

# Introducing IEA Bioenergy

Welcome to this Annual Report for 2018 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 energy derived from biomass. Biomass 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 Technology Collaboration Programme (TCP) 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 2018, 24 parties participated in IEA Bioenergy: Australia, Austria, Belgium, Brazil, Canada, Croatia, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Japan, the Republic of Korea, The Netherlands, New Zealand, Norway, South Africa, Sweden, Switzerland, the United Kingdom, the USA, and the European Commission.

IEA Bioenergy is now 41 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 Technology Collaboration Programmes 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 11 ongoing Tasks during 2018:

- Task 32: Biomass Combustion and Co-firing
- Task 33: Gasification of Biomass and Waste

- Task 34: Direct Thermochemical Liquefaction
- Task 36: Integrating Energy Recovery into Solid Waste Management Systems
- Task 37: Energy from Biogas
- Task 38: Climate Change Effects of Biomass and Bioenergy Systems
- Task 39: Commercialising of Conventional and Advanced Liquid Biofuels from Biomass
- Task 40: Sustainable Biomass Markets and International Bioenergy Trade to Support the Biobased Economy
- Task 41: Bioenergy Systems Analysis
- Task 42: Biorefining in a future BioEconomy
- 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 2018 is shown in Appendix 1.

A progress report for IEA Bioenergy for the year 2018 is given in Sections 1 and 2 of this Annual Report.



Attendees at the ExCo81 meeting in Ottawa.

# Progress Report

## 1. THE EXECUTIVE COMMITTEE

### Introduction and Meetings

The Executive Committee (ExCo) 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 Technology Collaboration Programme (TCP). The Executive Committee 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 webinars, and maintenance of the IEA Bioenergy website. In addition the ExCo produces technical and policy-support documents, and organises workshops and study tours for the Member Country participants.

The 81st ExCo meeting took place in Ottawa, Canada on 30 May – 1 June with 35 participants. The 82nd ExCo meeting was held in San Francisco, USA on 5-6 November and there were 54 participants. Paolo Frankl represented IEA Headquarters at ExCo82.

Jim Spaeth of the USDoE chaired both ExCo meetings in 2018 with Paul Bennett of New Zealand in the role of Vice-chair. At ExCo82, Jim Spaeth was elected as Chair and Paul Bennett was elected as Vice-chair for 2019.

### Secretariat

The ExCo Secretariat is currently based in Dublin, Ireland under the Secretary, Pearse Buckley. The fund administration for the ExCo Secretariat Fund and Task funds is consolidated with the Secretariat, along with production of ExCo publications and newsletters, and maintenance of the website.

The contact details for the Executive Committee can be found in Appendix 7 and for the Secretariat on the back cover of this report. The work of the ExCo, with some of the achievements and issues during 2018, is described below.

## Implementing Agreement

The current term of the IEA Bioenergy Technology Collaboration Programme (TCP) ends on the 29th February 2020.

## Contracting Parties/New Participants

A complete list of the Contracting Parties to IEA Bioenergy is included in Appendix 3.

Estonia joined the IEA Bioenergy Technology Collaboration Programme in 2018, bringing the number of contracting parties to 24. India made a presentation to ExCo81 in Ottawa and was invited to join the TCP. It is expected that India will complete the process of joining IEA Bioenergy in the 1st quarter of 2019. There are ongoing discussions with China, and Mexico with a view to engaging them in IEA Bioenergy.

## 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 presentations 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 increased the engagement of the ExCo 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 is reported to the IEA Governing Board.

## Approval of Task and Secretariat Budgets

The budgets for 2018 approved by the Executive Committee for the ExCo Secretariat Fund and for the Tasks are shown in Appendix 2. Total funds invoiced in 2018 were US\$1,797,900, comprising US\$260,800 of ExCo funds and US\$1,537,100 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 Bank of Ireland Global Markets in Dublin continues to work well. The Trust Account consists of a Call Deposit account and a Fixed Deposit account both of which bear interest. The Call Deposit account is accessed electronically while the Fixed Deposit account is accessed through the Bank's dealers. Both accounts are denominated in US dollars. The currency for the whole of IEA Bioenergy is US dollars. Details for making payments are provided with each invoice.

The main issues faced in fund administration are slow payments from some Member Countries and fluctuations in exchange rates. As of 31 December 2018, there was US\$51,500 of Member Country contributions outstanding.

At ExCo78, unanimous approval was given to the appointment of KPMG, Dublin as independent auditor for the ExCo Secretariat Fund until 31 December 2018. The audited accounts for the ExCo Secretariat Fund for 2017 were approved at ExCo81.

The Tasks also produce audited accounts. These are prepared according to guidelines specified by the ExCo. The accounts for the Tasks for 2017 were approved at ExCo81.

The audited accounts for the ExCo Secretariat Fund for the period ended 31 December 2018 have been prepared and these will be presented for approval at ExCo83 in Utrecht.

## Task Administration and Development

### Task Participation

In 2018 there were 100 participations in 10 Tasks. Please see Appendix 1 on page 108 for a summary of Task participation.

There were two active projects under Task 41 and two Inter-Task projects in 2018 – see below under '**Strategic Fund/Strategic Outputs**'.

## Strategic Planning and Strategic Initiatives

### Strategic Plan

[The Strategic Plan 2015-2020](#) continues to be the guiding document for the IEA Bioenergy work programme. Work on the new Strategic Plan 2020-2025 is well advanced and it was discussed in detail at ExCo82. The full set of term Request for Renewal (RfE) documents (Strategic Plan, End of Term Report and RfE Questionnaire) will be submitted for approval at ExCo83 in Utrecht in May 2019.

## Technical Coordinator

During 2018, the Technical Coordinator continued with his work of facilitating increased collaboration between the Tasks. In this context he has attended a number of Task meetings and associated conferences. He has maintained an updated schedule of deliverables and worked with the Task Leaders to achieve deadlines, with particular emphasis on completing the work programmes for the triennium 2016-2018. He has also continued to organise the webinars, which have become an important forum for dissemination of IEA Bioenergy outputs. The Technical Coordinator played a key role in the organisation of the ExCo81 workshop and also the IEA Bioenergy Conference 2018. He has been very active in engagement with IEA Headquarters and with other international organisations including FAO, IRENA, GBEP, Biofuture Platform, Mission Innovation and SEforALL.

## Communication Strategy

Communications is an important part of IEA Bioenergy activity and the Executive Committee has maintained its focus on the communication strategy through the work of the Communications' Team, which holds regular teleconference meetings. Some of the outcomes are presented here. The Twitter following has continued to increase steadily and the Communications Team has been considering ways to further enhance this development. The use of webinars as a dissemination tool has continued with eight webinars in 2018 – (i) *Methane emissions related to biogas systems*, (ii) *Main conclusions of the new IEA Technology Roadmap on Bioenergy*, (iii) *Aerosol emissions from biomass combustion*, (iv) *Biofuels for the Marine Sector*, (v) *GoBiGas: an Industry Relevant State-of-the-art Reference for Advanced Biofuel Production via Gasification*, (vi) *Approaches to govern and verify the sustainability of biomass supply chains*, (vii) *Decision Support Tools for Bioeconomy Transformation Strategies: Introduction of Natural Resources Canada I-BIOREF Software Platform* and (viii) *Biomass Production in Sustainably Managed Landscapes*. Two-page summaries of Task reports have been produced and uploaded to the website alongside the main reports. Pro-active material has been uploaded under FAQ – <https://www.ieabioenergy.com/iea-publications/faq/>.

Following the execution of a call for tender for a communication strategy that had been approved at ExCo81, BCS LLC undertook the work and prepared a detailed strategy. This was presented to ExCo82 for consideration and was adopted following a detailed discussion. The Communication Team was charged with the development of a proposal to implement the strategy and this will be rolled out in phases in 2019.

## 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.

Progress with strategic initiatives has continued. The summary and conclusions from the ExCo80 workshop 'Bioenergy Grid Integration' has been published and can be download at <https://www.ieabioenergy.com/wp-content/uploads/2018/02/ExCo80-Bioenergy-Grid-Integration-Summary-and-Conclusions.pdf>. All previous ExCo workshop publications are available at <http://www.ieabioenergy.com/iea-publications/workshops/>.

**Task 41 Project 5: Bio-CCS/CCUS:** This project has been completed and the report has been published at [https://www.ieabioenergy.com/wp-content/uploads/2018/06/IEA-Bioenergy-2-page-Summary-Bio-CCUS\\_FINAL\\_29.6.2018.pdf](https://www.ieabioenergy.com/wp-content/uploads/2018/06/IEA-Bioenergy-2-page-Summary-Bio-CCUS_FINAL_29.6.2018.pdf)

**Task 41 Project 9: Potential Cost reduction for novel and advanced renewable and low carbon fuels:** This one-year project is continuing and is expected to be completed in March 2019 with a final workshop and report.

**Inter-Task Project: Measuring, governing and gaining support for sustainable bioenergy supply chains:** This project (<http://itp-sustainable.ieabioenergy.com/>) is nearing completion. To date 25 papers have been published and uploaded to the website. Three more papers are expected to be completed in early 2019. A four-page executive summary is being prepared. The project will be completed by the end of March 2019.

**Inter-Task Project: Fuel pre-treatment of biomass residues in the supply chain for thermal conversion:** In this project (<http://itp-fuel-treatment.ieabioenergy.com/>) all of the case studies have been finalised. The policy report is in draft form. The project will be completed by the end of March 2019.

## ExCo Workshops

At ExCo81 in May a very successful internal workshop themed 'Planning for the new triennium' was held. Detailed proposals for programmes of work for the triennium 2019-2021 were presented by Task Leaders. The ExCo also considered proposals for strategic projects which were seen as important accompanying actions. Several topics were subsequently developed for Executive Committee review and decisions at ExCo82 in San Francisco.

There was no internal workshop at ExCo82. The meeting was held in conjunction with the *IEA Bioenergy Conference 2018* in San Francisco – see section at the beginning of this Annual Report.

## **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 facilitates effective exchange of information between the participants and information transfer to stakeholders. These sessions are described in the progress reports from the Tasks later in this Annual report. The papers presented at some of these sessions are listed in Appendix 4. Examples of this outreach are:

- Task 39 held a Task meeting in China in April 2018, hosted by the Beijing University of Chemical Technology (BUCT).
- Task 32, Task 33 and Task 36 together with the European Recovered Fuels Organisation organised a workshop on the topic of the production and utilisation of solid recovered fuels (SRF), as part of the European Biomass Conference in Copenhagen, Denmark in May 2018.
- Task 38 and Task 43, together with the Swedish University of Agricultural Sciences (SLU) organised a workshop on "The Consequences for climate and bioenergy of land sector carbon accounting under the Paris agreement" in Uppsala, Sweden in August 2018.
- Task 32 and Task 40 organised an international workshop in collaboration with NEDO/METI and with support from the REI in Tokyo, Japan on "Future perspectives of bioenergy development in Asia" in September 2018.

## **Collaboration with International Organisations and Implementing Agreements**

At ExCo82 a document on enhanced collaboration with other International Organisations was presented. There was a detailed discussion on the proposal with a consensus on the need for efficient and effective collaboration between all the organisations concerned to ensure consistency and clarity of the messages informing the global development of bioenergy. The process will be followed up in 2019.

## **Advanced Motor Fuels Technology Collaboration Programme**

There is ongoing collaboration between IEA Bioenergy and the Advanced Motor Fuels (AMF) Technology Collaboration Programme, being particularly facilitated through Task 39. The work has included a "Survey of Advanced Fuels for Advanced Engines", which was prepared through the collaboration.

## **GBEP**

IEA Bioenergy and GBEP renewed the letter of cooperation in 2018. Collaboration in the framework of GBEP Activity Group 7 "Biogas" is being pursued. Other areas are being kept under consideration for further engagement.



## **FAO**

The collaboration with FAO under the MoU signed in 2000 is continuing with ongoing discussions on areas for collaboration.

## **IRENA**

The collaboration with IRENA is continuing with both organisations reviewing outputs from each other's work programmes and regularly monitoring opportunities for potential cooperation.

## **SEforALL**

IEA Bioenergy is collaborating with SEforALL on the Biofuels Below50 Initiative through Task 39.

## **Biofuture Platform/Mission Innovation**

IEA Bioenergy has ongoing discussions with both the Biofuture Platform and Mission Innovation to investigate potential collaboration.

## **Promotion and Communication**

The effective communication of IEA Bioenergy activities and information to stakeholders, in particular to decision makers, is a key priority of ExCo, which is re-emphasised in the Strategic Plan 2015-2020. The range of promotional material available through the Secretariat includes Annual reports, technical brochures, copies of IEA Bioenergy news, the new Strategic Plan, strategic papers, and workshop proceedings. The IEA Bioenergy website is central to this publishing activity.

The 2017 Annual report included the special colour section on "*Bio-CCS and Bio-CCUS in climate change mitigation and extended use of biomass raw material*". Some copies from the original print run of 550 remain, with substantially increased distribution in electronic format.

The newsletter 'IEA Bioenergy News', which is distributed in June and December each year following the ExCo meetings, continues to be widely circulated. Two issues were published in 2018. As a special theme the first issue featured bioenergy in Canada and the second issue featured bioenergy in the USA. The newsletter is also produced in electronic format and is available from the IEA Bioenergy website. A single page electronic newsletter covering recent ExCo and Tasks' activities was also produced and distributed at the end of March and September 2018. A free subscription to the TCP newsletters is offered to all interested and there is a wide distribution outside of the normal IEA Bioenergy network.

Two contributions under the banner of 'IEA Bioenergy Update' were provided to the journal Biomass and Bioenergy in 2018 bringing the total to 65. 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. In 2018 the Technical Coordinator participated in meetings of the Transport Coordination Group and of the Fossil Fuels Working Party. He reviewed the *IEA Renewables 2018 – market analysis and forecast from 2018 to 2023* report and provided input on behalf of IEA Bioenergy. He has had regular engagements to facilitate information exchange from IEA Bioenergy to IEA Headquarters and vice-versa.

The Chair of IEA Bioenergy, Jim Spaeth, attended the REWP meeting in Paris in March and presented the IEA Bioenergy Annual Briefing report to the IEA. The Secretary, Pearse Buckley, attended the REWP meeting in October in Rome.

Paolo Frankl attended ExCo82 on behalf of IEA Headquarters and made a presentation to the IEA Bioenergy Conference 2018 in San Francisco. This participation by Headquarters is appreciated by the Members of the ExCo and helps to strengthen linkages between the Technology Collaboration Programme and relevant Headquarters initiatives.

Status reports were prepared by the Secretary and forwarded to the Desk Officer and the REWP following ExCo81 and ExCo82. Information was also sent to Carol Burelle, Vice Chair of the End Use Working Party (EUWP) for the Transport sector. This forms part of the exchange of information between Technology Collaboration Programmes and the Working Parties.

## IEA Bioenergy Website

The IEA Bioenergy website ([www.ieabioenergy.com](http://www.ieabioenergy.com)) has had incremental development in 2018. The content has been updated as required during the year.

From the website statistics for the year 2018 the key data were as follows:

- Total number of users: 33,790
- Total number of sessions: 48,380
- Total number of page views: 187,950

## 2. PROGRESS IN 2018 IN THE TASKS

### TASK 32: Biomass Combustion and Co-firing

#### Overview of the Task

Task 32 aims 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.

Biomass combustion technologies are commercially established with high availability and a multitude of options for integration with existing infrastructure on 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. The areas covered by the Task through different activities in the current triennium are:

- WP1. Decentralised heat production
- WP2. Efficient industrial combustion and CHP
- WP3. Near zero emissions from industrial combustion
- WP4. Cofiring and full conversion
- WP5. Low grade fuels and fuel pretreatment
- WP6. Climate impact of biomass combustion and bio-CCS
- WP7. Dissemination and outreach

The specific actions of Task 32 involve collecting, sharing, and analysing the policy aspects of results of international/national R&D programmes in the above areas. 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 areas are of a technical character, Task 32 also addresses non-technical issues on fuel logistics and contracting, environmental constraints and legislation, public acceptance and financial incentives. An example is the policy report on renewable heat, which is currently being drafted.

*Participating countries:* Austria, Belgium, Canada, Denmark, Germany, Ireland, Italy, Japan, The Netherlands, Norway, South Africa, Sweden, and Switzerland.

**Task Leader:** Ir Jaap Koppejan, Procede Biomass BV, The Netherlands

**Sub-Task Leader for Co-firing:** Marcel Cremers, DNV-GL, The Netherlands

**Sub-Task Leader for Industrial Combustion:** Anders Hjörnhede, RISE, Sweden

**Sub-Task Leader for Small Scale Combustion:** Thomas Nussbaumer, Verenum, Switzerland

**Operating Agent:** Ir Kees Kwant, NL Enterprise Agency, The Netherlands

The Task Leader directs and manages the work programme, assisted by sub-Task leaders for specific areas. 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, 4, 5 and 6; the Task website [task32.ieabioenergy.com](http://task32.ieabioenergy.com) and the IEA Bioenergy website [www.ieabioenergy.com](http://www.ieabioenergy.com) under 'Our Work: Tasks'.

## Progress in R&D

### Task Meetings and Workshops

In 2018, Task 32 organised two internal meetings and two workshops. The internal meetings were used to monitor progress in different Task activities and plan and reflect on new Task activities. Another important aspect of the Task meetings is that actual developments on application of biomass combustion are shared amongst the member countries of the Task, thereby facilitating an important learning effect.

Workshops are a proven concept to gather and disseminate information in a structured and effective manner. Normally, invited speakers present the 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 May 2018, Task 32 organised a workshop with Task 33, 36 and the European Recovered Fuels Organisation as part of the European Biomass Conference in Copenhagen, Denmark on the topic of the production and utilisation of solid recovered fuels (SRF). It was attended by approximately 40 persons and provided insight into relevant circumstances that could make SRF production an attractive alternative for mass incineration. Examples of such new applications are cement kilns, dedicated power plants, gasification feedstock and refinery input.

In September 2018, Task 32 and Task 40 jointly organised a workshop in Tokyo, Japan with NEDO, METI and UNU/IAS on potential technical and organisational improvements to biomass supply chains in South East Asia. Many East and South East Asian countries see rapid development in the use of both liquid and solid biomass for modern bioenergy. Apart from using domestic biomass, Japan and South Korea have started to import large volumes of biomass (wood pellets and palm kernel shells) for co-firing with coal from countries in the Pacific Rim such as Indonesia, Vietnam and Western Canada. In Thailand, Malaysia, Indonesia and several other Asian countries, the trade and use of liquid biofuels in transport and the modern use of solid agro-residues for combustion and anaerobic digestion is increasing rapidly, facilitated by conducive support frameworks.

The event was attended by approximately 70 industrial stakeholders as well as policy makers, academics and local biomass associations from Japan and other countries in Southeast Asia.

Several other workshops took place in this past triennium. All workshop reports can be downloaded from the Task 32 website. Reports from internal Task meetings are available to member countries only, using login credentials.

## Work Programme

The progress achieved during 2018 is shown below:

### ***D1. Strategic study on the potential for renewable heat from biomass boilers***

This project concerns a number of carefully selected case studies directed at policy makers that show how biomass combustion can play a role in the green transition (in terms of job creation, economic growth, climate change and mitigation) particularly for renewable heat. It contains both cases for successful projects as well as good examples of effective support policies. The cases are available since February 2019.

### ***D2. Status of PM measurement methods and new developments***

This report describes the pros and cons of different methods that are currently in use to sample and measure particle matter in flue gases from small scale combustion devices. It also describes new methods that could help to improve the existing methods.

### ***D3. State-of-the-art report on application of biomass combustion based CHP with case studies and identification and assessment of innovative developments***

This report describes good examples for existing CHP projects (proven technologies) on the one hand, and innovative CHP technologies on the other. The final report will be available in February 2019.

#### ***D5. Report on consequences of real life operation on performance of stoves***

This report evaluates the real life emissions of stoves and shows the differences between type testing results and operation in practise. The work calls for modification of existing measurements methods to better represent real life operation

#### ***D7. Report on options for better ash utilisation***

This project reviews current uses of biomass ashes in different Task 32 member countries and provides recommendations for improved use. It was performed under the coordination of DNV-GL with input from VGB, ECOBA, Vliegassunie, ESKOM, OPG, and other power utilities. Country reports were prepared for Sweden, Canada and The Netherlands and an internal workshop was held.

#### ***D10. Inter task project to evaluate the costs/benefits for fuel pretreatment of biomass residues in the supply chain for thermal conversion (with Task 33, 34, 36, 40 and 43)***

This is an Inter-Task project that contains case studies, a policy report and database. The results were presented at the IEA Bioenergy conference in San Francisco, November 2019. Five case studies have been published:

1. Biomass Torrefaction, Michael Wild, Lotte Visser
2. Moisture, physical property, ash and density management as pre-treatment practices in Canadian forest biomass supply chains – Evelyne Thiffault. Shahab Sokhansanj, Mahmood Ebadian, Hamid Rezaei, Ehsan Oveisi Bahman Ghiasi, Fahimeh Yazdanpanah, Antti Asikainen and Johanna Routa
3. Pretreatment of municipal solid waste (MSW) for gasification, Dieter Stapf, Giovanni Ceceri, Inge Johansson, Kevin Whitty
4. The steam explosion process technology, Patrick Wolbers (DNV GL), Marcel Cremers (DNV GL), Travis Robinson (NRCan), Sebnem Madrali (NRCan), Guy Tourigny (NRCan), Rob Mager (Ontario Power Generation), Rune Brusletto (Arbafame)
5. Leaching as a biomass pre-treatment method for herbaceous biomass, Koen Meesters, Wolter Elbersen, Pascal van der Hoogt, Hristo Hristov

The results of the cases were used as input for the policy report, which also contains more general information on the possible impact of pretreatment on biomass availability. This report will be published in February 2019.

A new database module on pretreatment operations was prepared as part of the IEA Bioenergy technology database. A number of records were inserted to illustrate advanced biomass pretreatment facilities.

### ***D12. Website upgrade and update (industry, policy makers)***

The Task 32 website [task32.ieabioenergy.com](http://task32.ieabioenergy.com) is continuously updated. It attracts about 4,000 visitors every month and is one of the key tools for information dissemination. The 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.

### ***D14. Report on the role of thermal biomass plants in a future renewable energy system***

This project analyses the strategic role of biomass based power plants for balancing a grid system with relatively high variable renewable energy sources. This project concerns a case study based on the expected future German renewable electricity system, where the potential role of biomass based electricity is evaluated using the Balmorel model. The results were presented at the final IEA Bioenergy conference and a report will be available in February 2019.

