final Task Meeting: together with the IEA Bioenergy ExCo conference in Vienna, proposed date of the ExCO will be 12th to 16th November

Day 2, Wed October 19

Expert workshop on "Biomass Gasification Opportunities in the Forest Industry"
Meeting Location: Smurfit Kappa Tech.
Smurfit Kappa Kraftliner Piteå
941 86, Piteå

Table of presentations

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

All presentations can be found at **www.ieatask33.org**

The list of the workshop participants can be found at attachment I.

Day 3, Thu, October 20

Site Visits

ETC laboratories

- **BLG pilot plant DP1**
  - 3 MW thermal power (20 ton BL/day)
  - 30 bar, 1000 °C
  - Accumulated run time > 13 000 hours (Aug 2011)

- **EF gasifier** (PEBG – Pressurized Entrained flow Biomass Gasification)
  - Project period 2009 – 2012
  - Combining Research, Industry and Society (Triple Helix)
  - Slagging entrained flow gasification of low grade wood-powder
  - Nominal plant capacity: 1 MW at 10 bar
  - Oxygen blown gasification
  - Refractory lined reactor operating at 1200–1500 °C
  - Bubbling quench for cooling and separation
  - Flaring of the product gas (side stream for analysis)

MEVA 1 MW_{el} gasifier

MEVA Innovation AB is a company with focus on research, development and sales of complete small-scale cogeneration systems based on a gasification technology with production of clean fuel gas in a cyclone reactor. MEVA, with very large internal and external expertise, developed VIPP - Vortex Intensive Power Process and found sustainable technical solutions to previously less efficient technologies and can now present a very reliable and cost-effective concept.

Smurfit Kappa wood intake and wood yard

The Kraftliner Mill in Piteå was built during 1960-1962. The production capacity in the beginning was 100 000 tonnes of kraft liner/year. After ten years, in 1972, the capacity was doubled when paper machine 2 was taken into operation. The capacity has increased every year due to continuous investments and improvements, and in 2003 the mill has reached the 700 000 tonnes/year level.

Smurfit Kappa Kraftliner Piteå is Europe's biggest kraft liner producer, with an annual output of some 700 000 tonnes. Kraft liner is a base paper made from fresh fibers and is used for the manufacture of high quality corrugated packaging. Smurfit Kappa Kraftliner Piteå is a part of the Paper Division Europe of the Smurfit Kappa Group.

SunPine tall oil biodiesel plant

SunPine have pioneered a "Wood to Wheel" renewable diesel process technology using crude tall oil, a residual product of the pulp and paper industry, as feedstock. The main product of the process is the SunPine crude tall diesel. A final refinery process step including hydrogenation treatment converts the Sun Pine crude tall diesel to a first class renewable diesel fuel with a very low carbon footprint and excellent well to wheel efficiency. The major by product is the SunPine Bio oil, a high quality tall oil pitch. It can be processed further to recover valuable chemicals including rosin and phytosterols.

Attachment I

Workshop participants list

Name	Affiliation	Country	Email
Rich Bain	NREL	USA	Richard.Bain@nrel.gov
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IEA Bioenergy Agreement: 2010-2012
Task 33: Thermal Gasification of Biomass
Fifth Semi-annual Task Meeting, 2012
Istanbul, Turkey
Tue. 17 to Thu. 19 April 2012

Minutes

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

Day 1, Tue April 17

The list of attendees, for the Task Meeting include:

Name	**Country**	**Affiliation**	**email**
Reinhard Rauch	Austria	TUW	rrauch@mail.zserv.tuwein.ac.at
Jitka Hrbek	Austria	TUW	jhrbek@mail.zserv.tuwein.ac.at
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Martin Ruegsegger	Switzerland	ETECA	Eteca@gmx.ch
Richard Bain	USA	NREL	Richard.bain@nrel.gov

Regrets for inability to attend were received from: Thomas Kolb, KIT, Germany; Mayumi Morita and Tomoko Ogi, NEDO and AIST, Japan; Shusheng Pang, UoC, NZ

The Agenda of the Meeting was:

Day 1, Tue, April 17

Meeting Location: Lares Park Hotel Taksim

Task Bussiness Meeting

1. **Introduction of Task Members and Observers**
2. **Review and Approval of Agenda**
3. **Review and Approval of Minutes from First Semi-annual Task Meeting, 2011, October, Piteå, Sweden**
4. **Discussion of IEA Bioenergy Conference 2012**

November 13 – 15, 2012
Vienna University of Technology

a) **Task Plans for 2013-2015 triennium**
   Overall structure
   Task website
   Special Projects
   Task Interactions

Member Country Summaries*: NTL's are being requested to provide executive summaries of the detailed country reports for the triennium, plus summarize the country gasifiers that are being used for the gasification project database*

1. Denmark, Morten Tony Hansen
2. Finland, Ilkka Hannula
3. Italy, Antonio Molino
4. The Netherlands, Bram van der Drift
5. Austria, Reinhard Rauch
6. Norway, Roger Khalil

Day 2, Wed, April 18

Task Meeting and Workshop "Bed materials"

Meeting Location Lares Park Hotel Taksim

7. Sweden, Lars Waldheim
8. Switzerland, Martin Rüegsegger
9. Turkey, Hakan Karatas
10. USA, Richard Bain

EERA bed materials workshop

Speakers:

1. H.J.M. Rian Visser, EERA/ECN, the Netherlands
2. Christiaan M. van der Meijden, ECN, the Netherlands
3. Bram van der Drift, ECN, the Netherlands
4. Friedrich Kirnbauer, bioenergy 2020+, Austria
5. Husnu Atakül, ITU, Turkey

Day 3, Thu, April 19

Site Visits

Site Visit-1 to **Tubitak Gasification Facilities, Gebze**

Site Visit-2 to **Ekolojik Enerji Gasification Plant, Kemerburgaz**

Country Updates on Biomass Gasification:

Denmark, Morten Tony Hansen, FORCE Technology

A short introduction to FORCE Technology was given by Morten Tony Hansen, the new Task 33 NTL of Denmark.

FORCE is a non-profit company with unique combination of competencies within testing, technology development and consultancy. FORCE has 25 years of experience with biomass conversion and managed the Danish Centre for Biomass Technology 1986-2002. FORCE has produced the Danish National RD&D Strategy for Thermal Biomass Gasification and the D&D Action Plan on Solid Biomass CHP Technology. FORCE is active in public and commercial projects, provides fuel market analyses for Denmark and Europe as well as feasibility studies for pellet plants and CHP plants.

Further an overview on Danish gasification technologies and RD&D organizations was given.

Technology name	Stakeholders	Technology	Purpose	State	Plants	Hours	Time to c.
Alternating Gasifier	Ammongas, Vølund	Twin Bed Filter	Fuel (gas)	Pilot	1	50	40940
Vølund Updraft Gasifier	B&W Vølund	Updraft	CHP	Commercial	4	130000	0
CHP System of BioSynergi	BioSynergi	Open core dd	CHP	Pilot	1	6000	40970
Staged Down Draft Gasification	Weiss, DTU, Cowi	Multiple steps dd	CHP	Demonstration	2	4000	1
Pyroneer	DONG, DFBT, DTU	LTCFB	CHP	Pilot	4	700	>4
Close Coupled Gasification	EP Engineering	Vibrating grate FB	CHP	Pilot	1	1000	2
Sublimator	Frichs	CDP	CHP	Commercial	0	?	0
Catalytic Low Temp. Pyrolysis	Organic Fuel Tech.	Catalytic LT Pyrol.	Fuel	Pilot	1	300	40940
Up Draft Gasifier & Stirling Engine	Stirling DK	Updraft	CHP	Commercial	6	12000	0
BlackCarbon	Stirling DK	Pyrolysis	CHP	Demonstration	1	2400	2
Biomass Gasification Gas Engine	Carbona, Aaen	CFB	CHP, fuel	Demonstration	1	6500	40970
?	TK Energi	?	?	?	?	?	?

Also, an overview on Danish energy policy along with a vision for the Danish energy system in 2050 was presented.

Finland, Ilkka Hannula, VTT

Characteristics of the energy sector in Finland were presented.

An overview on gasification of biomass and waste in Finland was given.
Commercial lime-kiln gasifiers were constructed in 1980´s by Ahlström, new development by Foster Wheeler in 1990´s for boiler applications.
Gasifiers in Finland now offered by Andritz-Carbona, Foster Wheeler and Metso Power in size range 15-150 MW.

VTT´s role and activities in biomass gasification:

- IPR on gas reforming for clean gas applications
- Support for industrial projects
- R&D on gas filtration, heavy metal removal and fuel characterization

New CFB gasification plants, which are in commissioning/under construction were introduced.

- Metso: 2x80 MW at Lahti waste-to-energy plant
- Metso: 140 MW in Vaasa
- Andritz: lime kiln gasifier 48 MW at Joutseno (start up in summer 2012)
- Foster Wheeler: lime kiln gasifier 12 MW at Varkaus returned to air-blown operation mode

Metso gasification projects:

Vaskiluodon Voima – Substituting Biomass for Coal in a PC boiler

- 140 MW_{th} gasifier adjoined to the existing 560 MW coal-fired power plant
- PC boiler in operation since 1982
- Coal consumption 400 000 – 500 000 t/y
- Enables biomass to replace up to 40% of coal
- Production capacity: 230 MW_{el}, 170 MW_{th}
- Total investment 40 mio. Euro

Metso scope:

- Fuel receiving and handling
- Drying
- Gasification
- Boiler modification
- Automation, electrification and instrumentation

LahtiStreams IP (Advanced Integrated Waste Management and WtE Demonstration)
(Lahti Energie/FI, VTT/FI, L&T/FI, Dong Energy/DK, FZK/D; total budget 23,5 M€)

- Demonstration of complete advanced waste management chain
- R&D of:
  - Improved hot gas cleaning
  - Waste processing and mat. recovery
  - Advanced ash treatment
  - New gasification based high efficiency WtE technologies

Lahti Energia – Gasification Power Plant

- 2x80 MW_{th} gasifiers, waste-derived fuel, 50 MW_{el}, 90 MW_{th}

Metso scope:

- Start up April 2012
- Total investment 157 mio. Euro

High-Efficiency Power from Biomass

IGCC based on press. Fluidized-bed gasif. and hot gas filtration

- Pilot scale by VTT 30-150MWe (1990´s)

Gasification coupled to engines for small-scale plants 0,1-5 MWe

- VTT´s Novel gasifier devel. In early 2000
- Gas reforming know-how licenced to Carbona and Skive plant
- Support to SME companies in “farm-scale” power

SME companies are developing small-scale gasifiers for gas engines in Finland (100-500kWe)
New R&D project at VTT with 5 SME companies is planned for 2012.

Gasification based small scale CHP development in Finland (downdraft, gas purification, gas engine)

- Gasek (50 kWe, 100kWth)
- Volter (30 kWe, 80 kWth)

Biorefinery BTL Demo plants in Finland

- 3 consortiums are planning sec. gen. BTL biorefineries
- Planned capacities 100 000-200 000 t/a of diesel
- EU NER300 funding expected end of 2012
- Investment 400-800 M€

Biomass-to-Syngas R&D at VTT:

- 2G 2020 BIOFUELS
- Production of SNG of H2 from biomass
- US-cooperation project on evaluation of gasification-based systems
- Nordsyngas
- Gasification reactivity

Italy, Antonio Molino, ENEA

ENEA´s activities regarding biomass:

- Biomass combustion
- LCA – Anaerobic digestion
- Biodiesel from algae
- WEB Geographic Information System of Biomass Energy Crops
- Biofuels 2nd generation

The policy and current status of biomass gasification were presented.

PLANT	POWER (kWe)	MANUFACTURER OF THE SYSTEM	CHARACTERISTICS OF THE PLANT
Belluno(BL)	1000	GAS-1000 MODEL	The plant is fed with 8500t/a of wood
Parma	1000		The plant produces 7.5GWhee 15GWht and it is powered with 9000 t/a of kenaf
Gadesco Pieve(CR)	960	Agroenergia	The pyrogasificator is fed with chopped or chipped vegetable biomass
Alessandria	640		The system is experimental and the process has been developed by poliTO; the plant is fed with 4100 t/a of biomass from forest
Vigevano(PV)	500	ModelloGAS-500	The plant produces 3.75GWhe and 7.5 GWht and it is powered with 4100 t/a of wood chips
Caluso(TO)	400	Autogas Nord	The plant is fed with residues of agricultural production, forest biomass, leaves, waste of food industry
Oltrepo Pavese(PV)	300	Bio&Watt	The plant uses an endothermic motor
Castel San Pietro(BO)	250	Bio&Watt	The pyrogasificator is fed with waste prunings, corn stalks, wood chips of poplar
Orzinuovi(BS)	250	Bio&Watt	The pyrogasificator is powered by biomass from forests
Verbania	250	CoVer Energy	The plant is classified as experimental

ENEA´s technological platform for the biomass gasification:

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

PI.GA – Downdraft gasifier

- 150-450 kWth
- Cleaning section: cyclone, scrubber, disk filter, sawdust filter
- Power generation: diesel engine modified to Otto cycle with gas feeding, coupled with alternator

PRAGA plant – Updraft gasifier
- 150 kWth
- Feeding: almond shells
- Gasif. medium: mix steam-air

JOULE plant – Steam gasification pilot plant FICFB
- 500 kWth
- In collaboration with TUV, University of L´Aquila, Louis Univ.

UNIQUE plant – FB with internal recirculation of 1 MWth
- Current activity: production of bio-SNG from syngas

ENEA´s projects:
- SNG from biomass
- Supercritical water gasification
- BRISK (Biofuels Research Infrastructure for Sharing Knowledge)
- HY-Tractor (Tractor powered with a fuel cells

The Netherlands, Bram van der Drift

Modern industry policy in the Netherlands, more renewable energy ahead

HoSt (small CFB gasification for difficult fuels)
- Portugal: 3MW_{th} CFB gasifier, OLGA, gas engine
  - Status: commissioning on wood and chicken manure
- 3 ton/h paper rejects plant in NL, gasifier, cooler, cyclones, boiler, steam
  - Start up: 2013

BioMCN (Methanol Chemistry Netherlands)
- The largest 2nd generation biofuels plant worldwide
- Now 30-40% glycerin in Natural Gas reformer (approx. 150$MW_{bio\text{-}methanol}$)
- Planned: gasification (Siemens) of 1500 ktonne/y waste wood for 400 ktonne/y methanol

NUON
- 250 MW_{el} coal-based IGCC, ability to co-fire biomass
- Biomass co-firing ongoing; significant extension of co-firing under investigation, implementation depends on government
- Test 70%: capacity drops to 170-200 MWe

ESSENT (RWE)
- **Amer-9 power station, Geertruidenberg**
- 600 MW_{el} coal-fired PF boiler
- 36% w/w direct co-firing, will be increased to 50%
- Plus 5% e/e indirect co-firing by gasification of waste wood

- Approx. 5000 h/year, cooling remains the biggest problem

DAHLMAN – renewable energy (**www.dahlman.nl**)
Became ROYAL DAHLMAN in Jan 2012

HEVESKES ENERGY (**www.heveskesenergy.nl**)

- Technology: oxygen driven JFE gasification technology, based on 3-years operational experience
- Feedstock: RDF
- Project Delfzijl: 10 ton/h RDF, start up 2013/2014

SYNVALOR (www.synvalor.com)

- New multi-stage low-tar concept for all, but more specifically difficult fuels
- Based on Vortex reactor designs
- Aimed at affordable (<2.50 €/kWe) and reliable technology
- CEO Jacques Poldervaart: history in Torbed gasification through Polow Energy Systems

HVC

- 12 MW (waste wood input) plant in preparation
- MILENA and OLGA based
- Phase 1a: heat production (first few years)
- Phase 1b: additional gas cleaning and SNG production (~850 Nm3/h)
- Start building 2012
- Phase 2: 50-100 MW plant

ECN

- Recent 500h test 0,8 MW MILENA-OLGA on wood were presented

Austria, Reinhard Rauch, TUV

Policy targets, energy consumption and renewables in Austria were presented.

Austrian research organizations and their activities were introduced: Graz University of Technology, Joanneum Research Graz, MCI, Vienna University of Technology, Bioenergy 2020+, FJ-BLT Wieselburg

Austrian companies active in biomass gasification:

- Andritz (now also owner of the Austrian part of Austrian Energy & Environment)
- AGT Agency for Green Technology – low temperature conversion=thermo-catalytic decomposition process operating without air supply
- Austrian Enviro Technologies
- GE Jenbacher
- Ortner Anlagenbau – builds FICFB for CHP applications
- Repotec – builds FICFB gasifiers for CHP, SNG and other synthesis
- SynCraft Engineering GmbH
- Urbas – fixed bed gasification
- Xylogas - fixed bed gasification

Commercial FICFB gasifiers in Austria:
Location: Güssing - el. Production using gas engine

-8.0 MW_{fuel}, 2.0 MW_{wl}
-start up in 2002, in operation
-SGC Energia finished successfully their demo

Oberwart -gas engine/ORC
-8.5 MW_{fuel}, 2.8 MW_{wl}
-start up in 2008, in operation
-operation difficulties and optimizations were presented
-project on polygeneration-production of valuable gases, electricity and heat from biofuels was presented

Villach - gas engine
-15.0 MW_{fuel}, 3.7 MW_{wl}
- in commissioning

Klagenfurt -gas engine
-25.0 MW_{fuel}, 5.5 MW_{wl}
-planning

Vienna -planning (decision end of 2012)
-hydrogen production
-50 MW_{fuel},30 $MW_{hydrogen}$

Commercial FICFB gasifiers abroad:

Location: Ulm (DE) -gas engine/ORC
-15.0 MW_{fuel}, 5.3 MW_{wl}
-since 3/2012 in operation

Urbas gasifiers:

- Ruden:
  - 150 kW_{el}/300 kW_{th} + 70 kW_{el}/150 kW_{th}
  - Development since 2001
  - 30 000 operating hours
- Eberndorf:
  - 20 000 oper. hours
  - 2x120 kW_{el} + 70 kW_{el}/650 kW_{th}
  - Start up 2006-8
- Neumarkt:
  - 2x120 kW_{el}/580 kW_{th}
  - Start up 2008
  - 16 000 operating hours
- Sulzbach-Laufen, DE:
  - 130 kW_{el}/280 kW_{th}
  - Start up 2009
- Neukirchen:
  - 2x150 kW_{el}/300 kW_{th}
  - Start up 2011
  - 1000 operating hours
- Konstanz, DE:
  - 150 kW_{el}/300 kW_{th}
  - Start up end of 2011

Cleanstgas (Clean Staged Gasification)

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

Norway, Roger Khalil, SINTEF Energy

The structure of SINTEF was presented.
Energy research cluster: SINTEF + NTNU – focus on:

- Hydropower
- Solar cells
- Wind
- Bioenergy
- CCS - Carbon Capture and Storage
- Zero emission buildings
- Oil and gas exploration and production
- Energy systems

STOP – STable OPerating conditions for biomass combustion plants

- The main objectives in STOP is the development of new strategies for improved operating conditions control in biomass and biomass residues combustion plants

Gasbio – new project within thermochemical biofuels production (duration 4 years)
Partners: SINTEF, Norske Skog, Metso, Statoil, Avinor, NTNU
Objectives: to establish an internationally oriented solid Norwegian competence base within biomass gasification to produce biofuels.

- Main objectives:
  - To develop Norwegian competence in the Biofuels area.
    - Emphasis on large-scale production of suitable qualities of synthesis gas
  - To contribute to the reduction of Biofuels production costs.
    - Innovations in gasification processes
    - Focus on low-value biomass fractions

LignoRef
Lignocellulosics as a basis for second generation biofuels and the future biorefinery

- Project type: KMB – Research Council of Norway
- Budget: 3 M€
- Duration: 4 years (2009 – 2012)
- Partners:
  - Coordinator: PFI (paper and fiber research institute)
  - Industry: Statoil, Borregaard, Weyland, Allskog, Cambi
  - Others: UMB, UiB, NTNU

Biomass to liquid fuels

- Budget:
  - Norwegian Research Council: 50%
  - Industry: 50%

  Total: 1 mil. Euro (2009-2011)
- Duration: 3 years

- Partners:
  - Coordinator – Project owner: NTNU – Dept. Chem. Eng.
  - Industry: Statoil
  - SINTEF Hydrocarbon Process Chemistry (Kincat Gemini center)

New, innovative pretreatment of Nordic wood for cost-effective fuel-ethanol production" (2007-2010)

- Project type: Nordic Energy Research
- Budget:
  - Total: 1.6 mil. Euro
- Duration: 4 years
- Partners:
  - Coordinator: PFI
  - Industry: Statoil, Borregaard, Novozyme, SEKAB, Norske Skog, Skogeierforeningen
  - R&D: Innventia, Matis, VTT, SINTEF

SusBioFuel
Sustainable Biofuel: Innovations in Bioethanol Production Technologies

- Project type: Nordic Energy Project
- Budget:
  - 1.6 mil. Euro
- Duration: 4 years (2010-2014)
- Partners:
  - Coordinator: SINTEF
  - Industry: Statoil, Weyland, Matis
  - Others: VTT, DTU, PFI, Innventia

The Biooil Refinery

- Project type: BIP – research Council of Norway
- Budget:
  - Total: 1.5 mil. Euro
- Duration: 2 years
- Partners:
  - Coordinator: PFI
  - Industry: Statoil, Holmen, Södra, Trondheim Energi, Fiborgtangen vekst
  - Others: Aston University

PROFIT
Profitable bioenergy and paper production through innovative raw material handling and process integration

- Project type: BIP – Research Counsil of Norway
- Budget:
  - Total: 4.5 mil. Euro
- Duration: 4 years (2009 – 2013)
- Partners:
  - Coordinator : VTT (Technical Research Center of Finland)
  - Industry: Total of 7 industry partners

Other: Chalmers, NTNU

AFORE
Added-value from chemicals and polymers by new integrated separation, fractionation and upgrading technologies

- Project type: EU project

- Budget:
  - SINTEF: EUR 395 378

Total: EUR 10 901 431

- Duration: 4 years (2009 – 2013)
- Partners:
  - Coordinator : VTT
  - Industry: Södra Cell, Danisco, hte; Granit, NATEX, KCl.
  - Other: total of 20 partners

EuroBioRef

European multilevel integrated biorefinery design for sustainable biomass processing

- Project type**:** EU project
- Budget:
  - SINTEF: EUR 619 858
  - Borregaard: EUR 3 000 000

Total: EUR 38 174 053

- Duration: 4 years (2010 – 2014)
- Partners:
  - Coordinator : CNRS
  - Industry: Arkema, Borregaard, Novozymes, Topsøe, Merck, Metabolic explorer, Umicore.
  - Other: total of 28 partners

Sweden, Lars Waldheim, Waldheim Consulting

Energy and climate bill and fuel prices and taxation in Sweden were presented.

R&D and D:

- Two gasification projects selected in the 2009 EOI for demonstration of 2nd. generation biofuels and energy technologies (100 M€)
- Energy intensive industry program 8 M€
- Bioenergy fuels program
- Government Bill "A Boost to Research and Innovation" 2010 gives support to 20 identified "Strategic Areas of Research" in 43 groupings for 5+5 years, 3 energy related
- STandUP (UU/KTH/LTU/SLU) - mainly electrical grid and vehicle technology, but also RE power generation
- Swedish Centre for Renewable Fuels (f^3) launched
- Swedish Gasification Centre launched
- NER300: bioenergy 5 out of 9 projects proposed to the EU
- Demonstration and SET-plan budget reinforced for FY 2012
- Biorefinery Norrtorp pre-study initiated

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

Swedish Centre for Renewable Fuels (f^3-fossil free fuels) – will be established as a nationwide knowledge platform and venue for cooperation in the production of renewable fuels and the related system aspects, with highest international credibility

- Budget for 2011-13 (~3 mio. Euro)
- Project areas:
  - System-wide studies
  - Studies for renewable fuels
  - Analysis of synergies between plants and diff. technology platforms
  - Method development for interdisciplinary studies

Swedish Gasification Centre (SFC) – 8 Academies and 9 companies

- CDGB (Centre for Direct Gasification of Biomass)
- CIGB (Centre for Indirect Gasification of Biomass)
- B4G (Biomass for Gasification, Entrained Flow Centre)

Chalmers

- Biogas production via thermal conversion (from lab-scale to 80 MW SNG)
- Indirect gasification: 2-4 MW_{fuel} gasifier integrated on the return leg of Chalmers 12 MW_{fuel} CFB boiler
- Goal of activity: to demonstrate
    - how an indirect gasifier could be built
    - a robust method for catalytic reformation of the gas to a syngas containing only CH_4, H_2, CO, CO_2, H_2O
    - an energy efficiency for dry biomass to clean syngas
- 22 researchers work at Chalmers, activity divided into:
    - Gasification process
    - Gas cleaning
    - High temperature corrosion

Swedish Gas Centre

- Gasification and gasification database
- Co-production of SNG and FT diesel
- International Gasification Seminar
- Particulate contaminants from indirect gasifiers (in planning)
- Autothermal regenerative POX tar reactor (in planning, Lund Technical Univ)

KTH School of Chemical Engineering

- Long experience of R&D within gasification. Activities started in 1970´s.
- 75 kW pressurized (30 bar) air & steam/oxygen FB gasifier with secondary reactor
- 50 kW air & steam/oxygen FB gasifier
- 5 kW air & steam/oxygen FB gasifier
- Test rigs for catalytic deactivation and particle separation concepts
- Tar analysis equipment
- Online alkali analyses
- Projects:
    - Demonstration of improved catalysts and reactor designs for the production of SNG
    - SNG for smart gas grids
    - SYNCON: Novel synthesis process concepts for efficient chemicals/fuel production from biomass
    - DeMiTar: development and market implementation of PID and FID tar analyzers
    - HTAG – high temperature air gasification

ETC

- Host for DP1: Chemrec black liquor, biomass

- VIPP gasifier: biomass, cyclone gasification, WESP, scrubber, engine CHP
- PEBG: pressurized entrained flow gasification, 1MW, 15 bar

Värnamo – pressurized combined cycle:

- Supplier: Bioflow (Foster-Wheeler, Sydkraft)
- Fuel: 18 MW
- Power: 6 MW
- Heat: 9 MW
- 18 bar
- Typhoon GT

VVBGC project status

- Engineering initiated in January 2010
- Project terminated in Feb. 2011 because of difficulties in attracting additional partners to close industrial funding targets

GoBiGas

- Biomass to biomethane 65 – 70 %
- Energy efficiency > 90%
- Phase 1:
    - Demo plant, 20 MW generating 160 GWh/y
    - In operation early 2013
    - Allothermal (in-direct) gasification
    - Gasification: cooperation between Metso Power and Repotec
    - Methanation: cooperation with Haldor Topsöe
- Phase 2:
    - 80-100MW generating 640-800 GWh/y
    - Technology not yet chosen

Project status –October 2011

- Funding: 222 MSEK granted for phase 1
  Project application for phase 2 sent to EiB for funding
- Investment decision – Dec. 2010 by Göteborg Energi
- Gasification – cooperation between Metso Power and Repotec
- Methanation – cooperation with Haldor Topsöe
- Phase in operation – early 2013

Black Liquor Gasification Activities

- Development plant for oxygen-blown high pressure BTL gasification (located at the Smurfit Kappa mill in Piteå, Sweden
- 30bar
- Capacity 20 metric tons/day of black liquor solids
- Used for technical development and design verification
- Started up 2005, now in operation, more than 12 000 operating hours

Black Liquor Demonstration Activities

- Domsjö and Chemrec in collaboration
- Feed: 200 MW of sodium sulphite liquor
- Products: 100 000 t/y of DME or 140 000 t/y of methanol or a mixture of both

E.ON

- Biomass to SNG
- Bio2G

Värmlandsmetanol

- Permitting is on-going
- No grant financing requested
- Planned construction start "as soon as permits are in place"
- FBG, forest residues, 100 000 t/y of fuel grade, methanol plus district heating 15 MW_{th}

Rottneros Biorefinery AB

BioMethanol opportunities:

- 150-200 kton BioMethanol via wood or blackliquor gasification
- Capital expenditure of 3 bill. SEK per project

MEVA

- Test unit, 10 kW_{th}, gas engine, in operation at ETC Piteå
- The first commercial unit, 1,2 MW_{el} under commissioning at Horlax, Piteå
- Target market is co-gen. plant, 2-20 MW_{th}, 1-10 MW_{el}
- Hot commissioning started in April (some few hours of gasification has been achieved up to now)

Cortus Wood Roll

- Indirectly heated gasification in industrial scale
- Successful syngas (CO/H_2) production during autumn 2011
- Relocation to Köpling planned
- Demo plant:
    - Power: 5 MW (future 25 MW)
    - Fuel: 30 TPD DS of biomass
    - Product: 1550 Nm^3/h synthesis gas
    - Investment 6,5 mill. Euro

MiUn BTL Research Laboratory

- 150 kW ICFB gasifier
    - Integration of FT synthesis reactor
    - Prove BtL integration
    - System modeling
    - Work on fuel flexibility

Switzerland, Martin Rüegsegger, ETECA GmbH

Policy in Switzerland is made by Swiss Federal Office of Energy (SFOE)

Policy & Programs:

Programs

- REN-Projects by the Cantons (CO_2-contribution)
- Cost-covering remuneration for feed in the electricity grid
- Further info: www.admin.bfe.ch

Facts:

- In 2009 56,15% of Sw. electricity production came from renewable

Research activities

- PSI
  - Gasification of dry biomass (SNG, CHP)
  - Gasification of moist biomass for SNG production
  - EU Infrastructure Project, collaboration with: BRISK
  - CCEM Competence centre Energy and Mobility
    - 3 projects (ARRMAT, WOODGAS-SOFC II, SYNGAS Diagnosis)
    - NFP66 – 3 projects rel. biom. gasification
      - Hot gas cleaning for production of bioSNG and electricity
      - Predictiong the complex coupling of chemistry and hydrodynamics in FB methanation reactors for SNG
      - Distributed production of ultra-pure hydrogen from woody biomass

Swiss Industry

- EKZ (supplier for turnkey biomass gasification plants)
- Pyroforce **(out of business)**
- XyloPower AG (supplier for turnkey biomass gasification plants)
- Foster Wheeler **(only office in Switzerland)**
- EMPA EAWAG Dübendorf CHP gasifier plant (2x350 kWel)
  - Project in detail planning stage
- 3MW Gasifier Project for brick production in rotating furnace (**CANCELLED** – fin. reasons)
- PSI: Biomethane Development => 20-80 MW BM-to-SNG based on BFB methanation technology in discussion

CHP plants - news

- AERNI Pratteln: plant in modification
- Woodpower Wila: out of operation since 7/2011
- Woodpower EMPA: Approved project awaiting building permission

Facts today:

1 Plant in stable operation (Stans)
1 Project in waiting position for realization
1 Plant in modification

Facts of the past 3 years:

1 Plant closed down
3 Planned projects abandoned
1 Main supplier out of business

Politics:

Visions clearly for Renewable Energy

Reality:

- Cost-covering remuneration (KEV) for new projects pending
- Thermal gasification is technically complex (higher costs)
- Risk investments for biomass-energy projects not existing
- CO_2 -certificates, -contributions and -compensations unsecure in the future
- Public and private frames not in line with political visions

- Volatile biomass-fuel-price

Turkey, Serhat Gül, Tubitak – MAM

Energy consumption, biomass potential and policy in Turkey was presented.

