

# Key achievements Triennium 2016-2018

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The work within IEA Bioenergy is structured in a number of Tasks, which have well defined objectives, budgets, and time frames, which are agreed per period of three years (triennium). 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 10 ongoing Tasks during this triennium:

- Task 32: Biomass Combustion and Co-firing
- Task 33: Thermal 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 Conventional and Advanced Liquid Biofuels from Biomass
- Task 40: Sustainable biomass markets and international trade to support the biobased economy
- Task 42: Biorefining in a Future BioEconomy
- Task 43: Biomass Feedstocks for Energy Markets

This overview shows a short summary of key achievements of the Tasks in the Triennium 2016-2018.

FOR MORE DETAILS ON THE INFORMATION PROVIDED BELOW, PLEASE REFER TO THE  
INDIVIDUAL TASK REPORT CONCERNED

### **Task 32: Biomass Combustion and Co-firing**

Task 32 aimed to stimulate the expansion of cost effective and clean biomass combustion and co-firing for the production of heat and power to a wider scale. Reports published in the triennium 2016-2018 include:

*State-of-the-art report on applications of biomass combustion based CHP with case studies and identification and assessment of innovative developments:* This report describes progress in the commercialisation and development of biomass fired CHP technologies.

*Aerosols from Biomass Combustion:* This report summarises the current knowledge on the health relevance of combustion generated PM, describes the mechanisms which can cause PM in biomass combustion, describes different particle types, and provides information on measures to reduce PM from biomass combustion. The report found that biomass could play an important role in future energy supply in an environmentally friendly manner through implementation of state-of-the-art combustion devices and their appropriate operation.

*The future role of thermal biomass power in renewable energy systems - a study of Germany:* A conclusion of this report was that, given favourable framework conditions, thermal biomass power could supply base load electricity and heat for district heating.

### **Task 33: Thermal gasification of Biomass and Waste**

The aim of Task 33 was to foster cooperation among the participating countries and industry to eliminate technological impediments to the advancement of thermal gasification of biomass and waste. Reports published in the triennium 2016-2018 include:

*Fuel pretreatment for gasification:* This report looked at pretreatment of municipal solid waste and showed that pretreatment of MSW could allow waste to meet the physical and chemical specifications required of gasification facilities.

*Hydrogen production via gasification:* This report gives an overview of possible ways to produce hydrogen via biomass gasification. Biomass to hydrogen efficiencies (LHV based) of up to 69% are achieved and a techno-economic study shows hydrogen selling prices of down to 2.7 EUR·kg<sup>-1</sup> (or 79 EUR·MWh<sup>-1</sup>).

*Valorisation of byproducts from small-scale gasification:* The aim of this project was to identify opportunities for other revenue streams from small-scale gasification systems to help improve economics. By-products such as ash and charcoal have potential value as complementary revenue streams. The report evaluates such opportunities and comments on practical aspects such as receiving approval for selling these products.

### **Task 34: Direct Thermochemical Liquefaction**

The objective of the Task in this triennium was to consider the field of direct thermochemical liquefaction technologies for biomass (both fast pyrolysis and hydrothermal liquefaction) and the upgrading of the products to liquid fuels in order to identify both technical and non-technical barriers to more rapid and wider spread implementation of the technologies. Some of the outputs in the triennium 2016-2018 are as follows.

The results of the Round Robin on Fast Pyrolysis Bio-oil Production were drafted into a technical

journal manuscript under the authorship of the Task members. As a result of this round robin, the research community could learn about the consistency of the bio-oil produced in the participating laboratories, and the participating laboratories could learn how their products compared to those produced elsewhere without the complication of feedstock effects.

Member countries of the Task, with input as needed from Task members, have continued to support the implementation of standard methods for the use of bio-oil, including ASTM D7544 for fast pyrolysis bio-oils. In other ASTM standards work, participants in member countries were also working towards a carbonyl analytical standard for bio-oils E3146-17.

### **Task 36: Integrating Energy recovery into Solid Waste Management Systems**

In the period 2016-18 Task 36 aimed to continue to inform decision makers on issues that were important to their decisions, to understand how policy decisions impacted on the opportunities for and efficiency of energy recovery and continued to inform the IEA Bioenergy Agreement Executive Committee on progress of the Task. Reports published in the triennium 2016-2018 include:

*Transboundary shipments of waste:* This subject was explored together with Task 40 and was performed as a master's thesis that was later also reformatted and edited to be suitable as an IEA Bioenergy report. The subject was narrowed down to look at waste wood flows in Europe.

*Trends on the use of SRF:* A study was undertaken to investigate apparent trends in the use of SRF. This work was aligned with work being done within the standardisation work of ISO TC 300 Solid Recovered Fuels. Despite the difficulty in obtaining data, the resulting report gives a background on terminology and origin and an overview of the market in some countries.

*Waste to Energy for the future:* A Swedish case study looked into the potential role of Waste to Energy in Sweden in 2045, assuming that a circular economy was more or less implemented. The work was financed by the Swedish strategic innovation programme RE:Source together with the trade association Avfall Sverige. Task 36 assisted with the translation and editing into an IEA Bioenergy report.

### **Task 37: Energy from Biogas**

The main objectives of the 2016-2018 work programme of Task 37 were to carry out expert technical work on sustainable digestion of substrates, associated reactor configurations and utilisation of produced biogas; to provide expert technical support to assess the externalities of biogas systems; to provide guidance and advice on best practice to policy makers; and to provide technical support to policy makers and to the public. Reports published in the triennium 2016-2018 include:

*Green Gas: Facilitating a future green gas grid through the production of renewable gas:* This report highlights the sources of renewable gas including for anaerobic digestion, gasification, algal biogas and power to gas systems. It highlights the Green Gas Commitment whereby 6 European Gas Grids have an ambition of substituting 100% of natural gas with green renewable gas by 2050.