## **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 pursued with other Bioenergy Tasks or other Implementing Agreements such as the IEA District Heating and Cooling agreement and the 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. Several power companies are currently directly involved in the Task. Effective coordination is achieved through joint events, and the exchange of meeting minutes and reports.

## **Deliverables**

The following milestones were achieved in 2018. Organising and minuting of two Task meetings. Organising and reporting of a workshop on "Production and Utilisation Options for Solid Recovered Fuels"; Organising and reporting of a workshop on "Future perspectives of bioenergy development in Asia"; Publication of reports on 'Advanced test methods for firewood stoves', 'Status of PM measurement methods and new developments', 'Improved Ash Utilisation', 'Consequences of Real Life Operation on Performance of Stoves', 'Application of Biomass Combustion Based CHP', five case study reports on pretreatment, 13 case studies on renewable heat. Further there was 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: Gasification of Biomass and Waste

### Overview of the Task

The objectives of Task 33 are:

- (1) to promote commercialisation of biomass gasification, including gasification of waste, to produce fuel and synthesis gases that can be subsequently converted to substitutes for fossil fuel-based energy products and chemicals, and lay the foundation for secure and sustainable energy supply;
- (2) to assist IEA Bioenergy Executive Committee activities in developing sustainable bioenergy strategies and policy recommendations by providing technical, economic, and sustainability information for biomass and waste gasification systems.

*Participating countries:* Austria, Denmark, Germany, Italy, The Netherlands, Norway, Sweden, Switzerland and USA.

**Task Leader:** Prof Kevin Whitty, University of Utah, USA

**Operating Agent:** Jim Spaeth, U.S. 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 the Task website [task33.ieabioenergy.com](http://task33.ieabioenergy.com) and the IEA Bioenergy website [www.ieabioenergy.com](http://www.ieabioenergy.com) under “Our Work: Tasks.”

### Progress in R&D

#### Task Meetings and Workshops

The first Task 33 meeting for 2018 was held 7-9 May in Alkmaar, The Netherlands and was organised by Task 33 and ECN. The Task business meeting was held on the first day and a workshop on Gasification of Waste was held on the second day. The third day included technical tours to the Torrgas gasification facility in Groningen and the ESKA gasification facility in Sappermeer where paper rejects are gasified for steam production.

The second Task 33 meeting was held November 5 in conjunction with the IEA Bioenergy Conference (one day of the ABLC Global Conference) in San Francisco. A half-day Task meeting was held in the morning and in the afternoon the Task members drove to Woodland, California to visit West Biofuels and tour their gasification development facility.

The meetings and workshops were well attended and provided very good opportunity for valuable information exchange. All presentation can be found at the Task 33 website.



## **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 program of work that addresses the needs of the participating countries.

Furthermore, the aim is to increase the number of countries participating in Task 33. Australia, Brazil, Canada, France, Japan, Spain and the UK, for example, are very active in thermal biomass gasification and their membership would be profitable for all participants.

The Task monitors the current status of key operations and R&D efforts relating to biomass and waste gasification, and identifies hurdles to advance further development, operational reliability, and economics of gasification systems. The Task meetings provide a forum to discuss the technological advances and issues critical to scale-up, system integration, and commercial implementation of these processes. 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 workshops to present their practical experiences and to discuss the options for development of critical process components to advance state-of-the-art biomass and waste gasification 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 to share information and foster cooperation in order to address and support basic research needs.

## **Work Program/Sub-task Studies**

The current work program 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. The two Task meetings and associated workshops and technical tours for 2018 were presented above.
- Prepare and publish reports on issues relating to gasification of biomass and waste. During 2018 several reports were completed and published on the Task 33 website. A list of those reports is given below in the "Deliverables" section of this report.
- Survey the current global biomass and waste gasification RD&D programmes, commercial operations and market opportunities for gasification, 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 biomass and waste gasification technology.
- 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 program on the Task website ([www.task33.ieabioenergy.com](http://www.task33.ieabioenergy.com)) for information dissemination. Maintain the website with Task updates.
- Maintain Task 33 database on thermal gasification facilities worldwide.

### ***Observations from Workshop: Gasification of Waste***

Typically Task 33 will host two workshops per year. In 2018, only one workshop was held since the final meeting of the Task was in conjunction with the IEA Bioenergy Conference in San Francisco and no Task-specific workshop was arranged.

The workshop, which was entitled Gasification of Waste, was held May 8 in Petten, The Netherlands. It was organised jointly between Task 33 and ECN, which hosted the workshop at their technical research centre. Several presentations focused primarily on applications of gasification technology were presented. A list of presentations is given below.

- Waste Gasification Overview: Two-stage Incineration and “True” Gasification  
*Lars Waldheim, Waldheim Consulting, Sweden*
- Valmet CFB Gasifier  
*Juhani Isaksson, Valmet, Finland*
- Synova: Waste-to-Energy  
*Bram Van der Drift, Synova, The Netherlands*
- EQTEC: From RDF to SNG – Previous Experiences to Overcome Gasification Challenges  
*C. Berrueco Moreno, EQTEC, Spain*
- Reject Gasifier ESKA  
*A. J. Grootjes, ECN, The Netherlands*
- Waste Gasification in Fluidised Bed for Cogeneration Application – Terracotta Collaborative Project  
*M. Insa, EDF, France*
- Poultry Manure Gasification with a Small CHP Plant  
*R. Andreatta, Proerg, Italy*
- Lignin Gasification – The AMBITION Project  
*E.T. Liakakou, B.J. Vreugdenhil*
- Electricity from Wood for 2 € cents/kWh  
*M. Huber, Syncraft, Austria*

The workshop was very well attended and built a platform for information exchange, which is one of the aims of Task 33. All presentations as well as a summary workshop report can be found at the IEA Bioenergy Task 33 website ([task33.ieabioenergy.com](http://task33.ieabioenergy.com)).

Site visits were held the day after the workshop and included tours of two gasification facilities. The ESKA gasifier in Sappermeer gasifies paper rejects for production of steam. The Torrgas facility that was toured is located in Groningen, and the gasification technology being developed by that company focuses on syngas production.

### **Website and Database**

The Task website ([www.task33.ieabioenergy.com](http://www.task33.ieabioenergy.com)) is the most important tool for dissemination of information and results from this Task. Descriptions of the gasification process and a description of the Task including the contact data of national experts are provided. Within 2 weeks after each Task meeting, all presentations in PDF form (country reports, workshop presentations) can be found on the Task website. The Minutes are posted on the member's area of the website as soon as all Task members provide their feedback. The summaries of the workshops can be found on the website in a Report form.

A Google-map based interactive database of implementations of gasification plants has been incorporated into the Task website. At the moment, there are over 150 gasification facilities, mostly in member countries, registered in the database. The database is interactive, which means that the technology, type, and status of the gasifiers can be chosen to filter all the gasification facilities registered in the database. The possibility to filter also based on the feedstock/raw material was recently added to the database. The database is updated regularly and provides a good overview on gasifiers throughout the world.

In 2016 a status report on thermal biomass gasification in member countries was completed. The report includes the description of the technology, synthesis gas applications and a list of all biomass gasification facilities in member countries that are active in the Task 33 database. At the beginning of 2019 an update of the status report covering activities for the 2016-18 triennium will be written.

### **Deliverables**

The Task deliverables include 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 and newsletter; updating and publishing country reports; conducting joint studies, conferences, and workshops with related Tasks, Annexes, and other international bodies to address mutually beneficial issues; and preparation of periodic progress, financial and annual reports as required by the IEA Bioenergy Executive Committee (ExCo).

# TASK 34: Direct Thermochemical Liquefaction (DTL)

## Overview of the Task

The objective of Task 34 is to facilitate commercialisation of liquid fuels from biomass as energy carriers. Of particular interest are fast pyrolysis and hydrothermal processing to maximise liquid product yield and production of renewable fuel oil and transportation fuels. The Task contributes to standardisation efforts of these energy intermediates, 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 advancement of issues that will permit more successful and more rapid implementation of biomass liquefaction technology, including identification of opportunities to provide a substantial contribution to bioenergy.

The Task scope includes all steps in a process of liquid fuels production from biomass extending 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 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 will cover optimisation, alternatives, economics, and market assessment.

The work of the Task aims at concerns and expectations of stakeholders such as:

|  |   |
|--|---|
| <ul style="list-style-type: none"><li>• Conversion technology developers</li></ul> | <ul style="list-style-type: none"><li>• Bio-oil/biocrude application developers</li></ul> |
| <ul style="list-style-type: none"><li>• Equipment manufacturers</li></ul>          | <ul style="list-style-type: none"><li>• Bio-oil users</li></ul>                           |
| <ul style="list-style-type: none"><li>• Chemical producers</li></ul>               | <ul style="list-style-type: none"><li>• Utilities providers</li></ul>                     |
| <ul style="list-style-type: none"><li>• Policy makers</li></ul>                    | <ul style="list-style-type: none"><li>• Decision makers</li></ul>                         |
| <ul style="list-style-type: none"><li>• Investors</li></ul>                        | <ul style="list-style-type: none"><li>• Planners</li></ul>                                |
| <ul style="list-style-type: none"><li>• Researchers</li></ul>                      |   |

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. At least three of the existing National Task Leaders (NTL) have continuing and close relationships with industrial partners that are currently commercialising liquefied biomass as energy carriers in Finland, The Netherlands, and Canada.

*Participating countries:* Canada, Finland, Germany, The Netherlands, Sweden, New Zealand, Norway, and USA

**Task Leader:** Mr Alan Zacher, Pacific Northwest National Laboratory, USA

**Operating Agent:** Mr Jim Spaeth, US Department of Energy, USA

A National Team Leader from each country is responsible for coordinating the national participation in the Task. For further details on Task 34, refer the Task website [task34.ieabioenergy.com](http://task34.ieabioenergy.com) and the IEA Bioenergy website [www.ieabioenergy.com](http://www.ieabioenergy.com) under 'Our Work: Tasks'.

### **Work Programme and Progress in 2018**

This year the national team leaders worked on a variety of efforts to advance research in thermally liquefied biomass for use as energy carriers, with the additional goal of providing value to Task 34, the international thermal liquefaction research community, as well as the interests of the individual member states. To further these efforts, Task meetings were held in conjunction with both international and regional bioenergy meetings and workshops in order to have the opportunity to influence and support planning and research in thermal liquefaction for use in renewable energy. Task work in 2018 included Task meetings, providing support to standards development work, supporting commercialisation work in pyrolysis and hydrothermal liquefaction, influencing research trends by multiple Task leaders presenting at regional and international bioenergy workshops, and continued information dissemination to stakeholders through the PyNe newsletter, journal publications, web resources, and circulation of articles and theses that may have broader use among member countries.

This was accomplished through collaborations among Task members to provide data and guidance to standardisation efforts, publications and outreach, Task meetings, technical seminars, technical tours, and Task projects, in addition to management and ExCo support actions. The work efforts in 2018 included:

- Two task meetings coinciding with international and IEA sponsored workshops or technical tours in The Netherlands, Germany, and the USA.
- Continued publication of the electronic PyNe newsletter to highlight current research, standards work, collaborations, and successes in bioenergy through thermal liquefaction of biomass.
- A new Round Robin was completed in comparative analysis of pyrolysis bio-oils and hydrothermal liquefaction bio-crudes representing a variety of liquefaction technologies and biomass types. The preliminary results were presented at the ABLC Global 2018, highlighting specific recommendations for the development of standardised analyses that better reflect some elemental analysis of bio-crudes.

- Participation in committees and/or dissemination of new of standards and norms for bio-oil intermediates and analytical standards has continued in both Europe and the USA with Task member input to some standardisation committees. Current progress with CEN and ASTM standardisation is detailed in PyNe42 newsletter during 2018.
- The Task 34 website on the IEA Bioenergy servers has undergone a major overhaul of information, links and resources. The original website had a 20 year history focused primarily on pyrolysis applications, so the site was updated with complementary resources on solvo- and hydrothermal liquefaction technologies, applications, and products. In addition, the primary pages were rewritten to move away from a pyrolysis centric approach, and the pyrolysis sections were updated with more current information. The old website was shuttered in 2017 and redirected to <http://task34.ieabioenergy.com> bringing a modern face and focus to the biomass liquefaction community.
- Reporting and publicising ongoing collaborations and research in bioenergy in the form of sharing of country reports by country representatives at Task meetings. This serves as a method for identifying and forming alignments between research organisations in member states to advance research and commercialisation efforts.
- Updates are being maintained to the web-based demo plant database developed by Bioenergy 2020+

## **Workshops and Associated Task Meetings**

There were two primary meetings that were held and associated with regional and international workshops and sites. The first was in both The Netherlands/Germany, and the second held in the USA.

### ***Task Meeting: The Netherlands and Germany, 22 -25 May 2018***

The first Task meeting of 2018 was held as a travelling meeting between The Netherlands and Germany with a series of site visits of active biomass research and applications. Due to the number of active DTL applications and research groups in The Netherlands and Germany, the Task 34 Meeting was interleaved with site visits to make efficient use of the time. Representatives from most member countries were present or served by alternates to the Task.

The business meeting portions of the Task were held in Eschede, The Netherlands and in Karlsruhe, Germany. Countries were represented by: Ben Bronson for Fernando Preto (Canada), Nicolaus Dahmen (Germany), Bert van de Beld (The Netherlands), Ferran de Miguel Mercader (New Zealand), Linda Sandström for Magnus Marklund (Sweden), and Alan Zacher (USA). Various observers from The Netherlands and Germany were present during different portions of the meeting.

Country reports were given by all NTLs present. It was noted that there is increased focus on industrial bio-energy applications in Sweden, Canada, and New Zealand. For the countries mentioned, there were specific priorities that were identified as drivers for renewable energy that could be (or are being) filled by technologies for thermally liquefied biomass. Specific international drivers and opportunities included government encouragement of industrial bio-energy, the opportunity of new attention to stranded biomass feedstocks where DTL could solve both an energy and waste problem simultaneously, the potential for biomass to supply energy needs for remote communities where energy is not available locally, and changes in some government's attitudes towards future bans on oil and gas exploration.

Regarding publications and outreach, the following topics were discussed: Analytical Round Robin, Task 34 Website progress, newsletter, and a proposal for a new Technical Expertise publication series. The Round Robin was finalised and the plans for target analytical, handling samples, handling data, and interpreting the results were discussed. The website was reviewed, and it was decided that the website was due for an overhaul to align it with the DTL scheme that was proposed previously with both pyrolysis and solvent liquefaction technologies represented in the Task and funds were committed to achieve this. Plans for the next PyNe newsletter were prepared. A proposal was conceived for a Task project of a Technical Expertise series to aid information transfer among the international research groups and stakeholders for the benefit of member countries. A need was identified for working group on materials compatibility for handling bio-oils and bio-crudes to share the current knowledge base among researchers, but also to equip industrial pioneers with information that would avoid surprises when choosing material handling equipment that they are familiar with for petroleum processing which may not be compatible with liquefied biomass. The consensus was that the priority topics should be pumps or materials compatibility, with plans for circulation among member countries. The Task agreed to test this by collecting information from willing country members for a white paper on Pump Experience. Additional discussion was held on refining the proposal for the next triennium.

Technical site visits were interleaved with the Task meeting to interact with a sample of the wide range of research and commercialisation efforts around biomass energy utilisation in The Netherlands and Germany. This included the BtG research facility in Enschede, The Netherlands; the Empyro Pyrolysis Oil Plant in Hengelo, The Netherlands; the pyrolysis oil powered boilers at FrieslandCampina in Borculo, The Netherlands; the ablative pyrolysis research unit at Fraunhofer Institute UMSICHT in Oberhausen, Germany; the bio-char demonstration plant and manufacturing facilities of Pyreg in Dörth, Germany; and the research facilities of Karlsruhe Institute of Technology in Germany along with the BIOLIQ demonstration plant.

### *Richland, Washington and San Francisco California, USA, 4-8 November 2018*

The second Task meeting of 2018 was held in Richland, WA, USA and then continuing to San Francisco to ExCo83, the IEA Bioenergy conference, and ABLC Global 2018. Representatives from most member countries were present or served by alternates to the Task.

The business meeting portions of the task were held in Richland, USA. Countries were represented by: Fernando Preto (Canada), Axel Funke (Germany), Bert van de Beld (The Netherlands), Ferran de Miguel Mercader (New Zealand), Magnus Marklund (Sweden), and Alan Zacher (USA).

Announcements were made with regards to NTL and Task Leadership for the upcoming triennium. It was announced that Ferran would be leaving his institution and unable to represent New Zealand and lead the Task, and a replacement NTL had not been decided. The Task decided that Germany would lead the upcoming triennium with Axel Funke as the new NTL. In addition, the following announcements for new NTL were made: Benjamin Bronson for Canada, Justin Billing for the USA, Linda Sandström for Sweden, Christian Lindfors for Finland. Discussions were held on pending invitations to new member countries for the coming triennium, and it was agreed that it would be good for the research community if Denmark, Australia, Korea, Norway, and the UK would consider involvement within the task.

Refinements were made to the proposal for the upcoming triennium. Including the customary deliverables, it was suggested that short videos on liquefaction topics may resonate with the research community and be more influential in the modern communication channels.

Technical tours included meeting with Manuel Garcia-Perez at WSU to talk about current research in pyrolysis at WSU, and tours at Pacific Northwest National Laboratory including the batch and continuous combinatorial catalysis centres; the alcohol-to-jet laboratory; the hydrothermal liquefaction pilot plant and demonstration plants; the bio-oil hydrotreating bench, pilot, and demonstration plants, among others.

Country reports were also discussed along with evaluating plans for completing the Round Robin and preparations for 2019.

The Task moved down to San Francisco to participate in ExCo82, the IEA Bioenergy conference, and ABLC Global 2019 with speakers and participation in these events.



## Newsletter

In 2018 the PyNe newsletter was produced twice to publicise and highlight ongoing research and collaborations in member countries, with particular emphasis on active research and growing commercialisation efforts. A variety of pyrolysis and pressure liquefaction research was featured in both issues. Notably PyNe42 had two articles on current bio-oil standardisation efforts with CEN and ASTM. Also featured in 2018 were the progress of various companies towards commercialisation in both pyrolysis oil applications as well as hydrothermal liquefaction work in Europe and North America.

The new network mailing list continues to grow, and the newsletter management accounts were set up to allow painless transfer of the distribution list and PyNe Editor's account to the next newsletter editor.

## Website/Dissemination and Substitute Electronic Brochure

The Task 34 website underwent a major overhaul of information, links and resources in 2018. To fully align with the expansion of the Task technologies this triennium, this year a complete rewrite of the site was completed. A new framework was established in graphical format to show the operations from biomass to energy and end products, showing harmonisations and differentiations among the direct thermochemical liquefaction routes. The primary graphic was rendered as a clickable index to the site content to serve as a contextual interface to the information on the site to supplement the existing textual menu structure, which was then set as the lower homepage. During the overhaul, a new template for every page was established that leads with key summary points, current examples (both onsite and offsite), and additional reading links to Task 34 publications. The original template was text heavy and geared for a research audience only, while the new template will appeal to stakeholders of any level of experience with direct thermochemical liquefaction

Additionally, the update included the creation of new content to provide current reference information on solvo- and hydrothermal liquefaction technologies, applications, and products. The new content was set up to complement the pyrolysis related information that had been the bulk of the content. Additionally, much of the site was updated to broaden the pyrolysis centric approach with information relating to applications of liquefied biomass in general. A complete overhaul was also performed on the most popular links to update both the textual information as well as example graphics in the pyrolysis focused sections.

The refresh of the site has increased traffic significantly in 2018 and website analytics have been identifying the areas that should be updated more frequently to provide the data that the research community is most interested in.

## Brochure

The updated brochure deliverable has been replaced with the additional effort to update the PyNe website as an electronic brochure. This was the correct path based on three factors: 1) Technology, 2) Flexibility, and 3) Avoids duplication of effort that leads to contradictory references over time.

First, the widespread availability of technology has resulted in most stakeholders receiving information from the Task in electronic format or on electronic devices. As a general reference for DTL, a brochure form would most likely be consumed in electronic, and not consumed linearly, but following particular topics and taking advantage of inter-document hyperlinks. These are either more cumbersome or difficult in a closed electronic document.

Second, the advancements in research are proceeding quickly enough that a brochure is out of date the moment it is printed. The brochure does not provide the ability to add and change content. This is particularly sensitive as the cover of the original brochure featured a company that did not succeed and left the industry. This allows for immediate links to be inserted for the reader when new research is published that would not be possible in a print format.

Third, this avoids a duplication of effort that soon leads to contradictory references. The information on the website and the brochure would be identical at the time of putting together a brochure. However, as found with the prior brochure, updates on research advancements made the brochure out of date and in some cases incorrect.

Thus, it was decided to expend the resources originally slated for the brochure on the website and the Task efforts making the dissemination of data more efficient and timely.

## Deliverables

Deliverables for 2018 included: Initial results presented at ABLC Global 2018 of the Analytical Round Robin, with manuscript to follow; reporting to the ExCo (Annual Report, progress reports, and audited accounts); updating of the Task website on bioenergy servers; Two task newsletters PyNe42 and PyNe43; and organisation and minutes of Task meetings.

For electronic links to this information visit: <http://task34.ieabioenergy.com>

## TASK 36: Integrating Energy Recovery into Solid Waste Management Systems

### Overview of the Task

In 2012 the World Bank estimated that there was around 1.3 billion tonnes of waste produced per annum globally and that this would grow to 2.2 billion tonnes/year by 2025. They attributed this rise in waste production to increased urbanisation in developing and emerging economies and the increase in per capita production of waste as a result of this trend. This trend is a considerable challenge for many countries. To meet the challenge there will need to be intensive legislative, managerial and institutional changes, including the introduction of strategic direction aimed at decreasing and controlling waste production; and the development of recycling, reduction and re-use as well as energy technologies to decrease the impact of waste. IEA Bioenergy Task 36 investigates the interface between waste management and energy recovery. Our prime aim is to understand the implications of technical and policy changes in the waste area that impact the integration of energy into solid waste management; and to provide support by disseminating and exchanging information on these developments.

Waste production varies markedly across the world, in terms of composition and quantity. Strategies and solutions that are appropriate in one region may not be right elsewhere. The consequence of this is that countries have different approaches to challenges in waste arisings, reflected in different mixtures of treatment and disposal. Nevertheless there are also common themes. Uppermost in these are concerns relating to the increasing quantities of waste needing to be treated and the impact of landfilling mixed wastes on the environment. In some regions additional pressures arise from decreasing available landfill void space. This is driving policy makers to examine alternatives to landfill, including reduction and recycling of waste, and recovery of value from waste, commonly encompassed in the 'Waste Hierarchy', which is governed by a set of principles dedicated to minimising the impacts of waste and improving resource use. In some regions there are calls for 'zero waste to landfill' and for policy to encourage the circular economy or 'smart waste management'. These moves are most advanced in the European Union and other regions where landfill is expensive or scarce. Elsewhere, notably in North America and Australia, countries continue to rely on landfill, but in these countries there are also increasing pressures to reduce waste production and to recycle or recover where possible, leading 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 continue to require guidance and information on waste and resource management systems that are environmentally and economically sustainable. 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.