TUBITAK

Current Laboratory Scale Test Facilities;

- Bubbling fluidized bed gasifier (20 kWfuel)
- Fixed bed gasifier (40 kWfuel)
- Circulating fluidized bed combustor (20 kWth)
- Circulating Fluidized bed combustor (35 kWth)
- Circulating Fluidized bed gasifier (150 kwfuel) – problems and solutions presented

Current Pilot Scale Test Facilities;

- Bubbling fluidized bed gasifier (450 kWfuel)
- Fixed bed gasifier (300 kWfuel)
- Circulating Fluidized bed combustor (750 kWth)

Under construction test facilities;

- Pressurised bubbling bed gasifier (1100 kwfuel, 11 bar)

Biomass gasification activities in MRC

1) Trigen - Liquid Fuel Production from Coal/Biomass Mixtures

- Project Duration: 4 Years (2009 – 2013)
- Supporting bodies: Nationally Funded
- Project partners : MRC, 2 Universities, 2 private company

Aim Of The Project

- to produce more economic, efficient and clean liquid fuels from coal and biomass
- to enhance the utilization of the widespread national resources for sustainable development and energy security
- to develop technologies to be used in industry
- to demonstrate the outcomes in pilot scale

2) Pressurised bubbling bed gasifier (1100 kwfuel, 11 bar)

- now under construction
- fuel feeding: 250 kg/h
- diameter (cm): 30 bottom, 45 top
- height: 350 cm
- gasif. agent: O2 + steam

USA, Richard Bain, NREL

- Energy consumption in 2009 covered by 8% from renewable
- Electricity generation in 2009 – about 10,8% covered from renewable

U.S. biodiesel production

- 2,85 billion gallons/y
- 478,06 cents/gal (Mar 2011)

U.S. corn ethanol production

- 218 commercial plants

- 14.554 billion gal/year nameplate capacity
- 11.987 billion gal/yr. production[2]
- Additional 0.27 billion gal/yr planned or under construction
- Mar 2011 Rack Price – 270.48 cents/gal

Biopower status
2010 Capacity – 10.7 GW
  - 5.8 GW Electric Power Sector
  - 4.9 GW End Use Generators

2010 Generation – 56TWh
Cost – 0.08 – 0.12 USD/kWh

Biomass resources scenarios, supply curve (2005-2030) and an overview on U.S. biomass gasifier developers were presented.

Nexterra

- gasification system at University of South Carolina.
- start up was at the end of 2007
- the power is 1,38 MW_{el} and capacity 60 000 lbs/hr of high pressure steam for district heating
- The biomass (wood residues, moisture 25-55 %) is converted to combustible gas with 3 gasifiers.

Enerkem

The process converts waste and residuals into advanced biofuels
Enerkem promotes sustainable development and that is why it uses the non-recyclable portion of the waste and creates value from the forest and agricultural residues. From one ton of waste (dry basis) 360 liters of ethanol are produced. The process requires little use of water and allows for its reuse in a closed circuit.

GTI Biomass Gasification Activities

Within the "2nd generation biofuels project", there are provided laboratory and pilot-scale test for Andritz/Carbona and UPM F-T project. The maximum feed rate of biomass is 40 tons/day. The gasifier is pressurized (25 bar) oxygen blown.

TRI Technology and Projects

TRI´s core technology is deep fluidized bed, indirectly heated, steam reforming of biomass.
TRI´s black liquor gasifier has been commercially operational for six years (Trenton, Ontario).
Two separate DOE "Small-Scale Biorefinery Projects" are employing TRI technology:
– New Page, Wisconsin Rapids, WI; 500 dry tons per day biomass to FT fuels and tail gas. Class 10 study underway ($30 million award, 2008)
– Flambeau River Biofuels, Park Falls, WI; 1000 dry tons per day biomass to FT fuels. Class 30 completed ($30 million award, 2008)

ICM, Inc.

ICM Inc.'s gasification technology has been successfully tested and supported at rates up to 250 tons per day by the Department of Energy. ICM currently offers three commercial-scale unit designs with feedstock processing ranges of 150-200 TPD, 300-350 TPD and 450-500 TPD.
ICM owns and operates a 200 ton per day commercial demonstration auger gasification unit in Newton, KS that was installed to process municipal solid waste from the Harvey County,

KS landfill. Since commencing operations at the facility, ICM has tested more than a dozen feedstocks and amassed more than 2,100 hours of operation on the unit.
Projects: ReVenture Project, Charlotte, NC: ReVenture Park is a proposed waste-to-energy facility for Charlotte, NC. Forsite Development, the lead developer for the project, selected the biomass gasifier technology by ICM, Inc.

Coskata – Project Lighthouse

The project is based on partnership between Coskata and Alter NRG. A semi-commercial demonstration, Westinghouse plasma gasifier is located in Madison, PA. The feedstocks are

Pine chips and capacity is 50 000 gal /year of ethanol. The successful start up was announced in October 2009.

University of California & West Biofuels

Thermochemical conversion of biomass to mixed alcohols is provided using 5 ton/day dual fluidized bed gasifier based on "Pyrox Process". The facility works under atmospheric pressure with air-blown combustor. It is now in start-up.

Discussion on Scope of Work for 2013-2015

Next Task Meeting: together with the IEA Bioenergy ExCo conference in Vienna, 12th to 16th November 2012.

Proposed programme:

12. November: **Site visits to Güssing and Oberwart**
13.-15. November **IEA Bioenergy ExCo conference**
16. November: **Task33 meeting and Site visits to TUV laboratories**

Each Task should prepare 5 abstracts for the IEA Bioenergy conference.

Please, visit IEA Bioenergy Conference webpage for further information
http://www.ieabioenergy2012.org

Proposed abstract for Task 33:

- Gasification overview (R. Bain)
- Gasification database and website (J. Hrbek)
- Gasification in Austria (R. Rauch)
- Danish Biomass Gasification for CHP (Morten Tony Hansen)
- Finland, VTT?
- The Netherlands, ECN?

Task 33 Status
An overview on Task 33 activities presented by Richard Bain:

- Overview on Task 33 members - Executive Committee and Member Countries Representatives
- Last Task 33 workshops 2011 (Christchurch, Piteå)
- New Task 33 website including BMG database activated
- Task 33 budget status
- Task 33 continuation

Work programme of Task 33

- Organize semi-annual Task Meetings to exchange and review global RD&D programs and projects to identify barriers to commercialize BMG
- NTLs will prepare and update Country Reports and RD&D needs and make them available for use by other NTLs and Executive Committee members to aid in the development of their respective national BMG and bioenergy plans
- Conduct subtask studies, including technical workshops, with industrial and academic experts to address the key barriers to advancing BMG on a country and global basis
- Conduct joint studies/workshops with related tasks, annexes, and other international activities to pursue mutually beneficial investigation

Proposed (not finalized yet) joined studies with other IEA Bioenergy Tasks

- Feed handling and feeder handbook (with 32 and 34)
- Project database (with 32 and 34)
- Lessons learned - Report

Deliverables and Target Groups

- A biomass gasification summary report (jointly authored by Task Lead and NTLs) in 2014 addressing BMG basics, BMG applications, outstanding technical and sustainability issues, gasification specific policies in member countries, and a directory of gasifier developers in member countries (information will include company, development status, projects locations, gasifier type, primary products, patents, publications)
- A gasification lessons learned report (jointly authored by Task Lead and NTLs) in 2015. This report will serve as a success/failure analysis that will identify common characteristics of successful development and common characteristics of unsuccessful development)
- Two workshops with subsequent published proceedings (jointly organized with at least one other task)
- Three Task workshops in selected member countries focused on BMG development. The workshops will focus on local development issues and BMG applications, as well as member country BMG status and projects. Proceeding in the form of collated presentations will be made available to IEA Bioenergy and other parties on the Task 33 website
- Continued updates of Task website and BMG Database
- Updated Country reports from member countries summarizing the status of BMG, and providing detailed information on projects for inclusion into the BMG database (to be completed in 2014)

Day 2, Wed October 19

Expert workshop on "Bed materials"
Meeting Location: Lares Park Hotel Taksim

Table of presentations

H.J.M. Rian Visser, EERA, ECN, NL	
Husnu Atakül, ITU, Turkey	"Hot gas clean-up with dolomite"
Friedrich Kirnbauer, bioenergy 2020+	"Chemistry of olivine and its influence on biomass gasification"
Christiaan van der Meijden, ECN, NL	"MILENA gasification bed materials"
Bram van der Drift, ECN, NL	"Tar dew point"

All presentations can be found at **www.ieatask33.org**

The list of the workshop participants can be found at attachment I.

Day 3, Thu, October 20

Site Visits

1. TUBITAK

Gasification and combustion facilities at TUBTAK – MAM were visited
There are 2 atmospheric gasifiers (20 kW and 50 kW) and the third one, pressure gasifier is under construction.

Energy Institute MRC - projects:

- BRISK
- Energy storage
- Electric vehicles
- Distribution & efficiency of el. energy
- Vehicles & railways
- Fotovoltaics

Projects financed by government

2. Ekolojik Enerji

The Integrated Waste Management and Clean Energy Production Plant of Ekolojik Enerji Inc. consists of waste reception, RDF preparation, chemical/biological sludge drying, solid waste drying, evaporation, gasification, gas clean up mechanisms, energy recovery, energy production units and laboratories.

The integrated plant takes its origins from a successfully completed R&D project in Turkey, which was approved by the Scientific and Technological Research Council of Turkey. The project led the company to cooperation with Istanbul Greater Metropolitan Municipality for recovering energy from the municipal solid waste, which lasted approximately 7 months with a capacity of 50 tons/day.
Once the developmental stage was over Ekolojik Enerji Inc. has been approved with the **Renewable Energy Production License.** This was then followed by the Operational License; granted by the Ministry of Environment and Forestry with a supporting approval of Ministry of Finance. In addition

to these the **Category A Emissions License** and HSE-Q Standards Certificate are also gained by the company.

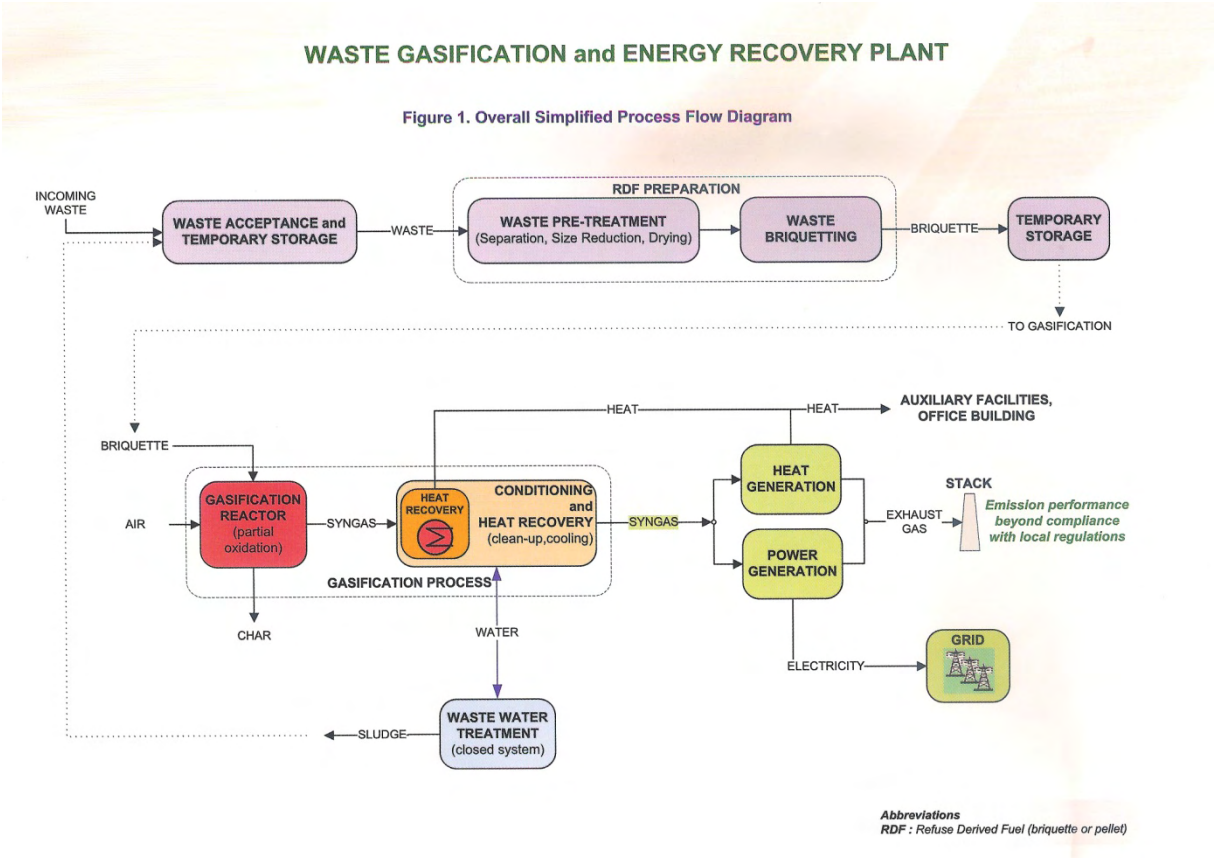

Fig. Process diagram of waste handling in Ekolojik Enerji

Attachment I

Workshop participants list

Name	**Country**	**Affiliation**	**email**
Reinhard Rauch	Austria	TUW	rrauch@mail.zserv.tuwein.ac.at
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Morten Tony Hansen	Denmark	FORCE	mth@force.dk
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Ville Hankalin	Finland	Metso	Ville.hankalin@metso.com
Serhat Gül	Turkey	Tubitak	Serhat.gul@mam.gov.tr
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Roger Khalil	Norway	SINTEF	Roger.a.khalil@sintef.no
Lars Waldheim	Sweden	WAC	Lars.waldheim@waldheim-consulting.se
Martin Ruegsegger	Switzerland	ETECA	Eteca@gmx.ch
Richard Bain	USA	NREL	Richard.bain@nrel.gov
Friedrich Kirnbauer	Austria	Bioenergy 2020+	Friedrich.kirnbauer@bioenergy 2020.eu
Husnu Atakül	Turkey	ITU	atakul@itu.edu.tr

END

IEA Bioenergy Agreement: 2010-2012
Task 33: Thermal Gasification of Biomass
Sixth Semi-annual Task Meeting, 2012
Vienna, Austria
Mon. 12 to Fri. 16 November 2012

Minutes

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

Day 1, Monday November 12

The list of attendees, for the Task Meeting include:

Name	Country	Affiliation	email
Shusheng Pang	NZ	UoC	Shushing.pang@canterbury.ac.nz
Thomas Kolb	Germany	KIT	Thomas.Kolb2@kit.edu
Reinhard Rauch	Austria	TUW	rrauch@mail.zserv.tuwein.ac.at
Jitka Hrbek	Austria	TUW	jhrbek@mail.zserv.tuwein.ac.at
Morten Tony Hansen	Denmark	FORCE	mth@force.dk
Ilkka Hiltunen	Finland	VTT	Ilkka.hiltunen@vtt.fi
Antonio Molino	Italy	ENEA	Antonio.molino@enea.it
Mayumi Morita	Japan	NEDO	moritamym@nedo.go.jp
Tomoko Ogi	Japan	AIST	t-ogi@aist.go.jp
Bram van der Drift	The Netherlands	ECN	vanderdrift@ecn.nl
Lars Waldheim	Sweden	WAC	Lars.waldheim@waldheim-consulting.se
Martin Ruegsegger	Switzerland	ETECA	Eteca@gmx.ch
Richard Bain	USA	NREL	Richard.bain@nrel.gov

Regrets for inability to attend were received from: Serhat Gül and Hakan Karatas, TUBITAK, Turkey, Roger Khalil, Sintef, Norway.

The Agenda of the Meeting was:

Day 1, Monday, November 12
Site visits

Visits of FICFB gasification plants in Oberwart and Güssing, Austria

Day 2-4, Tuesday to Thursday November 13-15
IEA Bioenergy Conference

Meeting venue: Schönbrunn Palace Conference Center, Austria
Schönbrunn Palace | Schönbrunner Schlossstrasse 47 | 1130 Vienna | Austria
Coordinates: **48.186657, 16.313215 / +48° 11' 11.97", +16° 18' 47.57"**

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

Day 5, Friday, November 16

Task 33 Meeting

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

Location: **http://www.vt.tuwien.ac.at/fileadmin/t/vt/Home/080328_tu_plan_print.pdf**

09:00 - Task 33 Meeting

5. Introduction of Task Members and Observers
6. Review and Approval of Agenda
7. Review and Approval of Minutes from First Semi-annual Task Meeting, 2012, April, Istanbul, Turkey
8. Task Plans for 2013-2015 Triennium
   - Overall structure
   - Special projects
   - Task interactions
   - Plans for 2013, Discussion
9. Technical tour at TUV

Day 1, Mon November 12

Site visits to FICFB Güssing and Oberwart

Güssing

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

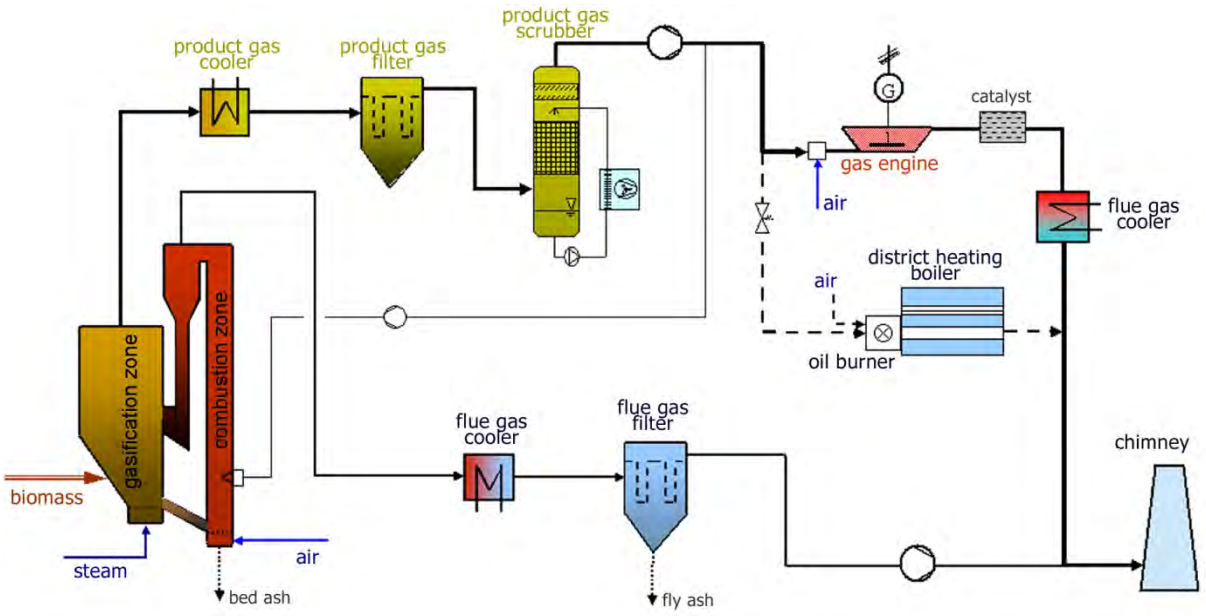


Figure: Güssing gasification plant – flow diagram

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

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

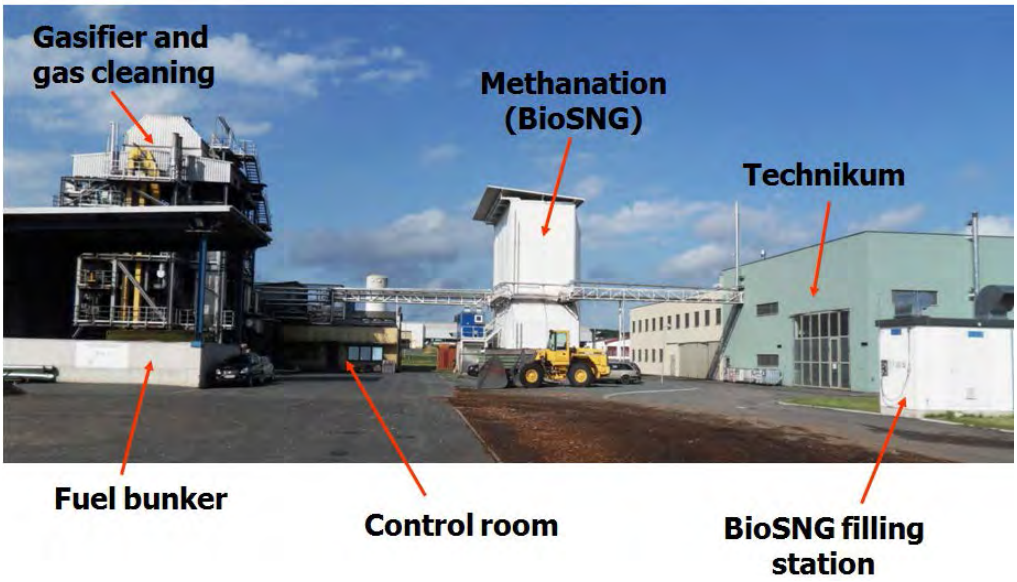


Figure: Synthesis platform in Güssing

Oberwart

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

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

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

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

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

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

Within the project a lab scale methanation unit is build up at the biomass CHP Oberwart, which will convert about 1Nm³/h of product gas to methane. The product gas will be taken either direct after the filter (contains all tars) or after the product gas scrubber (after tar removal), converted over the methanation catalyst and analysed. By adjusting the optimal parameters (temperature, steam carbon ratio) it will tried to optimise the conversion rate and also the long term stability. The long term aim of this research is to develop a simple robust methanation that natural gas from wood can be produced cost efficiently.

The second of the R&D in Oberwart is "Polygeneration". The aim of the project is to separate only some compounds such as H_2, CH_3, etc. from the product gas.

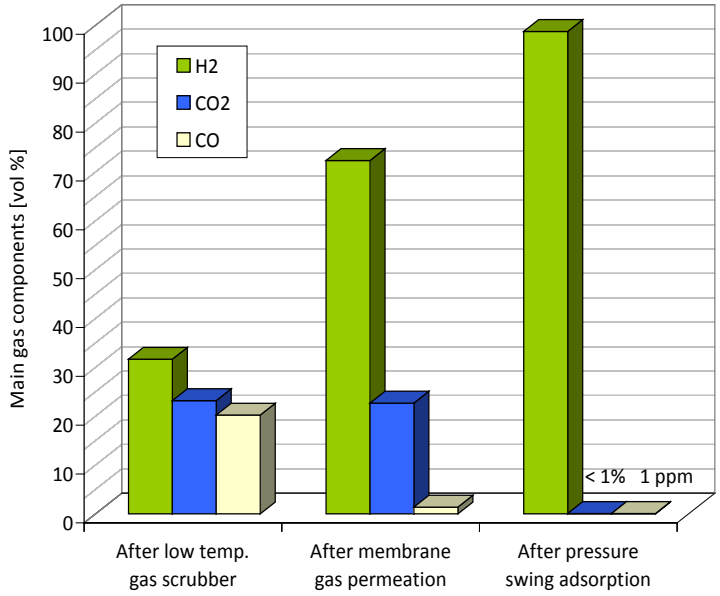


Figure: Polygeneration- results

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

The IEA Bioenergy Conference

www.ieabioenergy2012.org

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

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

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

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

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

Day 5, Fri November 16

Task 33 meeting

The most important topic of the Task 33 meeting on Friday was a discussion on plans for the next Triennium.
Task Leader, Richard Bain, informed Task 33 members about the news from ExCo meeting and proposed studies for the next Triennium:

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

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

In 2013, two Task 33 meetings with site visits and 2 workshops are planned.
The first semi-annual meeting should be held in Italy at the beginning of May. The workshop topic chosen was “Feeding systems and fuel quality”.
The second semi-annual meeting will be held in USA in October, the topic of workshop will be “Lessons learned”.

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

Country Updates on Biomass Gasification:

Denmark, Morten Tony Hansen, FORCE Technology

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

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

Technology name	Stakeholders	Technology	Purpose	State	Plants	Hours	Time to c.
Alternating Gasifier	Ammongas, Vølund	Twin Bed Filter	Fuel (gas)	Pilot	1	50	1-2
Vølund Updraft Gasifier	B&W Vølund	Updraft	CHP	Commercial	4	130000	0
CHP System of BioSynergi	BioSynergi	Open core down draft	CHP	Pilot	1	6000	2-3
Staged Down Draft Gasification	Weiss, DTU, Cowi	Multiple steps dd	CHP	Demonstration	2	4000	1
Pyroneer	DONG, DFBT, DTU	LTCFB	CHP	Pilot	4	700	>4
Close Coupled Gasification	EP Engineering	Vibrating grate FB	CHP	Pilot	1	1000	2
Sublimator	Frichs	CDP	CHP	Commercial	0	?	0
Catalytic Low Temp. Pyrolysis	Organic Fuel Technology	Catalytic low temp. pyrol.	Fuel	Pilot	1	300	1-2
Up Draft Gasifier & Stirling Engine	Stirling DK	Updraft	CHP	Commercial	6	12000	0
BlackCarbon	Stirling DK	Pyrolysis	CHP	Demonstration	1	2400	2
Biomass Gasification Gas Engine	Carbona, Aaen	CFB	CHP, fuel	Demonstration	1	6500	2-3
?	TK Energi	?	?	?	?	?	?

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

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

Finland, Ilkka Hiltunen, VTT

Characteristics of the energy sector in Finland were presented.

An overview on gasification of biomass and waste in Finland was given.
Commercial lime-kiln gasifiers were constructed in 1980´s by Ahlström, new development by Foster Wheeler in 1990´s for boiler applications.
Gasifiers in Finland now offered by Andritz-Carbona, Foster Wheeler and Metso Power in size range 15-150 MW.
VTT´s role and activities in biomass gasification:

- IPR on gas reforming for clean gas applications
- Support for industrial projects
- R&D on gas filtration, heavy metal removal and fuel characterization

New CFB gasification plants, which are in commissioning/under construction were introduced.

- Metso: 2x80 MW at Lahti waste-to-energy plant
- Metso: 140 MW in Vaasa
- Andritz: lime kiln gasifier 48 MW at Joutseno (start up in summer 2012)
- Foster Wheeler: lime kiln gasifier 12 MW at Varkaus returned to air-blown operation mode

Metso gasification projects:

Vaskiluodon Voima – Substituting Biomass for Coal in a PC boiler

- 140 MW_{th} gasifier adjoined to the existing 560 MW coal-fired power plant
- PC boiler in operation since 1982
- Coal consumption 400 000 – 500 000 t/y
- Enables biomass to replace up to 40% of coal
- Production capacity: 230 MW_{el}, 170 MW_{th}
- Total investment 40 mio. Euro

Metso scope:

- Fuel receiving and handling
- Drying
- Gasification
- Boiler modification
- Automation, electrification and instrumentation

LahtiStreams IP (Advanced Integrated Waste Management and WtE Demonstration)
(Lahti Energie/FI, VTT/FI, L&T/FI, Dong Energy/DK, FZK/D; total budget 23,5 M€)

- Demonstration of complete advanced waste management chain
- R&D of:
  - Improved hot gas cleaning
  - Waste processing and mat. recovery
  - Advanced ash treatment
  - New gasification based high efficiency WtE technologies

Lahti Energia – Gasification Power Plant

- 2x80 MW_{th} gasifiers, waste-derived fuel, 50 MW_{el}, 90 MW_{th}

Metso scope:

- Start up April 2012
- Total investment 157 mio. Euro

High-Efficiency Power from Biomass

IGCC based on press. Fluidized-bed gasif. and hot gas filtration

- Pilot scale by VTT 30-150MWe (1990´s)

Gasification coupled to engines for small-scale plants 0,1-5 MWe

- VTT´s Novel gasifier devel. In early 2000
- Gas reforming know-how licenced to Carbona and Skive plant
- Support to SME companies in "farm-scale" power

SME companies are developing small-scale gasifiers for gas engines in Finland (100-500kWe)
New R&D project at VTT with 5 SME companies is planned for 2012.

