



Annual Report 2019

IEA Bioenergy

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

Front Cover: Lahti Energia Gasification Plant, Lahti, Finland



Renato Godinho (Biofuture Platform), Michela Morese (GBEP), Olivier Dubois (FAO), Jim Spaeth (IEA Bioenergy) and Gerard Ostheimer (Below 50) at the Utrecht workshop.

To: IEA Headquarters, Paris

IEA BIOENERGY ANNUAL REPORT 2019

Under the IEA Framework for International Energy Technology Cooperation the Executive Committee of each Technology Collaboration Programme (TCP) must produce an Annual Report for IEA Headquarters.

This document contains the report of the IEA Bioenergy Executive Committee for 2019. This year, we have presented a special feature 'Gasification – a versatile technology', prepared by Task 33.

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

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Chair

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

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

IEA Bioenergy – Selected Highlights From 2019

1. Governing sustainability in biomass supply chains for the bioeconomy

A workshop in collaboration with the IEA, GBEP, FAO, IRENA, the Biofuture Platform, below50 and the Netherlands Enterprise Agency was held in conjunction with ExCo83 in Utrecht, The Netherlands on the 23rd May 2019. With more than 100 participants, the theme of the workshop was *Governing sustainability in biomass supply chains for the bioeconomy*. Key messages from the workshop were:

- **Creating trust** that biomass can be applied sustainably is crucial. This requires credible **governance** systems, and monitoring, traceability and **transparency** are key to gain trust.
- An important step will be to agree on and implement a minimum set of **key sustainability criteria** and related indicators (e.g., based on the GBEP sustainability indicators) in relation to the most important risks and opportunities that need to be addressed through sustainability governance. Where data gaps exist and methodologies are preliminary or lacking, proxies can foster initial steps
- Sustainability governance of bioenergy should not be separated from other uses of biomass (i.e., broader bioeconomy). Sustainability criteria should **apply to all biomass** and not just to the portion of it used for bioenergy. **Linking** sustainability governance **to incentive programmes** and **decarbonisation policies** can help drive acceptance and expand a sustainable bioeconomy
- **Future dialogue** should in principle involve all bio-based value chains' stakeholders, but also policymakers and the private sector, with an emphasis on the **financing** sector. Dialogue is also needed with **critical voices** ("meet the opposition"): what are real risks, what is actual practice, and how can sustainability governance help de-risking? Social and local economic opportunities should be brought forward more prominently, also towards developing countries. Also **younger generations** need to be more involved, as they will be in the driver's seat in the coming decades to steer the transition to a low-carbon economy
- For all this it is necessary to step out of one's own circle, **beyond** the bioenergy community: bioenergy is to be considered part of the bioeconomy. The workshop was a first step to reach a wider audience in order to explain what biomass can mean for society and the economy.

More detailed conclusions and priority actions identified during the workshop together with the workshop notes which cover all sessions and presentations are available in the report at <https://www.ieabioenergy.com/wp-content/uploads/2019/05/ExCo83-Governing-sustainability-in-biomass-supply-chains-for-the-bioeconomy-Summary-and-Conclusions.pdf>.



Attendees at ExCo83 workshop



Timo Tatar, Deputy Secretary General for Energy of Estonia presenting to the ExCo84 workshop

2. Developing business models for efficient use of biomass

A workshop was held in conjunction with ExCo84 in Tallinn, Estonia on the 22nd October 2019, facilitated by The Estonian Ministry of Economic Affairs and Communications. With more than 70 participants, the theme of the workshop was *Developing business models for efficient use of biomass*. Recommendations from the workshop were:

- **Communication and engagement** with the local community is very important. It is not only about risks and how these are covered, but also about communicating opportunities. Local support helps for scaling up and creating additional investments and can be particularly relevant for the concept of bio-hubs.
- We need to encourage the biobased sectors to take more risk and set up policy and investment frameworks that **improve their chances** to be successful.
- The bioenergy sector should explore and develop **CO₂ capture** as an option, which can be a main driver for support to the bioenergy sector.
- There are several studies on the **value of carbon reduction**. At a certain threshold level BECCS will be accelerated, looking at low hanging fruit. There are several emission points of CO₂ and things can evolve in parallel.
- The strength of IEA Bioenergy is to bring disparate groups and networks together. Nevertheless, we need to **expand to who and how we communicate** (broaden our audience).

More detailed conclusions from the workshop together with the workshop notes which cover all sessions and presentations are available in the report at <https://www.ieabioenergy.com/wp-content/uploads/2020/02/ExCo84-Developing-business-models-for-efficient-use-of-biomass-Summary-and-Conclusions.pdf>.

3. Measuring, governing and gaining support for sustainable bioenergy supply chains

This Inter-Task project, which started at the beginning in 2016 and concluded in late 2018, was a collaborative effort between different IEA Bioenergy Tasks and involved a number of studies focusing largely on the agricultural and forestry sectors. The reports summarise the efforts of the Inter-Task project, which was designed to address the challenges associated with measuring and governing, as well as communicating how bioenergy systems contribute to sustainable development. The project focused on three main objectives:

- Objective 1: How to measure and quantify progress towards more sustainable practices?
- Objective 2: How to improve the input, output, and throughput legitimacy of existing and proposed governance systems?
- Objective 3: How to engage more successfully with the broad range of stakeholders so that policies and sustainability governance are perceived as legitimate and helpful for build-up of social capital, trust, and support among all stakeholders?

The four summary reports are titled:

- Measuring, governing and gaining support for sustainable bioenergy supply chains: Main findings and recommendations
- Methods and tools to assess the sustainability of biomass and bioenergy supply chains
- Approaches to creating trust in sustainability of bioenergy through effective governance
- Understanding positions and underlying motivations of stakeholder groups relative to their perceptions of bioenergy

More information about this project and its results are available at

<https://www.ieabioenergy.com/publications/new-publication-measuring-governing-and-gaining-support-for-sustainable-bioenergy-supply-chains/>

4. Gasification – a versatile technology

Gasification is a technology that has a long history. Based on installed capacity, gasification is mostly associated with the conversion of coal, to allow the production of power, Synthetic Natural Gas or Fischer Tropsch products. Based on number of installations, the picture is somewhat different, with many CHP applications installed worldwide and operating on biomass. This feature article will highlight some of the current applications and will show the benefits of gasification in our future energy system. The underlying question, while writing this article, is why is gasification not yet reaching its potential and how can this be realised.

What is gasification

Gasification is the conversion of solid or liquid feedstock into a gaseous product. The gaseous product allows itself to be utilised in many different applications, ranging from heat and power, to transport fuels and chemicals. Depending on the technology chosen the gas can be classified as a producer gas (low – medium temperature conversion) containing all kind of hydrocarbons, or as synthesis gas (syngas; elevated temperature conversion) containing mostly CO and H₂. This syngas, after cleaning and tuning in composition ratios, can be used to produce all kinds of products. Gasification allows for the co-production of valuable by-products, certain technologies aim to valorise char (unconverted biomass), others focus on the gas components and co-produce biogenic CO₂, hydrogen, benzene, toluene and ethylene. The value chains that can be made based upon gasification are extensive and Figure 1, though a simplification of all the possibilities, does show that the technology is capable of serving different markets.

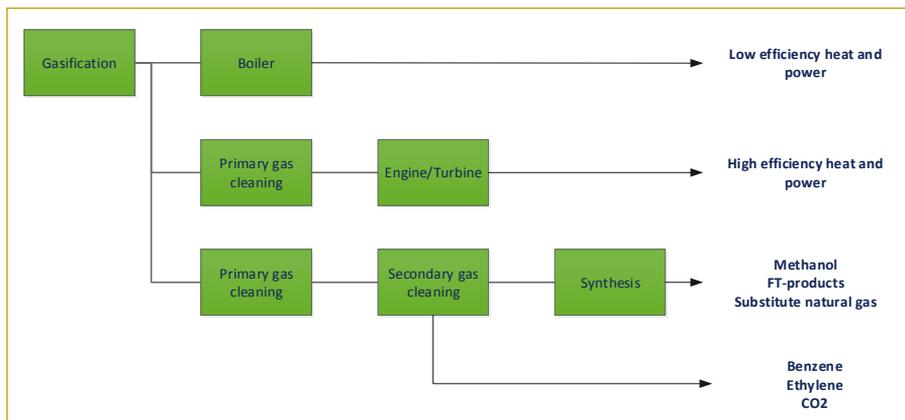
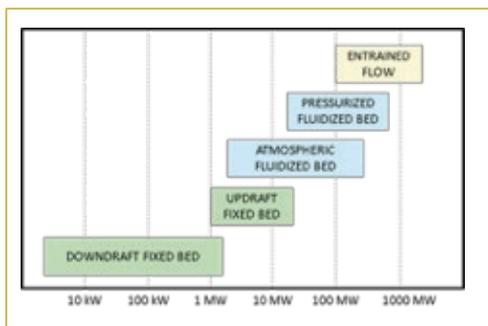


Figure 1: Various valorisation routes based on gasification of biomass and waste

In Figure 1 the technology to utilise a specific feedstock for a specific application is not given. The reason is that based upon several parameters a technology can be chosen that fits best with the specific case. These parameters can be:

- Scale (feedstock availability)
- Feedstock (quality and form)
- Application (power, heat or others)
- Others...

To illustrate that scale is a dominant factor in the applicability of certain technologies the following graph is given. This has been taken from the Factsheets on the IEA Bioenergy Task 33 website and can be seen as a guide on where gasification fits in the energy system.



Each type of gasification technology is best suited for certain scales and applications. Downdraft fixed-bed gasification is most appropriate for power production at small-scales. Updraft fixed-bed gasification fits best in small/medium scales for heat production. On the upper extreme, entrained-flow gasification is intended for IGCC or synthesis applications at very large scales.

Figure 2: Different forms of gasification, each focused on different applications.

Where Fixed Bed gasifiers typically favour rather larger particles as feedstock, the Entrained Flow gasifiers aim at very fine particle size. Also, the quantity and quality of ash components for these technologies is quite different. Especially for Entrained Flow gasifiers, where very high temperatures are realised, the ash chemistry becomes most important. Corrosion, slagging and melting behavior of the ash components is something that needs to be managed. Secondly, this ash behavior is quite different from the case of coal gasification, hence technologies cannot easily be interchanged when biomass is considered as feedstock. Another observation is that especially Fixed Bed gasifiers are utilised in CHP settings, Entrained Flow in syngas applications and Fluidised Bed gasifiers are utilised for both CHP as well as syngas applications.

Heat and power application

The most commonly applied form of gasification of biomass is for the production of heat and power. The FEE has an industrial guide¹ that gives a good overview of how CHP applications have developed for German, Austrian and Swiss suppliers. The following graph is taken from this report to highlight that in fact the installed capacity is not that much (compared to coal, which goes into the GW scale) but the number of installations is. Although this graph is only for suppliers from the three aforementioned countries,

It offers nevertheless important evidence. In fact, it shows that, in the referred period, the spread of gasification in the CHP sector has been characterised by a tremendous increase in numbers as well as installed capacity, thus confirming the feasibility of this kind of technology in the energy sector.

It is interesting to note that in the report of FEE most of the suppliers operate some form of fixed bed (sometimes moving bed) gasifier and there are limited suppliers of fluidised and entrained flow gasifiers for this application.



Figure 3: Development of CHP applications for German, Swiss and Austrian technology suppliers¹

The development of CHP applications based on gasification over the years has shown that this technology has good market potential. The installations in the report can be considered an nth plant (large repetition), which has resulted in reduced CAPEX and improved operability.

Although most CHP applications are based on fixed bed gasifiers, there are good examples of how fluidised bed gasification has been used to produce heat and power. Probably the best known example is Güssing, where the indirect gasifier developed at TU Vienna has been used to generate heat and power on an interesting scale (8MW_{input} to 2 MW_{el} and 4.5 MW_{heat}). This technology has been used in other applications as well, see for instance the country report on Austria in the IEA Bioenergy Task 33 website². The Güssing plant has operated for about 13 years, supported with subsidy. The track record of this installation

1 https://fee-ev.de/11_Branchenguide/2018_Industry_Guide_Biomass_Gasification_EN.pdf

2 <http://www.ieatask33.org/app/webroot/files/file/2019/Birmingham/CR/CR%20Austria.pdf>

is very good, with a high reliability. However, after the support ended, the financial viability of this installation no longer existed. The interesting thing with this Dual Fluidised Bed technology is that it can also be used to develop value chains for fuels and chemicals. Some of these to a smaller extent have been demonstrated at this scale.

An even larger example of how fluidised bed technology has been used for the production of heat and power is the Amer power station in the Netherlands. At this site (coal fired power station) a circulating fluidised bed (CFB) gasifier was built to utilise demolition wood in the power station. The CFB gasifier would convert the solid feedstock (no need to co fire it directly with coal) into a gas, that after simple cleaning (removal of ash) could be co-fired in the boiler. This installation was an 85 MW_{th} plant (supplied by Lurgi) that resulted in about 5% of coal replacement. It had some starting problems but finally operated several years under a Dutch subsidy scheme. After the funding ended, here also the financial operability of the installation was negative and the gasifier was taken out of operation.

In Finland there are several large scale CFB gasifiers in operation, either to replace a fossil fuel in a lime kiln or to produce power. Sumitomo FW, Valmet and Andritz are the three well known companies that successfully build and operate these installations. In Figure 4 some examples are given of sites where their gasifiers have been put into operation.



Figure 4: From left to right. Lahti (160 MW_{th} Valmet), Varkaus (12 MW_{th} SFW) and Joutseno (48 MW_{th} Andritz) all in commercial operation in either a pulp and paper setting or a power setting.

Considering the heat and power sector the following conclusions can be made.

- Small scale CHP is large in numbers and consists mostly of Fixed Bed technology
- Large scale applications are dominated by Fluidised Bed technology
- More complex applications need to operate under “funding schemes”; if these schemes end, typically the installations are taken out of operation
- Relatively easy replacement of fossil fuels in existing applications

Substitute Natural Gas (SNG) and biofuel applications

Besides these low hanging fruits, there are other combinations to be made, that have new challenges to be dealt with. Because of this, they have not yet been successful in commercial operation. These challenges are both technical and non-technical, e.g.:

- In order to utilise the gas, additional gas cleaning is needed, leading to increased CAPEX and as such, increased scale of operations;
- The increased complexity also leads to additional risks and associated costs;
- The increased scale needed for commercial operation has led to difficulties in financing these first-of-a-kind (FOAK) industrial plants;
- Long-term stable incentive schemes and binding targets for renewable fuels are missing

At this point a paradox occurs. Gasification is generally seen as a winning technology, from the perspective that it can in the future provide most of what is obtained from fossil fuels to date such as, chemicals, fuels, power and heat. This perspective can be found in many policy papers (for instance EERA Strategic Research and Innovation Agenda³) and shows the crucial role of gasification for the production of biofuels. This general belief that gasification is a key technology and crucial in providing us with chemicals and fuels, has led to a situation where the expectations are too high and new projects are approached from a single commercial perspective. This often leads to projects which cannot operate commercially because of limited scale (even though they were not built to be commercial projects), or to projects that have insufficient funds and cannot deal with setbacks. In the end these technologies are considered less attractive. Some examples of these are:

- The ARBRE biomass gasification plant in the UK: it has never operated properly and never had the chance to prove the concept.
- The CFB gasifier in Geertruidenberg in the Netherlands: the owner (Essent) and supplier (Lurgi) invested over 4 years of extra time and money to get the plant running. This was probably only worth it because of the attractive economic prospects of this co-firing concept.
- The CHOREN BtL plant in Germany. The gasification technology (Carbo-V) and the FT technology from Shell, were both technically ready. However, the lack of investment and policy support, are cited as the main reasons for Choren not building a commercial plant⁴.
- The Chemrec/LTU Green Fuels plant. The Chemrec gasifier operated on dry black liquor and has been in operation for over 27,000 hours. It has been tested in combination with a bioDME plant, that accumulated around 11,000 hours. A project was founded to convert black liquor from the Domsjö Mill to methanol based on this technology. However, long term policy in Sweden was lacking so it was impossible to finance this project.

3 <https://www.eera-set.eu/wp-content/uploads/EERABioenergySRIA2020.pdf>

4 <https://doi.org/10.1016/j.rser.2018.02.023>

- The DFB gasifier in Gothenburg (GoBiGas), which after successful operation still had to close down, because it was decided that this plant should operate on a commercial basis, although designed and constructed as a demonstration plant

The GoBiGas plant in itself is an interesting case because this project has shown that via gasification, cleaning and upgrading it is possible to make Substitute Natural Gas (SNG). SNG has all of the advantages of NG, used in many sectors from industry to households and used to produce chemicals, heat and power or provide mobility. From this perspective, SNG has been regarded as a key component in the energy transition. In many places in the world there are strong drivers to produce SNG (or Renewable Natural Gas) from renewable feedstock. In certain states in the United States of America, in Canada, in the UK, in the Netherlands and Italy there is policy in place to support this development. However, as can be learned from the GoBiGas project, producing SNG is not a simple task. It requires more complexity and a minimum scale at which it can be commercially attractive. The scale increase (compared to typical kW_{th} scale for CHP application) is a significant barrier, considering the uncertainty with these FOAK plants, and has made it difficult to find parties willing to invest.

At the same time, similar expectations are created by policies focusing on 2nd generation biofuel production, for which gasification again is seen as a key technology. In fact, the complexity will not change so much from SNG production (which in itself can be seen as a 2nd generation biofuel), but for these routes to be successful the same hurdles have to be overcome. They require large scale and sufficient support in order to develop to a commercially viable plant. Henrik Thunman et al. have made an extensive economic assessment of the GoBiGas plant, which can be found online⁵. The following graph is taken from this paper and nicely shows the complexity of an SNG plant. The authors furthermore conclude that an advanced biofuel plant or an SNG plant as such, are not so much different in complexity and costs, and based on their analysis the conclusion is that a production plant of 200 MW_{th} can have a healthy business case.

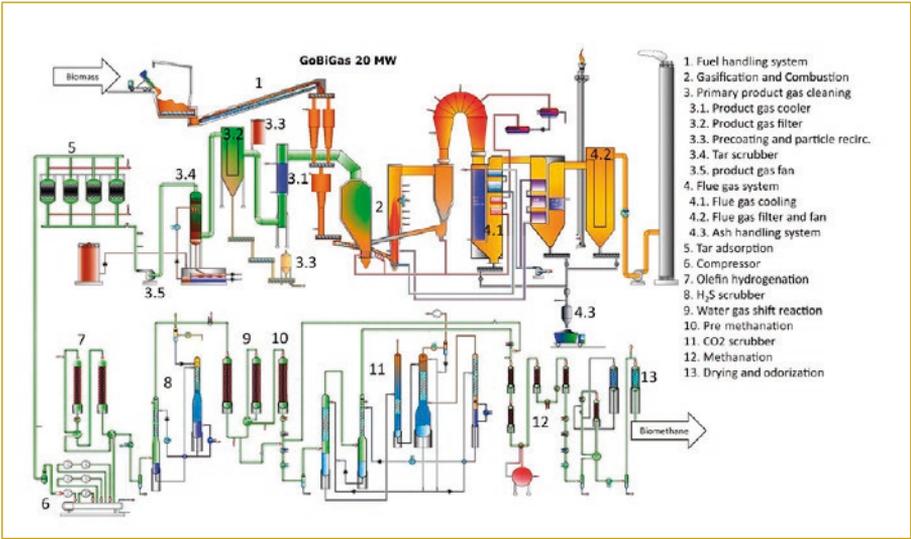


Figure 5: Schematic of the GoBiGas plant, only depicting the major process steps.

GoBiGas was a demonstration plant and all project targets were fulfilled and therefore it must be regarded as a technical success. The plan for investment in GoBiGas 2 at a scale of 100 MW biomethane was however stopped by the city council due to financial constraints. What this means for the development of the technology as such, remains to be seen. At the same time, there are still large scale SNG and biofuel plants under development. The following projects show the diversity of different routes. There is no route the same, which makes it much more difficult to learn from each other's projects. Next to this a list can be made of large projects that, even with funding from for instance the EU (NER300), never made it to realisation (Woodspirit and Ajos BTL).

Name	Product	Feedstock	Technology	Location
Gaya	SNG	Biomass	FICFB gasifier – Repotec	Lyon (F)
BioTFuel	FT	Torrefied biomass	PRENFLO gasifier – Thyssen Krupp	Dunkirk (F)
Fulcrum Bioenergy	FT	Waste	Indirect fluidised bed gasifier – TRI	Nevada (USA)
Red Rock Bio	FT	Forestry residues	Steam Reforming – TCG Global	Oregon (USA)
GoGreenGas	SNG	Waste	Fluidised bed gasifier & plasma – APP	Swindon (UK)

Commercial biomass gasification development in the United States of America includes Red Rock Biofuels and Fulcrum Bioenergy/Sierra Biofuels. Red Rock Biofuels is constructing an advanced biofuels production facility in Lakeview, Oregon to convert 136,000 tons of woody biomass into 15 million gallons (57 million litres) per year of biofuels using Fischer-Tropsch technology to make jet fuel and diesel. The feedstock is a mix of softwoods and forestry waste/slash materials plus pre-commercial thinnings. The feedstock will be obtained from non-federal land in southern Oregon and northern California within an economic haulage radius from the plant. Red Rocks Biofuels broke ground on the Lakeview facility in July 2018 and the plant is currently under construction. Completion is expected by mid-2020 with operations to begin later that year. Fulcrum Bioenergy's Sierra Biofuels plant near Reno, Nevada will convert approximately 200,000 tons per year of municipal solid waste into more than 10 million gallons (38 million litres) of renewable synthetic crude oil through feedstock preprocessing, gasification and Fischer-Tropsch synthesis to a FT wax; wax will be processed in Marathon's Martinez CA refinery. The Sierra Biofuels facility will use sorted municipal solid waste that has been pre-processed in an on-site feedstock processing facility (FPF) to remove inert materials and ferrous and non-ferrous metals. The feedstock is very heterogeneous, carbon-rich, and consists largely of paper, cardboard, wood, carpet and other similar materials. The FPF is located adjacent to Waste Management's Lockwood Regional Landfill, one of the largest landfills in the Western United States of America. The FPF is also in close proximity to the Sierra Biorefinery and has been in operation since 2017. The Sierra plant is under construction and scheduled to come on-line in the first quarter of 2020 with fully operational status obtained by the second quarter of 2020.

Considering the ongoing developments in the area of SNG and biofuels development the following observations can be made.

- Complexity of the value chain increases and as such the risks and costs also increase.
- FOAK plants cannot be commercially operated when a demonstration approach is taken and are very expensive when a commercial approach is taken. This means that either projects start but have limited operating hours (non-economic demonstrations) or projects are being developed only to realise that the funds are not there at this large scale.
- Gasification as a key enabling technology offers the opportunity to develop along many routes (on virgin biomass, on torrefied biomass and on waste). This in turn reduces the possibility to translate learnings from one project to the other.

Additional applications and co-productions schemes

Gasification is being applied for heat and power and currently a strong focus is on implementing the technology for the production of SNG and biofuels. There are, however, some additional features related to gasification that either play an important role in greenhouse gas reduction, in improving business cases or in realisation of a hydrogen future.

The problems associated with greenhouse gas emissions can be listed in the top ten of the biggest challenges mankind has to face in the 21st century. This has led to an increase in measures world-wide to reduce these emissions. Through what is known as bioenergy with carbon capture and storage (BECCS) negative CO₂ emissions can be achieved, while still supplying energy to the grid. The concept of negative emissions is depicted in the following graph⁶. Biomass is generated through capturing of CO₂ from the atmosphere. The biomass (forest or agriculture) is first used for the production of food, wood and paper. The residues from these processes can subsequently be used in gasification applications. After the conversion of the biomass, the gas is cleaned and processed for an end product. The surplus of carbon in the feedstock is separated from the process in the form of CO₂. This CO₂ can then be sequestered in empty gas fields.

