
International Energy Agency
Bioenergy Agreement
Task 32, Triennium 2004 - 2006
Biomass Combustion and Cofiring

Working Group Meeting
Arranged by:

Jaap Koppejan, TNO, Netherlands

Content:

Minutes of the 4th Task Meeting, triennium 2004 - 2006
Working Group Meeting-Biomass Combustion and Cofiring

October 18 and 21, 2005
Paris, France

IEA Working Group Meeting Task 32
Biomass Combustion and Cofiring
October 18 and 21, 2005, Paris, France

Table of contents

Programme.....	3
Attendance list	5
Task 32 meeting, Tuesday 18 October, 2005	8
Opening (Sjaak van Loo).....	8
Report of last meeting.....	8
News from ExCo:	8
Progress in revision of Handbook (2nd edition).....	10
Short country reports (facultative).....	12
Task funded projects: general information	15
Planning of workshops, synergy with other networks	17
Next meetings	17
Workshop on Recent Developments in Small Scale Combustion Devices, 21 October 2005	19
Future actions of Task 32	22
Annexes	
Annex 1.	Overhead sheets presented by Sjaak van Loo
Annex 2.	Article with statement on biomass cofiring in Biomass and Bioenergy Update
Annex 3.	Country presentation for Switzerland, Thomas Nussbaumer
Annex 4.	Country presentation for Sweden, Claes Tullin
Annex 5.	Country Presentation for Denmark, Anders Evald
Annex 6.	Book presentation: Production and utilisation of pellets – production process, properties, combustion technology, ecology and economy, Gerold Thek
Annex 6.	Biomass Action Plan in the Netherlands, Kees Kwant

Programme

Tuesday October 18, 2005: Task meeting

Location: Hotel Splendid Etoile, Paris, France

From	Topic
09:00	Opening
09:05	Report of last meeting
09:10	News from ExCo: <ul style="list-style-type: none">- Cofiring statement- Technology / Policy paper on aerosols- Plans for next triennium
09:45	Progress in revision of Handbook (2 nd edition)
10:30	<i>Refreshment Break</i>
11:00	Short country reports (facultative)
13:15	<i>Lunch break</i>
14:10	Task Projects: <ul style="list-style-type: none">- Global inventory of cofiring- Striated Flows- Impacts on SCR Catalyst Performance- Determination of efficiency
14:50	Planning of workshops, synergy with other networks
15:00	Next meetings
15:15	Closing
20:00	<i>Task 32 dinner</i>

**Friday October 21, 2005:
Workshop on Recent Innovations in Small Scale
Combustion**

Location: Palais des Congres, Paris, France

From	Topic
9:20	Introduction Jaap Koppejan, IEA Bioenergy Task 32
9:30	Austrian pellet boiler technologies - state-of-the-art, ecological evaluation and future developments Gerold Thek, Bios Bioenergiesysteme GmbH, Austria
10:10	Break
10:40	Assessment of factors affecting hazardous emissions from residential wood-burning appliances Fernando Preto; CANMET Energy Technology Centre – Ottawa, Canada
11:10	A systematic process identification as a tool for combustion control design Kai Pietila, VTT, Finland
11:40	A novel electrostatic precipitator (ESP) for residential combustion Morten Berndtsen, the National Institute of Technology, Environment and Safety, Oslo, Norway
12:10	Closing PD Dr. Thomas Nussbaumer, Verenum, Switzerland

Attendance list

Task 32 country representatives at the task meeting

Gerold Thek
(for this meeting representing task member
Ingwald Obernberger)
Inst. for Resource Efficient and Sust.
Systems
Working group thermal biomass utilization
Technical University of Graz
Inffeldgasse 25
A - 8010 GRAZ
Austria
tel +43 316 481300
fax +43 316 4813004
obernberger@rns.tu-graz.at
www.rns.tu-graz.at

Behdad Moghtaderi
(for this meeting representing Task
member Brett Corderoy)
Chemical Engineering
School of Engineering
Faculty of Engineering & Built
Environment
The University of Newcastle
University Drive
Callaghan NSW 2308
Australia
Ph: +61 (2) 4921-6183
Fax: +61 (2) 4921-6920
Behdad.Moghtaderi@newcastle.edu.au
www.newcastle.edu.au

Sebnem Madrali (Task member)
Canmet Energy Technology Centre-Ottawa
(CETC-O)
Renewable Energy Technologies
Bioenergy Development
580 Booth Street, Ottawa
Ontario K1A 0E4
Government of Canada
tel. +1 613 996-3182
fax. +1 613 996 9416
smadrالي@nrcan.gc.ca
www.nrcan.gc.ca

Anders Evald (Task member)
FORCE Technology
Gladsaxe Mollevej 15
DK-2860 SOBORG
Denmark
tel +45 39 555999
fax +45 39 696002
aev@force.dk
www.force.dk

Erich Nägele (Task member)
European Commission
DG RTD J3
MO75 7/18
Rue de la Loi, 200
B-1049 BRUSSELS
Belgium
tel +32-2-296-5061
fax +32-2-299-3694
Erich.Naegle@cec.eu.int
www.europa.eu.int