Gasification based small scale CHP development in Finland (downdraft, gas purification, gas engine)

- Gasek (50 kWe, 100kWth)
- Volter (30 kWe, 80 kWth)

Biorefinery BTL Demo plants in Finland

- 3 consortiums are planning sec. gen. BTL biorefineries
- Planned capacities 100 000-200 000 t/a of diesel
- EU NER300 funding expected end of 2012
- Investment 400-800 M€

Biomass-to-Syngas R&D at VTT:

- 2G 2020 BIOFUELS
- Production of SNG of H2 from biomass
- US-cooperation project on evaluation of gasification-based systems
- Nordsyngas
- Gasification reactivity

The Netherlands, Bram van der Drift

A new government started on 5. November 2012. EU renewable target 2020 increased to 16%.
New innovation system: TKI´s, being PPP´s with industry in lead

NUON

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

DAHLMAN – renewable energy (**www.dahlman.nl**)

- Became ROYAL DAHLMAN in Jan 2012
- Synova LLC invests in Royal Dahlman, citations from press release:
- *–… worldwide development of waste-to-energy power plants …*

- *–… enables Royal Dahlman to significantly accelerate its growth strategy in the field of renewable energy technology …*
- *–… cooperation should result in a revenue growth of at least 30 percent within the next three years …*
- *•www.synovapower.com*

SYNVALOR (www.synvalor.com)
- New multi-stage low-tar concept for all, but more specifically difficult fuels
- Based on Vortex reactor designs
- Pilot plant constructed, 50 kWe engine coupled, first results good

TORRGAS (**www.torrgas.nl**)
- Technology for gasification of torrefied biomass
- Based on torroidal reactor design: Torbed technology

HEVESKES ENERGY (**www.heveskesenergy.nl**)
- Technology: oxygen driven JFE gasification technology, based on 3-years operational experience
- Feedstock: RDF and biomass
- 10 ton/h RDF, start of construction 2013, start of production 2014

HVC (www.hvcgroep.nl)
- 12 MW (waste wood input) plant in preparation
- MILENA and OLGA based
- Phase 1a: heat production (first few years)
- Phase 1b: additional gas cleaning and SNG production (~850 Nm3/h)
- Start building 2012
- Phase 2: 50-100 MW plant

HoSt (small CFB gasification for difficult fuels)
- 3 ton/h paper rejects plant in NL, gasifier, cooler, cyclones, boiler, steam
  - Start up: 2013/Q4

ESSENT (RWE)
- Amer-9 power station, Geertruidenberg
- 80 MW CFB gasifier on waste wood or indirect co-firing into 600 MW_{el} coal-fired PF boiler
- Feed-in tariff will stop end 2013, exproring ways to continue operation

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

ECN

MILENA for low-grade coal gasification

•TARA technology for simpler gas cooling

•Benzene separation (bioBTX production) for added value and simpler upgrading and/or better emissions

CARLOS VILELA *Technical University of Eindhoven, TU/e*
- Thesis on Primary methods for tar reduction

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

Austria, Reinhard Rauch, VUT

Policy targets, energy consumption and renewables in Austria were presented.

Austrian research organizations and their activities were introduced: Graz University of Technology, Joanneum Research Graz, MCI, Vienna University of Technology, Bioenergy 2020+, FJ-BLT Wieselburg

Austrian companies active in biomass gasification:

- Andritz (now also owner of the Austrian part of Austrian Energy & Environment)
- AGT Agency for Green Technology – low temperature conversion=thermo-catalytic decomposition process operating without air supply
- Austrian Enviro Technologies
- GE Jenbacher
- Ortner Anlagenbau – builds FICFB for CHP applications
- Repotec – builds FICFB gasifiers for CHP, SNG and other synthesis
- SynCraft Engineering GmbH
- Urbas – fixed bed gasification
- Xylogas - fixed bed gasification

Commercial FICFB gasifiers in Austria:

Location:	Güssing	- el. Production using gas engine
		-8.0 MW_{fuel}, 2.0 MW_{wl}
		-start up in 2002, in operation
		-SGC Energia finished successfully their demo
	Oberwart	-gas engine/ORC
		-8.5 MW_{fuel}, 2.8 MW_{wl}
		-start up in 2008, in operation
		-operation difficulties and optimizations were presented
		-project on polygeneration-production of valuable gases, electricity and heat from biofuels
	Villach	- gas engine
		-15.0 MW_{fuel}, 3.7 MW_{wl}
		- in commissioning
	Klagenfurt	-gas engine
		-25.0 MW_{fuel}, 5.5 MW_{wl}
		-planning
	Vienna	-planning (decision end of 2012)
		-hydrogen production
		-50 MW_{fuel},30 $MW_{hydrogen}$

Commercial FICFB gasifiers abroad:

Location:	Ulm (DE)	-gas engine/ORC
		-15.0 MW_{fuel}, 5.3 MW_{wl}
		-since 3/2012 in operation

Urbas gasifiers:

- Ruden:
  - 150 kW_{el}/300 kW_{th} + 70 kW_{el}/150 kW_{th}
  - Development since 2001
  - 30 000 operating hours

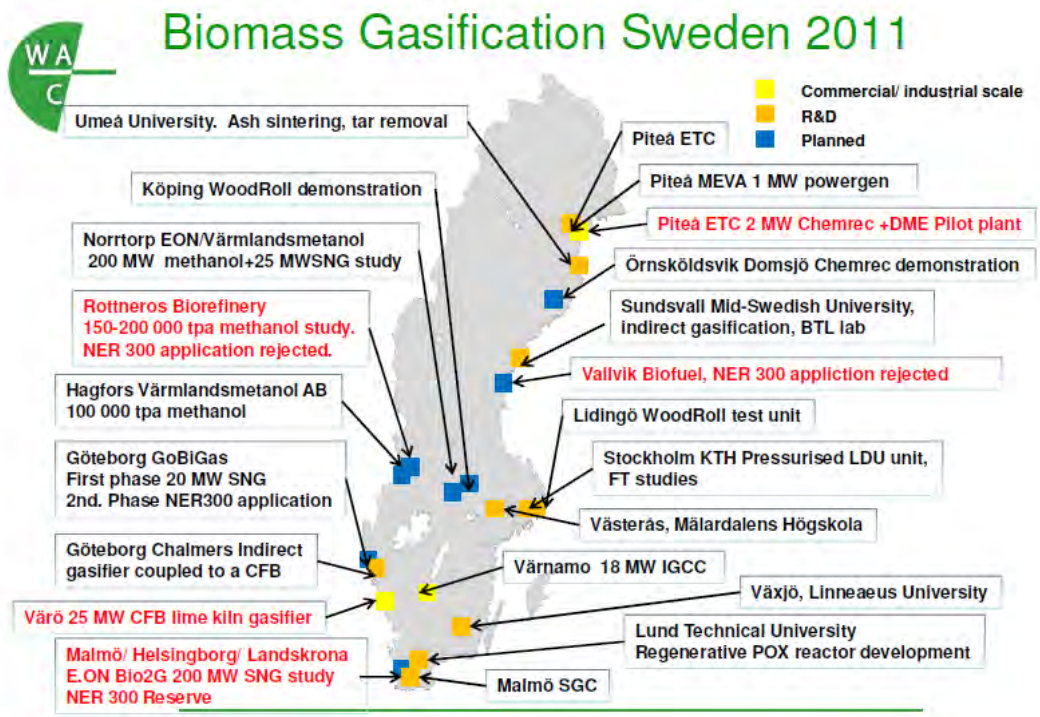
- Eberndorf:
    - 20 000 oper. hours
    - 2x120 kW_{el} + 70 kW_{el}/650 kW_{th}
    - Start up 2006-8
- Neumarkt:
    - 2x120 kW_{el}/580 kW_{th}
    - Start up 2008
    - 16 000 operating hours
- Sulzbach-Laufen, DE:
    - 130 kW_{el}/280 kW_{th}
    - Start up 2009
- Neukirchen:
    - 2x150 kW_{el}/300 kW_{th}
    - Start up 2011
    - 1000 operating hours
- Konstanz, DE:
    - 150 kW_{el}/300 kW_{th}
    - Start up end of 2011

Cleanstgas (Clean Staged Gasification)

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

Sweden, Lars Waldheim, Waldheim Consulting

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



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

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

New EC list by end of November.

Swedish Gasification Centre (SFC) – 8 Academies and 9 companies

- CDGB (Centre for Direct Gasification of Biomass)
- CIGB (Centre for Indirect Gasification of Biomass)
- B4G (Biomass for Gasification, Entrained Flow Centre)

New application for 4 year activity in March 2014

Chalmers

- Biogas production via thermal conversion (from lab-scale to 80 MW SNG)
- Indirect gasification: 2-4 MW_{fuel} gasifier integrated on the return leg of Chalmers 12 MW_{fuel} CFB boiler
- Goal of activity: to demonstrate
    - how an indirect gasifier could be built + 100MW_{fuel}
    - a robust method for catalytic reformation of the gas to a syngas containing only CH_4, H_2, CO, CO_2, H_2O
    - an energy efficiency for dry biomass to clean syngas >85%

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

Swedish Gas Centre

- Gasification and gasification database
- Co-production of SNG and FT diesel (to be published in 2012)
- International Gasification Seminar (18-19 October 2012)
- Particulate contaminants from indirect gasifiers (ongoing)
- Autothermal regenerative POX tar reactor (ongoing, Lund Technical Univ)

- Online detection of water vapor (ongoing, Chalmers technical university)
- CO_2 removal in indirect gasification (ongoing, Lund Technical Univ, ECN)
- Fuel testing in 500 kW wood Roll prototype (ongoing, KTH, Cortus)

KTH School of Chemical Engineering

- Long experience of R&D within gasification. Activities started in 1970´s.
- 75 kW pressurized (30 bar) air & steam/oxygen FB gasifier with secondary reactor
- 50 kW air & steam/oxygen FB gasifier
- 5 kW air & steam/oxygen FB gasifier
- Test rigs for catalytic deactivation and particle separation concepts
- Tar analysis equipment
- Online alkali analyses

New major grant (500.000 €) for upgrading research infrastructure

Värnamo – pressurized combined cycle:

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

VVBGC project status

- Engineering initiated in January 2010
- Project terminated in Feb. 2011 because of difficulties in attracting additional partners to close industrial funding targets
- VVBGC has taken over Bioflow Oy and associated IPR

Future: mothballing again

GoBiGas

- Biomass to biomethane 65 – 70 %
- Energy efficiency > 90%
- Phase 1:
    - Demo plant, 20 MW generating 160 GWh/y
    - In operation early 2013, agreement with Swedegas for pipeline transition of product gas
    - Allothermal (in-direct) gasification
    - Gasification: cooperation between Metso Power and Repotec
    - Methanation: cooperation with Haldor Topsöe
- Phase 2:
    - 80-100MW generating 640-800 GWh/y
    - Technology not yet chosen

Project status –October 2011

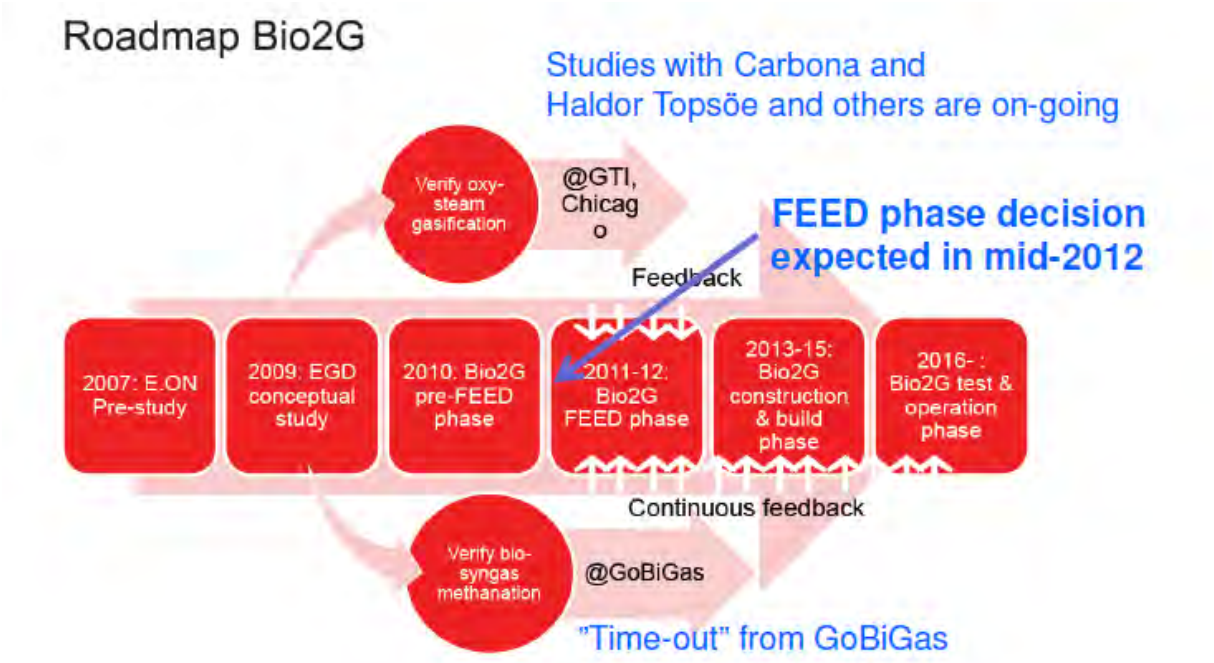
- Funding: 222 MSEK granted for phase 1
  Project application for phase 2 sent to EiB for funding
- Investment decision – Dec. 2010 by Göteborg Energi
- Gasification – cooperation between Metso Power and Repotec
- Methanation – cooperation with Haldor Topsöe
- Phase in operation – early 2013

Black Liquor Gasification Activities

- Development plant for oxygen-blown high pressure BTL gasification (located at the Smurfit Kappa mill in Piteå, Sweden
- 30bar
- Capacity 20 metric tons/day of black liquor solids
- Used for technical development and design verification
- Started up 2005, now in operation, more than 12 000 operating hours
- Project end 2012, Staff have been given redundancy notice
- The Lulea Technical University is investigating take over and operation for R&D purpose

E.ON

- Biomass to SNG
- Bio2G



Switzerland, Martin Rüegsegger, ETECA GmbH

Policy in Switzerland is made by Swiss Federal Office of Energy (SFOE)

Policy & Programs:

Programs

- REN-Projects by the Cantons (CO_2-contribution)
- Cost-covering remuneration for feed in the electricity grid
- Further info: www.admin.bfe.ch

Facts:

- In 2009 56,15% of Sw. electricity production came from renewable

Research activities

- PSI
    - Gasification of dry biomass (SNG, CHP)

- Gasification of moist biomass for SNG production
- EU Infrastructure Project, collaboration with: BRISK
- CCEM Competence centre Energy and Mobility
  - 3 projects (ARRMAT, WOODGAS-SOFC II, SYNGAS Diagnosis)
  - NFP66 – 3 projects rel. biom. gasification
    - Hot gas cleaning for production of bioSNG and electricity
    - Predictiong the complex coupling of chemistry and hydrodynamics in FB methanation reactors for SNG
    - Distributed production of ultra-pure hydrogen from woody biomass

- Engagement under EU SET-Plan (FP7-ERANET-2012-RTD) and European Industrial Bioenergy Initiative (EIBI) ERA-NET Plus BESTF Program supported by the Swiss Federal Office of Energy

Swiss Industry

- EKZ (supplier for turnkey biomass gasification plants)
- Pyroforce **(out of business)**
- XyloPower AG (supplier for turnkey biomass gasification plants)
- BR Engineering GmbH CH-6006 Luzern **www.br-engineering.ch**
  Engineering and commissioning of thermal Gasification plants and gasification components (involved with Holzstrom Stans)
- CTU Supplier for turnkey biomass gasifier plants **http://www.ctu.ch/de/home.html**
- Foster Wheeler **(only office in Switzerland)**

CHP project news

- EMPA EAWAG Dübendorf CHP gasifier Plant
  Project is in the stage of detail planning and in construction
  Supplier will be EKZ Woodpower-type gasifier with 2 x 350 kW el

- Spanner thermal Gasifier 45 kW CHP Unit for District heating using waste wood of a sawmill (A. Steiner + Cie. AG Ettiswil /Luzern)

- PSI: Biomethane Development => 20-80MW BM-to-SNG plant in discussion
  based on BFB methanation technology

CHP plants - news

- AERNI Pratteln: plant in modification
- Woodpower Wila: out of operation since 7/2011 (closed down)
- Holzstrom Stans Pyroforce Gasifier in continuous operation 20 000h/26 200h since start
- Woodpower EMPA: Approved project expected start of operation end of2013

Facts today:

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

Facts of the past 3 years:

1 Plant closed down
3 Planned projects abandoned
1 Main supplier out of business

Politics:

Visions clearly for Renewable Energy

Reality:

- Cost-covering remuneration (KEV) for new projects pending
- Thermal gasification is technically complex (higher costs)
- Risk investments for biomass-energy projects not existing
- CO_2 -certificates, -contributions and -compensations unsecure in the future
- Public and private frames not in line with political visions
- Volatile biomass-fuel-price

Italy, Antonio Molino, ENEA

Policy

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

ENEA´s activities regarding biomass:

- Biomass combustion
- LCA – Anaerobic digestion
- Biodiesel from algae
- WEB Geographic Information System of Biomass Energy Crops
- Biofuels 2nd generation

The policy and current status of biomass gasification were presented.

PLANT	POWER (kWe)	MANUFACTURER OF THE SYSTEM	CHARACTERISTICS OF THE PLANT
Belluno(BL)	1000	GAS-1000 MODEL	The plant is fed with 8500t/a of wood
Parma (PA)	1000		The plant produces 7.5GWhee 15GWht and it is powered with 9000 t/a of kenaf
Gadesco Pieve(CR)	960	Agroenergia	The pyrogasificator is fed with chopped or chipped vegetable biomass
Alessandria (AL)	640	nd	The system is experimental and the process has been developed by poliTO; the plant is fed with 4100 t/a of biomass from forest
Vigevano(PV)	500	ModelloGAS-500	The plant produces 3.75GWhe and 7.5 GWht and it is powered with 4100 t/a of wood chips

Caluso(TO)	400	Autogas Nord	The plant is fed with residues of agricultural production, forest biomass, leaves, waste of food industry
Oltrepo Pavese(PV)	300	Bio&Watt	The plant uses an endothermic motor
Castel San Pietro(BO)	250	Bio&Watt	The pyrogasificator is fed with waste prunings, corn stalks, wood chips of poplar
Orzinuovi(BS)	250	Bio&Watt	The pyrogasificator is powered by biomass from forests
Verbania (VB)	250	CoVer Energy	The plant is classified as experimental
Rossano (CS)	4200	Guascor	Commercial plant
Castel D`Aiano (BO)	35	Stirling	Commercial plant
Pomarico (MT)	300	Bio&Watt	Commercial plant
Quingentole (MN)	70	Caema	Commercial plant
Torre S. Susanna	500	ICQ/SIAG/ERBA	Experimental plant

ENEA´s technological platform for the biomass gasification:

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

PI.GA – Downdraft gasifier

- 150-450 kWth
- Cleaning section: cyclone, scrubber, disk filter, sawdust filter
- Power generation: diesel engine modified to Otto cycle with gas feeding, coupled with alternator

PRAGA plant – Updraft gasifier

- 150 kWth
- Feeding: almond shells
- Gasif. medium: mix steam-air

JOULE plant – Steam gasification pilot plant FICFB

- 500 kWth
- In collaboration with VUT, University of L´Aquila, Louis Univ.

UNIQUE plant – FB with internal recirculation of 1 MWth

- Current activity: production of bio-SNG from syngas

ENEA´s projects:

- SNG from biomass
- Supercritical water gasification
- BRISK (Biofuels Research Infrastructure for Sharing Knowledge)
- HY-Tractor (Tractor powered with a fuel cells

Other research projects:
ENERPARK

- The project was funded by Basilicata Region with the EU Structural Funds PO FERS 2007-2013 through which the EU aims to strength then economic and social cohesion of its territory by correcting imbalances between the regions

- The project provides the construction of a gasification plant coupling with a methanation plant for increase the biomethane content in the syngas

- The biomass used for the process derive from the routine maintenance of the Gallipoli Cognato's foresty. A second step of the project provides the use of biomethane for the service cars for the workers in park

Industry/Companies
The whole list of the companies with detailed contact information can be found online at **www.ieatask33.org**.

USA, Richard Bain, NREL

- Energy consumption in 2009 covered by 8% from renewable
- Electricity generation in 2009 – about 10,8% covered from renewable

U.S. biodiesel production

- 2,85 billion gallons/y
- 478,06 cents/gal (Mar 2011)

U.S. corn ethanol production

- 218 commercial plants
- 14.554 billion gal/year nameplate capacity
- 11.987 billion gal/yr. production[2]
- Additional 0.27 billion gal/yr planned or under construction
- Mar 2011 Rack Price – 270.48 cents/gal

Biopower status
2010 Capacity – 10.7 GW

- 5.8 GW Electric Power Sector
- 4.9 GW End Use Generators

2010 Generation – 56TWh
Cost – 0.08 – 0.12 USD/kWh

Biomass resources scenarios, supply curve (2005-2030) and an overview on U.S. biomass gasifier developers were presented.

Nexterra

- gasification system at University of South Carolina.
- start up was at the end of 2007
- the power is 1,38 MW_{el} and capacity 60 000 lbs/hr of high pressure steam for district heating
- The biomass (wood residues, moisture 25-55 %) is converted to combustible gas with 3 gasifiers.

Enerkem

The process converts waste and residuals into advanced biofuels
Enerkem promotes sustainable development and that is why it uses the non-recyclable portion of the waste and creates value from the forest and agricultural residues. From one ton of waste (dry basis) 360 liters of ethanol are produced. The process requires little use of water and allows for its reuse in a closed circuit.

GTI Biomass Gasification Activities

Within the "2nd generation biofuels project", there are provided laboratory and pilot-scale test for Andritz/Carbona and UPM F-T project. The maximum feed rate of biomass is 40 tons/day. The gasifier is pressurized (25 bar) oxygen blown.

TRI Technology and Projects

TRI´s core technology is deep fluidized bed, indirectly heated, steam reforming of biomass. TRI´s black liquor gasifier has been commercially operational for six years (Trenton, Ontario). Two separate DOE "Small-Scale Biorefinery Projects" are employing TRI technology:
– New Page, Wisconsin Rapids, WI; 500 dry tons per day biomass to FT fuels and tail gas. Class 10 study underway ($30 million award, 2008)
– Flambeau River Biofuels, Park Falls, WI; 1000 dry tons per day biomass to FT fuels. Class 30 completed ($30 million award, 2008)

ICM, Inc.

ICM Inc.'s gasification technology has been successfully tested and supported at rates up to 250 tons per day by the Department of Energy. ICM currently offers three commercial-scale unit designs with feedstock processing ranges of 150-200 TPD, 300-350 TPD and 450-500 TPD.
ICM owns and operates a 200 ton per day commercial demonstration auger gasification unit in Newton, KS that was installed to process municipal solid waste from the Harvey County, KS landfill. Since commencing operations at the facility, ICM has tested more than a dozen feedstocks and amassed more than 2,100 hours of operation on the unit.
Projects: ReVenture Project, Charlotte, NC: ReVenture Park is a proposed waste-to-energy facility for Charlotte, NC. Forsite Development, the lead developer for the project, selected the biomass gasifier technology by ICM, Inc.

Coskata – Project Lighthouse

The project is based on partnership between Coskata and Alter NRG. A semi-commercial demonstration, Westinghouse plasma gasifier is located in Madison, PA. The feedstocks are

Pine chips and capacity is 50 000 gal /year of ethanol. The successful start up was announced in October 2009.

University of California & West Biofuels

Thermochemical conversion of biomass to mixed alcohols is provided using 5 ton/day dual fluidized bed gasifier based on "Pyrox Process". The facility works under atmospheric pressure with air-blown combustor. It is now in start-up.

END

IEA Bioenergy, Task 33
Thermal gasification of biomass

WORKSHOP

"Biomass gasification opportunities in the forest industry"

19 October 2011 Piteå, Sweden

REPORT

Summarized by Dr. Jitka Hrbek, TUV, Austria

Table of Contents

Abstract

This publication provides the summary and conclusions from the workshop **'Biomass gasification opportunities in the forest industry'**, held for the IEA Bioenergy Task 33, on the 19 October 2011 in Smurfit Kappa Kraftliner, 941 86 Piteå, Sweden.

All workshop presentations can be found at **www.ieatask33.org**

Table 1: Workshop presentations

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

This report presents an overview of the workshop and includes the activities in thermal biomass gasification in Sweden, Finland, Austria and North America.

Introduction

Historically wood was once the main fuel for humanity. They burned it to heat their homes and cook their food.

The current global energy system is dominated by fossil fuels and renewable energy holds a second-rate role, because renewable energy costs are still higher than existing energy prices based on fossil fuels.

But now, the point where the cost of producing energy from fossil fuels exceeds the cost of renewable fuels is approaching or may already have been reached in some areas. With a few exceptions in the near future, energy from fossil fuels will cost more money than the same amount of energy supplied through the biomass conversion.
World production of biomass is estimated at 146 billion metric tons a year, mostly wild plant growth. Some farm crops and trees can produce up to 20 metric tons per acre of biomass a year. Types of algae and grasses may produce 50 metric tons per year.

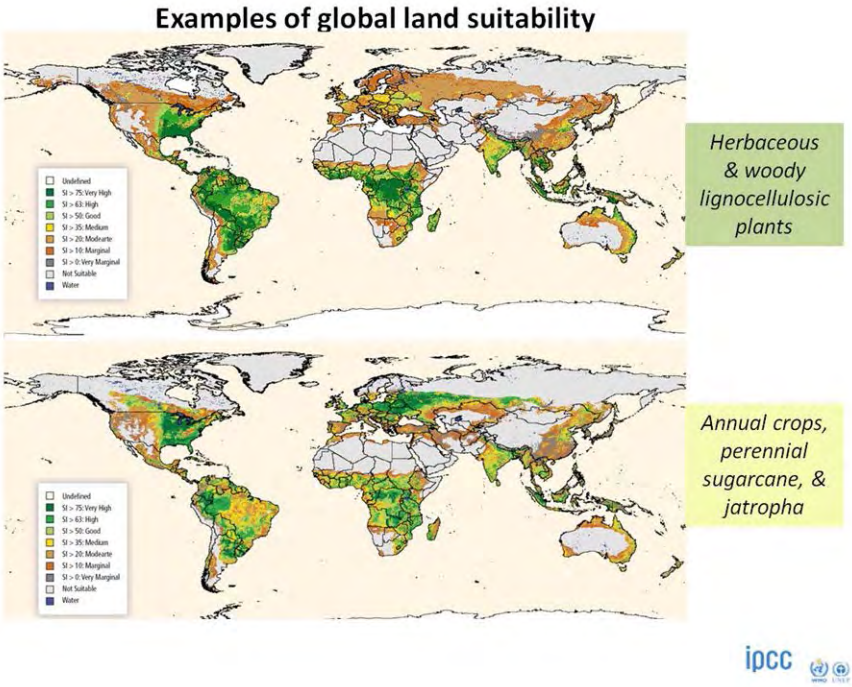


Figure: Global land biomass suitability

Biomass conversion may be conducted on two broad pathways: thermo-chemical decomposition (pyrolysis, gasification and combustion) and biological digestion.

Following figure shows the commercial bioenergy routes, from feedstock to a product. As a feedstock, oil crops, sugar and starch crops, lignocellulosic biomass and biodegradable municipal solid waste are mentioned.

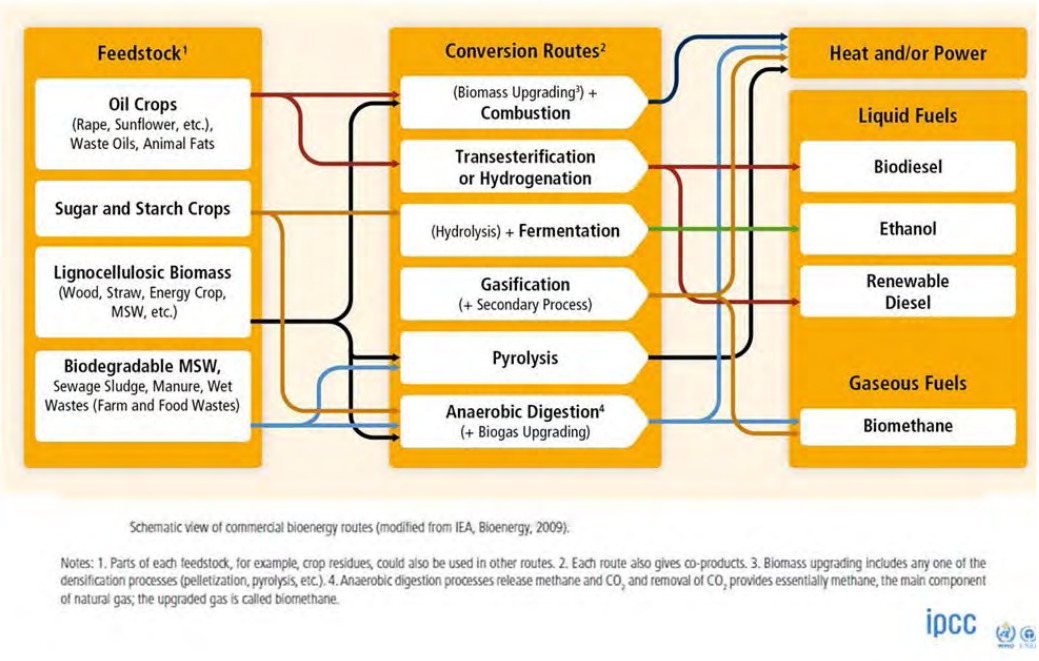


Figure: Bioenergy routes from feedstock to a product

Swedish Forest Owner´s Perspective on Bioenergy

Sveaskog is the leading forest owner in Europe with its base in the Swedish boreal forests. Sveaskog owns about 600 million hectares, what is about 18% of the world forest land and 20 % of the world industrial timber. It is a leading supplier of saw logs, pulpwood and bioenergy and has about 730 employees.