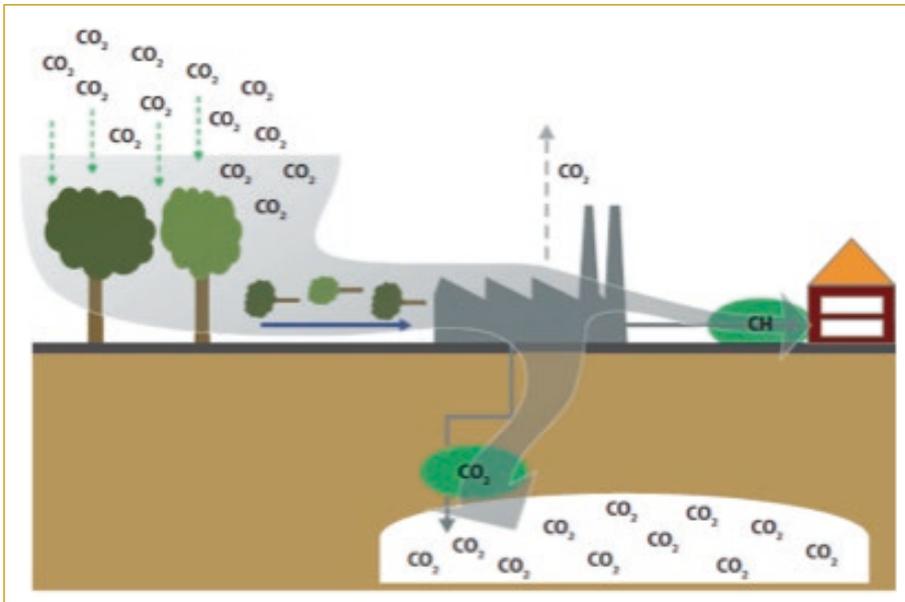


Figure 6: Negative emissions achieved by implementation of CCS to bioenergy processes

Negative emissions

The CO₂ sequestered this way contributes to negative greenhouse gas emissions. BECCS is also key in reaching the Paris agreements and as can be viewed from the IPCC special report on Global Warming of 1.5°C⁷, is recognised as a key technology in most scenarios. With the production of SNG or biofuels, CO₂ becomes readily available and needs to be disposed of. In a recent study into the cost effect of CCS on SNG and FT production performed by IEA Bioenergy Task 33⁸ it was shown that at large scale implementation

6 R. de Vos (ed.) Linking the chain. ISBN 978 90 822377 0 2

7 https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_Chapter2_Low_Res.pdf

8 http://task33.ieabioenergy.com/app/webroot/files/file/publications/bio-CCS/Implementation%20of%20bio-CCS%20in%20biofuels%20production_final_isbn.ptdf

the business case exists. Furthermore, with an increase of the CO₂ price to 100 €/tonne the NPV of an SNG + CCS plant breaks even after 6 years. This does relate to large scale operations, which have proven to be difficult to fund. From this IEA Bioenergy Task 33 study, based on a 600 MWth plant, the negative emissions can add between 150 and 200 ktonnes/annum for a single plant. Translating this number to the target for renewable transportation fuels in the EU by 2030 (3.5% advanced biofuels), under the assumption that it will be met by gasification based BECCS options, in total around 9-11 Mtonnes CO₂ can be sequestered. This also translates to 60 installations of 600 MWth to be brought into operation by 2030. Besides a large growth potential for gasification this also shows a major challenge with the current developments of BECCS options based on gasification, with none existing to date.

Co-production

Gasification technology providers are continuously working on optimising business cases. This can be achieved through economy of numbers. This has been observed for CHP applications, which in some cases are replicated several hundreds of times. Another option is economy of scale, which has worked for co-firing in kilns and boiler applications. This route is being explored for FT applications as well, by for instance Thyssen Krupp. However, the latter route still needs to be validated. Another option is to increase the product range from the gasifier, by valorising certain components in the gas phase, rather than having to remove them. This approach starts to mimic a refinery, which in principle does the same based on fossil fuel. A good example of this is the Dakota Gas Company, that owns and operates the Great Plains Synfuel plant. Today, they are producing besides SNG also ammonia, urea, CO₂ (for enhanced oil recovery), naphtha, tar oil and phenol. They operate 10 fixed bed gasifiers from Lurgi at 300 MWth scale. What started out as a plant producing SNG from lignite, over the years grew into a processing facility with several products, all with the purpose of improving the business case. One product from gasification of biomass is char, which is now marketed by several companies as a product, instead of a waste stream that needs to be disposed of. Char can be used for instance as a soil improvement, peat replacement or as an active carbon. Based on the applications the value increases, but of course this requires some post treatment and it sets some requirements on the gasification technology itself. Nonetheless, several companies now employ this strategy when marketing their technology. For instance Torrgas, Syncraft and Mavitech.

For gasifiers that operate under “mild” conditions, say between 700-800 °C, the product will contain a list of hydrocarbons that when separated would create significant benefits. The concentration of the larger hydrocarbons (ethylene, benzene and toluene) increases when operating on waste. The more contaminated the waste stream is with plastics, the higher their respective contribution in the gas phase will be. Current work done by for instance TNO and Chalmers has shown that with increasing plastics content a gasifier outlet will start to mimic the outlet of a naphtha cracker. Here we find again an interesting link with the current energy system, based on fossil fuels. Gasification of biomass can be used to co-produce chemicals (phenols, naphthalene, benzene, ethylene), and shifting from biomass to waste this can reach a point where a refinery integration can be realised. With this future perspective in mind IEA Bioenergy Task 33 will in the current triennium investigate several possible refinery applications based on gasification.

Hydrogen

Hydrogen is an attractive energy source due to its flexibility and low GHG at the point of use⁹. Potential applications include energy storage, electrical generation, space heating, industrial process heat and transport. Biomass gasification is well suited for hydrogen production and was investigated by IEA Bioenergy Task 33 in the previous triennium¹⁰. Parkinson et al.¹¹ have reviewed studies, suggesting a range from 1.48 \$US/kg to 3 \$US/kg (mean 2.24 \$US/kg) for hydrogen, with biomass supplied at 48 to 115 \$US/ton. The Task 33 report¹⁰ provided detailed modelling of a 50MW dual-fluidised bed (DFB) configuration and a 1MW Sorption Enhanced gasification configuration and assessed likely prices at 2.7 €/kg and 5.5 €/kg respectively. These prices are higher than the cost of hydrogen production from steam (fossil) methane reforming (SMR) but lower than most projections for electrolytic hydrogen production (e.g. 3.5 \$US/kg¹²). The biomass feedstock is typically the largest cost (57% for the 50MW DFB plant). Because of this, gasification of waste may be a more cost-effective option. Modelling of another 50MW (output) gasification facility using waste feedstocks and carbon-capture (based upon experience developing a similar scale bio-SNG plant¹³) resulted in cost estimates of 71 GBP/MWh (1.78 GBP/kg) for a first commercial plant (with a gate-fee of 20 GBP/ton waste, using approximately 100kt/yr), reducing to 42 GBP/MWh (1 GBP/kg) for an “n-th of kind” plant. At these levels, biomass gasification becomes cost competitive against SMR with CCS.

9 CCC. Hydrogen in a Low-Carbon Economy, 2018, www.theccc.org.uk/publications

10 task33.ieabioenergy.com/app/webroot/files/file/publications/Hydrogen/Wasserstoffstudie_IEA%20final.pdf

11 Parkinson, Brett, et al. “Levelised Cost of CO₂ Mitigation from Hydrogen Production Routes.” *Energy & Environmental Science*, Royal Society of Chemistry, 2019, pp. 19-40, doi:10.1039/C8EE02079E.

12 ieahydrogen.org/pdfs/IEA-HTCP-Task-35-FINAL-REPORT_v4.aspx

13 Cairns-Terry, Mike, et al. *Biohydrogen: Production of Hydrogen by Gasification of Waste*. 2017, www.progressive-energy.com

Biomass gasification to hydrogen with CCS has the potential to achieve significant lifecycle net negative GHG emissions as the majority of the carbon content of the biomass is available for capture. For example, -113%¹¹ or -132%¹³ of the GHG that would be emitted by unabated SMR. These GHG reductions are competitive, estimated at 75 \$US/ton-CO₂ or 39 GBP/ton-CO₂ respectively. The process of gasification to hydrogen is technically similar to the carbon-capture component of pre-combustion capture power generation and has similar overall negative emissions potential¹⁴. However, in decoupling the processes, it potentially de-risks development and enables better optimisation of the gasifier as its operation is independent of variable power generation demands.

Despite these merits, biomass gasification to hydrogen is yet to be developed at commercial scale. The fully integrated DFB system discussed above was assessed to be at only TRL-5⁹. However, most of the system components are well-proven for fossil-based feedstocks to produce hydrogen, and projects have successfully produced other hydrocarbons in which the syngas quality requirements are comparable (e.g. GobiGas bio-SNG). In the short-term, demonstration using slipstream from commercial-scale bio-SNG facilities has been suggested as a low-risk approach¹³. The dedicated nature of most hydrogen production to specific demands (e.g. a refinery or ammonia plant) might also pose a barrier to development of demonstration plants as it increases the impact of production shortfall risks. Alternative offtake arrangements, such as grid-blending or dedicated hydrogen grids fed from a range of different sources might encourage development, if sufficient support is available.

In alternative configurations, gasification and the following syngas processing to other fuels can present a worthwhile *demand for hydrogen*. These configurations can enable fuller use of the carbon content of biomass in producing hydrocarbon fuels. Where these hydrocarbon fuels are hard to substitute (e.g. for aviation) and the counterfactual production route is fossil-based, the overall lifecycle carbon savings can be similar to those achievable through BECCS hydrogen production. This may be attractive where carbon transport or storage options are constrained, and/or if developments make a low-carbon source of hydrogen (possibly geographically specific) available at sufficiently lower costs.

Steel application (high temperature heat)

Another outlet for gasification is in the steel making process. These processes consume plenty of fossil fuels, either coal or natural gas. Gasification can be used to produce char (to replace coal) and/or to produce a fuel gas (to replace natural gas).

Currently there is already one commercial plant in place in Sweden. Cortus Energy AB has very recently (Dec 2019) announced that their "WoodRoll"[®] plant (6 MW_{th}) installed at the steel plant of Höganäs is technically completed, including third-party certificates, instruction manuals and check-out of all components. The control system is now fully implemented and quality assured. Firing and hot tests (up to 1,100°C) with Natural gas has been completed and, with the approval of the Swedish Civil Contingencies Agency (MSB) has been achieved¹⁴. At this site they will produce a fuel gas to be used in the steel making process.

Way forward for gasification

IEA Bioenergy Task 33 will continue to work on supporting the gasification development. By organising workshops, webinars and providing publications on the subject, the goal is to support the development world-wide. From this article we hope to convey the message that gasification truly is a versatile technology and not only on paper. Many smaller and larger scale applications have been realised and are running successfully. Several successful demonstrations have shown that also the more sophisticated applications (SNG, biofuels, chemicals) can be realised through gasification, but there is a need for better business cases.

As mentioned before, gasification holds great promise. Sometimes this promise leads to one forgetting that there are hurdles to be overcome. These hurdles need to be solved through demonstrations or commercial demonstrations, but in both cases a better support system is needed. For instance:

1. Through demonstrations, gasification technologies can be much better de-risked and reduced in CAPEX. However, these routes always suffer from poor economics, therefore better supporting mechanisms are needed to keep these demonstrations in operation over their lifespan.
2. Through commercial demonstrations, where the size is large enough to have a positive business case. These plants are associated with higher CAPEX and risks. Here a supporting mechanism is needed as well, to allow companies to take these risks.

14 https://tools.euroland.com/tools/Pressreleases/GetPressRelease/?ID=3683132&lang=sv-SE&companycode=s-cteh&v=s-cteh_ticker

Gasification is used more and more for high end applications, SNG and biofuels currently having the most attention. This is a good development, because it allows demonstration of a market where other renewables cannot play a significant role. It also shows that through gasification, high value products can be produced. High value, in this sense means that people do not need to change the way they cook, heat their homes or fuel their cars, but can rely on a sustainable form of energy. This development also paves the way to chemicals, hydrogen and other catalysis applications that can be based on the produced gas.

Gasification, truly is a versatile technology, but in order to succeed on the various fronts, it does need careful nurturing and support.

B. Vreugdenhil on behalf of Task33 member countries

The Netherlands

Austria

Sweden

United Kingdom

United States of America

Italy

Germany

International Energy Agency

Mission

Founded in 1974, the IEA (<https://www.iea.org/>) was initially designed to help countries co-ordinate a collective response to major disruptions in the supply of oil, such as the crisis of 1973/4. While this remains a key aspect of its work, the IEA has evolved and expanded significantly.

The IEA examines the full spectrum of energy issues including oil, gas and coal supply and demand, renewable energy technologies, electricity markets, energy efficiency, access to energy, demand side management and much more. Through its work, the IEA advocates policies that will enhance the reliability, affordability and sustainability of energy in its 30 member countries and beyond.

Today, the IEA is at the heart of global dialogue on energy, providing authoritative analysis through a wide range of publications, including the flagship *World Energy Outlook* and the IEA Market Reports; data and statistics, such as *Key World Energy Statistics* and the Monthly Oil Data Service; and a series of training and capacity building workshops, presentations, and resources.

The four main areas of IEA focus are:

- Energy Security: Promoting diversity, efficiency, flexibility and reliability for all fuels and energy sources;
- Economic Development: Supporting free markets to foster economic growth and eliminate energy poverty;
- Environmental Awareness: Analysing policy options to offset the impact of energy production and use on the environment, especially for tackling climate change and air pollution; and
- Engagement Worldwide: Working closely with partner countries, especially major emerging economies, to find solutions to shared energy and environmental concerns.

Structure

The IEA is an autonomous body within the OECD framework. The Governing Board is the main decision-making body of the IEA, composed of energy ministers or their senior representatives from each member country. Through the IEA Ministerial meeting that takes place every two years, the IEA Secretariat develops ideas for existing or new work programmes, which are then discussed with member countries in various IEA committees and ultimately presented to the Governing Board for approval. In addition to the Governing Board, the IEA has several Standing Groups, Committees and Working Parties made up of member country government officials, which meet several times a year.

Member Countries

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

Association Countries

Brazil, China, India, Indonesia, Morocco, Singapore, South Africa and Thailand

Introducing IEA Bioenergy

Welcome to this Annual Report for 2019 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 2019, 25 parties participated in IEA Bioenergy: Australia, Austria, Belgium, Brazil, Canada, Croatia, Denmark, Estonia, Finland, France, Germany, India, Ireland, Italy, Japan, the Republic of Korea, the Netherlands, New Zealand, Norway, South Africa, Sweden, Switzerland, the United Kingdom, the United States of America, and the European Commission.

IEA Bioenergy is now 42 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 12 ongoing Tasks during 2019:

- Task 32: Biomass Combustion
- Task 33: Gasification of Biomass and Waste
- Task 34: Direct Thermochemical Liquefaction
- Task 36: Materials and Energy valorisation of waste in a Circular Economy
- Task 37: Energy from Biogas
- Task 39: Commercialising of Conventional and Advanced Transport Biofuels from Biomass and Other Renewable Feedstocks
- Task 40: Deployment of biobased value chains
- Task 41: Bioenergy Systems Analysis
- Task 42: Biorefining in a Circular Economy
- Task 43: Sustainable biomass supply integration for bioenergy within the broader bioeconomy
- Task 44: Flexible Bioenergy and System Integration
- Task 45: Climate and Sustainability Effects of Bioenergy within the broader Bioeconomy

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 2019 is shown in Appendix 1.

A progress report for IEA Bioenergy for the year 2019 is given in Sections 1 and 2 of this Annual Report.



ExCo83 study tour group at the Amer Power Plant

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 83rd ExCo meeting took place in Utrecht, The Netherlands on 21-23 May with 39 participants. The 84th ExCo meeting was held in Tallinn, Estonia on 22-24 October and there were 37 participants. Pharoah le Feuvre represented IEA Headquarters at ExCo83.

Jim Spaeth of the USDoE chaired both ExCo meetings in 2019 with Paul Bennett of New Zealand in the role of Vice-chair. At ExCo84, Jim Spaeth was elected as Chair and Paul Bennett was elected as Vice-chair for 2020.

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 2019, is described below.

Implementing Agreement

The term of the IEA Bioenergy Technology Collaboration Programme (TCP) has been renewed in 2019 and the new term covers the period 1st March 2020 to 28th February 2025.

Contracting Parties/New Participants

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

India joined the IEA Bioenergy Technology Collaboration Programme in 2019, bringing the number of contracting parties to 25. China made a presentation to ExCo84 in Tallinn and was invited to join the TCP. It is expected that China will complete the process of joining IEA Bioenergy in 2020. There are ongoing discussions with Indonesia 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. In order to improve efficiency, the ExCo has decided that in future Task Leaders attend the second meeting in each year so that they can make presentations on the progress in their Task and programme of work personally. Participation by Task Leaders in ExCo meetings 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 2019 approved by the Executive Committee for the ExCo Secretariat Fund and for the Tasks are shown in Appendix 2. Total funds invoiced in 2019 were US\$1,938,000 comprising US\$275,500 of ExCo funds and US\$1,662,500 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 in Bank of Ireland Global Markets in Dublin continues to function smoothly. The Trust Account consists of a Call Deposit account and a Fixed Deposit account both of which bear interest. The Call Deposit account is the account used to receive funds from the contracting parties and to distribute funds to the Task Leaders. It can be accessed electronically and transactions can be executed by the Secretary at all times. The Fixed Deposit account is a separate account that attracts a higher level of interest (approximately a factor of 10 higher than the Call deposit account). Funds in this account can only be transferred to the Call Deposit account following a written request from the Secretary and with a delay of several days. 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 2019, there was US\$44,400 of Member Country contributions outstanding.

At ExCo84, unanimous approval was given to the appointment of KPMG, Dublin as independent auditor for the ExCo Secretariat Fund until 31 December 2021. The audited accounts for the ExCo Secretariat Fund for 2018 were approved at ExCo83.

The Tasks also produce audited accounts. These are prepared according to guidelines specified by the ExCo. The accounts for the Tasks for 2018 were approved at ExCo83, with the exception of Task 43 whose accounts were approved by written procedure prior to ExCo84.

The audited accounts for the ExCo Secretariat Fund for the period ended 31 December 2019 have been prepared and these will be presented for approval at ExCo85.

Task Administration and Development

Task Participation

In 2019 there were 106 participations in 11 Tasks. This number was increased by 2 at ExCo84 as observers in Tasks 33 and 40 decided to join those Tasks. This meant that they also paid the fees for 2019. Please see Appendix 1 on page 112 for a summary of Task participation.

There were two active projects under Task 41 and three Inter-Task projects in 2019 – see below under '**Strategic Fund/Strategic Outputs**'.

Strategic Plan

The Executive Committee of IEA Bioenergy have adopted a new Strategic Plan for the term 2020-2025. The objectives of the plan are to enable bioenergy to substantially contribute to future global energy demand within a growing global bioeconomy; provide significant greenhouse gas savings across all energy sectors; and contribute to the Sustainable Development Goals. The Plan recognises that bioenergy can and must deliver increasing results in decarbonising transport, heat, power and electricity, including through its capacity to deliver negative emissions by, among many pathways, bioenergy with carbon capture and storage/utilisation (BECC/BECCUS)

Technical Coordinator

In 2019 the Technical Coordinator worked closely with the Tasks to finalise outstanding deliverables from the preceding triennium and was also involved in the Inter-Task and Task 41 projects. He coordinated the preparation of the programmes for the ExCo83 (Utrecht) and ExCo84 (Tallinn) workshops and led the drafting of the summary and conclusions reports from each. Regarding the IEA Secretariat, he provided a review of the Renewable Energy Market Report and coordinated the IEA Bioenergy provision of topics to the IEA initiative 'Today in the Lab/Tomorrow in Energy. The Technical Coordinator continued to facilitate interaction with GBEP, BioFuture Platform, Below50 and IRENA, particularly in the context of the preparation of the ExCo83 workshop in Utrecht. His work also incorporated implementation of the communication strategy including the communication playbook and he has led the organisation of the ongoing webinar series. He has continued to represent IEA Bioenergy on the ART Fuels Forum.

Communication Strategy

The Executive Committee of IEA Bioenergy has continued to emphasise communications as a critical factor in bringing its knowledge to the wider stakeholder community. As an ongoing step in this regard ETA Florence have been contracted to deliver communication services across a range of activities, including social media campaigns, the development of a new logo/brand and a refreshing of the website. It is expected that a new logo/brand and refreshed website will be implemented in the first quarter of 2020. In 2019 five webinars were presented – (i) *Perception and Positions of Stakeholders towards Bioenergy*, (ii) *Biomass Pretreatment Options to Diversify the Resource Base*, (iii) *Technical, Economic and Environmental Assessment of Biorefineries*, (iv) *Drop-in' Biofuels: The Key Role that Co-Processing will Play in their Production* and (v) *Future Prospects for Wood Pellet Markets*. 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/>.

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.

Task 41 Project 9: Potential Cost reduction for novel and advanced renewable and low carbon fuels: This project has been completed and the report has been published at https://www.ieabioenergy.com/wp-content/uploads/2020/02/T41_CostReductionBiofuels-11_02_19-final.pdf.

Task 41 Project 10: The contribution of Advanced renewable Transport Fuels to transport decarbonisations in 2030 and beyond: This project is expected to be completed by the end of June 2020 with a final report.

Task 41 Project 11: Renewable Gas – Hydrogen in the grid: This project is expected to be completed by the end of November 2020 with a final report.

Inter-Task Project: Measuring, governing and gaining support for sustainable bioenergy supply chains: This project was completed with four summary reports being published in June 2019 – <https://www.ieabioenergy.com/publications/new-publication-measuring-governing-and-gaining-support-for-sustainable-bioenergy-supply-chains/>.

Inter-Task Project: Fuel pre-treatment of biomass residues in the supply chain for thermal conversion: This project was completed with a final policy report being published in April 2019 – https://www.ieabioenergy.com/wp-content/uploads/2019/04/Pretreatment_PolicyReport.pdf.

Inter-Task Project: The role of bioenergy in a WB2/SDG world: This 3-year project started in the first quarter of 2019 and includes four activity areas. Studies are underway, including one on 'forests as long term C sinks' which will address the view that forests should remain uncut. The project is expected to be completed in the 4th quarter of 2021.

Inter-Task Project: Renewable gas – deployment, markets and sustainable trade: The main objective of the project is to see greater deployment of renewable gases and to underpin their sustainability. Collaboration is foreseen with IEA GHG, IEA Hydrogen, EC DG ENER and the JRC, and industrial partners. The project is expected to be completed in the first quarter of 2021.

Inter-Task Project: Bioenergy for high temperature heat in industry: This Inter-Task project was started in the second quarter of 2019. The project focus is on process heat. A case study template has been developed and each of the technical Tasks is responsible for a single case study. The policy report will be coordinated by Task 40. The project is expected to be completed in September 2021.

ExCo Workshops

At ExCo83 in Utrecht a workshop was organised in collaboration with the Global Bioenergy Partnership (GBEP), the Food and Agriculture Organisation of the United Nations (FAO), the International Energy Agency (IEA), the Biofuture Platform, the International Renewable Energy Agency (IRENA), and below50, and hosted by the Netherlands Enterprise Agency (RVO). The topic of the workshop was "Governing sustainability in biomass supply chains for the bioeconomy". With approximately 100 attendees, the workshop included two plenary sessions during which fifteen invited speakers gave presentations covering 'setting the scene and policy experience'; and 'collecting the evidence' with views from multi-lateral partnerships, industry and civil society. This was followed by two "World Cafe" sessions during which break-out groups discussed 'actions needed for progressing towards a sustainable, circular bioeconomy', and 'a collaborative way forward'. The workshop concluded with a plenary session collecting the summaries from the "World Cafe" sessions and elaborating on the conclusions and next steps. The presentations and summary report from the workshop are available at <https://www.ieabioenergy.com/publications/ws24-governing-sustainability-in-biomass-supply-chains-for-the-bioeconomy/>.

At ExCo84 in Tallinn a workshop was organised in collaboration with the Estonian Ministry of Economic Affairs and Communications. The topic of the workshop was 'Developing business models for efficient use of biomass'. With approximately 75 attendees, the workshop included three plenary sessions during which eleven invited speakers gave presentations. The sessions covered 'Setting up biomass supply chains', 'Examples of developing biobased business models' and 'CO₂ capture as part of future biomass business models'. Each session was closed by reflections from a rapporteur. The workshop concluded with a panel discussion addressing

- Challenges and opportunities to expand biomass mobilisation in a sustainable way and setting up supply chains
- Main barriers for industry investments in biobased business models and BECCS
- Recommendations to overcome these barriers.

The presentations and summary report from the workshop are available at <https://www.ieabioenergy.com/publications/ws25-developing-business-models-for-efficient-use-of-biomass/>.

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 meetings are described in the progress reports from the Tasks later in this Annual report. The papers presented at some of these meetings are listed in Appendix 4. Examples of this outreach are as follows:

- Task 33 organised a workshop on ‘Waste gasification’ in collaboration with Aston University in Birmingham, United Kingdom in November 2019 with presentations from industry and research. The presentations are available at http://www.ieatask33.org/content/home/minutes_and_presentations/2019_Nov_WS/
- Task 37 held a session within the International Renewable Energy Conference in Seoul, Korea in October 2019 (<http://kirec2019.kr/>). The presentations are available at <http://task37.ieabioenergy.com/workshops.html>
- Task 42 held a workshop on ‘New industrial models in the bioeconomic era: the biorefineries’ in the ENEA Headquarters in Rome, Italy in November 2019. The presentations are available at <http://task42.ieabioenergy.com/news/italian-iea42-workshop-on-new-industrial-models-in-the-bioeconomic-era-the-biorefineries/>
- Task 45, in collaboration with the Royal Swedish Academy of Agriculture and Forestry, organised a seminar and roundtable in Stockholm in September 2019 concerning the IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems – <https://www.ksla.se/aktivitet/ipcc-climate-change-and-land/>

Collaboration with other Technology Collaboration Programmes and International Organisations

The Executive Committee of the IEA Bioenergy TCP continues to place strong emphasis on collaboration with other Technology Collaboration Programmes and International Organisations, including those mentioned in the following.

Advanced Motor Fuels Technology Collaboration Programme (AMF TCP)

Collaboration with the Advanced Motor Fuels (AMF) Technology Collaboration Programme has continued with significant interaction through Task 39, including a project on ‘Advanced fuels in advanced engines’. There is also collaboration through Tasks 33 (Gasification) and 37 (Biogas).

GBEP

IEA Bioenergy and GBEP have continued their engagement, particularly through a number of IEA Bioenergy Tasks. GBEP activities on biogas (IEA Bioenergy Task 37) and advanced liquid biofuels (IEA Bioenergy Task 39) are excellent opportunities for enhanced collaboration. Work on sustainability brings opportunities for involvement with IEA Bioenergy Tasks 40 (Deployment) and 45 (Sustainability).

FAO

IEA Bioenergy and FAO continue to engage in examining opportunities for cooperation under the MoU between the two organisations.

