Annual Report 2011

IEA Bioenergy

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IEA Bioenergy is an international collaborative agreement set up in 1978 by the International Energy Agency (IEA) to improve international co-operation and information exchange between national bioenergy RD&D programmes. IEA Bioenergy aims to achieve a substantial bioenergy contribution to future global energy demands by accelerating the production and use of environmentally sound, socially accepted and cost-competitive bioenergy on a sustainable basis, thus providing increased security of supply whilst reducing greenhouse gas emissions from energy use.

Cover: Loading an ocean vessel with pellets by clam bucket in Straubing, Germany. Source: M. Wild, 2009, Vienna, Austria.

Professor Kai Sipila, Finland with Dr Tat Smith, Canada and Secretary, John Tustin.

To: IEA Headquarters, Paris

IEA BIOENERGY ANNUAL REPORT 2011

Under the IEA Framework for International Energy Technology Cooperation the Executive Committee of each Implementing Agreement must produce an Annual report for IEA Headquarters.

This document contains the report of the IEA Bioenergy Executive Committee for 2011. This year, we have presented a special feature 'Current Status of Production and Thermal Utilisation of Biomass Pellets' prepared by Task 32.

The contributions from the Task Leaders and Operating Agents to this report are gratefully acknowledged.

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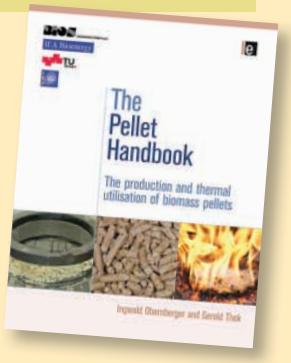
Further information on IEA Bioenergy can be obtained from the Executive Committee Secretary, see back cover of this Annual Report. Some useful addresses can be found on the inside of the back cover.

Current Status of Production and Thermal Utilisation of Biomass Pellets

Authors: Ingwald Obernberger and Gerold Thek, Bios Bioenergiesysteme GmbH, Graz, Austria



This overview was prepared by Task 32 based on The Pellet Handbook[1], written by Ingwald Obernberger and Gerold Thek and supported by members of the Task and external experts. It describes the major issues involved in the production and thermal utilisation of biomass pellets.

Introduction

Pellets are a biomass fuel with consistent and standardised quality – low moisture content, high energy density and homogeneous size and shape. By using pellets the drawbacks of conventional biomass (mainly low energy density, high moisture content and heterogeneity) as a fuel alternative to coal, oil or gas can be reduced or even prevented altogether. Consistent fuel quality makes pellets a suitable fuel type for many applications, from stoves and central heating systems up to large-scale plants, and with practically total automation possible in all of these. It was not until such a homogenous biomass fuel was introduced to the market that the development of fully automatic biomass furnaces for small-scale applications offering similar user comfort to modern oil or gas heating systems became possible.

Apart from the above-mentioned advantages of pellets, there is strong worldwide interest in using pellets for energy generation, due to:

- rising oil and gas prices;
- rising awareness of the limited reserves of fossil fuels;
- political benefits such as reduced dependency on imported fossil fuels;
- regional added value(e.g. employment creation); and
- international environmental obligations to reduce greenhouse gas emissions.

All pellet-related issues along the supply chain for all types of applications are covered in this overview.

Standards for Pellets

The standardisation of pellets has been a major contributor to their success. In particular, residential pellet markets, which are dominated by small-scale furnaces below 100 kW_{th}, demand high quality pellets to ensure fully automated and trouble free operation.

In the last two decades many countries have introduced their own national standards for pellets. However, parts of these have differed significantly. A series of European standards for solid biomass fuels was published in 2010, replacing the national standards. These consequently led to a harmonisation and better comparability of pellets on an international basis. On top of standardisation at a European level, work on International Organisation for Standardisation (ISO) standards for solid biofuels has been in progress since 2007 and will lead to international standards within a few years.

The new European standard for pellets (EN 14961-2:2011) provides three quality classes, i.e. A1, A2 and B. Class A1 represents the top quality to be used in small-scale furnaces below 100 kW_{th}. Class A2 might also become a relevant standard for pellets to be used in the residential heating sector as soon as pellet heating systems able to cope with their higher ash content are available on the market. Class B represents industrial pellets exclusively to be used in applications above 100 kW_{th}. What makes them different from the higher quality pellets is that larger diameters, higher ash, nitrogen, sulphur and chlorine contents and lower net calorific values are permitted.

Figure 1: Wood pellet classification according to EN 14961-2.[2]

Pellet transport and storage also requires standardisation, as incorrect fuel handling can have negative impacts on quality. The new certification system EN plus will address not only pellet quality but also transport and storage regulations for pellets, including the end user's storage.

Now that pellets have become an internationally and intercontinentally traded product, the harmonised commodity description and coding system (HS convention), the IMO (International Maritime Organisation, which provides a regulatory framework for shipping) and the Code of Safe Practice for Solid Bulk Cargoes (BC Code) have had to be applied and adapted accordingly.

The use of pellets requires high quality furnaces, particularly with respect to failure-free operation and minimal environmental impact in small-scale systems. Technical requirements differ greatly from country to country, in particular those relating to emission limits. Unification, at least on a European level, is therefore strongly recommended. The regulations currently under discussion based on the European ecodesign directive (directive 2005/32/EC of the European Parliament) might assist with this in the near future.

Suitable Raw Materials for Pellet Production

Basically any kind of woody biomass is a possible raw material for pelletisation. However, softwood pellets have become the established norm. Producing pellets out of hardwood is possible in principle but hardwood pellets are not as high quality (especially with regard to durability) as softwood pellets and are more difficult to manufacture. Keeping to the strict limit for ash content for class A1 pellets according to EN 14961-2 is almost impossible when pelletising hardwood species. However, the right combination of raw materials can allow the use of mixed hardwoods for pelletisation.

Wood shavings and saw dust are the most commonly used raw materials worldwide. Industrial or forest wood chips, short rotation crops (SRCs) and logs are suitable raw materials but need to be pre-processed (e.g. coarse grinding, drying, fine grinding, bark separation, separation of foreign material etc. – depending on the feedstock).

Pellets made from bark are only suitable for use in medium- and large-scale furnaces because of their high ash content.

Straw and whole crops are available in sufficient volume, but due to their specific characteristics (high ash, nitrogen, sulphur and chlorine content, low ash melting point) they are not suitable for the pellet furnaces currently on the market. Straw pellets can only be used in medium- or large-scale furnaces that are usually built in a more robust way. These are typically equipped with more sophisticated combustion, control and flue gas treatment systems. In order to obtain environmentally friendly and failure-free operation of small-scale pellet furnaces fed with straw pellets, further R&D is required.

Pellet Production and Logistics

The setup of a pellet production process is chiefly dependent on the raw materials used. If dry sawdust is used, the pelletisation process is narrowed to the simplest case, i.e. just the pelletising itself and subsequent cooling. Wood shavings, which are dry but coarse, must be ground before pelletising. If moist sawdust (moisture content usually between 50 and 55 wt.% (w.b.)) is used, upstream drying is necessary. A grinding process stage is vital for industrial or forest wood chips in order to achieve the required particle size. Dry wood chips from the wood working or wood processing industry need not be dried. If class A1 pellets are to be produced, the wood chips must be free of bark. So utilisation of logs for this grade of pellets, requires bark separation and chipping. Moreover, the raw materials are usually treated with hot water or steam just before the pelletising step. Finally, appropriate facilities for raw material, intermediate product and pellet storage and supply are necessary.

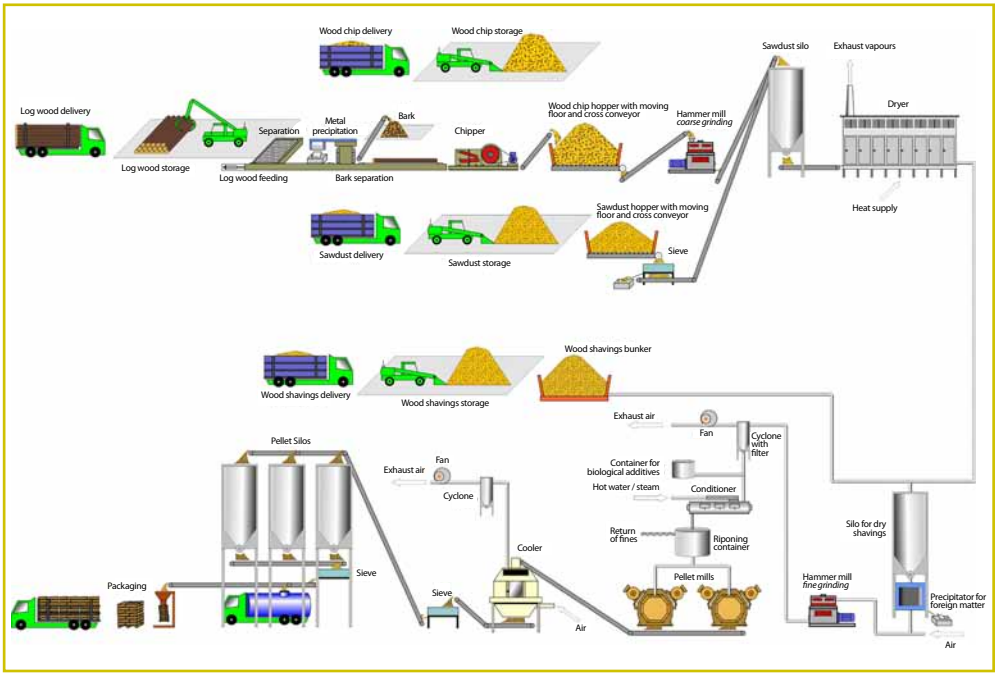


Figure 2: Process line of pelletisation. *Source: Bios Bioenergiesysteme GmbH.*

Belt dryers and tube bundle dryers are common drying technologies employed. Other options include dedicated low temperature dryers, drum dryers and superheated steam dryers. For subsequent grinding, hammer mills are normally used. For conditioning, mixers and small interim tanks are used so as to guarantee thorough mixing and long enough residence times. There are two key pelletising technologies available, namely flat and ring die technologies, however the ring die has become the more commonly used for wood pellet production. Pellet cooling is usually performed by a counter flow cooler. Pellets are finally stored either in bulk silos or flat storage, or packaged in bags.

Pellet transport usually takes place in bulk via silo or tank truck, or in bags. The use of silo trucks with on-board weighing systems is the state-of-the-art for loose pellet delivery to residential pellet heating systems. Small bags are mainly relevant for stoves. The use of large bags plays a minor role. In countries with large-scale consumers such as large power or CHP plants and for long-distance transport, pellets are also transported by different types of trucks or bulk containers, by rail or by sea.

For small-scale end user storage (integrated pellet reservoirs, storage rooms, underground storage or tanks made of synthetic fibre), different countries have standards and guidelines to enable safe and trouble free system operation.

Safety Considerations and Health Concerns Relating to Pellets

Pellets are a densified solid biomass fuel prone to mechanical degradation, chemical decomposition and other changes such as moisture absorption during handling and storage. Mechanical degradation generates fines and airborne dust, which can be considered a safety issue under certain circumstances because they can cause fires and explosions and become a health issue when inhaled. Pellets must therefore be handled with care in order to minimise fines and dust formation.

Another important safety aspect is related to the decomposition of pellet components resulting in self-heating and self-ignition in bulk storage. This is a known but not yet fully understood phenomenon and subject to research in many parts of the world. The danger of self-heating and self-ignition rises with increasing storage size and it takes place by means of biological and/or chemical oxidation. In order to avoid self-heating and spontaneous ignition, storage and transport of large volumes should be avoided, in particular where the fuel's tendency to self-heat is unknown. Mixing of different types of biomass fuel in storage, or fuel batches with different moisture contents should also be avoided. In order to minimise the risk of fire by abnormal self-heating and spontaneous ignition, temperature control sensors embedded in the stored product and gas analysis equipment for detection of CO should be installed in large-scale pellet storage units such as silos.

In addition to the above-mentioned issues pellets decompose over time and emit non-condensable (primarily CO, CO_2 and CH_4) and condensable (other toxic gases such as aldehydes and terpenes) gases, a phenomenon called off-gassing. The danger of off-gassing is present even at lower bulk temperatures during storage of wood pellets. Therefore, entering a storage area that is not thoroughly ventilated should only be permitted after having checked the concentration of carbon monoxide in combination with oxygen. Small-scale domestic pellet storage units should be equipped with natural ventilation facilities. Moreover, warning signs should be displayed,with ventilation instructions to be carried out prior to entering a pellet storage unit.

With small-scale systems, the main focus lies on pellet central heating systems. In this sector, high standards have been achieved in recent years with particular regard to the degree of automation, ease of use, emission reduction and efficiency improvement. Staged air supply, microprocessor control, automatic cleaning systems for the heat exchanger and automatic de-ashing systems are state-of-the-art. Pellet conveying systems based on feeding screws and pneumatic systems are available that can cope with all installation situations.

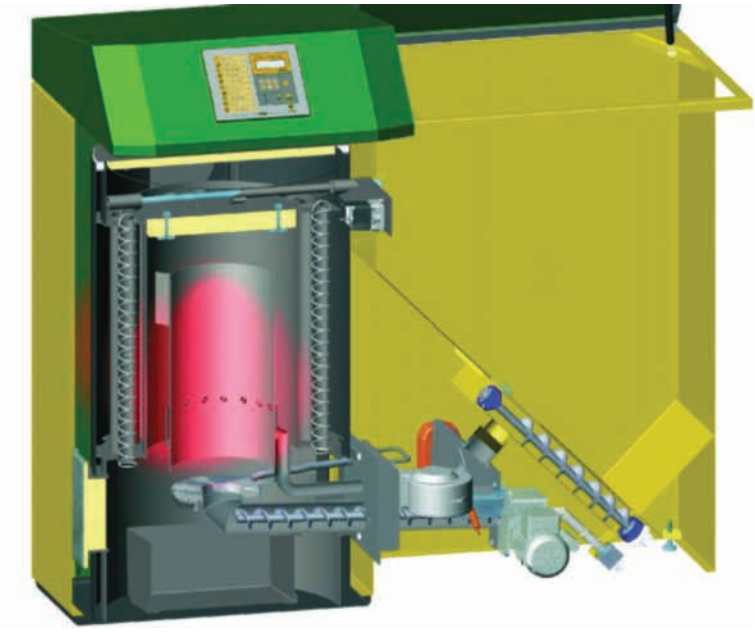


Figure 3: Typical small-scale pellet furnace. [3]

Stoves are also a significant area of interest. Here, automatic operation for periods from a few hours to a few days has been achieved by means of suitable micro-processor controls and integrated pellet reservoirs.

A lot of development work is in progress within all power ranges, which is leading to innovative concepts (e.g. flue gas condensation, small-scale furnaces with very low nominal thermal capacities).

The use of pellets in decentralised CHP (combined heat and power, or cogeneration) plants is rare and confined to Scandinavian countries. However, this area will be of interest in the future as soon as small-scale biomass CHP systems are developed. Stirling engine and the ORC (Organic Rankine Cycle) process are interesting technologies in this respect because they are the most developed to date.

In the area of large-scale systems, it is mainly co-firing in pulverised coal-fired power and CHP plants that is relevant. Complete conversion of coal-fired power and CHP plants to pellets is done to a minor extent. Biomass co-firing in existing coal-fired boilers represents an attractive means of utilising a fairly wide range of biomass materials for power generation. This is now widely recognised and the trend towards co-firing in both existing and new coal power plants is becoming more apparent worldwide.

Cost Analysis of Pellet Production

A detailed cost analysis of a typical pellet production plant with an annual pellet production capacity of approximately 40,000 tonnes using wet sawdust as a raw material has been carried out for Austrian framework conditions. It has been shown that the specific pellet production costs are dominated by raw material and drying which make up 78% of total costs. Personnel and pelletising together add 13% of all costs. The remaining 9% comprise costs for general investments (mainly construction), grinding, cooling, storage and peripheral equipment.

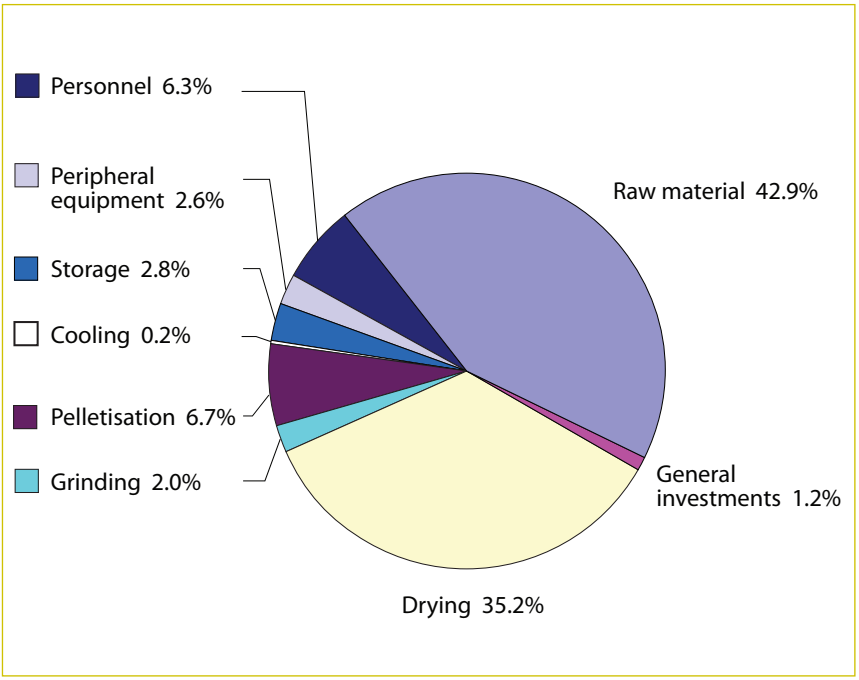


Figure 4: Pellet production costs and their composition according to the different cost factors when sawdust is used as raw material.[1]

Sensitivity analyses showed that (in order of decreasing importance) raw material costs, specific heat costs, pellet throughput, plant availability, annual full load operating hours as well as investment costs are the main influencing parameters.

The greatest cost saving potential – but also the greatest danger of uneconomic operation – also lies within these parameters.

In addition, pellet production plants operating under different framework conditions and at different scales were compared. It was shown that large-scale pellet production with appropriate plant utilisation, low temperature dryers using low temperature heat, a high degree of automation and moderate storage capacities due to intelligent logistics are the most attractive choice. In contrast, it was shown that economic pellet production at a very small-scale is also possible, if the framework conditions are right. However, the risk of uneconomic operation is high in small-scale systems. The use of wood chips for pelletisation is an economically feasible option. It is only the use of logs that is not economic under the present framework conditions with relatively modest pellet prices (and the stated pellet production of 40,000 $t(w.b.)_p/a$). Larger production capacities, drying during log storage and slightly higher pellet prices would make the use of logs for pelletisation economical too.

Cost Analysis of Pellet Utilisation in the Residential Heating Sector

When choosing a heating system, customers often decide on the basis of either investment or fuel costs, because these data are easily accessible. However, both approaches can mislead, because a holistic evaluation has to look at all costs related to a heating system over its complete lifetime. Thus, full cost calculations including consumption costs, capital costs, operating costs and others need to be considered. To provide appropriate information, full cost calculations for central heating systems based on pellets, oil, natural gas, wood chips and biomass district heat for a typical residential house under Austrian framework conditions were performed, taking an average detached house with a nominal heat load of 15 kW as a basis.

The cheapest alternatives were found to be the network-based systems, i.e. biomass district heating and natural gas heating with flue gas condensation. Biomass district heating was the least expensive. Naturally, systems requiring home-based fuel storage space are more costly, where the wood chip boiler is the most expensive option due to the high investment costs and large storage capacity required. Pellet central heating systems are cheaper than oil heating systems under present framework conditions (2008). This gain will shift further in the direction of pellet central heating systems as oil prices rise. Flue gas condensation systems for pellet furnaces have no advantage at present but may also be of rising interest with increasing fuel prices.

The full cost calculations were expanded by a consideration of external costs (costs caused by environmental impacts such as health damage, damage to flora and fauna and damage to buildings as well as climate and safety risks) in order to evaluate each heating system from a national economy point of view. Different scenarios were looked at to calculate external costs. These scenarios were based on the incorporation of small-scale furnaces in emissions trading (which is not the case at present) and on local

(emissions from the furnace only) as well as global (emissions alongside the fuel and auxiliary energy supply chain as well) emission prognoses.

External costs tend to burden heating systems based on fossil fuels more than biomass heating systems. Although external costs cannot be exactly determined, not taking them into account is incorrect with respect to the national economy. Consideration of average external costs based on global emission prognoses is thus recommended. Pellet central heating systems are already more economical than oil heating systems, even without considering external costs. If average external costs are considered, the use of pellet furnaces seems to be even more reasonable from both the ecological and national economy points of view. This evidence, in conjunction with the expected scarcity of fossil fuel, means that pellet heating systems and biomass district heating should be given preference.

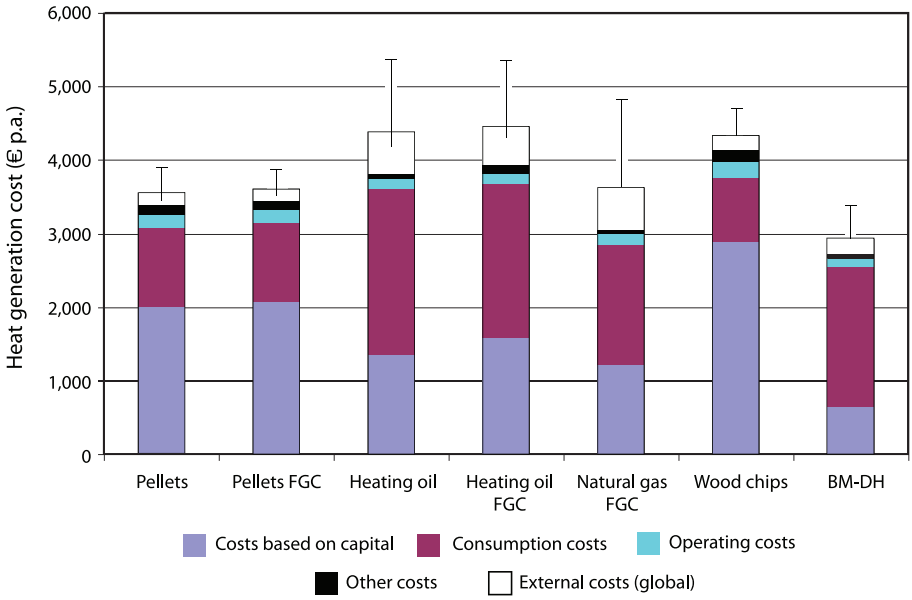


Figure 5: Specific heat generation costs of central heating systems with external costs based on global emission prognoses. [1]

Environmental Evaluation of Pellets for Residential Heating

An ecological comparison of central heating systems based on pellets, wood chips, natural gas, heating oil and district heat was performed using emission factors that take emissions along the supply of useful energy into account (fuel supply, auxiliary energy supply and thermal utilisation). For central heating systems based on pellets and heating oil, flue gas condensation was also considered.