Hans Hartmann (Task member)
Technologie- und Forderzentrum
Schulgasse 18
D-94315 Straubing
Germany
tel: +49 9421300112
fax: +49 9421 300211
hans.hartmann@tfz.bayern.de
www.tfz.bayern.de

Sjaak van Loo (Task leader)
TNO-MEP
P.O. Box 342
7300 AH APELDOORN
Netherlands
tel +31 55 5493745
fax +31 55 5493740
S.vanLoo@mep.tno.nl
www.mep.tno.nl

Jaap Koppejan
(Assistant Task Leader)
TNO-MEP
P.O. Box 342
7300 AH APELDOORN
Netherlands
tel +31 55 5493167
fax +31 55 5493740
J.Koppejan@mep.tno.nl
www.mep.tno.nl

Kees Kwant (Alternate Operating Agent)
SenterNovem
PO Box 8242
3503 RE UTRECHT
Tel: +31 - 30 -2393458
Fax:+31 - 30 -2316491
k.kwant@senternovem.nl
www.senternovem.nl

Øyvind Skreiberg, Ph.D. (Task member)
Research Scientist
Dept. of Energy and Process Engineering
Faculty of Engineering Science and
Technology
NTNU, N-7491 Trondheim
Norway
tel +47 69 261831
fax +47 99 137857
Oyvind.Skreiberg@ntnu.no
www.ept.ntnu.no

Observers at Task meeting:

John Tustin
Secretary, IEA Bioenergy ExCo
9 Moncur Drive
Rotorua
NEW ZEALAND
Tel: +64 7 348 2563
Fax: +64 7 348 7503
jrtustin@xtra.co.nz
www.ieabioenergy.com

Claes Tullin (Task member)
Swedish National Testing and Research
Institute
Box 857
S-501 15 BORAS
Sweden
tel +46 33 16 5555
fax +46 33 131979
claes.tullin@sp.se
www.sp.se

Thomas Nussbaumer (Task member)
VERENUM
Langmauerstrasse 109
CH-8006 ZÜRICH
Switzerland
tel +41 1 3641412
fax +41 1 3641421
thomas.nussbaumer@verenum.ch
www.verenum.ch

Fernando Preto
Group Leader - Biomass Conversion
CANMET Energy Technology Centre –
Ottawa
Natural Resources Canada
Canada
tel: +1-613-996-5589
fax: +1-613-992-9335
preto@nrcan.gc.ca
www.nrcan.gc.ca

Task 32 country representatives, absent at the task meeting:

Ingwald Obernberger
(Task member, for this meeting
represented by Gerold Thek)
Inst. for Resource Efficient and Sust.
Systems
Working group thermal biomass utilization
Technical University of Graz
Inffeldgasse 25
A - 8010 GRAZ
Austria
tel +43 316 481300
fax +43 316 4813004
obernberger@rns.tu-graz.at
www.rns.tu-graz.at

Brett Corderoy (Task member, for this
meeting represented by Behdad
Moghtaderi)
Development and Research Analyst
Delta Electricity
Level 12, Darling Park
201 Sussex Street
Sydney 2000
Australia
tel +61 2 4390 1758
fax +61 2 9285 2780
Brett.Corderoy@de.com.au
www.de.com.au

Jerome Delcarte (Task member)
Département de Génie Rural
Centre de Recherche Agronomiques
Chaussée de Namur, 146
B 5030 Gembloux
tel. +32 81 61 2501
fax +32 81 61 5847
delcarte@cragx.fgov.be
www.cragx.fgov.be

Erik W.J. Wissema (Operating Agent, for
this meeting represented by Kees Kwant)
Directorate General for Competition and
Energy
Ministry of Economic Affairs
Energy Production Department
P.O. Box 20101
2500 EC THE HAGUE
tel. +31-70-379-7718
fax:+31-70-379-6358
e.w.j.wissema@minez.nl
www.minez.nl

William R. Livingston (Task member)
Group leader - fuel technology
Mitsui Babcock Energy Limited
Technology Centre
High Street
Renfrew PA4 8UW
Scotland, UK
tel +44 141 8862201
fax +44 141 8853370
wlivingsto@mitsuibabcock.com
www.mitsuibabcock.com

Task 32 meeting, Tuesday 18 October, 2005

Opening (Sjaak van Loo)

The fourth meeting of IEA Bioenergy Task 32 in the triennium 2004-2006 took place on Tuesday 18 October 2005 in Hotel Splendid Etoile, Paris. In addition to this Task meeting, Task 32 organised a workshop on Recent Developments in Small Scale Combustion systems on Friday 21 October, as part of the 14th European Conference and Exhibition on Biomass for Energy and Industries, see page 19.

Sjaak van Loo welcomed all Task members and an introductory round was made. Except for Belgium, all member countries were represented, including new member Germany. For this meeting, Behdad Moghtaderi represented Australia instead of Brett Corderoy and Gerold Thek represented Austria instead of Ingwald Obernberger. The overhead sheets used by Sjaak van Loo to present several issues on the agenda of this task meeting are included as Annex 1.

Report of last meeting

A few linguistic corrections were provided on the draft report of the last meeting, which was pre-circulated electronically. The report will be finalised and distributed.

News from ExCo:

Germany is now a formal member of the IEA Bioenergy Agreement and has also decided to join Task 32 since 2005. Task member for Germany is Hans Hartmann of the Technologie- und Förderzentrum in Straubing.