IRENA

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

SEforALL

IEA Bioenergy is collaborating with SEforALL on the Biofuels Below 50 Initiative through Task 39.

Biofuture Platform

IEA Bioenergy and the Biofuture Platform are continuing to develop their collaboration. The IEA Bioenergy ExCo85 meeting in São Paulo, Brazil in April 2020 was not held as planned in conjunction with the Biofuture Summit II. The ExCo85 in person meeting was replaced with a Virtual meeting due to the coronavirus pandemic.

Promotion and Communication

Effective communication of IEA Bioenergy activities to the broader stakeholder community is a high priority for the Executive Committee of IEA Bioenergy. In this context IEA Bioenergy has engaged the services of a professional communications organisation. Support is being provided across a range of communication activities, including launching of reports, dissemination through social media and promotion of workshops and webinars. In 2020 the communications organisation will create a new IEA Bioenergy TCP logo and upgrade the website and all report/briefing templates to give a more contemporary look and to increase outreach and impact.

The 2018 Annual report included the special colour section on *“Measuring, governing and gaining support for sustainable bioenergy supply chains – lessons and messages from a three-year Inter-Task project”*. A limited number of printed copies were produced, with substantially increased distribution in electronic format.

The newsletter ‘IEA Bioenergy News’, which is distributed in June and December each year following ExCo meetings, continues to be widely circulated. Two issues were published in 2019. As a special theme the first issue in 2019 featured bioenergy in The Netherlands and the second issue featured biobased energy in Estonia. 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 2019. A free subscription to the TCP newsletters is offered to all interested parties and there is wide distribution outside of the normal IEA Bioenergy network.

Two contributions under the banner ‘IEA Bioenergy Update’ were provided to the journal Biomass and Bioenergy in 2019 bringing the total to 67. 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 2019 the Technical Coordinator provided a review of the Renewable Energy Market Report and coordinated the IEA Bioenergy provision of topics to the IEA initiative ‘Today in the Lab/Tomorrow in Energy’. He continued to maintain 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 April 2019 and presented the IEA Bioenergy Annual Briefing report to the IEA. Jim also attended the REWP meeting in September in Helsinki.

Pharoah Le Feuvre attended ExCo83 on behalf of IEA Headquarters and made a presentation to the IEA Bioenergy Executive Committee on activities in the IEA. 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 ExCo83 and ExCo84. Status reports were also sent to Carina Alles, 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) has had incremental development in 2019. The content has been updated as required during the year. From the website statistics for the year 2019 the key data were as follows:

- Total number of users: 48,200
- Total number of sessions: 65,400
- Total number of page views: 238,200

2. PROGRESS IN 2019 IN THE TASKS

TASK 32: Biomass Combustion

Overview of the Task

Task 32 aims to stimulate expansion of biomass combustion 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 in society and the integration in energy systems with variable renewable energy sources. 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 – Improvement of small-scale biomass combustion
- WP2 – Biomass combustion in industry
- WP3 – Integration and deployment of efficient and flexible large-scale biomass CHP

The specific actions of Task 32 involve collecting, analysing and sharing the policy aspects of results of international and national R&D programmes in the above areas. The results of these actions are disseminated in workshops and reports and potentially as well via handbooks and databases etc. In addition, 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.

Participating countries: Austria, Canada, Denmark, Germany, Japan, The Netherlands, Norway, Sweden, and Switzerland

Operating Agent: Ms Annika Fischer, Danish Energy Agency, Denmark

Task Leader: Morten Tony Hansen, Ea Energy Analyses, Denmark

Co-Task Leader: Anders Hjörnhede, RISE, Sweden

Consultant: Jaap Koppejan, the Netherlands (previous Task leader)

The Task Leader directs and manages the work programme, assisted by the co-task leader. 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 and the IEA Bioenergy website www.ieabioenergy.com under 'Our Work: Tasks'.

Progress in R&D

Task Meetings and Workshops

In the beginning of the year, effort was put into fitting the proposed work programme to a reality with less member commitment than in previous years (9 countries compared to 13).

In 2019, Task 32 organised one physical Task meeting and two virtual meetings. The first virtual meeting was used to kick-off the work programme of the new triennium while the physical meeting was used to monitor progress in different Task activities. The second virtual meeting was focused on planning of a workshop on residential biomass combustion.

An 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 thereby provide expert information for the participants. The workshops are usually organised in conjunction with high-profile bioenergy conferences to attract as wide an audience as possible. The results of the workshops are reported and published on the Task website, and key results are fed back to both the Task participants and the ExCo for evaluation and further dissemination.

The workshop on residential biomass combustion will be held in Graz, Austria in January 2020 at the Central European Biomass Conference and as such lives up to this classic approach. For the forthcoming workshops, however, the aim of Task 32 is to create a high-profile event itself by pooling two workshops and adding site visits to new and remarkable combustion units and, in addition, adding collaboration with other tasks as well as external stakeholders.

Work Programme and Outputs

In 2019 the 2016-2018 triennium was finalised with a number of Task 32 reports and contributions to collaborative projects being finalised and published on the Task 32 website and the IEA Bioenergy website. Please refer to the End-of Triennium Report at <https://www.ieabioenergy.com/publications/triennium-reports-on-iea-bioenergy-tasks-activities-2016-2018/>.

During the first half year of the 2019-2021 triennium, all proposed activities have been started up, the time schedule adjusted, and collaboration with other tasks as well as external partners has been initiated. Progress was discussed at the Task meeting in Norway. The budget and timing have been adjusted accordingly. Progress achieved during 2019 is shown below.

D1.1. Testing methods and real-life performance of pellet stoves (Austria)

The main project activities have taken place in the second half of 2019. The main results will be presented at the workshop in Graz in January 2020 (D1.4) and the report will be published in 2020.

D1.2. Technical guidelines for design of low emission wood stoves (Denmark)

The project has started. A draft guideline based on work made in ERAnet and contributions from Task members is scheduled for the beginning of 2020. The guideline will handle primary measures such as fire chamber design, ignition principles, load, air control and automation while secondary measures such as catalysts and filters (ESP, bag filters, chimney fans) will also be described. Preliminary results will be presented at the workshop in Graz (please see D1.4).

D1.3. Internal WS and report: National strategies for reducing the impact on air quality from residential and commercial wood combustion (Germany)

The project aims to gather information from each participating country on strategies to mitigate PM immision. Each participant is asked to prepare slides on the basis of a template to be presented at an internal workshop in the 1st/2nd quarter of 2021. The country reports will be a part of the basis for the main project report that is scheduled for Q2 2021.

D1.4. WS: Improved combustion in stoves and small biomass boilers (Austria)

It has been decided to organise the workshop in connection with the Central European Biomass Conference 2020 (CEBC) that is to be held in January in Graz, Austria. The workshop will be a parallel event at the conference on the 23rd of January and has benefited from the abstracts sent to the conference on small scale biomass combustion. CEBC is considered to be a perfect opportunity to on one hand gather a large number of stakeholders and on the other to disseminate news and findings from Task 32 to a wider group.

D2.5. Biomass for high temperature heat in industry (Inter-Task project, led by Task 32, Netherlands)

The project has been launched at a virtual meeting in May and cases are currently being selected. In order to broaden the potential cases, the scope has been widened to cover types of applications other than high temperature cases – also general biomass applications for generating process heat have been included. The results of the project will be presented at a webinar in late 2021.

D3.6. Biomass-based CHP for balancing an energy system with a large portion of uncontrollable production (Sweden)

This project is fully dedicated to feed into the activities of Task 44 on Flexible Bioenergy and System Integration. Task 32 has had initial conversations with Task 44 to discuss how Task 32 can optimally contribute to the outcome of Task 44. Task 32 will respond to the questionnaire distributed by Task 44 and participate in the Task 44 workshop to be held at the CEBC in Graz with a presentation of the results of the Task 32 project "The future role of Thermal Biomass Power in renewable energy systems – a study of Germany".

D3.8. WS: Experiences with combustion of wood chips for CHP production (Denmark)

Initial planning has taken place within the Task as well as with external stakeholders. It has been decided to organise the two workshops on the same occasion – in the last week of May 2020 in Copenhagen – to make a large event which could hopefully attract more participants. It is anticipated that the event can include visits to the new and World's largest wood chip fuelled circulating fluidised bed CHP plant of HOFOR as well as to the new MSW incineration plant Copenhill. The event involves cooperation with Task 40 that plans a Task meeting in Copenhagen as well as with members of IEA CCC and members of VGB Powertech.

Website

Handling of the website has been transferred to the new lead of Task 32 and an effort has been made to understand the functionality and to keep the site updated with new publications, events and member documents. Parts of the site could not be accessed and adjusted by the lead and the secretariat has been involved in the updating as well as clarification of specific functions.

Collaboration with other tasks/organisations/networking

The Task collaborates directly with industry and through industrial networks such as VGB Powertech. Within the IEA family, interaction is also solicited with other Bioenergy Tasks or other TCP's such as 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 utility companies are currently directly involved in the Task. Effective coordination is achieved through joint events, and the exchange of meeting minutes and reports.

Cooperation activities were carried out with:

Danish BMA Workshop:	Presentation of the Task 32 report "Options for increased use of ash from biomass combustion and co-firing" (March 2019)
VGB Powertech:	Presentation of the Task 32 report "The future role of Thermal Biomass Power in renewable energy systems – a study of Germany" (May 2019)
T33, T34, T36, T40:	Inter-Task project on high temperature heat for industry
T40:	Workshop on experiences with wood chips combustion in large plants
IEA CCC:	Contribution to biomass co-firing report, suggestion of speakers and announcement on website of IEA CCC co-firing workshop in Japan in February 2020
IEA Renewable Energy Division and BEIPA	Presentation concerning experiences with biomass-based district heating and straw combustion technology with focus on Danish experiences at the 2019 Global Biomass Energy Innovation Development Summit Forum in Beijing (November 2019).

Deliverables

The following milestones were achieved in 2019:

- Publication of Task reports from 2016-2018 triennium (please refer to Appendix 4)
- Presenting End-of-Triennium report and audited final accounts at the ExCo83 meeting in Utrecht
- Obtaining approval of the 2019-2021 triennium proposal and work programme
- Organising and minuting of two virtual and one ordinary Task meeting, kicking off the work programme and initiating all Task actions

- Organising workshop on residential biomass combustion in Graz, January 2020
- Updating and maintenance of the Task website
- Presenting progress report for the ExCo84 meeting in Tallinn
- Preparing section for the IEA Bioenergy Annual Report for 2019
- Preparing audited accounts for the planned ExCo85 meeting in Sao Paolo.

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, Germany, The Netherlands, Sweden, United Kingdom and United States of America

Task Leader: Berend Vreugdenhil, TNO, The Netherlands

Operating Agent: Kees Kwant, Netherlands 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 33 please refer to Appendices 2, 4, 5 and 6; the Task website (<http://task33.ieabioenergy.com/>) and the IEA Bioenergy website (www.ieabioenergy.com) under 'Our Work: Tasks'.

Task Meetings and Workshops

The first Task 33 meeting for 2019 was held on 5-7 June in Karlsruhe, Germany and was organised by Task 33 and KIT. The Task business meeting was held on the first day and a workshop on Gas cleaning, experience, new developments, analytics and diagnostics on the second day. The third day included a technical tour to BASF in Ludwigshafen.

The second Task 33 meeting was held in Birmingham, the UK and was organised by Task 33 together with Aston University. The Task business meeting was held on the first day and a workshop on Waste Gasification on the second day. The third day included a technical tour to KEW, a waste to energy gasification plant.

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

Work Programme and Outputs

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

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

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 identifying 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

(NLTs) 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 NLTs, and address matters related to the Task mission and objectives. The two Task meetings and associated workshops and technical tours for 2019 were presented above.
- Prepare and publish reports on issues relating to gasification of biomass and waste. During 2019 several reports were completed and published on the Task 33 website. A list of those reports is given in Appendix 4.
- 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. An important outcome of this ongoing survey is the role gasification can play in refinery settings. Task 33 has identified 3 possible routes to contribute to traditional refineries and in a newly defined Task project this will be further investigated.
- 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) for information dissemination. Maintain the website with Task updates.
- Maintain Task 33 database on thermal gasification facilities worldwide.

Observations from Workshops:

Typically Task 33 will host two workshops per year. In 2019 the first workshop was related to gas cleaning and the second was related to waste gasification.

The workshop titled: Gas cleaning, experiences, new developments, analytics and diagnostics, had speakers from industry and academia. On the Task 33 website a workshop report is available including the presentations of the speakers below.

- H. Leibold, KIT, Hot gas cleaning – Experience and improvements at the bioliq pilot plant

- B. Vreugdenhil, ECN part of TNO, MILENA gasification as a platform towards heat and power and sustainable fuels and chemicals
- T. Benstead, RATH Filtration, Latest developments in ceramic filter-based hot gas filtration
- S. Biollaz, PSI, Gas analysis working group (GAW): Status and perspective 2019
- Y. Neubauer, TCKON Engineering Services, Continuous on-line tar monitoring and tar analysis with UV-fluorescence
- A. Fateev, DTU, Online UV/IR measurement of tars and other gas compounds
- M. Schmid, University Stuttgart, Tar and impurity measurement and monitoring for biogenic residues gasification
- E. Kantarelis, KTH, Effect of gas phase S/K on tar reforming using Ni catalysts downstream and biomass gasifier
- P. Nau, DLR, Tunable diode laser absorption spectroscopy (TDLAS) for gas analysis in gasifiers
- F. Schmidt, Umea University, TDLAS-based in situ measurements of potassium in entrained flow gasifiers

The second workshop titled: Waste Gasification had a 50:50 mix between speakers from industry and research. During the workshop, one presentation was given via an internet connection; however this was not easy to follow and can be improved in future workshops. It does allow presenters from all over the world not having to travel, while still being able to present their results. 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 (not yet available) can be found at the IEA Bioenergy Task 33 website (task33.ieabioenergy.com). Below is the list of speakers at this workshop.

- P. Thornley, Supergen Bioenergy Hub, Rationale for gasification in the UK
- H. Stone, REA, Gasification: an industry perspective
- J. Isaksson, Valmet, Valmet CFB gasifier
- J. van Leeuwen, Synova, Synova renewable technology: Building a pure world
- P. Winstanley, ETI, Delivery and establishment of the first UK commercial scale plant to deliver ultra clean syngas
- M. Johnson KEW, 3rd Generation gasification
- J. Maric, Chalmers, Valorisation of plastic waste via gasification – Chalmers experiences
- C. Mourao Vilela, TNO, Gasification of end-life plastics

- M. Materazzi, UCL, Recent advances in plasma-assisted gasification for waste-to-fuel applications
- C. Pfeifer, J. Hrbek, BOKU, Waste gasification in Austria
- Fanxing Li et al., NCS University, Renewable Natural Gas from Carbonaceous Wastes via Phase Transition CO₂/O₂ Sorbent Enhanced Chemical Looping Gasification

Website and database

The Task website (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 2019 an update of the status report on thermal biomass gasification in member countries was published. 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. During the current triennium, the aim of Task 33 is to extend this report with relevant countries, who are not yet members. These countries include amongst others, Japan, Spain, France and China.

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; updating and publishing country reports; conducting joint studies and providing webinars on the content, 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 advance the international implementation of bioenergy technology through strategic information analysis and dissemination in the areas of direct thermochemical liquefaction of biomass (including bio-based waste) for bioenergy applications such as heat, power, transportation fuel, and the production of chemicals.

'Direct Thermochemical Liquefaction' is the controlled thermal degradation of biomass in any form to derive valuable energy and chemical products. It includes thermal and catalytic fast pyrolysis, hydrothermal and solvo-thermal liquefaction.

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:

- Conversion technology developers
- Equipment manufacturers
- Chemical producers
- Policy makers
- Investors
- Researchers
- Bio-oil/biocrude application developers
- Bio-oil users
- Utilities providers
- Decision makers
- Planners

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.

Participating countries: Canada, Denmark, Finland, Germany, The Netherlands, New Zealand, Norway, Sweden, and United States of America

Task Leader: Dr.-Ing. Axel Funke, Karlsruhe Institute of Technology (KIT), Germany

Operating Agent: Birger Kerckow, Fachagentur Nachwachsende Rohstoffe e.V. (FNR), Germany

The Task Leader directs and manages the work programme, assisted by National Team Leaders (NTL) that are responsible for specific work packages and/or deliverables. An NTL from each country is responsible for coordinating the national participation in the Task.

For further details on Task 34, please refer to Appendices 2, 4, 5 and 6; the Task website (<http://task34.ieabioenergy.com/>) and the IEA Bioenergy website (www.ieabioenergy.com) under 'Our Work: Tasks'.

Progress in R&D

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 2019 included Task meetings, providing support to creating and strengthening a network among the new Task 34 participants, 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 that may have broader use among member countries.

This was accomplished through collaborations among Task members to provide publications and outreach, Task meetings, and technical seminars/tours in addition to management and ExCo support actions. The work efforts in 2019 included:

- Two Task meetings coinciding with international and IEA sponsored workshops or technical tours in Germany and Denmark.
- Continued publication of the bi-annual electronic PyNe newsletter to highlight current research, standards work, collaborations, and successes in bioenergy through direct thermal liquefaction of biomass.

- Participation in European R&D projects, specifically regarding co-processing of fast pyrolysis bio-oil in existing refineries. This work will contribute significantly to development of associated analytical standards in Europe. Task 34 provides a platform for the researchers involved to connect and exchange information.
- 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 of member states to advance research and commercialisation efforts.
- Updates are being maintained to the web-based demonstration plant database developed by Bioenergy 2020+

Task Meetings and workshops

There were two face-to-face meetings that were held and associated with regional and international workshops and sites. The first was in Karlsruhe/Germany, and the second held in Aalborg/Denmark.

Task Meeting in Karlsruhe/Germany (June 25-26th, 2019)

The first Task 34 meeting of this triennium took place at KIT, Karlsruhe/Germany, June 25-26th, 2019. Participating countries were represented by their team leads and additionally IEA Bioenergy Technical Coordinator Luc Pelkmans participated throughout the meeting.

A strong focus of this first meeting was on team building and networking due to the fact that almost all Task members have changed and there were many new faces to Task 34.

Luc Pelkmans started the meeting with a general introduction to IEA Bioenergy, the different Tasks, communication strategies, and related workflows. Subsequently, presentation of the country reports commenced which represented the core of this Task 34 meeting. Each NTL had prepared a presentation to summarise activities/policies related to DTL in their countries. Country reports were presented and discussed almost the whole first day to provide a good basis for everybody to understand the countries different perspectives.

A short break-out session around the expectation of the NTL's associated with their Task 34 work was conducted in between the country reports to provide a reflection for the future work in the Task. Some of the key aspects are summarised as follows:

What do you expect from IEA TCP Bioenergy?

- To achieve/facilitate collaboration/joint research/industrial participation
- Credible, clear, concise and high quality publications/information. Facilitation of top level dissemination. Assistance in communicating key messages
- Quality assurance ("IEA stamp of approval", "weeding out the frauds")
- Standard look for reports/publications

How should Task 34 contribute to the field of DTL?

- Support R&D by sharing experience and putting international teams together (avoid duplication)
- Support industrial application/commercialisation
- Product standards
- Provide a repository of concise and factual information to give an overview of actual DTL status ("reality check"); also for non-technical audience
- Follow up emerging technologies ("early awareness")

How will participating Task 34 affect your personal development?

- Networking (very strong emphasis on this aspect)
- Exchanging experiences
- Gaining wider international perspective/understanding international trends

All leads for work packages from the Task 34 proposal to IEA Bioenergy have been discussed and assigned among the meeting participants (details can be found in the minutes). Additional budget is available from carryover funding and one additional country member (Norway). The Task discussed additional topics among the participants to give room for ideas of the new members. These topics have been structured as additional work packages and budgets assigned as follow up to the meeting. Final decisions on which additional work packages are conducted in this triennium have been taken in the 2nd Task meeting October 25th/26th (see below).

A workshop was organised in conjunction with the Task 34 meeting in Karlsruhe (Germany) providing the opportunity to discuss DTL trends with researchers from KIT. It included discussion and lab tours with Dr Ursel Hornung (hydrothermal liquefaction), Dr Klaus Raffelt (upgrading of fast pyrolysis bio-oil), Prof Nicolaus Dahmen (bioliq® concept and pilot unit) and active PhD students in the mentioned R&D fields.

Task Meeting in Aalborg/Denmark (October 25th/26th, 2019)

The focus of this meeting was a detailed discussion about the work packages of the Task 34 proposal and additional work packages due to excess funds (arising from last triennium carry-over plus one additional member country) with the aim to identify scope and responsible NTLs to coordinate them. All work packages will be explained in short descriptions including deliverables, a timeline and an indicative budget breakdown. An updated list, including the additional work packages, together with a Gantt Chart will also be created.

Some of the already active work packages have been discussed in more detail. For the work package about 'Technical notes on R&D and commercialisation experiences' the following topics were identified as suitable to prepare technical notes:

- Choice of quenching medium/setup in fast pyrolysis processes
- Storage/processing of fast pyrolysis bio-oil (aging)
- Balancing in general
- Safety/health issues (flaring/venting of byproducts)

The structure of the DTL brochure was discussed and feedback incorporated by Axel Funke. An intensive discussion developed around how highlights should be presented in the brochure to showcase actual plants without compromising Task 34's neutrality. It was decided that two highlights will be presented with a general text regarding the technology/application including a meaningful picture. The finalised brochure will be sent around for revision prior to publication.

It was decided that a single report will be created as a country report and updated annually covering DTL activities in all countries. The structure will be based on previous review work from Task 34 and all NTL's will fill in the text for their respective countries.

There are ongoing activities to develop a collaboration with Task 44 on flexible use of bioenergy. The scope of work still has to be defined and there is more to be expected after the joint workshop at the beginning of 2020. The interest of Task 34 is very high and it was decided that a budget of \$20k should be reserved for these activities because it is unclear whether it becomes an official Inter-Task or ExCo strategic project.

Finally, the content of PyNe newsletter 45 was discussed and agreed upon.

It was also discussed how Task 34 should take a position regarding the consideration of plastic pyrolysis, which is gaining increased attention in many of the participating countries. The consensus among participants was reached as follows:

Under the condition that the primary aim is to produce a liquid, Task 34 also looks at co-processing of biomass with other materials such as e.g. plastics.

A site visit and workshop was conducted in conjunction with the Task meeting. Reno Nord waste incineration plant, which operates a sorting facility for plastic waste, was visited by Task 34 members. The process was followed with great interest and it was also elaborated which fractions could be subject to downstream pyrolysis for recycling (potential cooperation with Quantum Fuels).

The workshop was conducted with Steeper, a company actively involved in commercialisation of hydrothermal liquefaction. Steeper also has a close collaboration with the host of this Task meeting. Dr Steen Iversen from Steeper gave a presentation about their current activities, the basic outline of their hydrofaction™ process and the Silva Green Fuel project. Silva Green Fuel is located in Tofte, Norway and a cooperation of Statkraft and Södra Pulp and Paper. Steeper Energy was chosen to supply the technology for the project from a variety of different alternatives. The first phase is to complete a commercial unit at a scale of 2000bpd. Wood/ forestry residues are input material; bio-crude is to be upgraded at a different facility. After upgrading Steeper Energy achieves suitable fractions that are miscible to achieve diesel (EN 590) and marine (ISO 8217) fuel (mixtures).

Subsequently, the continuous pilot HTL unit operated at Aalborg university in cooperation with Steeper Energy was visited and explained in detail. The tour continued with a visit to Lasse Rosendahl's labs at Aalborg University and meeting postdocs active in the field of hydrothermal liquefaction.

Work Programme and Outputs

The targets set for the reporting period were to establish a working team, assign responsible work package leads and establish a structure so that conduction of work together with the associated budget can be managed appropriately. It was necessary to set a strong focus on these targets due to the fact that almost all NTL's have been exchanged (some of which were even assigned only shortly before the first meeting) and there was almost no involvement in setting the directions for the triennium 2019-2021.

All of these three targets for 2019 have been reached. Additional videoconferences will be held to follow up work package conduction and avoid any further delay. As noted above, an updated work programme including additional work packages due to additional funds will be finalised and sent to IEA Bioenergy TCP Technical Coordinator Luc Pelkmans by Q1/2020.

Task 34 communication activities including content management of the website and publication of the bi-annual PyNe newsletter have been taken over by KIT without major trouble. Some additional adjustments were necessary by moving the responsibility to European jurisdiction (disclaimer, General Data Protection Regulation) which are completed now. PyNe 44 has been published July 20th 2019. The Follow up PyNe 45 has been published December 2019 in accordance with the initial schedule.

There is minor delay with publication of the DTL brochure and the first country report. Both are almost completed and publication in Q1/2020 is anticipated.

One important challenge to be considered will be further planning of WP 3.2 'Contribute to co-processing bio-oil/biocrudes in petroleum refineries Task 39 report'. This collaborative activity with Task 39 requires a different focus due to progress in the field (scheduled to start Q1 2020, so no delay anticipated, yet). Now, a joint Task 34/Task 39 workshop is intended as part of this work package.

Key activity will also be the website content refresh; an in-depth discussion is scheduled for the Task meeting Q2/2020 so that the actual work on the content can commence.

Newsletter

In 2019 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 PyNe 44 had two articles on co-upgrading/co-refining of fast pyrolysis and fossil oil, which is an increasing area of interest to ease introduction of biobased oils. PyNe 45 featured hydrothermal liquefaction work and events.

The new network mailing list continues to grow. Nevertheless, a campaign to increase audience is planned for 2020.