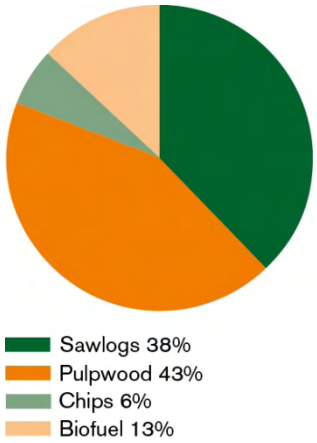


Figure: Sveaskog´s products

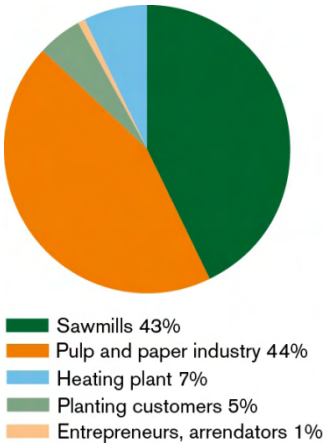


Figure: Sveaskog´s customers

The most important customers for Sveaskog are sawmills and the pulp and paper industry. Based on the new energy-political framework in Europe and growing demand of bioenergy, there are new challenges and opportunities for the forest industry. Furthermore, the Sweden renewable target in 2020 is the highest within the EU.

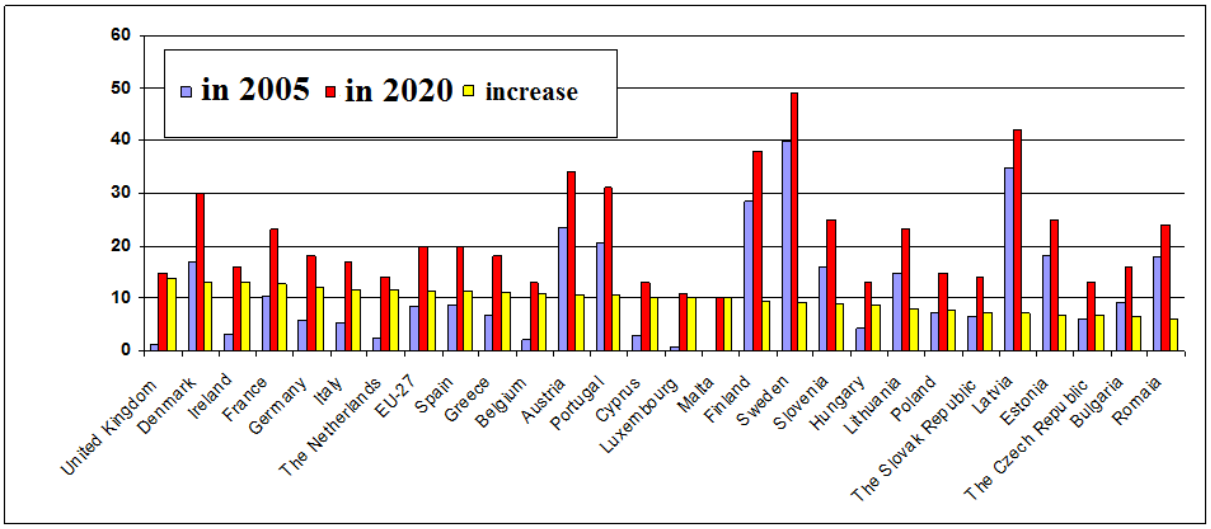


Figure: Share renewable energy 2005 and target 2020-target in Europe

Sveaskog´s key challenges:

- European biomass demand for energy will double until 2020.
- Huge challenges to mobilize the required biomass, forests are key.
- Biomass prices likely to increase.
- Biomass imports (outside of Europe) will increase.
- Sustainability will be an issue in some regions.
- Efficient use of biomass should be encouraged.
- New technologies are needed, especially to replace fossil in the transport sector - gasification technology is very important!!

Sweden has shown that a transition from fossil to renewable energy is possible. Today, bioenergy in Sweden is the largest energy source.
As a response to growing energy demand and new developments in bioenergy field, Sveaskog´s target is to increase forest growth by about 20% by 2030.

Thermal Biomass Gasification in Sweden

The Swedish Centre for Biomass Gasification

It is a competence centre funded by the Swedish Energy Agency, industry and academia. The centre is coordinated by University in Luleå (LTU). In total there are 25 companies, 9 universities and 2 institutes involved. Annual budget for the next 10 years is about € 5 millions.

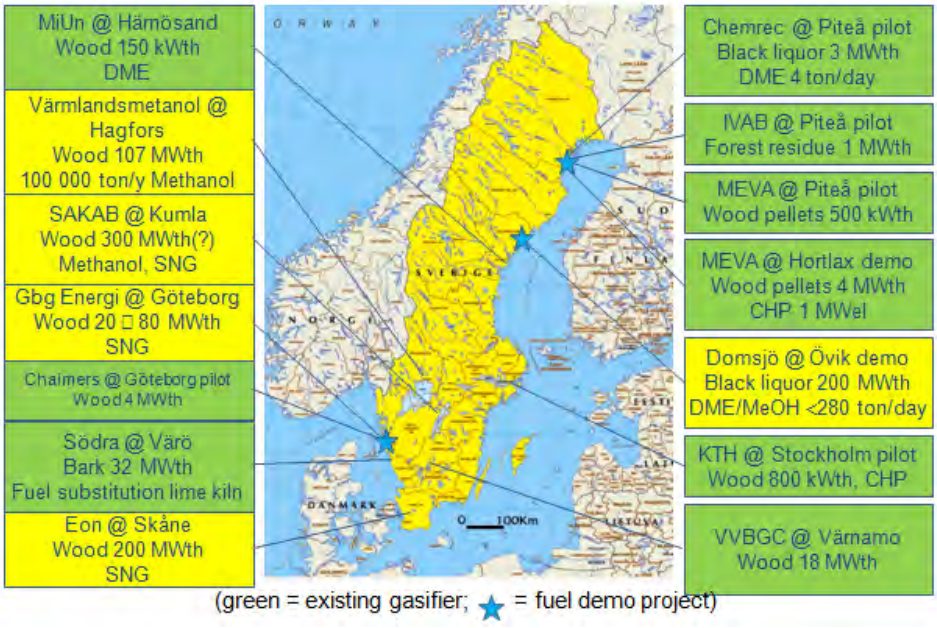


Figure: Swedish gasification projects in 2011

ETC (Energy Technology Centre)

ETC is a research and development centre for renewable energy with focus on combustion, gasification and biorefining processes. In collaboration with private companies and public and academic institutions, ETC carries out research and development projects, designs products, and analyses and solves problems associated with renewable energy sources. ETC has a highly competent staff and advanced experimental and computational facilities.

One of the projects is **"Transportation Fuels from Forest Residues via PEBG".** The project is scheduled from 2009-2012. Industry and society sectors are involved in the project

The project is based on pressurized entrained flow biomass gasification of low grade wood powder. The objectives of applied research and process development around a pilot plant are:

I. Proof-of-concept
II. Scientific basis for a continuous development

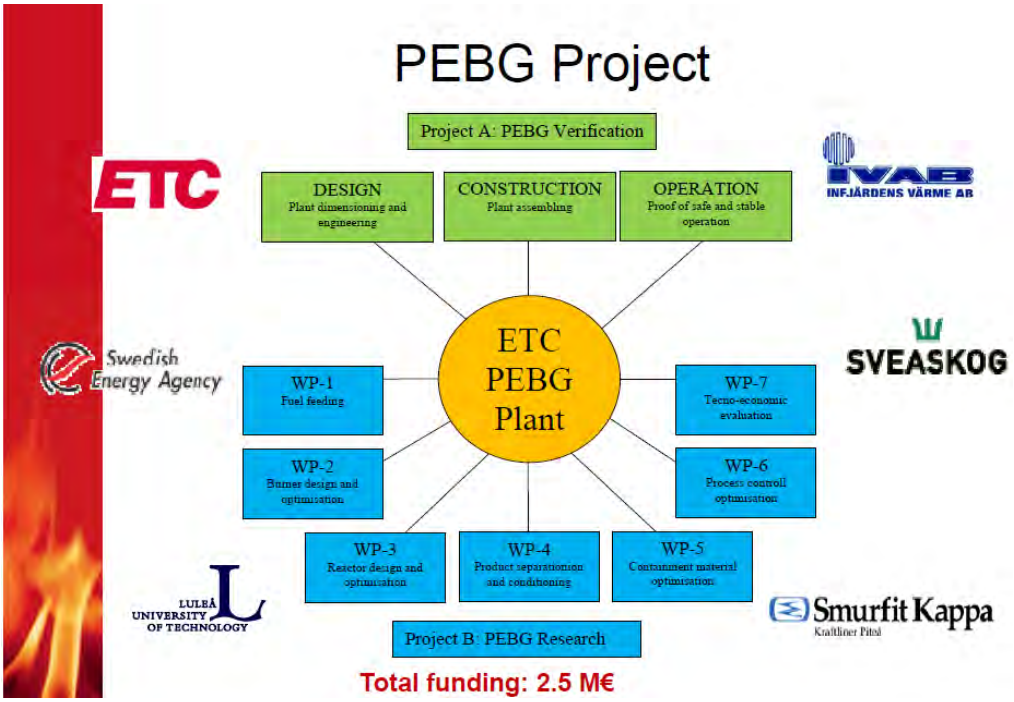


Figure: PEBG Project and project partners

IVAB Gasifier

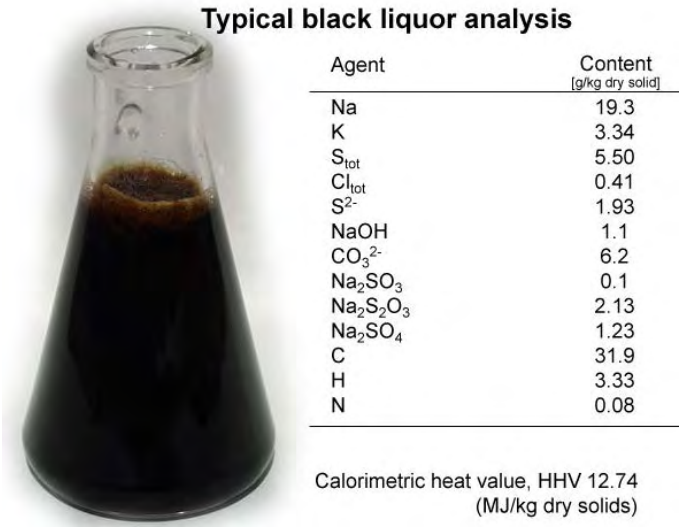
The IVAB gasifier is a pilot plant for direct gasification of biomass powder to syngas (CO + H_2). The pilot plant is situated in the ETC Gasification Centre, and R&D is performed by ETC and LTU. It is based on the PEBG concept. The objective is to verify the technology concept for future commercialization.

The Swedish Black Liquor Gasification R&D Program

Black liquor is the spent cooking liquor from the Kraft process when digesting pulpwood into paper pulp removing lignin, hemicelluloses and other extractives from the wood to free the cellulose fibers. Approximately 7 tonnes of black liquor are produced in the manufacture of one tonne of pulp.

Based on the black liquor properties it is suitable for pressurized entrained flow gasification.

The black liquor is an aqueous solution of lignin residues, hemicelluloses, and the inorganic chemicals used in the process. It comprises 15% solids by weight of which 10% are inorganic and 5% are organic. Normally the organics in black liquor are 40-45% soaps, 35-45% lignin and 10-15% other organics.



Typical black liquor analysis

Agent	Content [g/kg dry solid]
Na	19.3
K	3.34
S_{tot}	5.50
Cl_{tot}	0.41
S^{2-}	1.93
NaOH	1.1
CO_3^{2-}	6.2
Na_2SO_3	0.1
$Na_2S_2O_3$	2.13
Na_2SO_4	1.23
C	31.9
H	3.33
N	0.08

Calorimetric heat value, HHV 12.74 (MJ/kg dry solids)

Figure: Black liquor analysis

In Sweden, the black liquor production is concentrated at app. 20 pulp mills. Estimates have shown that about 25% of Sweden's use of gasoline and diesel can be replaced with synthetic fuels from black liquor.

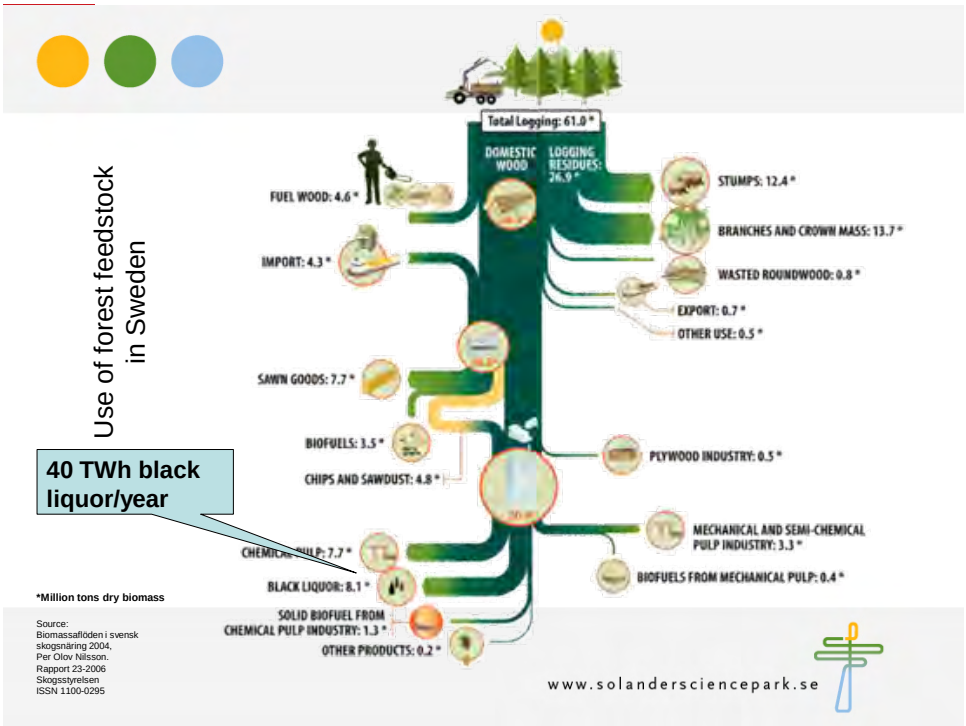


Figure: Use of forest feedstock in Sweden

Black liquor gasification has in Sweden relatively long history. In 1987 the first pilot plant for a “Chemrec” gasifier was built in Hofors. The first pressurized gasification pilot plant was in Skoghall in 1994. In 2005 the development plant (DP-1) was commissioned. Since 2007, the second phase of black liquor gasification is going on.

Chemrec

The DP-1 Gasifier

The Development Plant 1 is located at the Smurfit Kappa mill in Piteå in Sweden. It is used for development and technical demonstration.

The DP-1 gasifier – operation conditions:

- Thermal power: 300MW_{th} (20 ton BL/day)
- Oxygen blown
- Pressure: 30 bar
- Temperature: 1000°C
- Accumulated run time > 13 000 hours (August 2011)
- Provides BioDME plant with syngas

The black liquor enters the gasifier already highly preheated. During the tests on DP-1, the influence of BL (black liquor) preheating temperature on burner spray characteristics was investigated. There were experimental methods, “hot probe”, EMF and camera probe provided during the tests. Also the gas sampling and characterization of hot gas cooler from different levels in quench. Further, the characterization of tar components in liquid samples and selective absorption of H_2S in short time contactors was investigated.

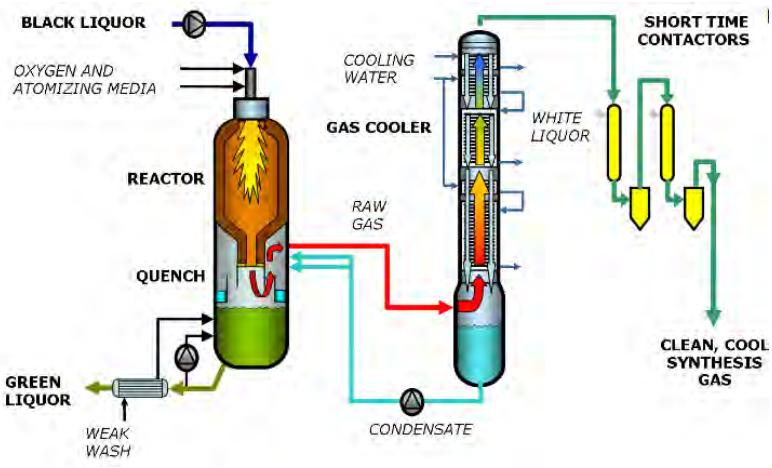


Figure: DP-1 and gas cooling system

Plant activity today

- Syngas provider for BioDME downstream train
- Development and optimization of process parameters
  - Atomization
  - Further optimization of quench operation
- Component development & testing
  - New designs tested for core components
  - Materials testing
- Gain experience of operating , to see what is needed to achieve a high availability
- Marketing, sales and educational purpose
- Test potential clients spent cooking liquors
  - *The knowledge base needed for scale-up to a larger plant!*

BioDME Project

BioDME consortium consists of 9 different companies and institutions involved in the project.

Chemrec builds and operates the BioDME plant, based on Haldor Topsøe technology; Volvo develops trucks; ETC, the Energy Technology Centre in Piteå, contributes its technical expertise. Preem is responsible for BioDME distribution and builds fuel stations in Sweden. Total is responsible for fuel and lubricant specifications. The project is financed by the participants, the EU and the Swedish Energy Agency.

The project was started at 1 September 2008; duration is 48 months. Total budget is 28,4 M€. EU funding is 8,2 M€ and the Swedish Energy Agency contributes 9,6 M€.

The process of BioDME production can be seen in the following diagram.

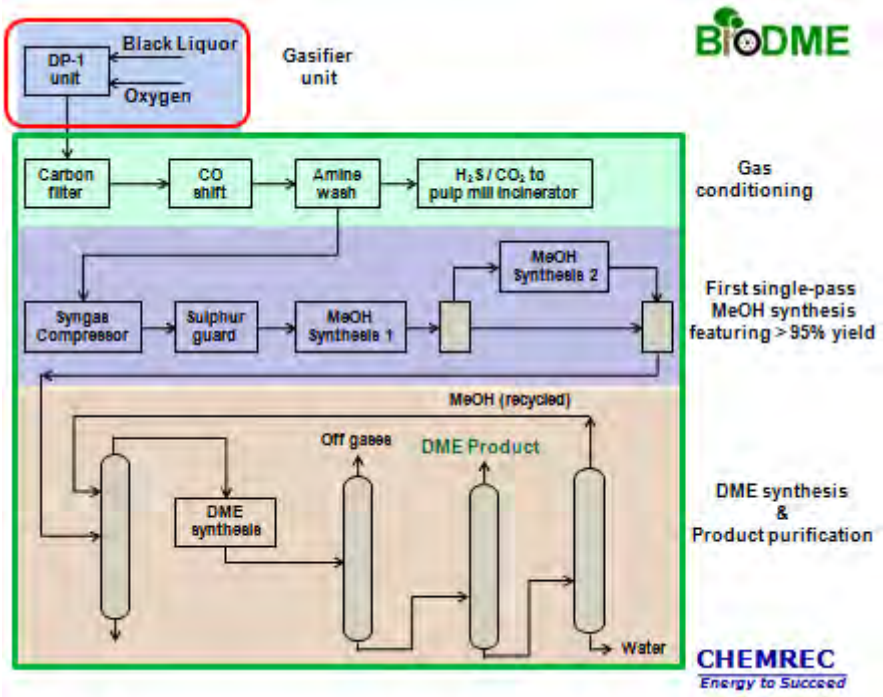


Figure: BioDME production process

The first bio-methanol (7 m^3) was produced on 18 July 2011. First BioDMe was produced on 27 July 2011. The pilot plant is expected to be in full operation in November 2011.

Fuel distribution

At the present there are 4 filling stations dedicated for the 10 DME trucks in Sweden. The technology and safety regulations are based on LPG and modified for DME. Investment is about 200 000 € per filling station.

Figure: 10 field test trucks

Chemrec – further industrial developments (Scale-up)

- full-scale operation
- to boost recovery capacity
- recovery capacity (~47 MW $_{fuel}$)
- October 2008
- refractory life
- refractory system and other components

The New Bern Booster gasifier, > 47 000 h of

Commercial atmospheric, air-blown gasifier

Capacity 300 t BLS/d, about 15% of total mill

Installed in 1996, operated >47 000 h until

Reached 95% annual availability and 2 years

Of great importance for development of

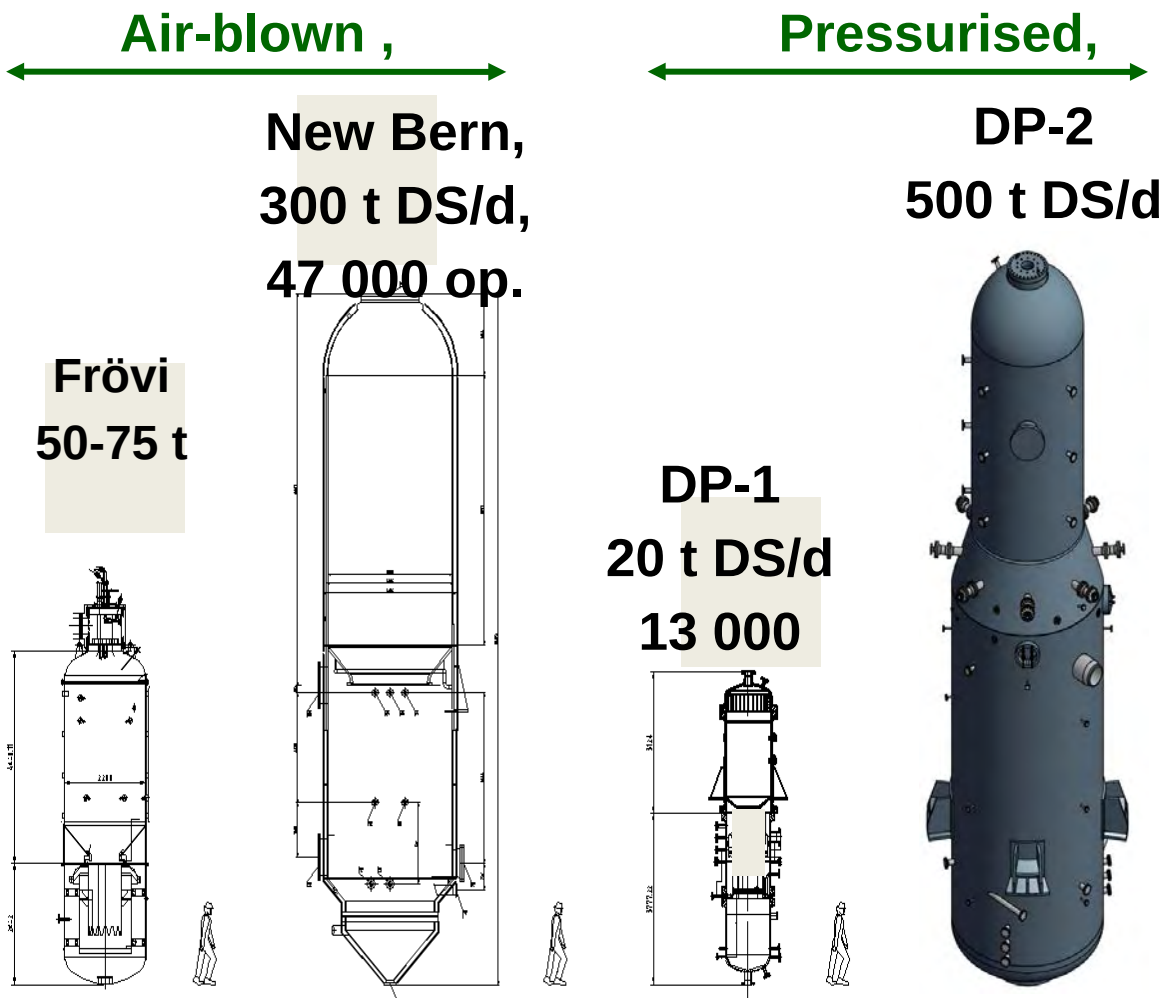


Figure: Scale-up: Operating experience

Chemrec – the Domsjö Project, Örnsköldsvik, Sweden

The scheduled start-up for the Domsjö project is in 2015. The planned products and capacity of the dual product plant is 100 000 t/y DME or 140 000 t MeOH/y. The project costs are approx. € 300 million.

The Domsjö is already a biorefinery today. The scheme of Domsjö with BioMethanol and BioDME production can be seen below.

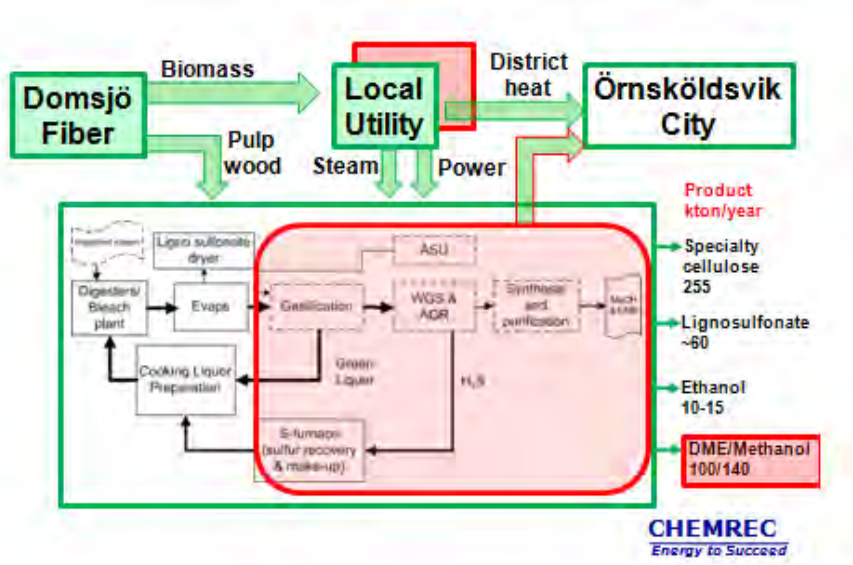


Figure: The Domsjö project

NSE Biofuels Oy

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

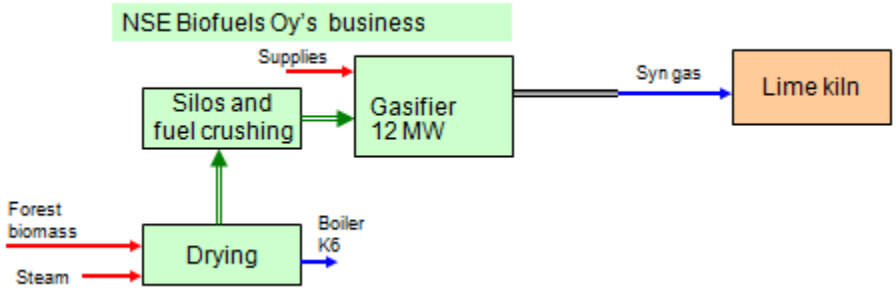


Figure: NSE Biofuels Oy's current business at Stora Enso Varkaus pulp mill

The future goal is an implementation of the first commercial BTL plant and further to develop profitable businesses based on experiences and on market demands (NOSE-Project).

NSE BTL concept:

- Combined competencies of two different industries:
  - Forest industry has strong raw material supply and logistics know how.
  - Oil refining industry has process, product and distribution know how.
- Forest based feed stock, the technical concept allows high tolerance for varying biomass properties.
- FT wax offers extension in renewable feed stock base for high quality traffic fuels outside food supply chain.
- Efficient energy integration with host plant.
- More than 85 % GHG savings compared to fossil transportation fuel.
- New, potential business area for forest industry.

NOSE project objectives:

- To develop and verify BTL technology based on biomass gasification route.
- To provide the overall commercial technology concept.
- To evaluate the techno-economic feasibility of the production concept.

Project partners are VTT, Foster Wheeler, NesteJacobs, Stora Enso and Neste Oil.