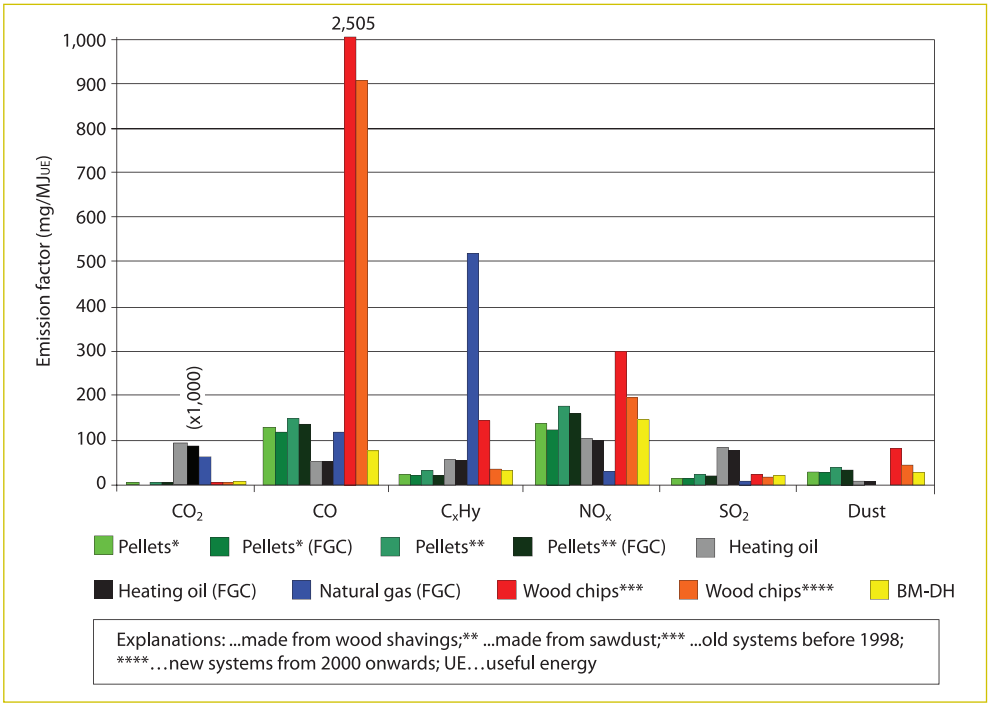


Figure 6: Emission factors of useful energy supply for different heating systems. [11]

Regarding CO_2 emissions and the resulting global climate impacts, heating systems based on biomass fuels have clear advantages over systems operated with fossil fuels. In terms of CO as well as particulate emissions, the biomass heating systems show clear disadvantages compared to the fossil energy carriers. Hydrocarbon emission factors are much higher in natural gas based systems than in any other system, which is a consequence of the emissions along the fuel supply chain. Old wood chip furnaces also exhibit comparatively high hydrocarbon emissions due to poor combustion control and hence poor burnout. Systems based on natural gas have very low NO_x emissions, which is mainly due to low emissions during combustion. Heating oil based systems stand out for their comparatively high SO_x emissions, caused by emissions during combustion due to the comparatively high sulphur content of heating oil.

Due to higher annual efficiencies when using flue gas condensation (about 6 to 8% higher), the systems in which this technology is applied show slightly lower emission factors. With regard to the resulting efficiency rises and thus emission reductions, flue gas condensation is to be preferred over conventional furnace technologies.

Fine particulate and aerosol emissions are a special problem due to their adverse health effects, and this issue is being dealt with in a number of national and international R&D projects. The use of modern pellet furnaces should be supported in new buildings, as well as the replacement of old wood furnaces often with high emissions. Because modern furnaces burn wood pellets under ideal conditions, this results in lower

emissions of elementary carbon (soot) and organic hydrocarbons, leading in turn to lower fine particulate emissions. In order to efficiently reduce inorganic aerosols, installation of appropriate fine particulate precipitation systems is an additional measure (especially for old systems). Such precipitation systems are being tested and developed in current research projects but further R&D needs to be done before they are introduced to the market.

International Market Overview and Projections

The first steps to introduce pellets as a fuel were undertaken at the beginning of the 1980s. Since the second half of the 1990s, pellet markets in a number of countries worldwide have exhibited rapid growth and there is no end to this development in sight.

What is interesting is the different development of various markets. Where as pellet use is limited to small-scale applications in some countries (e.g. Austria, Germany and Italy), it is large-scale plants for the most part that are fired with pellets in other countries (e.g. Belgium and the Netherlands). Moreover, in countries such as Sweden or Denmark, pellet utilisation takes place in small-, medium- and large-scale applications, where as other countries produce large quantities of pellets but have no or negligible domestic markets (e.g. Canada and some Eastern European countries). Worldwide, around 11 to 12 million tonnes of pellets are used (2008/2009), of which around 65% are applied in small-scale systems and 35% in power plants and other medium- and large-scale applications. The largest pellet consumers are Sweden, USA, Italy, Germany, Denmark and the Netherlands. The largest pellet producers are USA, Canada, Sweden, Germany and Russia. Prognoses for worldwide pellet production in 2020 are between 130 and 170 million tonnes per year.

The strong growth in pellet markets worldwide requires consideration of pellet production potential. Evaluations at European scales showed that there are still regions with potential for further pellet production plants using wood shavings and sawdust as raw materials. In terms of raw material potential for pellet production in Europe, there are regions where a shortage of saw dust has already occurred, but there are other regions where a further increase of pellet production based on sawdust is still possible. In addition to sawdust, alternative raw materials such as forest residues, logs or even energy crops offer good additional potential in many countries worldwide.

Over the past decade, the growth of wood pellet supply and demand has been closely linked to international trade and, at a rough estimate, between one third and one half of all wood pellets consumed are traded over an international border. This can vary from short distance trade by truck (e.g. from Austria to Italy) to long distance trade of more than 10,000 kilometres (e.g. from British Columbia to Japan or north western Europe) by vessel. Transport by train is almost unknown in Europe but common practice in North America. Most international wood pellet trade is carried out by means of ocean vessels.

Pellets are either imported or exported from almost every country in the EU and beyond. Trade routes from outside to the EU mainly come from Canada, the USA, South Africa and Russia. North America, north western Russia, Chile, South Africa and Australia are countries and regions that are expected to increase their pellet exports in the near future.

Figure 7: Overview of main wood pellet trade flows in and towards Europe. [4]

Against the background of international trade, efforts to implement robust certification schemes, such as the Belgian Pellet Supplier Declaration Form, are ongoing in order to guarantee sustainable production of pellets.

Based on socio-economic impact studies, financial incentives, the existence of a strong sawmill industry, stringent quality and sustainability requirements both for pellets and for pellet heating systems, qualified and certified installers of pellet heating systems, promotion campaigns, installation of pellet heating systems in public buildings and incentives for utilities to enter the biomass heating market have all been identified as crucial socio-economic factors in pellet market development.

Case Studies of Pellets for Energy Generation

The case studies presented here illustrate the broad range of possible applications for the use of pellets. From the very small-scale pellet stoves located in rooms for heating,with pellet demands of some tonnes per year, to medium-scale applications for large buildings or district heating networks, to large-scale power and CHP plants with pellet consumption of some 100,000 tonnes per year, pellets offer attractive and economic fields of applications. A selection of four case studies is presented in brief below. More information about these and additional case studies can be found in The Pellet Handbook. [1]

Case study 1: Pellet stove in the living room

Type	Small-scale application
Location	Straubing, Germany
Start-up	November 2007
Nominal thermal capacity	8 kW
Pellet consumption at nominal load	1.8 kg/h
Annual pellet demand	900 kg/a
Storage capacity	16 kg

Case study 2: Pellet central heating system

Type	Small-scale application
Location	St. Lorenzen/Mürztal, Austria
Start-up	Autumn 2006
Nominal thermal capacity	10 kW
Pellet consumption at nominal load	2.3 kg/h
Annual pellet demand	4.1 t/a
Storage capacity	6 t

Case study 3: Heating system for the Institute for Aurally Handicapped Persons

Type	Medium-scale application
Location	Straubing, Germany
Start-up	October 2008
Nominal thermal capacity	500 kW
Pellet consumption at nominal load	115 kg/h
Annual pellet demand	407 t/a
Storage capacity	70 m³

Case study 4: CHP plant Hässelby, district heat supply to Stockholm

Type	Large-scale application
Location	Hässelby, Sweden
Start-up	Converted from coal to pellets in 1994
Nominal thermal capacity	189 MW
Nominal electric capacity	75 MW
Pellet consumption at nominal load	61.9 t/h
Annual pellet demand	300,000 t/a
Storage capacity	15,000 m³

Research and Development

There remains a continuing need for R&D in many areas of pellet production and utilisation, which is being met by numerous national and international activities and projects.

Alternative raw materials for pellet production are a major focus because of the strong growth of the worldwide pellet market. In the medium term alternative raw materials could be logs, herbaceous raw materials and short rotation crops, which are already used for pelletisation to some extent. Problems with these raw materials are related to

the higher ash content, the lower ash softening and melting temperatures and the higher nitrogen content. Further improvement of the quality of wood pellets is also an R&D issue.

A relatively new pre-treatment step for raw material before pelletisation is torrefaction. Several R&D activities are focusing on this technology, which is close to being demonstrated for the first time at an industrial scale. Pellets from torrefied biomass are characterised by higher net calorific values and bulk densities and consequently by higher energy densities, and they can be ground easily and are of a hydrophobic nature, which makes their storage and logistics easier. Their main application will be co-firing in coal power plants, as torrefied pellets can be handled together with coal without any additional changes or investments in storage or feeding systems.

Additional problems in pellet production are off-gassing, self-heating and self-ignition in raw material and pellet storage. Research projects are under way to investigate the basics of these phenomena and develop suitable measures for prevention and fast detection.

In terms of pellet utilisation, the main issues are further emissions reduction, new pellet furnace developments and the utilisation of pellets made from new biomass fuels (e.g. herbaceous biomass or SRC). Besides combustion, pellet utilisation in gasification is also being investigated.

Another key issue within the field of small-scale pellet furnaces is their computational fluid dynamics (CFD) supported development and optimisation. Development times and test efforts can be clearly reduced and the reliability of developments can be improved by this innovation. Several R&D projects dealing with the improvement of CFD models and their application in furnace optimisation are under way.

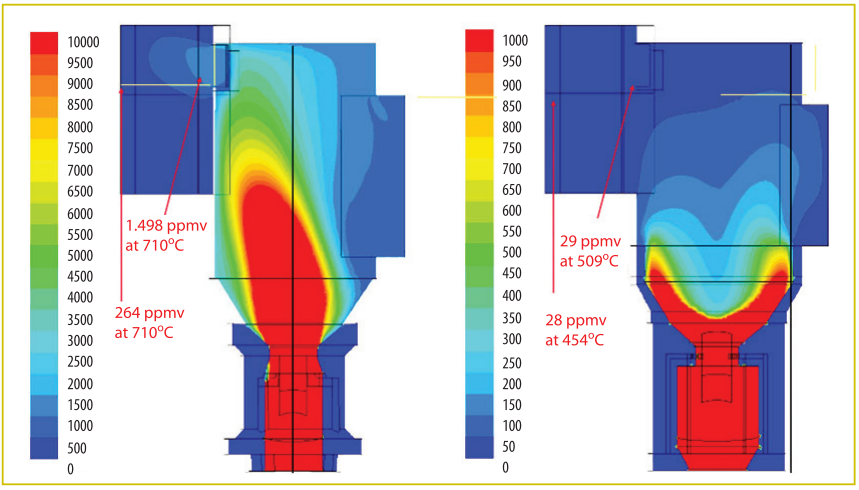


Figure 8: Computational fluid dynamics *simulation results of a small-scale pellet furnace showing iso-surfaces of CO concentrations in the flue gas [ppmv] in the symmetry plane of the furnace for the basic (left) and optimised (right) design. Source: Bios Bioenergiesysteme GmbH.*

In addition to the above, there are several initiatives looking at developing strategies and measures to boost the use and further distribution of pellets (e.g. by knowledge and information transfer from established markets to new and slowly developing markets). Finally, other R&D projects are looking at ways of ensuring sustainability criteria are being met, in particular for imported pellets from outside Europe.

Further Reading

For further information readers should, in the first instance, refer to The Pellet Handbook, published in 2010.

1. **Obernberger, I. and Thek, G.** 2010. The Pellet Handbook – The production and thermal utilisation of biomass pellets, ISBN 978-1-84407-631-4, Earthscan, London, UK.

The full publication can be found on the Task 32 website *www.ieabcc.nl* or the website of Bios Bioenergie systeme GmbH *www.bios-bioenergy.at.*

Other useful references include.

2. **Alakangas, E.** 2010. Written notice, VTT, Technical Research Centre of Finland, Jyväskylä, Finland.

3. **KWB.** 2005. Company brochure, Kraft & Wärme aus Biomasse GmbH, St. Margarethen/Raab, Austria.

4. **Lensu, T. and Alakangas, E.** 2004. Small-scale electricity generation from renewable energy sources –A glance at selected technologies, their market potential and future prospects. OPET Report 13, VTT, May 2004, p144, Jyväskylä, Finland.

International Energy Agency

The International Energy Agency (IEA) is an intergovernmental organisation which acts as energy policy advisor to 28 Member Countries in their effort to ensure reliable, affordable, and clean energy for their citizens. Founded during the oil crisis of 1973-74, the IEA's initial role was to co-ordinate measures in times of oil supply emergencies. Energy security remains a key priority, but has expanded beyond concerns about oil supplies to include natural gas and electricity. The Agency's mandate has also broadened to incorporate the 'Three E's' of balanced energy policy making: energy security, economic development, and environmental protection. Current work focuses on:

- Energy security: Promoting diversity, efficiency and flexibility within all energy sectors.
- Economic development: Ensuring the stable supply of energy to IEA member countries and promoting free markets to foster economic growth and eliminate energy poverty.
- Environmental awareness: Enhancing international knowledge of options for tackling climate change.
- Engagement worldwide: Working closely with non-member countries, especially major producers and consumers, to find solutions to shared energy and environmental concerns.

Objectives

- To maintain and improve systems for coping with oil supply disruptions.
- To promote rational energy policies in a global context through co-operative relations with non-Member Countries, industry and international organisations.
- To operate a permanent information system on the international oil market.
- To improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use.
- To promote international collaboration on energy technology.
- To assist in the integration of environmental and energy policies.

Organisation

The IEA is an autonomous agency and based in Paris. The main decision-making body is the Governing Board, composed of energy ministers from each member country or their senior representatives. A Secretariat, with a staff of energy experts recruited on a competitive basis primarily from OECD member countries, supports the work of the Governing Board and subordinate bodies. The Secretariat is headed by an Executive Director appointed by the Governing Board. The Secretariat collects and analyses energy data, organises high-level workshops with world experts on new topics and themes, assesses member and non-member countries' domestic energy policies and programmes, makes global energy projections based on differing scenarios, and prepares studies and concrete policy recommendations for governments on key energy topics.

Members

Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the USA. The European Commission also participates in the work of the IEA.

Introducing IEA Bioenergy

Welcome to this Annual Report for 2011 from IEA Bioenergy.

IEA Bioenergy is the short name for the international bioenergy collaboration under the auspices of the International Energy Agency - IEA. A brief description of the IEA is given on the preceding page.

Bioenergy is defined as material which is directly or indirectly produced by photosynthesis and which is utilised as a feedstock in the manufacture of fuels and substitutes for petrochemical and other energy intensive products. Organic waste from forestry and agriculture, and municipal solid waste are also included in the collaborative research, as well as broader 'cross-cutting studies' on techno-economic aspects, environmental and economic sustainability, systems analysis, bioenergy trade, fuel standards, greenhouse gas balances, barriers to deployment, and management decision support systems.

The IEA Implementing Agreement on Bioenergy, which is the 'umbrella agreement' under which the collaboration takes place, was originally signed in 1978 as IEA Forestry Energy. A handful of countries took part in the collaboration from the beginning. In 1986 it broadened its scope to become IEA Bioenergy and to include non-forestry bioenergy in the scope of the work. The number of participating countries has increased during the years as a result of the steadily increasing interest in bioenergy worldwide. By the end of 2010, 24 parties participated in IEA Bioenergy: Australia, Austria, Belgium, Brazil, Canada, Croatia, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Republic of Korea, the Netherlands, New Zealand, Norway, South Africa, Sweden, Switzerland, Turkey, the United Kingdom, the USA, and the European Commission.

IEA Bioenergy is now 34 years old and is a well established collaborative agreement. All OECD countries with significant national bioenergy programmes are now participating in IEA Bioenergy, with very few exceptions. The IEA Governing Board has decided that the Implementing Agreements may be open to non-Member Countries, i.e., for countries that are not Members of the OECD. For IEA Bioenergy, this has resulted in a number of enquiries from potential participants, and as a consequence new Members are expected. Three non-Member Countries currently participate in IEA Bioenergy – Brazil, Croatia, and South Africa.

The work within IEA Bioenergy is structured in a number of Tasks, which have well defined objectives, budgets, and time frames. The collaboration which earlier was focused on Research, Development and Demonstration is now increasingly also emphasising Deployment on a large-scale and worldwide. There were 12 ongoing Tasks during 2011:

- Task 29: Socio-economic Drivers in Implementing Bioenergy Projects
- Task 32: Biomass Combustion and Co-firing
- Task 33: Thermal Gasification of Biomass
- Task 34: Pyrolysis of Biomass
- Task 36: Integrating Energy Recovery into Solid Waste Management
- Task 37: Energy from Biogas
- Task 38: Greenhouse Gas Balances of Biomass and Bioenergy Systems
- Task 39: Commercialising Liquid Biofuels from Biomass
- Task 40: Sustainable International Bioenergy Trade – Securing Supply and Demand
- Task 41, Project 3: Fuel and Technology Alternatives for Buses
- Task 42: Biorefineries: Co-production of Fuels, Chemicals, Power and Materials from Biomass
- Task 43: Biomass Feedstocks for Energy Markets

Members of IEA Bioenergy are invited to participate in all of the Tasks, but each Member is free to limit its participation to those Tasks which have a programme of special interest. The Task participation during 2011 is shown in Appendix 1.

A progress report for IEA Bioenergy for the year 2011 is given in Sections 1 and 2 of this Annual Report.

ExCo67 study tour group at St1 Biofuel Ethanol Plant, Finland.

Progress Report

1. THE EXECUTIVE COMMITTEE

Introduction and Meetings

The Executive Committee acts as the 'board of directors' of IEA Bioenergy. The committee plans for the future, appoints persons to do the work, approves the budget, and, through its Members, raises the money to fund the programmes and administer the Agreement. The Executive Committee (ExCo) also scrutinises and approves the programmes of work, progress reports, and accounts from the various Tasks within IEA Bioenergy. Other functions of the ExCo include publication of an Annual Report, production of newsletters and maintenance of the IEA Bioenergy website. In addition the ExCo produces technical and policy-support documents, workshops, and study tours for the Member Country participants.

The 67th ExCo meeting took place in Helsinki, Finland on 10-12 May. There were 47 participants. The 68th ExCo meeting was held in Twin Waters, Australia on 22-24 November, with 33 participants. Representatives from IEA Headquarters attended both meetings.

At ExCo68 Birger Kerckow of Germany was re-elected Chairman and Paul Grabowski of the USA was re-elected Vice Chairman for 2012.

The ExCo Secretariat is based in Rotorua, New Zealand under the Secretary, John Tustin. The fund administration for the ExCo Secretariat Fund and Task funds is consolidated with the Secretariat, along with production of ExCo publications, the newsletter,and maintenance of the website. At ExCo68, the Secretary, announced that he would retire from the position on 31 March 2013. This would enable a new appointee to take up the position from 1 January 2013 with a three month transition period. The ExCo decided that a call for applications would be made early in 2012.

The contact details for the ExCo can be found in Appendix 7 and for the Secretariat on the back cover of this report. The work in the ExCo, with some of the achievements and issues during 2011, is described below.

Implementing Agreement

Extension of the Implementing Agreement to 31 December 2014 was approved by the IEA Committee on Energy, Research and Technology (CERT) at its meeting in November 2009,following a review by the REWP. The Chairman made a presentation at both

committee meetings to achieve this outcome. Subsequently, in order to implement the CERT's recommendations at its meeting of 3-4 March 2010, the ExCo unanimously agreed to extend the current term of the Implementing Agreement to 28 February 2015.

New Participants/Contracting Parties

In December 2010 the UK sent IEA Headquarters a formal notice of withdrawal from the Implementing Agreement effective from 1 January 2012. This notice was in accordance with Article 10(f) of the Implementing Agreement text. The move was triggered by the UK government's comprehensive spending review and the impact on DECC's international activities. However, at ExCo68 the UK representative was able to inform the ExCo that the UK would now not withdraw as earlier indicated and that the situation with respect to Task participation in 2012 would be as follows:

- Tasks 29, 34, 36 and 40 would continue to be supported by DECC.
- Task 37 participation would continue to be supported by DEFRA and industry members.
- Task 43 participation would continue to be supported by the Forestry Commission.
- Tasks 32, 39 and 42 would need support from their UK industry members for ongoing participation.

It was also announced that at the present time it was not possible to confirm UK participation is the Implementing Agreement beyond 2012 due to decisions on budgets which will not be made before April 2012.

Enquiries from potential Member Countries continued in 2011. These included Israel, Spain and Thailand.

For a complete list of the Contracting Parties to IEA Bioenergy please see Appendix 3.

Supervision of Ongoing Tasks, Review and Evaluation

The progress of the work in the Tasks is reported by the Operating Agents to the Executive Committee twice per year at the ExCo meetings. The ExCo has also continued its policy to invite some of the Task Leaders to each ExCo meeting so that they can make the presentation on the progress in their Task and programme of work personally. This has improved the communication between the Tasks and the Executive Committee and has also involved the ExCo more with the Task programmes.