Website/Dissemination

The Task 34 website was updated on a continuous basis regarding events, participants, and the PyNe newsletter. A refresh of website content is scheduled for 2020 (D 4.3).

Website traffic is categorically up and increasing significantly. Most page views are by far for pyrolysis reactors, followed by the PyNe newsletter. This shows the importance and outreach of the regular PyNe newsletter. Page views will be reflected in the website content refresh scheduled for 2020. Significant traffic from non-member countries to Task 34 includes India, China, UK, and Brazil suggesting potential areas for outreach.

All of the top 20 geographical distributions show increased traffic with the exception of a slight decrease for Canada.

Collaboration with Other Tasks/Organisations/Networking

Task 34 participates in the IEA Bioenergy ITP 'Process heat in industry'. It is also active in defining synergies/collaboration activities with the new Task 44 'Flexible Bioenergy and System Integration'. Collaboration with Task 39 'Commercialising Conventional and Advanced Transport Biofuels from Biomass and Other Renewable Feedstocks' is part of the proposal for this triennium.

Deliverables

Deliverables for 2019 included:

- Publication of two PyNe newsletter issues (D4.1a/b, completed)
- Direct liquefaction brochure (D4.2, delayed to Q1/2020)
- Two workshops, seminars, and/or site visits with key stakeholders (D4.4a/b, completed)
- Country Report (D4.6a, postponed to Q1/2020)

TASK 36: Material and Energy valorisation of waste in a Circular Economy

Overview of the Task

In 2012, the World Bank estimated that around 1.3 billion tonnes of municipal solid waste are generated per year globally and that this will grow to 2.2 billion tonnes per year by 2025. They attributed this rise in waste generation to increased urbanisation in developing and emerging economies and the associated increase in per capita generation of waste. This trend is a considerable challenge for many countries that will have to work towards intensive legislative, managerial and institutional changes, including the introduction of strategic direction aimed at decreasing and controlling waste generation; 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, and the role of waste-to-energy in a circular economy. 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 their integration in a circular economy; and to provide support by disseminating and exchanging information on these developments.

Waste generation 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 cases, additional pressure arises 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: Australia, Germany, Italy, Norway, South Africa, Sweden, and the United States of America.

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

Operating Agent: Mr. Jonas Lindmark, 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 and the IEA Bioenergy website www.ieabioenergy.com under 'Our Work: Tasks'.

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.

Workshop 1 – Nutrient Recovery from Waste, Stockholm, May 2019

Workshop aim: To provide an overview of the status of nutrient recovery from waste (particularly phosphorous) covering technological, legislative and socio-economic aspects around the world.

Workshop outcomes: Recovery of nutrients from waste allows reduction in the need for extracting nutrient resources while diversifying the markets; and phosphorus has been in focus in Europe for a few years now.

During the workshop, the Task members presented the situation regarding phosphorous extraction from waste in their countries. In addition, Bo Von Bahr, researcher at RISE and expert on nutrient recovery, was invited to provide an overview of the phosphorus situation and technologies in development for its recycling.

The main conclusions from the workshop were that:

- Nutrient recovery from incineration ash in countries where waste-to-energy (WtE) systems are established is accepted.
- Those countries with a non-developed WtE infrastructure, such as Australia or South Africa, have the possibility of implementing nutrient recovery systems more in line with a circular economy.
- Biochars can act as a source of nutrients and enhance soil properties while sequestering carbon, but they should not be considered as a universal solution.

The presentations from the workshop are available at the homepage. (www.task36.ieabioenergy.com).

Workshop 2 – Technological Pathways for Energy Recovery from Waste in a Circular Economy, Brisbane, November 2019

Workshop aim: Discuss the technology pathways available for energy recovery from waste in a Circular Economy and what it would mean for the sector and for the public/government engagement, and use this to shape the work program of the Task for the remainder of the triennium.

Workshop outcomes: The workshop was divided into:

- i. closed session for the Task members to work towards understanding circular economy principles in the context of energy and materials recovery, including combustion technologies, as well as digestion and gasification pathways and more niche technologies such as those based on pyrolysis.
- ii. open session to include local industry and government that resulted in an insight into Australia's development in terms of energy recovery from waste policy work, social acceptance or technical solutions.

Task Meetings and site visits

May 2019, Task meeting in Stockholm, Sweden, together with a study visit to the combined heat power plant (CHP) owned by E.ON and located in Högbytorp, outside of Stockholm. The visit was combined with a meeting with Ragn-Sells that will be handling the ash from the E.ON incineration plant. In addition, the Biochar plant in Stockholm was also visited.

September 2019, on-line Task meeting. Follow-up.

November 2019, Task meeting in Brisbane, Australia, together with a visit to the pear Global, Trisco Foods and QUU Luggage Pint Resource Recovery Centre.

Work Programme and Outputs

Most actions regarding the work programme are already mentioned in the previous section. In addition, two draft reports have been produced that are outstanding deliverables from the previous triennium. The other outputs so far are described in the section for deliverables.

Website

The website (<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. The website also provides access to past reports, articles, case studies and presentations at workshops associated with Task meetings. During 2019, the website has been updated with the content of the programme and members of the new triennium; as well as the news included in the newsletters released during 2019.

In addition, the website provides a 'members only' forum, to allow rapid access to the latest drafts of documents and to information on Task meetings. During 2019, the website received almost 1900 visitors. This corresponds to a 25% increase compared to 2018. The most hits were received from China, the United States of America and Ireland.

Collaboration with Other Tasks/Organisations/Networking

The main collaboration with other tasks has been the participation in Inter-Task/common projects. Task 36 is involved in two of those, the first one about BECCS/U and the other one regarding the use of High temperature heat from biomass in industry.

Discussions are also ongoing about a project regarding co-processing of waste and biomass feedstocks.

Deliverables

The deliverables for the Task in 2019 have included presentations from the workshops and minutes from the Task meetings; as well as presentations by several Task members in the Bioenergy Strong Conference representing the Task; two newsletters published during 2019 and contribution to the IEA Bioenergy Newsletter.

Publications and Reports

- Minutes from the Task meeting in Stockholm, May 2019
- Minutes from the on-line Task meeting, September 2019
- Presentations and Summary report for the Nutrient Recovery from Waste workshop, May 2019
- Presentations for the Technology Pathways for Energy Recovery from Waste in a Circular Economy, November 2019
- Presentation in the Bioenergy Strong Conference article in Brisbane, November 2019
Vienna, October 2018
- Contribution to the IEA Bioenergy Newsletter with one item
- Report: Biomass pre-treatment for bioenergy. Case study 3: MSW pre-treatment for gasification, November 2019.
- Progress reports to ExCo

TASK 37: Energy from Biogas

Overview of the Task

In 2019-2021 Task 37 proposes work on three broad themes: the role of biogas in energy systems; sustainability of biogas systems and methods to ensure good practice; and integration of biogas into processes.

To mitigate climate change, it is essential to develop integrated and sustainable decarbonised renewable energy systems. Heat and transport together, account for about 80% of final energy consumption. Significant progress has been made in renewable electricity but decarbonisation of transport fuel is problematic. Gaseous renewable energy carriers, such as renewable 'green gas' can have a considerable impact in future energy systems and play a key role in decarbonising heat and transport. Green gas¹⁵ at present is dominated by biomethane, which can be generated from the anaerobic digestion of organic biomass and residues produced in agriculture, food production and waste processing. In 2018, there were 577 biogas-upgrading plants in operation in the 15 IEA Bioenergy Task 37 countries. The market for biomethane is still growing. Sweden, the UK, Switzerland, France and the Netherlands have all increased their biomethane production significantly in the last six years. In the short term, the development of green gas projects, including the injection of biomethane into gas networks will be the primary focus of this developing industry. Management of this process and broad scale implementation will require a green gas certificate scheme to ensure sustainability, credible GHG reductions and to allow trade.

Recent policy measures facilitate the development of green gas and hydrogen pathways with progressively increasing obligations on decarbonisation. The share in renewable and low-carbon transport fuels will need to increase rapidly to meet climate targets. Biomethane can provide advanced sustainable biofuel for intercity buses, waste management truck fleets and heavy duty commercial vehicles. The on-going requirement to decarbonise will lead to integration of anaerobic digestion systems in other processes, be they agricultural, food and beverage processing, or other industrial and waste management. Anaerobic digestion is also seen as an integrated element in future innovative biorefineries and circular economy systems.

The approach of Task 37 involves the review and exchange of information and promotion of best practices for all steps of these process chains including anaerobic digestion 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 digestion process, the digestate, and the quality management methods for conversion to high quality organic fertiliser. Only in the

15 Referred to as renewable natural gas (RNG) in North America.

past number of years have the environmental performance and greenhouse gas footprint 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 and carbon 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, Canada, Denmark, Estonia, Finland, France, Germany, Ireland, Korea, The Netherlands, Sweden, Switzerland 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, 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 37, please refer to Appendices 2, 4, 5 and 6; the Task website (<http://task37.ieabioenergy.com/about-task-37.html>) and the IEA Bioenergy website (www.ieabioenergy.com) under 'Our Work: Tasks'.

Progress in R&D

Work Programme and Outputs

In 2019 the work programme consisted of the following Topics:

- Preparation of technical reports;
- Case Studies;
- Country reports;
- Task Meetings and Workshops;
- Website, Videos, Newsletters and Webinars;
- Deliverables of Task 37 in 2019.

Preparation of Technical Reports

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

Year 1 of a triennium (in this case 2019) involves detailed assessment of the content of the reports that will be written in that triennium, and assigning tasks to the authorship team. The technical reports are generally published in years two and three (in this case 2020 and 2021). The reports we will work on are as defined below:

D8. Technical aspects of integration of biogas systems into the energy system:

Target audience: Biogas producers/developers, Grid operators, Energy customers, Municipalities, Policy makers.

Champions: Germany, Ireland

Collaboration: with Task 44 (Flexible bioenergy and system integration)

The report will define energy flexibility from the perspective of biogas facilities. The impact of flexible operation on single components such as CHP, gas storage, gas transport and gas treatment as well as requirements for peripheral structures such as transformation systems or heat storage will be assessed. The report will also evaluate the ability of biogas systems to be dispatchable and to be incorporated with power to gas systems.

D9. Green gas certification and sustainability criteria:

Target audience: Policy makers, Biogas producers/developers, Gas Industry (Gas Grid Operators, Gas Traders), Gas customers

Champions: Finland, Germany, Ireland

Collaboration: Inter-Task project with Task 40;

The work on Green Gas Certification and Sustainability Criteria will include a number of sub tasks. Task 37 will produce on their own a report on the extent of green gas road maps including for: biomethanation; power to gas and hydrogen; steam reforming of biomethane to hydrogen with carbon capture and storage; steam reforming of natural gas to hydrogen with carbon capture and storage; carbon capture associated with natural gas fuelled power plants. The detail of the report can then deal with green gas certificates associated with biomethane with perspectives on sustainability of the other green gas technologies.

The work will also include collaboration with Task 40 on Renewable Gas and a second broader collaboration specifically "Renewable Gas – Hydrogen in the grid" led by Uwe Fritsche, Kyriakos Maniatis and Goran Berndes.

D10. Drivers for successful biogas schemes and their sustainability:

International perspectives:

Target audience: municipality, academics, practitioners, farmers, agri-food, utility gas grid operators, stakeholders, policy makers

Champions: Canada,

Contributor: all.

This deliverable will take the form of a symposium in Toronto in March 2020 held in conjunction with the 2020 Value of Biogas East Conference, a published proceedings of the symposium and an IEA Bioenergy webinar in May 2020. The symposium will have the following sessions and presentations:

Policy Landscape for Biogas/RNG

1. Wouter Siemers: Netherlands Roadmap
2. Jonas Ammenberg: Sweden Roadmap

Where it all begins – Feedstock

3. Bernadette McCabe; Agro-Industrial Wastes: Matching technology with feedstock
4. Saija Rasi: Sustainability of grass biomethane according to RED2

Technology – Friend or Foe?

5. Guenther Bochman: Digester types
6. Jerry Murphy: Advanced gaseous biofuel produced by integrating biological, thermo-chemical and power to gas systems in a circular cascading bioenergy system

Circular Economy and digestate

7. Timo Kikas: Process Integration including for torrefaction of woody biomass
8. Jan Liebetrau: Efficiency of the biogas process – results of a monitoring program

D11. Integration of anaerobic digestion into farming systems:

Target audience: farmers, agricultural stakeholders, policy makers

Champions: UK, Australia, Canada, Italy

It is proposed that there be two pieces of work:

“*Management of nutrient recovery systems, to meet regulatory restraints and sustainability*” led by the UK.

“*Applications of anaerobic digestion to farming*” including from perspectives from four very different geographical areas; the UK, Australia, Canada and Italy. This report is proposed to be structured as follows:

- Introduction to biogas industry in farming in each of the four countries
- Development of anaerobic digestion in each of the four countries
- Environmental sustainability of farming practices in each of the four countries
- Potential for carbon negative farming in each of the four countries
- Financial sustainability of farming practices in each of the four countries
- Opportunities and Challenges in each of the four countries
- Success Stories

D12. Increasing the range of feedstocks for anaerobic digestion

Champions: Switzerland,

Contributors: Austria, Canada, Estonia

Audience: operators of biogas facilities, farmers and agricultural organisations, feedstock suppliers, policy makers and consultants

The report will provide a technical assessment of poorly degradable substrates (such as straws, seaweeds, micro-algae, sewage sludge). The report will include energy and cost implications of pre-treatment processes. The report will describe composition of feedstocks and include technically available pre-treatment technologies integrated with anaerobic digestion processes. A cascading bioenergy system including further treatment of digestate via thermal conversion will be assessed.

D14. Integration of anaerobic digestion into industrial bioprocessing:

Champions: Austria, Australia, Norway, Finland

Audience: operators of biogas facilities, farmers and agricultural organisations, feedstock suppliers, policy makers and consultants

Collaboration with Task 42

The report will focus on food and beverage and pulp and paper industries. A number of examples will be presented including abattoirs, dairies, breweries, distilleries, olive mills, sugar factories, potato industry, wineries, juice factory. The analysis will include feedstock, fermentation, process integration, gas utilisation and energy balances.

D.13. Case Stories

Five case stories were published in 2019 and are available at <http://task37.ieabioenergy.com/case-stories.html>:

- BIOWERT GRASS BIOREFINERY, BIOBASED PLASTICS, GERMANY June 2019
- GREENING THE GAS GRID IN DENMARK, February 2019
- ORGANIC BIOGAS IMPROVES NUTRIENT SUPPLY, Kroghsminde Bioenergy I/S, Denmark February 2019
- DISTRIBUTED GENERATION USING BIOGAS IN A MICROGRID: in the Western Region of Parana, Brazil, February 2019
- MONO-DIGESTION OF CHICKEN LITTER: Tully Biogas Plant, Ballymena, Northern Ireland, January 2019

Country Reports

Six country reports were published in 2019 and are available at <http://task37.ieabioenergy.com/country-reports.html>:

1. Austria,
2. Denmark,
3. Switzerland,
4. Netherlands,
5. Canada,
6. Sweden,

A collaboration between ENE consulting, Bioenergy Australia and IEA Bioenergy Task 37 resulted in the publication of the report "Biogas Opportunities for Australia" March 2019. See <http://task37.ieabioenergy.com/country-reports.html>

Task Meetings and Workshops

Task 37 Meeting Tartu, Estonia, 7-10 May 2019

A Task meeting was held from May 7 to 10 in Tartu, Estonia. On the 9th of May an IEA Bioenergy Task 37 session was hosted within the **Biosystems Engineering 2019 Conference** (<http://bse.emu.ee/topics-and-scope/>) in the **Estonian University of Life Sciences, Institute of Technology, Tartu**. Presentations are available at <http://task37.ieabioenergy.com/workshops.html>

IEA Bioenergy Task 37 were allocated 6 presentations as follows:

- Saija Rasi (Finland): Anaerobic digestion as part of the cascade processing of biomass
- Bernadette McCabe (Australia): Integrated biogas systems: Local applications of anaerobic digestion towards integrated sustainable solutions
- Urs Baier (Switzerland): Food waste – Occurrence along the food chain, composition and anaerobic digestion
- Jerry Murphy (Ireland): Green gas production systems
- Jan Liebetrau (Germany): Flexible biogas systems
- Charles Banks (UK): Ammonia – technical challenges and solutions for high nitrogen substrates

Task 37 Meeting Seoul, Korea, 23-25 October 2019

A Task meeting was held from October 23 to 25 in Seoul, Korea. On the 24th of October an IEA Bioenergy Task 37 session was held within **the International Renewable Energy Conference** (<http://kirec2019.kr/>) **Location: COEX Hall E3, Seoul, Korea**

The presentations are available at <http://task37.ieabioenergy.com/workshops.html>.

IEA Bioenergy Task 37 were allocated 7 presentations as follows:

International perspectives on the future of biogas

1. Biogas opportunities for Australia (Bernadette, Australia)
2. Incorporating renewable gaseous fuel in future energy systems (Jerry, Ireland)
3. Enhancing bioenergy yields from sequential bioethanol and biomethane production by means of solid-liquid separation of the substrates (Timo, Estonia)
4. Current status and policy direction of biogas production in Korea (Lee, Korea)

Feedstocks

5. Industrial application of anaerobic digestion (Guenther, Austria)
6. Value from Food Waste (Saija, Finland).
7. Keep manure fresh, get more! (Kim, Korea)

The Task had a site visit to Goyang Biogas Facility, a food waste digester constructed predominately underground.

Planning of Future Task Meetings and Workshops

The Task meetings in 2020 will be held in Toronto Canada (March 25 to 27) in conjunction with the Value of Biogas East Conference and will include a site tour of a Power to Gas facility in Ontario. The second meeting will take place in Switzerland (9-11 September 2020) which will be timed to coincide with the final Triennium Conference of the Swiss Bioenergy Research Network BIOSWEET

Website, Videos, Newsletter and Webinars

Website

The website (www.iea-biogas.net and <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.

Newletters

There were 12 newsletters issued for Task 37 in 2019.

Deliverables

The deliverables are outlined in the publications list in Appendix 4. The first year of the triennium is very much a year of preparation and scoping of detail of works. The full technical reports tend to be published in year 2 (2020) and more frequently year 3 (2021).

TASK 39: Commercialising Conventional and Advanced Transport Biofuels from Biomass and Other Renewable Feedstocks

In 2019, Task 39 continued its work to advance development and deployment of sustainable, lower carbon-intensive transport biofuels with an overall goal of facilitating the decarbonisation of the multi-faceted transport sector using conventional and advanced transport biofuels. Four categories of transport biofuels that have been covered by Task 39 include:

- “Conventional” biofuels
 - ▶ Ethanol from sugar/starch (e.g. sugarcane, corn, sugar beet and wheat)
 - ▶ Biodiesel from oleochemicals/lipids (Fatty acid methyl ester (FAME))

- “Advanced” biofuels
 - ▶ Cellulosic ethanol (1.5G and 2G), oleochemicals/lipids from algae, biomethane/renewable natural gas (RNG), green hydrogen, etc.

- “Conventional” drop-in biofuels via oleochemical/lipid feedstocks
 - ▶ Hydrotreated esters and fatty acids (HEFA), hydrotreated vegetable oil (HVO), hydrogenation-derived renewable diesel (HDRD), renewable diesel, green diesel, etc., produced from lower carbon intensity feedstocks and waste materials such as used cooking oil (UCO)/tallow/tall oil and higher carbon intensity feedstocks such as vegetable oils

- “Advanced” drop-in biofuels via lignocellulosic biomass feedstocks
 - ▶ Production and upgrading of biocrude liquid intermediates from lignocellulosic feedstocks (sometimes algal oils) via standalone biorefineries or by co-processing in existing petroleum refineries
 - ▶ Production by upgrading of other bio-feedstock derived intermediates, e.g., Alcohol-to-Jet, Sugar-to-Jet, Gasification-followed-by-Fisher-Tropsch synthesis, etc.

Despite formidable obstacles such as continuing relatively low petroleum prices, slower-than-anticipated progress in commercialising cellulosic ethanol/other advanced biofuels technologies, and ongoing uncertainty around future biofuels policies, relatively good progress has been made in the biofuels area in 2019. Through a coordinated focus on technology, commercialisation, sustainability, policy, markets and implementation, Task 39 assisted fifteen member countries and other transport biofuels stakeholders in their efforts to develop and deploy biofuels, with the primary goal of decarbonising transport. The Task continued to identify and facilitate opportunities for comparative technical and life cycle assessment, and to monitor the various policies being used with varying levels of effectiveness to increase the production and use of biofuels. To a large extent, the success of the Task continues to

be a direct result of providing a forum for these types of integrated discussions, with the active involvement of participants from industry, government and academia.

In 2019, Task 39 delivered or helped to deliver six cooperative research projects (four internal projects and two Inter-Task projects). The Task's drop-in biofuels report was updated, focusing on the key role co-processing is likely to play in spurring accelerated deployment of drop-in biofuels production (full report: 156 pages; executive summary: 12 pages). In terms of policy and sustainability assessments, Task 39 completed the second phase of life cycle analysis (LCA) studies comparing four well-recognised biofuels LCA (i.e., EU's BIOGRACE, Canada's GHGENIUS, United States of America's GREET and Brazil's VSB). The first part of this work focussed on biofuels used for heavy duty road transport (FAME biodiesel) or aviation (HVO/HEFA biojet fuel) produced from soybean oil, palm oil or used cooking oil (UCO) (full report: 90 pages). The part focused on cellulosic ethanol produced from corn stover, wheat straw, sugarcane bagasse and straw, or forest residues (full report: 60 pages). This report is currently under final internal review by Task 39's LCA experts' steering committee.

Task 39 updated its periodically issued "Implementation Agendas" report (full report: 254 pages; executive summary: 15 pages) that compares and contrasts biofuels policies across countries that are members of Task 39, and in this update also China. Task 39 members expect both policy and sustainability issues to continue to play crucial roles in biofuel development. Consequently, policy and sustainability assessments continue to be a key activity for the Task during this 2019-2021 triennium.

In collaboration with a consortium of aviation industry stakeholders, in 2019 members of Task 39 completed an assessment of likely technology pathways to make biojet from forest residues. Task 39 members coordinated the production and distribution of three "biocrudes" produced by, respectively, fast pyrolysis, catalytic pyrolysis or hydrothermal liquefaction (HTL) of softwoods. These biocrudes were subsequently sent to NRCan's CANMET (Ottawa, Canada) and US DOE's PNNL (Richland, United States of America) for upgrading. This project significantly advanced the Task's knowledge of coprocessing as well as helping identify some key challenges that are likely to be encountered producing biojet fuels via thermochemical liquefaction and upgrading technologies (Full report: 213 pages; executive summary: 5 pages).

These reports are available on the Task's website (<http://task39.ieabioenergy.com/publications/>).

In addition to internal project activities, Task 39 contributed to two special Inter-Task project reports initiated by the IEA Bioenergy Executive Committee (ExCo): 1) Advanced biofuels – potential for cost reduction; and 2) The contribution of advanced renewable transport fuels to decarbonising transport by 2030 and beyond.

Task 39 has also been encouraging more publications in the peer reviewed literature, to be open access whenever possible. In 2019, two articles were published in peer-reviewed journals: 1) the paper by van Dyk et al., "Potential synergies of drop-in biofuel production with further co-processing at oil refineries," was published in the journal of Biofpr; and 2) the paper by Pereira et al., "Comparison of biofuel life-cycle GHG emissions assessment tools: The case studies of ethanol produced from sugarcane, corn, and wheat," was published in the journal of Renewable and Sustainable Energy Reviews. It is noted that in addition to these published manuscripts, an article from the "Implementation Agendas" report was prepared and submitted to the peer-review journal, "Energy Policy" in October 2019 and is still under review.

In addition, Task 39 presented highlights from its recent updated drop-in biofuels report, "Drop-in Biofuels – The key role that co-processing will play in its production," in an IEA Bioenergy Webinar on September 25, 2019.

As part of its communication strategy, in 2019 Task 39 organised two business meetings, first in Ispra, Italy in May and then in Stockholm, Sweden in September. Task 39 members also participated in several biofuels-related conferences and workshops. The business meetings' minutes are posted in the members only section of Task 39's website (albeit access to minutes is limited to Task 39 members and business meeting participants).

In addition to publishing commissioned reports, presenting at conferences and participating in workshop proceedings, Task 39 disseminates information through its periodic newsletters featuring country reports, hyperlinks to recent Task 39-relevant media stories and reports. In 2019, Task 39 published three newsletters providing progress updates on Task 39 activities, with feature articles highlighting technical and policy developments related to biofuel production and use in Brazil (Issue #51 in April), the Netherlands (#52 in August) and Denmark (#53 in December). These newsletters are distributed to over 2000 biofuels 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. Website statistics are reported in the Progress Reports submitted to the IEA Bioenergy ExCo.

In 2019, Task 39 continued strengthening collaborations with other IEA Bioenergy Tasks, i.e., Tasks 33, 34, 36, 37, 40, 42, 43, as well as the new deployment (Task 44) and sustainability (Task 45) Tasks. We continued our good rapport with allied stakeholder groups such as IEA HQ, IRENA, the IEA Advanced Motor Fuels Technology Collaboration Program (AMF TCP), UN FAO and various national programmes. Task 39 continued to benefit from extensive industry involvement by companies and institutions at the forefront of biofuels development such as ANL, Boeing, Borregaard DSM, ENI, GoodFuels, International Air Transport Association (IATA), IFPEN, ISCC, Haldor Topsoe, LanzaTech, LBST, Licella, Neste, Novozymes, Renewable Energy Group (REG), Roundtable on Sustainable Biomaterials (RSB), (S&T)² Consultants, skyNRG, Steeper, UPM, World Wildlife Federation, etc.