*Methane Emissions from Biogas plants:* 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.

*The Role of Anaerobic Digestion and Biogas in the Circular Economy:* This technical report has been written to highlight the diversity of benefits from anaerobic digestion and biogas systems. The process is illustrated with case stories from 4 countries (Denmark, Finland, Norway and Sweden).

### **Task 38: Climate Change Effects of Biomass and Bioenergy Systems**

The primary goal of IEA Bioenergy Task 38 "Climate Change Effects of Biomass and Bioenergy Systems" was to develop, demonstrate and promote methods to assess the net climate effects of bioenergy, to support greenhouse gas accounting for bioenergy, and to inform decision-makers in the selection of GHG mitigation strategies. Reports published in the triennium 2016-2018 include:

*Reference systems for evaluating climate effects of bioenergy:* This paper discusses the importance of the reference system in evaluating the climate effects of bioenergy and presents guidance on choosing the most appropriate reference system according to the purpose of the study, with particular focus on the land use reference.

*Quantifying the Climate Effects of Forest-Based Bioenergy:* 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.

*Harmonizing tools for biofuel assessment:* The study examined the basis for differences between tools used for assessing climate effects of biofuels in different jurisdictions. The study is relevant for policymakers and researchers because it shows that differences are a function of the framework setup for each of the tools, that includes legislative requirements in some cases.

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

Task 39's work was focused on accelerating the commercialisation of liquid biofuels, both conventional and advanced biofuels, including algal and 'drop-in' biofuels. Reports published in the triennium 2016-2018 include:

*Update the status and potential of algal biofuels production in a biorefinery context:* This report provided an international update on the status and prospects of using microalgae and macroalgae as feedstocks for producing biofuels and bioenergy products. It found that while in the near- to mid-term prospects for primary bioenergy/biofuels production are poor due to the cost of growing and harvesting (and concentrating/dewatering) algal biomass, algal processing in a multi-product biorefinery context or integrated with wastewater treatment may, eventually, enable economic bioenergy coproduction.

*Advanced biofuels in advanced engines:* This project involved a collaboration with IEA AMF. One of its conclusions is that it is likely that the area of co-optimising 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

*Biofuels for the marine shipping sector:* This study assessed the current and developing marine fuel regulations, marine fuel characteristics and the new CO<sub>2</sub> monitoring regime for ships. One of the conclusions is that 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.

#### **Task 40: Sustainable biomass markets and international trade to support the biobased economy**

The core objective of Task 40 was: 'to support the development of sustainable, international markets and international trade of biomass, recognising the diversity in biomass resources and applications for bioenergy and bio-materials in the biobased economy.' Reports published in the triennium 2016-2018 include:

*Global Wood Pellet Industry and Trade Study 2017:* The report shows that the global wood pellet market has increased dramatically since 2011, with an average increase rate of 14% per year. New countries have entered the market for both, pellet production (such as those from South-East Europe) and pellet consumption (such as East Asia). Inter-continental flows are dominated by the trade relations between the USA and the UK, while non-industrial use is still mainly an intra-European business.

*Transboundary flows of biomass waste streams:* This project investigated how much solid (biomass) waste feedstock is being transported for energy purposes around Europe in the years 2010-2017, and the underlying drivers, incentives and implications.

*International bioenergy trade in climate change mitigation strategies: projections and uncertainties:* This study compares global trade simulations of bioenergy among 8 different global integrated assessment models. The results show that global trade of bioenergy is projected to increase significantly. Most models showed that Latin America and Africa are projected to be the main exporting regions, with the EU, the USA and Asia likely being importers. The study found that robust sustainability governance is needed for global bioenergy trade and although many regions are likely to depend on imported biomass, this is not likely to lead to significant energy security concerns

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

The aim of IEA Bioenergy Task 42 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. Some of the outputs in the triennium 2016-2018 are as follows.

*Biorefineries expert system development and implementation & Biorefinery Factsheets:* A Biorefinery Assessment Platform Tool (BAP) was developed by the University of Graz with the input of all Task 42 NTLs. A full draft version of the platform is currently in operation, and was used in 2018 to deliver four case-study based Biorefinery Fact Sheets (BFSs).

Task 42 has produced and actively distributed several glossy reports showing the importance of the biorefining approach for the sustainable (co)production of food and feed ingredients, chemicals, materials, transport fuels, and energy as the foundation of a (future) Circular BioEconomy. However, several technical and non-technical barriers still exist that prevent large scale deployment of biorefineries into the market sector.

#### **Task 43: Biomass Feedstocks for Energy Markets**

The objective of Task 43 was to promote sound bioenergy development that was driven by well-informed decisions by land owners, businesses, governments and others. This was 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.

Several scenarios indicate that bioenergy will have to play an important role and increase drastically if ambitious climate goals are to be achieved. This increase will have to be a combined result of more efficient use of existing biomass resources but also with sustainable production of new biomass that will be used for energy and other purposes in the bioeconomy. Landscape management, effective supply chains, and governance issues are interrelated and need to be combined in optimal ways to implement sound bioenergy systems. Several such good examples have been brought forward during these years from the Task work and presented as examples for further extrapolation. At the same time, the development of an economy (for energy or other sectors) based on biomass resources faces several trade-offs, and several such examples have been presented, analysed and evaluated within the Task.