Annual Report 2012

IEA Bioenergy

IEA BIOENERGY:EXCO:2013:01

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: Enköping municipal wastewater plant, Sweden. Courtesy Per Aronsson, Swedish University of Agricultural Sciences, Sweden.

Chairman, Birger Kerckow and new Secretary, Pearse Buckley

To: IEA Headquarters, Paris

IEA BIOENERGY ANNUAL REPORT 2012

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 2012. It includes a special feature article 'Biomass Feedstocks for Energy Markets' prepared by Task 43.

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

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Chairman

John Tustin
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Contents

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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.

The opinions and conclusions expressed in this report are those of the authors.

Biomass Feedstocks for Energy Markets

This feature article provides an overview of some of the work of Task 43: Biomass Feedstocks for Energy Markets. It was prepared by Göran Berndes, Task Leader and Tat Smith, Associate Task Leader.

Introduction

In an Energy Vision article published recently in the journal Energy Strategy Reviews, Maria van der Hoeven, Executive Director of the IEA, concluded that:

'International energy governance is now more important than ever to address heightened uncertainty about energy security, energy cost and environmental impact. Energy markets in 2012 face a particularly daunting set of new challenges and risks. Vigilant analysis and concerted action can do much to mitigate them, and to counter the rise in uncertainty about global energy issues.'

Around the world, the promotion of renewable energy sources and measures to reduce the growth rate of our energy demand is a cornerstone strategy to address these challenges and risks. The IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation (2012) reports that renewable energy accounted for almost 13% of the primary energy supply in 2008, with biomass contributing more than 10%. Traditional use of biomass for cooking, space heating, and lighting presently accounts for roughly 80% of global bioenergy use. However, there has been a rapid increase in so-called modern biomass use in response to policies aimed at improving energy security and mitigating climate change. In many countries, the promotion of modern bioenergy is also considered a possible driver of rural development with the potential to improve energy access, increase employment, and stimulate positive development in agriculture and forestry.

At present, modern bioenergy use primarily involves the burning of municipal organic waste, straw, wood and forest industry by-products to provide heat and electricity, anaerobic digestion of organic waste to produce biogas, and the use of conventional agriculture crops such as cereals, oil seeds, and sugar crops to produce biofuels. However, the technologies used to convert biomass to fuels and other products continue to develop into increasingly sophisticated processes. New plant and biomass production systems can utilise a broader resource base. In forestry, new developments in planting, silvicultural treatments and biomass extraction support an increasing harvest from forests. In agriculture, the cultivation of perennial grasses and trees grown on short rotations (both coppice and single-stem plantations) represent new feedstock supply options (Figure 1).

The promotion of bioenergy offers considerable opportunities for the agriculture and forestry sectors, which can find new markets for their products and also make

economic use of biomass flows earlier considered to be waste. But there has also been an increase in the number of reports expressing concern about possible negative environmental and socio-economic impacts associated with bioenergy. The view that bioenergy represents an attractive alternative to conventional (primarily fossil) energy options has been challenged – particularly in the case of biofuels for transport.

Switchgrass, a perennial grass native to North America, is presently grown as forage for livestock or as ground cover to control erosion. It is established from seed and can achieve high yields with low fertiliser input. It can be cut and baled with conventional mowers and balers – either annually or semi-annually – for 10 years or more, before replanting is needed.

Eucalyptus species are planted extensively throughout the tropics and particularly in sub-tropical regions, primarily for industrial roundwood. The photo shows one way of integrating bioenergy with food crop production, where *Eucalyptus* has been inter-planted with corn. *Eucalyptus* can also be inter-planted with other crops and used in silvi-pastoral systems. It is suitable as a wind break and primarily in Australia is planted to lower the water table and thereby reduce soil salinisation.

Willow is a coppicing plant that is planted using cuttings. It can be harvested using modified agricultural machinery that also chips the stems every 3-4 years for about 25 years until re-establishment is needed. Willow can also provide environmental services, e.g. as a vegetation filter treating nutrient-rich water and for removal of cadmium from cropland.

Miscanthus is a perennial grass that is established by planting pieces of rhizome from fields where the crop is already established. Rhizomes can be broken up, collected and planted using existing agricultural equipment such as potato planters and harvesters. The crop is normally harvested from year two onwards, but yields continue to improve until they level off around the fifth or sixth year.

Figure 1: Selected biomass production systems in agriculture.

Policy makers who establish incentives or targets to promote bioenergy are understandably concerned that risks are properly considered when bioenergy projects are being contemplated or incentives designed. It is not self-evident that bioenergy is

environmentally (or socio-economically) superior to fossil-based energy and consumers may object to bioenergy products because of concerns about the impacts of their production. The fact that renewable feedstocks are used is not sufficient in itself to make bioenergy sustainable. One reason is that, in many instances, the production of bioenergy relies on non-renewable resources as inputs. Well-to-wheel studies clearly show that bioenergy systems differ greatly in their reliance on fossil inputs and consequently in their contribution to reduced greenhouse gas (GHG) emissions – one major rationale for governments promoting these fuels, and for consumers using them.

The production of renewable feedstocks can also cause negative impacts. In fact, bioenergy feedstock production is one major component in the bioenergy supply chain that has been in focus in the bioenergy debate. Much attention has been directed to the possible consequences of land use change (LUC), referring to well-documented effects of forest conversion and cropland expansion into previously uncultivated areas, possibly resulting in biodiversity losses, GHG emissions and degradation of soils and water bodies. Sustainability concerns relating to the feedstock supply systems also include direct and indirect social and economic aspects, including land use conflicts, food security impacts and human rights violations.

While vigilant analysis and concerted action can do much to identify risks and mitigate impacts, it is also essential to ensure that these actions reflect well-grounded conclusions considering the costs and benefits of different choices. The bioenergy sector's licence to operate cannot be based upon a complete absence of negative impacts. Human beings have always influenced their habitats and the conversion of ecosystems to land for biomass production is perhaps our most obvious impact on the Earth. Human societies have put almost half of the world's land surface to their service, and human land use has caused extensive land degradation and biodiversity loss. Emissions to air and water lead to impacts such as eutrophication, acidification, stratospheric ozone depletion and climate change.

It is evident that society will continue to set a large 'footprint' on Earth in the future, since our land use provides food and other products necessary for sustaining the increasing human population. It is also evident that society expects that new systems should reduce land use impacts and mitigate risks. The management of natural resources to meet the needs of human society, whilst recognising environmental balance, is the challenge facing society. Governance of bioenergy development is very much about balancing trade-offs between partly incompatible environmental and socio-economic objectives. In the end, bioenergy development will depend on the priority given to bioenergy products versus other products obtained from land – notably food and conventional forest products – and on how much biomass can be mobilised in total from agriculture and forestry. This in turn depends on natural factors (e.g. climate, soils, and topography) and on the agronomic and forestry practices employed to produce the biomass. It also depends on how society understands and prioritises nature conservation and protection of soils, water and biodiversity - and how the production systems are shaped to reflect these priorities.

There are currently a number of initiatives to develop sustainability certification systems. These may hedge against some of the undesired consequences of expanding feedstock supply systems and promote positive development when implemented effectively. Complementing sustainability certification, we need to develop competitive business cases that are efficient along the entire bioenergy supply chain, from feedstock production to energy markets. Capturing the benefits of bioenergy requires the creation of incentives to stimulate innovation in land use, including new ways to integrate bioenergy feedstock production with agriculture and forestry so as to stimulate productivity, local development and sustainable land use practices. A critical question to ask is: what are the basic prerequisites for financial investment in developing these biomass production systems?

The objectives of this article are to briefly discuss some of the risks and opportunities associated with bioenergy growth and also to consider the role of sustainability certification in the mix of governance mechanisms (e.g. mandatory regulations, local and state best management practices) established to satisfy public demand for sustainable bioenergy. A final section outlines conditions for the mobilisation of sustainable bioenergy supply chains, which will be explored by several Tasks within one of the Strategic Projects that has been established by the Executive Committee.

Bioenergy and Land Use Change

It has been well established that practically all bioenergy systems can deliver large GHG savings if they replace fossil-based energy causing high GHG emissions and if the bioenergy production emissions are kept low. However, in recent years there has been considerable debate about the connection between bioenergy and LUC and, in particular, 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.

Bioenergy projects can lead to both direct and indirect LUC. Direct LUC (dLUC) involves changes in land use on the site used for bioenergy feedstock production, such as the change from food or fibre production (including changes in crop rotation patterns, conversion of pasture land, and changes in forest management) or the conversion of natural ecosystems. Indirect LUC (iLUC) refers to the changes in land use that take place elsewhere as a consequence of the bioenergy project. For example, displaced food producers may re-establish their operations elsewhere by converting natural ecosystems to agricultural land, or due to macro-economic factors, the agriculture area may expand to compensate for the losses in food/fibre production caused by the bioenergy project. A wide definition of iLUC can include changes in crop rotation patterns and/or intensification on land used for food or feed production.

LUC can affect GHG emissions in a number of ways, for example (i) when biomass is burned in the field during land clearing; (ii) when the land management practice is changed so that the carbon stocks in soils and vegetation change; (iii) when changes in the intensity of land use lead to changes in GHG emissions, in particular N_2O emissions due to fertiliser use; and (iv) when LUC results in changes in rates of carbon

sequestration, i.e. the CO_2 assimilation of the land may become lower or higher than would have been the case in the absence of LUC. The impacts of these changes can increase the net GHG emissions (for example when land with large carbon stocks is brought into cultivation) or have a beneficial outcome (for example when energy crops are developed on marginal lands with carbon-poor soils). LUC can also influence the climate through other mechanisms besides GHG emissions, where changes in surface albedo (reflecting power) might be the most important factor.

Studies of LUC emissions associated with bioenergy report widely different results. The inclusion of iLUC in particular adds greatly to the uncertainty in quantifications of LUC effects (Figure 2). It should not be assumed that improved methodology leads to the convergence of estimates towards narrow ranges supporting globally agreed ranking of bioenergy options with regard to their influence on LUC and associated emissions. The drivers behind LUC are multiple, complex, interlinked, and change over time. This makes quantification inherently uncertain, since LUC is sensitive to many factors that can develop in different directions, including land use productivity, trade patterns, prices and price elasticity, and use of by-products associated with biofuels production. Not least, policies and legal measures that directly or indirectly influence land use can have a strong influence on future LUC and associated emissions.

There are many options for avoiding or mitigating the negative impacts associated with LUC and for optimising the climate benefits of bioenergy. First of all, the use of post-consumer organic residues and by-products from the agricultural and forest

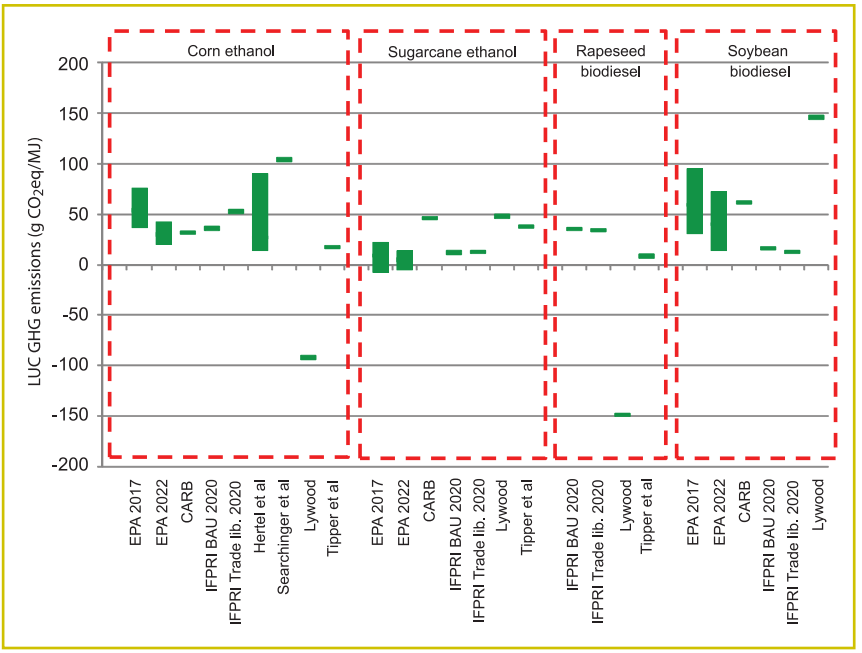

Figure 2: Ranges of model-based quantifications of LUC (dLUC + iLUC) emissions associated with the expansion of selected biofuel/crop combinations. The studies are reported with LUC emissions amortised over 30 years of production for comparison. Source: IEA Bioenergy ExCo 2011:04.

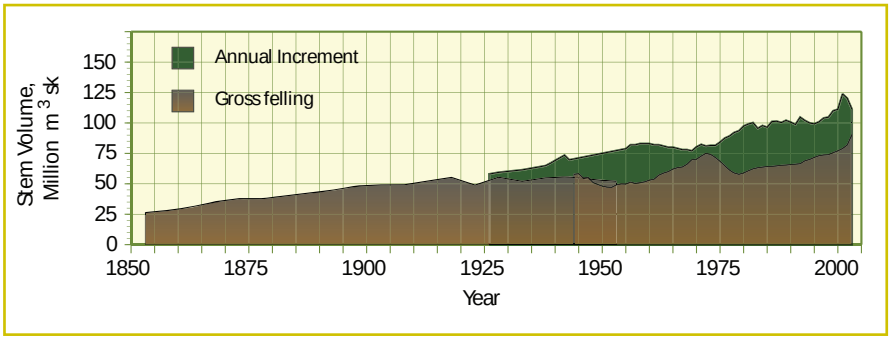

Figure 3: Historic overview of gross felling (1853–2003) and – placed behind the area showing gross felling – the annual increment (1926–2003) in the Swedish forest. The method of estimating felling changed between 1945 and 1955, resulting in two overlapping curves. In recent decades Sweden has had a very strong increase in bioenergy displacing much of the fossil fuel use in the stationary energy sector. At the same time as increasing volumes of biomass have been extracted from the forest there has also been an increase in forest stocks, as a result of changing forest management and planning for a future with higher biomass demand for both materials and energy. Source: IEA Bioenergy ExCo 2011:04.

industries does not cause LUC if these biomass sources are wastes, i.e. were not utilised for alternative purposes. Biomass that is burned, such as straw on fields, is an obvious example. The use of biomass that would otherwise be landfilled, or decompose in wet conditions, can also lead to additional benefits through reduced methane emissions. If not utilised for bioenergy, some biomass sources (e.g. felling residues left in the forest) would retain organic carbon for a longer time than if used for energy. This difference in timing of emissions can be considered a disbenefit for bioenergy in project level evaluations which only use a short time horizon, and is also a relevant factor in longer-term accounting in eco-regions where biomass decomposition is slow. However, proper evaluation also requires consideration of forest bioenergy and associated C flows on a landscape level as well as consideration of how forest management is affected by the promotion and growth of bioenergy demand. Experience shows that active forest management can ensure that increased biomass output need not take place at the cost of reduced forest stocks on the landscape level (Figure 3).

One promising way of reducing emissions from LUC is to increase the amount of lignocellulosic feedstocks for bioenergy that are grown on low carbon pasture land less suitable for annual crops, thereby decreasing the pressure on prime cropping land. Since the production of lignocellulosic feedstocks commonly requires less fuel, fertiliser and other inputs, there is also scope for higher GHG savings than when biofuels are produced from conventional crops such as cereals and sugar beet. However, a mix of lignocellulosic material and conventional food/feed crops is likely to be used for bioenergy feedstocks during the coming decades to supply biofuels and the heat and power markets. Strategies to increase agricultural productivity, especially in developing countries, will be critical to minimising LUC impacts.

Food, fibre and bioenergy crops can be grown in integrated production systems, mitigating displacement effects and improving the productive use of land. The targeting of unused marginal and degraded lands can also mitigate LUC emissions associated with bioenergy expansion. Biomass extraction for energy as part of fire prevention

management reduces the risk of wildfires with resulting emissions and other impacts. Bioenergy plantations can in many ways improve the productive use of land and can provide several benefits in addition to the GHG savings, as discussed in various places in this article. Thus, displacement of an existing land use should not necessarily always be avoided. Conversely, the opportunity to shift from unsustainable cultivation of annual food crops (e.g. intensive cultivation causing extensive soil losses and degradation on sloping lands) to perennial bioenergy plantations may represent an important step towards more sustainable land use. Income from such bioenergy cultivation may be invested in improving the productivity of food production on more suitable lands.

Bioenergy's contribution to climate change mitigation needs to reflect a balance between near-term GHG targets and the long-term objective to hold the increase in global temperature below 2°C (Copenhagen Accord). Sound bioenergy development requires adequate and transparent criteria that can be applied in a robust, predictable way. Policy measures to minimise the negative impacts of LUC should be based on a holistic perspective, recognising the multiple drivers and effects of LUC and taking into account the dynamics of both energy and climate systems. A balanced approach is likely to include incentives that discourage systematic decreases in biospheric carbon stocks while encouraging the sustainable use of biomass to replace fossil fuels instead of merely prioritising natural decay.