Overview of the Task

The goal of Task 39 is to facilitate the commercialisation of lower carbon-intensive transportation biofuels including conventional and advanced biofuels produced through various technology routes such as oleochemical, biochemical, thermochemical and hybrid conversion technology pathways. The success of the Task continues to be, 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 programme areas:

- **Technology and Commercialisation**
 - ▶ Helping develop and commercialise improved, cost-effective processes for the production of sustainable low carbon intensity biofuels, particularly the production and use of “drop-in” biofuels from oleochemicals and lignocellulosic feedstocks to decarbonise the long-distance transport sector;
 - ▶ Working with other Tasks 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; and
 - ▶ Describing advances and challenges in emerging less developed advanced transport biofuels technologies and processes such as biomass-to-hydrogen, algae-to-biofuels, etc.
- **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. This Task activity also provides information and analyses on policies, markets, and implementation issues that help participants foster commercialisation of sustainable low carbon biofuels. The broad goal is to replace non-renewable fossil-based fuels by enhancing the deployment of conventional (so-called first generation) biofuels and supporting the development of advanced biofuels and ‘future-generation’ biofuels. The Task also continues work to better clarify commonalities and main differences in methodological structures, calculation procedures and assumptions used within leading LCA models (i.e., EU’s BIOGRACE, Canada’s GHGENIUS, United States of America’s GREET and Brazil’s VSB).
- **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 2019, Task 39 organised two business meetings (in Ispra, Italy and Stockholm, Sweden). It also presented highlights from its recent update of the drop-in biofuel report, “Drop-in Biofuels – The key role that co-processing will play in its production” in an IEA Bioenergy Webinar on September 25, 2019. In addition, it published three newsletters

that included progress updates on Task 39 activities and featured articles on biofuel production and use technical and policy developments in Brazil, the Netherlands and Denmark as well as highlighting recent news articles and reports of interest to biofuels stakeholders).

Another vehicle for information dissemination is Task 39's large-scale demonstration plants website which provides a database of advanced biofuels production facilities in Task 39 member countries and the rest of the world (<https://demoplants.bioenergy2020.eu/>).

As part of its outreach to stakeholders, Task 39 also remains fortunate to have the active participation of many experts from academia, government and industry.

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, India, Ireland, Japan, Korea, The Netherlands, New Zealand, Norway, Sweden and the United States of America

Task Leader: Jim McMillan, National Renewable Energy Laboratory, United States of America

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 (United States of America) 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. Task leaders are assisted by Mahmood Ebadian (UBC), who serves as the coordinator of all Task activities and programmes, Editor of the Task Newsletter as well as Webmaster for the Task's website. Dina Bacovsky (Austria) manages the Task's demonstration plants database. Franziska Müller-Langer is the Task's primary liaison to IEA's AMF 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 the Task website (<http://task39.ieabioenergy.com/>) and the IEA Bioenergy website (<https://www.ieabioenergy.com/>) under 'Our Work: Tasks'.

Task Meetings and Workshops

As part of its organisational/communication strategy, Task 39 typically holds two business meetings per year, usually in conjunction with related conferences and workshops to help justify the extensive travel required for many Task 39 members to attend. In 2019, the Task held two formal business meetings (Ispra, Italy in May and Stockholm, Sweden in September). These business meetings involved significant knowledge exchange between participants in the form of country updates and project updates highlighting industry progress and challenges as well as special sessions hosted in conjunction with established biofuels-related events.

Task 39's first business meeting of 2019 was held May 15-17 at the European Commission's Joint Research Centre (JRC) in Ispra, Italy. The JRC is the European Commission's in-house science and knowledge service that provides independent scientific advice and support to EU policymakers, and has been contributing its expertise to the activities of IEA Bioenergy Task 39 over recent triennia.

The first day of the Ispra meeting (Wednesday, 15 May 2019) was devoted to internal Task business and primarily attended by Task 39 representatives as well as a few members of the IEA Bioenergy ExCo. The focus was reviewing the Task's ongoing and recently completed work and proposed activities for the new triennium. In addition, Task member country representatives presented updates on recent developments on biofuels policies, production and use in their respective countries.

The second and third days of the meeting comprised a joint JRC-Task 39 workshop on "Biofuels Sustainability – Focus on Lifecycle Analysis," in which many representatives of the biofuels industry also participated; companies/institutions with attending representatives included ENI, Haldor Topsoe, ISCC, IFPEN, LBST, Neste, REG, and UPM. The purpose of the workshop was to review and discuss recent progress and future work needs with subject matter experts to inform future additional Task 39 LCA model comparison work. The workshop discussed opportunity and challenge areas related to more quickly commercialising biofuels, including certification schemes for biofuels, feedstock availability, advanced (drop-in) biofuel developments and methodological aspects of biofuel greenhouse gas (GHG) lifecycle emissions' performance assessment. Workshop discussions extended to recent progress on co-processing and development of a 14C-based method for tracking the bio-component in co-processed fuels. Participants also discussed some of the principle opportunities and barriers encountered during the deployment of sustainable biofuels at a commercial scale. A consistent theme was ensuring that uptake of sustainable biofuels will be based on accurate LCA assessments. More details on the workshop are available at the Task 39 website: http://task39.sites.olt.ubc.ca/files/2019/07/T39-WorkshopReport-JRC-Sustainability-LCA_final.pdf

Task 39's second business meeting in 2019 was held on September 16-17 in Stockholm in conjunction with Sweden's 2019 Advanced Biofuels Conference held 17-19 September. This meeting also focused on reviewing the Task's ongoing and recently completed work and proposed future work activities for the 2019-2021 triennium. The main proposed future work activities discussed were drop-in biofuels for long-distance transport, especially advanced biofuels for marine and aviation applications since both of these transport sectors are highly international and in addition each has distinct characteristics and challenges. 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 techno-economic assessments (TEA) and LCA studies of leading and proposed routes to drop-in biofuels production.

During this meeting, it was also decided to update the Task's previous reports on "Drop-in Biofuels" and "Biofuels for the marine shipping sector." The most recent 2018-2019 drop-in biofuels report update will form the basis for establishing future collaborations with other Tasks such as Task 33 (Gasification), Task 34 (Direct Thermal Liquefaction), Task 43 (Feedstocks) and Task 45 (Climate and Sustainability) as well as with allied organisations such as IEA HQ, IRENA, GBEP, etc.

In addition, Task 39 will continue to investigate the life cycle and sustainability attributes of different biofuel production pathways. As sustainability and carbon intensity metrics are playing an ever more crucial role in policies for biofuels development and use, sustainability assessment remains a high profile activity for the Task. Other proposed future work activities that were discussed in the meeting were "TEA of co-processing" and "Assessing methods to reliably/accurately/cost effectively "track the green molecules". To conduct both LCA and TEA projects, Task 39 will likely collaborate with Task 43 (feedstocks) and Task 45 (sustainability) to better understand the cost of sustainable feedstocks and their associated impacts on the economics and GHG reduction potential (and other sustainability attributes) of producing drop-in biofuels via coprocessing or dedicated production.

Thanks to Tomas Ekbohm, Sweden's Task 39 country representative/national team leader, representatives from several Swedish governmental organisations presented during the morning of the second day of the Task meeting. The presenters shared recent updates on the status of Swedish gasification- and pyrolysis-based technologies for biofuels as well as Sweden's current technology-push and market-pull biofuels policies and climate investments.

In the afternoon of the second day, most Task 39 members participated in a study tour, visiting both the Henriksdal biogas production and upgrading plant in Stockholm and Scania's engine manufacturing/assembly plant in Södertälje.

On 18-19 September, a subset of Task 39 membership also attended and presented at Sweden's 2019 Advanced Biofuels Conference. This conference was hosted by the Swedish Bioenergy Association and over 200 participants from 24 countries participated. A summary of the presentations and project investment news is published in the October issue of Bioenergy International.

Task 39 members Franziska Müller-Langer and Dina Bacovsky, respectively Germany's and Austria's lead country representatives to the Task, participated in a joint workshop convened by the IEA AMF TCP and the IEA Combustion TCP on 6th November in Montreux, Switzerland; both also already participate in the IEA AMF TCP. Their attending this workshop is helping Task 39 identify areas for future collaboration with these other transport-related IEA TCPs, which like Task 39 are interested in advancing efficient low emission propulsion systems and new concepts for more efficiently using advanced fuels in advanced engines. Specific collaborations are still to be defined; however there is mutual interest in the advanced fuels for advanced engines arena to maximise the potential of biofuels (and also the potential of lower carbon renewable fuels of non-biological origin) to decarbonise transport. Next steps include preparing a "map" to identify overlapping topics of the IEA AMF, Combustion and Bioenergy TCPs for which joint projects should be exploring.

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

Work Programme and Outputs

Briefs on reports completed or advanced during 2019 follow:

'Drop-in' Biofuels: The key role that co-processing will play in its production

Task 39 originally published the report, *Potential and Challenges of Drop-in Biofuels*, in 2014. Since then, with the decrease in oil prices since mid-2014 and global fuels' markets in transition, several of the drop-in biofuels projects highlighted in the report have stalled or been abandoned while other projects have been initiated. Moreover, since 2014 several new papers have published reporting more recent progress in development and TEA analyses of prospective advanced/drop-in biofuels production processes. The 2018/2019 update to the original 2014 report incorporates this new information and project landscape as well as providing expanded sections on biofuels for aviation and maritime applications (as well as for rail and long-distance trucking).

The 2018/2019 drop-in report update will form the basis for future collaborations with other Tasks such as Gasification (Task 33) and Thermal Liquefaction (Task 34) 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; b) extending LCA studies to examine the life cycle/sustainability aspects of drop-in biofuels production; and c) investigating the policies that will be required to promote the production and consumption of drop-in biofuels. It is recognised that specific policies will likely have to be developed and implemented to help establish drop-in biofuels for the aviation and marine sectors, partly because these sectors are international and each has its own unique characteristics and challenges.

Both the full drop-in biofuels report update and its executive summary are available on the Task 39 website:

Full report:

<http://task39.sites.olt.ubc.ca/files/2019/02/Task-39-Drop-in-Biofuels-Full-Report-January-2019.pdf>

Executive summary:

<http://task39.sites.olt.ubc.ca/files/2019/02/IEA-Bioenergy-Task-39-Drop-in-Update-Executive-Summary-February-2019.pdf>

A peer-reviewed article summarising key findings of this project was published in the journal *Biofuels* in February, 2019: <https://onlinelibrary.wiley.com/doi/full/10.1002/bbb.1974>.

Update to country policies and implementation agendas

The Task’s periodically issued implementation agendas report was updated in 2018-2019 to summarise current biofuels usage within Task 39 member countries as well as other key countries such as China as well as policies being used in these countries to encourage greater production and use of biofuels. The policy environment has changed substantially since the last update to this report. As a result, the format of the report was revised to try to better compare and contrast the relative success of the various policies being used to promote biofuels development and use around the world. Overall, findings show that the policies proving most effective around the world are based on rewarding lowering of fuel carbon intensity by providing incentives to continue to reduce biofuels’ emissions reductions potential (i.e., variations of low carbon fuel standards (LCFS) type policies.

Both the full report and an executive summary are available on the Task 39 website:

Full report:

<http://task39.sites.olt.ubc.ca/files/2019/05/IEA-Bioenergy-Task-39-Implementation-Agendas-Full-Report-9-May-2019.pdf>

Executive summary:

<http://task39.sites.olt.ubc.ca/files/2019/05/IEA-Bioenergy-Task-39-Implementation-Agendas-Executive-Summary-9-May-2019.pdf>

A peer-reviewed article summarising highlight findings from this report was submitted to the journal of Energy Policy and remains in review for future publication.

Comparison of LCA models (with Task 38 and contributing to Inter-Task activities)

This project compared the leading LCA models being used to assess the sustainability of prospective biofuels pathways (i.e., feedstock and conversion process routes). The goal is to better understand and quantify why different LCA models, (e.g., EU's BIOGRACE, Canada's GHGENIUS, United States of America's GREET and Brazil's VSB) give different results when they are ostensibly assessing the same scenarios using the same model inputs. Although the project was originally conceived to have 3 phases carried out over three years, it was ultimately streamlined to two phases over three years so the work could be completed in 2018. Led by Antonio Bonomi at CTBE in Brazil, this project was a collaboration between Task 39 and Task 38 (led by Helena Chum, NREL, United States of America; now Task 45). Most of the work was carried out by a postdoctoral researcher based at CTBE, with Task 39 providing all of the funding.

Phase I was completed in 2017 and this work compared LCA models for conventional ethanol production. A peer-reviewed article was published in April 2019 from Phase I of this project: <https://www.sciencedirect.com/science/article/pii/S1364032119302552>

Phase II was initiated in January 2018 and consisted of two parts, one (Part 1) covering biodiesel and renewable diesel fuels (both FAME and HVO/HEFA) that displace fossil diesel, with a secondary focus on aviation kerosene, and another (Part 2) focused on cellulosic ethanol. As in Phase I, the objective was to compare the different LCA models across these fuel production pathways to identify the main differences and commonalities in methodological structures, inventory data, calculation procedures, assumptions and results. The full report from Phase II-Part 1 was published on the Task 39 website in February 2019 and is available at:

<http://task39.sites.olt.ubc.ca/files/2019/08/Task-39-CTBE-biofuels-LCA-comparison-Final-Report-Phase-2-Part-1-2019.pdf>

Phase II-part 2 technical report with the focus on “biochemical second-generation (2G) ethanol production and distribution” was completed in September 2019. The scope of this study was restricted to second generation ethanol produced from either corn stover, wheat straw, sugarcane bagasse and/or straw, and forest residues.

The full report of Phase II-Part 1 was published on the Task 39 website in January 2020 and is available to the public:

<http://task39.sites.olt.ubc.ca/files/2020/01/Task-39-Phase-2.2-Ethanol-2G-Comparison-of-Biofuel-Life-Cycle-Analysis-Tools.pdf>

A summary of this project was provided in July 2019 edition of the IEA Bioenergy newsletter: http://task39.sites.olt.ubc.ca/files/2019/07/IEA-B-T39_Summary_LCA-Project.pdf

As sustainability continues to play a crucial role in biofuels development and use, sustainability assessments like these will continue to be a high profile activity for the Task in the 2019-2021 triennium. The contributions of LCA experts and biofuel industry participants attending the recent joint JRC-Task 39 sustainability workshop helped to further focus Task 39’s proposed future work in this area.

Assessment of likely technology maturation pathways for biojet production from forest residues (ATM Project)

As part of its ongoing work on drop-in/biojet fuels, members of Task 39 received funding from Boeing and Canada’s Green Aviation Research and Development Network (GARDN) to carry out the project, An Assessment of the likely Technology Maturation pathways used to make biojet from forest residue (ATM project). Task 39 members coordinated the production and distribution of three “biocrudes” produced by the fast pyrolysis, catalytic pyrolysis and hydrothermal liquefaction (HTL) of softwoods, which were subsequently sent to NRCan’s CANMET (Ottawa, Canada) and US DOE’s PNNL (Richland, United States of America) for upgrading. All of the biocrudes were successfully upgraded to produce low carbon intensity biojet fractions which showed a high level of compliance with general ASTM standards for jet fuel certification. Life Cycle Analyses showed these approaches have significant emission reductions potential. A provisional supply-chain analysis based on biomass feedstocks available in British Columbia provided some of the data for subsequent TEA. A demonstration-scale biocrude production and upgrading facility was modelled that considered the possible location, general equipment requirements, supply chain and likely cost of final low carbon fuels. This project significantly advanced the Task’s knowledge about standalone and coprocessing-based upgrading of biocrudes and helped identify some challenges that are likely to be encountered when biojet fuels are produced via thermochemical liquefaction technologies. The full report and its associated executive summary are available on the Task 39 website.

Full report:

<http://task39.sites.olt.ubc.ca/files/2019/11/GARDN-NEC-21-ATM-project-final-report-public-release.pdf>

Executive Summary:

<http://task39.sites.olt.ubc.ca/files/2019/11/GARDN-NEC-21-ATM-project-executive-summary-public-release.pdf>

Updates to demonstration plant database

The Task continues to maintain a database of advanced biofuels production facilities. Led by Dina Bacovsky, Austria's national team leader to the Task, this "demoplants" database provides information on over 100 companies' biofuels production facilities, which encompass a wide variety of biochemical, thermochemical, and hybrid conversion approaches to producing biofuels (<http://demoplants.bioenergy2020.eu/>). However, it remains difficult to obtain and maintain accurate, up-to-date information from many of the companies as their various processing technologies scale up and approach commercialisation (or stall).

Inter-Task Projects (with Task 41)

In 2019, Task 39 contributed to two Inter-Task projects: 1) Advanced biofuels – potential for cost reduction; and 2) The contribution of advanced renewable transport fuels to decarbonising transport by 2030 and beyond.

From a policy perspective, it is important to understand whether and under what conditions advanced biofuels and other low-carbon fuels can be made affordable compared to petroleum fuels and conventional biofuels. In the first Inter-Task project, information on estimated costs for production of advanced biofuels was solicited and collected from project developers and biofuels experts in the EU, North America, Brazil, Asia and other regions; Task 39 helped to gather and compile information from the Americas. In addition, Task 39 drafted two other sections for the project report, one on feedstock costs and availability in North America and another on the role of biofuels policy in the potential future cost reduction of advanced biofuels. These Task 39 deliverables were submitted to Adam Brown, the project manager. Task 39 is also contributing to final review and formatting of the final project report.

For the second Inter-Task Project, Task 39 contributed three report sections, respectively on the "role of biofuel policies in the increased production and use of advanced biofuels in long-distance transport sectors", prospects about "future feedstock availability and costs (international perspective)" and on the "potential future GHG emissions of advanced biofuels". All of these deliverables were submitted to Dina Bacovsky the project manager, in September 2019.

These two Inter-Task reports are anticipated to be finalised and become publicly available in early 2020. A workshop held on the decarbonisation of transport 18th November 2019 in Brussels provided information on the availability of renewable transport fuels and related costs and GHG emissions reduction potentials, and also highlighted the role renewable transport fuels have to play in order to reach national GHG emission reduction targets in Brazil, Finland, Germany, Sweden, and the United States of America, with discussion focused on whether we are sufficiently on track to achieve the 2030 targets. All workshop presentations are available online at: <https://iea-amf.org/content/news/TD-WS>. Dr. Jack Saddler, Task 39 Co-Leader, presented in this workshop on "Biofuels state of the art and perspective towards 2030."

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 transport biofuels. In 2019, three newsletters were published and distributed to over 2000 recipients. These newsletters featured articles on biofuel production and use and policies in Brazil, the Netherlands and Denmark, respectively, and they are available at the Task 39 website: <http://task39.ieabioenergy.com/newsletters/>.

Task 39's Newsletter issue #51 was published in May 2019 and included a feature article on "Biofuels Production and Consumption in Brazil: Status, Advances and Challenges", a summary of Task 39's activities and successes during the last triennium (2016-2018), and the Task's proposed programme of work for the new triennium, which continues to span technology, policy, sustainability and commercialisation issues and to benefit from Task 39's established and active participating network of experts from within industry, academia and government research institutions.

Task 39's Newsletter issue #52 was published in August 2019 and included a feature article entitled, "Poldering a new Climate Agreement in the Netherlands." It also included a summary of Task 39's first business meeting of the 2019-2021 triennium and the joint JRC-Task 39 workshop on "Biofuels Sustainability – Focus on Lifecycle Analysis," in which many representatives of the biofuels industry also participated.

Task 39's Newsletter issue #53 was published in December 2019 and included a feature article entitled, "Biofuels Production and Consumption in Denmark: Status, Advances and Challenges." It also included a summary of Task 39's second business meeting of the 2019-2021 triennium held in Stockholm in conjunction with Sweden's 2019 Advanced Biofuels Conference held 17-19 September as well as the Task's recent progress with publications and information dissemination.

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 *Biofuels Digest* and on other websites, e.g., Advanced Biofuels USA (<https://advancedbiofuelsusa.info/>).

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 Task's progress reports.

Collaboration with Other Tasks/Organisations/Networking

In 2019, Task 39 continued strengthening collaborations with other IEA Bioenergy Tasks (Tasks 33, 34, 36, 37, 40, 42 and 43 as well as with other groups such as the IEA AMF TCP and IEA HQ). In 2019, Task 39 contributed to two special Inter-Task projects (funded by Task 41), namely: 1) Advanced biofuels – potential for cost reduction; and 2) The contribution of advanced renewable transport fuels to decarbonising transport by 2030 and beyond. The project comparing LCA models for GHG calculations was a collaboration with IEA Bioenergy Task 38 (now part of Task 45), and the outcomes of this project also helped to inform the previous large IEA Bioenergy inter-Task project on Sustainability.

Task 39 continued its good rapport with other groups such as IEA HQ, IRENA, the IEA AMF TCP, UN FAO, GBEP, and various national programmes. Task 39 also benefited from extensive industry involvement from companies and institutions at the forefront of biofuels development such as Boeing, Borregaard DSM, ENI, GoodFuels, IATA, IFPEN, ISCC, Haldor Topsoe, LanzaTech, LBST, Licella, Neste, Novozymes, REG, RSB, (S&T)² Consultants, skyNRG, Steeper, UPM, etc.

In 2019, India confirmed its interest in joining IEA Bioenergy and Task 39 for the current 2019-2021 triennium, however specific representatives to the Task are not yet identified. Other countries that are prospects to become new members of IEA Bioenergy and Task 39 in the current triennium include Chile, China, Indonesia, Malaysia, Mexico and Thailand. The economies in each of these countries are growing, with increased manufacturing and consumption leading to more heavy duty freight transport (i.e., long-distance trucking, rail, shipping and aviation). We remain optimistic that these countries will eventually join IEA Bioenergy and Task 39.

Deliverables

In summary, the deliverables for Task 39 in 2019 include:

1. Organised two business meetings (in Ispra, Italy and Stockholm, Sweden);
2. Published three newsletters (issues #51, 52 and 53);
3. Completed its End of Triennium Report (2016-2018) for the IEA Bioenergy ExCo;
4. Submitted its progress report and audited financial accounts statement;
5. Maintained and further developed the Task 39 website;
6. Organised and hosted an IEA Bioenergy webinar on "Drop-In Biofuels: The Key Role that Co-Processing will Play in their Production";
7. Updated Task 39's advanced biofuels demonstration plants database;
8. Published the "Drop-in Biofuels Report Update", "Implementation Agendas – Report Update", two "comparison of LCA models" reports (i.e., Phase II-Part 1 and the initial draft of Phase II-Part 2, with Part 2 to be published by end of March 2020), and the full report and executive summary of the "Assessment of likely technology maturation pathways for biojet production from forest residues" study (ATM study).
9. Published/submitted three manuscripts to peer-reviewed journals
10. Contributed to two Inter-Task special projects (Task 41 funded): 1) Advanced Biofuels – Potential for Cost Reduction; and (2) The contribution of advanced renewable transport fuels to decarbonising transport by 2030 and beyond.

All of the Task's published reports are available at the Task 39 website.

TASK 40: Deployment of biobased value chains

With the 2019 to 2021 triennium, much focus will be on how to meet the objectives of the Paris Agreement (limiting global temperature increase to well below 2°C – possibly even 1.5 °C – and global decarbonisation). Within respective scenarios, bioenergy as well as bioenergy combined with carbon capture and storage (BECCS) for the removal of CO₂ from the atmosphere may play a vital role in meeting these objectives. Looking at what it means in terms of numbers, a larger amount of energy needs to be provided by biomass.

Furthermore, various targets on the share of energy from renewable sources around the 2030 timeline are set, e.g. in the EU, and Japan. Many countries require large volumes of bioenergy to meet these targets, inducing more mobilisation of biomass resources for energy – as long as it also contributes to GHG emission reductions. Thus, both monitoring of the progress towards achieving these targets (evaluation of failures and challenges) and assistance for the governance and design of the policy for 2030 and beyond are needed during the 2019-2021 triennium.

In recent years, both the policy and market focus on the bioeconomy has been increasing; the climate targets explicitly cover more than energy; the agricultural and chemical sectors will be involved as well. At the same time, concepts such as the 'circular carbon economy' and 'green growth' are promoted, and R&D for the production of bio-chemicals, bio-plastics and other bio-materials (as part of biorefineries that may also produce biofuels, electricity and/or heat) is heavily promoted. Ultimately, the expectation is that moving towards a circular economy (of which the bio-based economy will constitute a significant share) will entail a far more efficient use of (bio-)resources, including more effective utilisation of biomass for various purposes, and reduction and use of bio-waste streams for energy. Here, cascading gained increasing importance.

It is likely that both with regard to feedstock (use of high quality lignocellulose for chemical purposes, wastes and residues for energy) and/or intermediates (sugars/high quality polymers for material purposes, lignin for energy), bioenergy may become a by-product rather than the main product in the bio-based economy.

In any case, direct use of pre-processed biomass to 'just' produce electricity, as has been stimulated in several EU Member States in the past, may possibly decrease after 2020. This is due to the increasing and also often more cost-effective availability of renewable electricity from wind and solar and also due to the fact, that in other sectors biomass might be the only (reasonable) option for substituting fossil fuels, for instance as fuel in the aviation and shipping sectors, or heat supply in industries such as steel and cement.