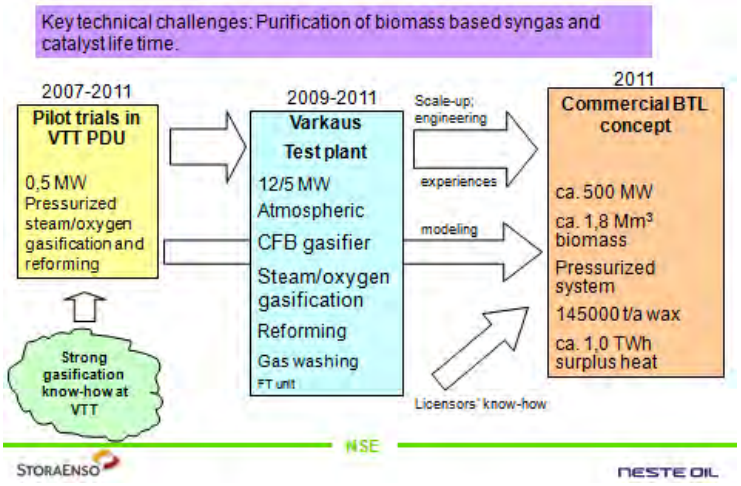


Figure: Stepwise BTL concept development

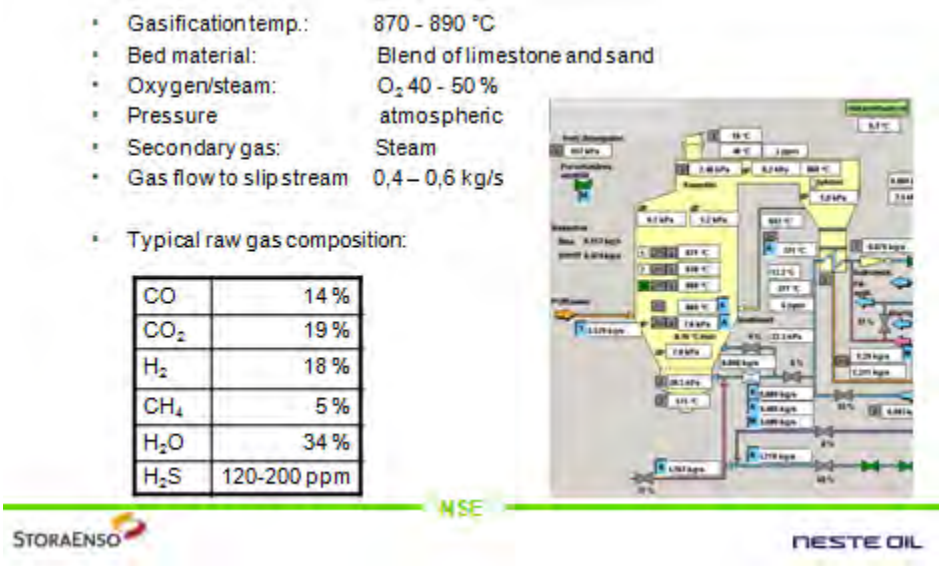


Figure: CFB steam/oxygen gasification at Varkaus test plant

The typical feed stock is a mixture of wood chips from logging residues, energy wood chips, bark and saw dust.

Current status:

- Trials completed in Varkaus test plant at the end of August 2011.
- Developed BTL- technology works and the life time of catalysts is long enough for industrial use.
- Decision to start Basic Engineering is waiting for the outcome of NER 300 funding application, expected in Q3-Q4/2012.
- To meet the profitability targets of commercial BTL plant is a challenge.
- Biomass dryer and air-blown CFB- gasifier continue production of raw syngas for mill's lime kiln.

SunPine Biorefinery – Second generation biofuels

*This presentation can be found at **www.ieatask33.org** in section Site visits presentations.*

SunPine AB was founded in 2006 and environmental permission obtained in March 2008. It is owned by KIRAM AB, Preem AB, Sveaskog and Södra Skogsägarna. It has about 20 employees.

The production of crude tall diesel started in April 2010, and investment costs were approx. € 32 mill.

Crude Tall Oil (CTO)

- CTO is a renewable, non food raw material.
- CTO is a residual product from the kraft sulphate process. After the digester (anthraquinone can be used for increased yield), soap is separated from the black liquor and acidulated with sulphuric acid into CTO.
- 2-3 procent of the wood becomes CTO.
- Swedish CTO volume is approx. 200 kton/year.
- CTO main components are fatty acids, resin acids and neutral elements.
- Sterols are part of the neutral elements, and are today recovered and used in functional foods.

Production facility for crude tall diesel

The feedstock for the crude tall diesel is the crude tall oil and methanol. Products are crude tall diesel (55%) and tall oil pitch (45%). The capacity is 100 000 m^3/year (about 2,5% of the Swedish diesel volume)

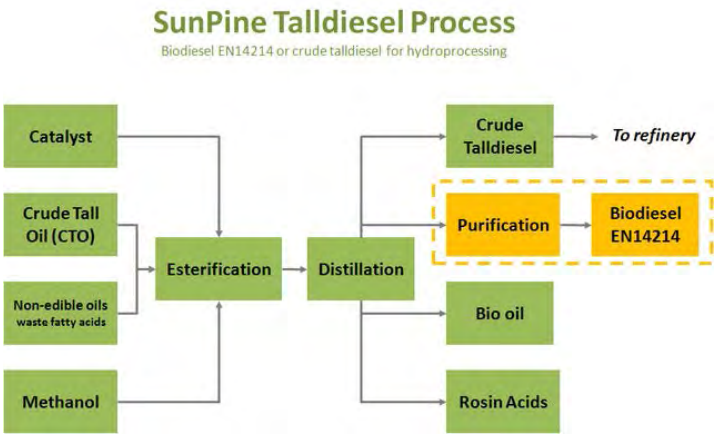


Figure: The SunPine process

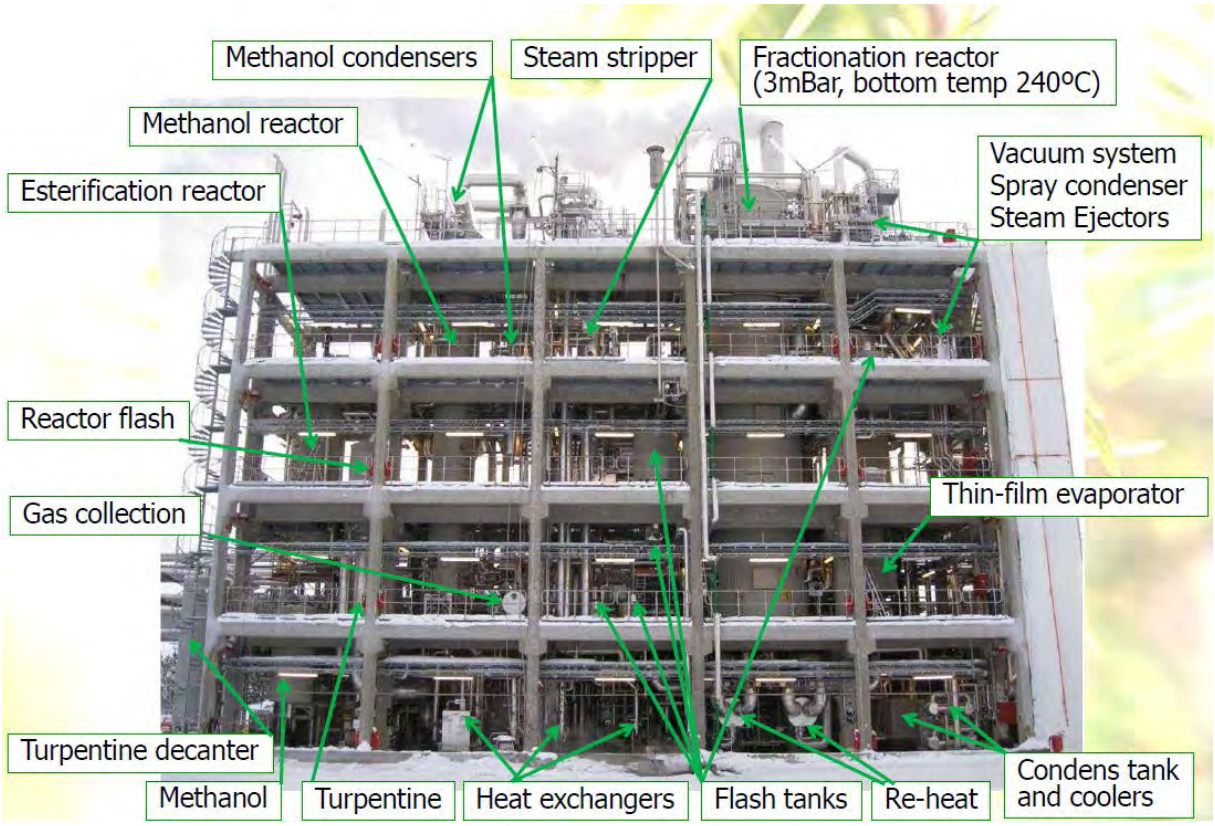


Figure: SunPine full scale production unit (25 m high, 35 meters bride)

SunPine – future plans:

- Increase feed
- Increase yield
- Process optimization
- Recovery of resin acids
- Recovery of anthraquinone
- Recovery of phytosterols

Thermal Biomass Gasification in Finland

VTT (Technical research centre of Finland)

VTT Technical Research Centre of Finland is a globally networked multi-technological contract research organization. VTT provides high-end technology solutions and innovation services. It enhances the customers' competitiveness, thereby creating prerequisites for society's sustainable development, employment, and wellbeing.

Biomass-to-Syngas projects at VTT in 2011

- NEXTUCG: 2007 – 2011
  - Industrial project funded by NSE Biofuels (Neste Oil ja Stora Enso), co-operation also with Foster Wheeler
  - Resulted in NER300 proposal – large FT-production unit
- NORDSYNGAS: 2010-14
  - Nordic co-operation: Luleå, Piteå, Sinteff, VTT
  - Fundamental aspects of pressurised gasification
  - System studies related to integrated plants to pulp and paper industries
- GASIFICATION REACTIVITY 2011 – 2014
  - Fundamental research with Åbo Akademi and Jyväskylä Univ.
  - Funded by Finnish Akademi
- US-CO-OPERATION PROJECT ON EVALUATION OF GASIFICATION-BASED SYSTEMS 2011-12
  - Ilkka Hannula as visiting scientist at Princeton University (USA)
  - Co-utilisation of biomass and coal for liquids and electricity and combinations of biotechnical and thermochemical routes
  - Evaluation of US development projects
  - Aspen modelling of selected concepts and technologies
- PRODUCTION OF SNG OR H_2 FROM BIOMASS 2011 - 2014
  - Evaluation of process alternatives – less capital intensive and suitable to smaller size than BtL plants
  - Pre-competitive R&D on gasification and gas cleaning

Advanced analysis technique for gasification gas

- The aim has been to develop better analysis methods for the impurities in biomass gasification gas
  - Shorten the analysis time, improve accuracy and reduce labor intensity
  - From off-line to on-line
- Research subjects:
  - Analysis of small concentrations of sulphur in the gasification gas
  - Improved analysis method for alkali metals
  - Establish on-line-tar analysis for light tars

- Improved NH_3- and HCN-measurement methods
- Development work in a projects with Carbona, Neste, Stora Enso, Foster Wheeler , Metso, VAPO, UPM and Gasum

"Rapid" on-line tar analysis of reformed product gas

- Analysis time 5-20 min (several possible operation modes)
- Calibrated compounds:
  - Benzene
  - Toluene
  - Naphthalene
  - Phenanthrene
  - Anthracene
  - Fluoranthene
  - Pyrene
  - (if desired, 30 additional compounds)
- HP-1 (10 m x 0.53 mm x 0.26 µm) or HP Ultra 2 –column (25 m x 0.32 mm x 0.52 µm)
- Gas phase samples online
- Can be connected to the reactor automation system
- Has been in use at VTT for more than three Years

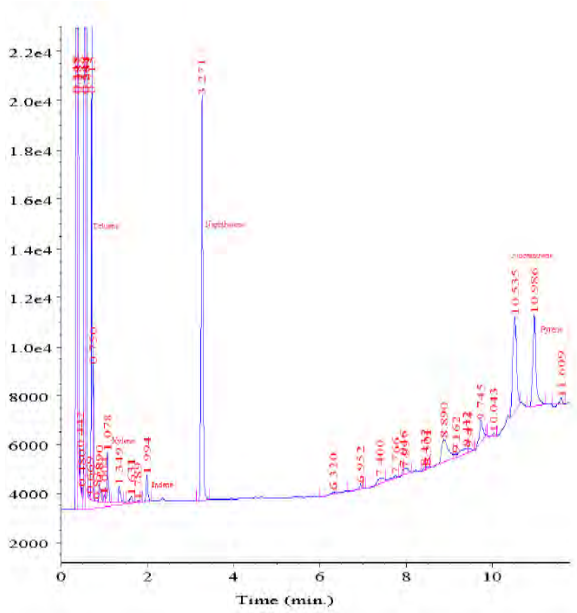


Figure: On-line tar analysis

More than 500 tar measurements were carried out and compared. Under carefully controlled conditions, both the Tar Protocol and the on-line method give consistent results.

Woody biomass based gasification process development for H_2 or SNG production (Vetaani project)

- Tekes/Biorefine project 1.6.2011 – 31.12.2013
- Total budget 1,5 M€, TEKES 60 %, VTT 30 %, companies 10 % (GASUM, HELEN, Metso, NesteOil, HVK, Outotec)
- Applications:
  - SNG, suitable for pipeline distribution
  - Bio-Hydrogen or hydrogen-methane gas mixture, e.g., for refineries
  - Clean fuel gas for SOFC power plants or NG based IGCC
  - Clean medium-Btu gas for industrial process kilns
- R&D methods
  - System studies using Aspen Plus modeling tools
  - Selective tar reformer and hot filtration R&D

- Indirectly heated gasification and reforming
- Overall process optimization: Higher efficiency and/or lower costs

Targets for catalytic reforming and shift conversion in SNG applications

- Complete conversion of C_2-hydrocarbon gases
- Low conversion of CH_4
- Tar conversion > 99 %
- As high benzene conversion as possible
- Shift conversion before gas cooling in order to minimize total steam consumption

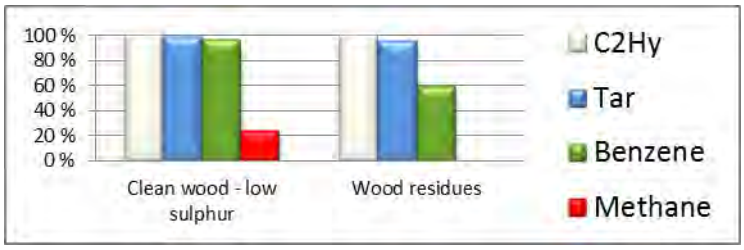


Figure: Conversions achieved in VTT´s reformer

Metso Gasification

Metso is a global supplier of sustainable technology and services. Metso´s customers operate in mining, construction, energy, oil and gas, recycling and pulp and paper industries. Metso employs about 28 500 people in over 50 countries.

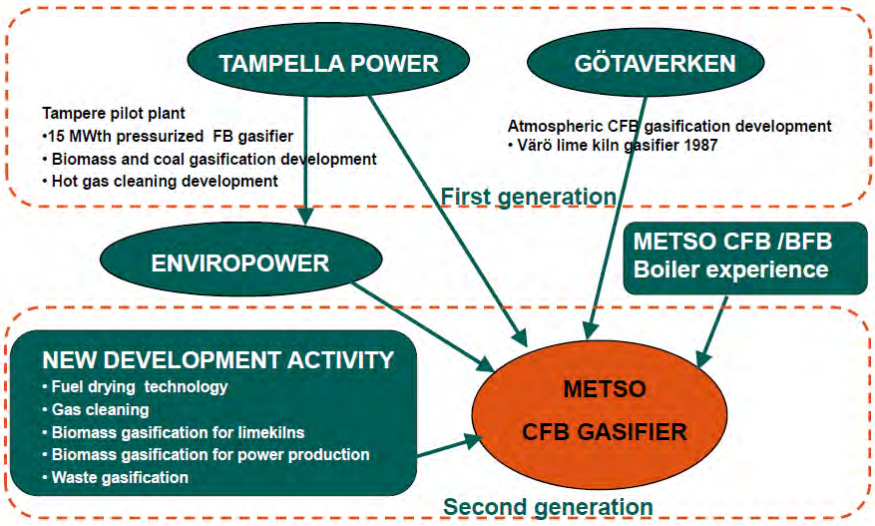


Figure: Metso´s evolution in gasification

Metso´s CFB gasifier

CFB Gasifier	
Size	20 – 140 (200) MWth
Fuel	Biomass, waste
Gasification media	Air (steam)
Operating temperature	750 – 900 C
Operating pressure	5-30 kPa(g) /0,05-0,3 atm(g)
Product gas heating value	3-7 MJ/kg (LHV)

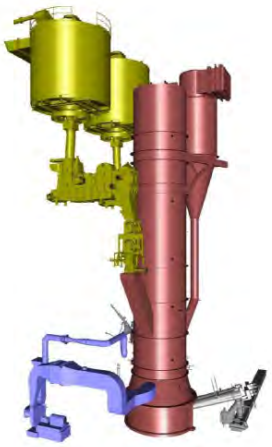


Figure: Metso´s CFB gasifier

From coal-firing to biomass gasification

Metso plans modification of an existing coal-fired plant (Vaskiluoto coal-fired plant in Vaasa) to biomass gasification facility. The benefits of the project are relatively low investment costs, short delivery time and minimized production interference, integrated drying process and availability of storage capacity.

Vaskiluoto coal-fired plant in Vaasa has been in operation since 1982. It produces 230 MW_{el} and 170 MW_{th}, which is about 90% of the district heat needs in the Vaasa region. The coal consumption is 400 000 – 500 000 t/year.

Now, it is planned to adjoin a 140 MW biomass gasifier and dryer and replace up to 40 % of coal by biomass. The contract was signed in June 2011 and plant operation is scheduled for December 2012. Total project cost is approximately € 40 millions.

Lahti Energia – solid waste gasification

The start up of the Lahti gasification plant is scheduled for April 2012. Total investment was € 157 millions. The capacity is 160 (2x80) $MW_{fuel,}$ 50 MW_{el} and 90 $MW_{th.}$

The temperature of the gasification process will be about 850-900°C. Then the product gas will be cooled to approx. 400°C and filtered. The clean gas will be burned in a gas fired boiler.

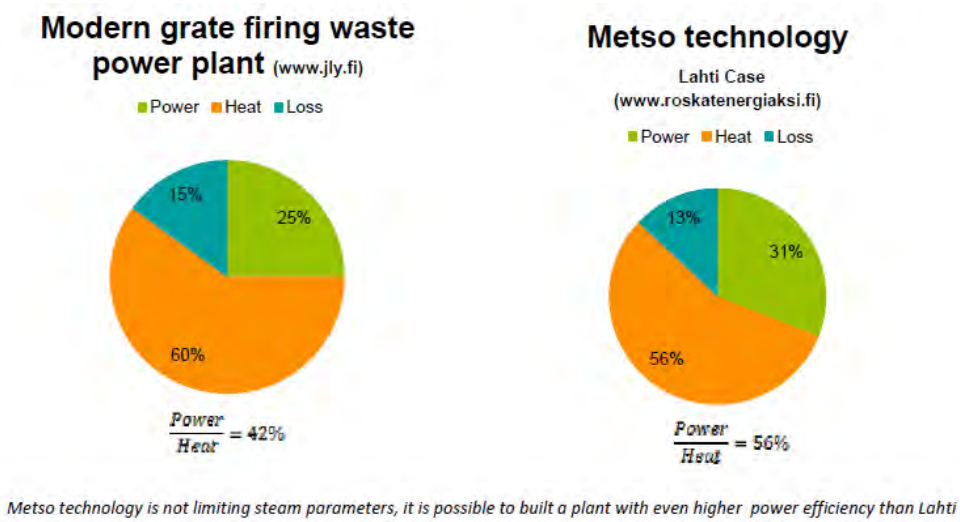


Figure: The comparison of modern grate firing power plant and Metso waste gasification

As can be seen in the figure above, the Metso technology offers higher power production efficiency in waste utilization.

Biomass Gasification in Pulp and Paper Industry (Andritz/Carbona)

Andritz/Carbona is active in different gasification areas:

- Equipment for biomass preparation and handling
- Belt and drum dryers
- CFB gasifiers (atmospheric, air blown, for boilers and kilns; 10-150 MW_{th})
- BFB gasifiers (low pressure, air blown; 10 – 50 MW_{th})

Circulating fluidized bed gasifiers (CFB)

Metsä-Botnia Joutseno, gasification plant (start up in summer 2012)
Target:

- To replace 100% NG at lime kiln with gasification gas
- To utilize biomass side products from mill
- To utilize waste heat available from mill for biomass drying
- To deliver whole line of Andritz products from fuel handling to lime kiln burner

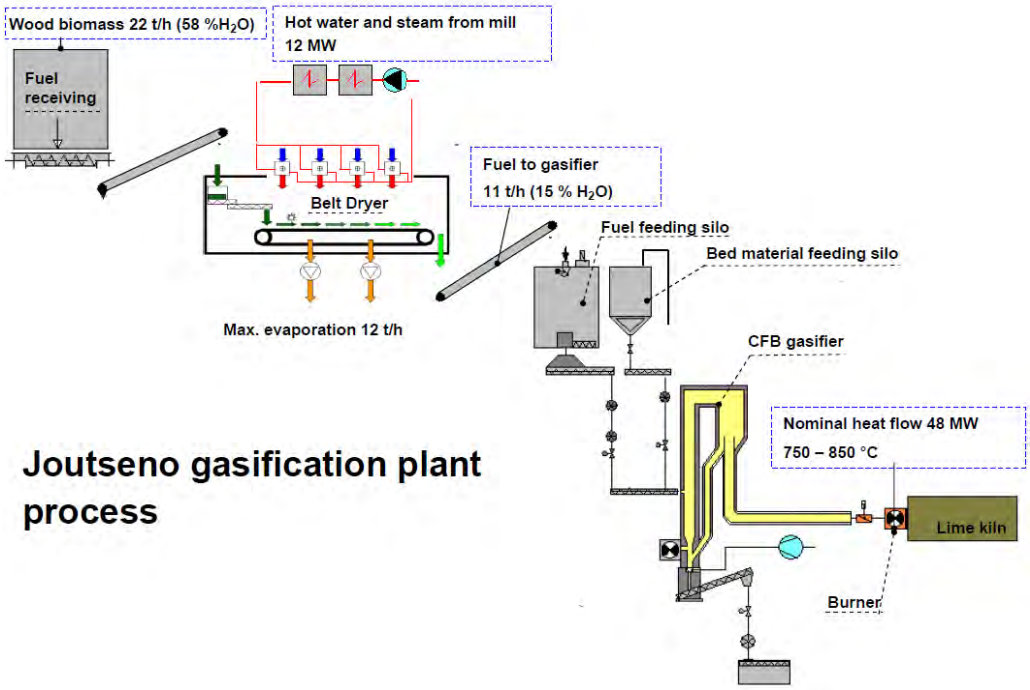


Figure: Metsä-Botnia Joutseno, gasification plant process

Lime kiln gasifier features:

- Can utilize cheapest fuel residues with high ash content
- Degree of fuel drying moderate, can be adjusted according to kiln properties
- Low temperature heat to be used in belt drying
- Harmful fuel ash/soil in gas can be minimized
- Lime quality not to be affected
- Total replacement of fossil fuels
- Lime kiln capacity stays as before
- Excellent gasifier operation history during decades
- CO_2 benefits and short pay-back time for the investment

Bubbling fluidized bed gasifiers (BFB)

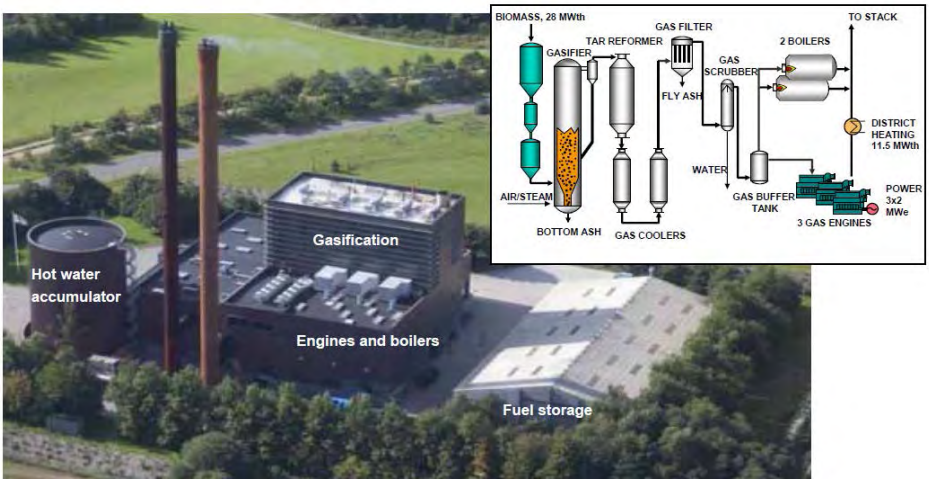


Figure: CHP plant in Skive, Denmark

The Skive plant consists of pressurized BFB gasifier, air blown, with capacity 19,5 MW_{fuel} (max. 28 MW_{fuel}), heat (11, 5 MW_{th}) and power (6,0 MW_{el}), 3 gas engines and 2 gas boilers. As a fuel are wood pellets and wood chips utilized.

Test facility at Gas Technology Institute in Illinois, USA

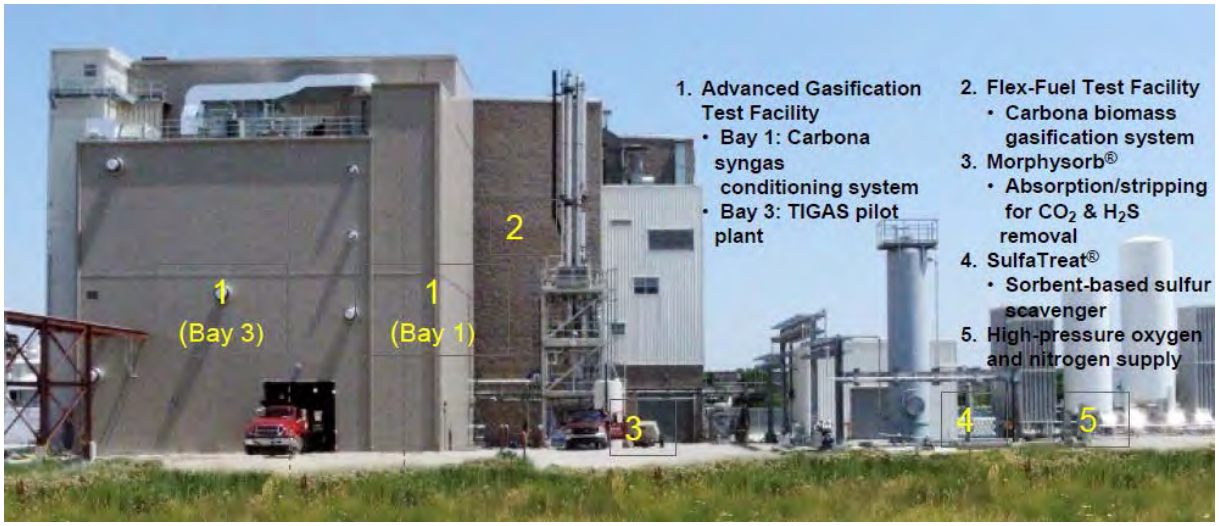


Figure: Gas Technology Institute facilities, Illinois, USA

High efficiency power generation (η_e = 40-50 %)

The concept is based on pressurized air-blown BFB gasifier (20 bar, demonstrated in Tampere, Finland). Hot product gas is cleaned by filtration and cooled by integrated steam cycle. The electricity is produced in gas turbine with air extraction. There is also a burner for

high temperature LCV gas. IGCC technology will be commercialized in near future. The details can be seen in the following schematic figure.

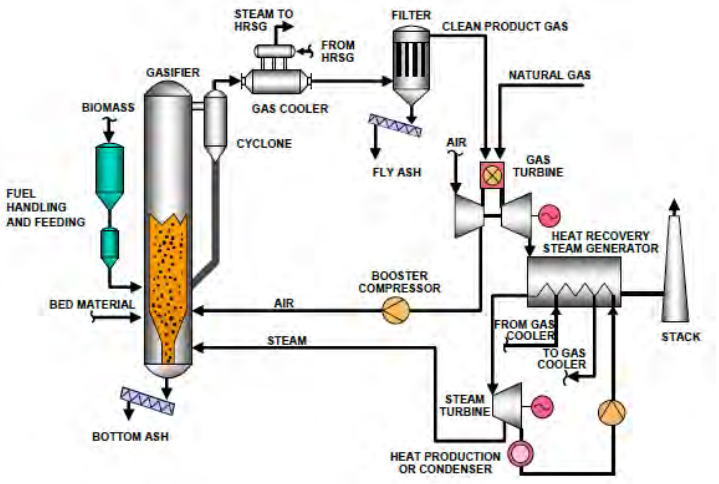


Figure: ICGG technology

Thermal Biomass Gasification in Austria

Economic frame conditions in Austria

The actual biomass costs in Austria are 0.018 – 0.019 €/kWh, which is about 80 – 90 €/t_{dry}. Feed in rate for electricity (not valid anymore) was 16 c€/kWh for electricity from forest wood chips, < 2 MW_{el}, independent of echnology. Price of heat is 0.02 – 0.04 €/kWh and depends on average biomass price and light heating oil price. There is no funding of investment costs, except of demonstrations plants in Austria.

R&D on large scale gasification

The funding for R&D in the area of gasification comes either from the EC or national funding (e.g. climate and energy fund).

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

In the following discussion some examples of actual R&D in the area of gasification are given:

Distribution of elements in DFB gasifier

The distribution of nitrogen, chlorine and sulphur using DFB gasifier was studied at TUV. This is a quite important aspect, if waste fuels are used, as then the gas treatment has to be modified.

In the flue gas components such as NO, SO_2 and HCl were found. In the product gas NH_3, H_2S and HCl were detected. But the interesting result was that more than 99% of the impurities

go to the product gas, so no special gas treatment for the flue gas is necessary if waste fuels are used in a dual fluidized bed gasifier.

G-volution system

At TUV an advanced system of dual fluidized bed biomass gasification was developed. The gasification part of a DFB reactor is divided in several zones, where the reactor diameter narrows. The product gas velocity in this narrow part is higher, than in the following wider section. In this wider section the product gas comes into more intensive contact with a bed material (e.g. dolomite, olivine) and tar content in the gas is reduced. At the present time cold flow models are being studied, and in the future a hot reactor of about 100kW fuel input will be built.