*Participating countries:* France, Germany, Italy, and Sweden.

**Task Leader:** Mr Inge Johansson, RISE Research Institutes of Sweden, Sweden

**Operating Agent:** Dr Åsa Forsum, Swedish Energy Agency, Sweden

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 the Task website [www.task36.ieabioenergy.com](http://www.task36.ieabioenergy.com) and the IEA Bioenergy website [www.ieabioenergy.com](http://www.ieabioenergy.com) under 'Our Work: Tasks'.

## Progress in R&D

### Task Meetings and Workshops

The Task's core work was undertaken as structured Task meetings, each of which was accompanied with a themed workshop. The aim of these workshops is to allow Task members to present work on the nature of the issues concerned within their own country; to invite speakers to present work of relevance and to allow discussion of the issues presented.

**In May the Task arranged a joint workshop together with Task 32, Task 33, and ERF0. The theme of the workshop was the production and utilisation of Solid recovered fuels, Copenhagen, May 2018. The workshop was arranged as an official side event to the EUBCE conference.**

#### *Workshop aim:*

The aim of the workshop was to give an overview of the production and utilisation of SRF, potentially combined with possible new markets.

#### *Workshop outcomes:*

The workshop gave an insight to challenges with SRF today, both regarding legislation, production and end uses. There is a lot of interest in looking towards utilising SRF as a feedstock for different end uses. This is partly due to the low cost of the feedstock and partly because of the decreased environmental footprint that can be accomplished by utilising waste instead of virgin materials.

The cement industry has introduced SRF in their process to replace fossil energy sources and have shown the impact it has on their CO<sub>2</sub> emissions. There is still a large potential in this sector- especially in countries like China.

Neste presented their thoughts and developments regarding the use of SRF as feedstock for transportation fuel. Depending on the kind of SRF used there are still a lot of technological challenges when converting it to transportation fuel.

A conclusion from the workshop was that SRF was an important piece that could help in going from energy recovery to material recovery, thus moving upwards in the waste hierarchy, which is in line with the policy in EU. However there are also a lot of challenges associated with different end uses/conversion processes that need to be solved to unleash the full potential.

The presentations from the workshop are available at the homepage.  
([www.task36.ieabioenergy.com](http://www.task36.ieabioenergy.com)).

### **Task Meetings and Site Visits**

May 2018, task meeting in Copenhagen together with a site visit to Amager Bakke

November 2018, Task meeting in San Francisco together with the end of triennium conference.

### **Deliverables**

The deliverables for the Task in 2018 have included presentations from the workshops and minutes from the Task meetings. A newsletter was published during 2018. The Task also prepared two progress reports for ExCo together with the annual report.

### **Website**

The website ([task36.ieabioenergy.com](http://task36.ieabioenergy.com)) is the key tool used for dissemination of information from the Task. It provides access to the latest publications produced by the Task, including the presentations from the workshop. The website also provides access to past reports, articles, case studies and presentations at workshops associated with Task meetings. In addition, it provides a 'members only' forum, to allow rapid access to the latest drafts of documents and to information on Task meetings. During 2018 there were about 1500 visitors to the site. Where the country of origin is known, the most page views were from users in the France, UK, USA, Canada and China.

## TASK 37: Energy from Biogas

### Overview of the Task

The main objective of the Task 37 work programme is to address the challenges related to the economic and environmental sustainability of biogas production and utilisation. While there are thousands of biogas plants in OECD countries, operation in the vast majority of cases can only be sustained with the help of subsidies to be able to compete with the fossil energy industrial sector. There is a clear need to enhance many of the process steps in the biogas production chain, particularly at small farm-scale, in order to reduce both investment and operating costs and to increase income.

The approach of Task 37 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. In addition, there is growing interest in the use of biogas and biomethane to help stabilise power grids that are increasingly fed from variable sources of generation like wind and solar.

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 at small and large farm-scale, in waste water treatment plants and treatment of the biodegradable fraction of municipal waste (biowaste), energy crops and algae.

Only recently have the environmental performance of biogas production and utilisation been assessed in detail. Recent studies have identified key sources of emissions of greenhouse gases at various stages of the biogas production chain. Task 37 has addressed emissions and is directing attention to environmental sustainability of biogas production and utilisation and is working towards defining best practices for emissions reduction.

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 drafting of standards in Member Countries.

*Participating countries:* Australia, Austria, Brazil, Denmark, Estonia, Finland, France, Germany, Ireland, Korea, Norway, Sweden, Switzerland, The Netherlands and the United Kingdom.

**Task Leader:** Prof Jerry D Murphy, MaREI Centre, Environmental Research Institute, University College Cork, Ireland

**Operating Agent:** Matthew Clancy, Sustainable Energy Authority of Ireland, Dublin, Ireland

The Task Leader directs and manages the work programme. National Team Leaders are responsible for coordinating the national participation in the Task and for coordinating specific topics in the work programme.

For further details on Task 37, please refer to Appendices 2, 4, 5 and 6; the Task website <http://www.iea-biogas.net/> and the IEA Bioenergy website [www.ieabioenergy.com](http://www.ieabioenergy.com) under 'Our Work: Tasks'.

## Progress in R&D

In 2018 the work programme consisted of the following Topics:

- Preparation of Technical Reports;
- Collaboration with other Tasks;
- Country Reports and Databases;
- Case Studies;
- Task Meetings and Workshops;
- Website, Videos, Newsletters and Webinars;
- Deliverables of Task 37 in 2018.

## Preparation of Technical Reports

The progress on the content of new technical brochures/reports is summarised below.

Published reports may be viewed at <http://task37.ieabioenergy.com/technical-brochures.html>

### *Methane Emissions from Biogas plants*

*Liebetrau, J., Reinelt, T., Agostini, A., Linke, B. (2017). Methane emissions from biogas plants*

*Methods for measurement, results and effect on greenhouse gas balance of electricity produced. Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2017:12 ISBN: 978-1-910154-35-9 (printed paper edition) ISBN: 978-1-910154-36-6 (eBook electronic edition)*

Full report and two-page summary published December 2017.

Methane is a potent greenhouse gas with a global warming potential much higher than carbon dioxide. Fugitive methane emissions from a renewable energy production system are not conducive to the ambition of reducing Greenhouse Gas (GHG) emissions. The biogas industry is growing and innovative technologies are associated with the rising numbers of facilities in operation. With new technologies it is essential to ensure minimum fugitive emissions; this leads to new challenges regarding emission monitoring, quantification and reduction. Within the biogas sector methane emission quantification is becoming a significant topic for the scientific community but is still under development for the industry sector. The methods used and the interpretation and evaluation of the results obtained is not as yet standardised. This report addresses methods used for evaluation, presents selected results of measurements, proposes mitigation measures and puts methane emissions in a context of a standard greenhouse gas balance in order to evaluate the impact of these emissions on the sustainability of the biogas system.

Three conference presentations were made based on this report:

- *J. Liebetrau, T. Clauß, T. Reinelt, Alessandro Agostini, Jerry Murphy. (2017) "Methane emissions from biogas plants – methods for determination results and relevance for greenhouse gas balances"" 15th International Water Association Anaerobic Digestion 17 – 20 October 2017, Beijing China*
- *Alessandro Agostini, J. Liebetrau, T. Clauß, T. Reinelt, Jerry Murphy. Evaluation of the impact of methane emissions on the carbon footprint of biogas plants. 4th International Conference on Renewable Energy Gas Technology, 22 – 23 May 2017, Parchi del Garda, Italy*
- *Jan Liebetrau (2018) Emissions from Biogas plants – methods for measurement, results and overall evaluation, Conference of the European biogas association, January 24-26 Antwerp*

### **Food Waste Digestion**

*Banks, C.J., Heaven, S., Zhang, Y., Baier, U. (2018). Food waste digestion: Anaerobic Digestion of Food Waste for a Circular Economy. Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2018: 12 ISBN: 978-1-910154-58-8 (eBook electronic edition), 978-1-910154-57-1 (printed paper edition)*

Full report and two-page summary published December 2018.

There is increasing awareness of the quantities of food that are lost every year across the globe; while the quality of available data varies, estimates suggest the total is around 1.3 billion tonnes. These losses occur at all stages of production, from pre-harvest on the farm through to post-harvest losses during processing, distribution, retailing and consumption. This report considers only those harvested food materials that are never consumed, but ultimately find their way into the waste stream. The emphasis of this report is on how food waste digestion can be done successfully, within the circular economy. The report includes case studies from 11 countries.



***Green Gas: Facilitating a future green gas grid through the production of renewable gas***

Wall, D., Dumont, M., Murphy, J.D. (2018). *Green Gas: Facilitating a future green gas grid through the production of renewable gas*. Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2018: 2  
ISBN: 978-1-910154-38-0 (eBook electronic edition), 978-1-910154-37-3 (printed paper edition)

Full report and two-page summary published February 2018.

The report deals with the Green Gas Commitment and includes 6 European Gas Grids who have an ambition of substituting 100% of natural gas with green renewable gas by 2050. The report discusses how such an industry will evolve. It discusses the gas grid, gas quality and the role of the gas grid in the future. It explains why biogas is used to produce biomethane instead of CHP. It sets out the importance of green gas in supplying renewable energy in transport and in renewable heat such as for industries on the gas grid. The potential route to green gas and scale of the potential industry is outlined for a number of member countries.

A paper was published based on this report:

- Wall, M.D., McDonagh, S., Murphy, J.D. 2017. *Cascading biomethane energy systems for sustainable green gas production in a circular economy*. *Bioresour. Technol.* <https://doi.org/10.1016/j.biortech.2017.07.115>

A conference presentation was made based on this report:

- Jerry D Murphy, David Wall (2017) "Use of circular economy and cascading bioenergy systems in ensuring sustainable biogas production" 15th International Water Association Anaerobic Digestion 17 – 20 October 2017, Beijing China

***INTEGRATED BIOGAS SYSTEMS: Local applications of anaerobic digestion towards integrated sustainable solutions***

McCabe, K., Schmidt, T. (2018). *INTEGRATED BIOGAS SYSTEMS: Local applications of anaerobic digestion towards integrated sustainable solutions*. Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2018: 5

ISBN: 978-1-910154-40-3 (eBook electronic edition), 978-1-910154-39-7 (printed paper edition)

Full report and two-page summary published May 2018.

In 2015, the United Nations adopted 17 sustainable development goals (SDGs). The biogas industry is well placed to achieve nine of these SDGs, which pertain to food and energy security, well-being, gender equality, sustainable water management and sanitation, resilient regions and cities, sustainable industrialisation and combating the effects of climate change.

To ensure that the biogas industry is on track to meet these nine SDGs it is imperative that the biogas sector is both economically and environmentally sustainable. Experiences from traditional biogas approaches have shown that significant government support is still required to make this market competitive and some of these systems are lacking sustainability in terms of high costs and environmental impact. Innovation, optimisation and implementation strategies are necessary to transform conventional digesters into more sustainable anaerobic digestion systems. Nine case stories from seven countries (Australia, Brazil, Ghana, Nepal, New Zealand, Rwanda and India) are used to illustrate local applications of anaerobic digestion towards integrated sustainable solutions.

### ***The Role of Anaerobic Digestion and Biogas in the Circular Economy***

*Fagerström, A., Al Seadi, T., Rasi, S., Briseid, T. (2018). The role of Anaerobic Digestion and Biogas in the Circular Economy. Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2018: 8*

*ISBN: 978-1-910154-45-8 (printed paper edition) ISBN: 978-1-910154-46-5 (eBook electronic edition)*

Full report and two-page summary published August 2018.

This technical report has been written to highlight the diversity of benefits from anaerobic digestion and biogas systems. Biogas from anaerobic digestion is not merely a concept of production of renewable energy; it cannot be compared to a wind turbine or a photovoltaic array. Nor can anaerobic digestion be bracketed as just a means of waste treatment or as a tool to reduce greenhouse gases in agriculture and in energy. It cannot be pigeonholed as a means of producing biofertiliser through mineralisation of the nutrients in slurry to optimise availability, or as a means of protecting water quality in streams and aquifers. It is all these and more. The multifunctionality of this concept is its clearest strength. Sustainable biogas systems include processes for treatment of waste, for protection of environment, for conversion of low-value material to higher-value material, for the production of electricity, heat and of advanced gaseous biofuel. Biogas and anaerobic digestion systems are dispatchable and as such can facilitate intermittent renewable electricity. The process is illustrated with case stories from 4 countries (Denmark, Finland, Norway and Sweden).

### ***Value of batch tests for biogas potential analysis***

*Weinrich, S., Schäfer, F., Bochmann, G., Liebetrau, J., (2018). Value of batch tests for biogas potential analysis; method comparison and challenges of substrate and efficiency evaluation of biogas plants. Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2018: 10*

*ISBN: 978-1-910154-49-6 (eBook electronic edition), 978-1-910154-48-9 (printed paper edition)*

Full report and two-page summary published October 2018.

The batch test is an established test system for the determination of the biogas potential of organic materials. Inter-laboratory tests and investigations analysing the impact of inoculum have revealed a significant variability in the results of the test. Other methods for the determination of the biogas potential based on chemical analysis show a significant lower variability in the results, but limited correlation with batch tests. Which test result is more accurate and free of bias remains unknown since there is no absolute value or method to be compared with.

Revisions of the available protocols and identification and elimination of causes for the variability is needed. If the variability of the batch test can be reduced, the development of biochemical analysis combined with regression analysis might become more precise and result in a higher accuracy. A further series of inter-laboratory tests (including for continuous processes and chemical analysis such as nutrient assessment) and the publication of these results are necessary for further improvement of applied test procedures and more precise results.

### **Collaborations with Other Tasks**

Collaboration with Task 40 on Sustainable Bioenergy Chains

#### ***Governance of environmental sustainability of manure-based centralised biogas production in Denmark***

*Al Seadi, T., Stupak, I., Smith, C. T. (2018). Governance of environmental sustainability of manure-based centralised biogas production in Denmark. Murphy, J.D. (Ed.) IEA Bioenergy Task 37, 2018: 7*

*ISBN: 978-1-910154-41-0 (printed paper edition) ISBN: 978-1-910154-42-7 (ebook electronic edition)*

Full report and two-page summary published July 2018.

In Denmark, at the moment, biogas is seen to have two new important functions: supporting intermittent renewable electricity (from wind and solar energy); and playing a central role in the circular bioeconomy. The most significant sustainability concern associated with biogas has been undesirable indirect land use changes and competition with fodder and food production. This led to restrictions on the use of energy crops as feedstock, and a political decision to phase out their use in Danish biogas production. Biogas sustainability is first of all about following best practice to ensure safety and sustainability improvements, throughout the closed loop supply chain. This involves the use of good practice in: crop production; handling and management of the feedstock; appropriate digestion to avoid sanitary problems of the digestate; reduction of fugitive emissions and leakages from the plant; and safe and sound application of the digestate as a biofertiliser in the field. A mix of laws, statutory orders, voluntary monitoring systems and good practice guidelines govern these issues.

## Country Reports and Databases

The Task published an updated Country Report Summary for 2017 in September 2018. It may be found at: <http://task37.ieabioenergy.com/country-reports.html>. The 71 page document summarises information on the biogas sector in 15 Task member countries, including energy recovery data, biogas utilisation data, details of support schemes and key research projects. Three individual country report presentations (Switzerland, Sweden and Brazil) were also uploaded.

In September 2018 the Task produced the 2017 upgrading plant list. This included details of approximately 600 upgrading facilities; 532 of these are in Task member countries with details of a further 68 outside Task member countries.

## Case Stories

Six case studies were published in 2018 and are available at <http://task37.ieabioenergy.com/case-stories.html>:

1. Profitable on-farm biogas in the Australian pork sector, February 2018
2. SØNDERJYSK BIOGAS BEVTOFT: Hi-tech Danish biogas installation a key player in rural development, March 2018
3. ICKNIELD FARM BIOGAS: An Integrated Farm Enterprise, August 2018
4. BIOLOGICAL METHANATION DEMONSTRATION PLANT IN ALLENDORF, GERMANY: An upgrading facility for biogas, October 2018
5. UPGRADING LANDFILL GAS TO BIOMETHANE: using the WAGABOX process, November 2018
6. GÖSSER BREWERY: The role of biogas in greening the brewing industry, December 2018

## Task Meetings and Workshops

### *Task 37 Meeting Jyväskylä, Finland, 7-9 March 2018*

A Task meeting was held from March 7 to 9 in Jyväskylä, Finland. On the 8th of March a workshop was held entitled "Circular Economy in the Food system". Presentations are available at <http://task37.ieabioenergy.com/workshops.html>. The Agenda is as below:

- Welcoming words, Saija Rasi, Senior Scientist, Natural Resources Institute Finland (Luke)
- Introduction to the work of the IEA Bioenergy Task 37, Jerry Murphy, Director SFI MaREI Centre/International Energy Agency Leader Task 37
- Circular economy in relation with biogas, Mathieu Dumont, Senior Consultant, The Netherlands Enterprise Agency (RVO.nl)

- Visions for improving circular economy in the food system in Finland, Sirpa Kurppa, Research Professor, Natural Resources Institute Finland (Luke)
- Case: Palopuro Agroecological Symbiosis – Increasing sustainability in food production, Elina Virkkunen, Researcher, Natural Resources Institute Finland (Luke)
- How to combine insect farming with a biogas processes? Jan Liebetrau, Head of Department for Biochemical Conversion and Head of Work group for Process biology at Deutsches BiomasseForschungsZentrum gemeinnützige Gmb (DBFZ)
- Case: Circwaste-project – catalyzing actions towards circular economy in Central Finland, Outi Pakarinen, Project Manager, Regional Council of Central Finland

On the afternoon of Thursday, March 8th 2018 two visits took place:

- Metener Oy, company offering solutions and technology for biogas production and upgrading, founder Mr Erkki Kalmari (Vaajakoskentie 104, 41310 Leppävesi)
- Metsä Group's bioproduct mill in Äänekoski. It is producing high-quality pulp and a broad range of other bioproducts, such as tall oil, turpentine, bioelectricity and wood fuel (Sarvelantie 1, 44100 Äänekoski)

### *Task 37 Meeting Cork, Ireland, 5-7 September 2018*

A Task meeting was held from September 5 to 7 in Cork, Ireland. On the 6th of September a workshop took place at University College Cork with an attendance of 135. The workshop was entitled "The role of anaerobic digestion and biogas in the Circular Economy." Presentations are available at <http://task37.ieabioenergy.com/workshops.html>. The agenda was as below:

#### Introductions

- Welcome to UCC from Brian Ó Gallachóir, Chair of Energy Engineering, UCC, Chair of IEA ETSAP, Director of MaREI Centre
- Welcome from Jim Gannon, Director of Sustainable Energy Authority of Ireland

#### Session 1: Anaerobic digestion in the circular economy

- Introduction from Chair Matthew Clancy, Sustainable Energy Authority of Ireland (SEAI) and Operating Agent Task IEA Bioenergy Task 37
- Introduction to IEA Bioenergy Task 37, Jerry Murphy, Director SFI MaREI Centre/ Chair of Civil Engineering & IEA Bioenergy Leader Task 37
- Local applications of anaerobic digestion towards integrated sustainable solutions, Bernadette McCabe, University of Southern, Queensland

- The role of anaerobic digestion in the circular economy, Anton Fagerström, Energiforsk, Sweden
- The biggest renewable energy generator in the world combining micro-grid with biogas and solar to foster sustainable development Jorge Callado, Itaipu Technology Park (PIT) Director, Brazil

#### Session 2: Technical aspects of biogas systems

- Introduction from Chair: Phil Hemmingway, Sustainable Energy Authority of Ireland (SEAI)
- Food Waste Digestion Systems: Charles Banks, University of Southampton
- Application of BMP Assays Günther Bochmann, IFA-Tulln BOKU – University of Natural Resources and Life Science, Vienna Institute for Environmental Biotechnology
- Fugitive Methane Emissions from Biogas Facilities Jan Liebetrau, Head of Department for Biochemical Conversion and Head of Work group for Process Biology at Deutsches Biomasse Forschungs Zentrum gemeinnützige Gmb (DBFZ)
- Flash presentations on Renewable Gas Research
- Panel discussion led by John Muldowney, Department of Agriculture, Food and Marine (DAFM)

#### Session 3: Policy aspects of greening the gas grid | The Causeway Project

- Introduction from Chair: Kevin Brady Department of Communications, Climate Action and Environment (DCCAE)
- Greening the Gas Grid David Wall, MaREI Centre, UCC
- The Dutch Experience of Greening the Gas Grid Mathieu Dumont, Senior Consultant The Netherlands Enterprise Agency (RVO.nl)
- The Irish plan for a Green Gas Industry Ian Kilgallon, Innovation & Business Development Manager, Gas Networks Ireland
- Q&A on Green Gas Grid led by Brian Ó Gallachóir, Chair of Energy Engineering, UCC, Chair of IEA ETSAP, Director of MaREI Centre

#### Session 4: Technical aspects of greening the gas grid | The Causeway Project

- Q&A on Technical Aspects of Green Gas Grid led by Gas Networks Ireland

### *ExCo San Francisco, USA, November 2018*

IEA Bioenergy Task 37 hosted a session in the ABLC Global San Francisco USA, Wednesday November 7, 2018. The presentations are available at: <https://www.ieabioenergy.com/publications/iea-bioenergy-conference-2018/>

Moderator: Åsa Forsum, Swedish Energy Agency

- Mathieu Dumont, The Netherlands Energy Agency: The Dutch Experience of Greening the Gas Grid;
- Jerry Murphy, Director SFI MaREI Centre, Ireland: Task 37 Energy from Biogas: Innovation in Biogas Systems
- Guenther Bochmann, BOKU, IFA Tulln, Austria: Industrial application of anaerobic digestion
- Ruihong Zhang, Professor, University of California Davis, Biogas Energy Development in California

### *Planning of Future Task Meetings and Workshops*

Task meetings in 2019 will be held in the Estonia (8-10 May 2019) and Korea (22-25 October 2019)

## **Website, Videos, Newsletter and Webinars**

### *Webinars*

1. Methane Emissions from Biogas Plants: Methods for Measurement, Results and Effect on Greenhouse Gas Balance of Electricity Produced \_ IEA Bioenergy Webinar Series, January 18, 2018

Presented by Jan Liebetrau, Alessandro Agostini and Jerry D Murphy. Audience in excess of 4000. Presentation available at: [http://task37.ieabioenergy.com/files/daten-redaktion/download/publications/Workshops/Methane\\_emissions\\_IEA\\_Webinar\\_Presentation\\_3.pdf](http://task37.ieabioenergy.com/files/daten-redaktion/download/publications/Workshops/Methane_emissions_IEA_Webinar_Presentation_3.pdf)

2. Green Gas Webinar 22 May 2018 – IEA Bioenergy Task 37 – Australia Bioenergy – invited speakers Prof Jerry Murphy (University of Cork, Ireland and Task 37 Leader) and Mathieu Dumont (The Netherlands Enterprise Agency)

### *Videos:*

- A look behind the scenes at the IEA/SEAI Bioenergy Symposium on “Anaerobic Digestion in the Circular Economy”. [https://www.youtube.com/watch?time\\_continue=8&v=Ae74MUV756s](https://www.youtube.com/watch?time_continue=8&v=Ae74MUV756s)
- How do you see the optimal role of biogas in the circular economy? <https://www.youtube.com/watch?v=2dnwybXAFrI>

## Newletters

There were 11 newsletters issued in 2018.