Overview of the Task

The Task 40 objective is to support deploying viable, efficient bioenergy value chains in the context of

- sustainable, national and international markets,
- reflecting on policy developments, and economic aspects, including financing
- international, national and regional trade of biomass,
- recognising the diversity in biomass resources, value chains and competitive applications for bioenergy, biobased materials and products.

The focus of Task 40 in the new triennium is on the **development and design of efficient, economically viable and bankable value chains in order to support a larger deployment of sustainable biomass for energy, but also for biobased products and materials, taking into account food, feed and fiber markets.**

In short, the Task will work on deploying sustainable biomass for energy in the context of the larger bioeconomy.

Within this scope, international, national and regional biomass trade remains vital. However, Task 40's scope is widened to understanding the functioning and improving the efficiency of entire biomass value chains, taking into account regional supply and use, in a balanced way and avoiding distortions and instability that can threaten investments in biomass production, processing, logistics and infrastructure, and conversion capacity.

It is key to understand biobased value chains and how to sustainably extend them. For this, the barriers and drivers for widespread and sustainable biomass deployment will be identified, and policy developments reflected that could foster biomass uptake in existing and new (emerging) markets.

A **new key** issue to be addressed from a deployment point of view will be the **financing aspect of bioenergy projects** (e.g. de-risking, sustainable profitability after initial support).

Task 40 aims to provide vital contributions to related decisions for market players and financial institutions, policy makers and international bodies, as well as civil society organisations (CSO, e.g. consumer and environmental groups, labor unions). It aims to do so by providing high quality information, analyses and synthesis.

The scope of work will holistically support the provision and use of sustainable biomass in different national and international markets, with a focus on bioenergy.

Participating countries: Belgium, Denmark, Germany, Japan, The Netherlands, Sweden, and the United States of America.

Task Leader: Uwe R. Fritsche, IINAS, Germany

Co-Task Leaders: Christine Hennig, DBFZ (Germany) and Olle Olsson, SEI (Sweden)

Secretary: Ms. Nora Lange, DBFZ, Germany

Operating Agent: Birger Kerckow, Fachagentur Nachwachsende Rohstoffe e.V. (FNR), Germany

The Task Leader directs and manages the work programme, together with the Co-Task Leaders (team approach). A National Team Leader from each country is responsible for coordinating the national participation in the Task.

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

Progress in R&D

Task Meetings and workshops

The Task organised two physical meetings in 2019: the kick-off (jointly with other Tasks) in Stockholm, and in Leipzig. Both were organised so that joint meetings with Task 45 and inter-Task projects were possible.

The Task also holds regular virtual meetings (on average: every 6 weeks), and continuously exchanges information through a dedicated **OneNote book**.

Future Meetings and Workshops

Task 40 plans a joint meeting and workshop with Task 32 for May 26-28, 2020 in Copenhagen, but this may be postponed due to Corona virus restrictions.

Task 40 will meet in September 2020 in the United States of America, and in March 2021 in Japan (with a joint workshop on renewable gases), and probably in October 2021 in a EU member country (Austria, Belgium or The Netherlands).

Several other meetings and conferences will be organised as part of Task 40's involvement in various inter-Task projects (WB2/SDG, RG, InHeat, BECCS/U).

Work Programme and Outputs

The Deployment Task (Task 40) will have **three core areas of operation** that all include Inter-Task project proposals considering the various biobased value chains, markets and applications, and sees itself as “horizontal” among the IEA Bioenergy TCP. The Task will also collaborate with other IEA renewable energy TCPs, IEA Hydrogen, and IEA GHG.

WP1: Market developments

- Regional transitions in existing bioenergy markets
- New regional bioenergy markets – key actors, policies and regulation, and technological challenges (e.g. future CHP) regarding deployment, and trade
- Market perspectives and deployment for aviation and marine biofuels (Collaborative Inter-Task project)
- Globalised sustainable biobased value chains, including market perspectives and synergies between bioenergy and bioeconomy (possible Collaborative Inter-Task project)

WP2: Industrial Heat and Processes

- Industrial heat (technologies, markets, and deployment) and processes, considering bioenergy pathways as alternatives/complements to CC(U)S (Strategic Inter-Task project)
- BECCS/U – industries and technologies suitable for BECCS applications, considering deployment requirements (Collaborative Inter-Task project)

WP3: Deployment Strategies

- Deployment guidance regarding technological barriers, economic aspects and financing
- Renewable gas – deployment, markets and sustainable trade (Strategic Inter-Task project)
- Role of bioenergy in a well-below -2°C/SDG world (Strategic Inter-Task project)

All reports and webinar presentations are available for free download from the Task 40 website <http://task40.ieabioenergy.com/>.

Report: Margin potential for a long-term sustainable/viable wood pellet supply chain

Task 40 finalised the study on the *margin potential for a long-term sustainable/viable wood pellet supply chain* which identified strategies for the operational continuation and viability of current wood pellet supply chains. The report, a summary and an annex are published on the Task 40 website <http://task40.ieabioenergy.com/iea-publications/task-40-library/>

Task 40 also held a webinar on this report on November 13, 2019 which is available online: <http://task40.ieabioenergy.com/iea-bioenergy-task-40-webinar-future-prospects-for-wood-pellet-markets/>

Report: Deployment of BECCS value chains

The first deliverable from the collaborative inter-Task project *Deployment of BECCS/U value chains* is a scoping report that is complete and has been internally reviewed and revised. Representatives from IEA GHG have been invited to provide comments on the report, after which final edits will be made and the report published by early April 2020.

Reports and papers to be finalised (in 2020/2021)

Task 40 will prepare

- a synthesis report of the BECCS/U Collaborative Inter-Task project in late 2020
- a final report for the Task 41 Special Project on “Renewables Gas – Hydrogen in the grid” at the end of 2020,
- a synthesis report of the Task 40 “Regional Transitions” project in 2021 and
- synthesis reports on the Strategic Inter-Task Projects Industrial Heat and Renewable Gas in 2021, and will contribute to the reports of the Strategic Inter-Task Project “Role of Bioenergy in a well-below 2 °C/SDG world” in 2021.

In addition, Task 40 members will prepare several scientific articles and conference contributions in 2020-2021.

Website

The website <http://task40.ieabioenergy.com/> has been officially launched since September 2016 and is under the management of IEA Bioenergy. The Task website is a key tool for dissemination of information. At the beginning of 2019 the website was revised and new members, new projects and the work programme were introduced. Furthermore, the website informs on upcoming events such as webinars or workshops, also from other Tasks of IEA Bioenergy and presents a library of all published reports for download.

In 2019, the number of visitors was about 3325, lower than the number of visitors in previous years. However, users spent more time on the individual pages of the website and viewed more pages than in previous year.

The new study **Margin potential for a long-term sustainable wood pellet supply chain** leads the list of downloaded documents. Still interesting for users is the updated **Global Wood Pellet Industry and Trade Study 2017** followed by the report **Socio-economic assessment of the pellets supply chain in the United States of America**. Other frequently downloaded documents included reports on transboundary flows of woody biomass waste streams 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/Organisations/Networking

Collaboration with IEA Bioenergy Tasks focused on all three Strategic Inter-Task projects (Role of Bioenergy in a well-below 2 °C/SDG world; Renewable Gas – led by Task 40; Industrial Heat) and the collaborative Inter-Task project on BECCS/U led by Task 40.

Task 40 also contributed to the IEA Bioenergy ExCo workshops in Utrecht (May 2019) and Tallinn (Oct. 2019) with concept development, speakers and moderators.

Task 40 also led the preparatory work of the Task 41 Special Project on “Renewable Gas – Hydrogen in the grid” which started in February 2020 under the lead of Task 40.

Deliverables

Deliverables in 2019 include the finalisation of the “**Margin potential for a long-term sustainable wood pellet supply chain**” study, including a related webinar; a first report from the BECCS/U project, and a contribution to the IEA ExCo Utrecht Workshop Outcome report.

Task 40 also finalised two publications from the previous Inter-Task Project “Measuring, governing and gaining support for sustainable bioenergy supply chains” (see Publications)

Furthermore, a first newsletter (circulation to 1500 subscribers), minutes from two physical and four virtual Task meetings were prepared.

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.

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 2019 as follows:

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 early 2020 with a final webinar in April 2020.

Project 10: The contribution of Advanced Renewable Transport Fuels to transport decarbonisation in 2030 and beyond

The objective of this one-year project is to bring together the expertise of IEA AMF, IEA Bioenergy and national experts to showcase the role of advanced renewable transport fuels to transport decarbonisation by 2030 and beyond. The project will analyse national strategies for decarbonising transport. It will also identify possible challenges and hurdles for the implementation of advanced renewable transport fuels. The project will assess the potential of ART Fuels from three different angles: a) Policy b) Markets and c) Technology.

Participating countries: European Commission, Finland, United States of America, Brazil, Sweden Germany, Sweden and IEA AMF

Status: The project is expected to be completed in the second quarter of 2020 with a final report and webinar.

TASK 42: Biorefining in a Circular Economy

Overview of the Task

Biorefining in a Circular Economy

Biorefining, the sustainable processing of biomass into a spectrum 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 CO₂.

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, 2015]. The Circular Economy mainly focuses on the efficient use of finite resources and ensures that these resources are being re-used 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 forestry, 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.).

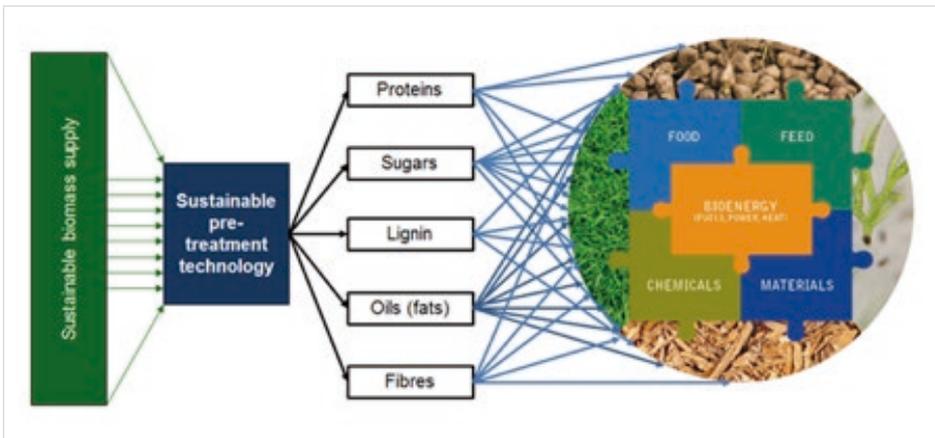


Figure 1. Bioenergy and biorefining being the lubricating oil of the Bio(based)Economy as part of the overall Circular Economy [IEA Bioenergy Task 42].

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. Today conventional industrial biorefineries are still mainly found in the food and paper sectors.

Within recently constructed biorefineries, bioenergy/biofuel based facilities are more common. In these biorefineries, 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. They use low-quality agro and process residues 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 today.

Assessing the number of biorefinery facilities currently in operation globally is challenging. However, over 100 commercial, demonstration and pilot facilities have already been identified in the IEA Task 42 participating countries. Furthermore, in 2017 over 220 facilities have been identified Europe-wide by Nova Institut (Germany), and the European Biobased Industries Consortium.

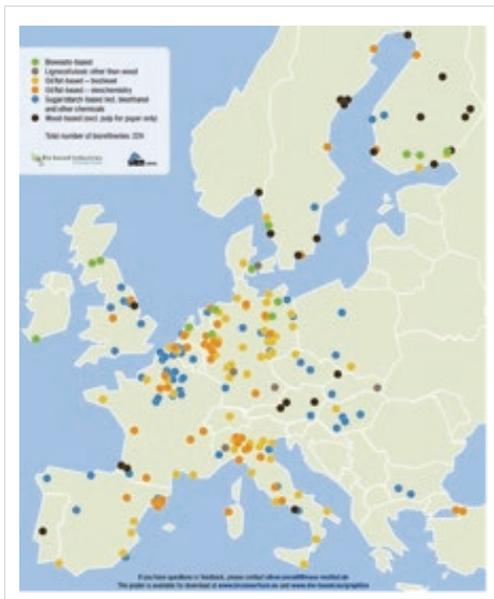


Figure 2. Biorefineries in Europe 2017 [Nova Institute/BIC, 2017].

It is expected that within the next 10-20 years the use of biomass for non-food and feed applications will shift from an energy to a more product-based approach. However, also 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) and bioenergy (HT-heat, RES-hybrids).

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 by:

- certified sustainable biocommodities that are now being developed and mobilised for energy applications 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 forestry residues, 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 potentially 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, or minimally a level playing field.

However, since such materials are generally higher-value products compared to 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.

Aim of IEA Bioenergy Task 42 – Biorefining in a Circular Economy

The aim of 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. 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. For this 2019-2021 triennium, the focus of the activities will be on:

- provision of quantitative, scientifically sound, and understandable data on the technical, economic and environmental added-value of biorefining to co-produce bioenergy and bio-products in a sustainable way (Biorefinery Assessment Platform, Biorefinery Fact Sheets, Reports on sustainable lignin valorisation);
- provision of global implementation status, major deployment barriers and market data (Biorefinery Country Reports, Global Biorefinery Status Report, Report on major non-technical deployment barriers, monitoring of international developments in biobased products certification and standardisation);
- provision of an international platform for cooperation and information exchange (Task 42 website, newsletters, lectures, webinars, thematic workshop on the role of biomass, bioenergy and biorefining in a Circular Economy, national stakeholder events, training).

The real added value of Task 42 'Biorefining in a Circular Economy' is its holistic approach of optimal sustainable use of biomass for a spectrum of non-food applications within the framework of a Circular BioEconomy. Therefore, Task 42 plays a central role in IEA Bioenergy linking the more (single) technology oriented Tasks to the Tasks dealing with biomass supply, climate and sustainability assessment, and deployment. Its activities, often performed in cooperation with the other Tasks, will provide real added value information for the other Tasks by providing technological, market and stakeholder data to further optimise their biomass conversion technologies to integrated biorefineries optimising their overall sustainable performance.

Challenges to be tackled

- multi-sectorial stakeholder involvement in the deployment of sustainable value chains, including industrial symbiosis of full sustainable biomass use for food and non-food, and advanced communication (still separate languages food/non-food and cultivation/processing);
- industry legitimacy, including social acceptance and a level-playing field, for sustainable biomass use;
- lack of quantitative, scientifically sound, and understandable data on the technical, economic and ecological added-value of biorefining to co-produce bioenergy and bio-products in a sustainable way;
- technological status of pre-treatment, extraction, conversion, downstream processing and separation technologies being part of integral biorefineries are often still at a non-commercial level;
- non-technical barriers preventing the real market deployment of biorefineries;
- 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/decentralised biorefineries, integral Bio Industrial Complexes, etc.;
- unlock available expertise and industrial infrastructure energy/fuel, agro/food, material and chemical manufacturing sectors;
- global sustainable biomass sourcing and developing an international trading market, including the development of biocommodities;
- internalisation of externalities (CO₂-price);
- standardisation/regulation of biobased products (BBPs);
- necessary human capital; need for training students and other stakeholders to become the biorefinery experts of tomorrow.

Task data

Participating countries: Australia, Austria, Denmark, Germany, Ireland, Italy, The Netherlands and Sweden

Task Leader: Bert Annevelink, Wageningen Food and Biobased Research, The Netherlands.

Assistant Task Leaders: Ed de Jong, Avantium, The Netherlands and Michael Mandl, tbw Research GesmbH, Austria.

Operating Agent: Kees Kwant, NL Enterprise Agency, Ministry of Economic Affairs, The Netherlands

The Task Leader directs and manages the work programme, assisted by two assistant 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 42, please refer to Appendices 2, 4, 5 and 6; the Task website (<http://task42.ieabioenergy.com/>) and the IEA Bioenergy website (www.ieabioenergy.com) under 'Our Work: Tasks'.

Progress in R&D

Task Meetings and Workshops

28th Task Progress Meeting on Skype for business, 11 March 2019

This was the kick-off meeting where all tasks discussed the working plan for the following months.

29th Task 42 Progress Meeting, Wageningen, The Netherlands, 20-21 May 2019

This meeting was the first physical meeting in the new Triennium. All tasks within the Work Packages were discussed and actions were initiated. Another topic was an update of the biorefinery situation in the participating countries.

30th Task Progress Meeting on Skype for business, 8 October 2019

This meeting was to monitor the progress of the various tasks within the Work Packages and to prepare the meeting in Rome.

31st Task Progress Meeting, Rome, Italy, 19-20 November 2019

All tasks within the Work Packages were discussed and further actions were initiated. Again an update was given of the biorefinery situation in the participating countries. On the morning of the 20th the Mater-Biopolymer Plant in Patrica was visited where the team got a presentation and guided tour. Thanks to Novamont for hosting Task 42! More information can be found at: www.novamont.com and www.materbi.com.

Italian IEA Bioenergy Task 42 workshop on 'New industrial models in the bioeconomic era: the biorefineries', 21 November 2019

On the 21st of November 2019 a successful workshop was held in the ENEA Headquarters in Rome on 'New industrial models in the bioeconomic era: the biorefineries' (<http://task42.ieabioenergy.com/news/italian-iea42-workshop-on-new-industrial-models-in-the-bioeconomic-era-the-biorefineries/>). The program with the titles of the presentations can be found here. About 70 Italian stakeholders participated from industry, research institutions, technological clusters, and associations. The workshop was organised by IEA Bioenergy Task 42 'Biorefining in a Circular Economy' in cooperation with ENEA and supported by Novamont. The workshop aimed at sharing knowledge and having discussions at national level on the current status and future challenges of biorefineries within the bioeconomy. Session 1 included several presentations by international delegates of IEA Bioenergy Task 42 (1) an overview of Task 42 activities, (2) an update of the biobased chemicals report, (3) the role of future energy mixes on the environmental performance of biobased products and (4) the newly developed Technical, Economic and Environmental assessment method (including biorefinery factsheets).

Planned Meetings/Workshops 2020-2021

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

- 2020: Sweden (coupled to Nordic Wood Biorefinery Conference) and Austria
- 2021: Denmark and Australia (combined with final ExCo meeting).

In between 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), end 2020.
- 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.

Work Programme and Outputs

The IEA Bioenergy Task 42 work programme 2019-2021 is based on three Work Packages, viz.:

- WP1. Provide quantitative, scientifically sound, and understandable data on the technical, economic and environmental added value of biorefining to co-produce bioenergy and bio-products in a sustainable way;

- WP2. Monitor the biorefineries deployment and market potential, including non-technical deployment barriers, in the Circular Economy;
- WP3. Dissemination and Communication.

WP1. Provide quantitative, scientifically sound, and understandable data on the technical, economic and environmental added value of biorefining to co-produce bioenergy and bio-products in a sustainable way

The activities in WP1 will be performed within the framework of the Collaborative Inter Task Project (CITP) Technical, Economic and Environmental (TEE) Assessment of Integrated Biorefineries. This CITP has four tasks:

TL.1) Selection of biorefineries for TEE-assessment

The biorefineries that will be assessed are gross-listed by Task 42 in close cooperation with other more technology specific Tasks. The gross-listed biorefineries will be characterised using Task 42's classification system, resulting in a comprehensive systematic overview of these biorefinery pathways. Selection and prioritisation – using qualitative evaluation criteria – of a short-list of biorefinery pathways to be TEE-assessed will be done by an Inter-Task-Team using an online survey and voting pool. The online survey is also intended to provide information and stakeholder contacts from biorefinery success stories over all involved Tasks.

TL.2) TEE-assessment of selected biorefineries using Task 42's Biorefinery Assessment Platform (BAP)

In this triennium the Biorefinery Assessment Platform (open-access, transparent and based on a public database) – that has been developed by the Austrian National Task 42 Team – will be filled by the TEE-assessment of minimally 10 biorefinery pathways. To be able to perform these TEE-assessments sufficient technical, economic and environmental data have to be available. The provision of (the right) data is a key success factor for the coverage of the TEE-assessments and the amount of Biorefinery Fact Sheets that can be produced. Task 42 – in close cooperation with the new Task on Climate and Sustainability (TC&S) – will execute the TEE-assessments using its BAP and latest scientific methods. The TEE-assessment presents a framework that can be used to explore potential impacts from the large-scale implementation of selected biorefineries via a multi-criteria approach, which fills the BAP biorefinery assessment platform with representative information on biorefinery value chains.

T1.3. Preparation of Biorefinery Fact Sheets for dissemination purposes

The Biorefinery Fact Sheets methodology developed by Task 42 will be used in this triennium to prepare minimally 10 additional factsheets providing open access on used primary data. The factsheet format will be further optimised and extended with other relevant information, such as: other sustainability issues (qualitatively), Technology-Readiness-Level (TRL) composing technologies and integrated BR, Market-Readiness-Level (MRL) integrated BR and produced biobased products/secondary energy carriers, resource efficiency (RE) within BR-facility, mapping of demonstration facilities, relevant stakeholders (in order to enhance a knowledge dialogue), case-studies/best-practices, relevant literature sources, news on emerging facilities, etc.

T1.4. Creating IEA Bioenergy broad support for using Task 42's BAP for TEE-assessment integrated biorefineries

Except for cooperation with the more technology specific Tasks, and IEA IETS, on biorefinery selection and data-input, Task 42 will also cooperate with the New Tasks dealing with i) Climate Change and Sustainability (Task 45) and ii) Bio-Integration (Task 44) with the goal to create IEA Bioenergy broad support for using the Task 42 BAP for TEE-assessment of integrated biorefineries. It will be identified how the BAP and Biorefinery Fact Sheets link to the tools/methodologies used in these other Tasks and IEA IETS (decision support system (DSS)), and how they can synergistically support each other.

WP2. Monitor the biorefineries deployment and market potential, including non-technical deployment barriers, in the Circular Economy

The Tasks in the work package are all defined to accelerate the successful market deployment of integrated biorefineries. The activities will be performed in cooperation and collaboration with the new IEA Bioenergy Task 40 on deployment of biobased value chains that has started in the new triennium.

T2.1. Barriers and Incentives for Market Diffusion

New product development and diversification into new markets and product areas, provide new business opportunities for stakeholders along the value chain, but also mean higher complexity and risk in business undertakings. The diversification into new markets and product areas calls for an early identification of specific barriers and incentives for a successful market diffusion of newly developed biobased products.

T2.2. Prepare Biorefinery Country Reports (slide decks)

Biorefinery country reports will contain information on: national (circular) bio(based) economy strategy, BR-related (national) policy goals and instruments, biomass use for energy and non-energetic applications, BR mapping at the national level, commercial BR facilities, BR demo-plants, BR pilot-plants, major BR-based R&D projects, national and regional BR initiatives, major national stakeholders, BR-related publications, etc.

T2.3. Publish a Global Biorefinery Status Report (GBSR)

A major deliverable in this triennium is to publish a Global Biorefinery Status Report (GBSR). This GBSR will be a summary of the information reported by the NTLs in the Biorefinery Country Reports (T2.2) concerning the partnering countries, and extended with data/initiatives in other important continents/countries. The focus will be on IEA Bioenergy member countries. However, also other important countries/continents will be described in a qualitative way.

T2.4. Global mapping scheme and database on Biorefineries

In this triennium, the available Task 42 information on biorefinery market deployment will be schematically organised in a Mapping Scheme and Database that will be made available through the Task 42 website. In this triennium, Task 42 will try to initiate a cooperation with other stakeholders working on databases and mapping systems to join forces, i.e. to come-up with a joint map/database for running biorefineries (pilot, demonstration and commercial facilities) at a global scale.

T2.5. Reports on markets for biobased products to get insight in deployment strategies

In former triennia, Task 42 has produced some very successful glossy reports on biorefinery related topics. Besides the Global Biorefinery Status Report (T2.3), in this triennium the following lignin-based reports will be made and distributed:

- Sustainable Lignin Valorisation to Metallurgical Coal (2019);
- Sustainable Lignin Valorisation in the Circular Economy (2020).

Task 2.6. Monitor international developments in biobased products standardisation/certification

In the 2016-2018 triennium Task 42 monitored international developments in biobased products standardisation and certification. This activity will be continued in the 2019-2021 triennium. However, this is not done as a single Task activity, but more as an activity linked to the new Task on Climate and Sustainability Effects (Task 45). The focus will be more on the quality of products on the application side, rather than on the raw material biomass supply side.

WP3. Dissemination and Communication

The major Task 42 deliverables produced in this 2019-2021 triennium will be actively disseminated to relevant target groups. These deliverables include:

- Biorefinery Assessment Platform (BAP) for the TEE assessment of selected integrated biorefineries;
- scientifically sound and understandable Biorefinery Fact Sheets (BFSs) to support market deployment;
- slide decks on international developments biobased products standardisation/certification;
- Biorefinery Country Reports;
- Global Biorefinery Status Report (GBSR), including best-practices: success stories and case-studies;
- global biorefinery mapping and database;
- report on Sustainable Lignin Valorisation to Metallurgical Coal;
- report on Sustainable Lignin Valorisation in the Circular Economy;
- Thematic Stakeholder Workshop (TSW) in close cooperation with other international organisations on the Role of Biomass, Bioenergy and Biorefining in a Circular Economy.

To involve more relevant stakeholders in Task 42, and to increase its platform role (central international scientifically based platform for information exchange) Task 42's existence will be actively communicated to the outside world. This will be done by means of operating an up-to-date Task 42 website (external communication) with password protected members area (internal communication), publishing biannual Task 42 newsletters, lecturing at international conferences, using new social media, organising a Thematic Stakeholder Workshop, and contributing to Biorefinery Training Schools.