The work within IEA Bioenergy is regularly evaluated by the IEA Committee for Energy Research and Technology (CERT) via its Renewable Energy Working Party (REWP) and reported to the IEA Governing Board.

Approval of Task and Secretariat Budgets

The budgets for 2011 approved by the Executive Committee for the ExCo Secretariat Fund and for the Tasks are shown in Appendix 2. Total funds invoiced in 2011 were US$2,158,540; comprising US$285,800 of ExCo funds and US$1,872,740 of Task funds.

Appendix 2 also shows the financial contributions made by each Member Country and the contributions to each Task. Very substantial 'in-kind' contributions are also a feature of the IEA Bioenergy collaboration but these are not shown because they are more difficult to recognise in financial terms.

Fund Administration

The International Energy Agency, Bioenergy Trust Account, at the National Bank of New Zealand is functioning smoothly. In 2011 this account was accessed electronically by Ms Jeanette Allen at the New Zealand School of Forestry, University of Canterbury on behalf of the Secretariat. The account is an interest bearing account denominated in US dollars. Details for making payments are:

Arrange an International Telegraphic Transfer/Swift Money Transfer (MT103) to:
Beneficiary Bank: The ANZ National Bank Ltd,
Beneficiary Bank Address: 215-229 Lambton Quay, Wellington, New Zealand
Swift/BIC Address: ANZBNZ22
Beneficiary: Bioenergy Research Services Ltd, for and on behalf of IEA Bioenergy.
Beneficiary Account Number: IEABRS-USD00.
Quoting: Invoice No. XXX
Correspondent Bank: JP Morgan Chase Bank, New York, NY, USA. Swift code: CHASUS33

The currency for the whole of IEA Bioenergy is US dollars. The main issues faced in fund administration are slow payments from some Member Countries and fluctuations in exchange rates. As at 31 December 2011, there were US$127,520 of Member Country contributions outstanding.

KPMG is retained as an independent auditor for the ExCo Secretariat Fund until 31 December 2012. The audited accounts for the ExCo Secretariat Fund for 2010 were approved at ExCo67. The Tasks also produce audited accounts. These are prepared according to guidelines specified by the ExCo. The accounts for the Tasks for 2011 were approved at ExCo67, except for Task 37 and 40. The accounts for these Tasks were approved by a written procedure.

The audited accounts for the ExCo Secretariat Fund for the period ended 31 December 2011 have been prepared and these will be presented for approval at ExCo69.

Task Administration and Development

Task Participation

Participation in the Tasks has continued to increase. In 2011 there were 125 participations in 12 Tasks. Please see Appendix 1 on page 84 for a summary of Task participation in 2011.

For 2012, apart from the changes in Task participation indicated by the UK above, the Netherlands will join Task 34 and Italy will cease participation in Task 43.

Strategic Planning and Strategic Initiatives

Strategic Plan

The fourth Strategic Plan for IEA Bioenergy for the period 2010-2016 was printed and distributed in November 2009. Like the third plan it underpins a stronger emphasis on market deployment of technologies and systems for sustainable energy production from biomass. Further work is now being initiated to link the 'objectives' of the Strategic Plan with 'actions and performance indicators'. The goal is to provide guidelines for monitoring progress with the plan and thereby strengthen the transparency of the work undertaken by IEA Bioenergy.

Technical Coordinator

Dr Arthur Wellinger, appointed in May 2010, is the Technical Coordinator (TC). During 2011 he significantly increased the time spent on facilitating collaboration between the Tasks – this now exceeds 50%. Other priority work items in 2011 included planning for the new triennium, completing ExCo workshop publications, information transfer to GBEP, collaborating with IEA Headquarters (heating and cooling road map) and leading the organising team for the upcoming IEA Bioenergy conference. At ExCo67 the TC's contract was extended to 30 April 2013. This reflects the value the ExCo places on his contribution to the Implementing Agreement.

Strategic Fund/Strategic Outputs

At ExCo53 it was agreed that from 2005, 10% of Task budgets would be reserved for ExCo approved work. The idea was that these 'Strategic Funds' would be used to increase the policy-relevant outputs of IEA Bioenergy. Initially the funds were distributed to the Tasks but it was decided that from 1 January 2008 these funds would be held by the Secretariat and distributed to the Tasks (or external contractors) for ExCo approved projects as they were undertaken. This allows uncommitted funds to be monitored more easily and implementation of the 'strategic' component of the work programme is facilitated.

There has been very good progress with strategic initiatives. The paper 'Using a LCA Approach to Estimate the Net Greenhouse Gas Emissions of Bioenergy' and the background

technical report 'Bioenergy, Land Use Change and Climate Change Mitigation' have both been published. The summary and conclusions from two ExCo workshops have also been formally published – ExCo65 'Developing Sustainable Trade in Bioenergy' and ExCo66 'Thermal Pre-treatment of Biomass for Large-scale Applications'. In addition a summary report 'Algae as a Feedstock for Biofuels – An Assessment of the Current Status and Potential for Algal Biofuels Production' was prepared by Task 39 and the AMF Implementing Agreement. This publication draws on previously commissioned independent reports on the same subject prepared by the two Implementing Agreements. The joint initiative with Advanced Motor Fuels and Hybrid and Electric Vehicles on 'Fuel and Technology Alternatives for Buses' is nearly completed. The final report will be available early in 2012.

New Strategic Projects: The Task 32-led project 'Health and Safety Aspects of Solid Biomass Storage, Transportation and Feeding' was approved with a budget of US$50,000. The objective of the project is to summarise the existing know-how and available research results on the issue of safe storage and transportation of different types of solid biomass and waste. The project will examine the issues and highlight current guidelines and requirements, rather than focus on new costly regulations etc. The project will be completed by the end of September 2012.

A new project 'Monitoring Sustainability Certification of Bioenergy' was approved with a budget of US$86,000. It will address the issues associated with the global proliferation of certification systems and is a joint effort between Tasks 38, 40 and 43. At present numerous biomass and biofuel sustainability certification systems are being developed or implemented by a variety of private and public organisations. These systems are not only championed by different types of organisations; but also have applicability to different feedstock production sectors (e.g. forestry, agriculture, etc.), different bioenergy products (e.g. forest residues, ethanol, biodiesel, electricity), and whole or segments of supply chains.

ExCo Workshops

At ExCo53 it was decided to create time for strategic topics at ExCo meetings and to use the first day of each meeting for a technical workshop on a topic of high priority. Two very successful workshops on 'Future Biomass-based Transport Fuels' (ExCo67) and 'Environmental Sustainability of Biomass' (ExCo68) were held in 2011. The presentations,summaries by the rapporteurs, and papers based on the presentations are available on the IEA Bioenergy website. A summary and conclusions publication is also produced for each workshop and these are available on the website.

Seminars, Workshops, and Conference Sessions

A large number of seminars, workshops,and conference sessions are arranged every year by individual Tasks within IEA Bioenergy. This is a very effective way to exchange

information between the participants and to transfer information to stakeholders. These meetings are described in the progress reports from the Tasks later in this Annual Report. The papers presented at some of these meetings are listed in Appendix 4. Two examples of this outreach are:

- Tasks 32 and 40 held a joint workshop 'Development of torrefaction technologies and impacts on global bioenergy use and international bioenergy trade' on 28 January in Graz, Austria, as a side-event of the Central European Biomass Conference (CEBC). The workshop provided a comprehensive overview of the fundamentals of torrefaction, and the main advantages of and challenges in producing torrefied biomass. Ongoing R&D activities were shown, demonstration plants were presented and the latest state-of-science in torrefaction was discussed. A total of eight speakers highlighted these topics. In addition, four speakers spoke on the effects that the commercial availability of torrefaction technology may have on bioenergy trade. Overall, the workshop was a huge success. While the room had 250 seats, at times attendees were standing in the corridors or at the back of the conference room. The presentations are available for downloading on the Task 32 and 40 websites.
- Tasks 38, 40, 43, and the Brazilian Bioethanol Science and Technology Laboratory (CTBE), jointly organised an international workshop on 'Quantifying and managing land use effects of bioenergy' from 19-21 September in Campinas, Brazil. This workshop brought together state-of-the-art research concerned with assessing land use effects of bioenergy, mitigating negative impacts, and promoting beneficial outcomes. More than 90 scientists and policy makers from Brazil, Europe, Canada and USA came together to discuss recent methodological developments, outcomes of case studies and subsequent policy implications. A summary article with an overview of the main findings and discussions will be submitted to the journal 'Biofuels, Bioproducts and Biorefining'. All of the presentations and most of the posters are available on the Task 38, 40 and 43 websites.

Collaboration with International Organisations

GBEP

The ExCo has continued to explore how to achieve closer ties with the Global Bioenergy Partnership (GBEP). There was an exchange of letters in April 2010 but this was only a start in creating a closer working relationship. There is considerable scope for IEA Bioenergy to contribute to the work of the GBEP Task forces (e.g. GHG Methodologies; and Sustainability) through information exchange from the relevant Tasks. The ExCo is very supportive that the Tasks contribute to GBEP in this way. They have also asked the Technical Coordinator to be more fully involved in this process.

FAO

The collaboration with FAO under the MoU signed in 2000 has continued. Both the Executive Committee and FAO are committed to capitalising on the opportunities provided

through this initiative. However, since the departure of the original prime contact, Miguel Trossero, there is a need to find a new key contact person, as an effective working relationship with FAO at the ExCo level depends on re-establishing this link. The TC has been charged with achieving this.

World Bank

From time to time there have been enquires from World Bank personnel wishing to join IEA Bioenergy. Accordingly the Secretary has contacted IEA Headquarters to clarify the correct mechanism that should be used. Feedback indicated that the World Bank, as an international, inter-governmental organisation, can only join as a Contracting Party (Article 3.2 of the IEA Framework). The World Bank does not fit into the definition of Sponsors. To date the World Bank has not joined any Implementing Agreement, however other organisations that belong to Implementing Agreements include the United Nations Industrial Development Organisation (UNEDO) and OPEC. Therefore the correct mechanism is for the ExCo to invite the World Bank to join as a Contracting Party which will need approval by the CERT. This is an ongoing initiative for the Executive Committee.

Promotion and Communication

The ExCo has continued to show lively interest in communication of IEA Bioenergy activities and information. There is a wide range of promotional material available through the Secretariat. This includes Annual Reports, technical brochures, copies of IEA Bioenergy News, the current Strategic Plan, strategic papers, and workshop proceedings. The IEA Bioenergy website underpins this publishing activity.

The 2010 Annual Report with the special colour section on 'Algal Biofuels Status and Prospects', was very well received. Only a few copies of the Annual Report from the original print run of 1500 remain with substantially increased distribution in electronic format.

The newsletter 'IEA Bioenergy News' remains popular. Two issues were published in 2011. The first issue featured bioenergy in Finland and the second issue featured bioenergy in Australia as special themes. A free subscription is offered to all interested and there is a wide distribution outside of the normal IEA Bioenergy network. The newsletter is distributed in June and December each year which follows the pattern of ExCo meetings. It is produced in electronic format so potential subscribers should ensure that the Secretary has their email address. IEA Bioenergy News is also available from the IEA Bioenergy website.

Four contributions under the banner of 'IEA Bioenergy Update' were provided to the journal Biomass and Bioenergy in 2011 bring the total to 50. This initiative provides excellent access to bioenergy researchers as the journal finds a place in major libraries worldwide.

Interaction with IEA Headquarters

There is continuing contact between the IEA Bioenergy Secretariat, and IEA Headquarters in Paris and active participation by ExCo representatives in relevant meetings. The Chairman, Technical Coordinator, Secretary, and key Task Leaders have worked closely with Headquarters staff at both administrative and technical levels. For example, the TC, Arthur Wellinger, and Chairman, Birger Kerckow, both attended two meetings in Paris to prepare the Roadmap on Heating and Cooling. In addition, Daniela Thrän from Task 40 attended the first meeting and at the second meeting Jaap Koppejan (Task 32), Uwe Fritsche and Martin Junginger (Task 40) were present. The Chairman also attended the workshop on 'RES – From Analysis to Action'. There was a heavy emphasis on learning curves for the various technologies. Dr Josef Spitzer represented IEA Bioenergy at the 'Communication' workshop which concluded that market penetration could be accelerated through improved communication strategies.

Takatsune Ito and Adam Brown attended ExCo67 and Anselm Eisentraut attended ExCo68. This participation by Headquarters is appreciated by the Members of the ExCo and helps to strengthen linkages between the Implementing Agreement and relevant Headquarters initiatives.

Status Reports were prepared by the Secretary and forwarded to the Desk Officer and the REWP following ExCo67 and ExCo68. Information was also sent to Nils-Olof Nylund, Vice Chairman of the End Use Working Party (EUWP) for the Transport sector to assist the report he prepares for the autumn meeting of the EUWP. This forms part of the exchange of information between Implementing Agreements and the Working Party.

Regular contributions are provided to the IEA OPEN Energy Technology Bulletin. This provides a most useful platform for distributing IEA Bioenergy newsletter and publications to stake holders. The Bulletin is also one of the most used referral mechanisms for introduction to the IEA Bioenergy website.

IEA Bioenergy Website

There are around 6,000 'bona fide' visitors to the website each month. The most popular areas of the website are the Library and the Media Centre. In 2011 there were around 31,000 downloads. The most popular items downloaded were:

- Bioenergy LUC and Climate Change Mitigation – Technical background report
- Bioenergy LUC and Climate Change Mitigation – Report for policy makers
- 2010 Annual Report
- IEA Bioenergy News

- Main Report: 'Bioenergy – a sustainable and reliable energy source'
- ExCo65 Workshop 'Developing Sustainable Trade in Bioenergy – summary and conclusions'
- ExCo64 Workshop 'Algae – The future for bioenergy – summary and conclusions'
- ExCo66 workshop presentations
- ExCo64 Workshop 'Algae – the future for bioenergy?

End of Triennium Conference – Vienna

An End of Triennium Conference will be held in Vienna during the week 12-16 November 2012, back-to-back with ExCo70 and hosted by the Austrian Federal Ministry of Transport, Innovation and Technology. The venue will be the University of Technology Vienna, which will also be the co-organiser with Joanneum Research. The aim is to provide stakeholders in R&D, industry and policy with insight into the recent research and market developments in bioenergy. The conference will embrace all of the subjects dealt with by IEA Bioenergy as well as by partner organisations like FAO, GBEP and UNDP. Presentations will address all stages in bioenergy systems: from growth of biomass, to conversion to energy carriers and, to use for energy services. Cross cutting topics like sustainability (GHG emissions), socio-economics and trade will also be discussed. Policy makers will benefit from the latest conclusions on policy recommendations based on a global scientific energy technology network.

Colleague Recognised

Professor Kai Sipilä, ExCo Member for Finland was awarded the Johannes Linneborn Prize for Achievements in Biomass Development. The award recognised his leadership in development of biomass conversion technologies and for promoting biomass as a sustainable energy source within Finland and worldwide for more than 25 years. Trained as a chemical engineer at the Helsinki University of Technology, he acquired impressive abilities for process development showing creative and practical solutions like in the combined combustion/pyrolysis process of VTT which drew a lot of attention. His interests and successful activities however, cover an integrated bioenergy approach, including all kinds of thermo-chemical conversion technologies, waste to energy and material recycling systems, alternative motor fuel production, renewable energy systems, refining of biomass, energy and climate issues, to name a few. Working for VTT, Kai has contributed to an extensive list of publications and reports and 10 patents. Apart from his technical papers, he has delivered authoritative reviews and overviews on biomass energy, biofuels and material resources at conferences and workshops which have had a lot of influence on the R&D and implementation agendas in the biomass field around the world. All those within IEA Bioenergy welcomed Kai's well-earned award.

2. PROGRESS IN 2011 IN THE TASKS

Task 29: Socio-economic Drivers in Implementing Bioenergy Projects

Overview of the Task

The objectives of Task 29 are to:

- achieve a better understanding of the social and economic drivers and impacts of establishing bioenergy fuel supply chains and markets at the local, regional, national and international level;
- synthesise and transfer to stakeholders critical knowledge and new information;
- improve the assessment of the above mentioned impacts of biomass production and utilisation in order to increase the uptake of bioenergy; and
- provide guidance to policy makers.

These objectives will be met through encompassing the results and findings obtained previously in the Task and also through the international state-of-the-art socio-economic evaluation of bioenergy programmes and projects. Activities will be expanded to include developing countries through the FAO and similar organisations. This will include the sharing of research results, stimulation of new research directions in national, regional, and local programmes, and technology transfer from researchers to resource managers, planners, and industry.

Participating countries: Canada, Croatia, Germany, Norway, and the United Kingdom
Task Leader: Dr Keith Richards, TV Energy Ltd, United Kingdom
Associate Task Leader: Dr Julije Domac, North-West Croatia Regional Energy Agency, Croatia
Operating Agent: Dr Elizabeth McDonnell, Department of Energy and Climate Change, United Kingdom

The Task Leaders direct and manage the work programme. A National Team Leader from each country is responsible for coordinating the national participation in the Task.

For further details on Task 29, please refer to Appendices 2-6 inclusive; the Task website: *www.Task29.net*, the biomass and bioenergy educational website: *www.aboutbioenergy.com* and the IEA Bioenergy website *www.ieabioenergy.com* under 'Our Work: Tasks'.

Task Meetings and Workshops

The Task organised two international events alongside Task meetings. The first event was an international conference on 'fuel poverty issues' held on 14 June in Aylesbury, UK. The event attracted an audience of around 70, including delegates from Housing Associations and Local Councils, installers and utility businesses. Presentations were given by members of the Task team; Canada, Croatia, Germany, Norway and UK as well as local partners of TV Energy. The presentations contrasted and compared the actions from different countries on fuel poverty issues and focused in particular on the role of bioenergy in mitigating the worst impacts. A series of case studies were presented to explain what is currently being done in the UK to harness the potential of local, renewable energy within their communities. A number of exhibitors, from the UK, were also in attendance to help demonstrate innovative and good practice and to illustrate the benefits of renewable energy to tenants and/or local communities. The conference was followed by a day of technical tours and site visits to show Task participants working examples of biomass boilers and other forms of renewable energy at various sites across the Thames Valley. The conference proceedings can be downloaded from *www.tvenergy.org* along with the PowerPoint presentations. The same information is also available from the Task 29 website.

The second event was an international conference 'Sustainable Energy Financing and Investment Summit Croatia 2011' held on 19-22 October in Cavtat, Croatia. The aim of the conference was to identify ways of financing energy efficiency and renewable energy projects using innovative financial instruments. The conference highlighted the importance of investment and regional cooperation to promote energy efficiency, with a view to reducing energy costs, creating a cleaner environment and increasing security of energy supply. The event attracted over 200 attendees with a number of renowned speakers from the European Commission, and governmental and financial institutions. The programme featured specialised workshops and sessions which highlighted the financial aspects of project management. Local and regional authorities took the opportunity to discuss the topic of developing and financing energy projects. Presentations were also given by members of the Task, Canada, Croatia, Norway and UK. The conference proceedings will be prepared by the North-West Croatia Regional Energy Agency in the form of a CD with PowerPoint presentations. The presentations are also available on the conference website *http://www.croenergy2011.com/* and the Task website.

Both meetings were attended by all participating countries. A list of the presentations made is provided in Appendix 4. The conference proceedings are also available on the Task website.

Work Programme

2011 was dedicated to expert work on planned activities from the work programme. The Task participants developed an outline for a focused scientific paper that includes

an overview of 14 case studies. The main purpose of this compilation is to improve the understanding of bioenergy projects by summarising them and finding common characteristics of successful project implementation. In this way it is hoped that the construction of additional projects will be able to take into account features that will maximise bioenergy's social, economic and environmental benefits. This paper will document the drivers in implementing the projects, record the barriers encountered by the project developers, list the impacts of the projects and identify the stakeholders. The studies will also identify methods of overcoming negative aspects and emphasising positive parts. As such, it will signpost those elements necessary to successfully develop a bioenergy project. This paper will be published in a recognised scientific journal.

Another completed deliverable was a brochure, important for the visibility of the Task and targeted at local and regional events in partner countries. The brochure was jointly created, published, and distributed to the Task participants.

The Task also commenced the production of a short video which will illustrate the use of biomass highlighting the role of socio-economic effects. The video will include snippets from each country featuring renewable energy projects that have made positive socio-economic impacts. As such, it will have an educational and promotional role and will be made available on the Task website.

The Task also prepared detailed plans for event-based meetings (conferences/workshops) over the three year programme. Germany and Canada will host workshops and conferences during 2012.

Website

The look and identity of the Task website (*www.Task29.net*) has recently been redeveloped and reorganised. Additional material from past events has been collected and made available for downloading (including presentations from Task events and workshops, meeting minutes, separate articles from Task proceedings and completed case studies). A Task brochure has been finalised and made available on the website.

As the Task website is a key tool for dissemination it has been periodically updated. All publications, including workshop proceedings and meeting minutes, Task brochures and posters, Task reports and papers, can be downloaded in PDF format. Several video files, explaining various socio-economic issues related to bioenergy, are being made available for downloading or online viewing.

Collaboration with Other Tasks/Networking

The Task Leaders have been approached by Task 43 which is working on bioenergy-water links as one of the themes during this triennium. Task 43 is also proposing work on mobilising sustainable bioenergy supply chains. Collaboration with these initiatives is being planned.

Deliverables

Deliverables in 2011 included workshop presentations at the two international conferences organised by the Task, meeting minutes, proceedings of the Norway Conference, an updated database on the website, case studies, a Task brochure, a scientific paper based on the case studies, papers published in international journals, papers presented at international events, two progress reports and an annual audit report to the Executive Committee, along with the biomass and bioenergy educational website.

TASK 32: Biomass Combustion and Co-firing

Overview of the Task

The objective of the Task is to stimulate expansion of biomass combustion and co-firing for the production of heat and power on a wider scale. The widespread interest in the work of the Task illustrates the relevance of biomass combustion and co-firing in society. Combustion applications vary from domestic wood stoves to industrial combustion technologies, dedicated power generation and co-firing with conventional fossil fuels.

In general, biomass combustion technologies are fully mature with high commercial availability and a multitude of options for integration with existing infrastructure at both large and small-scale. Nevertheless, there are still a number of challenges for further market introduction, the importance of which varies over time. Priority issues tackled by the Task through its activities in this triennium are:

- Aerosol emissions from residential solid fuel appliances
- Use of non-woody biomass types and ash-related problems
- Pre-treatment, storage, handling and sustainability of biomass resources
- New CHP concepts for small-scale applications
- Increasing co-firing percentages
- Utilisation of ash
- Database on biomass co-firing experiences

The specific actions of the Task involve collecting, sharing, and analysing the policy aspects of results of international/national R&D programmes that relate to these priorities. The results of these actions are disseminated in workshops, reports, handbooks, databases etc. In addition, a number of specifically designed, strategic actions are carried out by the Task to catalyse this process.