Biomass Cofiring

At ExCo55 (Copenhagen, May 25, 2005), Task 32 contributed to a workshop on biomass cofiring with presentations from Jaap Koppejan and Bill Livingston. All presentations from this workshop are available on the members section of the Task 32 website.

The Task32 background paper and statement on biomass cofiring was earlier supplied to the ExCo to serve as one of the inputs for a book on achievements from the different Implementing Agreements of IEA. As there the amount of text needed to be reduced significantly, it was then decided to publish this information elsewhere, namely in Biomass and Bioenergy Update. Copies of this article are enclosed in Annex 2.

The same Task 32 cofiring statement was also discussed at ExCo 55 and 56, and used in the process of drawing conclusions from the ExCo55 cofiring workshop and defining the position of the ExCo. Task32 will continue to provide input to position documents of the ExCo on the subject of biomass cofiring to ascertain that views of Task 32 and the ExCo remain in line on this topic.

Technology / Policy paper on aerosols

For ExCo56 we were asked for the first time to provide a technology report, which describes one development related to the Task coverage in more detail. This opportunity has been used to prepare a summary report on aerosols from biomass combustion, based on the results of the

Task 32 workshop organised in Graz, Austria. This report was greatly appreciated. We will get copies of technical reports provided by the other Tasks.

Strategic policy oriented outputs

It was earlier decided by the ExCo that from 2005 onwards, all Tasks should reserve 10% of their funds for strategic outputs, to be defined later. Task 40 (Biomass Trade) has proposed to coordinate the compilation of a policy paper that tries to answer the question how much the contribution of bioenergy to global energy supply could be and how this could be achieved with appropriate policy measures. For this paper, all Tasks will provide inputs. In the coming months all Tasks should agree with the leader of Task 40 what their specific contribution could be.

Plans for next triennium

There was a discussion in the ExCo how the procedure for delivering task proposals for the next triennium should be arranged. The contents and coverage of different tasks should be such that maximum policy relevant outputs are obtained.

A few months ago Task Leaders were asked to indicate their willingness to continue their Tasks in the next triennium. As for Task 32, almost every individual Task leader reacted positively.

Until March 2006 we will need to prepare a preliminary work programme for follow up of Task 32 in the next triennium. Proposals for work programmes in the next triennium will be presented and discussed in a joint ExCo-Task leader workshop at ExCo57 (March 2006, Paris). Based on comments received, proposals can then be elaborated and approved at ExCo58 (autumn 2006), so that the next triennium can start smoothly for all Tasks.

It was suggested that we should already start to prioritise issues for the Combustion and Cofiring Task for the next triennium. For this purpose, an inventory of major topics was first made, after which individual Task members were asked to give priorities to topics. The following topics were first identified:

Category	Issue
Co-firing	<ul style="list-style-type: none"> - Corrosion and deposit formation mechanisms - Deactivation of SCR - Increasing cofiring percentages - Influencing combustion quality / char burnout - Utilization of biomass ash
Emissions	<ul style="list-style-type: none"> - Flue gas cleaning technologies - Particulates (aerosols) - Primary measures for NOx reduction
Fuel supply	<ul style="list-style-type: none"> - Fuel storage, handling, and preparation (e.g. size reduction) - Identification of optimized fuel/technology combinations
Industrial scale biomass	<ul style="list-style-type: none"> - Processing fuel mixes and use of additives to improve combustion behaviour - Advanced process control / sensor development - Corrosion and deposit formation mechanisms - Improvement of existing and development of new CHP concepts - Influencing combustion quality / char burnout - Utilization of biomass ash
Policy issues	<ul style="list-style-type: none"> - Market introduction issues (new countries..) - System analysis / total energy chain efficiency and economics (CHP/fuels)

Small scale biomass (residential)	<ul style="list-style-type: none"> - Advanced process control / sensor development - Influencing combustion quality / char burnout - Small scale combustion systems
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As a second step, country representatives were asked to rank different topics. As a few member countries were not represented at the Task meeting, the final result of this procedure cannot yet be mentioned here. It was agreed that upon availability of all inputs, the Task leader will communicate the result with the Task members and start to prepare a draft work programme. This document will be prepared in draft and circulated amongst Task members for comments, after which it will be presented at the Task Leaders workshop at ExCo57 in Paris, France.

Progress in revision of Handbook (2nd edition)

Chinese translation

A Chinese translation of the Task 32 produced Handbook of Biomass Combustion and Cofiring is currently under preparation. Preparation of this Chinese edition has been delayed due to difficulties into the translation of some technical terms and finalisation is now due July 2006. Sebnem Madrali (Canada) suggested that the translators could get in touch with Chinese colleagues in her department for specific assistance.

Second edition

Task 32 currently works on a second edition of the same Handbook of Biomass Combustion and Cofiring. Based on an external peer review carried out in 2003, a revised Table of Contents and the division of work was agreed upon in 2004. In 2005 the actual work on rewriting individual chapters has started. During the Task meeting the progress in revision of the handbook was discussed chapter by chapter. The current state per chapter is described below:

Chapter 1 (Introduction)

This chapter will be rewritten completely by TNO once the other chapters have been supplied in draft. This work has not started yet.