## Website

The website ([www.iea-biogas.net](http://www.iea-biogas.net) & <http://task37.ieabioenergy.com>) is updated on a regular basis with: technical reports and corresponding two page summaries; case stories; databases, country report summaries; workshop proceedings; webinars. Data on website visits for the 9 month period January 1st to September 30th 2018 is outlined in table 1.

|                            | January       | February      | March         | April          | May            | June          | July          | August         | September      |
|----------------------------|---------------|---------------|---------------|----------------|----------------|---------------|---------------|----------------|----------------|
| <b>Australia</b>           | 17<br>(2.72%) | 10<br>(2.10%) | 22<br>(3.35%) | 31<br>(4.29%)  | 39<br>(6.64%)  | 14<br>(2.96%) | 14<br>(2.64%) | 27<br>(5.49%)  | 20<br>(2.97%)  |
| <b>Austria</b>             | 11<br>(1.76%) | 7<br>(1.47%)  | 18<br>(2.74%) | 14<br>(1.94%)  | 15<br>(2.56%)  | 6<br>(1.27%)  | 12<br>(2.26%) | 6<br>(1.22%)   | 14<br>(2.08%)  |
| <b>Brazil</b>              | 9<br>(1.44%)  | 11<br>(2.31%) | 36<br>(5.49%) | 21<br>(2.91%)  | 10<br>(1.70%)  | 21<br>(4.44%) | 27<br>(5.08%) | 25<br>(5.08%)  | 10<br>(1.48%)  |
| <b>Denmark</b>             | 11<br>(1.76%) | 15<br>(3.14%) | 11<br>(1.68%) | 20<br>(2.77%)  | 17<br>(2.90%)  | 17<br>(3.59%) | 6<br>(1.13%)  | 10<br>(2.03%)  | 13<br>(1.93%)  |
| <b>Estonia</b>             | 2 (0.32%)     | 1 (0.21%)     | 1 (0.15%)     | 1 (0.14%)      | 2 (0.34%)      | 2 (0.42%)     | 1 (0.19%)     |                |                |
| <b>Finland</b>             | 14<br>(2.24%) | 11<br>(2.31%) | 37<br>(5.64%) | 21<br>(2.91%)  | 9<br>(1.53%)   | 12<br>(2.54%) | 3<br>(0.56%)  | 10<br>(2.03%)  | 20<br>(2.97%)  |
| <b>France</b>              | 21<br>(3.37%) | 26<br>(5.45%) | 32<br>(4.88%) | 33<br>(4.57%)  | 25<br>(4.26%)  | 15<br>(3.17%) | 20<br>(3.77%) | 23<br>(4.67%)  | 21<br>(3.12%)  |
| <b>Germany</b>             | 42<br>(6.73%) | 28<br>(5.87%) | 31<br>(4.73%) | 35<br>(4.85%)  | 36<br>(6.13%)  | 34<br>(7.19%) | 25<br>(4.71%) | 18<br>(3.66%)  | 37<br>(5.49%)  |
| <b>The Netherlands</b>     | 15<br>(2.40%) | 14<br>(2.94%) | 12<br>(1.83%) | 97<br>(13.43%) | 16<br>(2.73 %) | 14<br>(2.96%) | 20<br>(3.77%) | 17<br>(3.46%)  | 24<br>(3.56%)  |
| <b>Norway</b>              | 12<br>(1.92%) | 9<br>(1.89%)  | 12<br>(1.83%) | 4<br>(0.55%)   | 9<br>(1.53%)   | 7<br>(1.48%)  | 8<br>(1.51%)  | 9<br>(1.83%)   | 20<br>(2.97%)  |
| <b>Republic of Ireland</b> | 25<br>(4.01%) | 16<br>(3.35%) | 38<br>(5.79%) | 42<br>(5.82%)  | 21<br>(3.58%)  | 25<br>(5.29%) | 52<br>(9.79%) | 51<br>(10.37%) | 94<br>(13.95%) |
| <b>Republic of Korea</b>   | 33<br>(5.29%) | 5<br>(1.05%)  | 15<br>(2.29%) | 8<br>(1.11%)   | 12<br>(2.04%)  | 2<br>(0.42%)  | 11<br>(2.07%) | 4<br>(0.81%)   | 11<br>(1.63%)  |
| <b>Sweden</b>              | 22<br>(3.53%) | 20<br>(4.19%) | 36<br>(5.49%) | 27<br>(3.74%)  | 24<br>(4.09%)  | 15<br>(3.17%) | 7<br>(1.32%)  | 19<br>(3.86%)  | 24<br>(3.56%)  |
| <b>Switzerland</b>         | 28<br>(4.49%) | 11<br>(2.31%) | 18<br>(2.74%) | 16<br>(2.22%)  | 14<br>(2.39%)  | 15<br>(3.17%) | 31<br>(5.84%) | 12<br>(2.44%)  | 18<br>(2.67%)  |
| <b>United Kingdom</b>      | 53<br>(8.49%) | 45<br>(9.43%) | 53<br>(8.08%) | 57<br>(7.89%)  | 50<br>(8.52%)  | 37<br>(7.82%) | 53<br>(9.98%) | 37<br>(7.52%)  | 53<br>(7.86%)  |
| <b>Total users</b>         | 621<br>(100%) | 474<br>(100%) | 648<br>(100%) | 718<br>(100%)  | 581<br>(100%)  | 471<br>(100%) | 529<br>(100%) | 490<br>(100%)  | 669<br>(100%)  |
| <b>United States</b>       | 58<br>(9.29%) | 42<br>(8.81%) | 50<br>(7.62%) | 60<br>(8.31%)  | 57<br>(9.71%)  | 38<br>(8.03%) | 40<br>(7.53%) | 29<br>(5.89%)  | 51<br>(7.57%)  |

Table 1. Results of visits to web page <http://task37.ieabioenergy.com/> by country between January 1, 2018 and 30th September 2018.



## TASK 38: Climate Change Effects of Biomass and Bioenergy Systems

### Overview of the Task

Although bioenergy is recognised as a renewable fuel and promoted as such through renewable energy policies in many countries, the climate change benefits of bioenergy have been increasingly challenged, due to emissions from direct and indirect land use change, supply chain emissions, and the relative emissions per unit energy of biomass vs fossil fuels. Nevertheless, in their special report on 1.5 degrees, released in October 2018, the IPCC has identified bioenergy, especially bioenergy linked to carbon capture and storage, as a key component of strategies to limit global warming to 2 degrees or less.

*IEA Bioenergy Task 38 on Climate Change Effects of Biomass and Bioenergy System* aims to shed light on these apparently conflicting perspectives on the effects of bioenergy on climate change. The primary goal of Task 38 is to promote the sustainable use of biomass and bioenergy through improved understanding of the climate change effects of biomass production and utilisation for energy. Task 38 devises and promotes standard methodology for quantifying the climate change effects of bioenergy systems. Our objective is to support decision makers in government and industry, in the development of climate change mitigation strategies involving sustainable bioenergy.

*Participating countries:* Australia, Brazil, Finland, France, Germany, Sweden, and USA

**Task Leader:** Annette Cowie, New South Wales Department of Primary Industries/  
University of New England, Australia

**Task Manager:** Miguel Brandão, Royal Institute of Technology, Stockholm, Sweden

**Operating Agent:** Mark Brown, Bioenergy Australia, Australia

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

For further information on Task 38, please refer to the Task 38 website <http://task38.ieabioenergy.com/> and the IEA Bioenergy website [www.ieabioenergy.com](http://www.ieabioenergy.com) under 'Our Work: Tasks'.

### Task Meetings and Workshops

During 2018 Task 38 held two face-to-face meetings of national team leaders, co-hosted a workshop and contributed to one international conference.

#### *Task 38 Business Meeting: Gothenburg, Sweden, 25-26 May 2018*

The key items covered were:

- Progress of work on 1) metrics for quantifying climate change effects, 2) Attributional vs Consequential LCA, 3) meta-analysis of GHG emissions from algae biodiesel, and 4) standard methodology
- Contribution to the Inter-Task projects “Measuring, governing and gaining support for sustainable bioenergy supply chains” and “Bio-CCUS”.
- Update on international developments: ISO, IPCC, UNCCD
- Planning for workshop with Task 43 on LULUCF accounting
- Planning for the new triennium.

#### *Task 38 Business Meeting: Uppsala (Sweden) 30-31 August 2018*

The key items covered were:

- Reflections on workshop with Task 43 and SLU on LULUCF accounting
- New Sustainability Task and related Inter-Task project proposals
- Discussion of a proposal to commission a review of integrated assessment models, including their assumptions regarding bioenergy and BECCU/S
- Progress of work on 1) metrics for quantifying climate change effects, 2) Attributional vs Consequential LCA, 3) meta-analysis of GHG emissions from algae biodiesel, and 4) standard methodology
- Contribution to the Inter-Task project “Measuring, governing and gaining support for sustainable bioenergy supply chains”.
- Update on international developments: ISO, IPCC, UNCCD, other.

*Joint Task 38, Task 43 and SLU workshop on Consequences for climate and bioenergy of land sector carbon accounting under the Paris agreement: Uppsala (Sweden) 29-30 August 2018*

The aim of the workshop, hosted by the Swedish University of Agricultural Sciences (SLU), was to inform coming decisions on an accounting framework for the land use sector under the Paris Agreement, and to contribute to the further discussion and planning of climate and energy policies. Specifically, the workshop examined and discussed:

- How different land sector carbon accounting frameworks create incentives or disincentives to harvest biomass for bioenergy and/or biomass-based products.
- How different land sector carbon accounting frameworks influence forestry and other land management options towards build-up of land carbon stocks,
- How the implementation of reference levels in carbon accounting schemes influences land management options.

The scope of the workshop was global, and case studies and analyses from different regions, biomes, political and institutional contexts were presented. The workshop brought together researchers from a range of disciplines to share insights from different approaches to assessing the consequences of land sector carbon accounting. The workshop examined the pros and cons of the current approach to land sector accounting, particularly the forest reference level (FRL, a dynamic forward baseline). While there is skepticism about the potential for gaming and creating a disincentive for harvest, it is generally agreed to be preferable to the previous gross-net approach. Recent refinements in modelling the baseline, and restriction to existing policies, have reduced criticism. The workshop identified future work required to resolve uncertain aspects. A review of effectiveness of the FRL will be undertaken by JRC, due to be released late 2019.

Presentations are available at: <http://task38.ieabioenergy.com>

## **Work Programme**

In 2018 the Task:

- Organised two Task 38 face to face business meeting (see above)
- Organised one Task 38 workshops, co-hosted with collaborating organisations (see above)
- Contributed to organising and delivering the first international conference on negative emissions
- Contributed to the letter from scientists ahead of the European Parliament vote on the EU Renewable Energy Directive, written to convey a balanced scientific view on forest bioenergy: <https://www.efi.int/news/forests-bioenergy-and-climate-change-mitigation-are-worries-justified-2018-01-16>.

- Contributed to the FAQ on climate effects of bioenergy published by IEA Bioenergy.
- Published scientific papers:
  - ▶ Review of impact-assessment methods
  - ▶ Review on quantifying the climate effects of forest-based bioenergy
- Progressed scientific papers:
  - ▶ Review of studies on the climate effects of microalgae biofuels
  - ▶ Harmonizing existing LCA tools for biofuels
  - ▶ The standard methodology for calculation of GHG emissions for different bioenergy systems developed by Task 38, being up-dated in order to capture the latest knowledge and state-of-the art methods for modelling the climate change effects of biomass and bioenergy systems.
- Participated in two Inter-Task projects (Bio-CCUS, and “Measuring, governing and gaining support for sustainable bioenergy supply chains”)

### *Scientific Papers*

The following scientific papers are published:

#### 1. Metrics for quantifying climate effects of bioenergy

Brandão, M., Kirschbaum, M.U., Cowie, A.L. and Hjulær, S.V., Quantifying the climate change effects of bioenergy systems: comparison of 15 impact-assessment methods. *Global Change Biology Bioenergy*

This paper demonstrates the differences between different metrics used to quantify climate effects of GHG emissions and sequestration. GHG emissions, including those of biomass and bioenergy systems, are traditionally quantified using the cumulative radiative forcing of greenhouse gas emissions (using GWP100 to combine impacts of different gases) as the indicator, but other indicators could be used such as global temperature potential or others metrics that take various approaches to differentiating impacts based on timing of emissions and removals. The paper uses three simplified bioenergy systems to illustrate the effects of using different metrics.

#### 2. Quantifying the Climate Effects of Forest-Based Bioenergy

Cowie, A.L., Brandão, M. and Soimakallio, S., 2019. Quantifying the climate effects of forest-based bioenergy. In *Managing Global Warming* (pp. 399-418). Academic Press

This book chapter explains the basis for divergent results amongst published studies on climate effects of forest-based bioenergy systems, and summarises the Task 38 recommended approach to assessing climate effects of forest-based bioenergy.

The following papers are nearing completion:

**Harmonizing tools:** The study examined the basis for differences between tools used for assessing climate effects of biofuels in different jurisdictions (viz. BioGrace, GREET and GHGenius, used in Europe, United States and Canada, respectively, and also the Brazilian tool Virtual Sugar Biorefinery VSB/CTBE). This study, commenced in collaboration with Task 39, has been expanded under the Inter-Task project “Measuring, governing and gaining support for sustainable bioenergy supply chains” (see below). The manuscript is in review by Renewable and Sustainable Energy Reviews.

**Indirect land use change:** Another component of the Inter-Task project, this paper analyses statistical data for the USA and trading partners to estimate whether corn use for ethanol has resulted in indirect land use change (iLUC), and is to be published in a special issue of the journal Sustainability, on land-use competition.

**Utilising land clearing biomass for bioenergy and biochar:** Also part of the Inter-Task project, this study evaluates the climate effects of utilising native scrub residues for bioenergy and biochar, rather than burning in the field. The manuscript is under review by the Journal of Cleaner Production.

**Updating the standard methodology:** This paper reiterates and expands the “standard methodology” paper (Schlamadinger et al 1997), synthesising recent work of Task 38, to present recommendations on quantifying climate change effects of bioenergy, with guidance on how to make appropriate choices for key aspects such as system boundary, reference land use, metrics for climate assessment, handling co-products.

### *Inter-Task Projects*

#### **Measuring, Governing and Gaining Support for Sustainable Bioenergy Supply Chains**

Annette Cowie and Göran Berndes (Task 43) are co-leaders of Objective 1, which has investigated aspects of methods and tools to quantify the sustainability of bioenergy systems, and pros and cons of developing a harmonised framework. Helena Chum coordinated the comparison of tools for assessing biofuels. Annette Cowie worked with NSW DPI colleagues to assess the applicability of current approaches to quantify climate effects of biomass supply chains based on invasive scrub, a common issue in the world’s drylands. Miguel Brandão is working with Task 43 members to examine the evidence for iLUC associated with ethanol production in the US.

### **Website/Communication**

#### *Task Website*

The Task 38 website (<http://task38.ieabioenergy.com/>) is the repository of publications and other material produced by Task 38 and predecessor task “Greenhouse Gas Balances of Biomass and Bioenergy Systems”.

Information on the site includes:

- publications of Task 38 including statements on timing of emissions, sustainability of bioenergy
- presentations from Task Workshops
- guidance on methods for quantifying greenhouse gas balance of bioenergy systems
- FAQ page
- case studies (identified by both country and process)
- contact details of national team leaders.

## **Collaboration with Other Tasks**

### *Inter-Task projects*

(see further detail above)

Within the Inter-Task project “Measuring, governing and gaining support for sustainable bioenergy supply chains” (led by Task 40), Task 38 and Task 43 co-led Objective 1. Within Objective 1 Task 38 led: Comparison of tools for assessing biofuels (Chum); Case study on the use of cleared scrub for bioenergy or biochar compared with in-field burning (Cowie), and contributed to the study on indirect land use change (Brandão, Cowie, et al). The Inter-Task project is profiled separately in this annual report.

Task 38 participated in the special project on Bio-CCUS, specifically the component related to GHG emission balances and prospects of hydrogen enhanced synthetic biofuels from solid biomass.

### *Joint publications*

Task 38 contributed to the following joint publications:

- “GHG emission balances and prospects of hydrogen enhanced synthetic biofuels from solid biomass in the European context” by Koponen & Hannula 2017 (<https://doi.org/10.1016/j.apenergy.2017.05.014>), an output of the special project on Bio-CCUS.
- letter to EU parliamentarians intended to convey a balanced scientific view, in response to the campaign against bioenergy ahead of the European decision on support for bioenergy.
- FAQ on climate effects of bioenergy published by IEA Bioenergy.

## Networking

- Annette Cowie, Task Leader, was a member of the ISO committee that revised the international standard for carbon footprint of a product, which was completed and published as ISO 14067: 2018. Improvements over the 2013 version include greater clarity on the treatment of biogenic carbon, land use change and land management; addition of the requirement to include and justify the reference land use; modifications to the treatment of green electricity; a new informative Annex providing guidance on agriculture and forestry; and revision of definitions to harmonise across the 14060 family. The carbon footprint standard will influence GHG quantification methods for environmental labelling, greenhouse gas accounting and carbon offset schemes, including GHG accounting for bioenergy products.
- Annette Cowie is a member of the Science Policy Interface of the UNCCD. 120 countries have now committed to pursue targets for land degradation neutrality (LDN). This widespread interest in LDN is anticipated to provide opportunities for biomass production for bioenergy, particularly as a viable option for rehabilitation of contaminated lands.
- Annette Cowie contributed to organising and delivering the first International Conference on Negative Emissions, 22-24 May, at Chalmers University of Technology, Gothenburg, co-sponsored by IEA Bioenergy. Annette presented on biochar, land degradation neutrality and the Bonn Challenge, and chaired the plenary session on land sector opportunities for negative emissions.
- Miguel Brandão (Task 38 Manager) participated in a workshop on allocation, organised by the ISO committee on LCA, to inform revision of the ISO LCA standard.
- Annette Cowie and Fabiano Ximenes (NSW DPI) delivered a webinar to Bioenergy Australia members on climate impacts of use of invasive native scrub for biochar; and reasons for the wide divergence of results between studies on climate impacts of bioenergy.
- Sebastian Rüter (NTL Germany) is leading the HWP chapter in the refinement of the 2006 IPCC Guidelines for inventory reporting. The approval of the IPCC 2019 Refinement is foreseen for May 2019.
- Annette Cowie presented at a conference held on March 12–13, 2018, in Stockholm Sweden, organised by the Royal Swedish Academy of Agriculture and Forestry, the Royal Swedish Academy of Sciences, and the Royal Swedish Academy of Engineering Sciences, on the topic "Forests and the climate: Manage for maximum wood production or leave the forest as a carbon sink?"
- Helena Chum (USA) and Glaucia Souza (Brazil) lead Task 38 collaboration with SCOPE (Scientific Problems on the Environment) on Bioenergy and Sustainability. In 2018 the 2016 publication was updated. The SCOPE process (led by FAPESP (State of Sao Paulo Research Foundation) and Latin American and African organisations) gathered significant input from IEA, IEA Bioenergy, IRENA, and SE4ALL. These activities led to the publication "Sustainable Bioenergy: Latin America and Africa." Policy Brief [Amstelveen: SCOPE, 2018, 8p. ISSN:2412-0286 available at <http://bioenfapesp.org/scopebioenergy/index.php/policy-brief/2018>].

- Annette Cowie participated in lead author meetings of the IPCC Special report Climate Change and Land, in Christchurch (March) and Dublin (September). Annette is a lead author of the chapter on land degradation. Bioenergy has a high profile in the report, as it is anticipated to play a key role in strategies to meet the Paris Agreement. The report discusses significant logistical and governance challenges from widespread adoption of bioenergy crops, including managing potential risks to the land resource base and food security.
- Annette Cowie gave a plenary presentation on the role of bioenergy in climate change mitigation at the end of triennium IEA Bioenergy conference, presented in conjunction with the Advanced Bioeconomy Leadership Conference, San Francisco, 7-9 November.

## **Deliverables**

Apart from the wide range of deliverables mentioned above, the Task also produced progress reports and audited accounts for the ExCo, and minutes of the Task meetings, and the “Task focus” section for the IEA Bioenergy December Newsletter. In addition, individual Task members published scientific papers that were informed by interactions with Task members, and some of these outputs were formally reviewed by Task 38 members.

## **TASK 39: Commercialising Conventional and Advanced Liquid Biofuels from Biomass**

During the last triennium Task 39 continued its work to advance deployment of sustainable, lower carbon liquid biofuels for transport with an overall goal of facilitating the commercialisation of conventional and advanced liquid biofuels. Despite formidable obstacles such as continuing relatively low petroleum prices, slower-than-anticipated progress in commercializing cellulosic ethanol/other advanced biofuels technologies, and ongoing uncertainty around future biofuels policy, relatively good progress has been made in the biofuels area.

During 2018, Task 39 focused on policy, technical, commercial and “sustainability” attributes (particularly the carbon intensity (CI) assessed using life cycle analysis (LCA)) of biofuels. As examples, in May 2018 the Task organised a webinar on the emerging opportunity for “Biofuels for the marine shipping sector,” and in October 2018 it completed the final report, “Survey of Advanced Fuels for Advanced Engines”, which although funded exclusively by Task 39, was prepared in collaboration with the IEA Advanced Motor Fuels (AMF) Technology Collaboration Programme (TCP). The Task also continued its work on drop-in biofuels for the long-distance transport sectors (i.e., Marine, Aviation, Rail and Truck), with the marine and aviation sectors receiving particular attention. A penultimate draft of the Task’s updated drop-in report (160 pages) and executive summary (12 pages) entitled, “Drop-in” Biofuels: the key role co-processing will play in production”, has been reviewed by Task members and outside experts and is currently in final formatting for publication in early 2019.