While emissions from LUC can be significant in some circumstances, the simple notion of LUC emissions is not sufficient reason to exclude bioenergy from the list of worthwhile technologies for climate change mitigation. What matters is the size of carbon stock reductions, and the drawback of such reductions needs to be weighed against the benefits of bioenergy expansion. For instance, forest carbon stock losses may well reflect a reorientation of forest management to develop a new forest state that provides biomass for bioenergy as well as other forest products. Whether this new forest state can be characterised as sustainable depends on a wide range of factors in addition to the forest carbon stock, which together determine a forest's biodiversity, productivity, regeneration capacity, vitality and potential to fulfil relevant ecological, economic and social functions. In any case, we recommend carbon stock losses or gains be determined through appropriate monitoring systems, perhaps in conjunction with certification schemes involving third party audit.

Bioenergy and Water

Agriculture accounts for about 70% of fresh water taken from rivers, lakes, and aquifers – more than 90% in some developing countries. Growing populations and changing dietary trends mean a rising demand for food and feed crop cultivation, implying further growth in agriculture water use. At the same time, fresh water is already scarce in some regions of the world and under the impact of climate change the population at risk of water stress could increase substantially.

Water scarcity can limit opportunities for both intensification and expansion of agriculture. Investment in increased irrigation can enhance water use competition in water scarce areas, but rain-fed cultivation can also impact on other production by reducing groundwater recharge and stream flows. Human land use and other activities also impact the quality of water in lakes, rivers and aquifers, with consequences for the health of aquatic ecosystems and also for human water use. Demand for bioenergy further adds to the growing pressure on water resources, and water scarcity has been proposed as a possible major obstacle for bioenergy expansion. However, it has also been recognised that bioenergy demand might open up new opportunities to adapt to water related challenges and to improve the productivity of water use.

Water scarcity can be partially alleviated through on-site water management and the productivity of agriculture could be improved in many parts of the world through improved soil and water conservation. Investment in agricultural research, development and deployment could produce a further increase in both water productivity and land use efficiency. In this context, bioenergy demand may offer new opportunities for the development of crop production systems that utilise key pathways of the hydrological cycle more efficiently.

As an illustration of possible land use options and associated consequences for water, Figure 4 shows water pathways on the cropland level. If the non-productive evaporation (E) is reduced in favour of plant transpiration (T), total biomass production may increase without necessarily reducing the downstream availability of water. Capture and recirculation of run-off water to fields can also increase the share of water going to plant transpiration and hence enhance biomass yields. If, however, total evapotranspiration (ET, which is the sum of E and T) increases this can have consequences for both groundwater recharge and run-off.

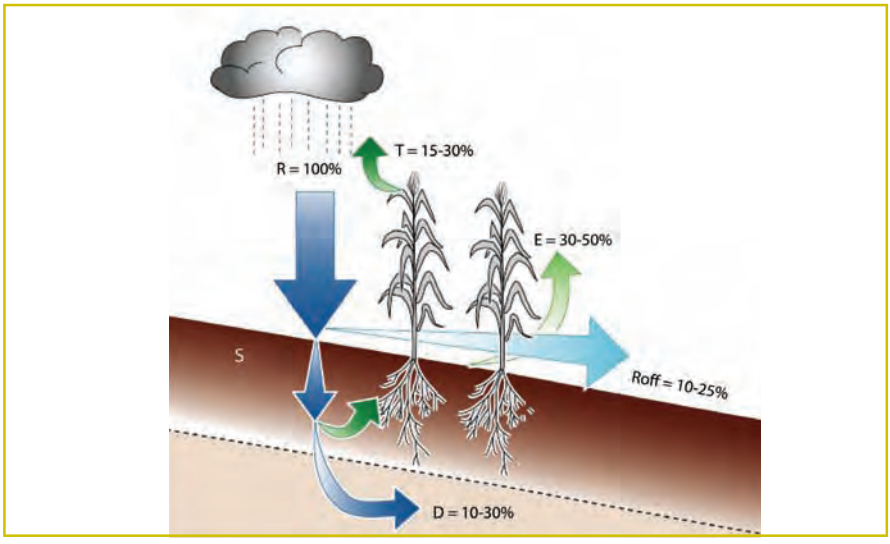

Figure 4: Overview of rainfall (R) partitioning. Run-off (Roff) and drainage (D) are lost from the field, but are potentially available for downstream use, although part of Roff is lost as evaporation as it flows through the landscape. Field evaporation (E) corresponds to a non-productive water loss, while transpiration (T) by the cultivated plants represents productive water use. The percentages shown correspond to conditions in the semi-arid tropics in sub-Saharan Africa. Source: Rockström, J. *et al.* 1999. Linkages among water vapor flows, food production, and terrestrial ecosystem services. Conservation Ecology 3(2): 5.

ET can increase both as a consequence of measures to enhance the yields of presently cultivated crops, or as a consequence of LUC such as when high-yielding biomass plantations are established on lands with sparse vegetation, for example degraded pastures. Such LUC may lead to substantial reductions in downstream water availability, which may become an unwelcome effect requiring management of a trade-off between upstream benefits and downstream costs. However, it should be noted that consequences of increased ET need not always be negative. Examples of positive consequences include when biomass plantations are used for salinity management or when plantation establishment on degraded lands reduces run-off intensity and the associated risks of flooding of cultivated areas.

New crops and biomass production systems may also facilitate utilisation of previously little used components of the hydrological cycle. For instance, hardy and drought tolerant plants can be cultivated in areas where water scarcity prevents cultivation of conventional food and feed crops. Salt-tolerant plants that can grow in conditions of high salinity are being studied as potential bioenergy crops with the ability to use saline water not suitable for most crops. The use of perennial plants and various agroforestry systems for food and bioenergy feedstock production can also increase productivity in rain-fed agriculture by capturing a larger proportion of the annual rainfall in areas where much of the rainfall occurs outside the normal growing season.

Thus, one strategy for adaptation to water scarcity can be to use biomass production for energy as a tool for increasing the spatial and temporal accessibility of water resources and at the same time improving the quality of freshwater flows. By concurrently introducing efficient water management techniques and providing a wider range of land use options to optimise the use of land and water, bioenergy development provides opportunities to improve water productivity and increase access to water. Catchment basin level planning could include biomass production as a land use option with the potential for combining, for example, erosion control and flood prevention with income generation from carbon sink generation and biomass sales for energy.

Bioenergy projects can also affect the quality of water. As with many other industrial activities, biomass conversion to energy products can require substantial volumes of water. Most of this process water is returned to rivers and other water bodies and is thus available for further use, albeit in changed (and sometimes degraded) states. These biomass conversion processes need to be monitored to minimise negative impacts due to chemical and thermal pollution of aquatic systems. This is not an issue affecting only the biomass-based industry on its own, but a general challenge for society, not least in countries with less stringent environmental regulations or limited law enforcement capacity.

In forests, water quality impacts can occur at different phases of the forest rotation. Excluding large-scale disturbances such as fires, storm losses and insect infestations, forest harvesting (including road construction) and subsequent site preparation for

forest regeneration are the largest disturbances in managed forests. However, the use of fertilisers, herbicides and other chemicals associated with intra-rotation silvicultural operations can also have water quality impacts. Short term water quality effects have been reported – most notably increased sediment movement in stream flows and also increases in, e.g. nitrates, phosphates, and cations – but there is no evidence of long term adverse impacts in forest catchments subject to normal management operations. Given use of existing best management practices that are designed for environmental protection and include nutrient management principles, forest bioenergy programmes are judged to be compatible with maintaining forest productivity as well as high-quality water supplies in forested catchments. In some situations, bioenergy schemes can improve the water quality in forested catchments. For instance, residue extraction in areas subject to high levels of atmospheric N deposition reduces the eutrophication load.

Due to more intensive land use, water catchments where agriculture is the dominant land use generally produce lower quality water than forested catchments. A large proportion of the fertilisers, pesticides and other chemicals that are lost from croplands end up in waterways and aquifers where they can have a negative influence on the quality of surface water and groundwater as a result of eutrophication and other pollution impacts. Extraction of harvest residues as bioenergy feedstock can cause soil erosion resulting in increased sediment flows impacting on aquatic ecosystems (see Figure 5). The cultivation

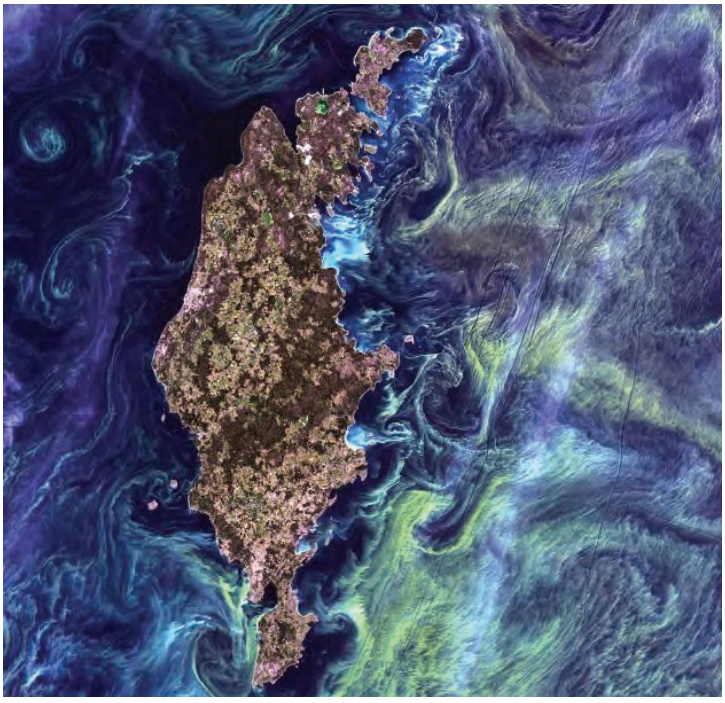

Figure 5: Algal blooms in the water around Gotland, a Swedish island in the Baltic Sea. Fertiliser run-off to the Baltic Sea from surrounding agricultural land contributes to a large nutrient load, primarily via river discharges. This run-off has changed it from an oligotrophic clear-water sea into an eutrophic marine environment experiencing summertime algal blooms. Courtesy: NASA's Goddard Space Flight Center/USGS.

of conventional agricultural crops such as cereals and oil seed crops for the production of so-called 1st generation biofuels for transport, will lead to the same water quality consequences as when such crops are produced for food and feed. Thus, a scenario where growing demand for both food and 1st generation biofuels drives a strong increase in conventional crop cultivation may cause further negative water quality impacts.

On the other hand, integration of other types of bioenergy plants into agriculture landscapes can mitigate some of the water quality impacts associated with conventional crop cultivation. Examples include perennial grasses and woody plants grown on multi-year rotations, which commonly require less fertiliser and other chemical inputs than conventional annual crops. The cultivation of such plants can help improve water quality and can also positively influence soil qualities such as texture and structure, which in turn improve water infiltration, permeability, and water-holding capacity. The possibility of combining biomass production for energy with the provision of additional environmental services is discussed further in the next section.

Bioenergy and Environmental Services

Bioenergy systems can – through well-chosen site location, design, management and system integration – offer additional environmental services that, in turn, create added value for the systems. Some bioenergy systems may be established to provide environmental services that are only relevant in specific conditions, for example when trees are established as a wind break to reduce wind erosion. Others are systems that provide environmental services of a more general nature, for instance soil carbon accumulation leading to improved soil fertility and enhanced climate benefit.

While the concept of shaping biomass production systems so as to deliver specific ecosystem services might appear a recent invention, the underlying idea – that certain plants can be produced in certain ways to provide various benefits in addition to the harvest – has probably always influenced land use strategies. Specifically, integration of different perennial grasses and short rotation woody crops has been suggested as a way of remediating many environmental problems, including biodiversity loss. These perennial crops differ from most arable crops in physical traits and management practices. Results so far imply many positive environmental benefits associated with implementation of bioenergy feedstock production using such crops, although the effects on the environment depend on the existing or previous land use, the scale of planting and the management practices applied.

Examples of bioenergy systems that are established for the purpose of providing specific environmental services include soil-covering plants and vegetation strips located to limit water erosion, reduce evaporating surface run-off, trap sediment, and reduce the risks of shallow landslides; tree plantations that are used for salinity management on land subject to productivity losses due to soil salinity induced by rising water tables; and plantations of suitable species that are used to remove cadmium and other heavy metals from cropland soils. In general, integration of specific biomass plantations in the agricultural

landscape can contribute to a more varied landscape, increased biodiversity and more animal life. More specifically, plantations can be located in the agricultural landscape so as to provide ecological corridors that provide a route through which plants and animals can move between spatially separated, natural and semi-natural ecosystems. In this way, plantations can reduce the barrier effect of agricultural lands.

Specific bioenergy applications can also prove economically attractive compared to other approaches to addressing these problems. As an example, Figure 6 shows a willow plantation that is irrigated with secondary treated municipal wastewater effluent. In this case, the municipality covered all costs of the storage ponds, pumps, automatic filters and irrigation pipes (which were cheaper than the estimated cost of installing improved conventional nitrogen treatment). The farmer/landowner planted the willows and is responsible for the cultivation including maintenance of the irrigation pipes. The willow producer has economic benefits from lower costs for conventional fertilisers and the irrigation contributes to higher yields and lower vulnerability to drought.

Plantations like the one shown in Figure 6 can be used as vegetation filters for the treatment (via irrigation) of collected run-off water from farmlands and leachate from landfills. Plantations can also be located in the landscape and managed as buffer strips for capturing the nutrients in passing run-off water. Sewage sludge from treatment plants can be used as fertiliser in vegetation filters. Low-input bioenergy plantations can be a land use option in areas where conventional agriculture practices are not allowed due to impacts on groundwater quality.

Figure 6: View of the Enköping municipal wastewater plant in Sweden, showing the water storage ponds and willows used as a vegetation filter. A 75 ha willow plantation treats and utilises decanted water from the dewatering of sewage sludge. The water contains approximately 25% of the N entering the wastewater treatment plant, but less than 1% of the water volume. By treating the water separately in the willow vegetation filter, instead of pumping it back into the treatment plant, the total N load is reduced by 25%. The biomass produced is used in the local district heating plant, contributing to the local supply of heat and electricity. Ash from the boiler is recycled back to the willow plantation. Courtesy: Per Aronsson, Swedish University of Agricultural Sciences, Sweden.

The environmental and socio-economic benefits from large-scale bioenergy plantations designed to provide various environmental services could be substantial. One key issue is to identify suitable mechanisms to put a premium on the environmental services that can be provided. Given that additional revenues can be linked to the bioenergy systems the competitiveness of the produced biomass on the market could be significantly improved. In some cases, actors can be identified who are willing to pay for a specific environmental service. In other situations, information campaigns and innovative government measures that credit the biomass producer may be required. A challenge when implementing such measures lies in the coordination of different policies in the energy, environmental and agricultural sectors.

Sustainability Certification

The previous sections of this article have identified some ways in which intelligently designed bioenergy feedstock production systems can significantly offset GHG emissions associated with fossil fuel-based energy systems, and at the same time lead to increases in ecosystem services. We must always seek to develop new systems that are sustainable and that have significant beneficial outcomes when considered in the wider context. Government policy makers should always determine whether new systems receiving incentives might have serious, unintended consequences.

In 1987, the World Commission on Environment and Development (WCED), which had been set up in 1983, published a report titled 'Our Common Future'. The document is now known as the 'Brundtland Report'. Since that time, there has been considerable effort spent on defining sustainable land use systems, especially with relevance to the forestry and agriculture sectors. For example, in 1993 the countries involved in what came to be known as the Montreal Process, agreed upon seven criteria for sustainable forest management. This agreement was significant globally, since the Member Countries represent about 90% of the world's temperate and boreal forests in the northern and southern hemispheres. This amounted to 60% of all of the forests of the world. Europe's forests were addressed by the Helsinki or Pan-European Process.

The seven criteria upon which the Montreal Process is based have been broadly accepted internationally and are similar to the foundation principles for practically all sustainability standards developed since that time. While originally conceived with forest management in mind, these seven criteria have also been adapted to sustainable trade in forest products including bioenergy feedstocks, so it is possible to verify whether wood products purchased by consumers were produced from timber or biomass harvested from sustainably managed forests. It can be argued that the proliferation of systems defining sustainable forest management (SFM) globally are merely local adaptations of the tenets originally agreed upon in the Montreal Process. It also appears that more recent developments related to international standards

for sustainable bioenergy are based on a similar set of criteria, even if their starting point and community of actors come from different sectors. This is reassuring, as it indicates that the careful thought given to definitions of sustainable systems is standing the test of time, even if the current level of complexity in system proliferation suggests otherwise.

Even if forests are managed according to the principles defining SFM, the public has been typically and understandably reluctant to accept the sustainability claims of producers - and especially industry - at face value. SFM certification schemes were first developed in Toronto in 1993 to formalise the process of evaluating forests to determine if they were being managed according to an agreed upon set of standards or principles. All schemes that have developed since that time utilise some process of developing standards of sustainability based upon input from relevant stakeholders. The evaluation process involves third party audit of both a company's management documentation and the condition of their managed forests according to the standards of the certification scheme e.g. Programme for the Endorsement of Forest Certification (PEFC) or Forest Stewardship Council (FSC). These basic processes for developing sustainability standards and conducting third party audits have been adapted by sustainability certification schemes for bioenergy systems, whether for feedstocks produced on agricultural lands or plantations or managed natural ecosystems.