While most of the above actions are of a technical character, Task 32 also addresses nontechnical issues on fuel logistics and contracting, environmental constraints and legislation, public acceptance and financial incentives. An overview of relevant policies is included in the Handbook of Biomass Combustion and Co-firing. In addition, the Task

produced a number of reports on harnessing the co-firing potential in both existing and new coal-fired power plants.

Participating countries: Austria, Canada, Denmark, Finland, Germany, Ireland, Italy, the Netherlands, Norway, Sweden, Switzerland, Turkey, and the United Kingdom
Task Leader: Ir Jaap Koppejan, Procede BV, the Netherlands
Sub-Task Leader for Co-firing: Ing Robert van Kessel, KEMA, the Netherlands
Operating Agent: Ir Kees Kwant, NL Agency, the Netherlands

The Task Leader directs and manages the work programme. A National Team Leader from each country is responsible for coordinating the national participation in the Task.

For further details on Task 32, please refer to Appendices 2-6 inclusive; the Task website *www.ieabioenergyTask32.com* and the IEA Bioenergy website *www.ieabioenergy.com* under 'Our Work: Tasks'.

Progress in R&D

Task Meetings and Workshops

In 2011, the Task organised two internal meetings, four workshops and a field trip. The first meeting was held in Graz, Austria and the second in Dublin and Carlow, Ireland. These internal meetings were used to monitor progress in different Task activities, reflect on Task-initiated workshops, share recent developments on application of biomass combustion in Member Countries and plan for the next triennium.

Workshops are a proven concept to gather and disseminate information in a structured and effective manner. Invited speakers present latest insights on one aspect of biomass combustion and/or co-firing, and thereby provide expert information for the participants. These workshops are usually organised in conjunction with high profile bioenergy conferences to attract as wide an audience as possible. The results of the workshops are reported and published on the Task website, and key results are fed back to both the Task participants and the ExCo for evaluation and further dissemination.

The Task meeting held in January, in conjunction with the Central European Biomass Conference (CEBC) was a short meeting, since it was only three months after the previous meeting. The meeting focussed on progress in the various Task activities. Two expert workshops were organised as part of the CEBC. The first focused on 'Fine particulate emissions from small-scale biomass furnaces' covering both primary and secondary options to reduce particle emissions, as well as the health effects. The second was co-organised with Task 40 and focused on the 'Development of torrefaction technologies and impacts on global bioenergy use and international bioenergy trade'. This workshop was very successful with the major torrefaction companies represented and approximately 250 participants.

The second Task meeting took place in October in Ireland. The formal meeting was used to discuss progress in the various Task projects, monitor combustion related developments in individual Member Countries and to prioritise the key issues for the next triennium. In conjunction with this meeting, two workshops and a field trip were organised. The first workshop was on current technology and policy developments in small-scale biomass combustion, and the relevance of health and safety issues to small-scale combustion. It was aimed at companies involved in this sector. The second workshop was co-organised with Task 36 with the topic 'Production and utilisation options for Solid Recovered Fuels' (SRF). Task 32 is interested in this topic since SRF (with their biogenic contents) could be an option for both co-firing with coal but also in dedicated combustion plants. The workshop provided the 100 participants with a good perspective of the suitability of various processing routes for SRF. In combination with this workshop, a field trip was organised to a cement kiln and a newly built waste-to-energy plant near Dublin.

The reports on Task meetings and workshops can be downloaded from the Task website.

Work Programme

The work programme in the current triennium is structured as follows:

Aerosol Emissions from Residential Solid Fuel Appliances

This topic was earlier prioritised as the most relevant topic for the current triennium, with four actions.

- A co-funded study is currently being carried out to evaluate and report on the cost effectiveness of new particle removal technologies. The report is currently available in draft form and will be finalised early in 2012.
- An expert workshop was held in January on the formation mechanisms, reduction measures, and health impact of aerosols from biomass combustion in Graz, Austria.
- An Irish national workshop was held in October on small-scale combustion.
- In November 2012 a workshop will be organised at the IEA Bioenergy Conference in Vienna on small-scale combustion.

Use of Non-woody Biomass Types and Ash-related Problems

One of the problematic 'biomass-containing' fuel types is Solid Recovered Fuel. Several thermochemical options are being proposed to process this material (such as pyrolysis, gasification, dedicated combustion, co-firing) however in practice there are few real initiatives in place, let alone a commercial breakthrough. A workshop was organised with Task 36 in Ireland, to explore and compare the different conversion routes available for Solid Recovered Fuel.

Pre-treatment, Storage, Handling and Sustainability of Biomass Resources

A study is currently being carried out to evaluate the technical characteristics of torrefied pellets, the flexibility of the process in terms of technical specifications of input and output,

and the suitability of burning torrefied pellets in conventional small-scale combustion devices. The study will be finalised early in 2012.

In a number of recent instances, biomass storages have unexpectedly caught fire. The mechanisms behind the heating up of large storages are not yet well understood. The ExCo agreed to support a Task 32 coordinated, multi-disciplinary study with several other Tasks to evaluate the safety issues associated with large-scale handling and storage of biomass. The work will culminate in 2012 with an overview report.

A joint workshop was organised with Task 40 at the Central European Biomass Conference in Graz, Austria in January on biomass torrefaction technologies, as well as financial and logistical aspects.

New CHP Concepts for Small-scale Applications

There has been no new work since the expert workshop organised in October 2010 on the current status of various small-scale CHP technologies.

Increasing Co-firing Percentages

A workshop will be organised in March 2012 in Copenhagen on high percentage co-firing in coal-fired power plants. The aim is to share initial experiences amongst plant operators, illustrating the importance of fuel flexibility and how to address various technical and non-technical issues to establish high percentage co-firing systems. This workshop will be jointly organised with the IEA Clean Coal Centre and the biomass power industry group of VGB Powertech (the European Association of power plant owners).

Utilisation of Ash

KEMA is coordinating the preparation of a paper on ash utilisation options from biomass combustion and co-firing systems. The report will show how the combustion process and biomass characteristics influence the quality of the various ashes produced, how the ashes are currently utilised, and what can be done to improve ash utilisation. Preparation of the paper has been delayed but it will be finalised early in 2012 and should facilitate the improvement of national policies on ash utilisation.

Database on Biomass Co-firing Experiences

The existing web database on biomass co-firing experiences is continuously updated with the latest information available worldwide. Recently the database has been made interactive to allow easy updating by various external editors who, after endorsement from the database moderator, can enter data themselves.

Website

The Task website (*www.ieabioenergyTask32.com*) attracts a continuously growing number of visitors (about 10,000 visitors every month) and is one of the key tools for information dissemination. Main products that are being downloaded from the website are publications

and meeting reports, the database on experience with biomass co-firing in different power plants, and the databases on the composition of biomass and ash from combustion plants. The website is updated on a regular basis. In 2011, several electronic newsletters have been produced and distributed to provide information on developments related to the work of the Task and biomass combustion and co-firing in general. Task participants and ExCo Members can obtain access to a secured section of the website which includes internal reports and work in progress.

Collaboration with Other Tasks/Networking

The Task collaborates directly with industry and through industrial networks such VGB Powertech. Within the IEA family, interaction is also solicited with other Tasks or other Implementing Agreements such as the IEA Clean Coal Centre. Market relevance is also enhanced by the involvement of ExCo Members in the selection of Task participants, based on their national programmes. Effective coordination is achieved through joint events, and the exchange of meeting minutes and reports. In 2011 joint workshops were held on torrefaction (with Task40) and SRF (with Task36). The production of the pellet handbook was undertaken with Tasks 29, 31 and 40 and the Health and Safety report is being prepared in conjunction with experts from Tasks 36, 37, and 40.

Deliverables

The following milestones were achieved in 2011. Organising and minuting of two Task meetings. Organising and reporting of four workshops on 'Fine particulate emissions from small-scale biomass furnaces', 'Development of torrefaction technologies and impacts on global bioenergy use and international bioenergy trade', 'National Irish workshop on local developments in small-scale biomass combustion', and 'Production and utilisation options for Solid Recovered Fuels'; updating of the international overview of initiatives for biomass co-firing; and maintenance of the Task website. The Task also produced progress reports and audited accounts for the ExCo.

TASK 33: Thermal Gasification of Biomass

Overview of the Task

The objectives of the Task are to monitor, review and exchange information on biomass gasification research, development, and demonstration; and to promote cooperation among the participating countries and industry to eliminate technological impediments to the advancement of thermal gasification of biomass. The ultimate objective is to promote commercialisation of efficient, economical, and environmentally preferable biomass gasification processes, for the production of electricity, heat, and steam, for the production of synthesis gas for subsequent conversion to chemicals, fertilisers, hydrogen and transportation fuels, and also for co-production of these products.

Participating countries: Austria, Denmark, Finland, Germany, Italy, Japan, the Netherlands, New Zealand, Norway, Sweden, Switzerland, Turkey and USA
Task Leader: Dr Richard Bain, NREL, USA
Operating Agent: Mr Paul Grabowski, Office of Biomass Program, US Department of Energy, USA

The Task Leader directs and manages the work programme. A National Team Leader from each country is responsible for coordinating the national participation in the Task.

For further details on Task 33, please refer to Appendices 2-6 inclusive; the Task website *www.ieaTask33.org* and the IEA Bioenergy website *www.ieabioenergy.com* under 'Our Work: Tasks'.

Progress in R&D

Task Meetings and Workshops

The third meeting for the triennium was held from 12-14 April in Christchurch, New Zealand. The Task meeting was held on the first day. The second day was a visit to the University of Canterbury gasification and gas cleaning facilities, cold model gasification plant and FT-reactor and the university's laboratories. Also visited were the Nature´s Flame wood pellet plant, Solid Energy Renewables and the SRS Sawmill. On the third day there was a workshop titled 'Gasification and alternative fuels development', which had an emphasis on biomass and other renewable energy development in New Zealand and Australia.

The fourth meeting was held from 18-20 October in Piteå, Sweden. The Task meeting was held on the first day. On the second day a workshop 'Biomass gasification opportunities in the forest industry' was held. It included presentations from major gasifier developers, including Chemrec, Metso Power, Andritz Carbona, and NSE. Presentations were given by Esa Kurkela, summarising gasification activities at VTT, and Reinhard Rauch summarising gasification-based cogeneration. On the third day Task representatives visited 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, and the SunPine tall oil biodiesel plant.

Work Scope, Approach and Industrial Involvement

The scope of work for the current triennium is built upon the progress made in the previous triennia. Historically, information exchange, investigation of selected sub-Task studies, promotion of coordinated RD&D among participating countries, selected plant visits, and industrial involvement in technical workshops at Task meetings have been very effective. These remain the basic foundations for developing and implementing a programme of work that addresses the needs of the participating countries.

The Task monitors the current status of the critical unit operations and unit processes that constitute biomass gasification (BMG) process, and identifies hurdles to advance further development, operational reliability, and reducing the capital cost of BMG systems. The Task meetings provide a forum to discuss the technological advances and issues critical to scale-up, system integration, and commercial implementation of BMG processes. Generally, these discussions lead to selection of sub-Task studies and/or technical workshops that focus on advancing the state-of-the-art technology and identifying ways to resolve barriers to technology commercialisation.

The Task has continued the practice of inviting industrial experts to the Task meetings to present their practical experiences and to discuss the options for development of critical process components to advance state-of-the-art BMG systems. The interaction with industry provides the opportunity for the National Team Leaders (NTLs) to evaluate refinements to existing product lines and/or processes. Academic experts are also invited as and when the need arises to seek information and cooperation in order to address basic and applied research needs.

Work Programme/Sub-task Studies

The current work programme includes the following elements:

- Plan and conduct semi-annual Task meetings including workshops on sub-Task studies selected by the NTLs, and address matters related to the Task mission and objectives. Details are:

Meeting	Associated Workshop	Dates and Location
1st Task meeting	WS1 'Second generation biofuels'	1-3 June 2010 Helsinki, Finland
2nd Task meeting	WS2 'State-of-the-art technologies for small biomass co-generation'	5-7 October 2010 Skive/Copenhagen, Denmark
3rd Task meeting	WS3 'Gasification and alternative fuels development'	12-14 April 2011, Christchurch, NZ
4th Task meeting	WS4 'Biomass gasification opportunities in the forest industry'	18-20 October 2011, Piteå, Sweden

- Survey the current global biomass and waste gasification RD&D programmes, commercial operations and market opportunities for BMG, and identify the technical and non-technical barriers to commercialisation of the technology. Use the survey results to prepare and update Country Reports for information dissemination.
- Conduct joint studies, conferences, and workshops with related Tasks, Annexes, and other international activities to address issues of common interest to advance BMG systems.

- Identify research and technology development needs based on the results from the work described above as a part of the workshop reports.
- Publish results of the work programme on the Task website (*www.ieaTask33.org*) for information dissemination. Maintain the website with Task updates.

Observations from WS3: Gasification and Alternative Fuels Development

NREL reported on biomass gasification in North America. R&D activities, biopower and biofuels status, resource potentials and gasifiers in the USA and Canada were presented.

Earth Systems reported on biomass gasification in Australia. There is currently no commercial biomass gasification plant operating in Australia. Some projects are in preparation, which may yield commercial biomass gasification installations in the near future. Accordingly there is limited activity in biomass gasification research in Australia at present and no funding 'specific' to the bioenergy sector. However, the activity fits within a number of sectors for which funding schemes exist. It is likely a combination of avoided waste costs plus income from energy production will be the key drivers for bioenergy processes such as gasification in the medium term.

VUT reported on the status of work concerning the conversion of biomass over steam gasification to biofuels and chemicals.

Fluidyne, NZ reported on small-scale charcoal gasification. The University of Canterbury reported on R&D activities and on the BTSL programme. The objectives of the BTSL programme are:

- Optimisation of biomass gasification and co-gasification for clean and H_2 rich syngas
- Gasification of energy-densified biomass slurry (pyrolysis and gasification)
- Fischer-Tropsch (FT) synthesis for biodiesel
- New biomass resources and feasibility studies for an integrated FT plant

The university reported on research into the gasification of biomass for clean and hydrogen-rich syngas. It has constructed and commissioned a 100 kW gasifier – dual fluidised bed gasifier using steam as the gasification agent. The impact of different bed materials and gasification temperature on gas quality was investigated. Also tests with different fuels and biomass-coal blends were carried out, together with a gas cleaning system.

CRL Energy Ltd and the Coal Association of NZ reported on gasification of coal and biomass for purified hydrogen production. New Zealand has 10 times more coal per inhabitant than the rest of the world. A four year programme on biomass gasification and hydrogen production was presented. The main points of the programme are:

- Bench-scale gasification tests on coal-biomass blends
- Modelling char reactivity and product streams
- Proof of concept of an O_2 blown gasifier

Solid Energy NZ reported on underground coal gasification. The underground coal reserves will not be mined but instead gasified *in situ* to produce gasification gas. During the process the gasifying agent (air, steam, and oxygen) is brought to the coal reserve and the product gas pumped out. This courageous idea is new and can save the costs of the gasifier, as well as the environment.

Observations from WS4: Biomass Gasification Opportunities in the Forest Industry

NREL reported on climate change and the pulp and paper industry and on BMG in North America. Furthermore, current biofuels and Biopower status in the USA was presented. Also mentioned were the gasification technology projects in the USA (Nexterra, Enerkem, etc.)

ETC reported on black liquor gasification and on a project 'Transportation Fuels from Forest Residues via PEBG'. In Sweden, the black liquor production is concentrated at about 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. Chemrec reported on the DP-1 gasifier. It is an oxygen-blown, pressurised entrained flow gasifier using black liquor as a feedstock to produce clean, cool synthesis gas. Chemrec also reported on BioDME plant that uses Haldor Topsøe technology to produce dimethyl ether for use as a diesel fuel in Sweden. Sveaskog is the leading forest owner in Europe with its base in the Swedish boreal forests. Sveaskog presented a forest owner´s perspective on bioenergy. Sweden has shown that a transition from fossil to renewable energy is possible. Today, bioenergy in Sweden is the largest energy source and that is why the forests can play a key role.

VTT reported on biomass-to-syngas projects including an advanced analysis technique for gasification gas and woody biomass based gasification process development for H_2 or SNG production (Vetaani project).

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. Metso presented details of their CFB gasifier and the Lahti Energia project – solid waste gasification.

VUT reported on economic frame conditions in Austria, R&D and projects concerning elements behaviour during the biomass gasification and mixed alcohols.

Andritz/Carbona reported on different gasification areas where it is active:

- 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})

NSE Biofuels Oy is owned by Oil Oy and Stora Enso Oy. The current business is to produce syngas from woody biomass to be used as fuel in the Stora Enso Varkaus pulp mill's lime kiln.

Website

The Task website (*www.ieaTask33.org*) is the most important tool for dissemination of results. It includes a wide variety of information including descriptions of the thermal gasification process; details of the Task and its participants; publications; Country Reports; meeting minutes and presentations and summaries of the workshops. Also on the website is a Google map-based interactive database of implementations of gasification plants. At present there are 87 gasification facilities registered. 66 of these facilities can be found in the participating countries. The database is interactive, and provides users with the capability to search by technology, type, and status from all of the plants registered. The database is updated regularly and provides a good overview on gasifiers throughout the world.

Deliverables

The Task deliverables included planning and conducting two semi-annual Task meetings focused on the workshops selected by the Task participants, involving academic and industrial experts; the preparation and distribution of workshop reports; updating and publishing Country Reports; conducting joint studies, conferences, and workshops with related Tasks, Annexes, and other international activities to address mutually beneficial issues; and preparation of periodic progress, financial, technology, and annual reports as required by the ExCo.

TASK 34: Pyrolysis of Biomass

Overview of the Task

The objective of the Task is to improve the rate of implementation and success of fast pyrolysis of biomass for fuels and chemicals (where this complements the energetic considerations) by contributing to the resolution of critical technical areas and disseminating relevant information particularly to industry and policy makers. The scope of the Task is to monitor, review, and contribute to the resolution of issues that will permit more successful and more rapid implementation of biomass pyrolysis technology, including identification of opportunities to provide a substantial contribution to bioenergy. This will be achieved by a programme of work, which addresses the following priority topics: norms and standards; analysis – methods comparison and developments; and country updates and state-of-the-art reviews.

Pyrolysis comprises all steps in a process from reception of biomass in a raw harvested form to delivery of a marketable product as liquid fuel, heat and/or power, chemicals and char by-product. The Task focus is on fast pyrolysis to maximise liquid product. The technology review may focus on the thermal conversion and applications steps, but implementation requires the complete process to be considered. Process components as

well as the total process are therefore included in the scope of the Task, which covers optimisation, alternatives, economics, and market assessment.

The work of the Task addresses the concerns and expectations of the following stakeholders: pyrolysis technology developers; bio-oil applications developers; equipment manufacturers; bio-oil users; chemical producers; utilities providers; policy makers; decision makers; investors; planners, and researchers.

Industry is actively encouraged to be involved as Task participants, as contributors to workshops or seminars, as consultants, or as technical reviewers of Task outputs to ensure that the orientation and activities of the Task match or meet their requirements. Participants at recent meetings have included representatives from biomass pyrolysis industry leader, Ensyn, and an important biomass processing industry support group FP Innovations of Canada.

Participating countries: Canada, Finland, Germany, United Kingdom and USA. The Netherlands will join from 1 January 2012.
Task Leader: Mr Douglas Elliott, Battelle-Pacific Northwest National Laboratory, USA
Operating Agent: Mr Paul Grabowski, US Department of Energy, USA

The Task Leader directs and manages the work. A National Team Leader from each country is responsible for coordinating the national participation in the Task. For further details on Task 34, please refer to Appendices 2-6 inclusive; the Task website *www.pyne.co.uk* and the IEA Bioenergy website *www.ieabioenergy.com* under 'Our Work: Tasks'.

Progress in R&D

Task Meetings

The first Task meeting was held on 6-8 April in Hamburg, Germany. All National Team Leaders were present for the meeting. The agenda items included Country Reports and formulation of a plan to publish the information; norms and standards developments and discussion of publication efforts for information on sulphur/nitrogen analysis and bio-oil transport and infrastructure issues, as well as an improved Material Safety Data Sheet (MSDS) for bio-oil; and the status of the round robin on bio-oil viscosity and thermal stability. An important outcome of the meeting was extension of the round robin analysis of bio-oil samples for viscosity and thermal aging. The list of participants in the initial round robin comprises 15 laboratories in the five participating countries. The bio-oil samples were being distributed by CanMet with the expectation that the results will be received by June. The group also toured the biomass pyrolysis laboratories of Dr Meier at the Johann Heinrich von Thünen-Institut for Wood Technology and Biology at the University of Hamburg. Most of the participants also took part in a study tour to the PyTec ablative fast pyrolysis pilot plant.

The second meeting was held in on 3-4 October in Richland, USA. The agenda included Country Reports, status of the bio-oil viscosity and aging round robin results, discussion of advances and needs for norms and standards. Country Reports were presented by USA, Finland, Germany, UK, and Canada. The results of the bio-oil viscosity and aging round robin from the 15 participating laboratories were reviewed at the meeting. On the subject of norms and standards it was reported that an expansion of the ASTM burner fuel standard, D7544, is being balloted which will expand the standard to a second category of bio-oil that is higher quality (lower solids and ash). There was discussion about future standards, such as further refined burner fuel or for turbine or diesel fuels. The status of the REACH support effort was also reviewed. Task 34 has agreed to support the effort by providing input as requested, such as for the chemical safety report. Further, the Task believes that the registration should be divided into a slow pyrolysis group and a fast pyrolysis group, along the lines of the two CAS numbers which are now in existence. Relative to a new bio-oil MSDS, the several existing examples need to be coordinated. The biotox results need to be reviewed to identify results that can be used in an improved MSDS. The flash point also needs to be removed from the document with the addition of the information that bio-oil does not support sustained combustion. The several publications in development within the Task were further progressed. The outline has been determined for the SOTA paper, based on the Country Reports, and some input has been received. The paper on sulphur analysis remains incomplete but nitrogen analysis has been added to the scope of the paper. Corrosion data is being incorporated into the paper on bio-oil guidelines, which will be complete when the biotox review input is ready. The meeting concluded with a tour of the Pacific Northwest National Laboratory pyrolysis and bio-oil upgrading laboratories.