The Task has also benefitted from active industry involvement with the aviation industry continuing to be the sector that is most actively championing the development of lower carbon intensity fuels. The aviation sector hopes to rapidly decarbonise and has set a number of ambitious targets, including a 50% reduction in net aviation CO<sub>2</sub> emissions by 2050 (compared to 2005 levels). There have also been several policy developments aimed at supporting the production and use of biojet/renewable fuels in countries such as The Netherlands, Norway and the USA. For example, United Airlines is using commercial-scale volumes of lower carbon intensity fuels for regularly scheduled flights and World Energy in California is regularly supplying biojet fuels (via upgrading of oleaginous feedstocks) to many of the airlines using lower carbon intensity fuels. As well as the lipid/oleochemical route to biojet fuels, five additional pathways to biojet fuels have been approved by ASTM, with more routes expected to be certified in the future.

As is also covered in the marine and drop-in biofuels reports, shipping is one of the fastest growing transport sectors and similar to the aviation sector, it is one of the hardest transport sectors to decarbonise. Alongside the technological challenges involved in cost-effectively producing low carbon fuels, there is currently a significant price gap between renewable and fossil fuels as well as a lack of strong enough “policy drivers” to encourage the development and use of lower carbon intensity maritime fuels, which makes the development of marine biofuels challenging. Although the Paris (COP21) agreement did not include international shipping, the International Maritime Organisation (IMO) has been developing a greenhouse gas emissions reduction strategy. In 2016, the IMO recommended that by 2020 most ships achieve a 0.5% sulphur cap on their marine fuels. As described in Task 39’s 2017 marine biofuels report, implementing this use of lower sulphur fuels offers large opportunities for the development of renewable biofuels for the marine shipping section.

The key role policy is playing and will continue to play is particularly evident in international aviation and marine transport sectors. These transportation sectors primarily fall under international jurisdiction and many of the domestic policies developed for biofuels are not directly applicable internationally. As described in the drop-in biofuels report, although good progress has been made in some of the conversion technologies, effective policies will be essential if we are to advance the commercialisation and growth of these types of drop-in biofuels.

In terms of policy and sustainability assessments, Task 39 completed its second phase of a study comparing four well-recognised biofuels life cycle analysis (LCA) models (EU’s BIOGRACE, Canada’s GHGENIUS, USA’s GREET and Brazil’s VSB). Task 39 also completed updating its periodically issued “Implementation Agendas” report that compares and contrasts biofuels policies across the countries that are members of Task 39 (and also including China and India), with this report now distributed for final internal review. Task 39 expects both policy and sustainability considerations will continue to play a crucial role in biofuels development and use and as such policy and sustainability assessments will continue to be a high profile activity for the Task in the coming triennium.

## Overview of the Task

The goal of Task 39 is to facilitate the commercialisation of low carbon transportation fuels, including conventional and advanced technologies such as drop-in biofuels and algae-based biofuels, especially liquid biofuels from biomass. Through a coordinated focus on technology, commercialisation, sustainability, policy, markets and implementation, the Task assists participants in their efforts to develop and deploy biofuels. These biofuels include cellulosic ethanol, biomass-based diesel, sustainable aviation fuel (SAF), etc., produced through various technology routes such as oleochemical, biochemical, thermochemical and hybrid technology pathways. The success of the Task has been, in large part, a direct result of providing a forum for integrated discussions aided by the active involvement of participants from industry, government and academia. The Task continues to lead and coordinate activities in three main program areas:

- **Technology and Commercialisation**
  - ▶ Help develop and commercialise improved, cost-effective processes for the production of renewable/low carbon intensity biofuels, particularly “drop-in” biofuels from biomass, particularly decarbonizing the long-distance transport sector (i.e., Marine, Aviation, Rail and Truck). The main recent Task works in this area are two reports entitled “Biofuels for the marine shipping sector” and “Drop-in’ biofuels: The key role co-processing will play in production.” The Task works with other IEA Bioenergy Tasks and related organisations such as IEA HQ, IRENA, GBEP, Advanced Motor Fuels TCP, etc., to assess and help develop cost-effective oleochemical, biochemical, thermochemical and hybrid technologies as well as to co-optimize fuel-engine systems to maximise transport performance efficiencies and associated greenhouse gas reduction potentials using advanced biofuels.
  - ▶ Describe advancements and challenges in developing ‘next-generation’ transport biofuel technologies, including biomass-to-hydrogen and algae-to-biofuel processes.
- **Policy, Markets, Implementation and Sustainability** which encompasses issues that address policy/legislative/regulatory and infrastructure concerns and needs regarding expanding conventional and advanced transport biofuels. It also provides information and analyses on policies, markets, and implementation issues (including regulatory and infrastructure development) that will help participants foster commercialisation of sustainable low carbon liquid biofuels as a replacement for non-renewable fossil-based fuels, by continuing the deployment of conventional (so-called first generation) biofuels and supporting development of advanced (so-called 2nd generation) biofuels and ‘future-generation’ biofuels. The Task also continues work to better clarify commonalities and main differences in methodological structures, calculation procedures and assumptions within four of the world’s most well-recognised biofuels LCA models (EU’s BIOGRACE, Canada’s GHGENIUS, USA’s GREET and Brazil’s VSB). The work of Task 39’s LCA expert steering committee (composed of Adrian O’Connell (EU), Michael Wang (USA), Mark Staples (USA), Don O’Connor (Canada), and Antonio Bonomi (Brazil)) has helped to further focus the Task’s activities in this area for the 2019-2021 triennium. We anticipate ongoing joint work with the newly formed IEA Bioenergy Sustainability Task as well as with groups such as GBEP, IRENA, etc., in this area, as these types of assessments continue to gain ever greater importance for policy makers and regulators.

- **A Multifaceted Communication Strategy** to facilitate knowledge transfer, information dissemination, outreach to stakeholders, and coordination with related groups both within IEA Bioenergy and externally. In 2018, Task 39 organised two business meetings in Beijing, China and San Francisco, USA. It also organised a webinar on “biofuels for the marine shipping sector” and published three newsletters that included progress updates on Task 39 activities and featured articles on biofuel production and use (profiling biofuel technical and policy developments in the USA, Canada and the EU as well recent news articles and reports of interest to biofuels stakeholders). These newsletters are distributed to about 2000 recipients and a country (or regional) specific feature article in each issue provides a unique source of information to biofuel stakeholders. The Task’s website is visited regularly and routinely receives enquires that are typically handled by the Task coordinator and webmaster, or referred to experts within Task 39’s network. Specific website statistics are reported in the Progress Report that is submitted to ExCo.

Another vehicle for information dissemination is IEA Bioenergy Task 39’s large-scale demonstration plants website which provides an up-to-date database of advanced biofuels production facilities in Task 39 member countries and the rest of the world (over 100 companies).

As part of its outreach to stakeholders, Task 39 is fortunate to have the active participation of experts from academia, government and industry. Examples of industry and institutional participants include: DSM, Boeing, Licella, Novozymes, LanzaTech, the Renewable Energy Group, International Air Transport Association, Boeing, S&T2 Consultants, World Wildlife Federation, Roundtable on Sustainable Biomaterials, Argonne National Laboratories and many others.

The Task’s structure allows participants to work together in a comprehensive manner on prioritised issues and challenges identified across the broad area of transport biofuels.

*Participating countries:* Australia, Austria, Brazil, Canada, Denmark, European Commission, Germany, Japan, South Korea, The Netherlands, New Zealand, South Africa, Sweden, and United States of America (USA)

**Task Leader:** Jim McMillan, National Renewable Energy Laboratory, USA

**Task Co-Leader:** Jack Saddler, University of British Columbia, Canada

**Operating Agent:** Alex McLeod, Natural Resources Canada, Canada

**Task Manager:** Mahmood Ebadian, University of British Columbia, Canada

The Task leadership is shared between the National Renewable Energy Laboratory (USA) represented by Jim McMillan, and the University of British Columbia (Canada) represented by Jack Saddler. Both Task Leaders are engaged in all aspects of the Task’s operations. Sub-Task leaders for technology and commercialisation include Antonio Bonomi, Franziska

Müller-Langer, Nicolaus Dahmen, Johan van Doesum, Claus Felby, Tomas Ekbom and Steve Rogers. Sub-Task leaders for policy, markets, implementation and sustainability include Warren Mabee, Glaucia Mendes Souza, Dina Bacovsky, Timo Gerlagh, Emile van Zyl, Shiro Saka, Jin-Suk Lee, Laura Lonza, Adrian O'Connell and Ian Suckling. Task leaders are assisted by Mahmood Ebadian (UBC), who serves as Editor of the Task Newsletter as well as Webmaster for the Task's website. Dina Bacovsky (Austria) manages the Task's demonstration plant database. Franziska Müller-Langer is the Task's primary liaison to IEA's Advanced Motor Fuels (AMF) Technology Collaboration Program (TCP). Country Representatives (also known as National Team Leaders) for each Task 39 participating country are responsible for coordinating their respective nation's participation in the Task.

For further details on Task 39, please refer to Appendices 2, 4, 5 and 6; the Task website (<http://task39.ieabioenergy.com/>) and the IEA Bioenergy website (<https://www.ieabioenergy.com/>) under 'Our Work: Tasks'.

## Progress in R&D

### Task Meetings and Workshops

As part of its organisational/communication strategy, Task 39 typically holds two business meetings per year, usually tied-into related conferences and workshops to justify the extensive travel required for many Task 39 members to attend. In 2018, the Task held two formal business meetings (Beijing, China in April and San Francisco, USA in November). These business meetings involved significant knowledge exchange between participants in the form of Country Reports as well as special sessions hosted in conjunction with established biofuels-related events.

As indicated in the most recent IEA World Energy Outlook, China and India are projected to become major global producers and users of transportation fuels as their economies continue to develop and grow. Low carbon transportation options are becoming increasingly important for both countries. This is one of the reasons IEA Bioenergy and Task 39 have been actively courting both of these countries to join the IEA Bioenergy TCP. To build on the desire to recruit "developing economies", Task 39 members unanimously accepted the Chinese invitation to hold its first Task meeting of 2018 in Beijing (7-9 April, 2018). Task members hoped that having senior Chinese officials be able to directly observe the activities of a typical IEA Bioenergy Task business meeting first hand would help them better understand the benefits of becoming an IEA Bioenergy member.

The Beijing meeting was generously hosted by Professor Tianwei Tan of the Beijing University of Chemical Technology (BUCT) and organised by Dr Huili Zhang of BUCT. Representatives from all Task 39 participating countries other than South Africa and Austria were able to attend. In addition, our Chinese hosts were impressed that several members of the IEA Bioenergy Executive Committee were also able to attend the meeting (i.e., ExCo Chair Jim Spaeth (USA), who provided an overview of the IEA Bioenergy TCP; ExCo Vice-chair

Paul Bennett (New Zealand), who provided an overview of Task 34 (Liquefaction); and Ex-Co member Mark Brown (Australia; who provided an overview of Task 43 (Feedstocks)). In addition to good academic, government and industry participation from China, representatives from Indonesia and Thailand also attended.

Day one of the meeting was devoted to internal Task 39 business and was primarily attended by Task 39 members. This part of the meeting was used to review the Task's ongoing and recently completed work, the Task's budget and priorities for the remainder of the triennium. The afternoon session was used to discuss proposed projects/deliverables for the next triennium (2019-2021). These discussions were aided by a presentation by Adam Brown (via Skype) highlighting findings of the IEA's Bioenergy Roadmap report.

Among the Task's highly informative activities for its membership are annual country report presentations from each country member participant highlighting and providing insights into recent developments in biofuels production and deployment occurring in Task 39 member countries and also in other important countries such as China and India, where aspirations for expanded biofuels production and use are growing. Task 39 country representatives provided short presentations summarizing biofuels production, use and policy developments in their respective countries/jurisdictions. This stimulated productive discussion and information exchange between meeting attendees, again demonstrating that the annual country report updates remain one of the invaluable benefits of Task membership.

Day two of the meeting was organised as an open workshop to provide Chinese observers with an overview of the IEA Bioenergy TCP and some of its tasks (e.g., Tasks 33, 34 and 43 in addition to Task 39) to help progress China's consideration to join the IEA Bioenergy TCP. This workshop featured a number of distinguished experts from academia and industry. It also included panel discussions on several topics at the forefront of biofuels development, namely: a) sustainability and life cycle assessment (LCA); b) aviation biofuels development; c) the status of biofuels in China; and d) the broader work of the IEA Bioenergy TCP (i.e., beyond Task 39). The Beijing Task 39 business meeting significantly benefited from the participation of representatives of China's National Energy Administration, Hunan Branch of Chinese Academy of Forestry, Lanzatech, International Air Transport Association, Boeing, S&T2 Consultants, World Wildlife Federation, Roundtable on Sustainable Biomaterials, and Argonne National Laboratories.

IEA Bioenergy Task 39 held its second business meeting of 2018 in San Francisco, USA on 5-6 November, in conjunction with IEA Bioenergy's end-of-triennium/ExCo82 meeting and the Advanced Bioeconomy Leadership Conference GLOBAL ("[ABLC GLOBAL](#)") held on 7-9 November, 2018. Day one of the Task 39 meeting was devoted to internal Task 39 business and primarily attended by Task 39 representatives from member countries (including newly rejoining member, Norway) and a few other IEA Bioenergy Task and ExCo members. The focus was reviewing the Task's ongoing and recently completed work and activities being proposed for the 2019-2021 triennium.

Task 39 members also participated in the joint IEA Bioenergy/ABLC GLOBAL conference held 7-9 November, 2018. This "ABLC Global 2018" conference was a collaboration involving [IEA Bioenergy](#), [USDOE BETO](#) and [The Biofuels Digest](#). The IEA Bioenergy Conference 2018 represented the first day of the conference (Wednesday, 7 November) and profiled the various IEA Bioenergy Tasks. In an "Advanced Biofuels Summit" session moderated by Alex Macleod (NRCan and Operating Agent for Task 39), presentations on current developments and the global and USA situations were given by Philip Stratmann (VP, Biofuels, Velocys), Jim McMillan, Jack Saddler and Adam Brown (IEA HQ). The overall conference included 180+ speakers and 17 distinct workshops, forums, and summits spanning Clean Fuels & Energy, Renewable Chemicals and Biomaterials, Feedstocks & Supply Chain Development, New Nutrition, Advanced Agriculture, International Partnerships, Policy & Finance and many more. The conference was well-attended, with almost 600 participants from industry, academia, and governments.

Regarding Task 39 specific activities, after the Task 39 business meeting, most attending Task 39 members were able to participate in a study tour to the Joint BioEnergy Institute ([JBEI](#)) and the Advanced Biofuels and Bioproducts ([ABPDU](#)) pilot plant facility in nearby Emeryville, California. JBEI is a U.S. Department of Energy (DOE) Bioenergy Research Center dedicated to developing advanced biofuels and bioproducts.

Regarding other workshops in which Task 39 participated, Claus Felby (Task 39's lead Danish representative and co-author of the Task 39 report, "[Biofuels for marine shipping sector](#)"), presented on November 26-27, 2018 at an Organisation for Economic Co-operation and Development (OECD) meeting in Paris on decarbonisation of the maritime sector. As discussed at this meeting, the maritime sector is facing substantial reductions in the allowable sulphur content of its fuels and has aspirations to reduce its carbon emissions by 50%. Claus presented the results from IEA Bioenergy's Task 39 marine biofuel report which describes the current state of the art for marine biofuels. Although E-fuels were also discussed in some detail, they are expected to continue to be quite expensive in the foreseeable future.

The active participation of most country team leaders and representatives at many of the Task 39 meetings is evidence of the value the Task 39 network plays in facilitating excellent international information exchange.

## **Work Programme**

The programme-of-work for the Task includes the following elements:

### *Technical Aspects of Advanced Biofuels*

Advanced biofuels remain a topic of key importance for decarbonizing the transport sector. The Task continues to focus on advanced biofuels such as cellulosic ethanol. However, drop-in biofuels have become a more prominent focus in recent years, primarily because drop-in fuels offer a direct replacement for petroleum fuels, requiring little change to the current petrochemical distribution and use in engines infrastructure.

The need for drop-in biofuels is especially relevant in sectors such as aviation where there are no real alternatives to achieving low carbon emission operation. As drop-in biojet fuel technologies progress from research and development through to pilot, demonstration and commercialisation, Task 39 has and continues to monitor these developments and act as an objective, informed observer to provide biofuels and transport sector stakeholders, including governments and policy makers, the information and data necessary to support decision-making.

The biojet/sustainable aviation biofuels (SAF) is an area that is receiving increasing international attention. This interest is primarily driven by aviation organisations, OEMs such as Boeing, as well as by airlines. Task 39 has and continues to play an important role in monitoring, evaluating and reporting on developments in this sector, in addition to providing guidance on essential policies to foster and facilitate biojet development and deployment. In addition, the role of biofuels in international shipping/marine sector has become important as a way of reducing emissions contributed by this industry, which is facing more stringent sulphur emissions regulations going forward.

Briefs on reports completed or advanced during 2018 follow:

**Report on “Biofuels for the marine shipping sector”** (Hsieh and Felby, 2017-2018): This study assesses the current and developing marine fuel regulations, marine fuel characteristics and the new CO<sub>2</sub> monitoring regime for ships. It also describes biofuel production technologies and the outlook for development of marine biofuels, providing a SWOT analysis of the potential and challenges for marine biofuels. A webinar on this topic was held in May 2018. Key findings include:

- Marine biofuels are a large, nearer-term opportunity, as sector sulphur emissions must be reduced, most biofuels have low sulphur levels, and many ship engines can use lower specification fuels compared to fuels used for aviation or road transport
  - ▶ Large market: Approximately 90% of international trade involves shipping
  - ▶ Simplified supply logistics: For international shipping, there are relatively few major marine ports to supply
  - ▶ *Significant potential for drop-in biofuels to replace part of the marine fuel mix*
  - ▶ *New multi-fuel heavy-duty marine engines can also use alcohol biofuels (e.g., MeOH, EtOH)*
- Development remains challenging: Testing requires: 1) very large volumes of biofuels; and 2) coordination among fuels producers, engine builders and ship owners.

**Survey on Advanced Fuels for Advanced Engines (with IEA’s Advanced Motor Fuels TCP (AMF)):** This Task work was recently completed and will soon be posted on the “publicly available” sections of the [Task 39 website](#). The final report is entitled, “Survey of Advanced Fuels for Advanced Engines” and was completed by Task 39 and the IEA Advanced Motor Fuels (AMF) Technology Collaboration Programme (TCP). This report contains up-to-date

information on current and prospective advanced biofuels – especially biomass-based liquid fuels – for road vehicles. Performance attributes, such as fuel properties and exhaust emission characteristics in compression or spark ignition type engines, are discussed in detail. The report shows how the results are influenced by the specific advanced biofuel that is used. It is likely that the area of co-optimizing fuel-engine systems to maximise transport performance efficiencies and associated greenhouse gas reduction potentials using advanced biofuels will continue to be an important research topic of interest. In addition to providing a useful reference for Task 39 stakeholders, this report also serves as an updated and complementary resource to AMF’s online fuel information portal (<http://www.iea-amf.org>).

**The potential and challenges of ‘drop-in’ biofuels – report update:** Task 39 first published the report, [Potential and Challenges of Drop-in Biofuels](#), in 2014. Since then, several of the technologies highlighted in the report have been abandoned and other drop-in biofuels projects have been initiated. This update to the original 2014 report includes expanded sections on aviation and maritime biofuels. The report is split into four parts: 1) an update of the more technical aspects of the existing report; 2) a section on biojet and marine biofuels; 3) a section on the policies that will be required to promote production and consumption of drop-in biofuels; and 4) the LCA of the production and use of drop-in biofuels. It is recognised that specific policies will likely have to be developed and implemented to help establish drop-in biofuels, partly because these sectors are international and each has its own unique characteristics.

This report update was recently completed and will soon be posted on the “members only” sections of the Task 39 website. This report is expected to form the basis for future collaborations with other Tasks (e.g., such as the Gasification and Thermal Liquefaction (Pyrolysis/HTL) Tasks as well as with allied organisations such as IEA HQ, IRENA, GBEP, etc). Future work in this area will include: a) assessing the various methods used to measure/ follow the “green” molecules when adopting co-processing and upgrading strategies within existing petroleum refineries; and b) extending LCA studies to examine the life cycle/ sustainability aspects of drop-in biofuels production.

**Yearly update of the Bioenergy Task 39 large-scale demonstration plants:** The Task continues to update its database of advanced biofuels production facilities, led by Dina Bacovsky, Austria’s national team leader. This “demoplants” database provides up-to-date information on over 100 companies’ biofuels production facilities, which encompass a wide variety of biochemical, thermochemical, and hybrid conversion approaches to producing biofuels (website: <http://demoplants.bioenergy2020.eu/>). However, it remains difficult to obtain and maintain detailed and accurate, up-to-date information from many of the companies as their various processing technologies scale up and approach commercialisation. It is particularly challenging to obtain information on facilities in countries such as China and India that are not (yet) part of the IEA Bioenergy network. This is one of the motivations for the Task’s ongoing efforts to recruit these countries to join the IEA Bioenergy TCP.



**Policy, Regulatory, Infrastructure and Sustainability Issues of Biofuels:** The overall objective of this component of the Task is to provide governments and policy makers with information that will help them enhance production and use of liquid biofuels within their respective countries/jurisdictions. The Task continues to compile country-specific information on biofuels development such as biofuels usage, regulations and regulatory changes, including any major policy changes that might affect the development, deployment or use of biofuels. At least one Task business meeting each year is allocated for country representatives to present updates on developments in their respective countries or regions. Country report presentations along with the meeting minutes and other presentations from these business meetings are posted in the 'members only' section of the Task website. The Task's periodic "Implementation Agendas" report, which was updated in 2018, compiles all of the country specific information into a single document. It also reports recent trends in policy development, including a compare-and-contrast of policy effectiveness in different global regions. This report is substantially updated and revised at least once per triennium. Through this effort, the Task maintains its role as a central source of relevant policy and regulatory information on biofuels.