It has been clearly established that sustainability certification schemes are not sufficient to achieve sustainable forest or agriculture management without additional governance mechanisms (e.g. local or state regulations, best management practices or international trade standards) with which management must comply. In fact, certification schemes always make direct reference to applicable regulations with which management must comply, and audits must verify whether the company's practices are in compliance, or not. Forest bioenergy supply chains therefore currently must pass several layers of governance which must work together to ensure the sustainability of bioenergy feedstocks sold in the marketplace (Figure 7). It is apparent that our aspirations for sustainable bioenergy production systems and supply and value chains can only be achieved through careful coordination among all the parties to ensure that all necessary governance mechanisms are in place and capable of fulfilling the appropriate standards setting, control, governance and assurance roles required.

Current investigations and international discussions suggest that the mix of governance mechanisms in place for the wood pellet trade, for example, may, according to some parties, not be sufficient to ensure and facilitate sustainable trade. This is rather striking given the fact that SFM systems in North America and the Nordic countries have been under intense development for over two decades. Furthermore, it is apparent that there is a huge amount of confusion around the world as a result of the fragmentation among key players, lack of consistency in standards development and lack of agreement on roles and responsibilities. There is an urgent need for careful coordination among all key parties to move the sector ahead.

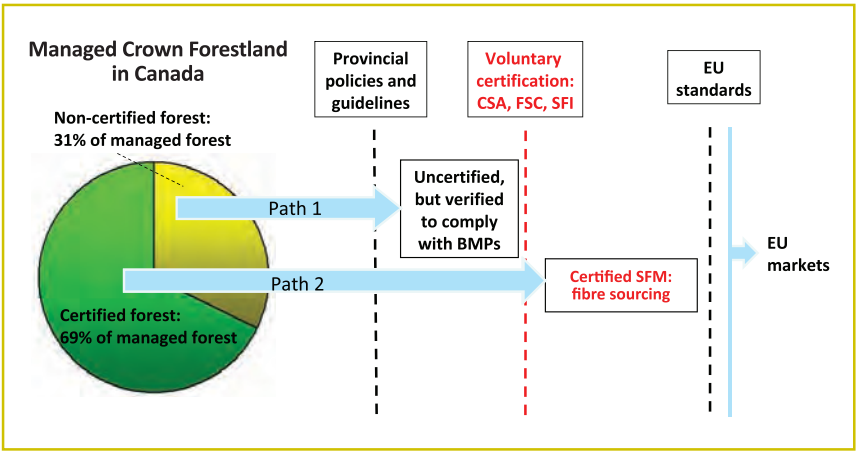

Figure 7: Multiple levels of sustainability claims can be made for Canadian wood pellets that are sold in domestic markets and exported to Europe. At this point, it is uncertain if the governance mechanisms and certification schemes that ensure the sustainability of the Canadian forest sector and thus exports will satisfy anticipated new EU-RED standards for solid bioenergy feedstocks. Source: Jessica Murray, University of Toronto; adapted from Kittler, B., W. Price, W. McDow and B. Larson. 2012. Pathways to Sustainability. Environmental Defence Fund. 54 pp. Available on line at edf.org/bioenergy.

It is also clear that sustainability certification and other tools for governance of bioenergy development need to aim for global coverage and coordination as a longer term goal. Markets requiring sustainability certification may simply not be attractive for producers if production for other markets with less stringent requirements offers an easy way to avoid red tape and certification costs. Such leakage effects - impacting the effectiveness of recurrent revision of certification systems, standards and other governance mechanisms as a strategy for moving the sector further towards sustainability - may also arise because bioenergy feedstock production is an integrated part of forest and agriculture operations. Producers can decide to target the food sector or to produce feedstock for the production of various bioproducts. Thus, the ultimate goal should be that biomass production complies with the same sustainability requirements regardless of whether the produced biomass is used as bioenergy feedstock or for other purposes.

Mobilising Sustainable Bioenergy Supply Systems

Previous sections have described how sustainable forest and agricultural bioenergy feedstock production systems can significantly reduce our dependence on fossil fuels and reduce greenhouse gas emissions while also sustainably increasing the environmental and social and economic services accrued by society. Yet it is clear that serious challenges to achieving this noble and essential goal remain to be solved. Our collective sense of priorities suggests the need to build teams that will focus intensively on those factors that hinder our current ability to realise the potential that we know is realistically possible – and thus mobilise sustainable bioenergy supply chains.

As summarised in the strategic inter-Task project that was approved at ExCo69, the challenges to resolve in mobilising sustainable bioenergy supply chains include:

1. Developing competitive feedstock supply and value chains, based on identification of appropriate feedstock and conversion technologies, including co-produced bio-based products and their substitution of alternative products.
2. Quantifying the positive and negative environmental and socio-economic consequences of different bioenergy supply chains, including benefits of co-products.
3. Assessing the effects of adoption of sustainability risk mitigation techniques on feedstock availability and cost.
4. Developing governance of sustainable supply chains that provides sound operating conditions for participants along the supply chains while addressing concerns about various risks associated with bioenergy. As feedstock production is dependent on geographical factors, another layer of complexity is added as site specific issues need to be reconciled within the context of global supply chains.

The concerns outlined above indicate a need for a comprehensive understanding of the many elements involved in bioenergy mobilisation, in order to create a truly sustainable, economic business case for bioenergy within the bio-economy framework. The Tasks in IEA Bioenergy have over recent years cooperated in diverse and inter-disciplinary teams to deal with increasingly complex issues. This trend is gaining momentum as the current triennium draws to a close and planning for the next three years of work is finalised. It is pleasing to see how the formation of projects to address complex issues places IEA Bioenergy in a strong position with significant impact on the way others view the opportunities and challenges we face in developing bioenergy systems, with the expectation that these will provide a substantial part of our future energy needs.

International Energy Agency

The International Energy Agency (IEA) is an autonomous organisation which works to ensure reliable, affordable and clean energy for its 28 Member Countries and beyond. Founded in response to the 1973-74 oil crisis, the IEA's initial role was to help countries co-ordinate a collective response to major disruptions in oil supply through the release of emergency oil stocks to the markets. While this continues to be a key aspect of its work, the IEA has evolved and expanded. It is at the heart of global dialogue on energy, providing authoritative and unbiased research, statistics, analysis and recommendations. Today, the IEA's four main areas of focus are:

- 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; and
- 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 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 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 2012 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 2012, 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 35 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 2012:

- 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
  Project 4: Biomethane in Heavy Duty Engines
- 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 2012 is shown in Appendix 1.

A progress report for IEA Bioenergy for 2012 is given in Sections 1 and 2 of this Annual Report.

ExCo70 group in Vienna, Austria.

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 69th ExCo meeting took place in Istanbul, Turkey on 8-10 May. There were 40 participants. The 70th ExCo meeting was held in Vienna, Austria on 12 November, back to back with an End of Triennium Conference, hosted by the Austrian Federal Ministry of Transport, Innovation and Technology. There were 44 participants. Adam Brown represented IEA Headquarters at ExCo69.

At ExCo70 Birger Kerckow of Germany was re-elected Chairman and Paul Grabowski of the USA was re-elected Vice Chairman for 2013.

Change in Secretariat

The ExCo Secretariat has been 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 and a formal application process was initiated. At ExCo69 Mr Pearse Buckley, Ireland, was appointed the new Secretary and Fund Administrator. He has a BE (Hons) in Mechanical Engineering and post-graduate qualifications in environmental science and technology with more than 20 years of experience in the bioenergy industry. His most recent position has been Programme Manager, Bioenergy and CHP at Sustainable Energy Ireland (SEI). At SEI his role included policy advice to the Irish government, designing and implementing

national support programmes for commercial development and applied R&D, and representing Ireland in a number of international fora, including IEA Bioenergy. He has been the ExCo Member for Ireland since 2002 and will take up his appointment on 1 January 2013. From this date the Secretariat will be based in Dublin, Ireland.

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 2012, 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.

Contracting Parties/New Participants

In December 2010 the UK sent IEA Headquarters a formal notice of withdrawal from the Implementing Agreement effective from 1 January 2012. 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 Task participation in 2012 would continue with participation in some Tasks being dependent on support from the relevant industry stakeholders. At ExCo70 it was announced that at the present time it was not possible to confirm UK participation in the Implementing Agreement for the new triennium until decisions on budgets were confirmed early in 2013.

At ExCo69, Canada tabled a letter dated 4 May 2012, that had been sent to the Executive Director of the International Energy Agency by Mr Bill Reynen, Executive Science Advisor, Office of Energy Research and Development, Natural Resources Canada. The letter provided formal notice that Canada would withdraw from seven Tasks (Annexes) but was silent on an effective date. Pursuant to Article 10(f) of the Implementing Agreement text Canada must give 12 months' notice before withdrawal from an Annex becomes effective. The ExCo unanimously agreed not to vary this requirement. Accordingly payments for 2012 from Canada are expected for the Tasks it participated in.

Interest from potential Member Countries has continued with Observers from Russia and Greece present at ExCo70. Russia was represented by Dr Boris Reutov and Professor Raif

Vasilov. Vasilov made a presentation on 'Bioenergy in Russia'. He indicated that bioenergy is a national priority in Russia and that RD&D on this topic would be managed through the Russian Bioenergy Technology Platform which was established in November 2011. The Platform will be coordinated by the National Research Centre 'Kurchatov Institute' and includes five Ministries and Agencies among its members. The main responsibilities of the Platform are to develop a strategic research agenda, coordinate R&D within the agenda and strengthen international cooperation. Targets have been set at 10% bioenergy in heat and electricity generation and 10% biofuels in total motor fuel use by 2020. Vasilov provided details of the significant biomass resources available in Russia from forests, agricultural residues, waste streams and the potential of energy crops on under-utilised land. He concluded by indicating that Russia had an interest in Tasks 36, 37, 40, 42 and 43. On the basis of the presentation the ExCo approved that Russia should be invited to join the Implementing Agreement.

Greece was represented by Professor Antonis Kokossis from the National Technical University of Athens, School of Chemical Engineering. They have a special interest in Tasks 36 and 42. It is hoped that Professor Kokossis will attend ExCo71 and make a presentation along the same lines as that by Russia.

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 to the Executive Committee twice per year at the ExCo meetings. The ExCo has continued its policy to invite 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 2012 approved by the Executive Committee for the ExCo Secretariat Fund and for the Tasks are shown in Appendix 2. Total funds invoiced in 2012 were US$2,115,540; comprising US$283,800 of ExCo funds and US$1,847,740 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 continued to function smoothly. As previously, in 2012 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.

As a result of the Secretariat changes outlined on page 23, new banking arrangements apply from 1 January 2013. Details for making payments are now:

Arrange an International Telegraphic Transfer/Swift Money Transfer to:
Beneficiary Bank: Bank of Ireland Global Markets
Beneficiary Bank Address: 2 Burlington Plaza, Burlington Road, Dublin 4, Ireland
IBAN Number: IE26BOFI90139471664020
Swift/BIC Address: BOFIIE2D
Beneficiary: ODB Technologies Ltd for and on behalf of IEA Bioenergy Trust Account
Beneficiary Account Number: 71664020
Quoting: Invoice No. xxx

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 2012, there were US$163,920 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 2011 were approved at ExCo69. The Tasks also produce audited accounts. These are prepared according to guidelines specified by the ExCo. The accounts for the Tasks for 2012 were approved at ExCo69, except for Task 37 which were approved at ExCo70.

The audited accounts for the ExCo Secretariat Fund for the period ended 31 December 2012 have been prepared and these will be presented for approval at ExCo71.

Task Administration and Development

Task Participation

In 2012 there were 123 participations in 11 Tasks. Please see Appendix 1 on page 85 for a summary of Task participation. In addition there were two joint projects with the Advanced Motor Fuels Implementing Agreement carried out under Task 41 (see page 73).

Task participation in the new triennium is still being finalised. Indications from ExCo 70 are for approximately 110 participations in 10 Tasks. For 2013-2015 Task 29: Socio-economic Drivers in Implementing Bioenergy Projects will merge with Task 43: Biomass Feedstocks for Energy Markets.

Strategic Planning and Strategic Initiatives

Strategic Plan

The fourth Strategic Plan for the period 2010-2016 was produced in November 2009. It underpins a stronger emphasis on market deployment of technologies for sustainable energy production from biomass. A draft set of performance indicators for the Strategic Plan has now been approved by the ExCo. This is the first time that progress with the objectives will be formally measured. The goal is to strengthen the transparency of the work undertaken by IEA Bioenergy.

Technical Coordinator

Dr Arthur Wellinger, has continued to make a most valuable contribution to the Agreement. During 2012 a strong focus was on facilitating and planning increased collaboration between the Tasks in the new triennium. Another major effort was leading the organising team for the IEA Bioenergy Conference 2012. Other activities included maintaining links with IEA Headquarters, transferring information to the GBEP, and organising and publishing (in conjunction with the Secretary) the ExCo workshops.

Communication Strategy

The Executive Committee revisited the 'communication strategy' paper prepared by the former Technical Coordinator, Adam Brown. The paper includes the following elements: identification of target groups; a review of existing communications; a communication strategy; and suggested actions. There was agreement that while IEA Bioenergy produced quality outputs they needed effective dissemination, so the strategy must focus on both products and channels – the latter needed more emphasis. The significance of ExCo Members as conduits for information back to national stakeholders was highlighted – with the Netherlands having a good model for others to follow. The importance of using major international organisations as 'vehicles for dissemination' was also noted. The Technical Coordinator was charged with revitalising the communication strategy and in doing this to involve the whole 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.

There has been very good progress with strategic initiatives. The summary and conclusions from the ExCo67 workshop 'Future Biomass-based Transport Fuels' has been formally published. The joint initiative with Advanced Motor Fuels and Hybrid and Electric Vehicles on 'Fuel and Technology Alternatives for Buses' is complete and the final report 'Fuel and Technology Alternatives for Buses: Overall Energy Efficiency and Emission Performance' is now available.

Health and Safety Aspects of Solid Biomass Storage, Transportation and Feeding: The objective of this project was to summarise the existing know-how and available research on the issue of safe storage and transportation of different types of solid biomass and waste. It examined the issues and highlighted current guidelines and requirements. Task 32 led the project with input from Tasks 36, 37 and 40 plus some individuals from Task 39 and 43. The final report will be published electronically in early 2013.

Monitoring Sustainability Certification of Bioenergy: This project addresses the issues associated with the global proliferation of certification systems. It 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. The project will identify major opportunities and problems with verification and certification of sustainability. The main findings will be presented at a workshop in association with the World Biofuel Markets Congress in Rotterdam in March 2013.

Mobilising Sustainable Bioenergy Supply Chains: A new project 'Mobilising Sustainable Bioenergy Supply Chains' has been approved – partially funded from the Strategic Fund at US$139,000. The project will address the following issues:

- Development of competitive feedstock supply and value chains, based on identification of appropriate feedstock and conversion technologies, including co-produced bio-based products and their substitution of alternative products.
- Quantification of positive and negative environmental and socio-economic consequences of different bioenergy supply chains, including benefits of co-products.
- Assessment of the effects of sustainability risk mitigation techniques on feedstock availability and cost.
- Development of governance of sustainable supply chains that provides sound operating conditions for actors along the supply chains while addressing concerns about various risks associated with bioenergy. As feedstock production is geography dependent, another layer of complexity is added as site-specific issues need to be reconciled within the context of global supply chains.

It will involve experts from Tasks 29, 38, 39, 40, 42 and 43. Task 43 will lead the project which aims to report in 2015.

Timing Issues of GHG Emissions: A report on this important, complex and topical subject is being prepared by Task 38. The aim is to have a clear statement of IEA Bioenergy's position. The present status of the report is an internal ExCo position paper. It is in the process of being finalised and approved.

Quebec Workshop on 'Sustainability': A strategic workshop on the environmental sustainability of forest bioenergy took place on 3-5 October in Quebec City, Canada. It was co-organised by Tasks 43 and 40, along with Laval University and Natural Resources Canada; and in association with the ExCo and GBEP. The workshop involved key European, Canadian and American experts involved with research and policy development in the bioenergy sector. They discussed the sustainability of forest bioenergy through field visits, scientific presentations and moderated discussions. Topics included

- information about the state-of-the-art in forest biomass practices at international and state levels and in Canadian provinces;
- 'on-the-ground' examples of key features of Canadian forests and on-going research projects on the sustainability of forest biomass harvesting;
- a better understanding how science can inform policy-making and support development of governance mechanisms; and
- knowledge of how levels of governance from the local to the global level can interact to ensure both sustainability of forest management and the vitality of domestic and international biomass markets.

Participants obtained a first-hand view of Canadian forest management. Most were impressed with what they saw. This event definitely helped European regulators to understand the Canadian situation better than they could through correspondence or holding meetings in Europe. The result is likely to be that when the EU mandatory sustainability criteria for solid biomass are finally released, they will reflect the Canadian situation and be written in such a way that Canadians will be able to comply under existing practices. In particular, the regulators recognised that a blanket prohibition on biomass from primary forests as defined by FAO would be very serious for Canada and that a better approach has to be found.

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. At ExCo69 the workshop was an internal meeting with the theme 'Planning for the new triennium'. The Task leaders presented detailed prolongation proposals for the period 2013-2015. The possibility to merge some Tasks was also discussed. As a result Task 29 will merge with Task 43 in the new triennium.