Chapter 2 (Basic Combustion Theory)

This chapter will be thoroughly edited under coordination of Norway, with key inputs from Austria. The work is scheduled for Nov 2005-Jan 2006

Chapter 3 (Biofuel production and supply)

This chapter is to be rewritten, and will include system perspectives. Work will be done mainly by Austria, with inputs from Sweden on system analysis.

Chapter 4 (Domestic wood burning applications)

A draft has been prepared by Canada and will be circulated by Jaap Koppejan, Sweden will provide major inputs to Canada in November 2005.

Chapter 5 (Industrial combustion)

The current chapter will be edited by Austria. Information on recent developments in control systems will be supplied by the Netherlands.

Chapter 6 (Power generation and cogeneration)

The existing chapter on power generation has already been edited by Switzerland. Major changes are a more detailed description of the Rankine cycle, as well as more realistic efficiencies. Jaap Koppejan will distribute it for comments.

Chapter 7 (Co-combustion)

The existing co-combustion chapter will be totally revised as a result of the rapid developments in the recent years. Ash related issues will be taken out of this chapter and discussed in the new chapter 8. The chapter will be coordinated by Australia, with major inputs from USA and UK. A key input to the chapter is the Australian handbook on biomass cofiring, which describes cofiring in pulverised coal boilers under typical Australian conditions prepared under coordination of CCSD. The text will be broadened to cover other circumstances as well.

Chapter 8 (Corrosion and ash deposition)

This new chapter will be written by UK and contain information related to ash deposition and corrosion. Major inputs will be provided by Austria and USA.

Chapter 9 (Environmental aspects)

The existing chapter on environmental aspects will be edited by Denmark. For this purpose, all IEA Task 32 member countries are requested to provide Denmark with updated information on national emission legislation and standards related to dealing with by-products. Environmental aspects of cofiring are also to be included in this chapter.

Chapter 10 (Policy aspects)

This new chapter is to be prepared by Netherlands and will contain different (support) policies related to biomass combustion in the member countries of IEA Bioenergy Task 32. It will be composed with inputs from all member countries in the period Nov 2005-Jan 2006.

Chapter 11 (R&D Needs)

This chapter will be coordinated by Austria, with contributions from all countries. John Tustin suggested that in addition to the updated chapters, key inputs could be obtained from information provided by the IEA Bioenergy ExCo for a book on R&D needs. It also strongly relates to the proposed work programme for 2007 onwards for Task 32.

As can be concluded from the above overview, the production of several individual chapters has been delayed by approx 6 months. As we will maintain our target to finalise the revised edition in this triennium, the timeframe for preparation of the individual chapters in draft and editing of the manuscript has been compacted and will be in accordance to the below time frame:

- Production of revised chapters by authors in draft (Feb 2006)
- Editing of the revised handbook to a revised draft (March – April 2006)
- Discussion of first revised draft of new edition (Task meeting, May 2006)
- Finalization and printing of the revised handbook (Summer 2006)
- Presentation of printed version (Task meeting, autumn 2006)

Short country reports (facultative)

The following Task 32 country representatives provided brief updates on developments related to biomass combustion in their respective countries:

Switzerland

Thomas Nussbaumer shared information on some recent R&D work in Switzerland, see also Annex 3. Currently there is significant emphasis on methods to reduce emission of NO_x and particles (aerosols) from wood stoves and boilers. NO_x reduction measures such as air and fuel staging, flue gas recirculation and advanced process control are being further developed. Related to particles and aerosols, research is done both to improve the understanding of the formation mechanisms and relate biomass combustion derived aerosols to health impacts.

A new woodlog stove has been designed, with two-stage combustion operation and natural draught. This new design leads to significantly lower emission of particles and aerosols (approx 10 mg/m³) due to the lower primary air ratio (approx 0.3 instead of 0.9).

Thomas Nussbaumer also reported on a feasibility study on an IGCC plant in Switzerland, fired with a mixture of 20% wood gas and 80% natural gas. The study indicated that power production costs between 9 and 14 Rp/kWh could be feasible for a power plant between 100-500 MWe, fired with mixtures of wood and natural gas. The reason for exploring new bioenergy options is the fact that nuclear power will come to an end in 2020.

Finally, an announcement was made for the next Holzenergie-symposium, 20 October 2006 in Zürich, Switzerland.

Sweden

Claes Tullin presented recent developments in Sweden (see Annex 4). The Swedish government recently announced increased R&D budgets for bioenergy, with a focus on short-term implementation. The exact priorities for R&D programs that will commence from 2006 onwards are still under discussion.

A large running Swedish project is running on innovative ways to separate and process waste in a manner that is more attractive from economical and environmental perspectives. SP is particularly involved in the optimization of the combustion process, using 2 waste fired BFB boilers with Advanced Combustion Zone in Borås.

Finally, on May 30- June 1, 2006 in Sweden the World Bioenergy Conference and Exhibition on Biomass for Energy will be held, together with a large pellet conference. At this meeting Task 32 will organise a workshop on fuel flexibility.

European Commission

The Biomass Action Plan is still under development and expected to be finalised November 2005. The plan contains specific measures that EU member countries should take to promote implementation of bioenergy in both the heat, electricity and transportation sector. The priorities of FP7 in the field of bioenergy will be based on the contents of the BAP. More information can be found on the B.A.P. page of the DG-TREN site.