Website

The dedicated Task 42 website was built in the previous Triennium. It is located at <http://task42.ieabioenergy.com>. This website was updated in April 2019 with the description of new Triennium plan, and with a list of the (new) team members. Furthermore, the TEE report, the newsletter and country report slide decks were published. Finally events and news were added, when they occurred.

Collaboration with other Tasks/organisations/networking

The cooperation with other Tasks and organisations was continued in 2019:

- A joint survey was performed with JRC and BBI JU.
- A presentation was given by Michael Mandl at the deep carbonisation workshop from 9th – 11th of October 2019 in Vienna. This was organised by the IETS TCP (the Technology Collaboration Programme on Industrial Energy-Related Technologies and Systems under the auspices of the International Energy Agency).
- Cooperation with other IEA Bioenergy Tasks within the Collaborative Inter Task Project (CITP) TEE Technical, Economic and Environmental (TEE) assessment of integrated biorefineries (Task 33, Task 34, Task 36, Task 37 and Task 39). At the moment most of these contacts still need to be confirmed.

The collaboration with industry will be established in several ways, viz.:

- WP1: For the TEE-assessments input-data can be provided by industry.
- WP2: Industry will be asked by the NTLs to provide input for both the biorefinery country reports, the Global Biorefinery Status Report, and the mapping scheme and database on biorefineries.
- WP3: Industry will be asked by the NTLs to provide input for the Task 42 website and the biannual newsletters. Webinars in cooperation with industrial stakeholders will be organised. At workshops major industrial stakeholders will be asked to come-up with their views. The NTLs will organise industrial/SME stakeholder events at national level to get in direct contact with key players in their respective countries to both disseminate Task 42 results and to collect information on requirements of these market parties. Biannual physical Task 42 Progress Meetings will be coupled if possible to national stakeholder meetings, conferences and/or excursions to further improve information exchange between Task 42 and interested stakeholders.

Deliverables

- Report on Technical, Economic and Environmental Assessment of Biorefineries (<http://task42.ieabioenergy.com/publications/tee-2019/>)
- Updated country reports of Austria, Germany, Italy, and the Netherlands (<http://task42.ieabioenergy.com/document-category/country-reports/>)
- Report on Alternative sustainable carbon sources as substitutes for metallurgical coal (<http://task42.ieabioenergy.com/publications/alternative-sustainable-carbon-sources/>)
- Newsletter Number 4 has been published end of July 2019. The link to this newsletter is: <http://task42.ieabioenergy.com/document-category/newsletters/>

- Description of new Triennium plan and new team members on the website (<http://task42.ieabioenergy.com/about/>)
- Denmark now has a national webpage (in Danish) describing our activities in Task 42 (and Task 39) with links to official task website (<https://plen.ku.dk/forskning/plante--og-jordvidenskab/plant-nutrition/forskningsprojekter/iea-bioenergy/>)
- Presentation at Italian WS of Bert Annevelink – An introduction to the IEA Bioenergy Task 42 Biorefining in a Circular (<http://task42.ieabioenergy.com/wp-content/uploads/2020/01/1-Annevelink-An-introduction-to-the-IEA-Bioenergy-Task-42-Biorefining-in-a-Circular.pdf>)
- Presentation at Italian WS of Ed de Jong – Biobased Chemicals – Current status and Potential (<http://task42.ieabioenergy.com/wp-content/uploads/2020/01/2-Ed-de-Jong-Biobased-Chemicals-Current-status-Potential.pdf>)
- Presentation at Italian WS of Stichnothe – Role of future energy mixes on the environmental performance on biobased products from agricultural residues (<http://task42.ieabioenergy.com/wp-content/uploads/2020/01/3-Stichnothe-Role-of-future-energy-mixes-on-the-environmental-performance-on-biobased-products-from-agricultural-residue.pdf>)
- Presentation at Italian WS of Michael Mandl – Technical, Economic and Environmental Assessment of Biorefineries (<http://task42.ieabioenergy.com/wp-content/uploads/2020/01/4-Mandl-Technical-Economic-and-Environmental-Assessment-of-Biorefineries.pdf>)



Figure 3. Two reports produced by Task42 in 2019.

A 2020 update of the Biobased Chemicals report is currently being finalised, and will be published on the Task 42 website in March 2020.

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

TASK 43: Sustainable biomass supply integration for bioenergy within the broader bioeconomy

Overview of the Task

The Task will explore technical and economic strategies to increase the quantity of biomass available, improve the quality of the biomass delivered for different energy purposes, and explore strategies to increase the value and foster confidence in biomass supply, for both direct and cascade use of biomass for bioenergy. The Task will work exclusively with terrestrial biomass sources including residues, by-product or co-product production from forest and agriculture production systems; residues, by-products or co-products from bio-based manufacturing industries; cellulosic biomass from post-consumer waste; as well as dedicated biomass crop systems as part of broader land management strategies. The Task focus will be on the production and supply of biomass feedstock for energy leading to value creation within the broader context of bioeconomy

Participating countries: Australia, Belgium, Canada, Croatia, Finland, Germany, Sweden, and the United States of America

Task Leader: Mark Brown, USC Australia, Australia

Deputy Task Leader: Ioannis Dimitriou, SLU, Sweden

Work Package leaders: Biljana Kulisic – Work Package 1 Leader, Croatia
Évelyne Thiffault – Work Package 2 Leader, Canada

Task Secretary: Kelly Murphy, USC Australia, Australia

Operating Agent: Mrs Shahana McKenzie, Bioenergy Australia, Australia

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 Appendices 2, 4, 5 and 6; the Task website (<http://task43.ieabioenergy.com/>) and the IEA Bioenergy website (www.ieabioenergy.com) under 'Our Work: Tasks'.

Task Meetings and workshops

Event (What/Where)	When	Status/Result
Task Leadership Meeting 1/2019 via videoconference	10 April 2019	Minutes of meeting
International Workshop – Adequacy of Spatial Databases for Conducting Risk Assessments of Sustainable Wood Sourcing Practices of the U.S. Industrial Wood Pellet Industry Supplying European Energy Demand	1-3 May 2019	http://task43.ieabioenergy.com/publications/international-workshop-adequacy-of-spatial-databases-for-conducting-risk-assessments-of-sustainable-wood-sourcing-practices-of-the-u-s-industrial-wood-pellet-industry-supplying-european-energy-dema/
Task Leadership Meeting 2/2019 via videoconference	16 May 2019	Minutes of meeting
Task Leadership Meeting 3/2019 via videoconference	5 June 2019	Minutes of meeting
Task Leadership Meeting 4/2019 via videoconference	20 August 2019	Minutes of meeting
Joint workshop with BioEast in Sopron, Hungary “ <i>Bio-hubs as keys to successful biomass supply integration for bioenergy within the bioeconomy</i> ”	10 October 2019	http://task43.ieabioenergy.com/publications/bio-hubs-as-keys-to-successful-biomass-supply-integration-for-bioenergy-within-the-bioeconomy-joint-iea-bioenergy-task-43-and-bioeast-initiative-workshop-10-october-sopron-hungary/

Targets reached and deliverables

Deliverable (What)	When	Status/Result
Report: Using "BEAST" to support the local dialogue on lignocellulosic cropping for energy use, climate protection and sustaining ecosystem services	June 2019	Available online: http://task43.ieabioenergy.com/publications/using-beast-to-support-the-local-dialogue-on-lignocellulosic-cropping-for-energy-use-climate-protection-and-sustaining-ecosystem-services-tr2019-05/
Attractive Systems for Bioenergy Feedstock		
Production in Sustainably Managed Landscapes: Contributions to the Call	July 2019	Available online: http://task43.ieabioenergy.com/publications/attractive-systems-for-bioenergy-feedstock-production-in-sustainably-managed-landscapes-contributions-to-the-call/
International workshop: Adequacy of Spatial Databases for Conducting Risk Assessments of Sustainable Wood Sourcing Practices of the U.S. Industrial Wood Pellet Industry Supplying European Energy Demand (1-3 May 2019)	May 2019	Available online: http://task43.ieabioenergy.com/publications/international-workshop-adequacy-of-spatial-databases-for-conducting-risk-assessments-of-sustainable-wood-sourcing-practices-of-the-u-s-industrial-wood-pellet-industry-supplying-european-energy-dema/
Report: Governance of sustainable forest management and bioenergy feedstock harvesting in Ontario, Canada	May 2019	Available online: http://task43.ieabioenergy.com/publications/governance-of-sustainable-forest-management-and-bioenergy-feedstock-harvesting-in-ontario-canada/
Report: Forest biomass as part of silvicultural systems and its potential contribution to the low-carbon transition of heavy industries.	May 2019	Available online: http://task43.ieabioenergy.com/publications/forest-biomass-as-part-of-silvicultural-systems-and-its-potential-contribution-to-the-lowcarbon-transition-of-heavy-industries-tr2019-03/
Report on expert workshop on variable demand for biofuels	March 2019	Available online: http://task43.ieabioenergy.com/publications/report-on-expert-workshop-on-variable-demand-for-biofuels-tr2019-02/
Report: Economic and Social Drivers for Optimal Bioenergy Implementation	February 2019	Available online: http://task43.ieabioenergy.com/publications/economic-and-social-drivers-for-optimal-bioenergy-implementation/

On-going key activities

Task 43 recently endorsed a new project titled *Improving framework conditions for bioenergy supply chains within bioeconomy – an approach for shaping evidence-based policies*. The activity will address how supply chains for a certain biomass affect the ability of bioenergy projects to curb the GHG emissions.

There are a range of projects from the previous triennium, which are in their final stages and will be completed within the next 4-6 months.

Website

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

Collaboration with Other Tasks/Organisations/Networking

The *Biohub in the development and deployment of efficient biomass supply chains* project will involve collaboration with Task 45 and a number of contributors to the previous triennium that have elected not to proceed as part of Task 43.

The workshop hosted in Sopron on Biohubs will be hosted jointly with the BioeEast initiative.

Deliverables

Work Package One

- D1 Strategies to integrate innovated biomass crops to leverage and expand existing residue and co-product supply chains
 - Workshop – 2020
 - Report – 2020

- D2 Scale of different biomass crops to economically supply bioenergy production as sole source and as an integrated contribution to residue supply chains
 - Report 2021

- D3 Quantifying the socioeconomic values of biomass crops as a part of local, regional and national renewable energy strategies.
 - Workshop 2021
 - Report 2021

D4 Influencing biomass sustainability through strategies to increase volume, value and quality of biomass supply.

- Joint workshop (sustainability task) 2021
- Report 2021

Work Package Two

D5 Key biomass quality drivers as they relate to bioenergy technology needs

- Workshop 2020
- Report 2021

D6 Identifying and managing technology bottlenecks in biomass supply chains

- Biomass supply chain process model 2020
- Report 2021

D7 Opportunities to economically extend the range of biomass supply chains through new and emerging biomass technology.

- Workshop 2021
- Report 2021

D8 Improving biomass quality and value with pre-processing or pre-treatment within the supply chain

- Report 2021

TASK 44: Flexible Bioenergy and System Integration

Overview of the Task

Task 44 contributes to the development and analysis of bioenergy solutions that can provide flexible resources for a low-carbon energy system. The objective is to improve understanding on the types, quality and status of flexible bioenergy, and identification of barriers and future development needs in the context of the entire energy system (power, heat and transport).

Bioenergy has some unique properties that can address many of the problems related to the on-going transition to a low-carbon energy system. When sustainably sourced and used, bioenergy can (i) operate as a key element in the coupling of different energy sectors; (ii) provide low-carbon energy to complement wind and solar (residual load and grid stabilisation); (iii) store electricity chemically into fuels to enable more efficient use of wind and solar; (iv) provide sustainable fuels for sectors where other decarbonisation options are not available or exceedingly expensive; (v) provide high temperature heat to industry,

and low temperature heat for buildings (and sanitary water) during dark and cold seasons; (vi) coproduce heat, electricity, fuels and other products in a single high-efficiency processing plant. Achieving these objectives requires a fundamental shift in the way bioenergy is being used, but there is currently a limited understanding on the details of such change.

Task activities in the current triennium are divided into four work packages that together address the main objectives of the Task:

WP1 – Flexible bioenergy concepts for supporting low-carbon energy systems,

WP2 – Acceleration of implementation,

WP3 – System requirements for bioenergy concepts, and

WP4 – Inter-Task projects and collaborative projects.

These actions involve collecting, sharing, and analysing existing information in the above mentioned areas. The results are disseminated through workshops, reports and databases.

Participating countries: Australia, Austria, Finland, Germany, Ireland, The Netherlands, Sweden, Switzerland and the United States of America

Task Leader: Dr Ilkka Hannula, VTT Technical Research Centre of Finland Ltd., Finland

Assistant Task Leader: Prof Dr-Ing Daniela Thrän, Helmholtz Centre for Environmental Research – UFZ, Germany

Operating Agent: Dr Antti Arasto, VTT Technical Research Centre of Finland Ltd., Finland

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

For further details on Task 44, please refer to Appendices 2, 4, 5 and 6; the Task website (<http://task44.ieabioenergy.com/>) and the IEA Bioenergy website (www.ieabioenergy.com) under 'Our Work: Tasks'.

Progress in R&D

Task Meetings and workshops

In 2019 Task 44 organised two internal meetings and one workshop. The internal meetings were used to initiate, coordinate and monitor progress in different Task activities and to plan new activities.

The Task kick-off meeting was organised in February 2019 in Stockholm, and the second Task meeting was organised in September 2019 in Helsinki.

In November 2019 Task 44 organised a workshop together with Tasks 40, 43 and 45 in Berlin. The aim of the workshop was to gather and distribute expert knowledge on recent scenarios relating to the roles of bioenergy technologies in energy system pathways towards a well below 2 degree (WB2) world. It was attended by an international audience of 44 persons seeking to present, examine and synthesise different inputs on how bioenergy and associated technologies may contribute to achieving the reductions in greenhouse gas emissions that are needed to meet the WB2 target. Studies from regional to global scale have been presented, and covered individual or several energy sectors. A report summarising these different perspectives and scales, analysing their common and contrasting features and embedding the synthesised findings in the larger framework of implementation strategies will be published in 2020. Conclusions are drawn regarding the potential and limitations of bioenergy in a WB2/SDG-world and the needs for further development of assessment methods and measures.

Work Programme and Outputs

Task objectives are advanced through the following work packages

WP 1 – Flexible bioenergy concepts for supporting low-carbon energy systems

focuses on the assessment and categorisation of flexible bioenergy technologies. The Task has prepared a questionnaire for gathering information and Tasks 32, 33, 34 and 39 have all been contacted. Additional contacts have been identified through Task NTLs.

WP 2 – Acceleration of implementation focuses on policy and market analysis of flexible bioenergy through country cases. All member states participating in the Task will be covered while additional countries will also be considered. A questionnaire for gathering information has been prepared and sent. Responses are currently being evaluated.

WP 3 – System requirements for bioenergy concepts focuses on reaching out to other IEA TCPs to foster discussion on flexible energy system. Initial contacts have been made during the 3rd/4th quarter of 2019 and an inter-TCP workshop is currently being planned for April 6th 2020 in Paris.

WP4 – Intertask projects and collaborative projects The Task is currently involved in 2 Inter-Task projects “The Role of Bioenergy in a WB2/SDG world” and “Renewable gas”.

Website

The Task website (<http://task44.ieabioenergy.com>) was established in the beginning of 2019, but significant problems were experienced with the system for the rest of the year. The back end was fixed only in Jan 2020.

Collaboration with Other Tasks/Organisations/Networking

One collaborative activity of Task 44 is set up in the form of an Inter-Task project “The Role of Bioenergy in a WB2/SDG world”. The IEA Bioenergy Tasks work together in this project regarding deployment (Task 40), resource potential and supply chains (Task 43), flexibility and systems integration (Task 44) as well as sustainability (Task 45 – the project lead). Many scenarios that meet the target of limiting global warming to well below 2 degree (WB2) include a significant and increasing contribution of biomass-based energy supply, but vary concerning the potential and usage of biomass at a global as well as a regional scale. To identify and disseminate strategies for bioenergy implementation that contribute positively to a societal transition towards the WB2 target, while simultaneously contributing to other SDG objectives, the Inter-Task project assesses the role of bioenergy in these scenarios. This also includes assessment of trade-offs and concerns about possible negative impacts of bioenergy expansion, mitigation of these challenges and the identification of synergies between bioenergy deployment and SDG implementation. Furthermore interactions of biomass uses with other opportunities for land-based mitigation, such as afforestation, reforestation, and biochar production and use to enhance carbon storage in vegetation and soils are included in the integrated assessment approach.

Task 44 has also participated in meetings organised by the Inter-Task project on Renewable gas.

Deliverables

The following milestones were achieved in 2019. Organising two Task meetings. Co-organising a workshop on the roles of bioenergy technologies in energy system pathways towards a well-below 2°C world. Coordinating a response document for the IEA HQ on their questions related to the role of flexible bioenergy. The Task also initiated a LinkedIn group on Flexible Bioenergy and produced progress reports for the ExCo.

TASK 45: Climate and Sustainability Effects of Bioenergy within the broader Bioeconomy

Overview of the Task

The Task will identify and address critical issues related to the climate and other sustainability effects of bioenergy and biobased products and systems. The objective is to promote sound development for bioenergy as an integral component of the overall bioeconomy. One key goal is to increase understanding of the environmental, social and economic impacts of producing and using biomass for bioenergy, within the broader bioeconomy. A central aspect concerns the development and application of science-based methodologies and tools for assessing the effects of biobased systems.

The Task will identify and address issues from several points of view (e.g., product/project level; national, regional and global levels; specific sectors or subsectors and applications) and will consider commercial, near-commercial and emerging/conceptual systems. An important point of departure is that bioenergy systems are commonly components in value chains or production processes that also produce other biobased products (including food, feed and fiber) and they may be shaped to address specific needs such as organic waste management, or water and soil protection.

Three Work Packages (WPs) represent the main elements to achieve the Task objectives:

WP1 – Metrics, methods, and tools for assessing climate change effects of bioenergy

WP2 – Metrics, methods and tools for assessing sustainability effects of bioenergy (excluding climate change effects)

WP3 – Sustainability stakeholders and implementation approaches (governance)

The work in the Task is relevant for a broad group of stakeholders including academia, commercial interests and private sector producers, exporters, importers, financing organisations, governments, policymakers, civil society organisations and others such as IRENA, GBEP and FAO. The Task also has high ambitions concerning scientific publishing and communication with the scientific community.

Participating countries: Australia, Brazil, Denmark, Finland, France, Germany, Ireland, The Netherlands, Norway, Sweden, the United Kingdom and the United States of America

Task Leader: Professor Göran Berndes, Chalmers University of Technology, Sweden

Work Package leaders: Annette Cowie, Univ. of New England, Australia, Floor van der Hilst, Copernicus Institute, The Netherlands, Uwe Fritsche, International Institute for Sustainability Analysis and Strategy (IINAS), Germany

Task Secretary: Gustaf Egnell, Swedish University of Agricultural Sciences, Sweden

Operating Agent: Mr Jonas Lindmark, Swedish Energy Agency (STEM), Sweden

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 45, please refer to Appendices 2, 4, 5 and 6; the Task website (<http://task45.ieabioenergy.com/>) and the IEA Bioenergy website (www.ieabioenergy.com) under 'Our Work: Tasks'.

Task Meetings and workshops

In 2019, Task 45 organised three face-to-face meetings and four GoToMeetings to exchange information, monitor progress of ongoing activities and to plan future activities. The Task also organised two workshops.

Task 45 held its kick-off meeting in Stockholm 17 February – 1 March, together with two other Tasks (40 and 44) that will have collaborative activities with Task 45 in the 2019-2021 period. In addition to the internal Task planning, there were meetings on planning these Task collaboration activities, especially in the inter-Task projects “The Role of Bioenergy in a WB2/SDG World”, which is coordinated by Task 45.

Task 45 contributed to the planning and arrangement of the ExCo83 workshop “Governing sustainability in biomass supply chains for the bioeconomy”, in Utrecht, The Netherlands, 23 May. The ExCo83 workshop was followed by a private sector roundtable where the workshop outcomes were discussed. An outcome report from the workshop has been published and is available at the IEA Bioenergy website.

Together with the Royal Swedish Academy of Agriculture and Forestry, Task 45 organised a seminar and roundtable meeting in Stockholm, 2 September, about the IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. The seminar also considered the IPBES Global Assessment Report on Biodiversity and Ecosystem Services.

On November 25 in Berlin, Task 45 and Task 44 organised a workshop “Roles of bioenergy technologies in energy system pathways towards a WB2/SDG world” as part of the above named Inter-Task project. A Call for contributions was circulated 5 months ahead of the workshop and responses were evaluated as part of the preparation of the workshop. An outcome report is being prepared. The Task had further meetings in Berlin (November 26-29) to progress Task work and also joint Task activities with Task 40 and 44.

A 2nd inter-Task project workshop is being planned, titled “Cumulative net GHG emissions – and warming contribution over time – associated with bioenergy systems and AFOLU measures in selected scenarios that meet WB2”. This workshop is planned to take place May 11 in Göteborg, in association with the 2nd International Conference on Negative CO₂ Emissions.

In addition to these meetings, Task 45 planned/participated in meetings as part of the activities in WP3: i) Private sector roundtable following-up on ExCo83 Workshop, Utrecht 24 May; 2nd Dialogue on Forest Landscape Restoration and Bioenergy: Focus on SSA-EU collaboration on FLR and bioenergy. Side event to the 27th EUBCE, Lisbon 28 May; (iii) Innovation Forum Conference “Is bioenergy sustainable? How biofuels will fit into

the energy mix by 2030 and beyond” Brussels, 25 May; and (iv) Sustainable Shipping Initiative seminar, London, 11 July.

Work Programme and Outputs

The objective of the Task is to promote sound development for bioenergy as an integral component of the overall bioeconomy. This objective will be achieved by providing analyses that support well-informed decisions by landowners, communities, businesses, governments and others. A central aspect concerns the development and application of science-based methodologies and tools for assessing the effects of biobased systems to contribute to available knowledge and experiences. The Task builds on previous work in IEA Bioenergy Tasks and Inter-Task activities in the 2016-18 triennium and previous triennia that have considered issues of sustainability assessment and governance.

The Task works within a dynamic area undergoing rapid change and the work programme is shaped to provide flexibility and capacity to respond constructively to emerging science and policy developments in the countries participating in the Task, as well as international developments. Ad hoc groups will be formed within the Task to respond promptly to requests from ExCo or other key international organisations. The ad hoc groups will also provide expert scientific and technical review of relevant reports and proposals, as appropriate. This will enable the Task to establish a position and provide input to important policy processes as opportunities arise and thereby support policy development concerning topics covered by the Task.

The Task will also seek to inform and address misconceptions about bioenergy in a wider sense, since public perceptions of bioenergy will determine the expansion of the bioenergy industry; unless there is acceptance by academics, NGOs and the general public, policy support for bioenergy will diminish, and the climate-change mitigation potential of bioenergy will not be realised.

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.

WP1 builds on the work of Task 38 and its predecessor Tasks, that operate at the science-policy interface, contributing balanced and science-based input to the ongoing debate on the climate effects of bioenergy. These Tasks have contributed to i) the development of methods for reporting and accounting for national greenhouse gas inventories under the UNFCCC and Kyoto Protocol, ii) development of rules for project level accounting for emissions trading and product certification, and iii) national policies on renewable energy.

WP1 aims to build the body of knowledge to equip the community of practice to undertake well-informed studies on the climate effects of bioenergy. We will develop, demonstrate, refine and promote metrics, methods and tools to quantify climate effects of bioenergy.

Methods applied will include land use and energy systems modelling, product-focused LCA, landscape and broader spatial scale assessments, and sectoral assessment. No single approach can provide full understanding; using many different approaches is expected to provide useful and robust insights.

The objective of WP2 is to inform academia, industry, policymakers and other stakeholders on the potential sustainability effects of bioenergy and the possible contribution of bioenergy deployment to the SDGs. To this end, WP2 will contribute to, and combine ongoing efforts on, developing and demonstrating metrics, methods and tools to quantify and qualify environmental, social, and economic effects of bioenergy systems, to support multi-stakeholder processes that seek to balance sustainability trade-offs and identify opportunities to realise synergies between several SDGs. While the focus is on bioenergy systems, the work will also be relevant for many other types of biobased products. As many of the potential effects of bioenergy are related to land use and LUC, biomass production in managed landscapes is a focus area in this work package.

The role of WP3 relates to the statement in the IEA Bioenergy Roadmap that *“Making the transition to a low-carbon energy system will require massive investment (...) The principal barriers to investment in bioenergy technologies relate to the risks as perceived by potential developers and, in particular, by other investors (...) The additional risks associated with the need to provide for the long-term supply of fuels or feedstock at an affordable cost and which meet appropriate sustainability criteria, are a significant complicating factor for financing bioenergy projects.”*

WP3 aims to create broader support among stakeholders for sustainable bioenergy as an integral part of the broader bioeconomy, as outlined in the IEA Bioenergy Roadmap, through three interrelated lines of activities: (i) identifying perspectives of the stakeholder and promoting exchange of views among relevant stakeholders to bridge international and local scales; (ii) suggesting ways to make indicators and tools provided by WP1 and WP2 useful for implementation procedures and instruments (governance); (iii) engaging with identified stakeholders to discuss barriers and risks associated with bioenergy investment, and identifying respective de-risking approaches, and support the implementation of such procedures and instruments.

Website

The Task website (<http://task45.ieabioenergy.com/>) has been updated in line with changes to the IEA Bioenergy website. Information concerning the Task 45 work is available and updated constantly.