There was no workshop at ExCo70 as this event was substituted by the IEA Bioenergy Conference 2012.

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. Examples of this outreach are:

- Task 32 held an expert workshop on 'biomass co-firing' in Copenhagen, Denmark in cooperation with the VGB industry group and the IEA Clean Coal Centre. The two day workshop attracted over 100 people from predominantly the power sector and was effective in exchanging practical information amongst plant operators.
- In April Task 37 held a meeting in Moss, Norway which included a technical seminar at the UMB University Campus in Ås. A mix of Task 37 participants and local experts addressed 'biogas in the loop of recycling'. The main focus was on how biogas is being integrated into waste management process chains and the benefits that biogas technologies offer.
- Task 39 held a meeting in partnership with Task 42 in Copenhagen, in conjunction with the Bio4Bio Conference 'Advanced Biofuels in a Biorefinery Approach'. Emphasis was placed on discussing Task 39's plans for the next triennium. Priorities were outreach to emerging economies (China, India, etc.) and collaboration with other Tasks in order to leverage the collective cross-cutting expertise.
- Task 40 provided presentations to the annual Canbio Conference in Vancouver to showcase growth in bioenergy in Canada, Asian markets, and partnership opportunities with Australia, New Zealand, China, Korea, Singapore, and others. This event provided an opportunity to network with key industry, non-profit, and public sector stakeholders from North America, Europe and Asia. Conference presentations and panel discussions covered various topics with global bioenergy trade one of the main themes.
- Task 43 organised four international workshops in 2012 as follows:
  - 'Mobilising Sustainable Supply Chains for Forest Biomass for Energy', Charleston, USA;
  - 6th World Water Forum seminar on 'Biofuels and Water', Marseille, France;
  - 'Water for Bioenergy: Quantitative assessments to support improved governance', World Water Week, Stockholm, Sweden; and
  - 'Economic Sustainability of Forest Fuel Supply Chains', Lisbon, Portugal.

Collaboration with International Organisations and Implementing Agreements

Advanced Motor Fuels Implementing Agreement

There have been some excellent joint projects with the Advanced Motor Fuels (AMF) Implementing Agreement. Recent examples include:

- Task 41, Project 3 'Fuel and Technology Alternatives for Buses'. This project aimed to assess the overall efficiency, emissions, and costs for several fuel and drivetrain technology options for buses. A final report is now available. See Appendix 4.
- Task 41, Project 4 'Biomethane in Heavy Duty Engines. This project will present emission and engine performance from state-of-the-art methane-fuelled heavy duty engines, either dedicated gas engines or diesel engines fuelled with a combination of methane (in various forms) and diesel. Two Contracting Parties from IEA Bioenergy (the European Commission and Norway) are participating.

There are many benefits from the two IAs working together, including: shared costs and pooled technical resources; avoidance of duplication; facilitation of technical consensus; and increased credibility with CERT and the IEA Secretariat. Opportunities for further collaboration include: Life Cycle Analysis of Transportation Fuel Pathways; Advanced Marine Fuels and Propulsion Technologies; and Performance Evaluation of Passenger Car Fuel and Power Plant Options. There is general agreement that IEA Bioenergy should capitalise on these opportunities in the new triennium.

GBEP

The ExCo has continued to develop closer ties with the Global Bioenergy Partnership (GBEP) through the Secretariat Manager Michela Morese. IEA Bioenergy is contributing to the work of the GBEP Taskforces (e.g. GHG Methodologies; and Sustainability) through information exchange from the relevant Tasks. The ExCo is very supportive that the Tasks contribute to GBEP. The Technical Coordinator is facilitating this collaboration.

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. Since the departure of the original prime contact, Miguel Trossero, the Secretariat has been striving to establish a new key contact at the ExCo level. An effective working relationship with FAO depends on this. Now progress is being made through Olivier Dubois, Senior Natural Resources Officer, and Florian Steierer from the Forestry Department. The latter attended ExCo70 as an Observer.

World Bioenergy Association

Effective contact has been made with the World Bioenergy Association (WBA) through a meeting with the President Heinz Kopetz. This was held in Vienna in conjunction with ExCo70. Formed in May 2008 WBA is a global organisation dedicated to supporting and representing the wide range of actors in the bioenergy sector. Its members include national and regional bioenergy organisations, institutions, companies and individuals. Its purpose is to promote the increasing utilisation of bioenergy globally in an efficient, sustainable, economic and environmentally friendly way.

World Bank

From time to time there have been enquires from World Bank personnel wishing to join IEA Bioenergy and the Executive Committee would welcome this. Feedback from IEA Headquarters indicates that the World Bank, as an international, inter-governmental organisation, must join as a Contracting Party (Article 3.2 of the IEA Framework). Therefore the correct mechanism is for the ExCo to invite the World Bank to join as a Contracting Party. 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 2011 Annual Report with the special colour section on 'Current Status of Production and Thermal Utilisation of Biomass Pellets', was very well received. Only a few copies 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 2012. The first issue featured bioenergy in Turkey and the second issue featured bioenergy in Austria as special themes. A free subscription is offered to all interested parties 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.

Three contributions under the banner of 'IEA Bioenergy Update' were provided to the journal Biomass and Bioenergy in 2013 bringing the total to 53. 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, Birger

Kerckow attended the REWP 61 meeting in Paris and presented the IEA Bioenergy mid-term report which was very well received. In conjunction with this meeting Kerckow also attended the workshop 'Renewables: Policy and Market Design Challenges. The workshop focussed on the question 'How do policies and markets need to evolve to provide the conditions in which investment in renewables and other low-carbon technologies can flourish?' The participants were an invited group of decision makers which included industry members of the newly formed Renewable Industry Advisory Board (RIAB), along with senior government policy makers and representatives from international organisations and academia. The focus was more on electricity, PV and wind than bioenergy.

Josef Spitzer attended the Workshop 'Developing Metrics and Assessing Progress Towards a Clean Energy Economy' set up by the IEA Experts Group on R&D Priority Setting and Evaluation to support the CERT and the Secretariat. The objective was to explore metrics for measuring and monitoring progress toward a clean energy economy as proposed in the BLUE Map Scenario; and to apply these metrics to assess progress in selected technology areas (e.g. Solar PV, Wind, Bioenergy, etc.).

Josef Spitzer also attended the Sustainable Biomass for Electricity Conference in Güssing, Austria. There was strong international representation with an orientation towards developing countries. A draft 'Sustainable Biomass for Electricity Charter' was distributed in advance and discussed within IEA Bioenergy (Chair, Vice-Chair, TC) and a written response was submitted by the Chair to the organiser of the Conference. During the conference the proposed Charter was discussed with the decision that a revised version should be produced.

Pearse Buckley attended the joint IRENA/IEA-RETD workshop 'Levelised Costs of Renewable Energy: What if Costs Continue to Drop?' in Bonn. It engaged over 60 participants from industry, government and research institutions. Participants agreed that costs will continue falling, and that policy makers, utilities and manufacturers need to continue working together to encourage this energy transition. Governments can facilitate it by putting a strong policy framework in place and encouraging industry and utilities to make the investments needed for a sustainable energy system. This is especially necessary given the rise of initial investment costs to reap lower system costs in the future. The main conclusions were:

- Cost reductions and performance improvements mean renewables are increasingly competitive;
- Many misperceptions on the real costs of renewable energy still exist; and
- Support policies for renewables must be shifted to the system level.

Adam Brown attended ExCo69. 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 ExCo69 and ExCo70. 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 newsletters 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 3,000 'bona fide' visitors to the website each month. The most popular areas of the website are the Library and the Media Centre. In 2012 there were around 27,000 downloads. The most popular items downloaded were:

- ExCo67 Workshop 'Future Biomass-based Transport Fuels - summary and conclusions'
- 2011 Annual report
- IEA Bioenergy News
- Main report: 'Bioenergy – a sustainable and reliable energy source'
- Bioenergy LUC and Climate Change Mitigation
- Joint Task 39-AMF Algal Biofuels Summary Report

IEA Bioenergy Conference 2012

The IEA Bioenergy Conference 2012 'Linking Policy, Science and Industry' took place in Vienna from 13-15 November, back-to-back with ExCo70. Hosted by the Austrian Federal Ministry of Transport, Innovation and Technology it attracted 240 participants from 31 countries to the historic Schoenbrunn Conference Centre. It was the second triennial conference of IEA Bioenergy following Vancouver in 2009. Three years of Task work were presented along with state-of-the-art contributions from internationally known scientists in the field of bioenergy. A total of 60 scientific and industrial speakers from 16 countries presented their achievements in research, development and industrial-scale applications. In the opening plenary session, keynote addresses by the Austrian Ministry for Transport, Innovation and Technology, the Austrian Climate and Energy Fund, the International Energy Agency's Renewable Energy Division and IEA Bioenergy emphasised the links between policy, science and industry.

Four study tours to selected sites around Vienna highlighted R&D facilities and commercial bioenergy plants thus providing an excellent overview of bioenergy developments in Austria. Very positive feedback from the participants indicated that the conference was a great success. This was a tribute to the Programme Coordinator Arthur Wellinger, the Conference Organizer Michael Fuchs, and their organising team.

Colleague Recognised

Professor Hermann Hofbauer from Austria was awarded the Johannes Linneborn Prize for his outstanding contribution and leadership for over 30 years in developing important technologies for energy carrier production and sustainable energy generation from biomass by thermochemical methods. He is known especially for his work on producing syngas from biomass by dual zone circulating fluid bed gasification which attracted worldwide attention and admiration.

Hermann is active in many international networks and advisory committees, chairman of scientific boards, and in various IEA groups including Task 33. He is also a key researcher at the competence centre 'Bioenergy 2020' Gasification. In addition, he has focused on educating young people through leading positions at the University of Technology in Vienna.

The European Linneborn Prize was established in 1994 for outstanding contributions to the development of energy from biomass. All those within IEA Bioenergy congratulate Hermann on his well-earned award.

2. PROGRESS IN 2012 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 (DECC), 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

During 2012, the Task organised an International Event alongside the Task meeting and also participated in the IEA Bioenergy Conference 2012, held in Vienna. Presentations were given by Canada, Croatia, Germany, and the UK. These contrasted and compared the actions from different countries on issues such as fuel poverty, policy consistency, the role of bioenergy networks, rural development through a socio-economic perspective and focused in particular on the role of bioenergy in mitigating the worst impacts.

A Task workshop 'Bioenergy - Valorising Potentials for Regional Benefits' was held on 29 November in Berlin, alongside the International Bioenergy Congress 'Regions - First Funding Phase 2009-2012'. Birger Kerckow, Chairman of IEA Bioenergy, welcomed the attendees. The workshop was aimed at exchanging and collecting experiences and results in the field of socio-economic drivers in implementing bioenergy projects at the local and regional level. Special emphasis was placed on the question of what is needed to bridge the gap between research, the public and investors. Based on these discussions, it is planned to identify factors of success and future needs, as well as possibilities for cooperation. Presentations were given by members of the Task team as well as local partners of SPRINT Consult. Short interviews with the speakers were carried out to highlight the main aspects of their presentations including asking the audience which focus they would like to set. The presentations contrasted and compared the actions from different countries on the potential for regional benefits. The conference and workshop were followed by a meeting organised by the NTLs together with FNR. The programme featured a day of visits to various sites across the Altmark region to show a number of working examples of biomass boilers and other forms of renewable energy, including the largest biomass power plant in Germany.

Conference proceedings are being prepared by SPRINT Consult. Presentations are available on *www.fnr.de/bioenergieregionen_2012* and the Task website.

Work Programme

2012 was dedicated to expert work on planned activities from the Work Programme. The main activity was the preparation of the final Task publication 'IEA Bioenergy Task 29 – 12 years of People First Project!' It recreates developments from the early days of Task start-up through the 12 year evolution of project activities. It describes in detail the results obtained. Each triennium in a separate chapter, revealing the focus of work activities at that time, viz. modelling of socio-economic aspects, education possibilities, and solutions for biomass supply systems which emphasised the importance of regional benefits and also addressed fuel poverty issues. The deliverables included studies published in a special issue of Energy Policy (Volume 35, Issue 12) 'Modelling Socio-Economic Aspects of Bioenergy

Use', a series of case studies developed over the years, as well as the educational website *www.aboutbioenergy.info* as a definitive source of information for the general public.

The Task also prepared detailed plans for event-based meetings (conferences/workshops) for 2012, with Germany hosting a workshop and conference in November. This was the last event of Task 29's activities.

An outcome of ExCo69 was a successful dialogue between Task 29 and Task 43 concerning merging their programme activities for the next triennium. Task 29 perspectives have been introduced as a distinct activity in the Task 43 proposal and further integration will take place. The objective of the new Task 43 is to promote sound bioenergy development that is driven by well-informed decisions in business, government and elsewhere. The programme of activities builds upon the work done in the current triennium where both Task 29 and 43 have established several activities that address key questions in the area of biomass feedstock production and are of high relevance for both forestry and agriculture, as well as for society at large given the expected contribution of bioenergy to important environmental and socio-economic objectives. In the new triennium, the Task will maintain a focus on such key questions and will seek new opportunities for cooperating with other Tasks as well as major organisations outside of the IEA Bioenergy. Julije Domac (North-West Croatia Regional Energy Agency, Croatia) will remain Associate Task Leader together with Tat Smith (University of Toronto, Canada) while Göran Berndes (Chalmers University of Technology, Sweden) will continue as Task Leader.

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

Task Leaders have been approached by Task 43 which has bioenergy-water links as one of the themes during this triennium. Task 43 is proposing work on mobilising sustainable bioenergy supply chains. Joint actions and collaboration is planned during 2013-2015 including involvement with Tasks 38, 39, 40 and 42 to build a team of experts with extensive interdisciplinary knowledge and ability to tackle the complex issues.

Deliverables

Deliverables in 2012 included workshop presentations at the international conference organised by the Task, meeting minutes, proceedings of the Berlin Conference, a final Task 29 publication, the 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 woodstoves 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 levels. 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
Sub-Task Leader for Small-scale Combustion: Ing. Eric Smit, Interfocos, 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 2012, the Task organised two internal meetings and three workshops. The 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.

In March, an expert workshop on biomass co-firing was organised in Copenhagen, Denmark in cooperation with the VGB industry group and the IEA Clean Coal Centre. The two day workshop included a site visit to the Avedore power station, It attracted over 100 people from predominantly the power sector and was effective in exchanging practical information amongst plant operators.

The first Task meeting was held in June, in conjunction with the European Biomass Conference and Exhibition (EBCE). The meeting focussed on progress in the various Task activities in this triennium, elaboration of the work programme for the new triennium and reports of progress in individual Member Countries. An expert workshop was organised as part of the EBCE on biomass torrefaction, covering the status of various torrefaction initiatives as well as ongoing R&D to address key challenges such as densification of torrefied material and hydrophobicity. This event was organised in collaboration with the European FP7 project SECTOR.

The second Task meeting took place in November in conjunction with the IEA Bioenergy Conference. The formal meeting was again used to discuss progress in the various ongoing Task projects, and to adapt the work programme for the next triennium according to changing country membership and interest. In conjunction with this Task meeting, a workshop was organised as part of the IEA Bioenergy Conference on small

scale combustion technologies. The workshop highlighted current technology and policy developments in small-scale biomass combustion, and ways to effectively mitigate adverse health related impacts of combustion aerosols.

The reports from the workshops can be downloaded from the Task 32 website. Reports from internal Task meetings are only available to participating countries using login credentials.

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.

- An expert workshop was held in January 2011 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 2011 on small-scale combustion.
- A co-funded study to evaluate and report on the cost effectiveness of new particle removal technologies was finalised and published in January 2012.
- A workshop on small-scale combustion was held in November in Vienna at the IEA Bioenergy Conference.

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

A workshop was organised in 2010 on this topic, covering the resource base of alternative fuels for small-scale and industrial combustion, and the consequences of using challenging fuels for furnace design, boiler material selection, boiler operation, and emissions.

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. In 2011 another 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 Task-initiated study was finalised in December 2012 to evaluate the technical characteristics of torrefied pellets, the different torrefaction technologies currently available, 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.

In a number of recent instances, biomass storages have unexpectedly caught fire. The mechanisms behind 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. This work will culminate in 2013 with a review report.

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 was organised in March 2012 in Copenhagen, on high percentage co-firing in coal-fired power plants. At this well-attended workshop, 'hands on' experiences were shared 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. The workshop was 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 coordinated the preparation of a paper on ash utilisation options from biomass combustion and co-firing systems. The report shows 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. The paper was published early in 2012, and will facilitate 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. The database is now interactive to allow easy updating by various external editors who, after endorsement from the database moderator, can enter data themselves. The database is viewed by several thousand people every month.

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 actual combustion plants. The website is updated on a regular basis. In 2012, two electronic newsletters were 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 as 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 active 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 2012 a joint workshop was held with IEA CCC on biomass co-firing. The production of the Pellet Handbook was done with Tasks 29, 31 and 40; the Health and Safety report was compiled with experts from Tasks 36, 37, and 40.