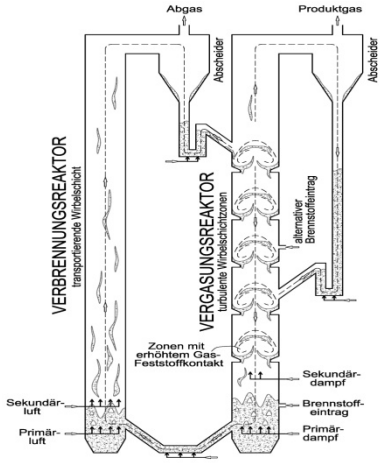


Figure: G-volution system

Gasification and synthetic biofuels – research along the process chain

At Bioenergy 2020+ R&D on the whole process chain of biomass gasification is done in cooperation with TUV. On the one side there is R&D on optimization existing biomass CHPs, like Güssing and Oberwart, on the other side also new concepts like polygeneration are introduced. One example is the separation of hydrogen from the biomass CHP Oberwart. Here the complete process chain to separate hydrogen and to use it in a PEM fuel cell is being investigated. Another example is the FT synthesis, where also the whole chain from wood chips, through the usage of the FT diesel in engines is being investigated.

Mixed alcohols

This project is funded by “Klima und Energiefonds” and Bioenergy 2020+. The aim of this project is to develop a fundamental know-how in the synthesis of mixed alcohols from biomass. Main advantage is very simple gas cleaning, due to sulphur resistant catalyst. During the process, the synthesis gas goes through the steam reformerand glycol scrubber; afterwards it is compressed and passes MAS reactor to condenser, where the mixed alcohols are produced.

The first experiments are already done and the first liters of mixed alcohols have been produced and analyzed.

Thermal biomass gasification in the USA

Current Biofuels Status and Biopower in the USA

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

The capacity of biodiesel is about 2,85 billion gal/year (status April 2011).
The biofuels facilities in North America are situated mostly in north-east part of the USA.

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

Gasification technologies in the USA (selected)

Nexterra

A gasification system of Nexterra can be found at University of South Carolina. The start up was at the end of 2007. The power is 1,38 MW_{el} and capacity 60 000 lbs/hr of high pressure steam for district heating. The biomass (wood residues, moisture 25-55 %) is converted to combustible gas with 3 gasifiers. Syngas is burned in the oxidizer. The hot flue gas is directed through heat recovery steam generator to produce steam. Steam is sent to a back pressure turbine to produce electricity. Turbine exhaust steam is distributed to campus heating system.

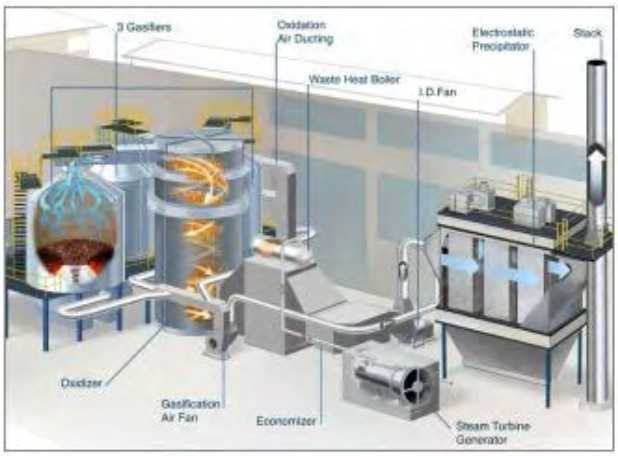


Figure: Illustration of Nexterra´s gasification system at USC

Enerkem

The process converts waste and residuals into advanced biofuels

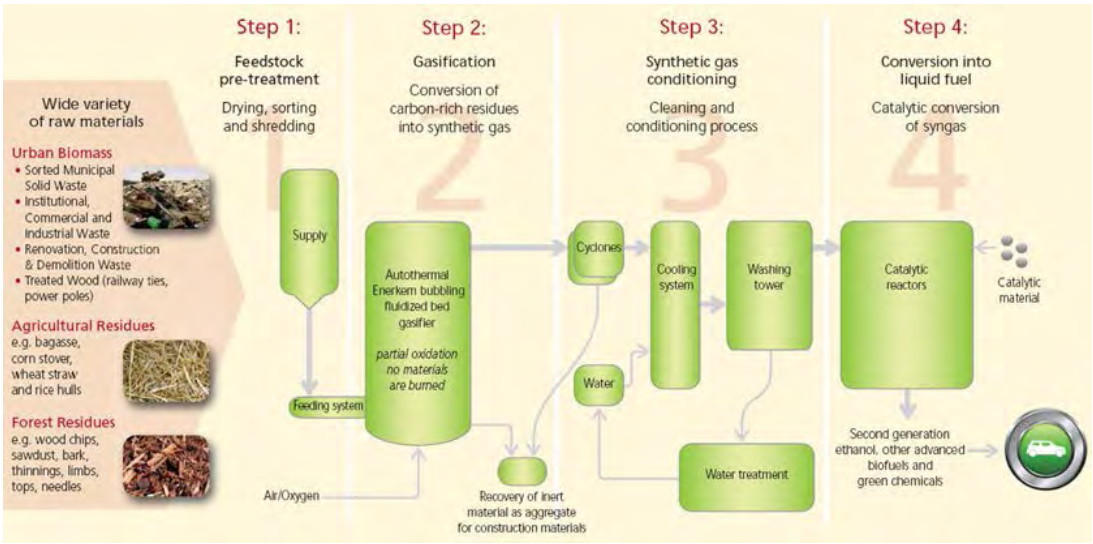


Figure: Enerkem – a unique gasification and syngas to biofuels technology

Enerkem promotes sustainable development and that is why it uses the non-recyclable portion of the waste and creates value from the forest and agricultural residues. From one ton of waste (dry basis) 360 liters of ethanol are produced. The process requires little use of water and allows for its reuse in a closed circuit.

GTI Biomass Gasification Activities

Within the "2nd generation biofuels project", there are provided laboratory and pilot-scale test for Andritz/Carbona and UPM F-T project. The maximum feed rate of biomass is 40 tons/day. The gasifier is pressurized (25 bar) oxygen blown.

Taylor Biomass Energy, LLC

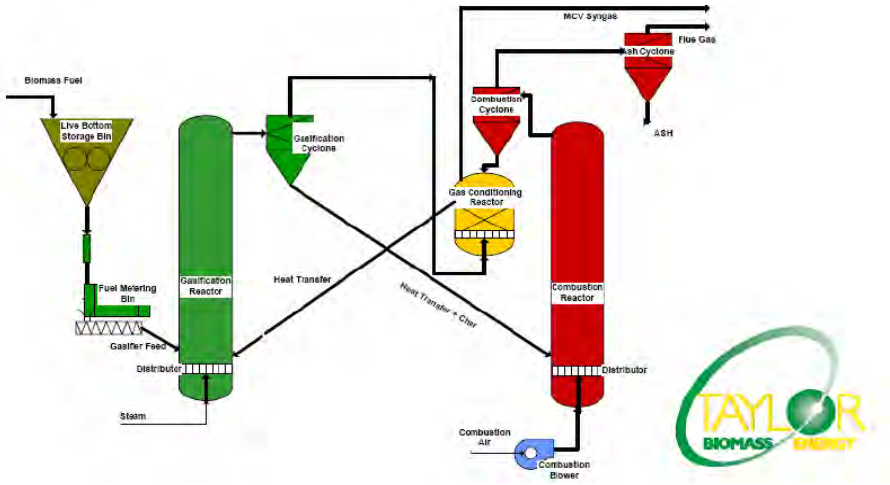


Figure: Taylor Biomass Energy system

The company has 3 gasifiers projects in North America, in Montgomery, NY; Alberta, Canada, and Maryland.

Montgomery, NY

- Feedstock: MSW
- bed material: calcite and dolomite
- modular gasification facility
- process system for liquid fuels and hydrogen production
- 24 MW combined cycle system
- Sells “green energy” to NY grid

Alberta, Canada

- 24 MW combined cycle system

Maryland

- Synthesis to FT liquids

TRI Technology and Projects

TRI´s core technology is deep fluidized bed, indirectly heated, steam reforming of biomass. TRI´s black liquor gasifier has been commercially operational for six years (Trenton, Ontario). Two separate DOE “Small-Scale Biorefinery Projects” are employing TRI technology:

- New Page, Wisconsin Rapids, WI; 500 dry tons per day biomass to FT fuels and tail gas. Class 10 study underway ($30 million award, 2008)
- Flambeau River Biofuels, Park Falls, WI; 1000 dry tons per day biomass to FT fuels. Class 30 completed ($30 million award, 2008)

ICM, Inc.

ICM Inc.’s gasification technology has been successfully tested and supported at rates up to 250 tons per day by the Department of Energy. ICM currently offers three commercial-scale

unit designs with feedstock processing ranges of 150-200 TPD, 300-350 TPD and 450-500 TPD.

ICM owns and operates a 200 ton per day commercial demonstration auger gasification unit in Newton, KS that was installed to process municipal solid waste from the Harvey County, KS landfill. Since commencing operations at the facility, ICM has tested more than a dozen feedstocks and amassed more than 2,100 hours of operation on the unit.

Projects: ReVenture Project, Charlotte, NC: ReVenture Park is a proposed waste-to-energy facility for Charlotte, NC. Forsite Development, the lead developer for the project, selected the biomass gasifier technology by ICM, Inc.

Coskata – Project Lighthouse

The project is based on partnership between Coskata and Alter NRG. A semi-commercial demonstration, Westinghouse plasma gasifier is located in Madison, PA. The feedstocks are pine chips and capacity is 50 000 gal /year of ethanol. The successful start up was announced in October 2009.

University of California & West Biofuels

Thermochemical conversion of biomass to mixed alcohols is provided using 5 ton/day dual fluidized bed gasifier based on "Pyrox Process". The facility works under atmospheric pressure with air-blown combustor. It is now in start-up.

Figure: Mixed alcohols facility at University of California

Conclusions:

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

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

One of the most important Swedish projects is "Transportation Fuels from Forest Residues via PEBG". The project is scheduled from 2009-2012. Into the project research, industry and

society sectors are involved. The project is based on pressurized entrained flow biomass gasification of low grade wood powder. The total funding of the project is 2,5 M€.

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

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

NSE Biofuels Oy (Sweden) is owned by Neste Oil Oy and Stora Enso Oy. The current business is to produce syngas from woody biomass to be used as fuel in Stora Enso's Varkaus pulp mill lime kiln.
In Finland the technical research is concentrated at VTT (Technical Research Centre of Finland). During the workshop the actual projects such as the biomass to syngas process and the production of hydrogen and SNG were presented.
Further, Metso, a global supplier of sustainable technology and services, presented their CFB gasifier and their plans of modification of existing coal-fired plant (Vaskiluoto coal-fired plant in Vaasa) to biomass gasification facility. The benefits of the project should be relatively low investment cots, short delivery time and minimized production interference, integrated drying process and availability of storage capacity.

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

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

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

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

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

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

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

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

IEA Bioenergy, Task 33
Thermal gasification of biomass

WORKSHOP
“Bed materials”

18. April 2012, Istanbul, Turkey

REPORT

Summarized by Dr. Jitka Hrbek, TUV, Austria

Table of Contents

Abstract

This publication provides the summary and conclusions from the workshop **'Bed materials'**, held for the IEA Bioenergy Task 33, on the 18 April 2012 in Istanbul, Turkey.

All workshop presentations can be found at www.ieatask33.org

Table 2: Workshop presentations

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

Introduction

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

EERA

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

Requirements on bed materials for fluidized bed systems

The requirements of bed materials for fluidized bed gasification are a good fluidization behavior of grains, attrition resistance, and relatively high melting temperature. Furthermore the bed material should be non-pollutant or hazardous and also cheap in use. The choice of the right bed material can help to optimize the gas composition and avoid operational problems.
The problems with the agglomeration and the possible catalytic effect of bed materials were presented during the workshop.
There are two extreme mechanisms of agglomeration processes. Details can be seen in the following figure.

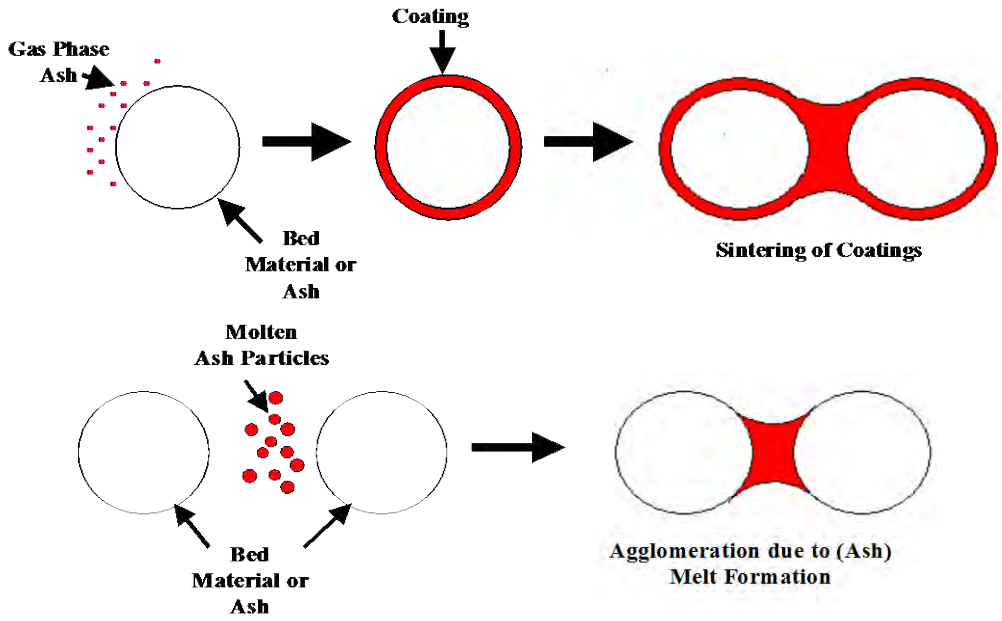


Figure 1: Agglomeration process

It should be considered, that based on the tests a porous coating of the bed material could have a positive effect on water gas shift reaction and gas composition.
The comparison of dolomite and olivine as a bed material for fluidized bed gasification was studied at ECN. The results can be seen in the table below.

Table 3: Comparison of olivine and dolomite for fluidized bed gasification

Olivine	Dolomite
Hardness OK	Too soft as FB bed material
Volume refreshment rate small	Refreshment rate high
Price rel. high (especially with pre- treatment)	Low price
Price/ton x volume/time determines the cost of use	
Chlorine/sulphur capture low	Cl and S capture high
Tar reduction depends on type of olivine and pre-treatment	Tar reduction high
No fines problem downstream/ no fouling of bed material	High quantity of fines downstream/fouling

Furthermore, three different types of olivine were tested; pretreated olivine from Austria and Canada and untreated olivine from Norway. As can be seen in the following table, not all the types of olivine have the same quality and properties.
Austrian olivine tested here was a porous material with partially segregated iron both internally and at the rim. Supplier has sintered material already at 1600°C for 4 hours and milled it to desired grain size.

Table 4: Characteristics of three different olivines

Characteristics	Norwegian olivine	Canadian olivine	Austrian olivine
Origin	Dunite (olivine) Mine, very pure	Residue from asbestos mining. Contains serpentines	Dunit (olivine) contains Forsterite rich olivine
Appearance	Solid grains, good hardness, light green	Brownish material, contains some porosity	Brownish material, contains some porosity
Pre-treatment	None	1260°C/2 hours	1600°C/4 hours
After oxidation /microscopy info	Some iron excluded and some Fe-minerals	Some iron excluded and some Fe-minerals	Some iron excluded and some Fe-minerals

In general, olivine as bed material reduces the amount of tar in the product gas better than silica sand. The main contribution is expected to be from iron segregated to the surface and on the different oxidation states the Fe can be in.
However, various “olivines” make difference to the extent of tar reduction. Noticeably, the higher the pretreatment temperature, the better the tar reduction capabilities are. Based on the tests, the worst performer was the untreated natural olivine.
The possible effects of tar reduction of olivine can be due to oxygen transport, active iron on the surface, or by forming a layer of CaO, which influences also the CO-shift reaction and catalytic methane reforming.

Table 5: Lab-scale experiments: summary results

	Sand	Olivine (Norway)	Olivine (Austria)	Olivine (Canada)	12% Dolomite in sand
Tar reduction	_ _	o	+	o/+	+
WGS shift	_	o	o/+	o	+
O2 transport	_	o/+	+	+	_
Carbon/tar transport	_	_	_	_	+
Attrition res.	+	+	+	+	_
Price	++	o	_	_	+

Further tests, which are planned at ECN:

- sintered serpentine and pretreated olivine, which one is the better bed material?
- lab sale testing on elucidating which effects are occurring under which conditions in order to optimize further use
- do coatings have a positive contribution on tar reduction and is this the effect we see coming up after some 2 or 3 days of operation?
- feasibility to push the pCO2/pCO to the stability field of metallic Fe
- are the optimum conditions for tar reduction bed materials so different from the gasifier/combustor system that a separate reactor would be the wiser option

MILENA gasification bed materials

Milena is a gasification facility developed for high efficiency. In operation is since 2008, later in 2009 was connected to OLGA tar removal. Gasifier diameter is 0,2 m, combustor diameter 0,8 m. Total height 8 m.
The product gas has a medium calorific value, high CH_4 content and low N_2 content. Thus is well suitable for BioSNG production, for scale-up and pressurized operation.

Design details can be seen in the following figure.

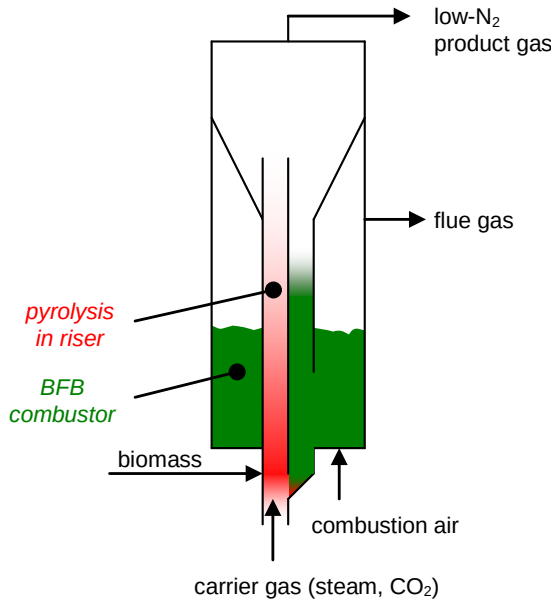


Figure 2: ECN Milena gasification unit

There were different fuels tested using MILENA 30 kW_{th} Lab-scale unit:

- Wood
- Sewage sludge
- Grass (not successful for the operation)
- Lignite

And different bed materials:

- Olivine (from Austria, Norway and Canada)
- Dolomite (calcinated and fresh)
- Silica sand (with additives)

Main goal of the bed material tests was to prevent fouling in cooler between gasifier and gas cleaning (OLGA) device. The results from the tests using dolomite can be seen in the following table and figure.

Table 6: Dolomite experiments: lab scale (30 kWth)

	Sand	Dolomite	12% Dolomite/ sand	6% Dolomite/ sand	9% Cal. dolo./ sand
Tavg [°C]	860	854	857	845	~835
S/B [-]	0.5	0.37	0.34	0.33	0.34
H_2 [vol%]	20	38-50	33	23	25
CO [vol%]	39	20-21	28	25	35
CH_4 [vol%]	13	8-11	11	10	12
Tar class 5 [g/nm3 dr]	5	0.5	2.2	3	2.5
Total tar [g/nm3 dr]	32	2.1	21.8	27.3	26
Fines [gr/hr]	50	550	275	n.m.	45

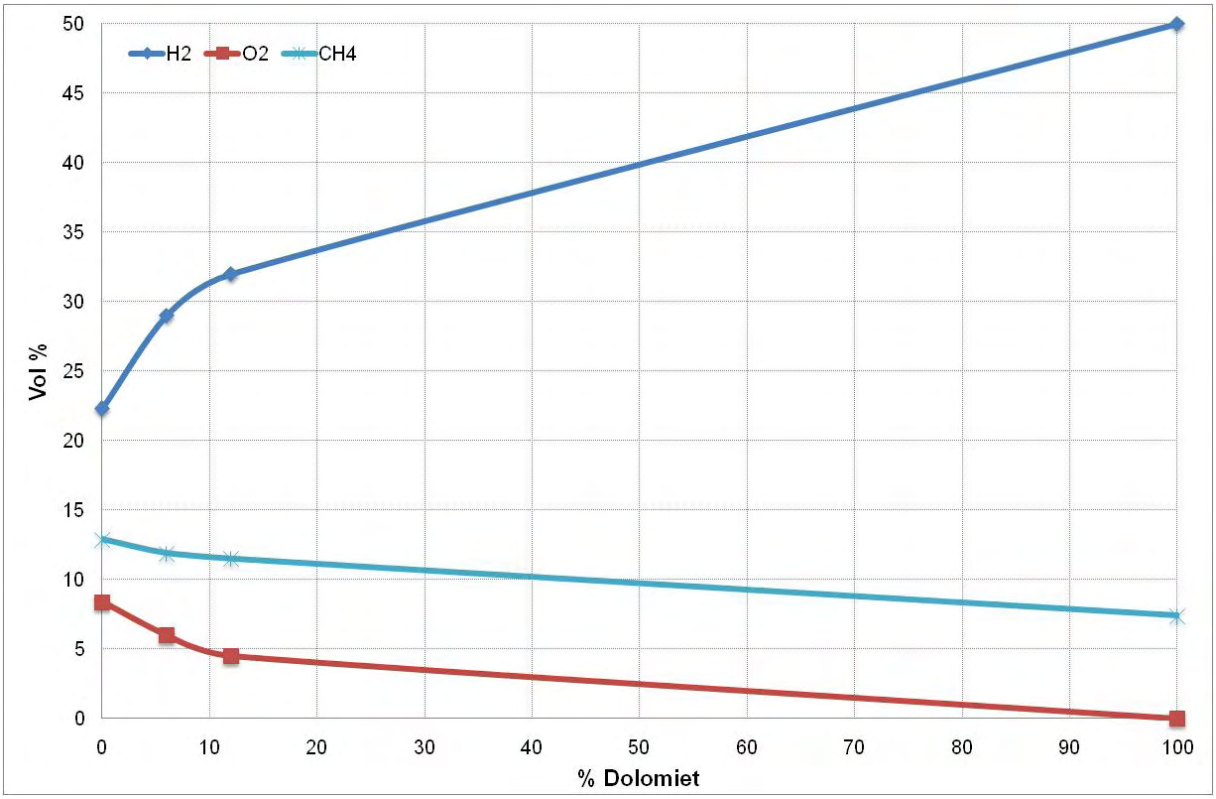


Figure 3: Hydrogen, oxygen and methane content in product gas using different dolomite content in bed material

Dolomite was flash calcinated when added to the hot bed. As the tests showed, using 100% dolomite it was too much tar/carbon transported to the combustor and increased the temperature. On the other hand 12% of dolomite in sand resulted controllable temperature and reduced tar content in product gas. Using calcinated dolomite there were no CO_2 peaks. There were also 3 types of olivine tested:

- Pretreated olivine from Austria and Canada
- Untreated olivine from Norway

The results of olivine experiments can be seen in the following table.

Table 7: Olivine experiments

	Sand	Olivine (No)	Olivine (At)	Olivine (Can)
Tavg [°]	860	865	860	856
S/B [-]	0.5	0.5	0.7	~0.35
H_2 [vol%]	20	26	21	22
CO [vol%]	39	33	31	30
CH_4 [vol%]	13	12	10	12
Sum O_2 + CO_2 [vol%]	18	17	14	15
Tar class 5 [g/nm3 dr]	5	3	3	3
Total tar [g/nm3 dr]	32	28	25	25

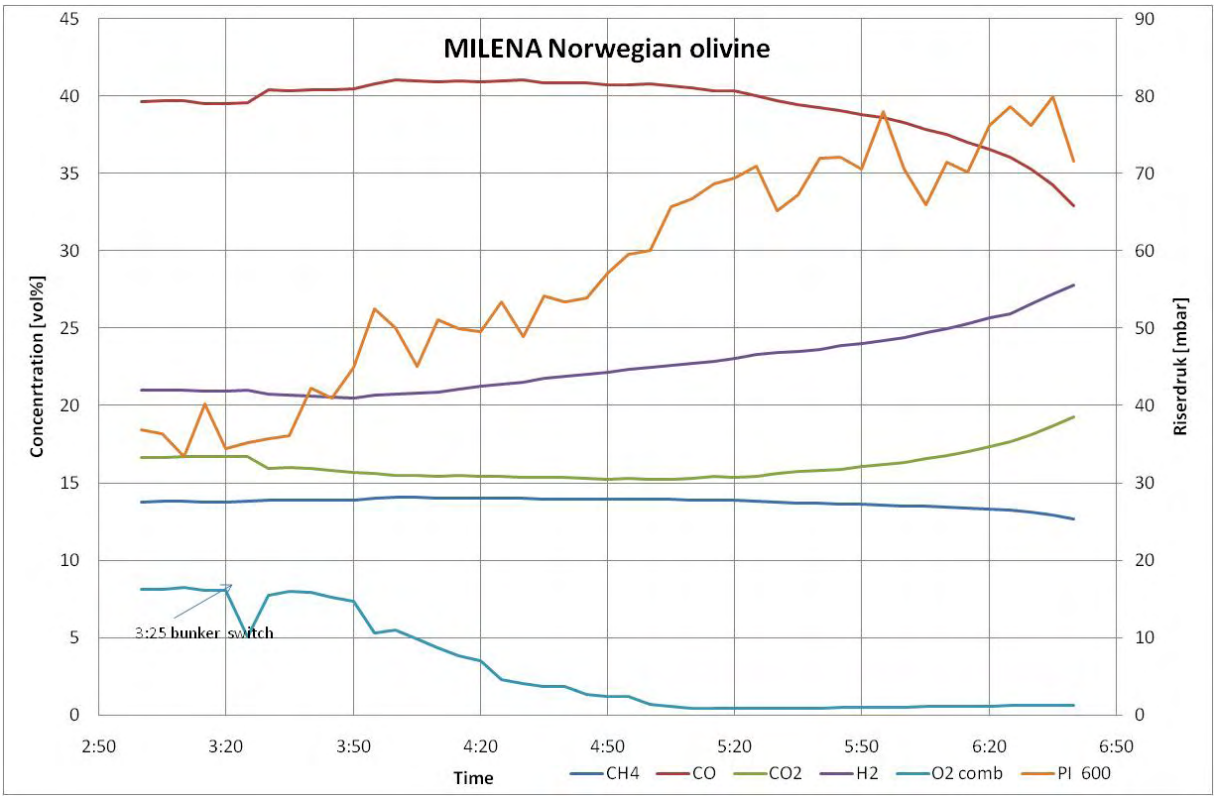


Figure 4: Olivine experiments, duration tests

Results from tests with olivine:

- Using the olivine as a bed material the tar reduction was limited
- Norwegian olivine was the worst option, but availability in right fraction was the best

- Pretreated olivine reduces tar concentration and transports O_2
- Untreated olivine, gets more active, over time during the reduction/oxidation cycles in MILENA
- Catalytic CO shift activity is influenced by air to fuel ratio in combustor
- Despite the bad performance was Norwegian olivine the standard in the lab and the pilot installation

Tar dew point

Tars are large hydrocarbons e.g. toluene, naphthalene, phenantrene, fluoranthene, coronene etc. Due to their undesirable effect on fouling problems, which occurs at surfaces with temperature of 300 and even above 400°C, tar removal from product gas is intensively studied since many years.
OLGA tar removal technology provides complete tar removal (heavy and light tars) from product gas. Furthermore it is responsible for particle removal and tar recycling.
During the gasification process tar content and composition is measured (SPA). This method is fast and easy, but limited to approx. 300 g/mol tar molecules (coronene). Tar Dew Point Analyzer (TDA), developed by ECN is a device, which is accurate and suitable up to 200°C.