Denmark

Anders Evald presented recent news from Denmark relevant for biomass combustion, see Annex 5 for his brief presentation. The Danish political interest is shifting from bioenergy to hydrogen and liquid biofuels, the lack of received fuel taxes is increasingly mentioned as a drawback of bioenergy. The targets on biomass volumes are more or less met. Nevertheless the interest in small scale bioenergy applications (pellet stoves) is increasing, driven by increasing fuel prices.

With regard to solid biofuels used for district heating systems, wood chips are winning grounds as compared to straw. Nevertheless there are significant R&D efforts to improve straw fired boiler design, reduce NO_x emissions from straw fired boilers and develop effective pre-treatment steps for straw. Other important R&D topics for biomass combustion in general are modelling and control systems

There are well advanced plans to merge the two largest Danish energy companies (E2 and Elsam), which could result in a very large energy company.

Norway

Øyvind Skreiberg presented developments in Norway related to bioenergy. A R&D project of approx. 10 MNOK is currently running in which the combination of a biomass gasifier and a SOFC fuel cell is examined. Feasibility studies are also done on Biomass To Liquids options from Fischer Tropsch gasification routes.

With regard to demonstration, there are plans to construct straw-fired CHP plants for district heating applications. There is about 3-4 TWh of straw available in Norway. In Norway, BIO-CHP plants are planned to be stimulated by green certificates from 2006. Heat plants may receive some 30-40% investment state funding.

Finally, a number of fundamental combustion studies are currently performed on release of HCN and NH₃, removal of H₂S, etc.

Canada

Sebnem Madrali presented some Canadian developments related to biomass combustion.

The Canadian government is launching a renewable power production incentive program, which provides 10 CAN\$ per MWh for producers of renewable electricity. The details of the program are now being fixed. A budget of 70 million CAN\$ is available for realisation of 1500 MWe renewable electricity capacity for 10 years operation. Green certificates are available for biomass fired power plants, in addition 30-50% of the investment may be deducted from company income before tax.

A project for a split gasification+combustion plant for green wood (approx 10 MW_{th}) has been initiated in a veneer plant. As local jurisdiction prevents direct combustion of solid fuels, the installation has been split into a separate gasifier and a separate combustor.

Alternatives are currently examined for the use of natural gas as a fuel to heat greenhouses.

Finally, modelling studies and experimental work is performed to analyse the feasibility of cofiring lignin with coal.

Austria

Gerold Thek presented the contents of the pellet book that has recently been produced by TU Graz in Austria. A lot of effort has been put into the collation of this book, which provides detailed technical, economic and legislative information on the production and utilization of pellets for energy. More information on this book is enclosed in the presentation in Annex 6.

The book has an Austrian focus, but information from other European countries has been included as well. The current edition is published in German language, however there are plans to translate the book into English. Task 32 was asked to consider providing financial support to the production of an English version.

A discussion took place on whether the book should be translated literally from German to English, considering the Austrian focus and the international scope of Task 32. Anders Evald (DK) noted that a similar book is under preparation in Denmark, while Claes Tullin (Se) mentioned that such a book is also available for the Swedish conditions. It was therefore argued that production of an English book would make more sense if views from other countries would be included to the same degree as Austria. As no decision was reached on the support of this translation action during the meeting, this issue will be discussed again later.

Australia

Behdad Moghtaderi presented some recent information from Australia. Major coals being used in Australia are lignite, low rank coal and black coal. Research on coal combustion is jointly carried out between industries and universities, with Univ. of Newcastle performing research on black coal and Univ. of Manchester on low rank coal.

Australia needs to fulfil its Kyoto targets of 2010, it is expected that 67% of the efforts come from biomass, with an estimated contribution of 9 GWh/year. This is mainly to be achieved through cofiring in pulverised coal boilers and Delta, CS Energy and others are already cofiring up to some 5% on mass basis. One interesting R&D project at the University of Newcastle focuses on comilling and cofiring biomass with black coal; the idea is to come up with rules for scaling up to real scale.

Another important topic is the production of an Australian handbook for cofiring. This handbook focuses on the Australian situation with regard to types of coal, biomass and power plants available but will be an important input for the cofiring chapter of the revised edition of the Task 32 handbook on biomass combustion and cofiring.

A 250 million Australian \$ budget has been made available for the 'Coal 21' program, aimed at building an advanced coal fired unit. Other research topics are oxyfuel combustion of biomass and liquid biofuels such as bio(m)ethanol which should replace up to 10% fossil fuels.

Netherlands

Kees Kwant (Operating Agent of T32) presented the results of the Biomass Action Plan which was developed in the Netherlands. The Netherlands aims to produce 9% renewable electricity and 5% renewable energy in 2010. This plan aims to tackle market barriers that hamper implementation of bioenergy and create optimal market conditions. Several stakeholders were

consulted in working groups, which carried out specific studies and formulated strategies how to address individual market barriers related to

- Financial perspectives, e.g. uncertainty about future stimulation of renewable electricity;
- Licensing and permitting, e.g. related to lack of specific knowledge with designated authorities and objections of some environmental groups;
- Availability, e.g. about the current lack of sustainability criteria for biomass import;
- Communication, e.g. related to guidelines for project implementation, definition of what can be considered as truly sustainable and desired forms of bioenergy;
- Technology and know how, e.g. unawareness with several key players on biomass-technology combinations that can be considered as proven;
- EU level playing field considerations related to e.g. different incentives and emission limits,

Details of the barriers and suggestions to address these are included in the presentation, enclosed as Annex 7.