Deliverables

The following milestones were achieved in 2012. Organising and minuting of two Task meetings. Organising and reporting of three workshops on 'Biomass Co-firing', 'Development of Torrefaction Technologies' and 'Developments in Small-scale Biomass Combustion'; Publication of reports on 'Improved Utilisation of Ash from Biomass Combustion', 'Status Overview of Torrefaction Technologies', 'Review of Health and Safety Aspects of Solid Biofuels' (published January 2013), a special feature article on biomass pellets in the IEA Bioenergy 2011 Annual Report, 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 Task 33 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 program. 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 first Task meeting was held on 17-19 April in Istanbul, Turkey and included a workshop 'Bed Materials in Fluid Bed Gasifiers' and a visit to the Tubitak gasification facilities in Gebze and a MSW gasification plant near Istanbul.

The second Task meeting was held on 12-16 November in Vienna, Austria. The meeting included visits to gasification plants at Oberwart and Güssing; and the Task business meeting. No workshop was planned for the meeting as Task participants attended the IEA Bioenergy Conference 2012 Conference instead.

Work Scope, Approach and Industrial Involvement

The scope of work for the current triennium is built upon the progress made in the previous triennia. In the previous years, 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 the 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 identify the options 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 support 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
5th Task meeting	WS5 'Bed Materials in Fluid Bed Gasifiers'	17-19 April 2012 Istanbul, Turkey
6th Task meeting	WS6 'IEA Bioenergy 2012 Conference'	11-16 November 2012 Vienna, Austria

- 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 WS5: Bed material in fluid bed gasifiers

The workshop was organised in cooperation of EERA (European Energy Research Alliance). EERA is an initiative by 10 (+5) leading European R&D institutes. The aim was to accelerate development of new energy technologies, expand and optimise research capabilities and harmonise national and EC programmes. During the workshop very informative contributions to this topic were presented. Furthermore, the EERA (European Energy Research Alliance) was introduced.

The synthesis gas from thermal biomass gasification process is an outstanding energy carrier. It can be used as a stand-alone fuel (heat and power applications) or it can be further treated and transformed into another energy source. Nowadays, product gas is used not just for heat and power generation as in the past, but also for transportation fuels production. That is why much more R&D work is performed and planned in this area. The quality of the product gas from biomass gasification process plays an important role by the synthesis gas applications and it is influenced by many factors. One factor is the type and quality of bed material. The most common bed materials used in commercial thermal biomass gasification facilities are silica sand, olivine and dolomite. Their influence on the quality of the product gas (especially tar content) was discussed during the workshop and confirmed by various projects and scientific studies. The most used bed materials are dolomite, calcite and olivine, because their catalytic activity is much higher than silica sand. The most important factor – why to use the bed material with a catalytic activity – is the tar reduction. Tars are higher hydrocarbons, which are formed during the thermal gasification and can cause serious technical problems during the process such as fouling and plugging.

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

Website

The Task website *(www.ieatask33.org)* is the most important tool for dissemination of results. It includes descriptions of the gasification process; a description of the Task; and contact information for the National Team Leaders. After each Task meeting, all presentations can be found on the Task website (minutes, Country Reports, workshop presentations, etc.). Summaries of the workshops are also available in report form.

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 leaders, Ensyn and BTG, and an important biomass processing industry support group FPInnovations of Canada.

Participating countries: Canada, Finland, Germany, the Netherlands, United Kingdom, and USA.
Task Leader: Mr Douglas Elliott, 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 17-19 April in Ottawa, Canada. All National Team Leaders were present for the meeting. The agenda items included Country Reports and formulation of a plan to publish this information; norms and standards developments (including publication); an improved Material Safety Data Sheet for bio-oil; and the status of the round robin on bio-oil viscosity and thermal stability. Final discussions were held on the first phase of the round robin recently completed for validation of bio-oil viscosity measurement and stability testing. Progress in the second (long-term) stage of the round robin was also reviewed. The report on the first phase of the round robin is in press (Energy & Fuels journal). Progress on the manuscript for the state-of-the-art of pyrolysis technology was discussed and input had been received from all participating countries, including the Netherlands. The toxicological and eco-toxicological data product in the EU BioTox project was reviewed and descriptive material drafted to include in a journal publication on Guidelines for Transportation, Handling, and Use of Fast Pyrolysis Bio-oil. Part 1—Flammability and Toxicity. The manuscript has been submitted to the journal Energy & Fuels. Within the 'Standards' Topic Area, the draft mandate that had been issued to the CEN was discussed. Several grades of bio-oil product were specified, including light and heavy burner fuel oil, internal combustion engine fuel and feedstock to gasification and petroleum refining. The Task focused on the European standards in the near term with the expectation to return to ASTM after the European work is complete, at least in part. Technical support has been offered to the SIEF organised around biomass pyrolysis bio-oil for the REACH registration effort. The meeting also included a tour of CanMet pyrolysis laboratories and an interactive seminar with Canadian industrialists with an interest in biomass pyrolysis.

The second meeting was held on 15-16 November in Vienna, Austria. 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 Netherlands. The SOTA draft paper submitted for publication was reviewed. The results of the bio-oil viscosity and aging round robin from the three participating laboratories and their publication 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, has been approved. 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. The Task has agreed to support this effort by providing input as requested, e.g. the chemical safety report. Furthermore, 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. The results of the BioTox study were released to the REACH participants. The meeting concluded with a discussion of the working assignments for the upcoming triennium.

Work Programme and Progress in 2012

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 and approved 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 ecotoxicology assessments.
- A round robin on bio-oil analysis was organised. It included two bio-oil samples distributed to 15 laboratories in the five participating countries. The analyses in the initial phase in 2011 focused on viscosity and thermal stability (change in viscosity, accelerated aging, for 24 hour at 80°C), as well as moisture analysis and insoluble solids determination. Prescribed optional analyses were also undertaken by some of the participants. In a second phase of the round robin extending into 2012, the bio-oils were stored at a range of temperatures and the change in viscosity over a year was measured in three of the laboratories. Two of the laboratories also undertook a 10-day repeatability assessment of the accelerated aging test. Results, from both the initial and second phases, were published in a technical journal.
- 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 has been 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 31 was published in June 2012 and Issue 32 was published in December 2012.

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 completed his assessment of a pyrolysis-based biorefinery, based on lignin feedstocks.

Deliverables

Deliverables for 2012 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 reporting of results from 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. For example, 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 the residual 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 decision 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 decision 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, Ricardo-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'.

Progress in R&D

Task Meetings and Workshops

The Task held two meetings in 2012. The first took place on 29-30 May at ADEME's Institute in Angers, France. This meeting enabled progress on the Topic Areas to be discussed and was held in association with a workshop on the work of ADEME on waste and energy recovery from waste, including the conversion of waste to liquid and gaseous fuels. ADEME is the French Environment and Energy Management Agency. Priority areas for ADEME's

research include energy, waste and environmental management. In association with this meeting the Task also had a site visit to two local waste management plants. These were the energy-from-waste plant at Lasse; and the Biopol plant, including anaerobic digestion, which serves Angers. The energy-from-waste plant treats 100,000 t per year, including residues from the Biopol plant. The Biopol plant is a mechanical and biological treatment plant, serving a population of 280,000 and takes up to 75,000 t per year. The plant includes a Kompogas anaerobic digestion plant designed to treat 20,000-72,000 t per year.

The second meeting took place in association with the IEA Bioenergy Conference. It included a site visit to the Spittelau energy-from-waste plant, which is an integral part of Vienna's district heating system and also includes a new plant providing cooling. This plant is most famous for its innovative exterior appearance, designed by Friedensreich Hundertwasser, which he completed in 1992. In association with the Task meeting a workshop was held on the methodologies for analysis of the biogenic content of waste. This was attended by Professor Rechberger and Johann Fellner of TU Wien, who presented their mass balance model designed to provide a cost effective alternative to routine sampling of the waste input to an energy recovery plant. The Task played an active role in the IEA Bioenergy Conference, providing presentations on global waste management issues, treatment of incineration residues, health and safety issues related to bio-aerosols, methodologies for measuring the biogenic content of waste and energy and environmental assessment of future energy-from-waste options.

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 recovery in solid waste management:

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 has examined key issues that are important to policy at present and which are important to the development of 'green certification' of energy generated from waste:

- A summary of the incentives for electricity and heat from waste in Europe.
- A summary of the methodologies available for measuring the biogenic content of waste. This drew on work undertaken by Ricerca sul Sistema Energetico S.p.A (RSE) and also the work of the European Committee for Standardisation (CEN) committee. It provides results from work RSE have undertaken to compare the reliability of these methodologies.

The Topic Report is now completed and will be published early in 2013.

Topic 2: Integration of Processes for Optimising Resource Recovery

This Topic examined 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 was 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 draft report has been prepared and is due for completion early in 2013. The results of this work show that waste to energy plants based on incineration provide an important contribution to the current energy supply, but that energy recovery in current plants is limited (in terms of both electrical and overall efficiency). Key technologies for a waste refinery concept are anaerobic digestion and gasification. This concept offers advantages in resource recovery, depending on the final use of the products, and heat use possibilities in an alternative energy recovery combustion plant.

Topic 3: Emerging Small-scale Energy Recovery from Waste

This Topic was to be led by Canada. Due to the funding issues, this Topic Report has been delayed and will now be done in the new Triennium.

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

This Topic provides an environmental impact assessment of the options being examined for waste refinery concepts identified in Topic 2. It uses the UK Environment Agency's Water and Resources Assessment Tool for the Environment (WRATE) Life Cycle Assessments to provide a comparative analysis for the waste refinery systems examined in Topic 2. The work has included discussions with Task 37 to ensure that anaerobic digestion systems examined are representative. A draft final report has been prepared and will be published on the website.

Topic 5: Management of Residues from Energy Recovery

This Topic examined the management of residues from energy recovery including bottom ash, fly ash and air pollution control ash. The report provides information on legislation of the management of these residues and tests on their environmental impact, together with an overview of the treatment and use of the residues and metal recovery. All thermal energy recovery systems are included together with all types of waste and solid recovered fuel combustion plants, including pyrolysis. It examines comparisons 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 were reviewed. This report is completed and will be published on the Task website.

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 workshops. 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 2012 the visitor numbers were around 143 per day, with over 52,212 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. Publication of information on workshops and events stimulates most interest.

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 inter-Task 'health and safety' report and to a Task 37 report on 'source separation of organic waste'.

Deliverables

The deliverables for the Task in 2012 have included presentations in the two Task meetings, the presentations at the IEA Bioenergy Conference and the final reports for the triennium. These reports and presentations are 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 a high degree of process efficiency, 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 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 and the production of standards 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'.

Progress in R&D

Task Meetings and Workshops/Seminars

Two Task meetings were held in 2012. The first meeting took place on 18-20 April in Moss, Norway. A technical seminar was also held at the UMB university campus in Ås where a mix of Task 37 and local experts addressed 'biogas in the loop of recycling'. The main focus was how biogas is being integrated into waste management process chains and how the benefits that biogas technologies offer can be maximised. The workshop was held at a time when Norway had ambitious plans to expand biological treatment of all kinds of wastes. Task members visited the laboratory facilities at UMB university campus in Ås.

The second meeting took place on 15 November in Tulln and on 16 November in Vienna, Austria. The Task also organised a session at the IEA Bioenergy Conference. Four of the five speakers in the biogas session were from Task 37 members.

Planning of Future Task Meetings and Workshops
A Task meeting has been planned for 17-19 April 2013 in Switzerland along with a workshop. The September/October meeting has still to be decided.

Work Programme

In 2012 the work programme consisted of the following Topics:
- Drafting of new technical brochures/reports
- Collaboration with other Tasks
- Reports to ExCo69 and ExCo70
- A new 'biogas handbook'
- Website: updating; maintenance; proceedings, Country Reports, etc.
- Planning of future Task meetings and workshops

Some of the Task members participated in the 20th European Biomass Conference in Milan at which biogas was a major focus of attention with special sessions addressing a range of technical topics. There has been close cooperation with the EU project VALORGAS and with the European Biogas Association (EBA).

The progress made on Task Topics is summarised below.

New Technical Brochures/Reports

'Quality management of digestate from biogas plants used as fertiliser', the second in the series of reports on digestate treatment and utilisation was published in May 2012. The following reports are in preparation:
- Feedstock pre-treatment: a final draft is being prepared for publication in March 2013.
- Digestion process optimisation: focussed on process monitoring techniques as a first step to the more complex topic of optimisation of the anaerobic digestion process. A final draft is being prepared for publication in March 2013.
- Economics of small-scale biogas production: a final draft is being prepared for publication in March 2013.
- Emissions from biogas plants: the report was completed and is included as a chapter in the new biogas handbook which will be published in March 2013.
- Of the planned series of five 'Success Stories': three more were published in 2012: Pioneering Biogas farming in Central Finland; Nutrient recovery from digestate and biogas utilisation by up-grading and grid injection in Switzerland; and Economic sustainability of manure based centralised co-digestion in Denmark.

Biogas Handbook

The new 'biogas handbook', a major project, was completed in 2012. The printed version is scheduled for the end of March 2013. Most of the authors of the 18 chapters are participants in Task 37. The book was edited by two members of the Task and the IEA Bioenergy Technical Coordinator (the former Leader of Task 37).

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.

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 ExCo69 and ExCo70, input to planning of the end of triennium conference held in 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. The annual audit report was also produced for the Executive Committee.

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, Rural Climate Solutions, 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.

For further details on Task 38, please refer to Appendices 2-6 inclusive, the Task 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

In 2012, the Task held two business meetings. The first was on 10-11 April in Chicago and the second was on 15 November in Vienna. Both business meetings were held in conjunction with conferences and/or working meetings.

In April the Task held an expert working meeting *'How to present the timing of emissions from bioenergy in LCA and GHG accounting'* at Argonne National Laboratory, Chicago. The meeting was attended by 20 invitee's .The meeting objectives were to:

- discuss issues surrounding the timing of emissions and mitigation benefits from bioenergy,
- discuss alternative methods for treating bioenergy in LCA and GHG accounting for national and project inventories, and
- formulate two papers on the subject to be submitted to a peer-reviewed journal (e.g. GCB Bioenergy)

In November the Task organised a follow-up meeting titled 'Impact of timing of GHG emissions' in Vienna. This meeting brought together researchers with expertise in quantifying the climate change mitigation value of bioenergy and reforestation, and experts on including time in LCA and carbon foot printing, to present and discuss latest research on these topics, and continue work on the scientific papers from Argonne and develop a summary for policymakers.

Work Programme

In 2012 the Task:

- Organised two Task 38 business meetings
- Organised two expert meetings
- Participated at ExCo69 in Istanbul and at ExCo70 in Vienna
- Organised one session on 'GHG balances of bioenergy systems' at the IEA Bioenergy Conference 2012
- Drafted a statement on the 'timing of benefits of bioenergy', submitted at ExCo69.
- Finalised case studies from the current and previous triennia
- Commenced or completed preparation of scientific papers:
  - Accounting for Algae
  - Reconciling area dependent emissions and the timing of emissions in intensityfocussed demand-based accounting frameworks for bioenergy

- Updating the Standard Methodology
- Timing of emissions from bioenergy in LCA and GHG accounting. Metrics; associated uncertainties, and discounting
- Reference systems for evaluating climate effects of bioenergy

• Contributed to the inter-Task project: 'Monitoring Sustainability Certification of Bioenergy'
• Prepared a prolongation proposal and
• Maintained the Task website.

Case Studies

Several case studies were delayed from previous triennia. A goal during 2012 was to bring these case studies to conclusion. The following were completed in 2012

• Environmental assessment of liquid biofuel from woody biomass (Germany).
• Greenhouse gas and oil use impacts of Fischer-Tropsch diesel and DME production integrated with pulp and paper mills (Sweden)
• EU biofuel targets, costs and GHG balance of the Finnish energy sector and forests, (Finland)
• Greenhouse gas and energy analysis of a bioethanol-oriented biorefinery based on wood (Austria)
• Impact on GHG balance of utilising biochar as a soil amendment (Australia)

One case study 'Harvested wood products (HWP) model for estimating the carbon storage potential in Germany' has been withdrawn. Another case study 'Alternatives to use sugarcane residues to reduce GHG emissions (Brazil)' was started in 2012 and will be completed in 2013.

Scientific Papers

Several scientific papers have been prepared or are in preparation, viz.

Accounting for Algae: Algae is used in biofuels, animal feeds, human foods and food supplements, and a range of products such as paints, cosmetics and plastics. There are also proposals for using algae as a soil amendment. This variety of uses for algal material, together with the fact that it will probably contain carbon of fossil origin, presents accounting challenges and reveals inconsistencies that have lain in the Kyoto Protocol's treatment of biomass emissions.

Reconciling area-dependent emissions and the timing of emissions in intensity-focussed demand-based accounting frameworks for bioenergy: Where feedstocks for bioenergy cross borders, the existing accounting frameworks for greenhouse gas emissions are challenged in both their efficiency and equity dimensions. There are valid concerns about potential perverse incentives for countries to achieve their emission reduction goals while causing increases in global anthropogenic emissions (i.e. emission displacement, sometimes termed 'leakage'). Policies that focus on efficiency enhancement are now

attracting attention, both through voluntary actions at consumer level and efforts of the private sector to meet consumer expectations, and by UNFCCC countries that may prefer efficiency enhancement goals over area-based emission caps. The Task analysed the interaction between the two types of accounting systems and the potential for hybrid approaches, using case studies of ethanol produced from sugar cane and woody biomass.