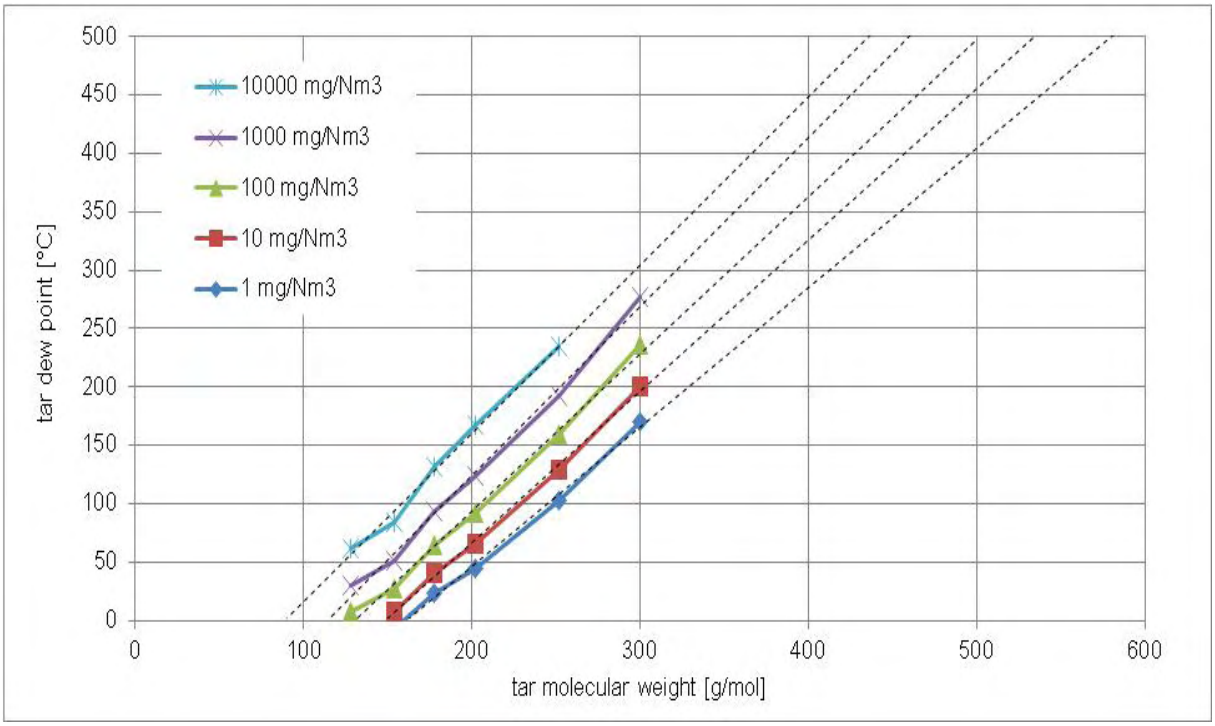


Figure 5: Tar dew point of larger tars

Table 8: Concentration of larger tars

	CFB/air - sand	MILENA - sand
<300 g/mol	9 000	33 000
300-350 g/mol	80	650
350-400 g/mol	28	295
400-450 g/mol	10	130
450-500 g/mol	3	59
500-550 g/mol	1	27
550-600 g/mol	0.4	12
% >300	1%	4%

A test showed that tar condensation is possible even at temperature of 400-500 ° C. OLGA is able to remove all tars, but the problem is upstream. Extrapolation leads to conclusion that fixed Tar Dew Point does not exist. Now a more practical approach is needed.

Chemistry of olivine and its influence on biomass gasification

Olivine is a natural mineral $(Mg, Fe)_2SiO_4$ with a high abrasion resistance and positive catalytic effects on tar reduction. Thus olivine is more suitable for thermal biomass gasification in DFB than silica sand. Calcination of olivine improves further its catalytic activity.

Tests at Bioenergy 2020+ showed that there are some differences between fresh and used olivine in DFB gasification. Used olivine is covered with inner and outer layer which is formed with CaO, SiO_2 and MgO (only in outer layer observed)

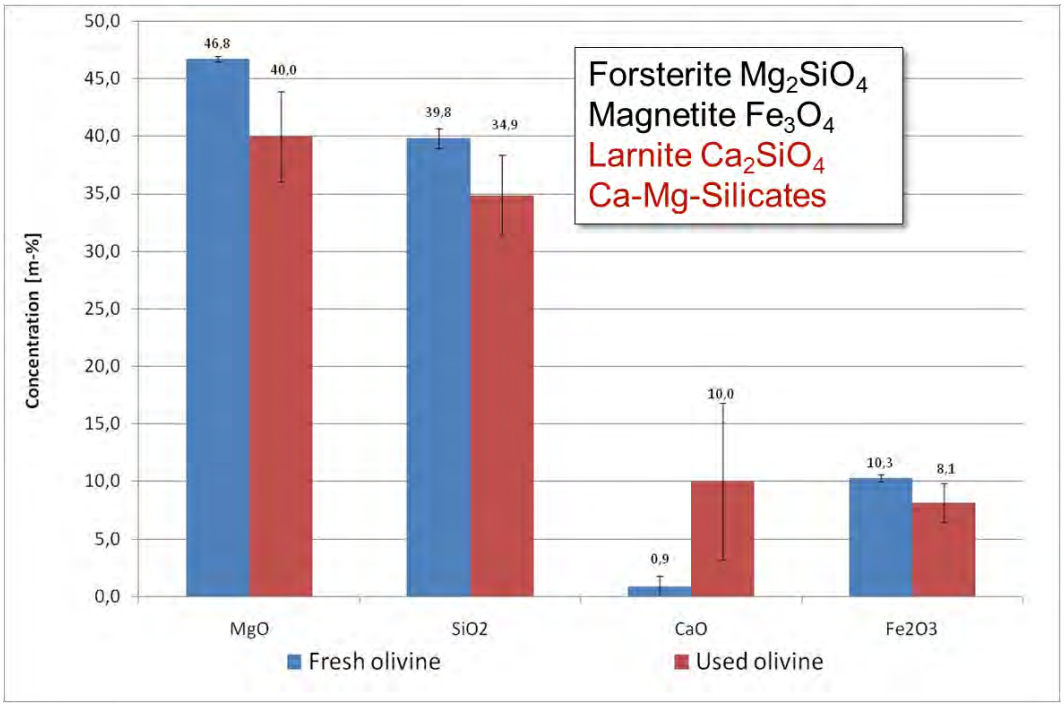


Figure 6: Analyses fresh and used bed material – main elements

Furthermore, the calcium content in bed material vs. CO content in product gas was tested in pilot plant and commercial plant in Güssing. Tests showed that with higher CaO content in bed material the concentration of CO in product gas decreases.

Product gas composition was studied also, using pilot gasification plant with fresh and used olivine. The product gas composition from commercial gasification plant in Güssing was compared with the results. As it can be seen in the following figure the water-gas shift reaction plays an important role in a product gas formation and is enhanced by the layer. Using used olivine, higher content of H_2 and lower content of CO was observed in product gas in comparison with fresh olivine. The influence of used olivine on tar reduction, about 60-80% was also proved. The main responsibility on the tar reduction has a calcium rich layer on olivine, which is probably formed during the DFB gasification process. The results of the 100 kW plant were in accordance with commercial scale plant in Güssing.

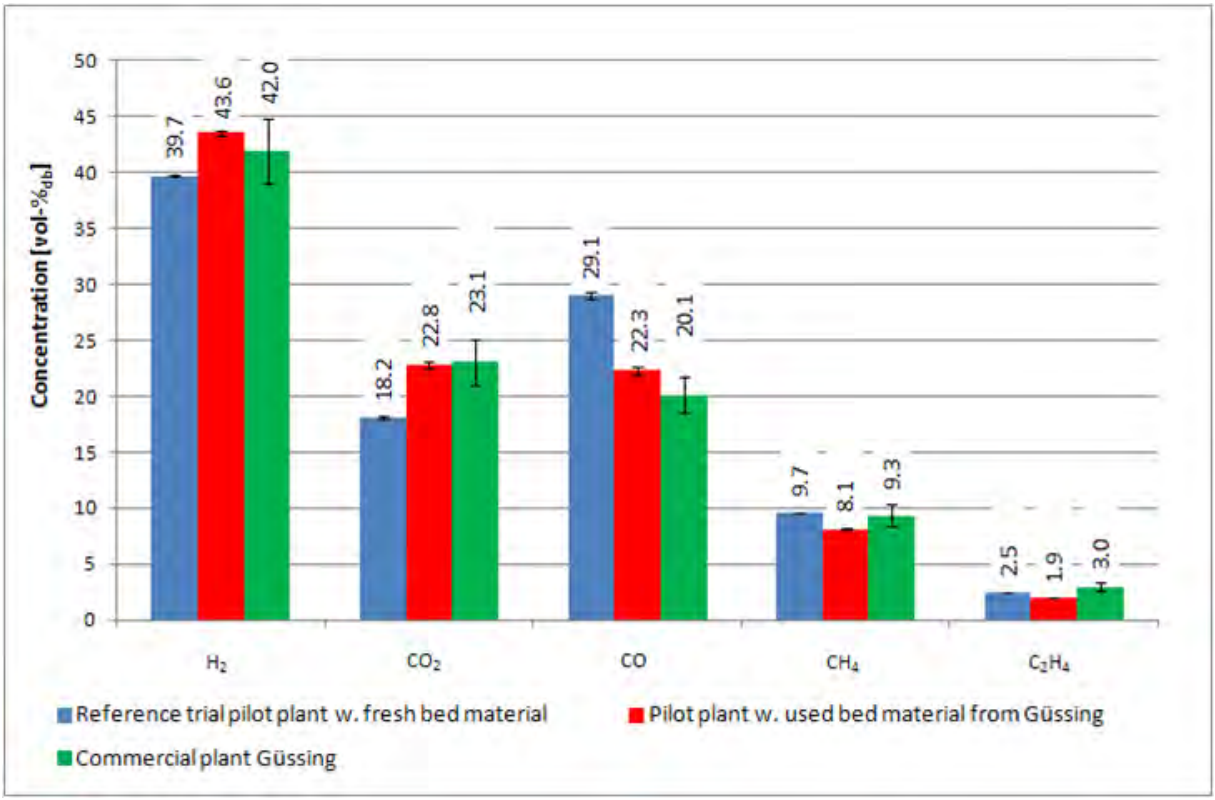


Figure 7: Comparison of influence of fresh – used olivine on product gas composition

Hot gas clean-up with dolomite

Turkish lignite in a mixture with biomass was used to prove the influence of dolomite on hot gas clean up during the thermal gasification process. This lignite has a high ash (21,5wt%) and sulphur content (1,85wt%-7wt%), which complicates the gasification process. Nearly 50% of sulphur presented in the coal leaves the gasification system in the gas phase and thus 5000-10000 ppmv of sulphur can be expected in the outlet stream of gasifier.

The sulphur removal is necessary not just for process reason, but also because of health risk. Higher concentrations of sulfur can cause also corrosion of pipelines. Furthermore, there are sulfur limits for catalytic systems such as FT process, methanol production etc.

In conventional treatment, H_2S or other sulfur components are removed via low temperature amine scrubbers. Wastewater containing chemicals from the scrubbing process must be treated accordingly to prevent the contamination of drinking water. Using scrubbers required lowering the temperature of the synthesis gas from 850°C to 50°C.

Furthermore, tar condensation can cause plugging and fouling of the condenser and is also a loss of hydrocarbon and leads to decrease in carbon utilization ratio.

Nowadays, there are different strategies to remove the tar from the product gas. One of them can be physical strategies (scrubber and filter) which are not really attractive because of their costs, large amount of waste water requiring treatment. On the other hand catalytic strategies are more efficient, improves the carbon efficiency, but the catalysts may be easy polluted with NH_3 or H_2S components.

In the project concerning the hot gas clean-up “TRIJEN Liquid Fuel Production from Biomass and Coal Blends” the influence of dolomite on cleaning of product gas was investigated. The experimental-set up can be seen in the following flow sheet.

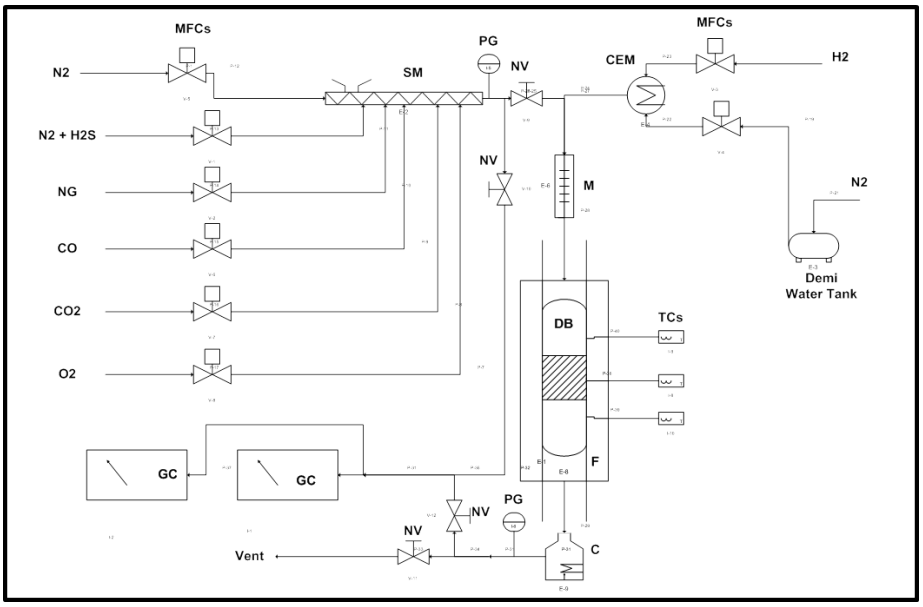


Figure 8: Flow sheet of the experimental set up

F: furnace, DB: dolomite fixed bed, GC: gas chromatograph, CEM: controlled evaporator and mixer, M: mixing manifold, NV: needle valve, SM: static mixer, PG: pressure gauge, TC: thermocouple, C: condenser

H_2S removal in N_2 atmosphere

At 700 K, the H_2S concentration in the reactor effluent gas was reduced to below 100 ppmw. The degree of H_2S chemisorption on dolomite reached to a maximum level at around 773 K. The H_2S levels of the effluent gases below 1 ppmw were observed between 773 and 1073 K. the H_2S concentration in the equilibrium at 750K is around 0,16 ppmw.

H_2S removal from binary gas mixtures (nitrogen + hydrogen) using dolomite

All H_2S was captured by dolomite, hydrogen behaved like an inert gas and consequently the results obtained were similar to that obtained in pure nitrogen.

H_2S removal from tertiary gas mixtures (nitrogen + hydrogen + CO_2)

H_2S removal efficiency was lower than that obtained with the binary gas mixtures. This might be attributed to the existence of CO_2 in the reactants and the water vapor produced as result of WGS reaction. The water vapor reduces the activity of dolomite toward H_2S. This tertiary gas seemed to promote the formation of COS to a larger extend in comparison to the binary mixture with similar CO.

H_2S removal from simulated gasifier outlet gas mixtures

H_2S removal was obviously low, efficiency about 30%. Thermodynamic calculations with this inlet gas composition dictated a maximum achievable equilibrium H_2S of ~120 ppm. Hence a 140 ppmv in the reactor off gas seems to be reasonable. The changes in the outlet gas stream with increased H_2 and decreased CO, indicated that the WGS reaction also took place to some extent. The carbonyl sulfur formed likely due to the reaction between H_2S and CO/CO_2.

The results of these studies showed that:

- H_2S removal by dolomite is limited to around 150-200 ppmv.
- Due to thermodynamical constraints, the H_2S removal efficiencies with calcium containing materials are only on the order of 90 % under typical gasification conditions, resulting in residual H_2S levels of 100 ppmv or greater.

- This may suggest that dolomite could be used for strictly bulk H_2S removal requiring an additional bed to further polish the gas for the applications with more stringent sulfur cleanup.

Further the tar removal with dolomite and commercial catalyst was investigated.
Dolomite showed a low degree of tar removal activity during the tests. Xylene and toluene concentrations decreased whereas benzene concentration increased in the outlet stream. At 750°C thermally/catalytically broken methyl groups in toluene producing benzene and methane. With the same mechanism, xylene was dealkylated into toluene and benzene, consecutively in the presence of excess hydrogen. The increase in methane percentage from 3.2% to 4.0% supported this suggestion.
Using a commercial catalyst, Xylene was converted into benzene and toluene. Gases such as CO, CO2, H_2, CH4 were detected at 563°C. This proces can be attributed to steam dealkylation reactions. At 775^{o}C: tar reduced from 61gC/Nm^3 to 6.6 gC/Nm^3.

Table 9: Experimental conditions using dolomite by tar removal

Exper. conditions	Feed gas comp., %V (db)	Outlet gas comp., %V(db)	Contaminants, inlet	Contaminants, outlet
T_r=750°C Steam/C=0.21 Steam/tar=4.9	% 28.5 CO, % 25.0 CO_2, % 31.4 H_2, % 3.2 CH_4, % 11.9 N_2	% 35 CO, % 22.0 CO_2, % 25 H_2, % 4.0 CH_4, % 14.0 N_2	240 ppmv H_2S 8.67 gC/Nm^3 2.63 g C/Nm^3 Benzene 2.60 g C/Nm^3 Toluene 3.44 g C/Nm^3 Xylene	216 ppmv H_2S with trace COS 7.28 gC/Nm^3 4.62 g C/Nm^3 Benzene 2.28 g C/Nm^3 Toluene 0.38 g C/Nm^3 Xylene

Conclusions

- H2S removal performance of dolomite is strongli depening on operating temperature. Operating temperature need to be higher than 700K.
- Removal degree of H_2S from hot gases by dolomite dictated by thermodynamic limitations
- During H2S removal process, in addition to H_2S chemisorption, the WGS and RWGS reactions may occur depending on gas composition.
- The Boudouard reaction was another concern to be taken into account.
- Deactivation of CaO likely occurred at high CO_2 concentrations in the atmosphere, namely higher than 10 % by volume at ~ 1023 K.
- COS formed during the H_2S removal by dolomite, possibly due to the presence of CO. Higher H_2S levels in the gas stream could likely improve the kinetics of reactions between CO/CO_2 and H_2S which produce COS.
- Preliminary results showed that dolomite has some activity toward Tar (benzene, toluene and xylene as surrogated compounds).
- The comercil precious metal based catalyst catalyst catalyzes dealkylation reaction tar components such as xylene

Conclusions

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

During the workshop very informative contributions to this topic were presented. Furthermore, the EERA (European Energy Research Alliance) was introduced. The aim of EERA is to accelerate development of new energy technologies, expand and optimize research capabilities and harmonize national and EC programs.

Task 33 - Newsletter Vol. 1

FROM THE TASK BY RICHARD BAIN AND REINHARD RAUCH

This newsletter is the inaugural edition of IEA Bioenergy Task 33 'Thermal Gasification of Biomass.' The intent of the newsletter is to provide updates of Task activities and links to additional information on biomass gasification status and developments in Member Countries.

In this issue we are presenting information on 2011 Workshops held in Christchurch, New Zealand (April 2011) and Piteå, Sweden (October 2011), the recent activation of a new Task website, and an overview of the biomass gasification database now available on the Task 33 website.

The Christchurch workshop **"Gasification and Alternative Fuels Development"** organized by Dr. Shusheng Pang, University of Canterbury brought together 40 people from universities, research institutes, energy industry, wood processing industry and engineering consultancy companies to learn about the latest progress in biomass gasification R&D and commercialization, as well as recent developments in other alternative energy sources in New Zealand, Australia, Austria, and the USA.

The Piteå workshop **"Biomass Gasification Opportunities in the Forest Industry"** organized by Lars Waldheim addressed development status and issues associated with development of gasification-based advanced fuels processes in the forest industry. An overview presentation on the biomass portion of the recent IPCC SRREN study was given as an introduction to the workshop. The workshop included presentations from major gasifier developers, including Chemrec, Metso Power, Andritz Carbona, and NSE. Presentations were given by Esa Kurkela, summarizing gasification activities at VTT, and Reinhard Rauch summarizing gasification-based cogeneration. There were 30 participants in the workshop.

The new version of the **Task 33 webpage** was activated in July 2011. The aim was to create a new, clear and informative webpage on thermal gasification of biomass, not just for task members, but also for all specialists in the gasification area and involved public. The webpage consists of eight sections: 1) Thermal Gasification of Biomass, 2) Task Description, 3) Participants, 4) Publications, 5) Country Reports, 6) Meeting Minutes & Presentations, 7) Future Task Meetings, and 8) Thermal Gasification Facilities - Database.

A new **database with worldwide biomass gasification facilities**, based on Google maps, was created as a part of the IEA Bioenergy Task 33 webpage. At the present, 87 gasification facilities are active in the database. Fifty-four of them can be found in Task 33 member countries and 33 in other countries. There are four technologies of gasifiers in the database: 1) co-firing (4 gasification facilities), 2) CHP (37 gasification facilities), 3) synthesis (34 gasification facilities), and 4) other innovative (12 gasification facilities). There are three types of gasifiers displayed in the database (pilot, demo and commercial). Nearly a half of all gasification facilities (47%) are commercial, 27 % pilot plants and 26% demo plants.

Task 33 Members—Executive Committee (ExCo*) and Member Country Representatives

Austria
Joseph Spitzer*
Reinhard Rauch

Denmark
Jan Bunger*
Erik Winther

Finland
Kai Sipila*
Ilkka Hannula

Germany
Birger Kerckow *
Thomas Kolb

Italy
Gerardo Montanino*
NTL—TBD

Japan
Fumiaki Ishida*
Myumi Morita

The Netherlands
Kees Kwant*
Bram van der Drift

New Zealand
Elspeth MacRae*
Shusheng Pang

Norway
Petter Nilsen*
Judit Sandquist

Sweden
Asa Karlsson*
Lars Waldheim

Switzerland
Sandra Hermle*
Martin Rüegsegger

Turkey
Ufuk Kayahan*
Serhat Gül

United States
Paul Grabowski *
Richard Bain

Task Management
Paul Grabowski (Operating Agent—USDOE)
Richard Bain (Task Leader—NREL)
Reinhard Rauch (Assistant Task Leader, TUV)
Jitka Hrbek (Task Secretary—TUV)

Gasification and Alternative Fuels Development April 14, 2011, Christchurch, New Zealand By Jingge Li

In conjunction with the First Semi-Annual Meeting 2011of IEA Bioenergy Task 33 (Thermal Gasification of Biomass), a workshop of Gasification and Alternative Fuels Development was held on 14 April in the Copthorne Hotel Commodore, Christchurch. It was organised jointly by Professor Shusheng Pang, University of Canterbury, and Dr Richard Bain, Leader of the IEA Bioenergy Task 33. Biomass gasification experts from USA, Austria, Australia and New Zealand presented the latest progresses in biomass gasification R&D as well as commercialisation. 40 people from universities, research institutes, energy industry, wood processing industry and engineering consultancy companies attended the workshop.

Dr. John Sanderson presenting on Biomass Gasification in Australia

North America and Europe have been very active in R&D and commercialisation of biomass energy and bio-liquid fuel technologies. Numerous biomass gasification demonstration and commercialisation plants have been constructed and in operation. Efforts now are on Fischer-Tropsch (FT) liquid fuels synthesis from biomass producer gas. Dr Richard Bain, Principal Engineer of the National Renewable Energy Laboratory in US, presented an overview about the R&D status in North America. In US, the capacity of biodiesel is 11 billion litres, corn ethanol 55 billion litres, and biopower 10 GW. The Department of Energy has set up goals to increase the quantity and reduce the cost by 2030. Biomass gasification is one of the approaches to generate biopower and biofuels. There are about 50 biomass gasifier developers in the US which have been developing various types of gasifiers for diverse feedstocks and energy products. Technical details were also presented by Dr Bain for some successful biomass gasification projects and integrated biorefinery projects in US and Canada.

Dr Reinhard Rauch, the Head of the R&D Group of Synthesis Biofuels in the Vienna University of Technology and Co -Leader of the IEA Task 33, presented his first hand information on the well-known Güssing gasification plant in Austria. The Güssing biomass gasification plant uses a fast internal circulating fluidised bed (FICFB) gasifier with steam as the gasification agent developed by the Vienna University of Technology, which can generate a producer gas with high content of H_2 and high calorific value. The project started as a CHP plant with 2MW electricity output, it now becomes a test facility for development of BioSNG, Fischer Tropsch fuels, mixed alcohols, and hydrogen. Based on the successful operation of Güssing plant, the FICFB gasifier has been commercialized in six plants in Europe in stages of planning, construction or operation.

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

The IEA Workshop was also a showcase for New Zealand's work on biomass gasification. Doug Williams, a long

time pioneer for development of downdraft gasifier and Director of Fluidyne Co., started his presentation with nice photos of Napier's 1930s gasifier plant with a gas engine. Then he showed the Fluidyne's recent project in California for commercialization of a 100kWe gasifier for generation of process heat and electricity. The emphasis of the technology has been to produce a clean gas free of condensable components and toxic particulates. The Fluidyne gasifiers are also used to produce biochar for carbon sequestration and syngas for FT fuels. The Fluidyne gasifier is currently licensed for sale in Australia through Flow Force Technologies as shown in Dr Sanderson's presentation.

University of Canterbury has been very active in biomass gasification R&D. Professor Shusheng Pang has been leading a research programme of biomass gasification and bioliquid fuels. In collaboration with Vienna University of Technology, the research team has designed, constructed and commissioned a 100 kW FICFB steam gasifier and various biomass originated from NZ have been tested. The technology has been proved to be capable for generation of syngas suitable for synthesis of FT fuels. Professor Pang gave an overview on the current biomass to hydrogen-rich syngas and liquid flue (BTSL) research progress. The BTSL programme, funded by the Ministry of Science and Innovation (previously FRST) aims to reduce production costs and increase conversion efficiency. Technologies in development include biomass gasification, co-gasification of biomass and coal, co-gasification of biomass and sewage solid, gasification of biomass pyrolysis slurry, biomass pyrolysis, gas cleaning, and small scale FT reactor. Fundamental studies are also being carried out for operation optimisation and scale-up design. Dr Woei-Lean Saw, a Research Fellow, presented latest trials on co-gasification of biomass and sewage solid. Chris Penniall, a PhD student, showed his research on development of micro-channel FT reactor and catalysts. Dr Tana Levi, Technical Manager in CRL Energy Ltd., talked about recent achievements in co-gasification of biomass and coal.

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

If anyone is interested in having more details of the workshop, please contact Mrs Jingge Li (jingge.li@canterbury.ac.nz), the Research Engineer and project Manager of the BTSL program, University of Canterbury.

Task Meeting, Christchurch, New Zealand, April 2011

Biomass Gasification Activities in the Forest Industry October 19,2011, Pitea, Sweden By Lars Waldheim and Jitka Hrbek

The IEA Task 33 sponsored workshop addressed development status and issues associated with development of gasification-based advanced fuels processes in the forest industry. There were 31 participants in the workshop. All presentations are available on the task web site.

As an introduction to the workshop, an overview presentation on the biomass portion of the recent IPCC SRREN study was given. The main conclusion is that by 2050, the biomass potential realistically available for use could amount to 1/3 of the projected world energy demand.

The workshop included presentations from major gasifier developers, including Chemrec, Metso Power, Andritz Carbona, and NSE, but also presentations on R&D work.

On the R&D side Esa Kurkela, summarized the gasification activities at VTT, including current biomass-to-syngas projects for fuels, H2 and SNG production (Vetaani project) as well as on advanced analysis technique for gasification. He also commented on the Finish black liquor gasification (BLG) activities in the 80's and 90's, and why these were stopped. Reinhard Rauch of TUW summarized gasification-based cogeneration including the economic conditions in Austria, but also discussed R&D and projects concerning elements behavior during the biomass gasification and the synthesis of mixed alcohols. Rich Bain of NREL reported on climate change and the pulp and paper industry and on biomass gasification (BMG) in North America. Furthermore, the current status of biopower and biofuels in the USA was presented. The progress on large-scale gasification technologies and projects in the USA and Canada (Nexterra, Enerkem, etc.) was also described. Rikard Gebart of ETC reported on the black liquor gasification (BLG) R&D and on the project "Transportation Fuels from Forest Residues via PEBG" as well as describing the newly started Swedish Gasification Centre. In Sweden, there are approx. 20 large pulp mills generating black liquor. If gasified, this represents a potential supply of about 25% of Sweden's use of transport fuels.

Chemrec is commercializing a BLG process using an oxygen-blown, pressurized entrained flow gasifier to produce synthesis gas. Ragnar Stahre reported on the DP-1 pilot plant. He also reported on the FP7 BioDME project where syngas from DP-1 is used to produce dimethyl ether (DME) by a technology developed by Haldor Topsøe, for use as a diesel fuel in Volvo trucks doing haulage for the Smurfit Kappa pulp mill. The industrial scale-up for the Domsjö project was also highlighted.

Jens Otterstedt, Sveaskog, presented a forest owner´s perspective on bioenergy. Sveaskog is the leading forest owner in Europe with its base in the Swedish boreal forests. Sweden has shown that a transition from fossil to renewable energy is possible, and where forestry plays a key role. Today, bioenergy in Sweden is the largest single energy source. Nevertheless, the supply of raw materials and energy from the forests has not yet been exhausted. Over time, an increase in the range between 30-100% is seen as possible.

Metso is a global supplier of sustainable technology and services. Metso´s customers operate in mining, construction, energy, oil and gas, recycling and pulp and paper industry. Metso employs about 28 500 people in over 50 countries. Timo Honkala presented details of their CFB gasifier and of the Lahti Energia project– solid waste gasifi-

cation.

Kari Salo of Andritz/Carbona reported on the company's capability for biomass handling and pretreatment, and on the different areas of gasification where it is active: CFB gasifiers (atmospheric, air blown, for boilers and kilns; 10-150 MWth) BFB gasifiers (low pressure, air blown; 10 – 50 MWth). Projects includes Skive and the cooperatioin with UPM, where tests are being made at the GTI Flexfuel unit in Chicago

NSE Biofuels Oy is a joint venture between Neste Oil Oy and Stora Enso Oy. The current activity includes developing technology for FT-diesel production via syngas from woody biomasses. Veikko Jokela presented the activities in the test plant in Stora Enso's Varkaus pulp mill that were concluded in August 2011. The next step is a scale up, the NOSE project,to be installed at either the Porvoo refinery or Imatra pulp mill, and for which support under the NER 300 program has been sought.

Lars Waldheim, the Swedish NTL, ended the day by concluding that there is a huge bioenergy potential for BMG to tap in to. He also observed that it appears as if the connection between the BMG unit and upstream fuel pretreatment and/or downstream synthesis processes are now realized already at the pilot scale whereas in the past this integration was only made at larger, more complete demonstration plants. Although, in some cases there may be good technical motives for the integration already at this scale, the difficulty to realize the demonstration scale project could be a likely explanation, as there is a tendency to go from an integration at pilot scale to the prototype industrial plant, without any intermediate demonstration unit.