Work Programme and Progress in 2011

The work typically consists of Task meetings, workshops, technical tours, and Task projects, in addition to the 'usual' Task management and ExCo support actions. Among the work efforts were the following:

- The standards development effort in North America and Europe continued. An expanded Burner Fuel Standard for fast pyrolysis bio-oil was balloted by ASTM. Further work on standards is proceeding in Europe with the support to the REACH registration process. A new pyrolysis bio-oil MSDS is being formulated based on new analytical efforts including sustained combustibility determination and eco toxicology assessments.
- A round robin was undertaken in 2011. The round robin included two bio-oil samples distributed to 15 laboratories in the five participating countries. The analyses focused on viscosity and thermal stability (change in viscosity following 24 hour ageing at 80°C), as well as moisture analysis and insoluble solids determination. Prescribed optional analyses were also undertaken by some of the participants.
- A continuing effort is the sharing of updated Country Reports by each of the participants at each of the Task meetings. These reports are being formulated into a state-of-the-art review, which will be submitted to a journal for publication.

Newsletter

The Task newsletter continues the tradition of the PyNe newsletter and is an important vehicle for dissemination of relevant information. It is circulated to participants via the Task 34 website in electronic format. Issue 29 was published in June 2011 and Issue 30 was published in December 2011.

Website/Dissemination

The Task 34 website is an important mechanism for information and technology transfer. It is revised and updated under a contract with Aston University.

Collaboration with Other Tasks

The priority topics in the Task work programme can be formulated to provide projects that can be shared with other IEA Bioenergy Tasks. As an example, there was a joint assessment of a fast pyrolysis-based biorefinery in collaboration with Task 42, which is led by the Netherlands. A Task 42 participant is undertaking an assessment of a pyrolysis-based biorefinery, based on lignin feedstocks.

Deliverables

Deliverables for 2011 were: reporting to the ExCo (Annual Report, progress reports, and audited accounts); continuation and updating of the Task website; two issues of the Task newsletter; organisation and minuting of two Task meetings; and organisation of the round robin.

TASK 36: Integrating Energy Recovery from Solid Waste Management

Overview of the Task

The waste and energy sector worldwide is currently undergoing a period of intense legislative and institutional change. The prime aim of Task 36 is to keep abreast of both technical and policy developments and to exchange information and dissemination on how energy integrates into these developments. This means that the sharing of good practice and/or new technology and techniques is also a major goal, so a further objective of the Task is to maintain a network of participating countries as a forum for information exchange and dissemination. To achieve these goals the Task participants have chosen a number of key Topic Areas for inclusion in the work programme.

Many countries have different approaches to waste treatment and disposal, but common themes are concerned about the increasing quantities of waste needing to be treated and

the impact of landfilling mixed wastes on the environment. For some countries decreasing available landfill void space adds to this pressure. Consequently policy makers are examining alternatives to landfill, including reduction and recycling of waste, followed by recovery of value from waste. Within the EU the Waste Framework Directive sets out a waste hierarchy that ranks priorities in waste management, puts forward conditions for determining whether or not processing changes waste to a product and sets out the requirements for classifying the incineration of waste as energy recovery (specifically related to the efficiency of energy recovery). A major driver for decision makers in Europe is the Landfill Directive, which sets targets for the diversion of biodegradable waste from landfill. This has led to increased interest in recycling and treatment of waste, followed by recovery of energy from the residual waste stream. Elsewhere, notably in North America and Australia, countries continue to rely on landfill, but in these countries there are increasing pressures to reduce waste production and to recycle or recover where possible, leading also to increased interest in recovery of energy from waste. Globally these policy pressures have led to a proliferation of research work on waste management, including policy development, environmental systems analysis, technology development and economic drivers. Whilst this has assisted in the development of more sophisticated waste management systems in many cases it has also delayed deployment of energy recovery systems (specifically for residual wastes) in particular due to confused policy making, public awareness (and opposition) and uncertainty over environmental performance and technology performance.

Against this background policy makers require guidance and information on all of these aspects if waste and resource management systems that are environmentally and economically sustainable are to be developed. Task 36 provides a unique opportunity to draw together information on how systems, policies and technologies are being applied in different countries to provide guidance for policy makers on key issues. It has already provided a guide to waste management systems in participating countries, which includes an overview of energy recovery options using combustion systems. It now aims to examine key work streams of relevance to the deployment of residual waste technologies, specifically to integrating energy recovery into such management systems.

Participating countries: Canada, France, Germany, Italy, Norway, Sweden and the United Kingdom
Task Leader: Dr Pat Howes, AEA, United Kingdom
Operating Agent: Dr Elizabeth McDonnell, Department of Energy and Climate Change, United Kingdom

The Task Leader directs and manages the work programme. A National Team Leader from each country is responsible for coordinating the national participation in the Task.

For further details on Task 36, please refer to Appendices 2-6 inclusive, the Task website *www.ieabioenergyTask36.org* and the IEA Bioenergy website *www.ieabioenergy.com* under 'Our Work: Tasks'.

Task Meetings and Workshops

The Task held two meetings in 2011. The first took place on 22-25 March at the Karlsruhe Institute of Technology (KIT) in Germany. This meeting enabled progress on the Topic Areas to be discussed and was held in association with a workshop on the work of KIT on combustion of waste. KIT is one of the leading European institutes working on waste combustion technologies and emissions from waste combustion. Their work includes improved efficiency of conversion technologies, advanced conversion technologies and management of ash from waste treatment plants. The presentations are on the Task website. A site visit was arranged to the Bioliq pilot plant and to the MVV plant at Mannheim where the participants were able to visit the new greater efficiency boiler plant and the waste wood incineration plant.

The second meeting took place on 19-21 October in Dublin, Ireland. This meeting was held in association with a workshop on the use of solid recovered fuel, jointly organised with Task 32. The workshop was a great success, attracting over 100 delegates. Presentations were given by the CEN standards working group dealing with SRF, the European Recovered Fuel Organisation, combustion plant operators, solid recovered fuel producers and researchers working on aspects of solid recovered fuel combustion and torrefaction. The workshop was followed by site visits to Lagen Cement, which will co-combusts 76,000t of SRF in 2011 and the Indaver Incineration plant at Meath, which will take 200,000t of municipal waste/year and generate 15 MW of electricity.

The Task also played an active role in the Bioenergy Australia 2011 Conference in association with ExCo68. Presentations were given on life cycle analysis of waste treatment options and on the environmental performance of modern energy from waste plants. These presentations are available from Bioenergy Australia, and will also be published on the Task 36 website.

Work Programme

The goal of the Task is to produce a series of Topic reports, each covering a subject that is important to the deployment of energy from waste. viz.

Topic 1: Policy support (Measurement of the biogenic content of waste and heat support)
Topic 2: Integration of processes for optimising resource recovery
Topic 3: Emerging small-scale energy recovery from waste
Topic 4: Life cycle assessment of waste management and recovery options
Topic 5: Management of residues from energy recovery

Progress on each Topic is summarised below.

Topic 1: Policy Support

This Topic will examine key issues that are important to policy at present and which are important to the development of 'green certification' of EfW:

- How to optimise (incentivise) the use of heat from EfW plants. This summarises the work being done in Sweden, the Netherlands, Germany and Denmark on the incentivisation of heat.
- How to measure the biogenic content of waste – this draws from work undertaken by RSE spa and from the work of the CEN committee on this subject. The topic leader has also reviewed methodologies being examined within Task Member Countries.

Topic 2: Integration of Processes for Optimising Resource Recovery

This Topic is examining proposed 'refinery-like' configurations for the processing of waste and recovery of energy in one integrated system. Three potential waste refinery configurations were examined. The first of these is modelled on systems that are available now; the second on systems that could be available in the near future; and the third of systems that might be offered further down the line. These 'waste refinery plants' are referred to as 'Integrated Advanced Waste Refineries (IAWARE)'. The future configurations include advanced conversion technologies where feasible. A preliminary paper setting out the proposed configurations for further study was presented in 2010. Further work was reported in 2011, including a workshop in Copenhagen in July to discuss anaerobic digestion systems with Task 37. A draft report has been prepared for comment and is due to be finalised by May 2012.

Topic 3: Emerging Small-scale Energy Recovery from Waste

This Topic will understand factors that influence and enable the development of relatively small-scale plants, less than 50,000t/y. The Task is currently considering a series of case studies on small-scale plants that have been developed including:

- Why small plants might need to be developed (e.g. rural areas or policy for small plants).
- Why it is difficult to develop plants that are small, cheap and efficient (or why it is more expensive, less efficient or higher risk to develop small plants).
- Technical versus policy issues e.g. how local policy may result in the need for local solutions which contradict the need to deal with technical issues.

Topic 4: Life Cycle Assessment of Waste Management and Recovery Options

This Topic provides an environmental impact assessment of the options being examined for IAWARE in Topic 2. It uses the UK Environment Agency's WRATE Life Cycle Assessments (LCA) to provide a comparative analysis for the IAWARE systems examined in Topic 2. The work has also included discussions with Task 37 to ensure that anaerobic digestion systems examined are representative.

Topic 5: Management of Residues from Energy Recovery

This Topic will examine the management of residues from energy recovery. It will cover:

- All types of combustion plants.
- Waste incineration, co-treatment of biomass, SRF, pyrolysis.
- Thermal energy recovery only (not biological treatment). Biological residues could be covered through liaison with Task 37.
- Comparisons of different technologies for use and the tests for use of fly ash.
- Provision of an overview of procedures, technologies and standards in all countries (including Danish standards).
- Comments on long-term impacts of use and how each country currently monitors these impacts.

This Topic examines the management of residues from thermal energy recovery systems, including all types of waste and solid recovered fuel combustion plants, including pyrolysis. It examines comparison of different technologies for use and tests to allow the use of fly ash. As part of this the procedures, technologies and standards for residue use in all Member Countries are reviewed. Preliminary results for this work were presented in Karlsruhe and the work is due to be completed before next spring's Task meeting.

Website

The website (*www.ieabioenergyTask36.org*) is the key tool used for dissemination of information from the Task. It provides access to the latest publications produced by the Task, including the presentations from the October workshop. The website also provides access to past reports, articles, case studies and presentations at workshops associated with Task meetings. In addition, it provides a 'members only' forum, to allow rapid access to the latest drafts of documents and to information on Task meetings. In 2011 the visitor numbers were around 66 per day, with over 47,000 visits over the year. Most visitors were interested in what the Task is about and the information included on the site, emphasising the importance of the website for information dissemination. The publication of the workshop presentations in October stimulated an increase in visits.

Collaboration with Other Tasks

Collaboration with other Tasks has included the very successful joint workshop with Task 32 on Solid Recovered Fuel; and collaboration with Task 37 to gather data for Topics 2 and 4. In addition Task 36 is contributing to the multi-Task 'health and safety' report.

Deliverables

The deliverables for the Task in 2011 included the presentations for the solid recovered fuel workshop, available on the Task website. Presentations from the workshop in Karlsruhe are also available on the Task website. The Task also prepared two progress reports and an annual audit report for the Executive Committee.

TASK 37: Energy from Biogas

Overview of the Task

The objectives of the Task are to promote commercialisation of biogas technologies and production, by identifying best practices leading to high quality products, minimum environmental impact and high levels of health and safety. The Task's approach involves the review and exchange of information and promotion of best practices for all steps of the process chain for anaerobic digestion (AD) of biomass residues and energy crops for the production of biogas as a clean renewable fuel for use either directly in combined heat and power generation or, after up-grading to biomethane where it replaces natural gas. The Task also addresses utilisation of the residues of the AD process, the digestate, and the quality management methods for conversion to high quality organic fertiliser. The scope of the work covers biogas production on the farm-scale, in waste water and sewage treatment plants, as well as for the treatment of the biodegradable fraction of municipal waste (biowaste).

Through the work of the Task, communication between RD&D programmes, relevant industrial sectors and governmental bodies is encouraged and stimulated. Continuous education is addressed through dissemination of the Task's publications in workshops, conferences and via the website. Information and data collected by the Task is used increasingly for providing support to all levels of policy making in Member Countries.

To achieve the objectives, the Task maintains strong relationships with the governments of Member Countries, R&D institutions and industry. Partners in the work are plant and equipment providers, existing and future operators and potential clients interested in the products of anaerobic digestion, i.e., fertiliser (digestate) and biogas up-graded to biomethane.

Participating countries: Austria, Brazil, Canada, Denmark, Finland, France, Germany, Ireland, the Netherlands, Norway, Sweden, Switzerland, Turkey, United Kingdom, and the European Commission
Task Leader: Dr David Baxter, European Commission, Petten, the Netherlands
Operating Agent: Dr Kyriakos Maniatis, European Commission, Brussels, Belgium

The Task Leader directs and manages the work programme. A National Team Leader from each participating country is responsible for coordinating the national participation in the Task.

For further details on Task 37, please refer to Appendices 2-6 inclusive; the Task website *www.iea-biogas.net* and the IEA Bioenergy website *www.ieabioenergy.com* under 'Our Work: Tasks'.

Task Meetings and Workshops/Seminars

Two Task meetings were held in 2011. The first meeting took place on 13-15 April in Istanbul, Turkey. On 14 April, a technical seminar with a mix of Task 37 and local experts addressed various aspects of the biogas production and utilisation chain. The timing of the workshop coincided very well with the commissioning of Turkey's first large-scale biogas demonstration facility. Task 37 members visited the demonstration facility, set up to treat biowaste and situated on the edge of Izmit city.

The second meeting took place on 14-16 September in Cork, Ireland. The second day was taken up with a biogas workshop aimed at policy makers and planners for biogas facilities in Ireland. The workshop was opened by the Chief Scientific Adviser to the Irish government, Prof Patrick Cunningham and included speakers from Ireland, the United Kingdom and Task 37. The main focus of the workshop was how to address the particular challenges of starting up and operating biogas facilities in Ireland, where the agricultural sector makes a major contribution to the country's exports.

Planning of Future Task Meetings and Workshops

Task meetings in 2012 will be held in Norway (18-20 April), while the September meeting has still to be agreed. There will be a national workshop connected to the meeting in Norway.

Work Programme

In 2011 the work programme consisted of the following Topics:

- Drafting of new technical brochures/reports
- Collaboration with other Tasks
- Reports to ExCo67 and ExCo68
- A new 'biogas handbook', scheduled for publication in 2012
- Website: updating; maintenance; proceedings, Country Reports, etc.
- Planning of future Task meetings and workshops

Task members participated in the 19th European Biomass Conference in Berlin. There has been close cooperation with the EU project VALORGAS and with the European Biogas Association (EBA). The international symposium on Anaerobic Digestion of Solid Waste & Energy Crops (ADSW&EC) was organised by the Austrian member and attended by a number of members of the Task.

The progress made on Task Topics is summarised below.

New Technical Brochures/Reports

'Biogas from Crop Digestion', an extension to the 2009 energy crop brochure was published in September 2011. The following reports are in preparation:

- Feedstock pre-treatment: first draft under development.

- Digestion process optimisation: focus changed to process monitoring techniques before tackling the main topic of optimisation of the anaerobic digestion process.
- Economics of small-scale biogas production: Data collection period extended in 2011 due to rapid changes in the sector, e.g. amended feed-in tariffs favouring small-scale biogas production in Member Countries.
- Quality management of digestate: delayed in 2011 in order to take into account new developments in Member Countries; work almost completed.
- Emissions from biogas plants: data collection completed, report scheduled for early 2012.
- New series of five 'Success Stories': covering high efficiency CHP, biomethane use as vehicle fuel, high quality digestate, small-scale AD and biogas from food waste; publication by the end of 2012.
- Review of gas quality requirements for natural gas pipeline injection: database regularly updated.

Biogas Handbook

Agreement has been reached with the publisher for a major new 'biogas handbook' authored in large part by members of the Task and edited by the Task.

Website

The website (*www.iea-biogas.net*) is updated with news, biogas data and publications on a regular basis. The Country Reports as well as the Task publications and proceedings of the workshops were made available along with important publications from the participating countries. The website was re-launched with new software at the start of 2011.

Collaboration with Other Tasks

The Task collaborated with Task 36 to contribute to the report on 'health and safety aspects of solid biomass storage, transportation and feeding' led by Task 32. The Task is also collaborating with Task 36 in a study on integration of energy recovery into solid waste management, where Task 37 is addressing source separation and providing data to Task 36 for LCA.

Deliverables

The deliverables for the Task included: publication of planned technical reports, minutes of the Task meetings, progress reports to ExCo67 and ExCo68, input to planning of the end of triennium conference scheduled for November 2012, Country Reports, technical workshops in collaboration with national organisations followed by publication of presentations, and input to Task planning for the 2013-2015 work programme.

TASK 38: Greenhouse Gas Balances of Biomass and Bioenergy Systems

Overview of the Task

The objective of the Task is to integrate and analyse information on greenhouse gases, bioenergy, and land use, thereby covering all components that constitute a biomass or bioenergy system. It focuses on the application of methodologies to greenhouse gas mitigation projects and programmes.

Participating countries: Australia, Austria, Belgium, Brazil, Finland, Germany, the Netherlands, Norway, Sweden, and USA
Task Leader: Mr Neil Bird, Joanneum Research, Austria
Co-Task Leader: Dr Annette Cowie, University of New England, NSW, Australia
Operating Agent: Dr Josef Spitzer, Austria

The Task Leader directs and manages the work programme. The Task Leader is assisted by Susanne Woess-Gallasch (Joanneum Research) and Annette Cowie (University of New England). A National Team Leader from each country is responsible for coordinating the national participation in the Task.

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For further details on Task 38, please refer to Appendices 2-6 inclusive, theTask 38 website *www.ieabioenergy-Task38.org* and the IEA Bioenergy website *www.ieabioenergy.com* under 'Our Work:Tasks'.

Progress in R&D

Task Meetings and Workshops

A Task business meeting was held in Graz from 28-29 March. Task NTLs reviewed progress made in 2010 and agreed to the work plan for the remainder of the triennium.

The Task together with Tasks 40, 43 and the Brazilian Bioethanol Science and Technology Laboratory organised an international workshop on 'Quantifying and managing land use effects of bioenergy' which was held from 19-21 September in Campinas, Brazil. The workshop highlighted state-of-the-art research concerned with assessing land use effects of

bioenergy, mitigating negative impacts, and promoting beneficial outcomes. More than 90 scientists and policy makers mainly from Brazil, Europe, Canada and USA came together to discuss recent methodological developments, outcomes of case studies and subsequent policy implications. In addition, participants took part in two study tours. All of the presentations and most of the posters are available at *http://www.ieabioenergy-Task38.org/workshops/campinas2011/.* This event was followed by a Task business meeting.

Work Programme

In 2011 the Task:
- jointly organised the Task 38, 40 and 43 international workshop in Campinas, Brazil;
- organised two Task 38 business meetings;
- participated at ExCo67 in Helsinki and at ExCo68 in Australia;
- continued working on case studies;
- prepared a poster and paper which appeared in the proceedings of the 19th EU Biomass Conference;
- finalised the strategic report on life cycle assessment and GHG emissions of bioenergy for the ExCo;
- published a Special Issue of Biomass and Bioenergy with papers from the Task workshops held in 2009 and 2010;
- prepared a paper on linking different emission trading systems (ETS);
- planned for the next triennium; and
- maintained the Task website.

Case Studies

Final amendments were made to case studies commenced during 2004-2006. Specifically:
- Austria: Greenhouse Gas Benefits of a Biogas Plant in Austria. The study has been finalised, two documents, a report and a brochure, are available on the website.
- Australia: GHG benefits of using biochar as a soil amendment. The report will be available in early 2012.

Further work on case studies for the period 2007-2009 includes:
- Austria: GHG and energy balance of a wood to bioethanol biorefinery concept in Austria. The draft report is currently under review.
- Finland: EU biofuel targets, costs and GHG balance of the Finnish energy sector and forests'. The draft report is currently under review.
- Sweden: 'Greenhouse gas and oil use impacts of Fischer-Tropsch diesel and DME production integrated with pulp and paper mills'. The draft report is currently under review.
- Germany: Environmental Assessment of Liquid Biofuel from woody biomass. The draft report has been reviewed, and preparation of the brochure has commenced.

These case studies will be finalised in 2012.

Other case studies for the period 2010-2012 include:

- Brazil: Alternatives to Use Sugarcane Residues to Reduce GHG Emissions.
- Norway: GHG accounting of a wood-based biorefinery system in Norway.
- Belgium/Australia: Integrated landscape management for food, timber and biomass production – title and details under negotiation.

Strategic Paper for the ExCo

The strategic paper titled 'Using a Life Cycle Assessment Approach to Estimate the Net Greenhouse Gas Emissions of Bioenergy' has been finalised. The report addresses the key methodological aspects of life cycle assessment with respect to greenhouse gas balances for bioenergy systems. It includes results from Task 38 case studies for some important bioenergy supply chains in comparison to fossil energy systems. The purpose of the report is to produce an unbiased, authoritative statement aimed especially at practitioners, policy advisors and policy makers.

Task 38 Special Issue of Biomass and Bioenergy

The Task finalised a special issue of Biomass and Bioenergy on 'Land use impacts of bioenergy: selected papers from the IEA Bioenergy Task 38 meetings in Helsinki, 2009 and Brussels, 2010', published in Volume 35, Issue 12, 2011. The seven articles cover a diverse range of issues relating to land use impacts and sustainability of different products and bioenergy pathways with particular focus on GHG emissions, and include both estimates of impacts and suggested solutions.

Paper on Linking Different Emission Trading Systems

The paper on 'The Influence of Linked Emission Trading Systems on the Bioenergy Market' was finalised. This paper analyses the incentives which emissions trading schemes created for the use of biomass. Furthermore, it assesses the effects on biomass use that occur when emissions trading schemes are linked.

19th European Biomass Conference

A poster and a paper titled 'The timing of greenhouse gas emissions from bioenergy systems using financial type indicators and terminology to discuss emission profiles from bioenergy' was presented at the 19th European Biomass Conference. The poster and the paper are one of the products from the Task expert meeting on the timing of emissions from bioenergy held in October 2010. In this paper the authors raise the question whether adaptation of terms and methods from financial theory may be of use to understanding the dynamic GHG characteristics of bioenergy systems.

Planning for the Next Triennium

The Task started work on the programme for the period 2013-2015 by gathering first ideas and topics. Also new proposals for case studies were identified.

Website/Communication

The Task website is continually updated. The presentations from the Campinas workshop and new Task papers and publications are available for downloading. In addition, publications and announcements are distributed through the 'climate change' mailing list and at national level through the NTLs.