Updating the Standard Methodology: As new issues emerge, the standard methodology for calculation of GHG emissions for different bioenergy systems developed by Task 38 needs to be updated. The Task is currently working on a paper which will give information on how to integrate new topics such as the timing of forest-based GHG emissions, land use change impacts and non-greenhouse gas effects (e.g. Albedo effect) and how to deal with e.g. harvested wood products.

Reference systems for evaluating climate effects of bioenergy: Stemming from the two working meetings in 2012, this paper will discuss the importance of the reference system in evaluating the climate effects of bioenergy. It will develop the concept that policy makers have different needs (for example, implications of a policy or selection of a particular bioenergy technology within a policy) hence the reference system should be selected to meet these requirements.

Timing of emissions from bioenergy in LCA and GHG accounting: Metrics, associated uncertainties, and discounting: Also stemming from the two working meetings is a paper that will discuss the implications of different metrics and discounting in evaluating the climate impacts of bioenergy. The Task generally use greenhouse gas emissions (using GWP_{100} to combine impacts of different gases) as the indicator, but other indicators such as radiative forcing, global temperature potential and others should be used. These metrics include other climate forcing such as changes in surface albedo. A brief summary of these concepts is given in Bird, DN. 2009. On the timing of greenhouse gas emissions. IEA Bioenergy Task 38 Technology Report. ExCo64, Liege, Belgium.

Collaboration with Other Tasks

Monitoring Sustainability Certification of Bioenergy: Tasks 38, 40, and 43 are involved in this project led by Task 40. The NTLs from USA are undertaking this work with input from the Australian NTL. The Task provided input to the project plan in December 2011 and reviewed its presentations products. The project is coordinated through monthly phone calls and active email discussions. The Task contributed to the draft report as follows:

- Topic 1'Implementation of sustainability requirements': by reviewing existing schemes and providing a visual summary framing the relationships amongst schemes (voluntary) and mandatory, as well as related multi-governmental efforts (GBEP) which aim at facilitating the development of sustainability indicators for the use of governments and their programs. It also provided descriptions of USA systems on biofuels sustainability and the voluntary system under development by the Council on Sustainable Biomass Production.

- Topic 2 'Survey on governance and certification of sustainable biomass and bioenergy': by participating in the development and design of the survey, identifying organisations and contacts to receive the survey in several countries, disseminating the survey to 9,000 stakeholders, reviewing survey results prepared by Tasks 40 and 43. The raw results of the completed surveys are posted on the Task 38, 40 and 43 websites.
- Topic 3 'Impacts of sustainability certification on bioenergy markets and trade': the study primarily centred on EU case studies of quantifiable certified biofuels trade. Task 38 framed the situation in the Americas and highlighted the intersection of bioenergy with issues surrounding supply and demand of food commodities involved in the major biofuels commercial production.

Draft reports of the above were distributed to the ExCo in Vienna and preliminary recommendations were presented. The three topics were also presented at the Conference. With input from community comments and discussions, the recommendations report (Topic 4) is being prepared for submission to the ExCo. The main findings of the report with the recommendations will be presented at the upcoming dedicated half-day workshop connected to the 2013 World Biofuel Markets Congress in Rotterdam in March.

Mobilising sustainable bioenergy supply chains: Within this inter-Task project the Task will demonstrate the utility of the updated standard methodology by assessing case studies from participating countries. It will also work with Tasks 34, 36 and 37, to undertake or review GHG assessment for fast pyrolysis processes, waste-to-energy and biogas applications. Where possible, Task 38 will perform LCA analysis utilising data from the technoeconomic analyses being conducted by Tasks. Case studies proposed include pyrolysis oils used in combined heat and power applications and biomass pyrolysis-based biorefinery to multiple products, including biofuels at centralised or distributed pyrolysis oil production.

Website/Communication

The Task website is continually updated. The presentations from both expert working meetings (Argonne and Vienna) and case studies are available for downloading. In addition, publications and announcements are distributed through the 'climate change' mailing list and at national level through the NTLs.

Networking

The Task Leader, Neil Bird, Co-Task Leader, Annette Cowie, and Susanne Woess-Gallasch made presentations about the work of the Task at the following:

- Haus der Papierindustrie, Vienna, March, 2012
- Carbon Emissions from Bioenergy, How it impacts our climate, Brussels, March 2012
- Enlargement and Integration Workshop Scientific Basis of Biomass Sustainability in EU Energy Policy that followed ExCo69 in Istanbul. This was sponsored by the EU.
- Sustainable Biomass for Electricity Conference: greening electricity generation for energy access, Güssing, Austria, May 2012, sponsored by FAO, IEA Bioenergy, GBEP, UNEP, UNIDO

- Bioenergy and GHG-accounting, Lund University PhD course, Lund, May 2012
- Wirtschaftskammer, Vienna, May 2012
- Bioenergy Australia quarterly meeting June 2012; Clean Energy Week, July 2012; and
- Bioenergie Fachgespräch, Graz, November 2012

Deliverables

Apart from the wide range of deliverables mentioned above, the Task also produced progress reports and audited accounts for the ExCo. Other outputs were minutes of the Task meetings. 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 a coordinated focus on policy and technical aspects, 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 and for the active involvement of representatives from industry, government and academia. 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 second generation) biofuels and (potentially) 'next-generation' biofuels.

- Provide information dissemination, outreach to stakeholders, and coordinate 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, 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, Michael Persson, Tuula Makinen, and Axel Munack. Sub-Task Leaders for Policy, Markets and Implementation include Manfred Wörgetter, and Warren Mabee. The Task leadership is assisted by Dr Sergios Karatzos (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

The Task 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 2012, the Task held two business meetings each of which was combined with a 'special session' at a biofuels conference. In addition, one informal Task meeting and one technical workshop were also organised during 2012.

The first Task business meeting took place in partnership with Task 42 on 27 February in Copenhagen, in conjunction with the Bio4Bio conference 'Advanced Biofuels in a Biorefinery Approach'. Emphasis was placed on discussing plans for the next triennium. Priorities were outreach to emerging economies (China, India, etc.) and collaboration with other Tasks in order to leverage collective cross-cutting expertise. The Task also organised a special

session 'IEA Bioenergy Task 39' within the conference. This involved a four member panel presentation followed by an open discussion. There was strong Task participation throughout the conference with an additional seven members presenting in other sessions. Task 39 participants played a key role in helping organise this successful conference.

An informal Task meeting took place in New Orleans on 1 May, in conjunction with the 34th Symposium on Biotechnology for Biofuels and Chemicals. The attending Task members convened informally and participated in the sessions that were relevant to Task 39. The Task did not have a formal session within the Symposium, (this is planned for next year's symposium to be held in Portland, Oregon).

A key aspect of any biomass-to-fuels-and-chemicals process, the pre-treatment step, was covered in a Task-sponsored workshop held on 4-6 June in Vancouver. This meeting brought together many of the 'traditional' pre-treatment sectors such as pulp and paper, forest operations, agricultural engineering with many of the leading engineering (Andritz, Metso, etc.); bioconversion (Abengoa, Mascoma, etc.); technology providing (Lignol, Catchlight, etc.); and oil, chemical, energy companies as well as some of the world's top pre-treatment researchers. The two day workshop was followed by field trips to several organisations and facilities (FP Innovations, UBC's Clean Energy Research Centre (CERC), the Centre for Interactive Research on Sustainability (CIRS); Nextera gasifier; and the UBC Process Development Unit). Papers based on the presentations at the workshop will be published in a special issue of the journal Biotechnology for Biofuels.

The second Task business meeting took place on 15 November in Vienna and was held in conjunction with the IEA Bioenergy Conference 2012.

The excellent participation of National Team Leaders from the participating countries at all of the Task meetings confirms the value that the network plays in facilitating information exchange.

Work Programme

The programme-of -work 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 Copenhagen and Vienna 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 (coordinated by Austria). This database provides up-to-date information on over 100 companies which includes biochemical, thermochemical, and hybrid conversion approaches to producing biofuels. However, it is proving increasingly 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 common problem as companies understandably want to protect their proprietary information.

Major Reports

One major report was completed and is summarised below:

T39-T5 - Energy and GHG emissions balance of biofuel technologies at demonstration stage: As mentioned above, the Task members have contributed to a database that has spatially mapped and documented many of the process development units (PDU's), pilot and demonstration plants around the world that are focussed on producing biofuels from lignocellulosic biomass or algal biomass feedstocks. However, information is generally lacking on the energy and greenhouse gas (GHG) balances of these processes. When this project was conceived it was recognised that a major challenge would be the ability to obtain detailed information on individual integrated processes across the wide range of biomass-to-biofuels processes being demonstrated, particularly when the scope of the work was extended to include a range of advanced 'drop-in' hydrocarbon biofuels. Notwithstanding these difficulties, the GHGenius LCA model was applied to the best data available for a variety of leading process options using a 'cradle-to-grave' LCA approach. Analyses were compared across feedstock types (woody, herbaceous) and conversion technology routes (biochemical, thermochemical and hybrid) for different biofuel products (ethanol or diesel) and compared to reference fossil fuel baselines. Data was mainly derived from publically available company presentations and from USA National Laboratory technoeconomic analyses (NREL and PNNL). The results indicated that, depending on the choice of finished fuel and feedstock, a variety of technology pathway routes can provide quite variable energy and GHG balances. The study also

showed quantitatively how biofuel LCAs are sensitive to production yield, and are even more sensitive to the source of power (biomass or fossil) used for the process as well as the value of any co-product electricity produced. A major concern with the first draft of the report was the basis of some of the assumptions that resulted in less than favourable findings. As this was likely a result of the specific data sets that had been used (it is difficult to access actual commercial data due to its proprietary nature) the draft report is currently under review by the country representatives and input from participating companies and researchers are being used to update the model. The next draft of the report will be circulated around December 2012.

Colleagues in the Advanced Motor Fuels (AMF) Implementation Agreement have recently released reports that Task members have contributed to. More information on these reports can be found at *www.iea-amf.vtt.fi*

Newsletter

The Task published three newsletters in 2012 (featuring Country Reports from Italy, South Korea and Australia). The newsletters provide information about the Task activities and international events related to biofuels. The newsletter has an active distribution list of nearly 3,000 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 redesigned website *(www.Task39.org)* and the newsletter have had very positive reviews. The website is heavily visited/cited (with more than 350,000 hits in 2012) 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 USDOE, the Global Bioenergy Partnership, and FAO. There is excellent ongoing collaboration with the Advanced Motor Fuels IA.

Deliverables

The deliverables for the Task in 2012 included: organisation of several meetings throughout the year; two progress reports and audited accounts, (as required by ExCo); development and maintenance of the Task website; three newsletters and one technical report on issues relating to biofuel implementation, deployment, and sustainability. The full library of Task reports, Country Reports, etc. are available through 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 from 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 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

[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. Renewable and Sustainable Energy Reviews, 16 (2012) 3176–3199.

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

From January 2013, Prof Dr André Faaij will be succeeded by Dr Martin Junginger. Chun Sheng Goh (Copernicus Institute, Utrecht University, the Netherlands) is supporting the Task.

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 'Óur Work: Tasks'.

Progress in R&D

Task Meetings and Workshops

The Task organised several workshops in 2012. The first event was a workshop 'Biomethane Trade' which took place on the 24 January as part of the 'Fuels of the Future' Conference in Berlin. The workshop was jointly organised with the funding programme of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety 'Biomass Energy Use'; Fachagentur Nachwachsende Rohstoffe (FNR); and the German Bioenergy Association (BBE). Important stakeholders and experts from industry as well as from academia presented and discussed the latest developments in this rapidly growing market. Task speakers included Uwe Fritsche, Daniela Thrän and André Faaij. The European market for biomethane is growing rapidly so the trade of biomethane across borders is getting more important. Various possibilities for better use of biomethane and knowledge exchange between countries were discussed. Furthermore, biogas certification is expected to simplify the trade while at the same time addressing the sustainability issue. The experts agreed that instruments should be developed to secure the fair evaluation and trade of biomethane in Europe.

In June, the Task organised a session 'Biomass and Bioenergy - an Investor's Perspective - Challenges and Opportunities for the Financial Community' at the European Biomass Conference in Milan. This provided the financial community with information on the latest

trends in the biomass and bioenergy industry; market perspectives for biomass, biofuels and bio-based chemicals; trade opportunities; options to mitigate risks, ensuring sustainability; and where to find profit. The workshop also looked at investments to promote trade from the point of view of the investor and project proponents, and examples of successful ventures.

In October, Tasks 40 and 43, along with the Faculty of Forestry, Geomatics and Geography of Laval University, Natural Resources Canada, and in cooperation with the Global Bioenergy Partnership organised a workshop involving key European, Canadian and American academics, industry representatives, policy makers and NGO's. The workshop was held in Quebec City (Forêt Montmorency) and addressed the sustainability of forest bioenergy through field visits, scientific presentations and moderated discussions. Stakeholders with decision-making responsibilities must base their decisions on state-of-the-art knowledge gained from research findings and operational experience in the field. This workshop engaged participants in discussions that will be essential for formulation of rational policy to ensure sustainable forest biomass production and trade.

In November, the Task provided presentations at the annual Canbio Conference in Vancouver to showcase growth in bioenergy in Canada, Asian markets, and partnership opportunities with Australia, New Zealand, China, Korea, Singapore, and others. This event provided an opportunity to network with key industry, non-profit, and public sector stakeholders. Conference presentations and panel discussions covered a range of topics including global bioenergy trade. Task 40 members presented the trend of solid bioenergy trade, including the long term outlook and expected demand in Europe, with additional invited speakers covering new demand for wood pellets in East Asia, and various issues related to trade such as sustainability certification (including the results from the Quebec workshop mentioned above) and logistics. Furthermore, the Task also moderated a forum on torrefaction. The conference included a tour to Fibreco wood pellet terminal and Nexterra's biomass CHP installation.

In addition to these workshops and meetings, Task business meetings were held in Berlin, Moss, and Vancouver to discuss current business and to plan the work programme for the new triennium. These meetings included field trips, during which participants visited the biomethane plant (Berlin), biorefinery Borregaard and stove manufacturing plant Jøtul (Oslo), and Fibreco pellet terminal in Vancouver harbour.

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

Future Meetings and Workshops

The first meeting of Task 40 in the new triennium is scheduled for the week of 11 March 2013 in the Netherlands. It will be linked to a joint workshop with Task 43 (and tentatively Task 38) as a side event of the World Biofuels Markets Congress. During the workshop, results of the inter-Task project 'monitoring sustainability certification' will be presented.

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 2012, the Task produced a number of significant deliverables related to these objectives.

Implementation of Sustainability Requirements for Biofuels and Bioenergy and Related Issues for Markets and Trade

With public debate on potentially unsustainable consequences of biomass use for energy (or biofuels), the growth of bioenergy has resulted in implementation of a variety of sustainability systems, both mandatory and voluntary. This report, in line with Objectives 2 and 3, focuses on the implementation of mandatory sustainability requirements for biomass (liquid, solid and gaseous), and evaluates the experiences and issues seen or expected, both for commercial and administrative actors on the basis of public information, partly provided by Task participants through a questionnaire.

Global Wood Chip Trade for Energy

In relation to Objectives 3 and 4, this report was commissioned to identify and present global data on wood chip trade, to examine the underlying trade patterns, and to determine their interactions with bioenergy policies. At the centre of the analysis is direct trade of wood

chips for modern bioenergy use in markets where respective policies are in place. Associated trade flows, where the focus is not directly related to energy usage, e.g. wood chips for pulp and paper (of which a fraction ends up as black liquor and is used for energy) are outlined to put the energy related trade into perspective, but not investigated in detail.

The Potential Role of Biofuels in Commercial Air Transport - Biojetfuel

This report, connected to Objectives 1 and 3, provides an overview of the use of biofuels in commercial aviation. Aviation is a global industry with global problems and challenges that also demand global solutions. Key objectives of commercial aviation are to find reliable fuel alternatives to cut costs, and reduce volatility of fuel supply, GHG and improve logistics. The use of biofuels in aviation has received considerable attention in recent years, as it is currently one of the best short to medium term alternatives. Commercial aviation is predicted to grow at 5% annually until 2030, exceeding expected fuel efficiency improvements of approximately 3%; this implies that fuel consumption and emissions will continue to rise. According to IATA (2011b) the airline industry will progress from carrying 2.4 billion passengers in 2010 to an estimated 16 billion passengers in 2050. The global fleet now numbers 100,000 and there are eight major aircraft manufacturers. This is an industry that requires huge investments but provides low returns.

Country Overviews

All Task participants prepared a comprehensive update of their Country Report in 2012. They are relevant to all four objectives of the Task. The 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)*.

Torrefaction Overview

As a final deliverable, a short study was prepared covering the current status of torrefaction. The focus of this study was to briefly examine the status of torrefaction technology, and more importantly assess likely biomass sources and impacts the development of torrefied wood will have on global trade, between now and 2020. The study assessed the extent to which torrefaction might open up new biomass feedstock sources, and explored how torrefied biomass will perform along the logistical chain of long-haul international transport and at the end-use conversion plants. The torrefaction process was compared with two other important preconditioning technologies – traditional pelletisation and flash pyrolysis. This study was published in November 2012.