Germany

Hans Hartmann works at the Technology and Förderzentrum of the ministry for Forestry and Agriculture in Straubing, Bayern, Germany and is the new country representative for Germany in Task 32. As this is the first time that Germany is officially represented at a Task 32 meeting, he introduced the situation with regard to bioenergy in Germany.

Applications of bioenergy in Germany are rapidly growing as a result of supporting policies (e.g. feed-in rates) and legislation. For example the growth rate in biogas plants has been more than 100% per year in the last number of years, with currently some 4000 biogas plants in Germany. Maize is often used as feedstock for co-digestion.

For heat-only biomass combustion plants such as pellet stoves, 1700 € of investment subsidy is provided. This has resulted in growth rates of 80% per year over the last few years, with pellet prices declining by approx 25% to a level of approx 170 €/ton for small scale users. With regards to standards for pellets, Austrian standards currently dominate the German market.

Woodlogs are still the largest contributor to bioenergy in Germany. An increasing number of woodlog stoves are being sold in Germany, also stoves that are imported from India and Eastern European states. The price of woodlogs is approx 50-55 €/ton.

With the increasing prices for domestic heating oil, wood logs and wood pellets are considered as the most suitable alternative biofuel for domestic purposes. For BTL routes, straw is considered to be more attractive.

Task funded projects: general information

An overview of the current status of running Task 32 supported activities in the current triennium is provided below, a detailed description follows.

Activity	Current status
1. Internet site	Ongoing
2. Handbook of Biomass Combustion	Preparation of chapters continued
3. Cofiring overview (Jaap Koppejan)	Finished, to be continuously updated
4. Efficiency of biomass combustion (Thomas Nussbaumer)	Ongoing, to be finalised end of 2005
5. Striated Flows (Larry Baxter)	Draft report available
6. SCR deactivation (Larry Baxter)	Finished

Internet site

The Task 32 internet site still attracts approx. 2500 visitors per month. Visitors are mostly interested in downloading meeting reports and publications.

Handbook of Biomass Combustion and Cofiring

The handbook of biomass combustion was already discussed before, see page 10.

Cofiring overview

On the Task 32 internet site, a database of installations is available with experience on cofiring biomass and coal cofired. It is being used quite frequently. Jaap Koppejan urged everyone to supply updated information on plants with new expertise if available.

Determination of efficiency for automatic biomass combustion plants and comparison of efficiency and emissions for different operation modes

This study is performed jointly by Thomas Nussbaumer (Verenum, Switzerland) and Jerome Delcarte (CRA, Belgium). A number of slides are included in the presentation of Thomas Nussbaumer, see Annex 3.

The aim of the study is to demonstrate how the conversion efficiency from delivered fuel to useful heat of automatic biomass combustion plants can be determined in a more cost effective and practical way, so that fuel deliveries can be paid on the basis of heat produced. As the average heating value for a whole heating season is determined, this method is suitable only in case of one single supplier.

Theoretical approaches have been developed by VERENUM, Switzerland to predict the dependence of annual efficiency on plant operation modes. Tests have been performed in an actual 500 kW grate fired boiler at CRA to evaluate how the theoretical approaches work out under practical conditions and measure emissions and efficiencies under part load and full load. Remaining in this project is the determination of uncertainties in the results.

It is anticipated that with the developed method, annual plant efficiency of a typical automatic woodfuel fired heating system can be determined within 5% accuracy, which is considered acceptable for plant operators, keeping in mind current costs and inaccuracy of sampling and testing. The project is expected to be finished by the end of 2005.

Formation of Striated Flows during Biomass-coal Cofiring (Task project)

Although the research in this project has been finalised, we are still awaiting release of the final report.

Biomass Impacts on SCR Catalyst Performance (Task project)

This study is finalised, the report is now available on the Task 32 website. It provides detailed information on the relevance of different deactivation mechanisms of SCR catalysts when cofiring different types of biomass.

Planning of workshops, synergy with other networks

A number of other networks are currently running, for which it is important to examine if we can create synergy with Task 32. Examples are the European Netbiocof network on biomass cofiring and the European ThermalNet network on thermal conversion of biomass. Joint activities between Task 32 and the European ThermalNet network are:

- a workshop on recent developments in small scale biomass combustion (Paris, October 21, 2005);
- a joint meeting on biomass cofiring and ash related issues, September or October 2006 in Glasgow, Scotland,.

Further, Task 32 provided some minor inputs to a workshop on modelling grate furnaces held September 2005 during a ThermalNet conference in Innsbruck. Presentations were delivered by partners in the EU OptiComb project, a project focussed on increasing the flexibility of biomass combustion plants with respect of fuel input, and substantially reduce the emissions with this technology. The reports of this workshops have been made available on the Task 32 website.