Collaboration with Other Tasks

The Task collaborates widely with other Tasks and external organisations. Work on a joint Task 38, 40 and 43 project 'Monitoring Sustainability Certification of Bioenergy' has started. The contribution of Task 38 will be text describing how GHG emissions are considered in the selected sustainability certification schemes, and a review of the draft document.

The Task is also working with Tasks 40 and 43 on a proposal for an inter-Task strategic project 'Mobilising Sustainable Bioenergy Supply Chains'.

Networking

The Task Leader, Neil Bird and the Co-Task Leader, Annette Cowie, were both very active networkers in 2011.

Through numerous EU-funded projects outside of the Task, Bird has developed networks with palm oil researchers and industry through the CIFOR – BioSusT project. He has also worked with the Biotechnology and Biological Sciences Research Council (BBSRC) and the Energy Technologies Institute (ETI) to facilitate a workshop on sustainability issues for bioenergy, especially related to soil carbon, in which Cowie also participated. A paper on using emission intensities to assess bioenergy will be forthcoming from this workshop.

Cowie continued to participate in the ISO Technical Committee 207 Subcommittee 7 Working Group 2 'GHG management in the value or supply chain', which is nearing completion of ISO 14067 Carbon footprint of products. She has recently been nominated to participate in ISO Technical Committee 248 which is developing ISO 13065 Sustainability Criteria for Bioenergy. She will also be involved with Working Group 2 Greenhouse Gas Methodologies for Quantification and Comparisons.

Bird and Cowie continue to be involved with the GBEP. Cowie participated in the GBEP meetings on 15-18 November in Tokyo, which included a one-day workshop on the GBEP GHG methodological framework.

Bird, participated in the following workshops and meetings on behalf of the Task
- 'Highlights der Bioenergieforschung', 3-30 March, Wieselburg, Austria;
- 'Workshop on climate effects of applying boreal forest in bioenergy production' 20 October, Norwegian Climate and Pollution Agency, Oslo, Norway; and

• 'Assessing GHG default emissions from biofuels in the EU legislation', 22-23 November, Joint Research Centre, Ispra, Italy.

Cowie presented on the work of the Task, particularly relating to quantifying the impacts of timing of emissions and removals to:

• The Australian Life Cycle Assessment Conference Agriculture Working Group, 11 February, Melbourne, Australia;
• National Centre for Rural Greenhouse Gas Research Symposium, 3-4 May;
• Rural Industries R&D Corporation LCA workshop, 31 May, Canberra, Australia;
• Meat and Livestock Australia workshop, 6 September, Brisbane, Australia; and
• Asia Pacific Biochar Conference, 16-18 September, Kyoto, Japan.

In addition, Cowie was invited to present to, and participate in the ExCo68 workshop on Environmental Sustainability of Biomass, held in conjunction with the Bioenergy Australia conference 24-25 November. Cowie also completed a paper on GHG accounting for inventory, emissions trading and life cycle assessment, which was presented at the Climate Change Research Strategy for Primary Industries conference in Melbourne in February and will be published in Crops and Pasture Science in early 2012. This paper draws heavily on the work of Task 38.

Helena Chum (NTL, USA) was the coordinating lead author and Alison Goss Eng and Kim Pingoud participated as lead authors of the bioenergy chapter of the IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. It was published by the IPCC in August 2011 (*http://srren.ipcc-wg3.de/*).

Deliverables

Apart from the wide range of deliverables and networking mentioned above, the Task also produced progress reports and audited accounts for the ExCo. Other outputs were minutes of the Task meetings and updating of the website. Please see Appendix 4 for more details.

TASK 39: Commercialising Liquid Biofuels from Biomass

Overview of the Task

The goal of Task 39 is to support the commercialisation of liquid biofuels from biomass, with a primary focus on conventional and advanced technologies, but with a mandate that includes 'next-generation' fuels (for example, algal and 'drop-in' biofuels). Through coordinated policy and technical networks, the Task assists participants in their efforts to develop and deploy biofuels, including ethanol from lignocellulosics, Fischer-Tropsch fuels, and biomass-to-liquid (BTL) biosyndiesel (biodiesel made from synthesis gas), etc. It also continues to identify

and facilitate opportunities for comparative technical assessment and support for policy development. The success of the Task has been, in large part, a direct result of providing a forum for these types of integrated discussions. The Task objectives are to:

- Catalyse cooperative research and development projects to help participants:
  - develop and commercialise improved, cost-effective bio-based processes for the generation of advanced biofuels, particularly biomass to biofuels;
  - work with other Tasks to develop and commercialise improved, cost-effective thermochemical-based processes, such as the Fischer-Tropsch process for converting syngas to synthetic biodiesel and other advanced biofuels; and
  - understand advancements in 'next-generation' liquid biofuel technologies, including biomass-to-hydrogen, algae-to-biofuel processes, and the development of so-called 'drop-in' biofuels.

- Provide information and analyses on policy, markets, and implementation issues (including regulatory and infrastructure development) that will help participants encourage commercialisation of liquid biofuels as a replacement for fossil-based biofuels by continuing the deployment of conventional (so called first generation) biofuels and supporting development of advanced (so called 2nd generation) biofuels and (potentially) 'next-generation' biofuels.

- Provide information dissemination, outreach to stakeholders, and coordination with related groups both within IEA Bioenergy and externally.

The Task structure allows participants to work together in the broad area of liquid/transportation biofuels in a comprehensive manner.

Participating countries: Australia, Austria, Brazil, Canada, Denmark, Finland, Germany, Italy, Japan, Korea, the Netherlands, New Zealand, Norway, South Africa, Sweden, United Kingdom, and USA
Task Leader: Dr Jack Saddler, University of British Columbia, Canada
Co- Task Leader: Dr Jim McMillan, NREL, USA
Operating Agent: Mr Ed Hogan, Natural Resources Canada, Canada

The Task leadership is shared between the University of British Columbia (Canada) as represented by Jack Saddler, and the National Renewable Energy Laboratory (USA) as represented by Jim McMillan. Both Task Leaders are engaged in all aspects of the Task's operations. Sub-Task Leaders for Technology and Commercialisation include Tony Sidwell, Michael Persson, Guido Zacchi, Tuula Makinen, and Axel Munack. Sub-Task Leaders for Policy, Markets and Implementation include Manfred Wörgetter, Tony Sidwell, and Warren Mabee. The Task is coordinated by Jana Hanova (UBC), who acts as Editor of the Task Newsletter and Webmaster. Dina Bacovsky (Austria) manages the demonstration plant database. Axel Munack has been acting as the liaison person with the Advanced Motor

Fuels Implementing Agreement. A National Team Leader for each country is responsible for coordinating the national participation in the Task.

For further details on Task 39, please refer to Appendices 2-6 inclusive; the Task website *www.Task39.org* and the IEA Bioenergy website *www.ieabioenergy.com* under 'Our Work: Tasks'.

Progress in R&D

Task Meetings and Workshops

Task 39 continues to be very active in terms of both business meetings (which involve significant knowledge exchange between participants in the form of Country Reports) as well as special sessions hosted in conjunction with established biofuels events. In 2011, the Task held three business meetings each of which was combined with a Task 'special session' at a biofuels conference.

The first meeting took place on 1 May in Seattle, USA, in conjunction with the 34th Symposium on Biotechnology for Fuels and Chemicals. One of the highlights of the business meeting was discussion of the latest iteration of the 'Implementation Agenda' report (T39-P1a). This involved a comparison of the various policies used by Member Countries to help facilitate the development of biofuels. The Task also organised a special session titled 'International biofuel commercialisation efforts' at the symposium. This involved a 10 member panel presentation followed by an open discussion. This two hour session ran for almost 3½ hours with the room filled to capacity.

Prior to the second meeting the Task had been invited to take a lead role in the first Brazilian BioEnergy Science and Technology (BBEST) Conference on 14-18 August in São Paulo by organising a special session which included 10 international speakers from the Task network. The participation of the Task was well received and the organisers subsequently invited the Task to participate in the delivery of the next BBEST conference. One of the main benefits of combining the BBEST meeting with a Task 39 business meeting was the opportunity to participate in a two day field trip where Task participants visited ethanol production facilities (Iracema sugarcane mill in Iracemapolis), a sugar cane research field station (RIDESA – Interuniversity Network for the Development of the Sugar-Ethanol Sector in Araras) and CTBE (Brazilian Bioethanol Science and Technology Laboratory in Campinas). The current capability and the enormous potential for Brazil to truly become the 'Saudi Arabia of Biofuels' was evident in both the tours and the presentations given. A brief press release on the BBEST conference is available at: *http://agencia.fapesp.br/en/14441.*

The second business meeting was hosted by Petrobras and took place on 22-23 August in Rio de Janeiro, Brazil. It included excellent contributions from Brazilian and international Task experts as well as local corporations who demonstrated the potential of Brazil to expand biofuel production even further than its current record capacity.

A third technical meeting was held in conjunction with the XIX ISAF (International Symposium on Alcohol Fuels) on 14 October in Verona, Italy. The meeting was organised by the Italian NTL, David Chiaramonti and Kyriakos Maniatis (ExCo Member for the EC). The Task session involved 14 presentations from participants including, academic, industry and government representatives and AMF Implementing Agreement colleagues. This session was very well attended.

All of these meetings emphasise that the participants value the primary role that the Task network plays in facilitating information exchange. The Task not only 'bridges the gap' between Europe and North America, it also incorporates exchange with other Member Countries active in the liquid biofuels area, such as Brazil, Australia, New Zealand, Korea, Japan and South Africa.

Work Programme

The work programme for the Task included the following elements:

Providing Information on Policy, Regulatory, and Infrastructure Issues
The overall objective is to provide governments and policy makers with improved information that will help them identify and eliminate non-technical barriers to liquid biofuels deployment.

The Task continues to compile country-specific information on biofuels including fuels usage, regulatory changes, major changes in biofuels policies, and similar items. The purpose of this effort is to maintain the Task's role as a central source of relevant information on biofuels. The business meetings allocate time for country representatives to present updates on developments in their respective regions. However, this often leaves less time for 'brainstorming' and discussion. Future meetings will try to ensure that there is more time allocated to these aspects of networking and provide effective interaction. Country Report presentations along with the meeting minutes and other presentations from the Seattle and Rio de Janeiro meetings are posted in the 'members only' section of the Task website.

Technical Aspects of Lignocellulosic Biomass-to-Ethanol Processes
The Task provides an information exchange network for participants who are conducting research and development activities in the area of lignocellulosic biomass-to-ethanol.

The working group in this area is primarily focused on the technical and economic aspects of biomass-to-biofuels. The Task continues to update the database on advanced biofuels facilities. This database provides up-to-date information on over 66 companies which includes biochemical, thermochemical, and hybrid conversion approaches to producing biofuels. However, it is proving increasing difficult to obtain detailed and accurate information from many of the companies as the various processes approach commercialisation. This is expected to be an increasingly difficult problem as companies understandably want to protect their proprietary information.

Major Reports

Three major reports were completed and are summarised below:

T39-T1a 'Biodiesel GHG emissions, past, present, and future': In this report, the GHG emission reductions associated with biodiesel production were analysed using the 'GHGenius' LCA model. These emissions were found to vary considerably over time and between feedstocks and regions. For example, the emission reductions for rapeseed oil-derived biodiesel, as compared to petroleum diesel, on a 'cradle-to-grave' basis, were estimated to increase overtime from 60% in 1995 to 70% in 2005. They were projected to reach more than 80% by 2015. The greatest area for potential GHG improvement was shown to be in the feedstock production area while the potential improvements in oilseed crushing and biodiesel production were shown to be relatively small. Large differences in GHG emissions were identified from regional feedstock production factors such as fertilisation management and weather conditions. Finally the report assessed the sensitivity of the results to the type of LCA model used. The GHGenius was compared with other LCA models such as ones used for the EU Renewable Energy Directive and US Renewable Fuel Standard (RFS2). It was shown that most of the other models underestimated the GHG improvements. This was attributed to the inability of other models to account for the dynamic improvements occurring over time due to biodiesel production practices as well as the other models using narrower and outdated (15-20 years old) sources of data and emission factors. For example some calculators did not consider the effect of using different fertiliser formulations (e.g. nitrate vs. ammonia based) or for the fact that glycerol, as a biodiesel co-product, is a source of biogenic (hence GHG-neutral) carbon energy. The report also compared the results observed with biodiesel production with the previous results determined during ethanol production. Ethanol production was shown to result in slightly greater reductions in GHG emissions than was obtained with biodiesel production. However, this was suggested to be due to the ethanol industry's longer experience in trying to reduce process emissions.

IEAHQ Report - Biofuels Roadmap: The Task contributed to the biofuels roadmap which was coordinated and primarily authored by Anselm Eisentraut from IEAHQ. A draft of the roadmap was circulated to the NTLs and their feedback was incorporated into a consolidated response to Eisentraut. The document explores the BLUE map scenarios presented in the IEA's Energy Technology Perspectives 2010 and identifies the primary issues that must be addressed in order to reach the projections for sustainable biofuel deployment.

T39-T3 'Algal Biofuel Joint Executive Summary with the AMF': The highly cited Task 39 Algal Biofuel report was recently followed by a similarly-themed Algal Biofuel report subcontracted by the AMF Implementing Agreement. With the encouragement of the ExCo's from both Implementing Agreements, Task 39 and AMF developed a joint Executive Summary to collate the findings of the two reports. This was to achieve effective and coordinated dissemination of IEA information. The joint summary was reviewed by members of both Task 39 and the AMF and is now published.

The summary provides a concise description of the current and future commercialisation potential of algae-derived biofuels. Algae possess a number of conceptually attractive characteristics such as direct conversion of CO_2 to lipids, high yields and no utilisation of agricultural land. However, algae fuels are not currently commercially viable and this was supported by both reports. Despite the 200 companies and US$270 million of market value invested in algae fuels today, their cost of production remains high (US$5 - 30/gal or US$1.2 - 7.9/litre) and well above their petroleum counterparts. These costs are projected to come down over the next decade or so and it is estimated that about 100 million gallons of algal fuel might be available by 2020 at a cost equivalent to ca. US$60/bbl of crude oil. However, many issues still need to be addressed. The productivity, cost and robustness of algae systems need to be ameliorated by improving algae strains, reactor setups and oil extraction processes. The successful algal biofuels companies will be those that optimise the whole production system and not necessarily those with the highest oil producing strain or the best extraction process. This optimisation will be challenging and numerous trade-offs will have to be considered before each system component can be defined. For example, on the choice of reactor, photo bioreactors (PBR) may provide a more controlled culture but come with a high capital cost while open pond reactors are cheaper but more susceptible to exogenous factors such as weather conditions and contaminants. Similarly, strains with high oil yields tend to be less hardy than those with higher amounts of proteins and carbohydrates and do not typically thrive in uncontrolled open systems. Another important trade-off is between autotrophic (CO_2-fed) and heterotrophic (sugar-fed) fermentations where the former is limited by productivity while the latter lacks the highly-touted CO_2 sequestration advantage. Finally, very little is known about the sustainability and LCA profile of commercial algal biofuels. This will remain a limitation until the first demonstration facilities come on line and can provide the data needed for a more rigorous environmental impact analysis.

Newsletter

The Task has published three newsletters in 2011 (featuring the Country Reports of Finland, Germany and Austria). The newsletters provide information about the Task activities and international events related to biofuels. The newsletter has an active distribution list of more than 1,000 individuals worldwide and copies are routinely downloaded from the Task website.

Website

The Task continues to build on its already considerable influence on the international community working in the liquid biofuels area. The recently redesigned website (*www.Task39.org*) and the newsletter have had very positive reviews. The website is heavily visited/cited (more than 300,000 hits in 2011) and has generated many enquires that are typically handled by the Task coordinators and webmaster, or referred to experts within the Task 39 network.

Collaboration with Other Tasks/Networking

The Task has ongoing interactions with the other Tasks, IEAHQ, other Implementing Agreements and with external groups such as FAO, USDOE, the Global Bioenergy Partnership, and others. The Task continued discussions with Task 42 on 'biorefining' and is organising a joint Task meeting in Copenhagen, Denmark at the end of February 2012.

There has been excellent collaboration with the Advanced Motor Fuels Implementing Agreement (AMF) with Axel Munack acting as the liaison person and attending meetings of the AMF as an observer on behalf of Task 39. More recently Dina Bacovsky has taken on a role with the AMF Implementing Agreement as their overall coordinator, providing even better linkages between the two Implementing Agreements. An example of the Task's collaboration with the AMF for 2011 was the aforementioned joint summary of the algal biofuel reports.

Deliverables

The deliverables for the Task in 2011 included: two progress reports and audited accounts, as required by the ExCo; development and maintenance of the website; plus three newsletters and three technical reports on issues relating to biofuel implementation, deployment, and sustainability. The full library of Task reports, country specific reports, etc. are available from the Task website (*www.Task39.org*). These are detailed in Appendix 4.

TASK 40: Sustainable International Bioenergy Trade: Securing Supply and Demand

Overview of the Task

In the first decade of the 21st century, a strong increase in the trade of both solid and liquid biofuels has been observed. Global biodiesel trade has increased form 30 PJ in 2000 to 572 PJ in 2009, while the fuel ethanol trade is estimated to have increased from 340 PJ in 2000 to 1540 PJ in 2009[1]. The global solid biomass trade is estimated to have grown from roughly 10 PJ in 2000 to 300 PJ in 2010[2]. While the recent economic crisis may have reduced activity, it is likely that global bioenergy trade will further increase strongly until 2020. This will be driven by the renewable energy targets in the EU (as defined in the NREAPs), and subsequent demand for both solid and liquid biomass, as well as increasing demand from East Asian countries – especially South Korea and Japan – driven by current renewable energy policies. More speculative additional drivers may be a search for alternatives to nuclear energy (after Fukushima), the upcoming development of

[1] Lamers, P., Hamelinck, C., Junginger, M., Faaij, A., (2011) International bioenergy trade – a review of past developments in the liquid biofuels market. Renewable and Sustainable Energy Reviews, 15 (2011) 2655–2676.
[2] Lamers, P., Junginger, M., Hamelinck, C, Faaij, A. Developments in international solid biofuel trade - an analysis of volumes, policies, and market Factors. In press.

the bio-based economy, and further increases in oil prices. Thus, there is increasing need to develop biomass resources and exploit biomass production potentials in a sustainable way and to understand what this means in different settings. In some markets, prices of biomass resources and fuels are already rising, causing indirect effects on raw material prices, for example in the forest and food industries (e.g. sugar). Biomass markets are still immature and vulnerable, and this is particularly true for the demand side of the market. Many biomass markets, e.g. solid biofuels, rely on policy support and incentives.

It is important to develop both supply and demand for biomass, and energy carriers derived from biomass, in a balanced way and to avoid distortions and instability that can threaten investments in biomass production, infrastructure and conversion capacity. Understanding how this is best organised and managed needs further investigation. International biomass markets have been mapped by the Task, but the analyses, statistics, and modelling exercises undertaken so far still have limitations.

The core objective of the Task remains 'to support the development of a sustainable, international, bioenergy market, recognising the diversity in resources, and biomass applications'.

Developing a sustainable and stable, international, bioenergy market is a long-term process. The Task aims to provide a vital contribution to policy making decisions by market players, policy makers, international bodies, and NGO's. It will do this by providing high quality information and analyses, and overviews of developments. It will also provide a link between different sectors, and act as a clearing-house for information through targeted dissemination activities.

Participating countries: Austria, Belgium, Brazil, Canada, Denmark, Finland, Germany, Italy, Japan, the Netherlands, Norway, Sweden, United Kingdom, and USA
Task Leader (Scientific): Prof Dr André Faaij, Copernicus Institute, Utrecht University, the Netherlands, assisted by Dr Martin Junginger, Copernicus Institute, Utrecht University, the Netherlands
Task Leader (Administrative): Mr Peter-Paul Schouwenberg, RWE Essent, the Netherlands
Operating Agent: Ir Kees Kwant, NL Agency, the Netherlands

The Task Leaders direct and manage the work programme. A National Team Leader from each country is responsible for coordinating the national participation in the Task.

For further details on Task 40, please refer to Appendices 2-6 inclusive; the Task website *www.bioenergytrade.org* and the IEA Bioenergy website *www.ieabioenergy.com* under 'Our Work: Tasks'.

Task Meetings and Workshops

The Task organised several workshops in 2011. The programme and presentations (and in some cases summaries) can be downloaded from the Task website: *www.bioenergytrade.org*

The first event was a joint Task 32 and 40 workshop 'Development of torrefaction technologies and impacts on global bioenergy use and international bioenergy trade' on 28 January 2011, as a side-event of the Central European Biomass Conference (CEBC), in Graz, Austria. The workshop gave a comprehensive overview of the main advantages of and the challenges in producing torrefied biomass. Ongoing R&D activities were shown, demonstration plants were presented and the latest state-of-science in torrefaction was discussed. A total of eight speakers highlighted these issues. In addition, four speakers highlighted the effects that the commercial availability of torrefaction technology may have on bioenergy trade, including Task 40 participants Michael Wild (Austria), who spoke on 'The ratio behind torrefaction: trade-off between additional investment and energy use vs. logistical and end-use advantages'; and Andre Faaij (the Netherlands) who presented a case study on the export of torrefied and non-torrefied biomass from a Latin American country to Rotterdam, including a comparison of costs and GHG emissions. Overall, the workshop was a huge success. While the room had 250 seats, at times attendees were standing in the corridors and at the back to follow the presentations. The Task also had a two-day business meeting before the workshop.

In February, Task 40 supported the conference 'Biomass Trade & Power, Americas' in Atlanta, USA, organised by CMT. In total, four speakers from the Task spoke at this conference (see Appendix 4). The conference, which aimed to promote both domestic biomass utilisation and international trade, covered a large number of topics, including the DOE's direction on biomass utilisation in energy/utilities sectors, USA and European's utilities' expectations for biomass-based initiatives, opportunities to use the Southeast's biomass potential, and specific attention on the entire supply chain from feedstock sourcing to the end consumer in Europe, including discussion of all the intermediate logistic steps. The overall impression from the conference was that the USDOE is very much promoting the utilisation of biomass, but that EPA regulations are considered amongst the largest and least-controllable risks for the successful development of domestic biomass plants. Wood pellet production and export has been booming recently, and all of the presenters expected it to grow further – however this is highly dependent on the future growth of European demand. This in turn may depend on the policy developments in the UK and the Netherlands, but also on the decision of the European Commission whether or not to introduce mandatory sustainability criteria for biomass. Furthermore, the large number of presentations emphasising optimisation of the logistic supply chains (both of the feedstock to the processing plant, and from there to the port, up to distribution of biomass through Europe after arrival in a major harbour) showed the importance of this aspect in the development of future trade.