Workshops

In addition to written deliverables, workshops are linked to the work programme objectives as follows:

- The workshop on biomethane related to Objectives 1 and 4, as it focused both on the potential and logistics of biomethane.
- The workshop in Milan linked to Objective 3, allowing investors to discuss possible opportunities and challenges to develop international bioenergy trade projects.

- The joint workshop in Quebec had a large sustainability aspect (Objective 2), covering topics for a better understanding of on-the-ground practices, how science can inform and support policy making, and how levels of governance from the local to the global level can interact.
- The Vancouver workshop covered Objectives 1 to 4, providing opportunities for communication between market actors across Europe and the Pacific Rim.

Ongoing Topics

- The strategic study initiated with Tasks 38 and 43 to monitor the implementation process of sustainability certification of bioenergy will evaluate how stakeholders are affected by certification initiatives, quantify the anticipated impact on worldwide bioenergy trade, assess the level of coordination among schemes, and make recommendations to remove barriers which may depress markets and reduce sustainable trade. This work is based on questionnaire replies from Task participants. The results will be presented at a workshop in Rotterdam in March 2013.
- 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 in early 2013 and publication is expected in late 2013.
- A project is being carried out to obtain a global overview of the biomass use in industrial applications and transport sectors. The study investigates data availability and challenges related to identifying the largest industrial users of energy biomass. The aim is to produce a list of the world's largest users of energy biomass. The study includes heat and power plants and biofuel plants. Publication is expected early 2013.
- The Task is also investigating the outlook for 'bioenergy trade' in order to provide an insight into 'possible futures' and discuss implications and challenges related to different developments. In this project, the Task intends to investigate the extent to which various global energy models and scenarios take into account bioenergy trade; to identify the implications of different global bioenergy scenarios on bioenergy trade; and to summarise the range of results into 3-5 storylines of future international bioenergy trade. Publication is expected early 2013.

Other studies that will be carried out in 2013 are:

- ***New low-cost long distance supply chains:*** To compare current and near current transportable biomass forms, current and prospective sources of biomass, and current and contemplated methods of transportation to assess which provide the best options for long-distance transportation of biomass, and the likely cost.
- ***Sustainability of certified solid wood bioenergy feedstock supply chains:*** To compare and contrast the proposed EU sustainability requirements for the use of solid biomass with existing international trade in wood pellet supply chains in North America and Europe.
- ***Biomethane:*** Jointly carried out with Task 37, the study aims to give an overview of the status on biomethane production, grid injection and use in different EU countries (and

possibly other selected countries, mainly the ones active in the Tasks) and the options and needs for the development of larger biomethane supply strategies. The focus will be on technical, economic and management related hurdles to injection of biomethane into natural gas grids and thereby enable its international trade.

Website

The Task website is a key tool for dissemination of information. In 2012, visitor numbers varied between 6800-7500 per month, on average higher than in 2011. Since 2007, visitor numbers have been relatively stable, with a five year average of 6200 visitors per month. However, the amount of monthly downloaded data has increased over the past 10 years, reaching 19 GB of data on average since April 2012. As in previous years, each month, at least 10 documents are downloaded over 100 times, with one report (global wood pellet study) achieving 14,000 views from March to December. All Task deliverables (for 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 38 and 43. 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 during 2012, such as the workshops organised by the Task with many other parties in Berlin, Milan, Quebec and Vancouver, as well as the 12th IAEE European Energy Conference in Venice. The Task aims to continue this outreach and collaboration in 2013.

Deliverables

Deliverables in 2012 included four workshops, various reports, several market studies, three newsletters, minutes from three Task meetings, two progress reports and audited accounts to the ExCo; plus 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. Four Projects have been initiated to date and three 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: Completed in September 2012

Project 4: Joint project with the Advanced Motor Fuels Implementing Agreement, Annex XXXIX 'Enhanced Emission Performance and Fuel Efficiency for Heavy Duty Methane Engines'
Participating countries: Norway and the European Commission
Project Leader: Dr Kyriakos Maniatis, European Commission, Belgium
Operating Agent: Professor Kai Sipilä, VTT, Finland
Status: Ongoing with completion around May 2013.

The project is divided into two phases. Phase 1, a literature survey, has been completed. A final report can be downloaded from *http://www.iea-amf.vtt.fi/pdf/annex39_final.pdf*

Phase two is to present emission and engine performance from state-of-the-art methane fuelled heavy duty engines, either dedicated gas engines or diesel engines fuelled with a combination of methane (in various forms) and diesel. These concepts are called diesel-dual fuel or methane-diesel.

The intention is to carry out testing partly on chassis dynamometer under controlled laboratory conditions and partly on the road during real life operation. Measurement equipment will be installed on the test vehicles and measurements will be carried out during various driving and traffic conditions as well as at ambient temperatures.

On the chassis dynamometer, vehicles will be tested during operation according to the new Worldwide Harmonised Driving Cycle with both cold and warm engines at the start of the test. Tests will also be carried out in accordance with European Stationary Test Cycle. Analyses will be carried out and calculated for regulated pollutants such as carbon monoxide, total hydrocarbons, oxides of nitrogen and particles. Unregulated emissions such as methane, non-methane hydrocarbons, carbon dioxide and particle number will also be measured. Fuel consumption will be calculated according to the carbon balance method. For vehicles operated on dual fuel they will be carried out both in dual fuel mode and in diesel mode. Also the energy efficiency will be calculated and the rate of diesel replacement.

On the road the same vehicles will be tested according to different routes; one is called the 'PEMS-route' and the other the 'Bus line 835' representing two different modes of operation.

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 (and cross fertilisation) will include: biomass feedstocks (crops, algae, agro- and process residues) – fractionation, conversion and downstream processing technologies – integral process development and optimisation – sustainability issues, i.e. economic aspects, environmental performance and 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 to 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 to 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 overall environmental impacts.

- Co-operate with ongoing national and international activities and programmes (other Tasks, Implementing Agreements, EU Technology Platforms, etc.).
- Disseminate knowledge, including teaching material to make students familiar with the biorefining approach.

The Task commenced in January 2007.

Participating countries: Australia, Austria, Canada, Denmark, France, Germany, Ireland, Italy, the Netherlands, Turkey and USA.
Task Leader: Drs Ing René van Ree, Wageningen University and Research Centre (Wageningen UR), 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 business meetings in 2012. The 11th meeting was held on 27 February in Copenhagen in conjunction with the international conference on 'Advanced Biofuels in a Biorefinery Approach'. Rene van Ree, chaired a specific Task session with the following presentations provided by Task participants:
- Biomass conversion into YXY (Furan);
- Building blocks for polyester applications (Ed de Jong, Avantium);
- Innovative biofuel-driven biorefinery concepts and their assessment (Gerfried Jungmeier, Joanneum Research);
- Value-added products from biorefineries – Bio-based chemicals (Patrick Walsh, Galway Mayo Institute of Technology);
- Biorefinery developments in Australia (Gil Garnier, Monash University); and
- Current status of biorefineries in Italy (Isabella de Bari, ENEA Research Centre).

The 12th meeting was held on 16 November in Vienna. The main focus was development of the work programme for the new triennium. It is expected that the Task will have 10-14 participants. The Task name will change slightly to 'Biorefining – Sustainable Processing of Biomass into a Spectrum of Marketable Bio-based Products and Bioenergy'. The framework for Task activities will be the Bio-economy, i.e. the sustainable production and valorisation

of biomass to both human food, animal feed, bio-based products (chemicals, materials) and bioenergy (fuels, power, heat). Because of the energy focus of IEA Bioenergy, the major part of the activities will be energy/biofuel-related. This meeting was in conjunction with the IEA Bioenergy Conference 2012 where the Task chaired a biorefineries session with some external contributions, Task presentations came from Gerfried Jungmeier and Maria Wellisch.

All of the presentations can be found on the Task website.

Work Programme

As already outlined, the 2010-2012 work programme was based on a prioritisation of activities agreed upon by the participating countries. The activities were:

- 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 'fully 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.

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 at the end of 2011. The BCI will be developed in 2013, but only at a low-profile level with a few countries involved. For the time being there is no consensus in the Task on the added-value or potential disadvantages of this BCI methodology on biorefinery market deployment. The main activity results are reported in the report 'Energy-driven Biorefineries' that was published late in 2012 and is available on the Task website.

Bio-based Products to be Co-produced with Bioenergy

A report has been prepared on 'Bio-based Chemicals – Value Added Products from Biorefineries'. It 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 is available on the Task website. It will be upgraded in 2014 as part of the work programme in the new triennium. In 2013 a similar report will be prepared on 'Proteins for Food, Feed and Non-food Applications – Value Added Products from Biorefineries'.

Current Status and Development Potential of Both Energy and Product-driven Biorefineries Based on a Fully Sustainable Value Chain Approach

The most promising biofuel-driven biorefineries (commercial, demonstration, pilot, and concept) were identified, and some of them have been technically and economically assessed in 2012. The results of this work were published in the report 'Energy-driven Biorefineries' and is available on the Task website. The report 'Assessment of Bio-product-driven Biorefinery Chains' was not completed in 2012 due to budget and time restrictions.

Guidance Document on Sustainability Assessment for Biorefineries

A report 'Sustainability Assessment of Biorefineries' has been delivered by the Canadian representative with input from all other participants. This report includes definitions, sustainability goals and issues, assessment status, and tools for assessment, including biorefinery applications. It is available on the Task website. For the 2013-2015 triennium the sustainability activities of the Task will be more integrated with activities of other IEA Bioenergy Tasks by participating in the inter-Task project 'Mobilising Sustainable Bioenergy Supply Chains'.

Strategic Biorefinery Paper

This paper is to be replaced by the brochure 'IEA Bioenergy – Task 42 Biorefining – sustainable synergetic processing of biomass to food and non-food', and is scheduled to be produced in 2013. All relevant Task results produced in the last six years have been 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 BioEconomy. The brochure will also include the 2013-2015 work programme and information on running commercial, demonstration and pilot-facilities in the participating countries.

Country Reports on Current Processing Potential and Mapping of Existing Biorefinery Plants and Major RTD-projects

In the 2010-2012 triennium most participating countries produced a Country Report. These provide an overview of the biomass, bioenergy and biorefinery situation, and activities in the participating countries. The reports 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. The reports are available on the Task website. The countries that did not deliver had as main arguments that they

were not able to collect the data asked for, as these are not easily achievable in their respective countries (i.e. it will involve unjustifiable effort), or not available at all. For the next triennium a better format will be prepared for the country reporting so that all of the participants will be able to deliver.

Biorefinery Training Course

The Task has developed an extensive Biorefining Training Course and three successful courses have been held: a one day course in 2010 in Amsterdam with 75 attendees; a four day course in 2011 in Paris with 120 attendees, and a four day course in 2012 in Wageningen, with 75 attendees.

The focus now is on informing stakeholders and training PhD students in biorefinery skills. The goal is to contribute to the training of biorefinery experts for the future. These highly trained experts are needed for the development of biomass value chain-based innovations and also to facilitate the transition to a bio-based economy which includes biorefinery facilities.

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. International knowledge exchange between the Task and these stakeholder forums have taken place frequently, for example by inviting them to Task-related workshops, and were reported to the other participants at Task meetings. In the new triennium even more effort will be put into the dissemination of Task results and expertise at national levels by organising national Task events in the participating countries. These events will also be used to import knowledge and data from national levels to the Task participants for international knowledge dissemination.

Task Website

A 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. In the new triennium a way will be found to keep the website more up-to-date, and also to accelerate the filling of the database. For the latter, co-operation with Task 39 will be sought.

Collaboration with Other Tasks/Networking

In 2012 co-operation was established with international activities including: other Tasks, European-based Technology Platforms, International Council of Chemical Association (ICCA), Specific Support Actions, and EC FP7 Integrated Projects. This co-operation will

be enhanced in the new triennium by organising joint events, e.g. workshops and meeting regularly with ongoing EU-initiatives.

In 2012 the following activities took place:

- Two Task business meetings
- Co-organising/hosting the Danish Conference 'Advanced Biofuels in a Biorefinery Approach' – Copenhagen
- Biorefinery Excursion, Copenhagen
- Contributing to the IEA Bioenergy Conference 2012. During this conference the Task chaired a biorefineries session.
- Chairing a biorefinery platform day at the WBM-2012 Conference.
- A variety of Task lectures were given at international conferences, seminars and to stakeholders.
- Organising jointly with EC FP7-project BIOCORE and Wageningen UR, the third European Training Course on Biorefining.

Deliverables

Deliverables in 2012 included organising and reporting of two Task business meetings in conjunction with conferences in Copenhagen and Vienna; 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 Training Course.

TASK 43: Biomass Feedstocks for Energy Markets

Overview of the Task

The work of the Task is based on the premise that in many countries biomass demand for energy will enter a period of 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.

For the new triennium, 2013-2015, Task 29: 'Socio-economic Drivers in Implementing Bioenergy Projects', will merge with Task 43. The work programmes of the two Tasks will be carefully integrated to maximise the benefits of these Tasks working as one (see page 38).

Participating countries: Australia, Canada, Denmark, European Commission, Finland, Germany, Ireland, Italy, the Netherlands, New Zealand, Norway, Sweden, United Kingdom, and the USA
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. The Task capacity is further increased through the NTLs engaging support persons within their country and through establishing cooperation with other organizations in specific areas. The aim is 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 and Workshops

Two business/planning meetings were held in 2012: in Charleston, USA, on 20 February; and in Vienna, from 15-16 November (Day 1 was a meeting for the inter-Task project 'Mobilising Sustainable Bioenergy Supply Chains', and Day 2 was the Task business meeting). The Task also organised four international workshops/seminars as follows:

- Mobilising Sustainable Supply Chains for Forest Biomass for Energy in Charleston, USA
- 6th World Water Forum seminar on biofuels and water, in Marseille, France
- Water for bioenergy: Quantitative assessments to support improved governance, World Water Week, in Stockholm, Sweden
- Economic Sustainability of Forest Fuel Supply Chains, in Lisbon, Portugal

The Task presented results from selected activities during a session at the IEA Bioenergy Conference 2012. 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 achieved substantial outreach as part of their role.

Tasks 40,43 and the Technical Coordinator, along with the Faculty of Forestry, Geomatics and Geography of Laval University and Natural Resources Canada, and in cooperation with GBEP, organised the workshop 'Science-policy interface on issues of the environmental sustainability of forest bioenergy' and a field visit in Quebec, Canada. About 60 key European, Canadian and American experts, involved with research and policy development in the bioenergy sector, met to discuss the sustainability of forest bioenergy through field visits, scientific presentations and moderated discussions. The event was very well received. See also page 29.

Work Programme

The work programme 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 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 is engaged with several scientific journals: Journal of Forest Energy (managed by the Finnish team); which this year merged with the International Journal of Forest Engineering; WIREs: Energy and Environment (Associate Editor for the bioenergy area);

and Biofuels, Bioproducts and Biorefining (Consultant Editor). These and other journals offer valuable opportunities for outreach via special issue publications, occasional articles and editorials.

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 to 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 43 team. The Dutch Task 43 team has also developed a web-based dissemination tool – Perennial Biomass Crops on the Map *(see: http://www.pbconthemap.org).*

Collaboration with Other Tasks/Networking

The events presented above have involved cooperation with other Tasks and several organisations outside IEA Bioenergy, including Roundtable for Sustainable Biofuels, UNEP, Stockholm Environment Institute, FAO, and GBEP. The Task also collaborated with the following:

- 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 knowledge and synthesises existing knowledge, to increase the flow of relevant information between scientists, industry, government and civil society *(see www.focali.se/en)*;
- The COST Action FP0902 - Development and Harmonisation of New Operational Research and Assessment Procedures for Sustainable Forest Biomass Supply. Several Task participants are involved, including the FP0902 Chair Dominik Röser who is the Alternate Task 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 the Task website. The Rating SRC project has also published two special issues in Scientific Journals.

The Task also collaborates with Task 38 and 40 in the inter-Task project 'Monitoring Sustainability Certification of Bioenergy'. Since ExCo69 the Task has engaged with several other Tasks in the planning of a new inter-Task project Mobilising Sustainable Bioenergy Supply Chains'. Both these projects will continue in the new triennium.

Deliverables

Deliverables for 2012 included; technical and more popular reports (see section 'Library' on the Task website) as well as special issues in scientific journals; reporting to the ExCo (two progress reports, audited accounts, and a contribution to the Annual Report). 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 2012

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					•			•		•					•							•	⊗		6
36					•				•	•		•					•		•			⊗			7
37		•		•	•		•	•	•	•	•				•		•		•	•	•	•		⊗	15
38	•	⊗	•	•				•		•					•		•		•				•		10
39	•	•		•	⊗		•	•		•		•	•	•	•	•	•	•	•				•		16
40		•	•	•	•		•	•		•		•	•		⊗		•		•			•	•		14
42	•	•			•		•		•	•	•	•			⊗						•		•		11
43	•				•		•	•		•	•				•	•	•		⊗			•	•	•	13
Total	4	7	2	4	9	1	7	8	3	11	4	6	3	1	9	3	9	1	8	3	4	7	7	2	123

⊗ = Operating Agents • = Participant

Note: In addition to the above the following Task was ongoing in 2012: Task 41, Project 4 (participants are the EC and Norway). This is a joint project with the AMF Implementing Agreement.