Biofuels can play an important role in reducing emissions from transportation (air, marine and road transport) and help countries meet long-term climate goals. However, not all biofuels offer the same emissions reduction potentials. Thus, the analysis of emission reduction potential of different feedstock and technology combinations has become vital to accurately assess the carbon intensity and sustainability of biofuels. However, lack of standardisation of assessment methodologies has hampered developing consensus in this key area. While many life cycle analysis (LCA) models are available, they often give substantially different results for ostensibly the same or a quite similar scenario. The Task's on-going work (jointly with former Task 38/new sustainability Task 45) in comparing LCA models and providing reliable information on emission reduction potential forms an essential component of the Task's triennium plan of work. In 2016-2017, the Task initiated work to systematically compare and harmonise leading LCA models via a multiple phase project being led by Antonio Bonomi, Brazil's national team leader. In the 2019-2021 triennium, LCA activities will be led by Task 39's LCA expert steering committee (composed of Adrian O'Connell (EU), Michael Wang (USA), Mark Staples (USA), Don O'Connor (Canada), and Antonio Bonomi (Brazil), all internationally-recognised LCA experts).

A summary of the Task 39 reports completed or advanced during 2018 include:

**Comparison of LCA models – with Task 38 and also contributing to ongoing IEA Bioenergy Inter-Task sustainability project** (publication pending; under review by the journal of Renewable and Sustainable Energy Reviews): This work assesses GHG emissions and energy balances for advanced biofuels. The current project involves a comparison of four well-recognised biofuels LCA models (EU's BIOGRACE, Canada's GHGENIUS, USA's GREET and Brazil's VSB), focusing on how each of these models estimates GHG emissions. Although the project was originally conceived to have 3 phases carried out over three years, because of delays it now is streamlined to two phases over three years so as to be able to be completed in 2018. Phase I was completed in 2017 and compared LCA models for

conventional ethanol production. Phase II kicked off in January 2018 and is doing similarly for biodiesel fuels (both fatty acid methyl esters (FAME) and hydrotreated vegetable oils (HVO)/hydrotreated esters and fatty acids (HEFA)).

This project has helped identify the commonalities and main differences in the models' methodological structures, calculation procedures, assumptions, etc. It has also highlighted the most influential parameters impacting the determination of emissions associated with the production and use of diesel-type biofuels (both FAME and HVO/HEFA types (also called hydrotreated renewable diesel, HRD or HDRD, or just renewable diesel, RD). Through a "harmonisation" procedure, it is possible to successfully align the results of the models to agree with one another. After the report is assessed internally in early 2019, it will become publicly available.

The updated progress was presented and discussed at the Task's Beijing meeting in April and the main results of Phase II were presented at the San Francisco meeting in November.

As sustainability continues to play a crucial role in biofuels development and use, sustainability assessment will continue to be a high profile activity for the task in the 2019-2021 triennium. The contributions of the Task 39 LCA expert steering committee who attended the Beijing and San Francisco meetings helped to further focus Task 39 work proposed in this area for the next triennium.

We anticipate continuing joint work with the new IEA Bioenergy Sustainability Task 45 in this area in the next triennium as these types of assessments continue to be of importance to policy makers and regulation. The Task 39 LCA expert steering committee continues to discuss how to further harmonise and extend LCA modeling approaches going forward, e.g., how to more broadly consider key aspects that influence LCA results, such as system boundaries and specific assumptions about soil carbon changes and how coproducts are handled (i.e., by displacement, energy or economic allocation, etc).

**Implementation Agendas – international policies compare and contrast report:** Another recently completed report that will soon become publicly available is the update of Task 39's periodically issued "Implementation Agendas" study that compares and contrasts biofuels policies being developed and used within Task 39 member countries (and other key biofuels-producer/user countries). Task membership has discussed ways to further improve data collection and aggregation processes used by the member country contributors to provide input for this report. Although a questionnaire was developed and used to simplify data collection for this report, the group agreed that the template should continue to be refined in the new triennium to enable better comparisons of biofuel policies within Task member countries.

It should be noted that the policy environment has changed substantially since the last update of this report. Thus, the format of the report has been revised to try to better compare and contrast the relative successes of the various policies that are being used to promote biofuels development and use around the world.

## Newsletters

In addition to commissioned reports, conference and workshop proceedings, Task 39 disseminates information through its periodic newsletters including feature stories highlighting developments in a member country or region of interest and providing hyperlinks to media stories and reports of interest to the biofuels stakeholder community. The newsletters detail the latest developments in industry and government policies pertaining to liquid biofuels. In 2018, three newsletters were published and distributed to about 2000 recipients. These newsletters featured articles on biofuel use and production and policies in the US, Canada and the European Union, respectively, and they are available at the Task 39 website: <http://task39.ieabioenergy.com/newsletters/>.

The country (or regional) specific feature article in each newsletter provides a unique source of information to global biofuel stakeholders and we regularly receive requests for permission to republish these reports in other magazines, e.g., Oils and Fats and Advanced Biofuels USA.

Newsletter readers are also asked to review the most recent updates of the [Task's Demonstration plant database](#). This is an ongoing Task activity and we depend upon our readership, as well as input from other sources, to ensure this database remains accurate and up-to-date.

## Website

The Task continues to build its influence within the international community working in the transport biofuels arena. The Task's website is well visited and routinely receives enquires that are typically handled by the Task coordinator and webmaster, or referred to experts within Task 39's network. Specific website statistics are reported in the Progress Reports submitted to ExCo.

## Collaboration with Other Tasks/Networking

In 2018, Task 39 strengthened collaborations with other IEA Bioenergy Tasks (Tasks 33, 34, 36, 37, 40, 42 & 43 in particular, and hopes to be as productive in working with the new sustainability and deployment Tasks being initiated in the 2019-2021 triennium) as well as with other groups such as the IEA [Advanced Motor Fuels TCP](#) and IEA HQ. Task 39 also benefited from extensive industry involvement from companies at the forefront of biofuels development such as DSM, Boeing, Licella, Novozymes, LanzaTech, the Renewable Energy Group (REG), etc.

Task 39 leadership routinely reviews and provides feedback on draft IEA reports, most recently on the draft Tracking Clean Energy Progress (2018) report. The Survey on Advanced Fuels for Advanced Engines is a collaboration with the IEA AMF TCP, while the Comparison of LCA Models for GHG Calculations is a collaboration with IEA Bioenergy Task 38. The outcomes of this project are also helping to inform the new Inter-Task project on Sustainability. Task 39 also engages with organisations such as IEA-RETD and IRENA in reviewing reports in the biofuels sphere.

During 2018, Ireland and Norway confirmed their interest in (re)joining Task 39 for the new 2019-2021 triennium. Other countries that are prospects to become new members of IEA Bioenergy and Task 39 in this new triennium include Chile, China, India, Indonesia, Malaysia, Mexico and Thailand. The economies in each of these countries are growing, with increased manufacturing and consumption leading to more freight transport (long-distance trucking, rail, shipping and aviation). Good interest has been expressed by India and Mexico, and contacts with China have also been greatly strengthened. We remain optimistic that these countries will eventually join IEA Bioenergy and Task 39 during this triennium.

## **Deliverables**

The deliverables for the Task in 2018 included: (1) organisation of two business meetings during the year in Beijing, China and San Francisco, USA; (2) two bi-annual progress reports and audited financial accounts (submitted to ExCo); (3) further development and maintenance of the Task 39 website; (4) three newsletters featuring country reports (USA, Canada and the EU) on biofuels production, use and policies; (5) webinar on “biofuels for the marine shipping sector”; (6) Update of Task 39’s Advanced Biofuel Demonstration Database; (7) completing the “Survey on Advanced Fuels for Advanced Engines” report; (8) Final drafts of “drop-in’ biofuels – report update” and “Implementation Agendas – report update”, currently both out for final internal review; and (9) (ongoing) the comparison of LCA models, Phase 2 to be completed by end of March 2019.

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

### Overview of the Task

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 2011, the European Commission started to stimulate the further development of the biobased economy<sup>1</sup>, which has shown promising developments in the last four years, in particular investments in technological innovation in several member countries. However, more efforts still need to be made in the establishment of European standards and the related certification of biobased products. The UNFCCC Conference of the Parties, or COP 21 have come up with historical decisions<sup>2</sup> to reaffirm the goal of limiting global temperature increase well below 2 degrees Celsius and established binding commitments by all parties to make nationally determined contributions as well as to pursue domestic measures aimed at achieving them. The European Union (EU) has committed by the end of 2016 to cut GHG emissions by at least 40% by 2030<sup>3</sup> (from 20% in 2020) while modernising the EU's economy and delivering on jobs and growth for all European citizens as well as achieving global leadership in renewable energies.

In view of these perspectives, biomass markets have possibilities to grow, however, they are still immature and vulnerable. Many biomass markets, e.g. solid biofuels, rely on policy support and incentives. For example, after two years negotiation, the Renewable Energy Directive II, adopted by the European Parliament and the Council by the end of 2018, requires sustainability requirements to be officially established for all forms of bioenergy in the whole of the EU. These requirements will to a large extent determine the future of biomass deployment in general, and also affect the possibilities to trade biomass internationally. At the same time, a recent meta-analysis of scenarios of integrated assessment models (co-authored by Task 40 members<sup>4</sup>) shows that substantial deployment and trade of both solid and liquid biomass will be required to meet stringent targets to limit global temperature increase to below 2 degrees. Therefore, 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 much-needed investments in biomass production, infrastructure and conversion capacity. Understanding how this is best organised and managed needs further investigation. International biomass markets (industrial and residential) have been mapped as well as the assessment of technological development and policy effects has also been carried out by Task 40. The analyses, statistics, and modelling exercises undertaken so far still have some limitations.

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1 <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52012DC0060&from=EN>

2 <http://newsroom.unfccc.int/unfccc-newsroom/finale-cop21/>

3 <https://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/COM-2016-707-F1-EN-MAIN.PDF>

4 Vassilis Daioglou, Matteo Muratori, Patrick Lamers, Shinichiro Fujimori, Alban Kitous, Martin Junginger, Etsushi Kato, Alexandre C. Koberle, Florian Leblanc, Silvana Mima, Marshal Wise, Detlef van Vuuren (2018). Implications of climate change mitigation strategies on international bioenergy trade. Paper submitted to climatic change, forthcoming.

The core objective of the Task is '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 does this by providing high quality information and analyses, and overviews of developments. It will also provide a link between different sectors, and act as a clearing-house for information through targeted dissemination activities.

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

*Participating countries:* Austria, Belgium, Denmark, Finland, Germany, Italy, The Netherlands, Sweden, United Kingdom, and USA.

**Task Leader (Scientific):** Prof Dr Martin Junginger, Copernicus Institute of Sustainable Development, Utrecht University, The Netherlands

**Task Leader (Industry):** Mr Peter-Paul Schouwenberg, RWE Generation, The Netherlands

**Secretary:** Ms Thuy Mai-Moulin, Copernicus Institute of Sustainable Development, Utrecht University, The Netherlands

**Operating Agent:** Ir Kees Kwant, RVO, The Netherlands

For further details on Task 40, please refer to Appendices 2, 4, 5 and 6; the Task website (<http://task40.ieabioenergy.com/>) and the IEA Bioenergy website ([www.ieabioenergy.com](http://www.ieabioenergy.com)) under 'Our Work: Tasks'.

## Progress in R&D

### Task Meetings

The Task organised two Task meetings in 2018: Task 40 meetings were held in Brussels, Belgium in March and in San Francisco, United States in November respectively. In addition, there were also two teleconferences organised with all Task members in August and in December 2018 to discuss Task progresses and studies. The meeting programme, study reports and updates are provided at the dedicated page for Task 40 members under the Task 40 website: <http://task40.ieabioenergy.com/>.

### Future Meetings and Workshops

On 27th February – 1st March 2019, Task 40 will organise a kick-off meeting for the new triennium 2019-2021 in Stockholm, Sweden. In May 2019, the Task will have another Task meeting in Utrecht, The Netherlands and have a leading role in the organisation of a workshop organised by IEA Bioenergy. Collaborations with other Tasks will be decided upon by Task leaders and participating members.

## Work Programme and Outputs

The core objective of Task 40 is: 'to support the development of sustainable, international bioenergy markets and international trade, recognising the diversity in resources and biomass applications'. The work programme in the 2016-2018 period consisted of the following five topics:

1. Mobilisation of sustainable biomass resources for the international market across different regions in the world.
2. Analysis of the future market demand for biomass from the broader biobased economy perspective.
3. Sustainability and certification.
4. Support of business model development for biomass supply and value chains.
5. Assisting the development and deployment of advanced analysis tools to improve the understanding of potential future market developments, implications and impacts of policies.

Due to the contributions by 10 members countries, Task 40 was able to organise a number of workshops and commission several studies, as well as contribute to (and lead) the Inter-Task project on measuring, governing and gaining support for sustainable bioenergy supply chains.

In 2018, the Task has participated in a number of events and published three reports. The conference **Governing sustainability of bioenergy** was organised on 16th-19th April 2018 with Martin Junginger and Uwe Fritsche participating in the scientific committee and Martin Junginger leading a roundtable discussion. Thuy Mai-Moulin had a presentation as part of the Inter-Task Sustainability project. The workshop "**Measuring, governing and gaining support for sustainable bioenergy supply chains**" was organised as a side event at EUBCE 2018 conference and led by Martin Junginger and Uwe Fritsche

The international workshop on **Future perspectives of bioenergy development in Asia** was organised in Tokyo on 6th-7th September by IEA Bioenergy and several Japanese organisations, Task 40 (with contributions of Martin Junginger and Michael Wild) and Task 32. The event reached a broad Asian audience and received positive feedbacks from stakeholders attending the events. This workshop provided technical information (technical and organisational improvements to biomass supply chains) to Asian member countries, as well as information on the activities of IEA Bioenergy to support the decision making process for membership. The *Advanced Bioeconomy Leadership Conference* was organised by IEA Bioenergy, USD OE BETO and The Digest on 6th-9th November 2019 on the most important issues in the Bioeconomy today. Task 40 members including Martin Junginger, Christiane Hennig, Uwe Fritsche and Olle Olsson presented Task 40 outcomes in the Sustainability Forum, Biomass Supply Chains and Market Deployment Forum. The presentations have received high interests by audience attending the events.

The three published reports are *Building a Biorefinery Business: Strategies for Successful Commercialisation*; *Transboundary flows of woody biomass waste streams in Europe 2018*; and *Socio-economic assessment of the pellets supply chain in the USA*. All reports and webinar presentations are available for free download from Task 40 website <http://task40.ieabioenergy.com/>.

***Report: Socio-economic assessment of the pellets supply chain in the USA***

This study focused on the socio-economic assessment of the pellets supply chain in the USA. The pellet production to export has reached 5 Million tons in recent years providing positive socio-economic impacts in the South East regions but also some socio-economic issues that need to be further improved. The main aim of this report is to understand the dynamics between local development and forestry activities related to the production and export of pellets on local communities. The forest sector in the USA shows few signs of development. Income increases slowly, but steadily in the United States, but the forest sector does not follow this same path. Job creation was clearly affected between 2000 and 2010 in the USA in feedstock production and with no signs of general improvement between 2010 and 2014, but improvements are seen in the transformation sector. This could provide better opportunities for the expansion and adaptation of the pellet sector.

***Report: Building a Biorefinery Business: Strategies for Successful Commercialisation***

This study aims to explore and analyse which barriers to commercialisation can be successfully overcome by biorefineries, and which may require support from additional actors within the system, such as policy makers. The study found that when building a biorefinery business, it is crucial to decide the kind of strategy and corresponding business model to implement. Careful attention needs to be paid to the ability to mobilise biomass resources and to establish supply and demand structures at the same time. A collaborative approach, leveraging resources and building a web of favourable system components, has proven a viable strategic approach towards developing and commercializing biorefineries.

***Report: Transboundary flows of woody biomass waste streams in Europe 2018***

The report focused on trans boundary shipment flows of solid biomass waste particularly wood waste (hazardous and non-hazardous) in the north western part of Europe in the years 2010-2016. Non-hazardous wood waste is a rather cheap fuel in comparison to other solid biomass resources and hence is used in some countries for bioenergy production on a significant scale. Also large amounts of hazardous wood waste are traded, but an overview of these trade flows is so far lacking in literature. An analysis of its trans boundary shipment can be helpful for the national plans of the countries involved as well as the industries and organisations. The study chose the European Waste Codes (EWC) to shortlist the type of wood waste. The EWC narrowed down to mainly 191206\* (hazardous wood waste) and 191207 (non-hazardous wood waste) which have considerable shipment flows in Europe. Next to the valorisation as material wood waste is being used for producing energy in modern bioenergy plants in Germany, The Netherlands and Sweden. The main importers of both hazardous and non-



hazardous wood waste are Germany and Sweden with a yearly import of 600+ kilotonnes. The Netherlands also imports non-hazardous wood waste from the UK and Belgium for the feedstock of its bioenergy plants. The main exporters of non-hazardous wood waste are the UK, The Netherlands and Norway. The combined exports exceed 800 KT every year. The major exporter for hazardous wood waste is The Netherlands with a yearly average of 100 KT to Germany.

***PhD thesis: International trade in biomass for energy production – the local and global context***

Commissioned by Task 40, Svetlana Proskurina has led an effort to update global biomass trade statistics, which has resulted in two scientific publications in the journal BioFPR (accepted for publication in 2018) with Task 40 co-authors Martin Junginger and Jussi Heinimö. The two papers deal with 1) statistical and methodological considerations and 2) production and trade streams of wood pellets, liquid biofuels, industrial roundwood and emerging energy biomass. The two papers are also part of Dr Proskurina's PhD thesis published and defended in 2018.

The thesis focuses on the status of biomass trade for energy in the global and local EU-Russia context. Within the local EU-Russia context, it is possible to show the international biomass trade streams in detail. Europe is currently the major player in global biomass trade and Russia is one of the leading exporters of wood pellets to the EU. Wood pellets are the main traded solid biofuel, thus its market can be studied in more detail. The thesis presents a global overview of trade in solid and liquid biofuels, particularly wood pellets, biodiesel, and bio-ethanol, and biomass products such as industrial roundwood. The thesis presents the main production, export and import volumes of studied products as well as global trade streams including potential developments of emerging trade streams such as torrefied biomass. In addition, the thesis describes the role of bioenergy in renewable energy development in the EU, and in the local context, wood pellet markets in Finland and Russia.

The findings from the work indicate that due to the variety of available biomass resources and continuing supportive policy and regulation in many countries, biomass trade will continue to be an important aspect of renewable energy markets for the foreseeable future. Despite slow progress in bioenergy development encountered in several EU countries, currently the EU remains a leader in biomass utilisation and trade. Based on the example of the Finnish and Russian markets, it is evident that wood pellet markets vary considerably in different countries and have different orientations. Thus, the study concludes that fertile ground exists for further development of international trade in biomass for energy production.

## IEA Bioenergy Country Report series

From the template and draft Country Reports provided by Luc Pelkmans, IEA Bioenergy Technical Coordinator, a number of Task 40 members including Christiane Hennig, Jussi Heinimö, Laura Craggs, Martin Junginger, Olle Olsson, Ruben Guisson, Svetlana Proskurina, Thuy Mai-Moulin, Uwe Fritsche, Chenlin Li and Richard Hess have added more information to those reports. Updates on policy development, energy supply and consumption at a country level and recent development of bioenergy within the investigated countries have been further provided and discussed. The contributions have been completed before the end of the triennium.

## Reports and papers to be finalised (early 2019)

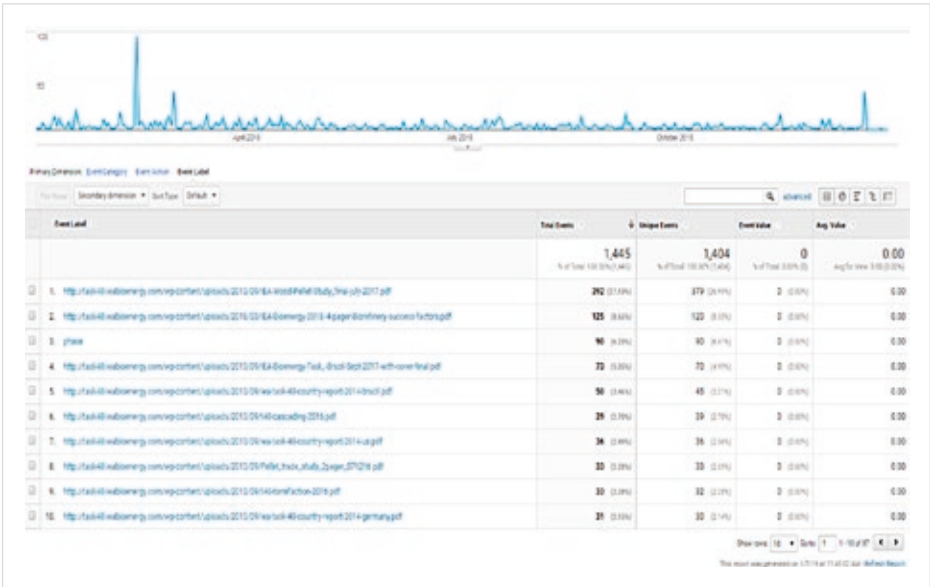
A number of Task 40 members are also finalising the report based on a study on the *margin potential for a long-term sustainable/viable wood pellet supply chain* with the aim to identify strategies for the operational continuation and viability of present wood pellet supply chains. The report is aimed to be published on the Task 40 website by early 2019. Last but not least, almost all Task 40 members have also contributed to a scientific paper on the future of bioenergy trade, which will be published in a special issue of the Biofuels, Bioproducts and Biorefining (BioFPR) in the first quarter of 2019.

## Website

The website <http://task40.ieabioenergy.com/> has been officially launched since September 2016 and it is now under the management of IEA Bioenergy organisation. The trademark bioenergytrade.org is planned to be kept in the upcoming 10 years. The Task website is a key tool for dissemination of information. In 2018, the average number of unique visitors is about 685 per month, slightly lower than the number of visitors in the previous years.



The updated **Global Wood Pellet Industry and Trade Study 2017** leads the top 10 downloaded documents. Other frequently downloaded documents included reports on cascading, torrefaction and success factors for biorefineries, and several country reports, showing that Task 40 readers are interested in Task studies on biomass trade and technological development for processing biomass.



### Collaboration with Other Tasks/Networking

Collaboration with both IEA Bioenergy Tasks and external partners is important, therefore the Task has been continuing this effort in 2018. The Inter-Tasks Sustainability project has been running since January 2016 with various IEA Bioenergy Tasks including Task 40 members. Under the lead of Task 40, this Inter-Tasks project has brought together and synthesises part of the work done by the individual Tasks. Final results of the Inter-Tasks Sustainability were presented in an international conference in San Francisco, the United States in November 2018. Also, a high number of scientific articles have already been published as project outcomes.