Biomass trade will be essential for Europe to achieve renewable energy targets, yet the financial community does not fully understand the risks of the biomass sector. Thus capital to develop biomass trade is difficult to source. A 'Biotrade Equity Fund' could reduce the risk of investing in biomass densification facilities, even in remote locations, by also investing in the supply chains to bring the biomass to market, thus reducing the risk of individual project components. The Task commissioned a report highlighting the possibilities of such a fund, and then decided to organise two workshops, which aimed to inform possible investors about the ongoing bioenergy trade developments, and raise interest in the creation of a Biotrade Equity Fund. The first workshop was organised jointly with the World Biomass Association (WBA) as a side event at the 2nd AEBIOM Bioenergy Conference on 30 June in Brussels. There were 30 participants, including representatives from industry and the financial sector. There was good interest and lively discussion. A second workshop was held on 8 November in London, again in combination with WBA, and also supported by CanBio, with a similar attendance.

One of the most important scientific events was the joint Task 38, 40 and 43 workshop 'Quantifying and managing land use effects of bioenergy' on 19-21 September in Campinas, Brazil. The workshop attracted almost 100 scientists and policy makers, predominantly from USA, Europe and Brazil. With over 35 presentations and a dozen poster presentations, the programme was very comprehensive, providing insights of the developments of the top-down computable general equilibrium and partial equilibrium models for assessing iLUC and how ongoing local and regional case studies are addressing the impacts of landuse change caused by bioenergy. All presentations are available online, as well as abstracts and a short workshop summary. The Task Leaders are planning to process the results, insights and discussions of the workshop into a 3-5 page article to be submitted for publication in the journal BioFPR. On 22-23 September, the Task held a business meeting.

In addition to these workshops and meetings, the Task also had a meeting in Aarhus, Denmark, in June hosted by DTI, to discuss current business, including the progress of several studies and the preparation of the workshop in Brazil. The meeting was followed by a study tour, to the biomass-fuelled CHP plant of Verdo near Aarhus which, in part, uses imported biomass (e.g. wood chips) from the Baltic countries.

The programmes, presentations, and summaries are available on the Task website.

Future Meetings and Workshops

Preparations for a workshop on 'biogas/biomethane trade' on 24 January 2012 in Berlin are progressing steadily. It is being jointly organised with the funding programme of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and Fachagentur Nachwachsende Rohstoffe (FNR). The one day workshop will be part of the 'Fuels for the Future' Conference. Task 40 speakers will include Uwe Fritsche, Daniela Thrän and André Faaij.

Other events being planned are:

- a workshop on biorefineries and bioenergy trade in June 2012 in Oslo, Norway,
- a workshop on bioenergy trade on the Pacific Rim in November 2012 in Vancouver, Canada., and
- a contribution to the IEA Bioenergy Conference in November 2012 in Vienna, Austria.

For the first two workshops, the exact focus and timing will be determined at the Task meeting to be held in January 2012. As usual, these workshops will be linked to Task business meetings. The contribution to the IEA Bioenergy Conference will be arranged in consultation with the conference organisers.

Work Programme and Outputs

As outlined in the 2010-2012 work programme, the Task has four key objectives. A fifth objective is dissemination of the results of 1 to 4 below:

1. *Biomass supplies:* To deliver refined insights of the availability, potential production, and supply of biomass resources at regional, national, and global levels. This explicitly includes a range of biomass residue streams, land use, and competition for land in various markets worldwide, including developing regions.

2. *Sustainability and certification:* To determine how the sustainability of biomass supplies, use and trade can be secured optimally and efficiently, especially from a market perspective, with specific attention on the impacts of certification on international biomass and biofuels trade.

3. *Trade, market and demand dynamics:* To map and provide an integral overview of biomass markets and trade at a global level, as well as for specific regions. Identify and map new markets and products, improve the understanding on how biomass trade and markets respond to fluctuating fossil energy prices, developments on global markets for food and forestry products, emission trading, and the policies of different countries.

4. *Transport, logistics, and trade:* To provide insights of international biomass supply lines and logistic requirements (including new producing regions, i.e. developing countries and Eastern Europe) and how these can be optimised over time. This includes increasing the understanding of how costs of biomass production, pre-treatment and transport can be reduced. Such work includes advanced forecasting exercises on the required logistic capacity to facilitate increased biomass use and trade.

In 2011, the Task produced a number of significant deliverables related to these objectives.

Development of a Tool to Model European Biomass Trade

With increasing demand in several (mainly western) European countries for solid and liquid biomass and surplus amounts of biomass available in other (mainly Eastern) European

countries, but also outside of Europe (e.g. in Canada and the USA); there is currently, no model that can adequately capture these biomass-related trade flows. As data availability for both current and future supply and demand of biomass in Europe was available, it was decided to devise a modelling tool capable of describing ongoing and future trade flows. The aims were:

- To get a comprehensive overview of expected biomass production and demand for the EU-27 Member States, and the resulting biomass deficits/surpluses which may be covered by international bioenergy trade. This was largely based on the recently published National Renewable Energy Action Plans (NREAPs), and the data contained in the Green-X model. (Phase 1)
- To develop an Excel/GIS-based geospatial explicit intermodal transport modelling tool linked to the Green-X model to simulate biomass trade flows in the EU-27 up to 2020 (based on the projected demand and supply from Phase 1 above).

This work was carried in 2011, and has clear relevance for Objectives 1, 3 and especially 4. The analysis of the NREAPs focused on final energy produced from biomass that is expected to contribute to the total share of renewables in the NREAPs and the amount of biomass EU Member States expected to mobilise from domestic sources and the quantity required from imports for electricity and heat. The results of the NREAPs for bioenergy were compared with the supply potentials, as available in the GREEN-X model and with existing model projections. Biomass used for transport fuels were (for the time being) beyond the scope of this study. In addition, a detailed analysis on the quality of the NREAPs was conducted for selected Member States.

In parallel, to model trade flows of solid biomass within Europe, a geospatial explicit intermodal transport model was developed in the Network Analyst extension of ESRI's ArcGIS. The model includes four transport modalities (truck, train, inland ship and short sea shipping) that are connected via trans-shipment terminals. The origins and destinations of biomass supply and demand regions are connected via lowest cost routes. In addition, the model is also capable of calculating the GHG emissions of each supply chain, and is able to calculate biomass supply to a selected destination optimising minimum GHG emissions (instead of minimum costs). This model was then linked to the Green-X model, and combined with 'low' and 'high' import scenarios of non-EU biomass. For these scenarios, combined with the EU targets on renewable energy, likely trade flows were modelled in GREEN-X. The detailed results have been published in Hoefnagels *et al.* (see Appendix 4). However, it must be emphasised that this is merely to illustrate the approach to include logistic cost of biomass in an energy model and the implications to supply and demand of biomass for bioenergy. The costs, as presented in this report, are not intended to reflect actual prices of feedstocks, pre-processing and transport of bulk freight.

In the second half of 2011, Idaho National Laboratories and Utrecht University have been working on an inter-continental transport module to link the European model to a logistic model available at INL, to be able to model inter-continental supply chains. The results of this effort will be published in the first quarter of 2012.

An Updated Wood Pellet Study with an Additional Wood Chip Trade Analysis

Historically, the 'wood pellet trade overview' study by the Task has been one of the most downloaded documents. However, as it was published in 2007, the Task decided to update this study. In addition, wood chips are increasingly traded for energy purposes, but very little is known regarding trade routes, volumes and possible barriers for this commodity. Therefore, the Task has decided to carry out an update of the wood pellet study, in conjunction with an analysis of wood chip markets. The work was led by Maurizio Cocchi (wood pellets) and Didier Marchal (wood chips), with input from almost all Task participants. The results are currently being finalised, and will be published in December 2011. This study covers the Objectives 1, 3 and 4.

Country Overviews

The Task participants each prepared another comprehensive Country Report in 2011. These reports describe ongoing market and trade developments, and cover the types and volumes of biomass traded, prices, and current drivers and barriers. Country Reports are available on the Task website *(www.bioenergytrade.org)*. They are relevant to all four objectives of the Task.

Torrefaction Overview

As a minor deliverable, a short study was prepared covering the current status of torrefaction, including a literature review, activities overview in Member Countries, and a summary of the main issues. The study will be published in February 2012.

Workshops

Depending on the available budget and participant interests, other topics to be covered in the remainder of the triennium may include:

- A study on optimising logistic fuel supply chains.
- A study assessing to what extent certification/accreditation requirements affect international bioenergy trade.
- A handbook on biomass trade, in which the accumulated experiences of the Task could be collated.
- A study on 'business models that work'.
- An analysis of sustainability through the entire supply chain.

Ongoing and New Topics

Other topics for 2012 and 2013 include:

- A brief inventory of how sustainability criteria for solid and liquid biomass currently influence international bioenergy trade. This work is led by VITO, and is based on questionnaire replies from the Task participants. It will serve as input data for a much larger effort that will be led by Task 40, and carried out jointly with Task 43 and 38.
- The Task participants have decided to prepare a book on international sustainable biomass trade, in which the accumulated experiences of the Task will be collated. Recently a publishing agreement was signed with Springer. The final manuscript will be submitted by the end of 2012 and publication is expected in 2013.

- Other topics currently proposed for the work programme are:
  - the potential role of biofuels in aviation – bio-jet fuel;
  - renewable fuels for maritime shipping and trade;
  - bioenergy trade perspectives, analysing scenarios for international bioenergy trade up until 2050; and
  - the creation of an inventory of the 50 single largest consumers of bioenergy in the world.

A decision on whether or not to proceed with each of these topics will be taken in 2012.

Website

The Task website is a key tool for dissemination of information. In 2011, visitor numbers varied between 4700-7900 per month, on average slightly higher than in 2010. Since 2007, visitor numbers have been relatively stable, with a four year average of 6000 visitors per month. However, the amount of monthly downloaded data has increased steadily over the past nine years, reaching 13 GB of data in October 2011, and 138 GB over the period Dec. 2010 - Nov. 2011. As in previous years, each month, at least 10 documents are downloaded over one hundred times. All Task deliverables (e.g., Country Reports, market studies, etc.) and presentations given at the Task workshops are available for downloading.

Collaboration with Other Tasks/Networking

As described above, events were organised jointly with Tasks 32, 38 and 43, and with the World Biomass Association and CanBio. At these events, the work of the Task was disseminated via presentations. The Task's work was also presented to a large number of other audiences on four different continents during 2011, such as the Biomass Trade & Power America conference, Atlanta, USA, the 2nd Biomass Pellets Trade Asia Conference in Seoul, Korea, the AEBIOM Bioenergy Conference in Brussels, Belgium, and the Bioenergy Australia Conference in Twin Waters, Australia. The Task aims to continue this outreach and collaboration in 2012.

Deliverables

Deliverables in 2011 included four workshops, various types of reports, several market studies, a newsletters (circulation of 1200), minutes from three Task meetings, two progress reports and audited accounts to the ExCo; plus several presentations at various international workshops and conferences. These are detailed in Appendix 4.

TASK 41: Bioenergy Systems Analysis

Overview of the Task

The objective of the Task is to supply various categories of decision makers with scientifically sound and politically unbiased analyses needed for strategic decisions related to research or policy issues. The target groups are particularly decision makers in Ministries, national or local administrations, deploying agencies, etc. Depending on the character of the Projects some deliverables are also expected to be of direct interest to industry stakeholders. Decision makers, both public and private, have to consider many aspects, so the Task needs to cover technical, economic, and environmental data in its work. The Task's activities build upon existing data, information sources, and conclusions. It does not intend to produce new primary scientific data.

The Task differs from the other Tasks in that it does not have networking as one of its prime objectives. Nor do the Task's activities have continuous and repeating components, e.g., biannual meetings, country updates, etc. The work programme has a pronounced Project emphasis with each Project having very specific and closely defined objectives. Because of its special character in terms of participation, financing and cross-cutting orientation, the Task aims to become a valuable resource and instrument to the ExCo serving the ExCo with highly qualified resources to carry out Projects, involving several parties (e.g., other Tasks and organisations) as requested by the ExCo. Due to the close contact with the other Tasks, Task 41 is intended to develop into a platform for joint Task work and a catalyst for proposals from the Tasks to the ExCo.

A Project Leader directs and manages the work of each Project. For new projects an appropriate Project Leader is appointed by the Project participants acting through the Executive Committee. The ExCo Member from each participating country acts as the National Team Leader and is responsible for coordinating national input to the Projects undertaken.

For further details on Task 41, please refer to Appendices 2-6 inclusive; and the IEA Bioenergy website *www.ieabioenergy.com* under 'Our Work: Tasks'.

Progress in R&D

Work Programme

The work programme is comprised of a series of Projects. Each Project has its own budget, work description, timeframe, and deliverables and is approved by the participants. The focus is on the needs of the participants by way of Project outputs. Three projects have been initiated to date and Projects 1 and 2 have been completed. Details are:

Project 1: Bioenergy – Competition and Synergies
Participating Countries: Germany, Sweden, United Kingdom, USA and the European Commission
Project Leader: Mr Sven-Olov Ericson, Ministry for Sustainable Development, Sweden
Operating Agent: Dr Björn Telenius, Ministry of Enterprise, Energy and Communications, Sweden
Status: Completed in December 2008

Project 2: Analysis and identification of gaps in fundamental research for the production of second generation liquid transportation biofuels
Participating countries: Finland, the Netherlands, Sweden, United Kingdom, USA and the European Commission
Project Leader: Dr Michael Ladisch, Purdue University, USA
Operating Agent: Mr Paul Grabowski, US Department of Energy, USA
Status: Completed in July 2008

Project 3: Joint project with the Advanced Motor Fuels Implementing Agreement, Annex XXXVII 'Fuel and Technology Alternatives for Buses: Overall energy efficiency and emission performance'
Participating countries: Finland, Germany and the European Commission
Project Leader: Professor Kai Sipilä, VTT, Finland
Operating Agent: Professor Kai Sipilä, VTT, Finland
Status: The project commenced in January 2009 and is expected to be completed in 2012.

The objective of this joint project is to bring together IEA expertise to access overall energy efficiency, emissions, and costs, both direct and indirect costs, of various technology options for buses. City buses are amongst the most coherent vehicle fleets. Procurement of bus services is often handled by municipalities or state in a centralised manner. The impact of city buses on urban air quality is huge, and fuel efficiency is crucial for operational costs. Biofuels have a major role in the test programme.

The project is of interest to seven Implementing Agreements, including IEA Bioenergy, all of which have transport-related activities. The participants from IEA Bioenergy are co-financing the project at the level of US$75,000. The total budget is US$1,075,000. A final report is expected early in 2012.

Deliverables

The deliverables may consist of progress reports and financial accounts to the ExCo, and a final report on each project – see details in Appendix 4.

TASK 42: Biorefineries: Co-production of Fuels, Chemicals, Power and Materials from Biomass

Overview of the Task

The aim of the Task is to initiate and actively promote information exchange on all aspects of the energy-driven biorefinery concept. The information exchange will include biomass feedstocks (crops, algae, agro- and process residues); fractionation, conversion and downstream processing technologies; integral process development and optimisation; and sustainability issues, i.e. economic aspects, environmental performance, social acceptance (impact on food production, water use and quality, changes in land use, access to resources, biodiversity). The work of the Task should minimise fragmentation in this multi-disciplinary field by providing a platform for stakeholders. It will also result in cross-thematic synergies, identification of gaps and overlaps, and definition of priority research needs and infrastructure. The following activities have been identified and agreed by the participants:

- Prepare a common definition of biorefineries, including a clear and widely accepted classification system.
- Gain better insights into the processing potential of existing biorefineries in the participating countries.
- Assess biorefinery-related RD&D programmes in participating countries to help national governments define their national biorefinery policy, goals, and related programmes.
- Prove the advantages of biorefinery concepts over more conventional single product processes by assessing and comparing their financial, economic, ecological, and societal characteristics.
- Bring together key stakeholders normally operating in different market sectors (e.g. agriculture, forestry, transportation fuels, chemicals, energy) in multi-disciplinary partnerships to discuss common biorefinery-related topics, to foster necessary RD&D trajectories, and accelerate the deployment of developed technologies.
- Identify the most promising added-value chemicals, e.g. functionalised chemicals and platform chemicals (building blocks), to be co-produced with energy to optimise overall process economics and minimise the overall environmental impact.
- Co-operate with ongoing national and international activities and programmes, e.g. other Tasks, Implementing Agreements, and EU Technology Platforms.
- Disseminate knowledge, including teaching material to make students familiar with the biorefinery approach.

Participating countries: Australia, Austria, Canada, Denmark, France, Germany, Ireland, Italy, the Netherlands, Turkey, United Kingdom, and USA. The United Kingdom will withdraw from 2012.

Task Leader: Dr Ing. René van Ree, Wageningen University and Research Centre (WUR), the Netherlands

Assistant Task Leader: Dr Ed de Jong, Avantium Technologies BV, the Netherlands

Operating Agent: Ir Kees Kwant, NL Agency, the Netherlands

The Task Leader directs and manages the work programme. A National Team Leader from each country is responsible for coordinating the national participation in the Task.

For further details on Task 42, please refer to Appendices 2-6 inclusive; the Task website *www.IEA-Bioenergy.Task42-Biorefineries.com* and the IEA Bioenergy website *www.ieabioenergy.com* under 'Our Work: Tasks'.

Progress in R&D

Task Meetings and Workshops

The Task organised two meetings in 2011. The first was from 4-6 April in Tortona, Italy; and the second was from 22-25 November in Twin Waters, Australia. Both meetings were held in conjunction with workshop/conference events in which industrial stakeholders met with Task participants to discuss biorefinery-related topics and to undertake study tours of biorefinery facilities.

The Italian meeting started with a stakeholder meeting, organised by ENEA, M&G and POLIBRE, in which Italian representatives from industry, universities and research institutes as well as the Task NTLs presented their activities within the biorefinery framework. On the second day the participants visited the POLIBRE Innovation Pole and the M&G pilot-plant on 2nd generation biorefining. The Task business meeting was held on the last day.

The Australian meeting started with a one day business meeting, followed by a technical tour on the second day. On the third and fourth days presentations by Task participants were delivered to the Bioenergy Australia 2011 Conference. This included a half day 'biorefinery session'.

Together with INRA(F) and partners from the EU FP7 BIOCORE project, the Task organised a four day Biorefinery Summer Course from 28 August - 1 September in Paris, France. With more than 100 participants (PhD and master students, representatives from industry and government) this event was fully subscribed.

Presentations can be found on the Task website.

Work Programme

The work programme of the Task is based on a prioritisation of activities agreed upon by the participating countries, and is as follows:

- Development of a classification system and complexity index on biorefineries.
- Identification of the most promising bio-based products to be co-produced with bioenergy.
- Assessment of the current status and development potential of both energy and product-driven biorefineries based on a 'full sustainable value chain' approach.

- Preparation of a guidance document on sustainability assessment for biorefineries.
- Preparation of a strategic biorefinery paper.
- Preparation of Country Reports on current processing potential and mapping of existing biorefinery pilot, demonstration and commercial plants, and of major RTD projects.
- Organisation of bi-annual Task meetings, including excursions to operating facilities (internal knowledge dissemination).
- Organisation of industrial stakeholder workshops and setting up a Task website (external knowledge dissemination).
- Setting up and organising a Biorefinery Training Course/Summer School.

The progress achieved is described below

Classification System and Complexity-index for Biorefineries (BCI)
The Classification System was further upgraded with new raw materials, platforms and products and was finalised by the end of 2011. The BCI will not be developed further because this tool will not add any significant information to the stakeholders concerned. The main result will be reported as part of a Task brochure that will be published early in 2012, before ExCo69 in Turkey. This activity is coordinated by Austria.

Bio-based Products to be Co-produced with Bioenergy
A 65 page draft report 'Bio-based Chemicals – Value Added Products from Biorefineries' has been prepared. The report deals with potential chemicals and polymers that could be produced from bio-based intermediates (biorefinery platforms), the economic and environmental benefits of co-producing fuels and chemicals, product commercialisation strategies, and an extensive overview of commercially available and near market products subdivided into C1-C6 and Cn containing compounds. The report will be published early in 2012. This activity is coordinated by the Netherlands and the UK, with major contributions from Ireland and Canada.

Current Status and Development Potential of Both Energy and Product-driven Biorefineries Based on a Full Sustainable Value Chain Approach
The Task is currently assessing the status and development potential of both energy-driven biorefineries (including biofuels) and product-driven biorefineries. These assessments will be based on a 'full value chain' approach, covering raw material issues (crops, residues, algae), conversion processes, and final product applications in an integrated approach. A start was made in 2010 with the assessment of promising biofuel-driven biorefinery chains, and with the development of a gross list of promising advanced biofuel-driven value chains. In 2011 this gross list was used to select 10 advanced biofuel value chains for further assessment. One of the selection criteria was that the value chains to be considered should be of interest to the participating countries, i.e. pilot, demonstration, or commercial initiatives which can deliver market sound data input for the project. The expectation is that they will be finalised early in 2012 and published as a Task brochure. This activity is coordinated by Austria.

Guidance Document on Sustainability Assessment for Biorefineries
Because 'sustainability assessment' is also an important activity in other Tasks (for example Tasks 29, 38, and 39) this type of activity has to be performed as a joint Task activity. From a Task 42 point-of-view, the co-production of both human food, animal feed, and/or bio-based chemicals/materials with bioenergy/biofuels, should be an integral part of any sustainability assessment methodology. This activity is coordinated by Canada.

Strategic Biorefinery Paper
The paper is scheduled to be produced in 2012. The proposed title is 'Adding Value to the Sustainable Utilisation of Biomass on a Global Scale - Biorefining'. All relevant Task results produced over the last six years will be integrated showing the technical, economic, ecological, and social advantages of co-production of bioenergy and bio-based products for sustainable biomass use in a future bio-based economy. The Task will invite representatives from other Tasks to contribute to this paper. This activity is coordinated by the Netherlands.

Country Reports on Current Processing Potential and Mapping of Existing Biorefinery Plants and Major RTD-projects
For the 2010-2012 triennium each participating country will produce a Country Report (both as a report and as a PowerPoint presentation). The reports will provide an overview of the biomass, bioenergy and biorefinery situation and activities in the participating countries. They will include current biomass use for both energy (power, heat, CHP, fuels) and non-energy (food, feed, materials, chemicals) purposes, biorefinery-related policy goals and funding programmes, operating commercial biorefineries, biorefinery demonstration and pilot plants, major RTD projects, and stakeholders (industry, universities, institutes, GOs, and NGOs). These reports will be published on the website as soon as they are available. This activity is coordinated by Denmark.