BUDGET IN 2012 – SUMMARY TABLES

Budget for 2012 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	12,700	89,820	102,520
Japan	9,700	44,500	54,200
Korea	7,700	15,000	22,700
Netherlands	15,700	138,000	153,700
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	13,700	110,320	124,020
USA	13,700	109,000	122,700
European Commission	8,700	29,000	37,700
Total	283,800	1,847,740	2,115,540

BUDGET IN 2012 – SUMMARY TABLES

Budget for 2012 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	6	20,000	120,000
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	16	15,000	240,000
Task 40: Sustainable International Bioenergy Trade – Securing Supply and Demand	14	17,000	238,000
Task 41: Bioenergy Systems Analysis, Project 4	2	#	#
Task 42: Biorefineries: Co-production of Fuels, Chemicals, Power and Materials from Biomass	11	15,000	165,000
Task 43: Biomass Feedstocks for Energy Markets	13	15,000	195,000
Total			1,847,740

Cash and 'in kind' contributions were made to the AMF implementing Agreement

CONTRACTING PARTIES

Bioenergy Australia (Forum) Ltd

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'Environnement et 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 Development Institute (SANEDI)

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

The Executive Committee

Final Minutes of the ExCo69 meeting, Istanbul, Turkey, May 2012.

Final Minutes of the ExCo70 meeting, Vienna, Austria, November 2012.

IEA Bioenergy News Volume 24(1), June 2012.

IEA Bioenergy News Volume 24(2), December 2012.

IEA Bioenergy Update. Number 49. Biomass and Bioenergy. In Press.

IEA Bioenergy Update. Number 50. Biomass and Bioenergy. In Press.

IEA Bioenergy Update. Number 51. Biomass and Bioenergy. In Press.

IEA Bioenergy Update. Number 52. Biomass and Bioenergy. In Press.

IEA Bioenergy Update. Number 53. Biomass and Bioenergy. In Press.

Anon. IEA Bioenergy Annual Report 2011. IEA Bioenergy ExCo:2012:01.

Anon. Future Biomass-based Transport Fuels. Summary and Conclusions from the IEA Bioenergy ExCo67 Workshop. IEA Bioenergy ExCo:2012:02.

All publications listed are available on the IEA Bioenergy website: *www.ieabioenergy.com*

TASK 29

Minutes of the Task meeting in Berlin, Germany, November 2012.

Progress report for ExCo69, Istanbul, Turkey, May 2012.

Progress report for ExCo70, Vienna, Austria, November 2012.

Anon. Papers presented at the international workshop 'Bioenergy - Valorizing Potentials for Regional Benefits', Berlin, Germany, November 2012.

Richards, K.M. Can bioenergy help to alleviate rural fuel poverty?

Domac, J. Socio-economic effects of valorizing biomass. The regional perspective.

White, W. Bioenergy as a contribution for a decentral energy system.

Elbe, S. Strategies for financing bioenergy networks for regional added value – Experiences from the German model project.

Hohle, E. Wood, wood, wood – What would you do?

Lutsyuk, C. What do you expect from your national Biomass Action Plan/Renewable Energy Action Plan (nBAP/REAP)?

Kiefel, M. Cluster energy efficiency and renewable energy sources.

Bachmann, S. Promoting sustainable bioenergy production and consumption on a sub-regional level.

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Domac, J. Bioenergy and people – why is this so important?

Richards, K.M. Bioenergy, fuel poverty and rural development.

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White, W. The government role in renewable energy systems: The importance of policy consistency.

Opalic, T. How to bond energy and people? Assessing economic and social impacts of the SERVE project.

Please also visit the Task website: *www.task29.net*

TASK 32

Minutes of the Task meeting in Milan, Italy, June 2012.

Minutes of the Task meeting in Vienna, Austria, November 2012.

IEA Bioenergy Task 32 Newsletter, Issue 5, Jan, 2012.

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Progress report for ExCo69, Istanbul, Turkey, May 2012.

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Lönnermark, A., Persson, H., Larsson, I., Nikolaisen, L., Koppejan, J., Wheeler, P., Howes, P., Al Seadi, T., Southgate, J., Godley, A. and Melin, S. Health and Safety issues in Handling, Storage and Transportation of Solid Biofuels, January 2013.

Koppejan, J., Sokhansanj, S., Melin, S. and Madrali, S. Status Overview of Torrefaction Technologies, December 2012.

van Eijk, R.J., Obernberger, I. and Supancic, K. Options for Increased Utilization of Ash from Biomass Combustion and Co-firing, January 2012.

Koppejan, J. Report from the workshop 'Cofiring Biomass with Coal', Copenhagen, Denmark, March 2012.

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Ryckmans, Y. Laborelec - Sustainable biomass for large power generation.

Khodayari, R. Vattenfall Research and Development - Vattenfall strategy and experiences of co-firing biomass with coal.

Willeboer, W. Essent - Status and future of Essents' biomass activities.

Livingston, W. Doosan Babcock - Recent developments in biomass co-firing in large pulverised coal boilers.

Dunnu, G. Institut für Feuerungs- und Kraftwerkstechnik - Torrefied and hydrothermal carbonised biomass products: co-milling, combustion and emission properties.

Ohliger, A. Institute of Heat and Mass Transfer, RWTH Aachen University - Grindability of torrefied beechwood and co-firing with pulverized lignite at pilot scale.

Abd Rahman, A. Universiti Tenaga Nasional - Upgrading of Malaysian biomass for co-firing with coal.

Bartolomé, C. Fundación CIRCE - Co-firing comparison of two energy crops with coal in a pulverized fuel combustion pilot plant.

Moeller, M. DONG Energy - Demonstration of a new gasification technology for indirect co-firing of difficult biomass with coal.

van der Drift, B. Advantages of allothermal biomass gasification for co-firing.

Pickard, S. University of Leeds - Combustion characteristics and ash analysis results from pilot-scale co-combustion of brownfield biomass in air, O_2-enriched air and oxy-fuel environments.

Post van der Burg, R. Topell - Energy torrefaction.

van Eijk, R. KEMA - Co-firing and ash quality.

Plaza, P. TU Delft + Cardiff School of Engineering - Ash deposition prediction tool for PF boilers fired with coal and biomass.

Kazagic, A. JP Elektroprivreda BiH d.d. Sarajevo - Co-firing tests of Bosnian coal with wooden biomass and natural gas in laboratory and on a 110 MW_e power station.

Koko, M. Steinmueller Engineering GmbH - A 1-D simulation tool for biomass co-firing - development and application.

Hussain, T. Cranfield University - Pilot plant experiments of co-firing various levels of cereal co-product (CCP) with El-Cerrejon coal.

van der Broek, R. Vattenfall Europe Generation AG - The future of cofiring.

Middelkamp, J. KEMA - Present situation and future developments on biomass co-firing and coal-to-biomass conversions at large power stations.

Dixon, T. IEAGHG Activities on bio-CCS, including techno-economic evaluation of power plants, global potential, and carbon market issues.

Koppejan, J. Report from the workshop 'Torrefaction: Market Implementation of a New Solid Biofuel and its Midterm Prospects', Milan, Italy, June 2012.

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Post van der Burg, R. Topell - Energy torrefaction.

Dahl, J. DTI - Densification concepts.

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Hirvonen, M-R. University of Eastern Finland - Toxicological characteristics of particulate emissions from biomass combustion.

Please visit the Task website for the reports and original presentations: *www.ieabioenergytask32.com*

TASK 33

Progress report for ExCo69, Istanbul, Turkey, May 2012.

Progress report for ExCo70, Vienna, Austria, November 2012.

Workshop Report 'Bed Materials in Fluid Bed Gasification', Istanbul, Turkey, April 2012.

Please also visit the Task website: *www.ieaTask33.org*

TASK 34

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Progress report for ExCo70, Vienna, Austria, November 2012.

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TASK 36

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2012 Presentations

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Schüßler, I. Integration of processes for optimising resource recovery from waste streams.

Vehlow, J. Management of residues from waste to energy processes.

Martignon, G. Renewable energy from mixed fuels: existing and new methods to measure their biogenic content and financial incentives.

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Rechberger, H. and Fellner, J. Determination of the biogenic fraction in waste: Balance method.

Ciceri, G. Determination of the biomass content of waste: the software OBAMA.

Ciceri, G. Determination of biogenic fraction of waste on the base of 14C measurement.

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RSE. Energy recovery from renewable content of waste: incentives and methodology for analysing biogenic content of mixed waste.

KIT. Management of residues from energy recovery by thermal waste to energy systems and quality standards.

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Ricardo-AEA. Life cycle assessment modelling of IAWARES – draft.

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

TASK 37

Minutes from the Task meeting in Moss, Norway, April 2012.

Minutes from the Task meeting in Tulln/Vienna, Austria, November 2012.

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Lystad, H. Avfall Norge – Biogas and waste management in Norway.

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Ihler, Ø. Oslo EGE – Waste handling of organic residues for biogas in Oslo.

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TASK 38

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Cherubini, F. *et al.* Climate impact of forest bioenergy: contributions from biogenic CO2 and albedo.

Leal, M.R. *et al.* Alternatives to use sugarcane residues to reduce GHG emissions (presented. by Seabra J.).

Soimakallio, S. *et al.* Land Use in Life Cycle Assessment of GHG emissions (presented. by Helin T.).

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Chum, H. Some considerations LUC, iLUC, LUCCMe, and others.

Cowie, A. Quantifying climate change impacts of bioenergy systems – current approaches.

Parikka, M. A policy maker's view of the discussions during from the working meeting.

Pingoud, K. GWP based indicators to describe the climate impacts of the wood product.

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Cowie, A. Dealing with time in LCA and carbon foot printing – current approaches, focus on bioenergy.

Ros, J. Bioenergy in the Netherlands, now and in the future.

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TASK 39

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TASK 40

Minutes from the Task meeting in Berlin, Germany, January 2012.

Minutes from the Task meeting in Oslo, Norway, June 2012.

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Progress report for ExCo70, Vienna, Austria, November 2012.

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Junginger, M. Sustainability and global feedstock trade - What Biomass Feedstocks Look Most Promising For Global Trade Over The Next Five Years? Presentation at the BIOM2E Global Bioenergy congress, 25 September 2012, Amsterdam, The Netherlands.

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Junginger, M. Overview of global solid and liquid biomass trade for energy. IEA Bioenergy Conference 2012, Session III: Sustainable International Bioenergy Trade, 13-15 November, Vienna, Austria.

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TASK 41

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Ericson, S-O. Summary and conclusions.

Nylander, B.N., and Nilssen, S. Part A: Identifying synergies and competition in forest-based bioenergy in selected countries.

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TASK 42

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Progress report for ExCo69, Istanbul, Turkey, May 2012.

Progress report for ExCo70, Vienna, Austria, November 2012.

Anon. Task 42 Report 'Bio-based Chemicals - Value Added Products from Biorefineries', February 2012.

Anon. Task 42 Report 'Energy-driven Biorefineries – A Selection of the Most Promising Biorefinery Concepts to Produce Huge Volumes of Road Transportation Biofuels until 2025', December 2012.

Anon. Task 42 report 'Sustainability Assessment of Biorefineries', December 2012.

These publications are available on the Task website *www.IEA-Bioenergy.Task42-Biorefineries.com.*

TASK 43

Minutes from the Task meeting in Charleston, USA, February 2012.

Minutes from the Task meeting in Vienna, Austria, November 2012.

Progress report for ExCo69, Istanbul, Turkey, May 2012.

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Anon. Technical Reports.

Screening Life Cycle Analysis of a Willow Bioenergy Plantation in Southern Ontario. 2012. IEA Bioenergy: Task43:2012:01.

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Anon. Workshop: 'Mobilizing Sustainable Supply Chains for Forest Biomass for Energy'. Charleston, South Carolina, USA February 21, 2012.

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Asikainen, A. Forest biomass in the EU how much is available and how to mobilize the potential?

Devlin, G. Feedstocks for energy production in Ireland – challenges in developing economically sustainable supply chains.

Spinelli, R. Research efforts to improve the harvesting of forest biomass from the mountainous areas in Italy.

Smith, T. Mobilizing sustainable supply chains – opportunities and challenges.

Thiffault, E. Forest biomass supply chains from natural forests in Canada: Integrating ecological and local constraints.

Stupak, I. Constraints to mobilizing sustainable biomass supply chains – the ecological perspective.

Kittler, B. Challenges of sustainable supply chains in the Southeast US. (Introduction and moderation of panel discussion).

Meyers, S. Wood procurement in a highly heterogeneous landscape. Pellet Export Perspective.

McDow, W. Sustainability Criteria and Practices in the Southeast U.S. Environmental Perspective.

Ikonen, T. IEA Bioenergy Task 43 efforts in 'Mobilizing economically sustainable supply chains'.

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Fingerman, K. Governance challenges and institutional responses at the water/biofuel nexus: lessons from ongoing work at FAO.

Jungueira, V. Addressing water related aspects in certification systems and standards.

Neary, D. Best Management Practices for managing water in bioenergy feedstock production.

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Beringer, T. Quantitative assessment of global bioenergy-water linkages.

Wani, S.P. Jatropha for rehabilitation of wastelands, improving livelihoods and downstream consequences.

Klocker Larsen, R. Competing water claims in biofuel feedstock operations in Central Kalimantan: community grievances and pathways to improved governance of oil palm concessions.

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Berndes, G. Bioenergy and water: assessments and policies to support improved governance.

Gan, J. Biomass and producer decision making: direct and indirect transfers in different spheres of interaction.

Smith, C.T. Are multiple layers of governance systems a barrier for sustainable forest bioenergy production?

Schweinle, J. Assessing the Environmental Performance of Biomass Supply Chains - An Effort under Construction.

Asikainen, A. Forest energy in Finland and Sweden – technology and market development supporting economic viability of feedstock supply.

Anon. COST Action FP0902- Report on Economic Sustainability of Forest Fuel Supply Chains Conference – Portugal. September 2012.

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Routa, J. *et al.* Forest energy procurement: state of the art in Finland and Sweden. WIRES – Energy and Environment. DOI: 10.1002/WENE.24.

Please also visit the Task 43 website: *www.ieabioenergytask43.org* and *Journal of Forest Energy www.journal.forestenergy.org* for access to more publications.

KEY PARTICIPANTS IN EACH TASK

TASK 29 — Socio-economic Drivers in Implementing Bioenergy Projects

Operating Agent: Elizabeth McDonnell, Department of Energy and Climate Change (DECC), United Kingdom.
For contacts see Appendix 7.

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Germany	Sebastian Elbe	SPRINT Consulting
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TASK 32 — Biomass Combustion and Co-firing

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TASK 33 — Thermal Gasification of Biomass

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TASK 34 — Pyrolysis of Biomass

Operating Agent: Paul Grabowski, US Department of Energy, USA.
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Germany	Dietrich Meier	Thünen Institute for Wood Research
Netherlands	Bert van de Beld	BTG (Biomass Technology Group)
United Kingdom	Anthony Bridgwater	Aston University
USA	Douglas Elliott	PNNL (Pacific Northwest National Laboratory)

TASK 36 — Energy Recovery from Municipal Solid Waste Management

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TASK 37 — Energy from Biogas

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European Commission	David Baxter	European Commission, JRC Petten
Finland	Jukka Rintala	University of Tampere
France	Olivier Théobald	ADEME
Germany	Bernd Linke	Leibniz-Institute for Agricultural Technology
Ireland	Jerry Murphy	University College Cork
Netherlands	Mathieu Dumont	NL Agency
Norway	Espen Govasmark	Bioforsk
Sweden	Tobias Persson	Swedish Gas Centre
Switzerland	Nathalie Bachmann	EREP
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TASK 38 — Greenhouse Gas Balances of Biomass and Bioenergy Systems

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Brazil	Manoel Regis Leal	Brazilian Bioethanol Science and Technology Laboratory
	Newton Paciornik	Brazilian Ministry of Science and Technology
Finland	Kim Pingoud	VTT Technical Research Centre of Finland
	Sampo Soimakallio	VTT Technical Research Centre of Finland
Germany	Sebastian Rueter	Federal Research Institute for Rural Areas, Forestry and Fisheries
Netherlands	Jan Ros	Netherlands Environmental Assessment Agency
Norway	Anders Hammer Strømman	Norwegian University of Science and Technology
Sweden	Matti Parikka	Swedish Energy Agency
	Leif Gustavsson	Mid Sweden University
USA	Alison M. Goss Eng	US Department of Energy
	Helena Chum	National Renewable Energy Laboratory (NREL)

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
	Anders Kristoffersen	Novozymes

Finland	Tuula Makinen	VTT Biotechnology
Germany	Axel Munack	Johann Heinrich von Thünen Institute
	Jürgen Krahl	Coburg University of Applied Sciences
Italy	Alessandra Frattini	Chemtex Italia SRL
	David Chiaramonti	Chemtex Italia SRL
	Stefania Pescarolo	Chemtex Italia SRL
Japan	Shiro Saka	Kyoto University
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TASK 41 — Bioenergy Systems Analysis

Project 4: Joint Project with AMF: Biomethane in Heavy Duty Engines

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