Next meetings

The next meeting will be held at the World Bioenergy 2006 Conference and Exhibition on Biomass for Energy in Jönköping, Sweden. This event takes place 30 May – 1 June, 2006. In addition to a regular task meeting, Task 32 will also organise a workshop here on fuel flexibility. The exact date and location of the task meeting and the workshop will be decided once the conference programme is clear in somewhat more detail.

The final meeting of Task 32 will take place in Glasgow, Sept or Oct 2006. This meeting will be held together with a workshop on ash related issues with biomass combustion and cofiring and will include a field trip to a biomass fired power plant.

An overview of all task 32 (co)organised workshops in this triennium is shown below

Topic	Organizing country	Planning
Co-firing	Netherlands	14 May 2004 (already done)
Public perception	Canada	30 August 2004 (already done)
Aerosols	Austria	18 March 2005 (with this Task meeting)
Modelling grate furnaces	Netherlands	21 September 2005 (Task 32 provided input to this ThermalNet/OptiComb workshop)
Small scale systems	Netherlands	October 2005 (as part of the 14 th Eur. Biomass Conference)

Fuel flexibility	Sweden	Spring 2006 (in connection to the World Bioenergy 2006 conference)
Corrosion and deposit formation	UK	Autumn 2006 (in connection to a ThermalNet meeting)

Workshop on Recent Developments in Small Scale Combustion Devices, 21 October 2005

Introduction, Jaap Koppejan, IEA Bioenergy Task 32

This workshop, which was part of the 12th European Bioenergy Conference, was organised jointly by IEA Bioenergy Task32 and the Combustion task within the EU ThermalNet project (COMBNET). The individual presentations are not included with this report, but can be downloaded from the Task 32 website (www.ieabcc.nl).

Jaap Koppejan welcomed all participants and provided a brief introduction to the workshop. Driven by requests for lower emission limits (particularly PM10) and competition for increasingly reliable, efficient and cost effective combustion devices in a growing market, the technical and environmental performance of small scale biomass combustion devices is still improving. This is true for both domestic woodstoves, pellet and wood chip fired boilers.

The workshop presented some of the latest advances in combustion modelling tools, furnace design, combustion control systems, and flue gas cleaning systems to obtain high environmental performance and reliability for small scale combustion applications at minimum costs.

Austrian pellet boiler technologies - state-of-the-art, ecological evaluation and future developments"

Gerold Thek, Bios Bioenergiesysteme GmbH, Austria

Gerold Thek presented an overview of the growing Austrian pellet market and then focused on technology developments in geometry, control systems and boiler technology of small scale pellet combustion systems which have resulted in lower emissions, increased reliability and higher efficiency.

In the last 5 years, the market for pellet boilers in Austria has increased from approx. 2000 per year to approx. 6000 boilers today. The approx. 28.000 pellet boilers used for domestic scale central heating systems alone consume some 216 kton of pellets, in addition there is demand from pellet stoves and larger combustion systems. The 18 pellet producers have a total production of some 500 ktons pellets, the quality of which is regulated by ÖNORM standards for transport, transporation and storage. Similarly, the quality of pellet furnaces produced by some 30 manufacturers is regulated with the ÖNORM EN 303-5.

The combustion quality has improved significantly due to measures such as air staging, flue gas recirculation, automatic heat exchanger cleaning systems, CFD aided design and optimized positioning of secondary air nozzles, and finally improved control systems that guarantee low emissions at all load conditions.

Due to technical improvements, dust emissions of modern pellet furnaces could be reduced in the last 5 years from approx 10-25 mg/MJ to 7-12 mg/MJ today. As the remaining dust consists mainly of aerosols, this emission strongly depends on the composition of the fuel. Similarly, CO emission has gone in the past five years from typically 55 mg/MJ to 30 mg/MJ today.

Some important near future developments are in the areas of CFD aided combustion design, reduced aerosol emissions, integration with solar systems, as well as flue gas condensation. The first pellet boiler with flue gas condensation (efficiency 103% on LHV basis) is already on the market. Finally, there is great interest in Austria for application of Stirling engines for wood chip and pellet furnaces. A few pilot plants of 35 and 70 kW are already in operation.

Assessment of factors affecting hazardous emissions from residential wood-burning appliances; Fernando Preto; CANMET Energy Technology Centre – Ottawa, Canada

Fernando Preto (senior research scientist at CANMET, Canada) presented the results of a recent study in which emission factors (particulate matter, VOC, Dioxins and Furans) for residential wood burning appliances were assessed.

Environment Canada has estimated that 14% of total national PM_{2.5} emissions and 15% from national VOC emissions are from residential combustion systems. However, apart from British Columbia where the government has adopted US standards, there are currently no requirements for wood burning appliances to meet any emissions criteria. For this reason the process has been recently initiated for a national emission regulation.

Emission measurements were performed at CANMET for three types of cordwood stoves (conventional old, conventional new and a certified stove) as well as a pellet stove under different operating conditions (fuels and load rate). The measurements showed wide variations, total PM emissions ranged from 0.019 g/MJ for the pellet stove operated at a high burn rate to 3.68 g/MJ for the “old” conventional stove operated at a low burn rate. Average emissions are 1.68 g/MJ for the conventional cordwood stove and 0.44 g/MJ for certified non-catalytic stoves. VOC emissions ranged from 0.02 - 13 mg/kg for pellet stoves, up to as high as 38 - 13,100 mg/kg for Cord Wood Stoves, these VOC's are mainly benzene and toluene.