### Deliverables

Deliverables in 2018 included three main reports, contributions of Task 40 members to IEA Bioenergy Country Report series, one newsletter (circulation to 1500 subscribers), four minutes from two Task meetings and two tele-conferences, two progress reports and audited accounts to the ExCo. These are detailed in Appendix 4.

With the end of 2018, also an end has come to fifteen years of Dutch Task leadership. As of 1-1-2019, Task 40 will be jointly led by Uwe Fritsche, Olle Olsson, Christiane Hennig and Lena Bruce. Also, the focus of Task 40 will shift towards the successful deployment of bioenergy and related issues. The departing Task management (Martin Junginger, Peter-Paul Schouwenberg and Thuy Mai-Moulin) wish the joint Swedish-German Task lead and all Task members best of luck and success for the coming triennium and beyond.

## 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 be 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, 4 and 5; and the IEA Bioenergy website [www.ieabioenergy.com](http://www.ieabioenergy.com) under 'our Work: Tasks'.

### 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. Two projects were active in 2018 as follows:

#### **Project 5:** Bio-CCS and Bio-CCUS in Climate Change Mitigation

This two-year special project has been set up in order to fully define concepts of Bio-CCS and Bio-CCU, and to define their realistic significance in the medium and long term. Two workshops were held in 2016 and one was held in 2017 (<http://task41project5.ieabioenergy.com/iea-publications/>). A final workshop was held in 2018 prior to project completion.

*Participating Countries:* The European Commission, Finland, The Netherlands and Norway

*Status:* This project has been completed and the report has been published at [https://www.ieabioenergy.com/wp-content/uploads/2018/06/IEA-Bioenergy-2-page-Summary-Bio\\_CCUS\\_FINAL\\_29.6.2018.pdf](https://www.ieabioenergy.com/wp-content/uploads/2018/06/IEA-Bioenergy-2-page-Summary-Bio_CCUS_FINAL_29.6.2018.pdf)

#### **Project 9:** Potential Cost reduction for novel and advanced renewable and low carbon fuels

The objective of this one-year project is to identify the scope for cost reduction for novel advanced biofuels, to develop a model for likely costs as deployment grows and to examine the impact of policy measures, including carbon pricing, on the competitiveness of novel biofuels.

*Participating countries:* European Commission, Germany, Sweden and The Netherlands

*Status:* The project is expected to be completed in March 2019 with a final workshop and report.

## **TASK 42: Biorefining in a Future BioEconomy**

[www.iea-bioenergy.task42-biorefineries.com](http://www.iea-bioenergy.task42-biorefineries.com)

### Overview of the Task

#### **Biorefining in the Circular Economy and BioEconomy**

Biorefining, the sustainable processing of biomass into a range of marketable biobased products and bioenergy/biofuels, is an innovative and efficient approach to use available biomass resources for the synergistic co-production of power, heat and biofuels alongside food and feed ingredients, pharmaceuticals, chemicals, materials, minerals and short-cyclic CO<sub>2</sub>.

The Circular Economy is defined as an economy that is restorative and regenerative by design, and which aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological-cycles [Ellen MacArthur Foundation]. The Circular Economy mainly focuses on the efficient use of finite resources and ensures that these resources are reused as long as possible. Biorefining is one of the key enabling strategies of the Circular Economy, closing loops of raw biomass materials (re-use of agro-, process- and post-consumer residues), minerals, water and carbon. Therefore, biorefining is the optimal strategy for large-scale sustainable use of biomass in the BioEconomy. It will result in cost-competitive co-production of food/feed ingredients, biobased products and bioenergy combined with optimal socio-economic and environmental impacts (efficient use of resources, reduced GHG emissions, etc.).

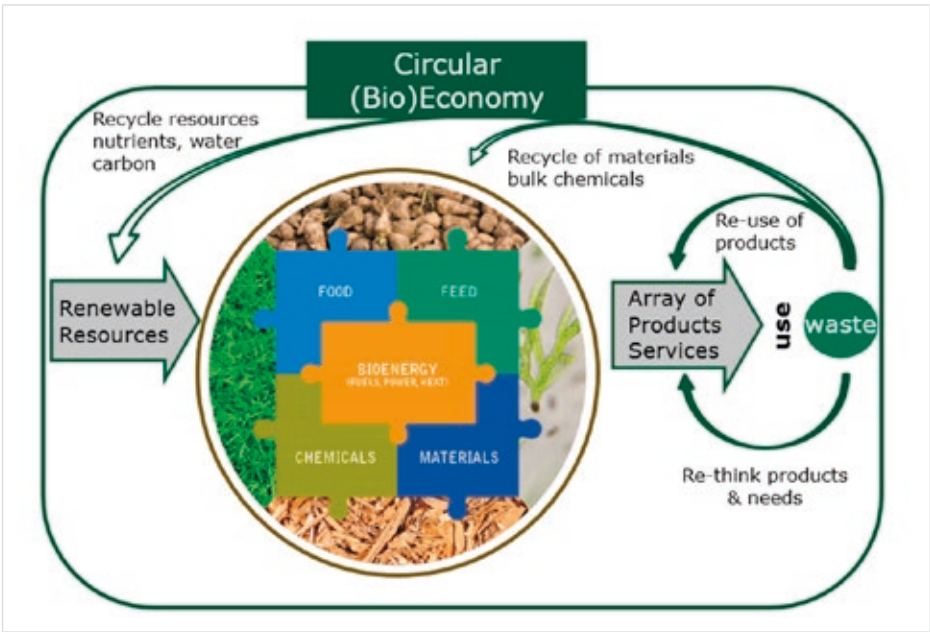


Figure 1. Role bioenergy in Circular (Bio)Economy [IEA Bioenergy Task 42, 2017].

### Biorefineries – Current Status and Expected Developments

Biorefining is not a fully new approach. Thousands of years ago the production of vegetable oils, beer and wine already required pre-treatment, separation and conversion steps; whereas paper production started around 100 AD. Industrial conventional biorefineries are currently still mainly found in the food and paper sectors.

Within recently constructed biorefineries, bioenergy/biofuel based facilities are more common. In these, heat, power and biofuels are the main products, and both agro and process residues are used to produce additional biobased products. In product based biorefineries, higher-value food and feed ingredients, pharmaceuticals, chemicals, fibrous materials (e.g. pulp, paper) and/or fertilisers are the main products, with low-quality agro and process residues used for the production of bioenergy and less commonly, biofuels. Product based biorefineries are mainly found in the food, feed and dairy, and pulp and paper industries at the current time.

It is expected that within the next 10-20 years the use of biomass for non-food/feed applications will shift from an energy to a more product-based approach. However, in the longer-term part of the biomass resources is still expected to be used for the production of advanced biofuels for transport (heavy duty road transport, aviation and shipping).

In the short-term (up to 2025) advanced biorefineries may be introduced in a variety of market sectors, mainly by means of upgrading of existing infrastructures, reducing both initial investment costs and the time-to-market. Bioenergy will play both an initiating and central role for the market deployment of these advanced biorefineries:

- Certified sustainable biocommodities that are now being developed and mobilised for energy applications in the mid/longer-term will also be available as raw materials for the biorefinery facilities ensuring sustainable biomass supply.
- Industrial bio-transportation fuel production facilities and digestion facilities can be further upgraded to integrated biorefineries co-producing fuels and added-value biobased products to optimise their overall sustainability, i.e. increase their financial market competitiveness.
- Low-quality value chain residues, i.e. residues that cannot be reused for added-value applications in an economically attractive way, like agro-residues, process residues and post-consumer residues, will be used for bioenergy production.

A portfolio of new biorefining concepts – i.e. whole crop biorefineries, lignocellulosic feedstock biorefineries, oleo-chemical biorefineries, green biorefineries, thermochemical biorefineries, micro and macro algae (marine) biorefineries and next generation hydrocarbon biorefineries – is currently being developed. These concepts are expected to be implemented into the market in the medium-term (2025-2030). However, the current economic conditions (low oil price, credit crisis, recessions in part of the world) might cause severe delays in their market deployment.

A very important non-technical barrier for the market deployment of product-based biorefineries is the availability of sufficient amounts of sustainable biomass resources. Product-based biorefineries can accelerate their market deployment by using both the certification expertise and logistical infrastructures that are currently being developed and set-up for the use of sustainable biobased commodities for energy purposes.

Towards 2050, the portfolio of product based biorefinery concepts could expand further. Lignocellulosic feedstock, herbaceous (green), oleo-chemical and marine (microalgae and seaweeds) biorefineries may enter the market. However, expansion will require further technology development as product-based biorefinery facilities are generally less technically mature than bioenergy/biofuel alternatives. In addition, current policy support is more favourable towards bioenergy and biofuels than the production of biobased products. As such, facilitating the market development of product-based biorefineries is likely to require more widespread policy frameworks to support biobased products.

However, since such materials are generally higher-value products than bioenergy and biofuels, expanding markets for biobased products will be a key factor in product-driven refinery expansion.

Initiatives to support industry development include: a Biorefineries Roadmap in Germany in 2012, a Strategic Biomass Vision 2030 in The Netherlands, and ongoing funding for innovative biorefinery projects from the US Department of Energy (DOE). Deployment in Europe should be boosted by the Bio-Based Industries Joint Undertaking, a partnership between the European Union and the private sector to invest USD 4.1 billion in innovative technologies and biorefineries to produce biobased products from biomass wastes and residues. In addition, the European Commission's Circular Economy package includes biomass and biobased products as a priority sector and outlines the promotion of support to innovation in the BioEconomy.

Bioenergy markets will play a central role in facilitating the growth of product based biorefineries through the development of sustainability certification processes and biomass fuel and feedstock supply chains. In addition, biofuel and biogas plants offer potential for upgraded and integrated biorefineries co-producing fuels and added-value biobased products, with such facilities benefiting from diversified product streams and increased market competitiveness. Furthermore, even in the context of wider deployment of product based biorefineries, lower-value biomass feedstock, such as agricultural and post-consumer residues that are less suitable for economic biobased product manufacture are likely to remain destined for bioenergy markets.

### **Aim of IEA Bioenergy Task 42 – Biorefining in a Future BioEconomy**

The aim is to facilitate the commercialisation and market deployment of environmentally sound, socially acceptable, and cost-competitive biorefinery systems and technologies, and to advise policy and industrial decision makers accordingly. Task 42 provides an international platform for collaboration and information exchange between industry, SMEs, GOs, NGOs, RTOs and universities concerning biorefinery research, development, demonstration and policy analysis. This includes the development of networks, dissemination of information, and provision of science-based technology analysis, as well as support and advice to policy makers, involvement of industry, and encouragement of membership by countries with a strong biorefinery infrastructure and appropriate policies. Gaps and barriers to deployment will be addressed to successfully promote sustainable biorefinery systems market implementation.





## Challenges to be Tackled

- Develop industry legitimacy, including social acceptance and a level-playing field, for sustainable biomass use.
- Global sustainable biomass sourcing and developing an international trading market, incl. the development of biocommodities.
- Internalisation of externalities (CO<sub>2</sub>-price).
- Multi-sectorial stakeholder involvement in the deployment of sustainable value chains, incl. industrial symbiosis of full sustainable biomass use for Food AND Non-food, and advanced communication (still separate languages food/non-food and cultivation/processing).
- Technology development and biorefinery scale-up using best practices, i.e. for lignocellulosic-based biorefineries, herbaceous and aquatic biomass based biorefineries, protein-based biorefineries, food/non-food flexible biorefineries, mobile/decentral biorefineries, integral Bio Industrial Complexes, etc.
- Unlock available expertise and industrial infrastructure energy/fuel, agro/food, material and chemical manufacturing sectors.
- Standardisation/regulation biobased products (BBPs).
- Develop the necessary human capital by training students and other stakeholders to become the biorefinery experts of tomorrow

## Task Data

The Task commenced in January 2007.

*Participating countries 2018:* Australia, Austria, Canada, Denmark, Germany, Ireland, Italy, The Netherlands, and the USA.

**Task Leader:** Drs Ing René van Ree, Wageningen Food and Bio-based Research, The Netherlands. Assistant

**Task Leaders:** Dr Ed de Jong, Avantium Technologies BV, The Netherlands, and Dr Bert Annevelink, Wageningen Food and Bio-based Research, The Netherlands.

**Operating Agent:** Ir Kees Kwant, NL Enterprise Agency, Ministry of Economic Affairs, 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, 4, 5 and 6; the Task website ([www.task42.ieabioenergy.com](http://www.task42.ieabioenergy.com)), and the IEA Bioenergy website ([www.ieabioenergy.com](http://www.ieabioenergy.com)) under 'Our Work: Tasks'.

## Progress in R&D

### Task Meetings and Workshops

#### 24th Task 42 Progress Meeting – Montreal, Canada

On the 5th of February 2018 the Task 42 NTLs met in Hotel Fairmont The Queen Elizabeth in Montreal, Canada, for their 24th Progress Meeting. All country reports and other presentations of the Task 42 Progress Meeting can be found on the Task 42 website.

#### Contribution to International Conference BIOFOR –Montreal, Canada

The Task 42 NTLs actively contributed to the International Conference BIOFOR-2018 "Forest Products: Part of a New Bioeconomy". Two lectures were given, viz.:

- Ed de Jong (NL), "Zambezi Biorefinery: Pure glucose from 2nd generation feedstocks"
- Bert Annevelink (NL), "The IEA Bioenergy Task 42 Perspective for Biorefining in a Growing BioEconomy".



Figure 2. Selection Task 42's NTLs lecture contributions BIOFOR Conference in Montreal, Canada.

#### 25th and 26th Task 42 Progress Meetings – Skype



To monitor the progress of the Task activities, specifically for this final year of the triennium period, and to be prepared for the next physical Task Progress Meeting and ExCo82 Meeting in San Francisco, USA, two Skype Meetings have been organised in June and October.

### ***27th Task 42 Progress Meeting – San Francisco, California, USA***

On 5 and 6 November 2018, the Task 42 NTLs met in San Francisco, California, USA, for their 27th Progress Meeting. All country reports and other presentations of the Task 42 Progress Meeting can be found on the Task 42 website. On 7 November 2018 Task 42 contributed to the IEA Bioenergy End-of-Triennium (EoT) Conference by providing a Biochemical/Biorefining Session, incl. three lectures from Task 42 members, viz.:

- Johannes Lindorfer (AT), “Biorefinery Systems Analysis and Factsheets”.
- Vincenzo Motola (IT), “Global BioEconomy Survey with a focus on Biorefineries”.
- Ed de Jong (NL), “Biobased Chemicals – Current Status & Future Perspectives”.

The EoT Conference was part of the three-day ABLC Global 2018 Conference, which took place in San Francisco on the 7-9 November 2018.

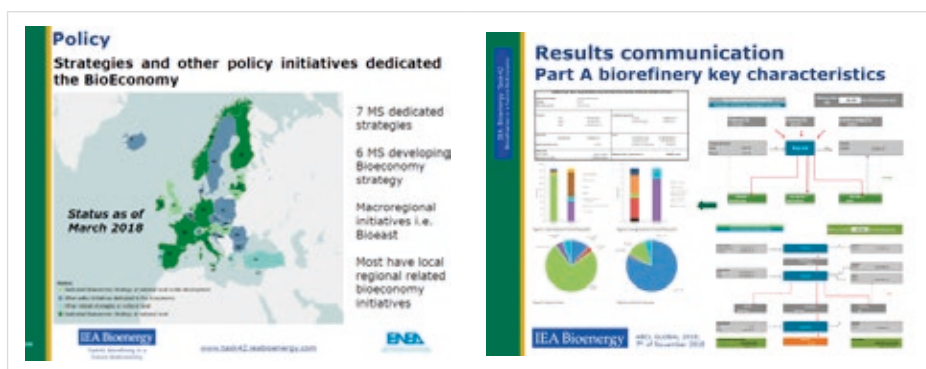


Figure 3. Selection Task 42's NTLs lecture contributions IEA Bioenergy EoT Conference in San Francisco, USA.

### ***Planned Meetings/Workshops 2019-2021 (start of new triennium)***

The Task 42 Progress Meetings scheme for the next triennium is:

- 2019: NL and Italy
- 2020: SWE (coupled to Nordic Wood Biorefinery Conference?) and AUS/AT
- 2021: DK and place final ExCo meeting (tbd).

Intervening Skype meetings will be organised to monitor Task progress.

Task 42 Workshops will be organised on:

- Technical, economic and environmental (TEE) assessment of integrated biorefineries, as part of the Collaborative Inter Task Project (CITP): a) joint-Tasks workshop for biorefineries selection (1st half 2019), and b) a workshop on biorefineries factsheets assessment methodology and results, and their support for activities being performed in other Tasks and IEA IETS (2nd half 2021).
- Role of biomass, bioenergy and biorefining in a Circular Economy, cooperation with other international organisations (IRENA, JRC, FAO, OECD, ETIP and EERA Bioenergy), 2nd half 2020.

Furthermore, annual Webinars will be organised on biorefining related subjects.

## **2016 -2018 Work Programme and Major Achievements**

The Task 42 **work programme 2016 – 2018** was based on four Activity Areas (AAs) with composing activities, viz.:

### **AA1) Biorefinery Systems – Analysis and assessment of biorefining in the whole value chain:**

- Biorefinery expert system [D1]
- Biorefinery factsheets [D2]
- Upgrading industrial infrastructures to integrated biorefineries [D3]

### **AA2) Product Quality – Reporting on related biobased products/bioenergy standardisation, certification and policy activities at national, European and global levels:**

- International developments in biomass standardisation/certification [D4]

### **AA3) Evolving BioEconomy – Analysing and advising on perspectives of biorefining in a Circular BioEconomy:**

- Role of Bioenergy and Biorefining in a Circular Economy [D5]
- Contribution to JTP Sustainable Supply Chains [D6]
- Monitoring of the Evolving BioEconomy in co-operation with EC DG JRC [D7]

### **AA4) Communication, Dissemination and Training – Knowledge exchange by stakeholder consultation, reporting and lecturing:**

- Biorefinery Success Stories [D8]
- Biorefinery Country Reporting [D9]
- Report on Biobased Chemicals [D10]

- Report on Proteins for Food/Feed and Industrial Applications [D11]
- Report on Biobased Fibrous Materials [D12]
- Task 42 dissemination items (brochure, banner, website) [D13-15]
- Task 42 Progress Meetings [D16]
- Task 42 Newsletters [D17]
- Training Activities [D18]
- Papers/lectures International Events [D19]
- Thematic Stakeholder Workshops (TSWs) [D20]

### **AA1) Biorefinery Systems – Analysis and assessment of biorefining in the whole value chain**

A Biorefinery Assessment Platform Tool (BAP) [D1] was developed by our Austrian NTL (the University of Graz) with input of all Task 42 NTLs. A full draft version of the platform is currently in operation, and was used in 2018 to deliver some case-study based Biorefinery Fact Sheets [D2]. Both the methodology/platform and some results (factsheets) have been presented in a lecture given at the EoT Conference in San Francisco in November 2018. A report describing the platform and presenting the factsheets (combination of D1 and D2) will be put on the Task 42 website for further dissemination in Q1 2019. The BAP platform will be used in the new triennium for assessment of an additional amount of factsheets within a Collaborative Inter Task Project coordinated by Austria.

As already explained early in 2016, no activities dealing with upgrading of industrial infrastructures [D3] to integrated biorefineries took place in this triennium.

### **AA2) Product Quality – Reporting on related biobased products/bioenergy standardisation, certification and policy activities at national, European and global levels**

The international developments in biomass standardisation and certification were monitored in this triennium by our German NTL. The results were reported in slide-decks that were made available at the Task 42 website. During 2018, the information in all of the slide-decks of 2016-2018 was combined, assessed and reported in a short summarising report [D4].

### **AA3) Evolving BioEconomy – Analysing and advising on perspectives on biorefining in a Circular BioEconomy**

Wageningen UR has carried out a literature and web analysis concerning the potential role of biomass, biorefining and bioenergy in the future BioEconomy and Circular Economy [D5]. The result (a slide-deck) was presented in January 2017 both at an IEA Workshop in Paris (F) and the International Biomass Conference in Graz (AT).

Concerning the assessment of the role of bioenergy and biorefining in a Circular Economy also a workshop in Brussels in September 2017 was organised, where representatives of IEA Bioenergy, FAO, OECD, EERA Bioenergy, ETIP Bioenergy, IRENA, JRC, and DOE were invited to present their views and activities in this field (for slides see Task 42 website).

Task 42 (German NTL) participated as observer in the Joint Tasks Project on Sustainable Supply Chains [D6], and brought in biobased products related data, where needed.

Together with EC DG JRC and the EU BBI JTU, our Italian NTL (ENEA) has set-up and distributed a questionnaire to monitor the evolving BioEconomy worldwide. Based on the replies, ENEA analysed the current deployment of biorefineries within this framework, presented the major results in a lecture at the EoT Conference in San Francisco in November 2018, and came up with a summarizing report [D7], that was made available at the Task 42 website, by the end of 2018.

No activities dealing with Biorefinery Success Stories [D8] took place in this triennium.

#### **AA4) Communication, Dissemination and Training – Knowledge exchange by stakeholder consultation, reporting and lecturing**

In this triennium, updated extensive Country Reports [D9] were produced by the Australia, Denmark, Germany, Italy, and the USA, and are available for downloading from the Task 42 website. Updates from Austria, Canada, Ireland and The Netherlands are expected to be published on the website in Q1 2019.

Concerning Task 42 Reports, within this triennium the following glossy reports were delivered:

- a report on Proteins for Food/Feed and Industrial Applications (2016) [D11],
- a report on Standards and Labels related to Biobased Products (2018) [D12],
- a report on Bioeconomy and Biorefining Strategies in the EU Member States and Beyond (2018) [D7],
- a report on Natural Fibers and Fiber-based Materials in Biorefineries (2018) [D12].

Furthermore, contributions were made to the Workshop Report of ExCo79 on “The Role of Industrial Biorefineries in a Low-carbon Economy (2017), and the Joint Survey on Bioeconomy Policy Developments in Different Countries (2017).



Figure 4. Major glossy reports produced by Task 42 in the 2016-2018 triennium (the last two will be officially published in Q1 2019).

An update of the Biobased Chemicals report [D10] is currently being finalised, and will be published on the Task 42 website in Q1 2019. The same applies for the final report on the Biorefinery Assessment Platform and Factsheets [D1/D2].

Other Task-related information (brochures, leaflets, newsletters, papers etc.) are available at the Task 42 website: [www.task42.ieabioenergy.com](http://www.task42.ieabioenergy.com).