Biorefinery Training Course/Summer School
Together with INRA(F) and partners from the EU FP7 BIOCORE project, the Task organised a four day 'Biorefinery Summer Course' from 28 August – 1 September in Paris, France. With more than 100 participants (PhD and master students, representatives from industry and government) this training event was fully subscribed. This event is scheduled to be repeated in 2012 in Wageningen, the Netherlands.

Multi-disciplinary Partnerships
In 2007 it was decided that the National Team Leaders would be responsible for the creation of 'stakeholder forums' at national level. For example, in the Netherlands, WUR is doing this by organising a variety of biorefinery-related activities within the framework of the National (Dutch) Platform on Biorefineries. International knowledge exchange between the Task and these stakeholder forums will take place frequently, for example by inviting them to Task-related workshops, and will be reported to the other participants at Task meetings.

Website

A new Task website was set up in 2010 (*www.IEA-Bioenergy.Task42-Biorefineries.com*). It is used for both information management using a password protected extranet-site and a public area for knowledge dissemination. The website contains information on the progress of the Task activities, biorefinery news, biorefinery events, contacts for National Team Leaders, country-specific stakeholders, publications, and a database on country specific commercial facilities, demonstration and pilot plants, and major RTD projects.

Collaboration with Other Tasks/Networking

Co-operation has been established with international activities, e.g. other Tasks, European-based Technology Platforms, International Council of Chemical Association (ICCA), Specific Support Actions, and Integrated Projects. This co-operation will be enhanced in 2012 by organising joint events, e.g. workshops and meeting regularly with ongoing EU-initiatives. In 2011 the following activities took place:

- In October 2011 the EC FP7 project Star COLIBRI was finished. Task 42 made a significant contribution to the major deliverables from this project, i.e.: a joint European Biorefinery Vision for 2030 and a European Biorefinery Joint Strategic Research Roadmap. Both documents can be found on the Task website. Within this project a database on running biorefineries was setup. Discussions are now ongoing to make this database available on the website.
- A Stakeholder Workshop was organised in Tortona, Italy; and a significant contribution was made at the Bioenergy Australia 2011 Conference in Twin Waters.
- Presentation of the Task at a variety of national and international workshops and conferences:
  - The Biorefinery Projects Networking Event, February 2011, Brussels, Belgium.
  - The Biorefinery Platform Day at the World Biofuels Markets 2011 Conference, March 2011, Rotterdam, the Netherlands.
  - The European Expert Forum on Biorefineries, April 2011, Budapest, Hungary.
- Co-organising with INRA(F) and the EC FP7 BIOCORE project the first Biorefinery Summer Course, August 2011, Paris, France.

For 2012 the following networking activities are planned:

- Task business meeting, 27 February 2012, Copenhagen, Denmark.
- Co-organising the Danish Conference 'Advanced Biofuels in a Biorefinery Approach', 28-29 February 2012, Copenhagen, Denmark.
- Biorefinery Excursion, 1 March 2012, Copenhagen Denmark.
- 2nd Biorefining Summer/Training School, mid to late 2012, Wageningen, the Netherlands.
- Task business meeting in conjunction with the IEA Bioenergy Conference, 12-15 November 2012 Vienna, Austria.

Deliverables

Deliverables in 2011 included organising and minuting of two Task meetings, coupled to a related Italian stakeholder workshop and an Australian conference; reporting to the ExCo (two progress reports, audited accounts, and a contribution to the Annual Report); maintenance of the Task website; preparation of a classification system for energy-driven biorefineries; report on bio-based Chemicals, Country Reports on biorefinery mapping; and a four day Biorefinery Summer Course.

TASK 43: Biomass Feedstocks for Energy Markets

Overview of the Task

Work in the current triennium is based on the premise that in many countries biomass demand for energy will enter a period of rapid expansion as a way to ensure sustainable and secure energy sources. Feedstocks from many land uses and cropping systems (e.g. agriculture, forestry, dedicated energy crops) can become a plausible energy source if production systems are economically and environmentally attractive. New science, tools, and technology must be developed to support this era of rapid expansion. Such developments will ensure that suitable production systems are established and can be relied on to help achieve the energy policy targets in many countries.

The objective of the Task is to promote sound bioenergy development that is driven by well-informed decisions in business, governments, and elsewhere. This will be achieved by providing relevant actors with timely and topical analyses, syntheses, and conclusions on all matters relating to biomass feedstock, including biomass markets and the socio-economic and environmental consequences of feedstock production.

The work programme has a global scope and includes commercial, near-commercial and promising production systems in agriculture and forestry. The primary focus is on land use and bioenergy feedstock production systems. The Task will be concerned with issues related to the linking of sustainable biomass feedstocks to energy markets, explicitly considering environmental and socio-economic aspects.

Participating countries: Australia, Canada, Denmark, European Commission, Finland, Germany, Ireland, Italy, the Netherlands, New Zealand, Norway, Sweden, United Kingdom, and the USA. Italy will withdraw from 2012
Task Leader: Associate Professor Göran Berndes, Chalmers University of Technology, Sweden
Associate Task Leader: Professor Tat Smith, University of Toronto, Canada
Task Secretary: Assistant Professor Sally Krigstin, University of Toronto, Canada
Operating Agent: Dr Åsa Karlsson, Swedish Energy Agency, Sweden

The Task Leader directs and manages the work programme assisted by an international team. A National Team Leader (NTL) from each country is responsible for coordinating the national participation in the Task. During 2010, the Task capacity was further increased through the NTLs engaging support persons within their country. The aim was that all participating countries should have a national team consisting of participants actively supporting the NTL at the national level as well as being engaged in Task activities at the international level.

For further details on Task 43, please refer to Appendices 2-6 inclusive; the Task website *www.ieabioenergyTask43.org* and the IEA Bioenergy website *www.ieabioenergy.com* under 'Our Work: Tasks'.

Progress in R&D

Task Meetings

Two business meetings were held in 2011. The first was on 22-25 March, in the Hague, and the second on 22-23 September in Campinas. The meeting in March included a planning meeting for an inter-Task project on 'sustainability certification' with Technical Coordinator Art Wellinger, and the leaders of Tasks 38 and 40.

The Task organised two international workshops and a seminar in 2011 as follows:

- 'Quantifying and managing land use effects of bioenergy', 19-21 September in Campinas, Brazil (together with Task 38 and Task 40);
- 'Bioenergy and water', 25 November in Twin Waters, Australia; and
- A seminar 'Sustainability Criteria of Bioenergy: Status, Visions and Challenges' jointly organised with the Swedish research network Focali and the Swedish Standards Institute on 28 March in Göteborg, Sweden.

The NTLs have been engaged in sub-Task working group meetings in connection with Task events, and have been involved in relevant activities at the national level. The NTLs also achieve substantial outreach as part of their role.

The Brazil workshop was arranged together with Tasks 38 and 40 and focused on a much-debated topic – the connection between bioenergy and Land Use Change (LUC) and especially whether there is a risk that GHG emissions associated with LUC could significantly undermine the climate change mitigation benefits of bioenergy, and how this risk can be minimised. The workshop was successful from many points of view, not the least that participants from many countries and influential organisations – representing diverging views on the topic – engaged in an open and constructive dialogue that generated a state-of-the-art view on where science and policy stands in the area. A summary report is being produced for publication in the journal Biofuels, Bioproducts and Biorefining.

The Australian workshop was organised in the context of cooperation activities within a so-called 'Targets and Solutions Group' (TSG7) that supports preparation for the 6th World Water Forum, which will take place on 12-17 March 2012 in Marseille, France. The TSG7 is coordinated by the Roundtable for Sustainable Biofuels and includes Task 43, UNEP, WWF, WBCSD, and several individual researchers from different universities and institutes. The focus is on sustainability issues and innovative solutions with regard to water and bioenergy. The workshop in Australia was the second Task workshop on the subject of bioenergy and water. Among the material presented was the outcome from the first workshop consisting of a state-of-the-art report (including a summary report and key messages leaflets) and a special issue of the scientific journal Biofuels, Bioproducts and Biorefining.

Work Programme

The work programme for the current triennium is planned to provide answers, from different perspectives, to the following questions:

- How can the Task further develop and implement feedstock production systems to provide attractive solutions for energy security, climate change, and sustainable development?
- How can policy- and market-based instruments effectively promote sustainable development, and how can science-based sustainability criteria and standards be formulated to take into account the vast regional variation in conditions for production of different feedstocks?
- What are the costs and gains associated with productivity, competitiveness, and environmental performance of feedstock supply systems and how do they impact deployment and market penetration of the systems?
- What are the motivations, opportunities, and capabilities for producers in agriculture and forestry to change from conventional production systems and deploy or integrate sustainable bioenergy production systems in response to new demands? What are necessary and sufficient conditions for financial investment in developing feedstock production systems?

A number of Focus Topics have been established as a basis for Task activities:

- Bioenergy and land use change, including the water implications of bioenergy
- Integration of food and fibre production with cost effective biomass supply for energy
- Sustainability of bioenergy feedstock supply systems
- Bioenergy and environmental services
- Certification systems to ensure sustainable bioenergy systems

Systematic knowledge transfer is achieved through the website, reports and briefs, international collaboration, and IEA networks to educate and inform the bioenergy sector. The Task supports the Journal of Forest Energy (managed by the Finnish team), and has taken a role as Associate Editor (bioenergy) for the Wiley journal WIREs: Energy

and Environment. The Task also cooperates with the journal Biofuels, Bioproducts and Biorefining in instances where this journal can offer suitable channels. The Netherlands team is developing a GIS-based tool for dissemination, which is planned to go online by early 2012.

Website

The Task website (*www.ieabioenergyTask43.org*) designed with the objective of obtaining a wider Task exposure, is updated regularly. The website informs about Task 43 and presents the outcomes of Task activities. It also provides web-based archives for the previous Tasks 30 and 31, as well as a link to the Forest Energy Portal (see *www.forestenergy.org*), which is managed by the Finnish Task team.

Collaboration with Other Tasks/Networking

Besides the collaboration associated with the two workshops presented above, the Task has ongoing collaboration with the Swedish network Focali, which is a part of The Forest Initiative - a strategic partnership between the Swedish International Development Cooperation Agency, the Swedish Forest Agency and the Swedish Forestry Association. Focali develops new and synthesises existing knowledge, and increases the flow of relevant information between scientists, industry, government and civil society (see *www.focali.se/en*). Several Task members are involved with the COST Action FP0902 - Development and Harmonisation of New Operational Research and Assessment Procedures for Sustainable Forest Biomass Supply, including the FP0902 Chair Dominik Röser who is also the Alternate NTL for Finland. The cooperation includes the management of the Journal of Forest Energy and the associated Forest Energy Portal (see *www.forestenergy.org*); the project Rating SRC, which is funded by ERA-NET bioenergy. This cooperation has resulted in two Task reports that are available on *www.ratingsrc.eu.* The Task also collaborates with Tasks 38 and 40 on the inter-Task project 'Monitoring Sustainability Certification of Bioenergy'.

Deliverables

Deliverables for 2011 included reporting to the ExCo (two progress reports, audited accounts, and the annual report); technical and more popular reports (see 'Library' section of the Task website) as well as three special issues in scientific journals. Also the organisation and minuting of two Task meetings, and updating of the Task website. Please see Appendix 4 for more details.

IEA BIOENERGY TASK PARTICIPATION IN 2011

TASK	AUS	AUT	BEL	BRA	CAN	CRO	DEN	FIN	FRA	GER	IRE	ITL	JAP	KOR	NEL	NZE	NOR	SA	SWE	SWI	TUR	UK	USA	EC	Total
29					•	•				•							•					⊗			5
32		•			•		•	•		•	•	•			⊗		•		•	•	•	•			13
33		•					•	•		•		•	•		•	•	•		•	•	•		⊗		13
34					•			•		•												•	⊗		5
36					•				•	•		•					•		•			⊗			7
37		•		•	•		•	•	•	•	•				•		•		•	•	•	•		⊗	15
38	•	⊗	•	•				•		•					•		•		•				•		10
39	•	•		•	⊗		•	•		•		•	•	•	•	•	•	•	•			•	•		17
40		•	•	•	•		•	•		•		•	•		⊗		•		•			•	•		14
42	•	•			•		•		•	•	•	•			⊗						•	•	•		12
43	•				•		•	•		•	•	•			•	•	•		⊗			•	•	•	14
Total	4	7	2	4	9	1	7	8	3	11	4	7	3	1	8	3	9	1	8	3	4	9	7	2	125

⊗ = Operating Agents • = Participant

Note: In addition to the above Task 41, Project 3 was ongoing in 2011. This is a joint project with the AMF Implementing Agreement. The IEA Bioenergy participants are Finland, Germany and the EC.

BUDGET IN 2011 – SUMMARY TABLES

Budget for 2011 by Member Country (US$)

Contracting Party	ExCo Funds	Task Funds	Total
Australia	10,700	59,500	70,200
Austria	13,700	103,000	116,700
Belgium	8,700	31,500	40,200
Brazil	10,700	60,500	71,200
Canada	15,700	140,320	156,020
Croatia	7,700	14,000	21,700
Denmark	13,700	103,500	117,200
Finland	14,700	123,000	137,700
France	9,700	44,320	54,020
Germany	17,700	167,320	185,020
Ireland	10,700	59,000	69,700
Italy	13,700	104,820	118,520
Japan	9,700	44,500	54,200
Korea	7,700	15,000	22,700
Netherlands	14,700	118,000	132,700
New Zealand	9,700	42,500	52,200
Norway	15,700	132,320	148,020
South Africa	7,700	15,000	22,700
Sweden	14,700	118,320	133,020
Switzerland	9,700	41,500	51,200
Turkey	10,700	56,500	67,200
UK	15,700	140,320	156,020
USA	13,700	109,000	122,700
European Commission	8,700	29,000	37,700
Total	285,800	1,872,740	2,158,540

BUDGET IN 2011 – SUMMARY TABLES

Budget for 2011 by Task (US$)

Task	Number of participants	Annual contribution per participant	Total Task funds
Task 29: Socio-economic Drivers in Implementing Bioenergy Projects	5	14,000	70,000
Task 32: Biomass Combustion and Co-firing	13	15,000	195,000
Task 33: Thermal Gasification of Biomass	13	12,500	162,500
Task 34: Pyrolysis of Biomass	5	20,000	100,000
Task 36: Integrating Energy Recovery into Solid Waste Management	7	15,320	107,240
Task 37: Energy from Biogas	15	14,000	210,000
Task 38: Greenhouse Gas Balances of Biomass and Bioenergy Systems	10	14,500	145,000
Task 39: Commercialising Liquid Biofuels from Biomass	17	15,000	255,000
Task 40: Sustainable International Bioenergy Trade - Securing Supply and Demand	14	17,000	238,000
Task 41(3): Joint Project with AMF Implementing Agreement	3	0	0
Task 42: Biorefineries: Co-production of Fuels, Chemicals, Power and Materials from Biomass	12	15,000	180,000
Task 43: Biomass Feedstocks for Energy Markets	14	15,000	210,000
Total			1,872,740

CONTRACTING PARTIES

Rural Industries Research and Development Corporation (Australia)

The Republic of Austria

The Government of Belgium

The National Department of Energy Development of the Ministry of Mines and Energy (Brazil)

Natural Resources Canada

The Energy Institute "Hrvoje Pozar" (Croatia)

The Ministry of Transport and Energy, Danish Energy Authority

Commission of the European Union

Tekes, Finnish Funding Agency for Technology and Innovation

L'Agence de l'Environnementet de la Maîtrise de l'Énergie (ADEME) (France)

Federal Ministry of Food, Agriculture and Consumer Protection (Germany)

The Sustainable Energy Authority of Ireland (SEAI)

Gestore dei Servizi Energetici – GSE (Italy)

The New Energy and Industrial Technology Development Organization (NEDO) (Japan)

Ministry of Knowledge Economy, the Republic of Korea

NL Agency (The Netherlands)

The New Zealand Forest Research Institute Limited

The Research Council of Norway

South African National Energy Research Institute (SANERI)

Swedish Energy Agency

The Swiss Federal Office of Energy

Tubitak Marmara Research Center Energy Institute (Turkey)

Department of Energy and Climate Change (United Kingdom)

The United States Department of Energy

LIST OF REPORTS AND PUBLICATIONS

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Anon. IEA Bioenergy Annual Report 2010. IEA Bioenergy ExCo:2011:01.

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TASK 29

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TASK 32

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TASK 34

Minutes of the Task meeting in Hamburg, Germany, April 2011.

Minutes of the Task meeting in Richland, Washington, USA, October 2011.

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TASK 36

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The publications are available from Pat Howes, please email: *pat.howes@aeat.co.uk*

TASK 37

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Minutes from the Task meeting in Cork, Ireland, September 2011.

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TASK 38

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TASK 39

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Minutes from the Task meeting in Aarhus, Denmark, June 2011.

Minutes from the Task meeting in Campinas, Brazil, September 2011.

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Faaij, A. Presentation on International Biomass Trade Flows with Special Focus on Wood Chips and Pellets. Biomass Trade & Power Americas, Feb 2011, Atlanta, USA.

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Minutes of the 10th Task meeting, Twin Waters, Australia, November 2011.

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KEY PARTICIPANTS IN EACH TASK

TASK 29 — Socio-economic Drivers in Implementing Bioenergy Projects

Operating Agent: Elizabeth McDonnell, Department of Energy and Climate Change, United Kingdom.
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For contacts see Appendix 6.

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For contacts see Appendix 6.

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TASK 32 — Biomass Combustion and Co-firing

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Ireland	John Finnan	Teagasc
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TASK 33 — Thermal Gasification of Biomass

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	Antonio Molino (2012)	ENEA
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The Netherlands	Bram van der Drift	ECN
New Zealand	Shusheng Pang	University of Canterbury
Norway	Judit Sandquist	SINTEF
Sweden	Lars Waldheim	Waldheim Consulting
Switzerland	Martin Rügsegger	ETECA
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TASK 34 — Pyrolysis of Biomass

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USA	Douglas Elliott	Battelle Pacific Northwest

TASK 36 — Energy Recovery from Municipal Solid Waste Management

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Italy	Giovanni Ciceri	ERSE
Norway	Michael Becidan	SINTEF
Sweden	Evalena Blomqvist	SP Sweden
UK	Pat Wheeler	Lend Lease

TASK 37 — Energy from Biogas

Operating Agent: Kyriakos Maniatis, European Commission, Belgium.
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European Commission	David Baxter	European Commission, JRC Petten
Finland	Jukka Rintala	University of Jyväskylä
France	Olivier Théobald	ADEME
Germany	Bernd Linke	Leibniz-Institute for Agricultural Technology
Ireland	Jerry Murphy	University College Cork
Netherlands	Mathieu Dumont	NL Agency
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	Tobias Persson (2012)	Swedish Gas Centre
Switzerland	Nathalie Bachmann	EREP
Turkey	Selman Çagman	Tubitak Marmara Research Center
UK	Clare Lukehurst	Probiogas UK

TASK 38 — Greenhouse Gas Balances of Biomass and Bioenergy Systems

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TASK 39 — Commercialising Liquid Biofuels from Biomass

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	Warren Mabee	Queen's University
Denmark	Michael Persson	Inbicon A/S
	Henning Jørgensen	University of Copenhagen

Finland	Tuula Makinen	VTT Biotechnology
	Niklas von Weymarn	VTT Biotechnology
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	Seonghan Park	Pusan National University
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	Maria Nyquist	Swedish Energy Agency
	Jonas Lindmark	Swedish Energy Agency
UK	Tony Sidwell	British Sugar
USA	Jim McMillan	NREL

TASK 40 — Sustainable International Bioenergy Trade: Securing Supply and Demand

Operating Agent: Kees Kwant, NL Agency, the Netherlands.
For contacts see Appendix 7.

Task Leader: (Scientific) André Faaij, Copernicus Institute, Utrecht University, the Netherlands
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	Didier Marchal	Walloon Forest Service, Service Public de Wallonie

Brazil	Arnaldo Walter	University of Campinas
Canada	Douglas Bradley	Climate Change Solutions
Denmark	Lars Nikolaisen	Danish Technological Institute
Finland	Tapio Ranta	Lappeenranta Technical University
	Jussi Heinimö	Lappeenranta Technical University
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	Peter-Paul Schouwenberg	RWE Essent
	Martin Junginger	Copernicus Institute, Utrecht University
Norway	Arildn Fallan	Enova SF
	Erik Tromborg	Norwegian University of Life Sciences
Sweden	Bo Hektor	Svebio
UK	Frank Rosillo-Calle	Imperial College
USA	Richard Hess	Idaho National Laboratory
	Richard Nelson	Kansas State University

TASK 41 — Bioenergy Systems Analysis

Project 3: Joint Project with AMF Annex XXXVII project 'Fuel and Technology Alternatives for Buses: Overall energy efficiency and emission performance'

Operating Agent: Professor Kai Sipila, VTT, Finland.
For contacts see Appendix 7.

Project Leader: Professor Kai Sipila, VTT, Finland.
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European Commission	Kyriakos Maniatis	DG Energy and Transport

TASK 42 — Biorefineries: co-production of fuels, chemicals, power and materials from biomass

Operating Agent: Kees Kwant, NL Agency, the Netherlands.
For contacts see Appendix 7.

Task Leader: René van Ree, Wageningen University and Research Centre (WUR), the Netherlands.
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Denmark	Henning Jorgensen	University of Copenhagen
France	Alba Departe	Ademe
Germany	Thomas Willke	Johann Heinrich von Thunen-Institut
Ireland	Patrick Walsh	Galway – Mayo Institute of Technology
Italy	Isabella De Bari	ENEA
The Netherlands	René van Ree	Wageningen University and Research Centre
	Ed de Jong	Avantium Technologies B.V.
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TASK 43 — Biomass Feedstocks for Energy Markets

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For contacts see Appendix 7.

Task Leader: Göran Berndes, Chalmers University of Technology, Sweden.
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Finland	Antti Asikainen	The Finnish Forest Research Institute
Germany	Jörg Schweinle	Johann Heinrich von Thünen-Institute (vTI)
Ireland	Kevin McDonnell	Biosystems Engineering, Bioresources Research Centre
Italy	Fabrizio Rossi	Agriconsulting S.p.A.
Netherlands	Jan van Esch	Ministry of Agriculture, Nature and Food Quality
New Zealand	Peter Hall	SCION
Norway	Simen Gjølsjø	Norwegian Forest and Landscape Institute
Sweden	Gustaf Egnell	Swedish University of Agricultural Sciences
UK	Ian Tubby	Forestry Commission England
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