TASK 33 WEBSITE

By Jitka Hrbek, TUV, Austria

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

A schematic figure of thermal biomass gasification, with input and output of the process can be found on the first site. Cellulosic biomass (mostly forest and agricultural residues) is converted by thermal gasification into heat and/or power and steam and/or synthesis gas, which can be used for production of liquid fuels (e.g. Fischer Tropsch liquids, mixed alcohols, or gasoline), hydrogen, methane, and other chemicals.

The webpage consists of eight sections:

- Thermal Gasification of Biomass
- Task Description
- Participants
- Publications
- Country Reports
- Meeting Minutes & Presentations
- Future Task Meetings
- Thermal Gasification Facilities - Database

The section "Thermal Gasification of Biomass" is new. The short, clear description of the gasification process, products and product gas usage can be found here. It is possible to download a table with primary gasification reactions, which provides important information on thermal biomass gasification process.

The section "Participants" was created from the former "Member countries" and "National representatives" sections. Here, the contact information about Task33 members can be found. In this Triennium 2010-2012, there are 21 Task 33 members from 13 countries.

National Task Leaders provide an update on their country reports regularly. The actual status of biomass gasification in all member countries can be found in the section "Country Reports".

Within two weeks after the Task 33 meetings, all presentations from meeting and joined workshop are posted on the webpage in section "Meeting Minutes & Presentations". And also the Meeting minutes, after the approval by all Task 33 members, can be found here.

In the section "Future Task Meetings" the Task 33 members informed about the next meeting and Workshop topics for the Triennium 2013-2015.

The important part of the webpage is the section "Thermal Gasification Facilities", which consists of a worldwide gasifier database.

Biomass Gasification Database
By Jitka Hrbek and Reinhard Rauch, TUV, Austria

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

At the present, 87 gasification facilities are active in the database. Fifty-four of them can be found in Task 33 member countries and 33 in other countries as shown in the following table.

Austria	9	NZ	1
Denmark	7	Norway	0
Italy	0	Sweden	4
Finland	4	Switzerland	4
Germany	7	Turkey	2
Japan	2	USA	8
Netherlands	8	Total	54

All gasification facilities can be divided by technology, type and status.

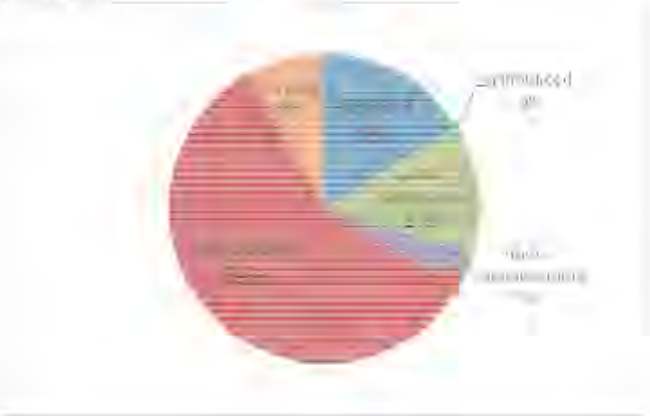
There are four technologies of gasifiers in the database:

Co-firing (4 gasification facilities)
CHP (37 gasification facilities)
Synthesis (34 gasification facilities)
Other innovative (12 gasification facilities)

There are three types of gasifiers displayed in the database (pilot, demo and commercial). Nearly a half of all gasification facilities (47%) are commercial, 27 % pilot plants and 26% demo plants.

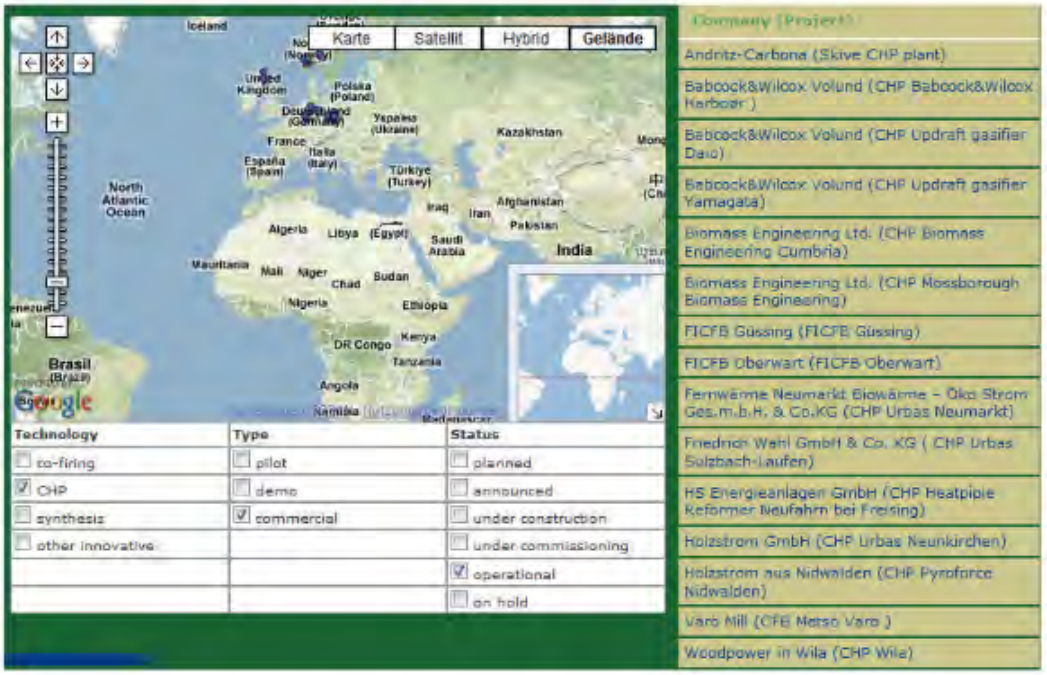
All gasification facilities can be divided also by status:

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



As can be seen in the figure above, the majority of all 87 gasification facilities are now in operation (59%), an additional 14% are in construction, 3% are in commissioning and 16% are planned. Only 8% of all gasification facilities are on hold.

Not only technology, type and status of the gasification facilities can be found in the database.
If technologies, types or status of the facilities are selected, the table on the right can be seen.



As an example, the FICFB gasifier in Oberwart in Austria was chosen.

As can see in the table below, all the important information including location, technology, raw material used, input and output data, products, facility type, partners, total investment, status and start up is displayed. Also a short technology brief or a flow sheet is enclosed. If there is more information needed, the contact person displayed in the table can be contacted to answer questions concerning the gasification facility.

Data sheet:	
Coordinating Organisation/Company	FICFB Oberwart
Project Name	FICFB Oberwart
Location	Oberwart, 7400, Austria
Technology	CHP conversion
Raw Material	lignocellulosics; wood chips
Input	8,7 MWfuel
Product	heat; power;
Output	1-6 MWth; 2,7 MWel
Facility Type	commercial
Partners	Ortner Anlagenbau
Total Investment	16 M Euro
Status	operational
Start-Up	2008
Technology Brief	FICFB, steam as oxidizing agent in gasification zone, air in combustion zone In Oberwart the second Biomass CHP with the concept of the FICFB gasification system was realised. It consists similar to the biomass CHP Güssing of gas generation in a DFB system, gas cooling and gas clean-up in a bag filter followed by a tar scrubber. The cooled and cleaned producer gas is fed into two gas engines for power generation. In addition there is an biomass drying unit and an organic rankine cycle (ORC) integrated, to have a higher electric efficiency. For the ORC all heat at the biomass CHP is collected by thermo-oil and transferred in the ORC in electricity.
Contact Person	Ing. DI (FH) Dr. Klaus Bosch ; Tel.: +43 (0) 26829015-752
Picture	

The database is updated regularly. It is based on the member countries Country Reports and information from the National Task Leaders. It is very helpful for searching about information in the thermal biomass gasification area.

Task 33 Overview

Objectives: To promote commercialization of biomass gasification (BMG) to produce fuel and synthesis gases that can be subsequently converted to substitutes for fossil fuel based energy products and chemicals, and lay the foundation for secure and sustainable energy supply; to assist IEA Bioenergy Executive Committee activities in developing sustainable bioenergy strategies and policy recommendations by providing technical, economic, and sustainability information for BMG systems; to conduct subtask studies to review and evaluate information from the current worldwide RD&D programs and operating gasification systems to identify and resolve barriers for advancement of economical, efficient, and environmentally preferable BMG processes; and to enable National Team Leaders (NTLS) to develop forward looking strategies and policies to implement programs in their respective countries, and help 'leapfrog' resource consuming repetitive and redundant exercises

The Task builds on a number of years of activities that have concentrated primarily on technical barriers to development and commercialization of BMG for diverse markets, e.g., small scale combined heat and power systems (CHP), utility scale CHP systems, and emerging liquid fuels and chemicals markets. A major is devoted to dissemination of international status and BMG development through a series of workshops in member countries. Workshop presentations are posted on the Task website. The Task has developed a BMG projects database for member countries that is posted on the Task 33 website.

Our work programme involves

- *Organize semi-annual Task Meetings to exchange and review global RD&D programs and projects to identify barriers to commercialize BMG.*
- *NTLs will prepare and update Country Reports and RD&D needs and make them available for use by other NTLS and Executive Committee members to aid in the development of their respective national BMG and bioenergy plans.*
- *Conduct subtask studies, including technical workshops, with industrial and academic experts to address the key barriers to advancing BMG on a country and global basis.*
- *Conduct joint studies/workshops with related tasks, annexes, and other international activities to pursue mutually beneficial investigation.*

FUTURE MEETINGS

April 17-19, 2012—Task Meeting and Workshop, Istanbul, Turkey

November 12-16, 2012—IEA Bioenergy Conference and Task Meeting, Vienna, Austria

Task 33 Newsletter , Vol.1 und Vol. 2 – Österreich

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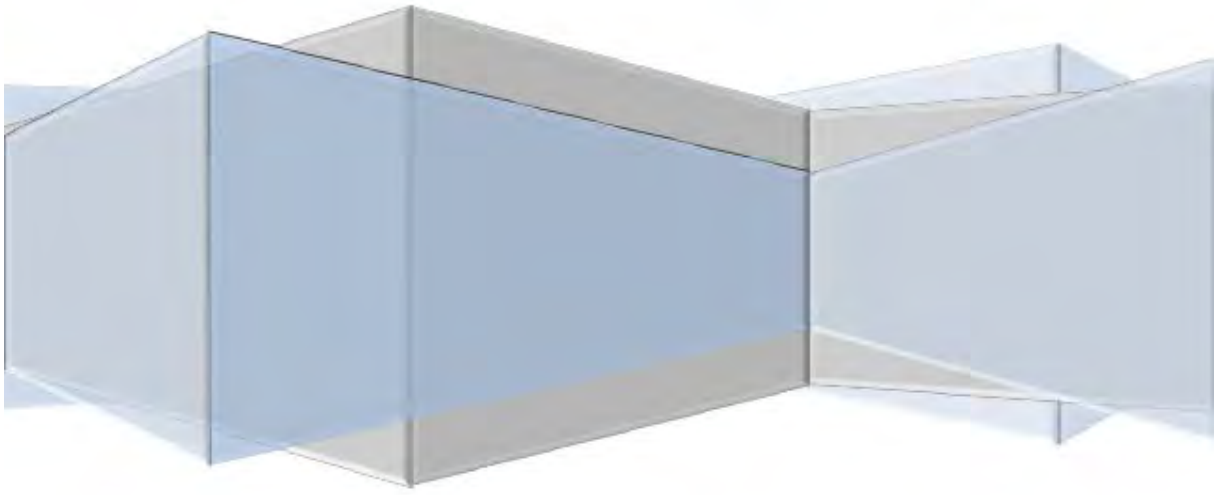
IEA Bioenergy – Task 33: Thermische Biomasse Vergasung

NEWSLETTER Vol. 1/2012

Verfasst von Dr. Jitka Hrbek, TU Wien, Institut für Verfahrenstechnik



1. Einführung

Task 33 ist ein internationales Expertenteam im Bereich thermischer Vergasung von Biomasse. Die Aufgaben des Tasks 33 sind:

- Informationsaustausch zwischen den teilnehmenden Staaten und der Industrie
- Forschung und Entwicklung im Bereich der thermischen Biomassevergasung
- Förderung der effizientesten, sparsamsten und umweltfreundlichsten Vergasungstechnologien für die Produktion von Kraft, Wärme, Dampf und für die Herstellung von Synthesegas, das in Chemikalien, Düngemittel, Wasserstoff und Bio-Treibstoffe umgewandelt werden kann

Teilnehmende Staaten sind Österreich, Dänemark, Finnland, Deutschland, Italien, Japan, Niederlande, Neuseeland, Norwegen, Schweden, die Schweiz, die Türkei und die USA.

In Österreich wird die Teilnahme an dem Task 33 durch BMVIT unterstützt im Rahmen der IEA Forschungskooperation. Die Vertreter sind Dr. Reinhard Rauch, TU Wien (National Team Leader) (**reinhard.rauch@tuwien.ac.at**) und Dr. Jitka Hrbek, TU Wien (**jitka.hrbek@tuwien.ac.at**).

2. Highlights des Triennium 2010-2012

Im laufenden Triennium 2010-2012 wurden bis jetzt 5 Meetings jeweils mit einem Workshop veranstaltet. Die Themen der letzten Workshops umfassten die Bereiche wie Biotreibstoffe der neuen Generation, Biomassevergasung und Verbrennung in kleinem Maßstab, Biomassevergasung und Entwicklung der Alternativen Brennstoffen, Vergasung der Biomasse und Möglichkeiten der Holzindustrie und Bettmaterialien für thermische Biomassevergasung. Alle Vorträge zu diesen Workshops sind online aufrufbar unter **www.ieatask33.org** (Meeting Minutes and Presentations).

Biotreibstoffe der neuen Generation (Advanced biofuels)
An diesem Workshop haben sich die führenden Firmen und Forschungsinstitute aus Finnland, den Niederlanden, Österreich, der USA, der Türkei und Schweden, die im Bereich der Biomassevergasung tätig sind, präsentiert. Die Firma ECN aus den Niederlanden hat Neuigkeiten über Biosyngas und BECCS (Bioenergy Carbon Capture and Storage) präsentiert sowie weitere Möglichkeiten der Produktion von Biotreibstoffen erläutert. Andritz Carbona, eine Firma die im Bereich BFB&CFB Biomassevergasung tätig ist hat über die Druckvergasung von Biomasse berichtet. TU Wien hat einen schönen Überblick über die Produkten die aus Synthesegas hergestellt werden können gegeben. Höchstinteressant war ein Vortrag von Neste Oil über Flüssige Biotreibstoffe die als Ersatz für fossile Treibstoffe in Finnland Verwendung finden könnten.
NSE Biofuels, eine Kooperation von Stora Enso und NSE Biofuels, präsentierte die neusten Entwicklungen im Bereich BtL.

NREL aus den USA hat eine techno-ökonomische Bilanz über die Produktion von den gemischten Alkoholen via Entrained flow- Vergasung präsentiert. Über eine techno-ökonomische Bilanz bei der Herstellung der flüssigen Biotreibstoffen hat auch das PSI (Paul Scherrer Institut) berichtet. Simulationsstudien der Herstellung der Biotreibstoffe wurden bei Tubitak MRC aus Türkei präsentiert. Sehr interessant war auch ein Vortrag von VTT (Research Institute of Finland) über CFB und BFB Vergasung und Syngasanwendungen in großem Maßstab. Alle Vorträge finden Sie unter:
http://128.131.132.12/app/webroot/files/file/minutes_and_presentations/Helsinki_Jun2010/Helsinki_Workshop.pdf

Biomassevergasung und Verbrennung in kleinem Maßstab (Small scale biomass co-generation techn. status and market opportunities)
Der Workshop wurde zusammen mit Task 32 "Biomasseverbrennung" veranstaltet da die Grundlagen der thermischen Biomasseumwandlung für beide dieselben sind, wobei sich die Prozessbedingungen wesentlich unterscheiden. Es wurde über Vergasung und Stirling Turbinen Anwendungen berichtet, und auch über gestufte Vergasung von Biomasse. Viel Aufmerksamkeit haben die Vorträge über Gleich-, Indirekt- und Gegenstromvergasung bekommen. Höchstinteressant war auch ein Vortrag über den Biomassevergaser in Skive, Dänemark. Es wurden auch Betriebshindernisse zugegeben und die Weise der Behebung präsentiert. Alle Vorträge können Sie unter
http://128.131.132.12/content/home/minutes_and_presentations/2010_October_Workshop/
herunterladen.

Vergasung und Entwicklung der alternativen Treibstoffen (Gasification and alternative fuels development)
Dieser Workshop wurde in Neuseeland veranstaltet, deswegen haben sich hauptsächlich die Firmen und Vorschungsinstitute aus NZ und Australien beteiligt und über ihre Ergebnisse berichtet. Interessant war ein Vortrag über Vergasung von Biomasse-Kohle Mischungen von CRL Energy Ltd. Als Neuigkeit wurde die unterirdische Kohlevergasung vorgestellt von Solid Energy, NZ. University of Canterbury, NZ hat über Wasserstoffproduktion via dual fluidized bed reactor und über eine Entwicklung von dem Reactor und Katalysatoren für Fischer-Tropsch Synthese berichtet. Alle Präsentationen finden Sie hier:
http://128.131.132.12/content/home/minutes_and_presentations/2011_April_Workshop/

Möglichkeiten der Biomassevergasung in Holzindustrie (Biomass gasification opportunities in the forest industry)
Auf diesem Workshop haben Firmen hauptsächlich aus Schweden, Finnland, USA und Österreich ihre Vorträge gehalten. Es wurde über Vergasung der flüssigen Brennstoffe in Schweden berichtet (Blackliquor gasification) und über Forschung an ETC, Schweden im Bereich der Biomassevergasung. Chemrec, Schweden hat eine interessante Präsentation über Pilotanlage und BioDME gehalten. Es wurden auch die Forschungsprojekte in VTT (Finnisch Forschungsinstitut) präsentiert. TU Wien und Bioenergy 2020+ hat über Erzeugung verschiedener Produkten aus Synthesegas berichtet. Einen sehr informativen Beitrag zu diesem Thema hat auch METSO aus Finnland geleistet, wenn es über Vergasungstechnologie berichtet worden ist. Zum Schluss wurde ein Überblick über Klimaänderung und Holzindustrie in USA berichtet. Hier können Sie alle Vorträge finden:
http://128.131.132.12/content/home/minutes_and_presentations/2011_10_pitea_workshops/

Bettmaterialien in Biomassevergasung (Bed materials)
Bei diesem Workshop wurde EERA, eine Initiative mit 10 (+5) führenden Europäischen F&E Instituten vorgestellt. Das Ziel ist das Vorantreiben von neuen Energietechnologien und Koordination von Europäischen Projekten. Weiter wurde es berichtet über Bettmaterialien, die im Prozess der Biomassevergasung eine wesentliche Rolle spielen. Es wurden die Ergebnisse von Tests mit verschiedenen Bettmaterialien bei Biomassevergasung präsentiert. Die Einwirkung an Teere Bildung und Senkung wurde diskutiert. Sehr interessante Vorträge über Vergasung in Österreich sowie in der Niederlande und Türkei wurden gehalten. Alle Präsentationen von diesem Workshop finden Sie unter:
http://www.ieatask33.org/content/home/minutes_and_presentations/2012_April_WS/

3. Ausblick

Das letzte Task 33 Meeting im laufenden Triennium wird zusammen mit der IEA Bioenergy Konferenz im November in Wien stattfinden (**www.ieabioenergy2012.org**).
Für das kommende Triennium (2013-2015) ist die Behandlung der folgenden Schwerpunkte geplant:

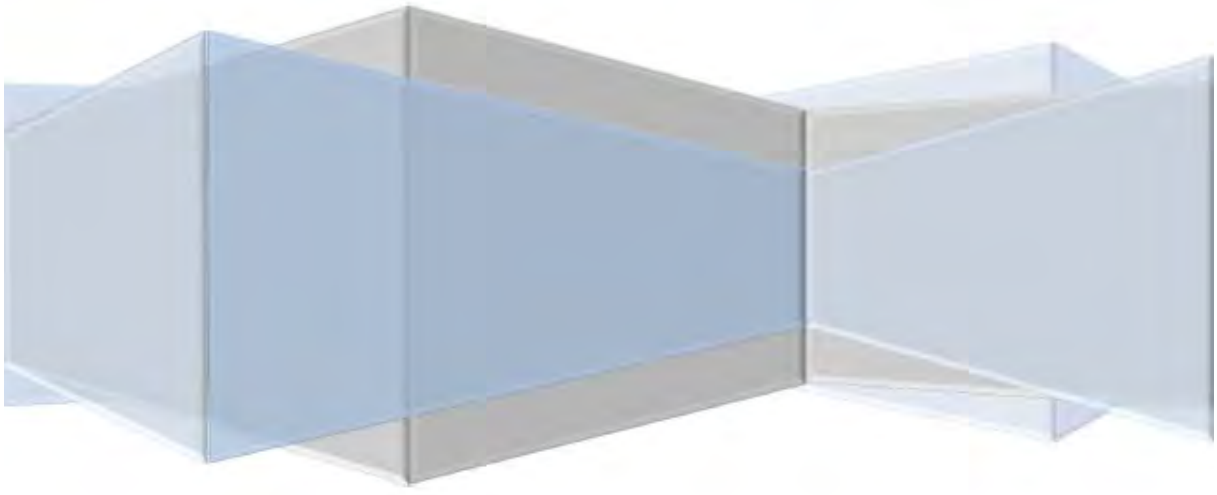
1. Bed materials in fluidised bed gasification
2. Product gas cleaning and usage
3. Tar formation, analysis and removal
4. Small scale fixed bed gasification
5. Analysis & measurements (trace components)
6. Sustainability
7. Fuel pre-treatment, demands of gasifiers on fuel quality
8. Drop in fuels

IEA FORSCHUNGS KOOPERATION FFG bmvit

IEA Bioenergy – Task 33: Thermische Biomasse Vergasung

NEWSLETTER Vol. 2/2012

Verfasst von Dr. Jitka Hrbek, TU Wien, Institut für Verfahrenstechnik



1. Einführung

Task 33 ist ein internationales Expertenteam im Bereich thermischer Vergasung von Biomasse. Die Aufgaben des Tasks 33 sind:

- Informationsaustausch zwischen den teilnehmenden Staaten und der Industrie
- Forschung und Entwicklung im Bereich der thermischen Biomassevergasung
- Förderung der effizientesten, sparsamsten und umweltfreundlichsten Vergasungstechnologien für die Produktion von Kraft, Wärme, Dampf und für die Herstellung von Synthesegas, das in Chemikalien, Düngemittel, Wasserstoff und Bio-Treibstoffe umgewandelt werden kann

Teilnehmende Staaten sind Österreich, Dänemark, Finnland, Deutschland, Italien, Japan, Niederlande, Neuseeland, Norwegen, Schweden, die Schweiz, die Türkei und die USA.

In Österreich wird die Teilnahme an dem Task 33 durch BMVIT und FFG unterstützt im Rahmen der IEA Forschungskooperation. IEA-Verantwortliche sind: Frau Martina Ammer von BMVIT, sowie Frau Karin Hollaus und Frau Maria Bürgermeister vom FFG. Die Vertreter sind Dr. Reinhard Rauch, TU Wien (National Team Leader) (**reinhard.rauch@tuwien.ac.at**) und Dr. Jitka Hrbek, TU Wien (**jitka.hrbek@tuwien.ac.at**).

2. IEA Bioenergy Konferenz

Vom 13. Bis 15. November 2012 hat die IEA Bioenergy Konferenz in Wien stattgefunden. Insgesamt 235 IEA Bioenergy Taskmitglieder, Studenten und Spezialisten aus dem Bereich der erneuerbaren Energie, davon 49 Vortragende aus 16 Ländern haben bei der Konferenz teilgenommen. Nähere Informationen können Sie unter **www.ieabioenergy2012.org** finden.
Im Bereich der Biomassevergasung wurden vier interessante Vorträge präsentiert.

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

Die volle Version der Vorträger können Sie auf der Task 33 Webseite finden (**www.ieatask33.org**)

Status and future of BioSNG in Europe

BioSNG (biogenes Synthetisches Erdgas) ist ein Produkt, das mittels Biomassevergasung, nachgefolgt von der Gasreinigung und Konversion zu Methan hergestellt werden kann. Es handelt sich um ein Bioprodukt, das als vollwertiger Ersatz des Erdgases angewendet werden kann.
In Großbritannien ist die Erdgasnetz sehr gut ausgebaut allerdings wird die Eigenproduktion des Erdgases immer niedriger. Deswegen ist auch der Bau 50-100MW Anlagen für Abfallvergasung inklusive Konversion zu BioSNG geplant damit der Gasverbrauch gedeckt werden kann.

Auch in den Niederlanden ist Erdgas sehr wichtig mit einem Anteil von 44% am Primärenergieverbrauch. Für 2014 ist es eine SNG Demoanlage mit 12 MW geplant. Die Technologie basiert auf MILENA Vergasung und OLGA Teerentfernung. In der Zukunft ist der Bau der großen SNG Anlagen (100 MW+) geplant. Es ist vorgesehen, dass in 2030 3bcm/y und in 2050 30bcm/y BioSNG produziert werden können.
In der Schweiz wurde noch kein Ziel bezüglich BioSNG gesetzt. Die Schweiz lässt sich alle Möglichkeiten offen, hat jedoch bereits zahlreiche Anlagen zur Aufbereitung von Biogas und verwendet dieses teilweise im Transportsektor.
In Schweden ist die Gasnetz ziemlich limitiert, deswegen ist BioSNG ist für Transportsektor interessanter. Aber die Hauptrolle bei der Verbreitung von BioSNG spielen die CO_2 Taxen die sich auf Erdgas beziehen. Derzeit gibt es 2 größere Projekte in Schweden, die sich auf BioSNG-Erzeugung (GoBiGas, Bio2G)konzentrieren.
Auch in Österreich gibt es bis jetzt kein bestimmtes Ziel oder Regelung bezüglich BioSNG-Produktion. Mit der erfolgreichen Demonstration der Biomassevergasung und BioSNG Produktion in Güssing, sieht sich Österreich eher in der Rolle als Technologieentwickler.

Thermal biomass gasification for CHP - Danish success stories

Eine Übersicht der Vergasungstechnologien in Dänemark kann man in der folgenden Tabelle sehen.
Bis 2035 sollte der Strom und Wärme ausschließlich aus erneuerbarer Energie kommen. Bis 2050 sollte der ganze Energieverbrauch aus erneuerbare Energie gedeckt werden.

Technology name	Stakeholders	Technology	Purpose	Status	Plants	Hours	T to c.
Alternating Gasifier	Ammongas, Vølund	Twin bed filter	Fuel (gas)	Pilot	1	50	1-2
Vølund Updraft Gasifier	B&W Vølund	Updraft	CHP	Commercial	4	130 000	0
CHP System of BioSynergi	BioSynergi	Open core dd	CHP	Pilot	1	6 000	2-3
Staged Down Draft Gasification	Weiss, DTU, Cowi	Multiple steps dd	CHP	Demo	2	4 000	1
Pyroneer	DONG, DFBT, DTU	LTCFB	CHP	Pilot	4	700	>4
Close Coupled Gasification	EP Engineering	Vibrating grate FB	CHP	Pilot	1	1 000	2
Sublimator	Frichs	CDP	CHP	Commercial	0	?	0
Catalytic Low Temp. Pyrolysis	Organic Fuel Tech.	Catalytic LT Pyrol.	Fuel	Pilot	1	300	1-2
Updraft Gasifier & Stirling	Stirling DK	Updraft	CHP	Commercial	6	12 000	0
BlackCarbon	Stirling DK	Pyrolysis	CHP	Demo	1	2 400	2
Biomass Gasification Gas Engine	Carbona, Aaen	CFB	CHP, fuel	Demo	1	6 500	2-3

Tabelle: Vergasungsanlagen in Dänemark

Biomass steam gasification - A platform for synthesis gas applications

Das Biomassekraftwerk Güssing und Oberwart, welche sich zu Plattformen für die verschiedenen Synthesen aus Synthesegas entwickelt hat, wurden vorgestellt, wie z.B. Polygeneration, BioSNG, FT Synthese, Bio- Wasserstoffherstellung, Gemische Alkohole.

Jetzt sowie auch in der Zukunft wird der Fokus bei der Biomassevergasung nicht nur auf die Erzeugung von Strom und Wärme gelegt, sondern mehr auf die Produkte, die aus dem Synthesegas hergestellt sind, wie z.B. flüssige Biotreibstoffe, die im Transportsektor verwenden werden können um die fossile Brennstoffe zu ersetzen und die negative Auswirkung auf die Umwelt verhindern.

Synthesis of Bio-LPG from Biomass-derived Syngas in Japan

Das Erdbeben in März 2011 hat ein Umdenken in Energieversorgung in Japan verursacht. Das Land verfügt über 25 Mil. Ha Waldfläche, deswegen bietet sich die Biomasse als eine der Ressourcen von Bioenergie.

Eine der nationalen Projekte ist die Erzeugung von BioLPG via Entrained Flow Vergaser und Synthese aus Produktgas. Dazu wird ein Methanol- Zeolite-Katalysator verwendet. Es ist geplant 5,8 kt/y von BioLPG zu herstellen.

3. Ausblick

Für das neue Triennium (2013-2015) ist die Behandlung der folgenden Schwerpunkte in Form von Workshops geplant:

9. Bed materials in fluidised bed gasification
10. Product gas cleaning and usage
11. Tar formation, analysis and removal
12. Small scale fixed bed gasification
13. Analysis & measurements (trace components)
14. Sustainability
15. Fuel pre-treatment, demands of gasifiers on fuel quality
16. Drop in fuels

Nähere Informationen und Termine können Sie auf **www.ieatask33.org** finden. Alle Firmen sind zu den Workshops herzlich eingeladen!