### Collaboration with Other Tasks/Networking

Within this 2016 – 2018 triennium, the following collaborations were effectuated:

- Role of Bioenergy in Circular Economy: Task 36 (solid waste management); EERA Bioenergy, ETIP Bioenergy, EC DG JRC, IRENA, and FAO
- BioEconomy Monitoring: EC DG JRC and EC BBI JU
- Sustainable supply chains: Task 40 coordinated JTP
- Biorefinery Country Reporting: IEA Bioenergy/Energy 2020+
- Thematic Stakeholder Workshops: Industrial Biorefineries (IEA-IETS)

Furthermore, scheduled cooperation with other Tasks, such as Task 40 on Biorefinery Success Stories, and Task 34/Task 37/Task 39 on Biorefinery Assessments and Fact-sheeting, was not established in this triennium. However, this is one of the main goals of the new 2019-2021 Work Plan.



Earlier this triennium, a joint analysis brought together expertise from three IEA Bioenergy Tasks, namely Task 34 on Pyrolysis, Task 40 on International Trade and Markets, and Task 42 on Biorefineries. The underlying hypothesis of the work was that the BioEconomy Market Developments potentially could benefit from lessons learned and developments observed in modern bioenergy markets. The question was not only how the BioEconomy can be developed, but also how this can be done sustainably in terms of economic and environmental concerns. The results of this analysis resulted in the book "Developing the Global BioEconomy". Both the conclusions and book ordering details can be found at the IEA Task 42 website.

## TASK 43: Biomass Feedstocks for Energy Markets

### Overview of the Task

The work of the Task in the current triennium addresses issues critical to mobilizing sustainable bioenergy supply chains, including all aspects of feedstock production, its markets and environmental, social and economic impacts. The objective is to promote sound bioenergy development that is driven by well-informed decisions by land owners, businesses, governments and others. This is achieved by collecting, analysing, and sharing technical and non-technical information related to biomass feedstock supply and providing relevant actors with timely and topical analyses, syntheses and information.

The Task has a global scope and includes commercial, near-commercial and promising feedstock production systems in agriculture and forestry. The primary focus is on land use and land management of biomass production systems. The Task work builds upon the work of the previous triennium and seeks new opportunities for collaboration with other Tasks as well as organisations outside IEA Bioenergy. The Task also interacts with other research networks and programmes that have workplans in the same areas.



*Participating countries (as in December 2018):* Australia, Belgium, Canada, Croatia, Denmark, Finland, Germany, Ireland, The Netherlands, Norway, Sweden, and the USA

**Task Leader:** Associate Professor Ioannis Dimitriou, Swedish University of Agricultural Sciences, Sweden

**Work Package leaders:** Göran Berndes, Chalmers University of Technology; Mark Brown, University of the Sunshine Coast; Hans Langeveld, Bioenergy Research; Tat Smith, University of Toronto

**Task Secretary:** Assistant Professor Sally Krigstin, University of Toronto, Canada

**Operating Agent:** Dr Åsa Forsum, Swedish Energy Agency, Sweden

The Task leader, together with the Work Package (WP) leaders, manages the work of the Task. A Steering Committee (SC), consisting of the Task Leader, WP leaders and the National Team Leaders (NTLs), is responsible for reviewing progress and making overall priorities. Each NTL forms a national team of experts that support the NTL in making national contributions to the collaboration. Other associated experts are also involved.

For further details on Task 43, please refer to the Task website <http://task43.ieabioenergy.com/> and the IEA Bioenergy website [www.ieabioenergy.com](http://www.ieabioenergy.com).

## Progress in R&D

### Task Meetings and Workshops

A number of business/planning meetings and workshops were held in 2018.

- i) Seminar "What does science tell us about biofuels?" European Parliament, 10 January, 2018. Hosted by MEPs Fredrick Federley (Sweden) and Sirpa Pietikäinen (Finland). Göran Berndes co-organiser.  
  
Other participation of IEA Bioenergy: Kees Kwant, Luc Pelkmans, Hans Langeveld, Uwe Fritsche.
- ii) Conference (invited only) Forests and the climate – manage for maximum wood production or leave the forest as a carbon sink? Royal Swedish Academy of Agriculture and Forestry, Stockholm, Sweden, March 2018. PDF-presentations and other documentation available at <http://www.ksla.se/aktivitet/forests-and-the-climate/>
- iii) Workshop (organised by Task 43): "How Attractive Systems for Bioenergy Feedstock Production in Sustainably Managed Landscapes are for Rural Development". Osijek, Croatia. March 2018.

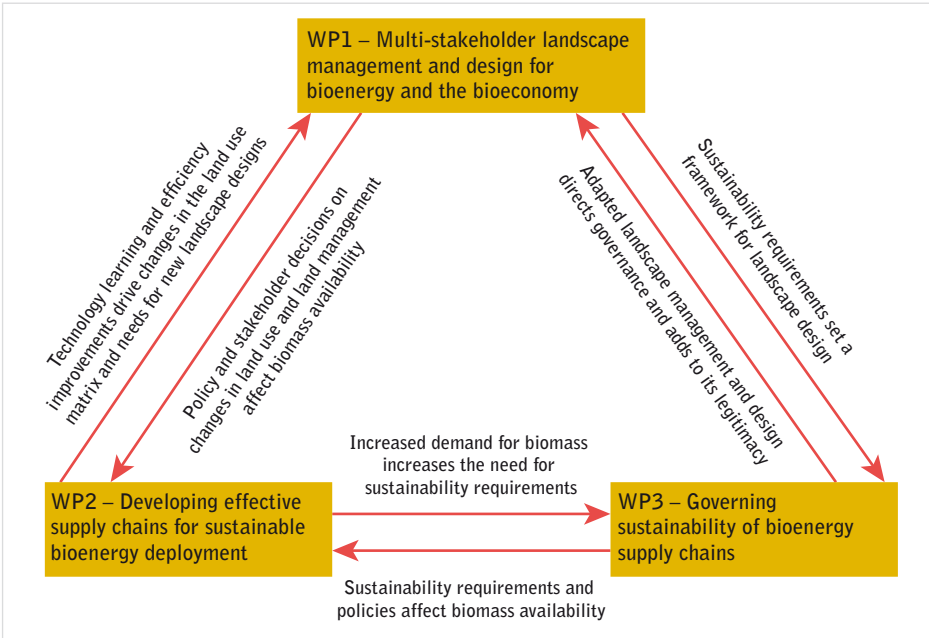
- iv) Conference "Governing sustainability of bioenergy, biomaterial and bioproduct supply chains from forest and agricultural landscapes", Copenhagen, Denmark, 17-19 April 2018. More information at <http://ign.ku.dk/bioenergy-conf-2018/>.
- v) Conference on "Negative CO<sub>2</sub> emissions", Gothenburg, Sweden, 22-24 May 2018. More information at [www.negativeCO2emissions2018.com](http://www.negativeCO2emissions2018.com).
- vi) Workshop "Intended and unintended consequences for climate and bioenergy of LULUCF accounting methodology choices". EUBCE, Copenhagen, May 2018
- vii) Workshop (joint Task 38-43) "Consequences for climate and bioenergy of land sector carbon accounting under the Paris Agreement", Uppsala, Sweden, August 2018.
- viii) Webinar "Approaches to gain trust in sustainability of bioenergy through credible governance", September 2018. Link to the recorded webinar: <http://cif-ifc.adobeconnect.com/pqj4ewwvskrq/>
- ix) Workshop (joint IEA Bioenergy Task 43 & FAO Workshop) "Sustainable Landscape Management for Bioenergy and the Bioeconomy". 11-12th October 2018, FAO, Rome, Italy. Workshop material at <http://task43.ieabioenergy.com/publications/sustainable-landscape-management-for-bioenergy-and-the-bioeconomy/>

## Work Programme

The objective of the Task work is to promote sound bioenergy development that is driven by well-informed decisions by land owners, businesses, governments and others. This will be achieved by collecting, analysing, and sharing technical and non-technical information related to biomass feedstock supply and providing relevant actors with timely and topical analyses, syntheses and information. The work of the Task addresses issues critical to mobilizing sustainable bioenergy supply chains, including all aspects of feedstock production, its markets and environmental, social and economic impacts.

Studies integrating several disciplines are conducted to analyse trade-offs, compatibility and synergies between food, fibre and energy production systems and the bio-economy. The Work Programme is organised in three WPs that are each organised in a set of Task Activities. Research priorities include Landscape management and design for bioenergy and the bio-economy (WP1); Developing effective supply chains for sustainable bioenergy deployment (WP2); Governance sustainability of bioenergy supply chains (WP3). The Task also participates in three strategic Inter-Task projects run in the 2016-2018 triennium: i) Measuring, governing and gaining support for sustainable bioenergy supply chains; ii) Fuel pretreatment of biomass residues in the supply chain for thermal conversion; iii) Bioenergy Success Stories.

The three WPs represent the main elements to achieve the general Task objectives. Specific focus areas and associated work and activities have been outlined within each WP. Topics addressed are critical for deployment of sustainable biomass supply chains and many are relevant for more than one WP as exemplified in the following figure:



WP1 aims at supporting landscape management and design for bioenergy and the bio-economy, by expanding the knowledge base required for sustainable expansion of biomass production systems that also contribute positively to biodiversity and the generation of other ecosystem services. The work takes a landscape level approach to deployment of biomass production for bioenergy and integration of this objective with ownership and societal objectives for existing land use and associated systems. The WP activities address the below overarching questions, which are relevant for both agricultural and forestry systems and reflect that agriculture and forestry activities often co-exist and shape the landscape together.

Which are the most suitable areas for production and/or extraction of various biomass feedstocks? How can biomass feedstock production systems be located, designed and managed to increase resource use efficiency, avoid/mitigate negative and promote positive environmental, economic, and social effects? How can outcomes be optimised to meet the goals of individual stakeholders and society as a whole, including environmental, economic, and social goals? How can analysis and assessment inform participatory processes engaging land owners, policy makers, and other stakeholders in further developing and re-defining goals and plans for landscape management and designs?

A number of feedstock systems and landscapes are analysed and compared with each other and with relevant reference systems, e.g., cultivation of conventional food/feed crops and forest management to produce saw timber and pulpwood. The feedstock alternatives, their location in the landscape, and the needed management systems vary in how they perform relative to different stakeholder objectives (e.g., biomass yields, economy, nutrient use efficiency, energy efficiency, water quality, soil quality, biodiversity and GHG balances). Comparison with stakeholders' preferences, existing guidelines and regulations will help clarify benefits and trade-offs related to choices and alternatives.

The aim of WP2 is to identify opportunities, strategies and practices for improved supply chains and supply chain technology to support large-scale bioenergy deployment. WP2 synthesises and advances state-of-the-art knowledge on biomass supply chains to increase understanding, development and deployment of effective, efficient and sustainable biomass production, harvest, and delivery options. The roles of technologies and of logistics and other management aspects are analysed in varying regulatory and policy contexts. Particular attention is given to integration and interaction between biomass supply chains and the operating and regulatory environment in which they are set, and how that impacts the efficient, sustainable production and use of the biomass resource. The WP is organised around four main activities: Biomass resource assessment and system mapping; technology learning and systems mapping; integration of natural resources and energy systems; and integration of biomass supply chains with existing forest and agricultural supply chains.

The aim of WP3 is to identify how public or private regulatory systems governing the sustainability of land use and bioenergy supply chains can be improved in terms of abilities to monitor, assess and promote achievement of economic, social, and environmental goals while considering the perspectives of land owners, biomass users, and the society as a whole. WP3 examines the interactions among sustainability governance, bioenergy supply chain deployment and climate change. WP3 uses field research, modelling, reviews, syntheses of scientific knowledge, assessments of existing and emerging governance systems, and surveys to determine the views and experiences of different stakeholder groups with sustainability governance. The work intends to inform development of governance from local to international levels, and focuses on the following activities: Improving legitimacy, including effectiveness and efficiency, of governance developed to address sustainability of biomass and bioenergy at different scales; advancing governance mechanisms and science-based assessment of GHG balances and climate effects of LULUCF activities associated with biomass and bioenergy systems.

The work within the different WPs is interrelated and conducted in close co-operation with the WPs; findings in activities of one WP affect the baselines of other activities and therefore close collaboration is a prerequisite to successfully tackle the great number of open questions that the Task has identified and aims to answer.

## Website

The Task website (<http://task43.ieabioenergy.com/>) has been updated in line with changes of the IEA Bioenergy website. Extensive information concerning the Task 43 work is available and updated constantly.

## Collaboration with Other Tasks/Networking

As mentioned above, Task 43 is involved in three Inter-Task projects: i) Measuring, governing and gaining support for sustainable bioenergy supply chains (Leader: Martin Junginger, Task 40), Bioenergy success stories (Leader: Uwe Fritsche, Task 40); Fuel pretreatment of biomass residues in the supply chain for thermal conversion (Leader: Jaap Koppejan, Task 32). Concerning the Inter-Task project "Measuring..." Göran Berndes (Task 43) and Annette Cowie (Task 38) coordinate the work of Objective 1 while Tat Smith and Inge Stupak (both Task 43) coordinate the work of Objective 2. Several Task 43 members (including Biljana Kulicic and Ioannis Dimitriou) are involved in the work of Objective 3. In the "Pretreatment" Inter-Task, there will be involvement of Task 43 collaborators in two sub-case studies: Wolter Elbersen in ag-residues leaching and potential, and Antti Asikainen and Évelyne Thiffault in forest residues.

The collaboration of Task 43 with FAO has developed in several levels: the Bioenergy and Food Security (BEFS RA) division at FAO has been invited and participated in our workshops aiming at closer collaboration e.g. on sustainability assessment issues, and a joint workshop with FAO in October 2018 was organised (contact person from FAO Olivier Dubois) with great success attracting several external stakeholders that contributed to that success (more information can be found above).

Task 43 has been collaborating with several worldwide networks engaged in the same topics and has co-organised several events in 2018 (see list above) which resulted in several publications (see Appendix 4). Collaboration with the Biofuelnet Canada community has occurred (mainly via Évelyne Thiffault), and the ambition is to continue with this co-operation in the future. The same is valid for Task 43's co-operation with Oak Ridge National Laboratory and other US National Labs and their collaborating organisations, with extensive participation in our activities. An example is Task 43's collaboration with the Woody Crops network and the co-organisation of the International Short Rotation Woody Crops Conference 2018 on July 22-26 in Rhinelander, WI, USA between Short Rotation Woody Crops Operations Working Group, the Poplar and Willow Council of Canada, the IUFRO Working Party 2.08.04 (Physiology and Genetics of Poplars and Willows), the IUFRO Working Party 1.03.00 (Short Rotation Forestry), the IEA Task 43 (Biomass Feedstocks for Energy Markets) and the IPC Environmental and Ecosystem Services Working Party (<http://www.woodycrops.org/>).

Networks such as CAR-ES (Centre of Advanced Research on Environmental Services from Nordic Forest Ecosystems), which brings together Nordic and Baltic forest researchers with the aim to provide scientific knowledge on the impacts of forest management, and the SNS "Effects of bioenergy production from forests and agriculture on ecosystem services in Nordic and Baltic landscapes" bring together Task 43 researchers (Bentsen, Berndes, Dimitriou, Stupak, and others) with several research and research projects in the area. A result of this collaboration was a joint IEA Bioenergy Task 43, SNS-NKJ and CAR-ES conference "Governing, documenting and measuring sustainability of bioenergy and biomaterials supply chains from forest and agricultural landscapes which took place from the 17-19 April 2018 at the University of Copenhagen.

The collaboration between Task 38 and Task 43 members is continuous in terms of common work within reports (example "Forest biomass, carbon neutrality and climate change mitigation" that has been published by the European Forest"), in the Inter-Task projects but also in Task 43 activities, e.g. the iLUC activity involving members of Task 38 (Annette Cowie; Miguel Brandao). Additionally, concrete collaboration with Task 40 has been initiated via the Task 43 activity "Exploring novel regional and landscape-based approaches to govern sustainability of bioenergy and biomaterials supply chains", which started in autumn 2017 and continued in 2018 involving Rocío Diaz-Chavez from Task 40.

Task 43 has also further developed the collaboration with SEforALL Forum by attending and contributing to the 2018 Bioenergy Partner Working Session in Lisbon. SEforALL actively participated in the joint FAO-Task 43 workshop in Rome, as did IRENA which is also another organisation that Task 43 has worked closely with.

APPENDIX 1: TASK PARTICIPATION IN 2018

| TASK  | AUS | AUT | BEL | BRA | CAN | CRO | DEN | EST | FIN | FRA | GER | IRE | ITL | JAP | KOR | NEL | NZE | NOR | SA | SWE | SWI | UK | USA | EC | Total |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|-----|-----|----|-----|----|-------|-----|
| 32    |     | •   | •   |     | •   |     | •   |     |     |     | •   | •   | •   | •   | •   | ⊗   |     | •   | •  | •   | •   |    |     |    | 13    |     |
| 33    |     | •   |     |     |     |     | •   |     |     |     | •   |     | •   |     |     | •   |     | •   |    | •   | •   |    | ⊗   |    | 9     |     |
| 34    |     |     |     |     | •   |     |     |     | •   |     | •   |     |     |     |     | •   | •   |     |    | •   |     | ⊗  |     |    | 7     |     |
| 36    |     |     |     |     |     |     |     |     |     | •   | •   |     | •   |     |     |     |     |     |    | ⊗   |     |    |     |    | 4     |     |
| 37    | •   | •   |     | •   |     |     | •   | •   | •   | •   | •   | ⊗   |     |     | •   | •   |     | •   |    | •   | •   | •  |     |    | 15    |     |
| 38    | ⊗   |     |     | •   |     |     |     |     | •   | •   | •   |     |     |     |     |     |     |     |    | •   |     |    | •   |    | 7     |     |
| 39    | •   | •   |     | •   | ⊗   |     | •   |     |     |     | •   |     |     | •   | •   | •   | •   |     | •  | •   |     |    | •   | •  | 14    |     |
| 40    |     | •   | •   |     |     |     | •   |     | •   |     | •   |     | •   |     |     | ⊗   |     |     |    | •   |     | •  |     |    | 10    |     |
| 42    | •   | •   |     |     | •   |     | •   |     |     |     | •   | •   | •   |     |     | ⊗   |     |     |    |     |     |    | •   |    | 9     |     |
| 43    | •   |     | •   |     | •   | •   | •   |     | •   |     | •   | •   |     |     |     | •   |     | •   |    | ⊗   |     |    | •   |    | 12    |     |
| Total | 5   | 6   | 3   | 3   | 5   | 1   | 7   | 1   | 5   | 3   | 10  | 4   | 5   | 2   | 2   | 8   | 2   | 4   | 2  | 9   | 3   | 2  | 7   | 1  |       | 100 |

⊗ = Operating Agents      • = Participant

## APPENDIX 2: BUDGET IN 2018 – SUMMARY TABLES

### Budget for 2018 by Member Country (US\$)

| Contracting Party   | ExCo funds     | Task funds       | Total            |
|---------------------|----------------|------------------|------------------|
| Australia           | 11,700         | 77,500           | 89,200           |
| Austria             | 12,700         | 91,500           | 104,200          |
| Belgium             | 9,700          | 45,000           | 54,700           |
| Brazil              | 9,700          | 45,000           | 54,700           |
| Canada              | 11,700         | 80,500           | 92,200           |
| Croatia             | 7,700          | 15,000           | 22,700           |
| Denmark             | 13,700         | 106,500          | 120,200          |
| Estonia             | 7,700          | 14,000           | 21,700           |
| Finland             | 11,700         | 78,000           | 89,700           |
| France              | 9,700          | 45,400           | 55,100           |
| Germany             | 16,700         | 155,900          | 172,600          |
| Ireland             | 10,700         | 61,500           | 72,200           |
| Italy               | 11,700         | 77,900           | 89,600           |
| Japan               | 8,700          | 30,000           | 38,700           |
| Korea               | 8,700          | 29,000           | 37,700           |
| The Netherlands     | 14,700         | 124,500          | 139,200          |
| New Zealand         | 8,700          | 33,000           | 41,700           |
| Norway              | 10,700         | 59,000           | 69,700           |
| South Africa        | 8,700          | 30,000           | 38,700           |
| Sweden              | 15,700         | 138,400          | 154,100          |
| Switzerland         | 9,700          | 44,000           | 53,700           |
| UK                  | 8,700          | 29,000           | 37,700           |
| USA                 | 13,700         | 111,500          | 125,200          |
| European Commission | 8,700          | 30,000           | 22,700           |
| <b>Total</b>        | <b>260,800</b> | <b>1,537,100</b> | <b>1,797,900</b> |



BUDGET IN 2018 – SUMMARY TABLES

Budget for 2018 by Task (US\$)

| Task   | Number of participants | Annual contribution per participant | Total Task funds |
|--|------------------------|-------------------------------------|------------------|
| Task 32: Biomass Combustion and Co-firing  | 13                     | 15,000                              | 195,000          |
| Task 33: Gasification of Biomass and Waste   | 9                      | 15,000                              | 135,000          |
| Task 34: Direct Thermochemical Liquefaction  | 7                      | 18,000                              | 126,000          |
| Task 36: Integrating Energy Recovery into Solid Waste Management Systems                               | 4                      | 15,400                              | 61,600           |
| Task 37: Energy from Biogas  | 15                     | 14,000                              | 210,000          |
| Task 38: Climate Change Effects of Biomass and Bioenergy Systems                                       | 7                      | 16,000                              | 112,000          |
| Task 39: Commercialising Conventional and Advanced Liquid Biofuels from Biomass                        | 14                     | 15,000                              | 210,000          |
| Task 40: Sustainable biomass markets and international bioenergy trade to support the biobased economy | 10                     | 15,000                              | 150,000          |
| Task 41: Bioenergy Systems Analysis  | 5                      | 0                                   | 0                |
| Task 42: Biorefining in a future BioEconomy  | 9                      | 17,500                              | 157,500          |
| Task 43: Biomass Feedstocks for Energy Markets   | 12                     | 15,000                              | 180,000          |
| Total  |                        |                                     | 1,537,100        |

## APPENDIX 3: 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

The Ministry of Economic Affairs and Communications (Estonia)

Commission of the European Union

Innovation Funding Agency Business Finland

L’Agence de l’Environnement et de la Maîtrise de l’Énergie (ADEME) (France)

Federal Ministry of Food and Agriculture (Germany)

The Sustainable Energy Authority of Ireland (SEAI)

Gestore dei Servizi Energetici – GSE (Italy)

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

Ministry of Knowledge Economy, the Republic of Korea

NL Enterprise Agency (The Netherlands)

SCION (New Zealand)

The Research Council of Norway

South African National Energy Development Institute (SANEDI)

Swedish Energy Agency

Swiss Federal Office of Energy

Department of Business, Energy and Industrial Strategy (United Kingdom)

The United States Department of Energy