Key factors in bad combustion quality observed are related to stove design and transient state operation. Some stoves lack proper refractory lining, baffle and air staging. Higher emissions of CO, VOC and dust were observed for wood with increased moisture content (except for CO), lower firing rates (except for VOC) and use of softwood instead of hardwood.

A systematic process identification as a tool for combustion control design, Kai Pietila, VTT, Finland

Kai Pietila presented methods to perform systematic process identification as a tool for combustion control design. By performing emission measurements at different operation conditions of a 300 kW woodchip fired boiler, reproducible correlations were found for CO as a function of primary and secondary air ratio and heat load. Step response tests showed that first order models with dead time appropriately describe the dynamic behaviour.

Finally, the possibility was evaluated to use soft sensors for the estimation of O₂, CO₂, CO and heat output, using primary and secondary air and fuel power as input variables and the Takagi-Sugeno fuzzy model. A comparison of model results with actual measurements indicated that CO₂/O₂ can be modelled reliably, using temperature measurement data. The prediction of CO concentrations is less straightforward and will require more research.

A novel electrostatic precipitator (ESP) for residential combustion, Morten Berndtsen, the National Institute of Technology, Environment and Safety, Oslo, Norway

Morten Berndtsen introduced the preliminary results of Clean Air, a European project in which a small scale Electrostatic Precipitator has been developed for domestic wood stoves. The project had a budget of approx. 1.2 M€ and was coordinated by APP (Norway) with industrial participation of Sereps(France), VUKOV (Slovakia), CSO (UK), ShroederPlast(Denmark), BK+K (Germany) and RTD partners TI (Norway) and PERA (UK).

The background for the development of the ESP was the recognition that domestic wood combustion, although being renewable, can have significant health costs due to the emission of fine dust particles (particularly PM_{2.5}), which are associated with increased mortality and cardiovascular and lung disease. This is largely due to the transient operation of woodstoves; particularly during the start-up phase, high dust emissions occur.

A prototype of an electrostatic precipitator for end-of-pipe/chimney applications was developed and successfully tested under practical conditions in Norway. The ESP has a cleaning efficiency of 90-95% for particles above 0.1 µm. Typically it can collect up to 20 kg of dust, which limits manual cleaning of the unit to once per year. Electric power consumption is below 120 W.

The unit has an expected sales price of 400€. A case study on the avoided health costs for the inner city of Oslo (due to lower aerosol concentrations) indicated that this would be equivalent to a social payback period of only one year. However, as there are no financial incentives yet for private households to invest in small scale air cleanup, political commitment and financial incentives are needed to achieve real environmental improvements and create a market for this environmental technology.

Conclusions and closing

PD Dr. Thomas Nussbaumer, Verenum, Switzerland

Thomas Nussbaumer concluded the session with a number of interesting observations. Firstly, small scale biomass combustion already has an important contribution to renewable energy production today, however also to harmful aerosol emissions. Technological developments in pellet combustion systems, better combustion control devices and particle removal systems have resulted in more efficient and cleaner combustion systems, however there are great geographic differences in performance of combustion technologies. Particularly for log wood combustion there is still a great need for improvement of systems available on the market today. Environmental performance can be improved by replacing low quality stoves by better stoves. In many cases this results in additional costs for the device.

Particularly for improvements that are beneficial mostly for society in terms of lower health costs, and have much less direct benefits for the owner/user, it is a government task to inform end-users to operate stoves properly, provide proper legislation enforcing quality standards on equipment sold, as well as incentives for further emission reduction using add-on technologies. This includes use of the proper fuel, which can also be established through standardisation.

Future actions of Task 32

- Production of chapters for revised handbook by authors (Until February 2006)
- Editing of the revised handbook to a revised draft (March- April 2006)
- Discussion of edited draft (Spring 2006 Task meeting)
- Finalization and printing of the revised handbook (Summer 2006)
- TNO will coordinate the preparation of a proposal for follow up of Task 32 in the new triennium and present the plans at ExCo57.
- The next meeting of Task 32 will be held in Jönköping, in the week of 29 May - 2 June, 2006 at the World Bioenergy 2006 conference.
- A workshop on fuel flexibility will be organised by Sweden at the same conference.
- A workshop on corrosion and deposit formation will be organised by Bill Livingston, Autumn 2006 in Glasgow
- All are again requested to forward data on national research programmes or major projects related to the interest of Task 32 to the Task Leader, in order to facilitate knowledge exchange in accordance with the priorities of Task 32.

Annex 1. Overhead sheets presented by Sjaak van Loo

Annex 2. Article with statement on biomass cofiring in Biomass and Bioenergy update

Annex 3. Country presentation for Switzerland, Thomas Nussbaumer

Annex 4. Country presentation for Sweden, Claes Tullin

Annex 5. Country Presentation for Denmark, Anders Evald

**Annex 6. Book presentation: Production and utilisation of pellets – production process, properties, combustion technology, ecology and economy
Gerold Thek**

Annex 7. Biomass Action Plan in the Netherlands
Kees Kwant