Collaboration with Other Tasks/Organisations/Networking

Task 45 cooperated with Tasks 40, 43 and 44 in Inter-Task projects and respective joint activities. The Task has further collaborated with GBEP, IRENA, and the Biofuture Platform as well as Sustainable Shipping Initiative (follow-up to ExCo83 workshop in Brussels). Together with Task 40, the Task has also engaged in joint work on Forest Landscape Restoration – Bioenergy, where also GIZ, GBEP, IRENA and UNCCD have contributed.

Related to the seminar and roundtable on the IPCC and IPBES reports in Stockholm September 2, Task 45 cooperated with the Royal Swedish Academy of Agriculture and Forestry. In the Renewable Gas Inter-Task project, there is cooperation with IEA Hydrogen and ERIG.

Deliverables

The following milestones were achieved in 2019:

- Workshop “Governing sustainability in biomass supply chains for the bioeconomy”
- Dialogue on Forest Landscape Restoration and Bioenergy
- Seminar and roundtable on the IPCC and IPBES reports
- Circulation of Call for contributions: Roles of bioenergy technologies in energy system pathways towards a WB2/SDG world
- Workshop “Roles of bioenergy technologies in energy system pathways towards a WB2/SDG world”
- Detailed Task work planning, including approved work plans for a number of Task projects
- Detailed work planning for Strategic Inter-Task project “Renewable Gas”
- First draft of scoping report on Deployment of BECCS/U Value Chains (Collaborative inter-Task project)
- Detailed work planning for Inter-Task project “The Role of Bioenergy in a WB2/SDG World”
- The Task also produced progress reports and audited accounts for the ExCo.

APPENDIX 1: TASK PARTICIPATION IN 2019

TASK	AUS	AUT	BEL	BRA	CAN	CRO	DEN	EST	FIN	FRA	GER	IND	IRE	ITL	JAP	KOR	NEL	NZE	NOR	SA	SWE	SWI	UK	USA	EC	Total
32		•			•	⊗					•				•		•		•		•	•				9
33		•								•	•						⊗				•		•			6
34					•		•		•		⊗						•	•	•		•		•			9
36	•									•	•			•					•	•	⊗			•		7
37	•	•		•	•		•	•	•	•			⊗			•	•					•	•			15
39	•	•		•	•	⊗					•	•	•		•	•	•	•	•					•	•	16
40			•				•				⊗				•		•							•		7
42	•	•					•				•		•				⊗									8
43	⊗		•		•				•		•										•			•		8
44	•	•							⊗		•		•				•							•		9
45	•			•			•		•	•	•		•				•		•		⊗		•	•		12
Total	7	6	2	3	5	1	7	1	5	2	11	1	5	2	3	2	9	2	5	1	11	3	3	8	1	106

⊗ = Operating Agents • = Participant

APPENDIX 2: BUDGET IN 2019 – SUMMARY TABLES

Budget for 2019 by Member Country (US\$)

Contracting Party	ExCo funds	Task funds	Total
Australia	13,700	108,000	121,700
Austria	12,700	91,500	104,200
Belgium	8,700	30,000	38,700
Brazil	9,700	44,000	53,700
Canada	11,700	77,000	88,700
Croatia	7,700	15,000	22,700
Denmark	13,700	109,500	123,200
Estonia	7,700	14,000	21,700
Finland	11,700	77,000	88,700
France	8,700	29,000	37,700
Germany	17,700	171,000	188,700
India	7,700	15,000	22,700
Ireland	11,700	76,500	88,200
Italy	8,700	34,000	42,700
Japan	9,700	45,000	54,700
Korea	8,700	29,000	37,700
Netherlands	15,700	139,500	155,200
New Zealand	8,700	33,000	41,700
Norway	11,700	79,500	91,200
South Africa	7,700	16,500	24,200
Sweden	17,700	171,000	188,700
Switzerland	9,700	44,000	53,700
UK	9,700	44,000	53,700
USA	14,700	124,500	139,200
European Commission	7,700	15,000	22,700
Total	273,500	1,632,500	1,906,000

Budget for 2019 by Task (US\$)

Task	Number of participants	Annual contribution per participant	Total Task funds
Task 32: Biomass Combustion	9	15,000	135,000
Task 33: Gasification of Biomass and Waste	6	15,000	90,000
Task 34: Direct Thermochemical Liquefaction	9	18,000	162,000
Task 36: Material and Energy valorisation of waste in a Circular Economy	7	16,500	115,500
Task 37: Energy from Biogas	15	14,000	210,000
Task 39: Commercialising Conventional and Advanced Transport Biofuels from Biomass and Other Renewable Feedstocks	16	15,000	240,000
Task 40: Deployment of biobased value chains	7	15,000	105,000
Task 41: Bioenergy Systems Analysis		0	0
Task 42: Biorefining in a Circular Economy	8	17,500	140,000
Task 43: Sustainable biomass supply integration for bioenergy within the broader bioeconomy	8	15,000	120,000
Task 44: Flexible Bioenergy and System Integration	9	15,000	135,000
Task 45: Climate and Sustainability Effects of Bioenergy within the broader Bioeconomy	12	15,000	180,000
Total			1,632,500

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)

Ministry of Petroleum and Natural Gas (India)

The Sustainable Energy Authority of Ireland (SEAI)

Gestore dei Servizi Energetici – GSE (Italy)

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

Ministry of Knowledge Economy, the Republic of Korea

NL 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

APPENDIX 4

The Executive Committee

Final Minutes of the ExCo83 meeting, Utrecht, The Netherlands, May 2019

Final Minutes of the ExCo84 meeting, Tallinn, Estonia, October 2019

IEA Bioenergy Bulletin February 2019

IEA Bioenergy News Volume 31(1), June 2019

IEA Bioenergy Bulletin September 2019

IEA Bioenergy News Volume 31(2), December 2019

IEA Bioenergy Update. Number 65. Biomass and Bioenergy, Volume 121, pages iii-viii

IEA Bioenergy Update. Number 66. Biomass and Bioenergy, Volume 128, pages i-vi

IEA Bioenergy Update. Number 67. In press

Anon. IEA Bioenergy Annual Report 2018. IEA Bioenergy ExCo:2019:01

Anon. Inter-Task – Measuring, governing and gaining support for sustainable bioenergy supply chains – Proj. Obj 1. IEA Bioenergy ExCo:2019:02

Anon. Inter-Task – Measuring, governing and gaining support for sustainable bioenergy supply chains – Proj. Obj 2. IEA Bioenergy ExCo:2019:03

Anon. Inter-Task – Measuring, governing and gaining support for sustainable bioenergy supply chains – Proj. Obj 3. IEA Bioenergy ExCo:2019:04

Anon. Inter-Task – Measuring, governing and gaining support for sustainable bioenergy supply chains – Synthesis Report. IEA Bioenergy ExCo:2019:05

Anon. IEA Bioenergy Work Programme 2019-2021 Triennium. IEA Bioenergy ExCo:2019:06

Anon. Governing sustainability in biomass supply chains for the bioeconomy. Summary and Conclusions from the IEA Bioenergy ExCo83 Workshop. IEA. Bioenergy ExCo:2019:07

Anon. End of Triennium 2016-2018 Report series. IEA Bioenergy ExCo:2019:08 A-J

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

TASK 32

Task documents List

- End-of-triennium 2016-2018 report
- Final triennium 2019-2021 proposal
- Minutes of the virtual task meeting, 25 April 2019
- Draft minutes of the task meeting in Hurdal, Norway, 18-19 June 2019
- Progress report for ExCo84, Tallinn, Oct 2019 (Report and presentation)
- Annual report Task 32 (this report)

Publications List

Oskar Räftegård and Anders Hjörnhede, Bioenergy for heat – the Hot Cases, Borås, December 2018

Reinhard Padinger, Stefan Aigenbauer, Christoph Schmidl and Jens Dall Bentzen, Best practise report on decentralized biomass fired CHP plants and status of biomass fired small- and micro-scale CHP technologies, Wieselburg, 2019

Morten Tony Hansen, Lars Pauli Bornak, Alberto Dalla Riva, Hans Henrik Lindboe, The future role of thermal biomass power in renewable energy systems – a study of Germany, Copenhagen, 2019

Jaap Koppejan, Michael Wild, Évelyne Thiffault, Kevin J. Whitty, Marcel Cremers, K.P.H. Meesters (Koen), Biomass Pretreatment Options to Diversify the Resource Base, Webinar, 25 April 2019

Please visit the task website for the reports and original presentations:

<http://task32.ieabioenergy.com/>

TASK 33

Task documents List

- Minutes of Task meeting in Karlsruhe
- Business slides of meeting in Karlsruhe
- Minutes of Task meeting in Birmingham (pending approval)
- Business slides of meeting in Birmingham (pending approval)

Publications List

Inter-Task Project: Biomass pre-treatment for bioenergy, Case study 3: Pretreatment of MSW for gasification

Status report on thermal gasification of biomass and waste 2019

- Annex 1 – CHP operational facilities
- Annex 2 – CHP non-operational facilities
- Annex 3 – Fuel synthesis operational
- Annex 4 – Fuel synthesis non operational
- Annex 5 – Other gasification technology operational
- Annex 6 – Other gasification technology non-operational

Please visit the Task website for the reports and original presentations:

<http://task33.ieabioenergy.com/>

TASK 34

Task documents List

- Minutes from the Task meeting in Karlsruhe/Germany, June 2019
- Minutes from the Task meeting in Aalborg/Denmark, October 2019
- Progress report for ExCo84, Tallinn, Estonia, 2019

Publications List

Please visit the Task website for the reports and original presentations:

<http://task34.ieabioenergy.com/>

Task documents List

- Minutes from the Task meeting in Stockholm, May 2019
- Minutes from the on-line Task meeting in September 2019
- Draft Minutes from the Task meeting in Brisbane, November 2019
- Progress report to ExCO

Publications List

Summary report for the Nutrient Recovery from Waste workshop, May 2019

Draft summary report for the Technology Pathways for Energy Recovery from Waste in a Circular Economy, November 2019

Draft report Trend of use of SRF, (intended publication beginning of 2020)

Draft report Trends and Drivers in Alternative Thermal Conversion of Waste, (intended publication beginning of 2020)

Report: Biomass pre-treatment for bioenergy. Case study 3: MSW pre-treatment for gasification, November 2019

Presentations from the Nutrient Recovery from Waste and Technology Pathways for Energy Recovery from Waste in a Circular Economy, May and November 2019

Please visit the Task website for the reports and original presentations:

<http://task36.ieabioenergy.com/>

TASK 37

Task documents List

- Minutes from the Task meeting in Tartu, Korea, 7-10 May 2019
- Minutes from the Task meeting in Task 37 Meeting Seoul, Korea, 23-25 October 2019

Publications List

Five case stories

- BIOWERT GRASS BIOREFINERY, BIOBASED PLASTICS, GERMANY June 2019
- GREENING THE GAS GRID IN DENMARK, February 2019
- ORGANIC BIOGAS IMPROVES NUTRIENT SUPPLY, Kroghsminde Bioenergy I/S, Denmark February 2019
- DISTRIBUTED GENERATION USING BIOGAS IN A MICROGRID: in the Western Region of Parana, Brazil, February 2019
- MONO-DIGESTION OF CHICKEN LITTER: Tully Biogas Plant, Ballymena, Northern Ireland, January 2019

Six IEA Task 37 Country Reports (Austria, Denmark, Switzerland, Netherlands, Canada, Sweden)

ENEA consulting, Bioenergy Australia and IEA Bioenergy Task 37 "Biogas Opportunities for Australia" March 2019

Presentations from Biosystems Engineering 2019 Conference (<http://bse.emu.ee/topics-and-scope/>) in the Estonian University of Life Sciences, Institute of Technology, Tartu <http://www.iea-biogas.net/workshops.html>

Presentations from the International Renewable Energy Conference (<http://kirec2019.kr/>) Location: COEX Hall E3, Seoul, Korea <http://task37.ieabioenergy.com/workshops.html>

Newsletters: 12 issues in 2019

Please visit the Task website for the reports and original presentations:
<http://task37.ieabioenergy.com/about-task-37.html>

TASK 39

Task documents List

- Minutes from the Task meeting, Ispra, Italy, May 2019
- Minutes from the Task meeting, Stockholm, Sweden, September 2019
- Progress report for ExCo83, Utrecht, Netherlands on 23 May 2019 (End of Triennium Report)
- Progress report for ExCo84, Tallinn, Estonia, October 2019
- Ebadian (Ed.) IEA Bioenergy Task 39 Newsletter Vol. 51, April 2019
- Ebadian (Ed.) IEA Bioenergy Task 39 Newsletter Vol. 52, August 2019
- Ebadian (Ed.) IEA Bioenergy Task 39 Newsletter Vol. 53, December 2019

Publications List

Please visit the Task website for the reports and original presentations:

<http://task39.ieabioenergy.com/publications/>

TASK 40

Task documents List

- Minutes from Task meetings in Stockholm (Feb/March 2019), and Leipzig (Nov 2019)
- Task 40 Newsletter. Issue 1, March 2019

Publications List

Fritsche, Uwe et al. (2019) Margin potential for a long-term sustainable/viable wood pellet supply chain. IEA Bioenergy Task 40 (Summary, Full Report, Annex)

<http://task40.ieabioenergy.com/iea-publications/task-40-library/>

Webinar on this report on November 13, 2019: <http://task40.ieabioenergy.com/iea-bioenergy-task-40-webinar-future-prospects-for-wood-pellet-markets/>

Fritsche, Uwe R. (2019) Sustainability of Bioenergy – State of the art. In: Lago, Carmen; Caldes, Natalia and Lechon, Yolanda (eds.) The Role of Bioenergy in the Emerging Bioeconomy – Resources, Technologies, Sustainability and Policy. Academic Press. London etc.: 225-241 <https://doi.org/10.1016/B978-0-12-813056-8.00006-6>

Junginger, Martin et al. (2019) Measuring, governing and gaining support for sustainable bioenergy supply chains – Main findings and recommendations. IEA Bioenergy: ExCo: 2019: 05 <http://itp-sustainable.ieabioenergy.com/wp-content/uploads/2019/06/Intertask-Sustainability-Main-findings-and-recommendations-17.5.2019-1.pdf>

Junginger, Martin; Fritsche, Uwe; Mai-Moulin, Thuy et al. (2019) Understanding positions and underlying motivations of stakeholder groups relative to their perceptions of bioenergy. Summary of findings under Objective 3 of the IEA Bioenergy inter-Task project “Measuring, governing and gaining support for sustainable bioenergy supply chains”. IEA Bioenergy: ExCo: 2019: 04 <http://itp-sustainable.ieabioenergy.com/wp-content/uploads/2019/06/Intertask-Sustainability-03-summary-26.3.2019.pdf>

Olsson, O. Bang C., Borchers M., Hahn A., Karjunen H., Thrän D. and Tynjälä T. (2020) *Deployment of BECCS value chains: technological pathways, policy options and business models*, IEA Bioenergy Task 40 Report (forthcoming, in final draft)

Please visit the Task website for the reports and original presentations:
<http://task40.ieabioenergy.com/>

TASK 42

Task documents List

- Minutes from the Task 42 meeting in Wageningen, The Netherlands, May 2019
- Minutes from the Task 42 meeting in Rome, Italy, November 2019
- Progress report for ExCo84, Tallinn, Estonia, October 2019

Publications List

Annevelink, E., 2019. An introduction to the IEA Bioenergy Task 42 Biorefining in a Circular Economy. Power Point presentation at Italian IEA42 workshop on ‘New industrial models in the bioeconomic era: the biorefineries’

Jong, E., 2019. Biobased Chemicals – Current status and Potential. Power Point presentation at Italian IEA42 workshop on ‘New industrial models in the bioeconomic era: the biorefineries’

Lindorfer, J., M. Lettner, F. Hesser, K. Fazeni, D. Rosenfeld, E. Annevelink and M. Mandl, 2019. Technical, Economic and Environmental Assessment of Biorefinery Concepts. IEA Bioenergy, Task42, 2019:01, 55 pp

Mandl, M., J. Lindorfer and F. Hessert, 2019. Technical, Economic and Environmental Assessment of Biorefineries – Developing a practical approach for characterisation. Power Point presentation at Italian IEA42 workshop on 'New industrial models in the bioeconomic era: the biorefineries'

Sahajwalla, V., S. Maroufi, G. Bell, P. Bell and I. De Bari, 2019. Alternative sustainable carbon sources as substitutes for metallurgical coal. IEA Bioenergy, Task42, 2019:02, 28 pp

Stichnothe, H., 2019. Role of future energy mixes on the environmental performance on biobased products from agricultural residues. Power Point presentation at Italian IEA42 workshop on 'New industrial models in the bioeconomic era: the biorefineries'

Please visit the Task website for the reports and original presentations:

<http://task42.ieabioenergy.com/>

TASK 43

Task documents List

- Minutes from the Task meeting, April 2019
- Minutes from the Task meeting, May 2019
- Minutes from the Task meeting, June 2019
- Minutes from the Task meeting, August 2019
- Minutes from the Task meeting, October 2019
- Progress report for ExCo84, Tallinn, Estonia, 2019

Publications List

TR2019-01 – Economic and Social Drivers for Optimal Bioenergy Implementation (<http://task43.ieabioenergy.com/wp-content/uploads/2019/02/TR2019-01f.pdf>)

TR2019-02 – Report on expert workshop on variable demand for biofuels (<http://task43.ieabioenergy.com/wp-content/uploads/2019/03/TR2019-02.pdf>)

TR2019-03 – Forest biomass as part of silvicultural systems and its potential contribution to the lowcarbon transition of heavy industries (http://task43.ieabioenergy.com/wp-content/uploads/2019/05/Report_Forest-biomass-procurement-as-part-of-larger-forestry-and-industrial-systems-Part-1_compressed.pdf)

TR2019-04 – Governance of sustainable forest management and bioenergy feedstock harvesting in Ontario, Canada (<http://task43.ieabioenergy.com/wp-content/uploads/2019/06/TR2019-04r1.pdf>)

TR2019-05 – Using “BEAST” to support the local dialogue on lignocellulosic cropping for energy use, climate protection and sustaining ecosystem services (http://task43.ieabioenergy.com/wp-content/uploads/2019/05/TASK43-BEASTrev_fin_Formatted-2.pdf)

TR2019-06 – Attractive Systems for Bioenergy Feedstock Production in Sustainably Managed Landscapes (http://task43.ieabioenergy.com/wp-content/uploads/2019/07/Contributions-to-the-Call_final.pdf)

TR2019-07 – Sustainable Landscape Management for Bioenergy and the Bioeconomy (http://task43.ieabioenergy.com/wp-content/uploads/2019/07/FAO_T43_workshop_REPORT_final.pdf)

TR2019-08 – Dry matter losses during biomass storage (http://task43.ieabioenergy.com/wp-content/uploads/2020/01/EIA-Dry-Matter-Loss_Final.pdf)

Please visit the Task website for the reports and original presentations:
<http://task43.ieabioenergy.com/>

TASK 44

Task documents List

- Minutes from the Task meeting in Stockholm, Sweden, Feb-Mar 2019
- Minutes from the Task meeting in Espoo, Finland, Sep 2019
- Progress report for ExCo84, Tallinn, Estonia, 2019

Publications List

Please visit the Task website for the reports and original presentations:
<http://task44.ieabioenergy.com/>

Task documents List

- Minutes from the Task meeting in Stockholm, Sweden, February 2019
- Minutes from the Task meeting in Utrecht, The Netherlands, May 2019
- Minutes from the Task meeting in Berlin, Germany, November 2019
- Progress report for ExCo84, Tallinn, Estonia, 2019

Publications List

Please visit the Task website for the reports and original presentations:

<http://task45.ieabioenergy.com/>

APPENDIX 5: KEY PARTICIPANTS IN EACH TASK

TASK 32 – Biomass Combustion

Operating Agent: Ms Annika Fischer, Denmark. For contacts see Appendix 7.

Task Leader: Morten Tony Hansen, Ea Energy Analyses, Denmark.
For contacts see Appendix 6.

The Task is organised with 'National Teams' in the participating countries. The contact persons for 2019 (National Team Leader) in each country are listed below. An up-to-date list can be found on <http://task32.iebioenergy.com>

Country	National Team Leader	Institution
Austria	Christoph Schmidl	Bioenergy 2020+
Canada	Sebnem Madrali	National Resources Canada
Denmark	Morten Tony Hansen	Ea Energy Analyses
Germany	Hans Hartmann	Technologie- und Forderzentrum
Japan	Masayuki Mizuno	New Energy and Industrial Technology Development Organization (NEDO)
The Netherlands	Jaap Koppejan	Pro Biomass BV
Norway	Øyvind Skreiberg	SINTEF
Sweden	Anders Hjörnhede	RI.SE
Switzerland	Thomas Nussbaumer	Verenum

TASK 33 – Gasification of Biomass and Waste

Operating Agent: Kees Kwant, Netherlands Enterprise Agency, The Netherlands.
For contacts see Appendix 7.

Task Leader: Berend Vreugdenhil, TNO, The Netherlands. For contacts see Appendix 6.

The Task is organised with national teams in the participating countries. The contact person (National Team Leader) in each country is listed below.

Country	National Team Leader	Institution
Austria	Jitka Hrbek	University of Natural Resources and Life Sciences
Germany	Thomas Kolb	KIT
The Netherlands	Berend Vreugdenhil	TNO
Sweden	Joakim Lundgren	Swedish Center for Biomass Gasification (SFC)
UK	Patricia Thornley	Aston University
USA	Robert Baldwin	National Renewable Energy Laboratory (NREL)

TASK 34 – Direct Thermochemical Liquefaction

Operating Agent: Birger Kerckow, Fachagentur Nachwachsende Rohstoffe e.V. (FNR), Germany. For contacts see Appendix 7.

Task Leader: Dr.-Ing. Axel Funke, Karlsruhe Institute of Technology (KIT), Germany. For contacts see Appendix 6.

The Task is organised with 'National Teams' in the participating countries. The contact persons for 2019 (National Team Leader) in each country are listed below, an up-to-date list can be found on <http://task34.ieabioenergy.com/>

Country	National Team Leader	Institution
Canada	Benjamin Bronson	CanmetENERGY, Natural Resources Canada
Denmark	Lasse Rosendahl	Aalborg University
Finland	Christian Lindfors	VTT (Technical Research Centre of Finland Ltd.)
Germany	Axel Funke	Karlsruhe Institute of Technology
Netherlands	Bert van de Beld	BTG (Biomass Technology Group)
New Zealand	Paul Bennett	Scion
Norway	Kai Toven	RISE PFI
Sweden	Linda Sandström	RISE Energy Technology
USA	Justin Billing	PNNL (Pacific Northwest National Laboratory)

TASK 36 – Material and Energy valorisation of waste in a Circular Economy

Operating Agent: Jonas Lindmark, Swedish Energy Agency (SWEA), Sweden. For contacts see Appendix 7.

Task Leader: Inge Johansson, RISE Research Institutes of Sweden, Sweden. For contacts see Appendix 6.

The Task is organised with 'National Teams' in the participating countries. The contact persons for 2019 (National Team Leader) in each country are listed below, an up-to-date list can be found on <http://task36.ieabioenergy.com/>

Country	National Team Leader	Team Leader Institution
Australia	Daniel Roberts	CSIRO
Germany	Dieter Stapf	KIT
Italy	Giovanni Ciceri	RSE
Norway	Michäel Becidan	SINTEF
South Africa	Cristina Trois	University of KwaZulu-Natal
Sweden	Inge Johansson	RISE
USA	Beau Hoffman	Department of Energy – Bioenergy Technology Office U.S

TASK 37 – Energy from Biogas

Operating Agent: Matthew Clancy, Sustainable Energy Authority of Ireland, Dublin, Ireland. For contacts see Appendix 7.

Task Leader: Prof Jerry D Murphy, MaREI Centre, Environmental Research Institute, University College Cork, Ireland. For contacts see Appendix 6.

The Task is organised with 'National Teams' in the participating countries. The contact persons for 2019 (National Team Leader) in each country are listed below, an up-to-date list can be found on <http://task37.ieabioenergy.com/about-task-37.html>

Country	National Team Leader	Institution
Australia	Bernadette McCabe	University of Southern Queensland
Austria	Bernhard Drosch Gunther Bochmann	BOKU University, IFA-Tulln BOKU University, IFA-Tulln
Brazil	Paulo Afonso Schmidt Marcelo Alves de Sousa Rodrigo Regis de Almeida	Itaipu Binacional, Foz do Iguaçu, Brazil Itaipu Binacional, Foz do Iguaçu, Brazil Galvao CIBiogas Foz do Iguaçu, Brazil
Canada	Maria Welsch	Agriculture and Agrifood Canada
Denmark	Teodorita Al Seadi Jakon Lorenzen	BIOSANTECH Dansk Fagcenter for Biogas-DFFB
Estonia	Timo Kikas	Estonia University of Life Sciences
Finland	Saija Rasi	Natural Resources Institute Finland (Luke)
France	Olivier Théobald	ADEME
Germany	Jan Liebetrau	DBFZ, Leipzig, Germany
Ireland	Jerry D Murphy David Wall	MaREI centre, University College Cork MaREI centre, University College Cork
Korea	Soon Chul Park	Korea Institute of Energy Research
Netherlands	Mathieu Dumont Wouter Siemens	Netherlands Enterprise Agency Netherlands Energy Agency
Sweden	Jonas Ammenberg Mats Eklund	Linköping University Linköping University
Switzerland	Urs Baier	ZHAW Zürcher Hochschule für Angewandte Wissenschaften
United Kingdom	Clare Lukehurst Charles Banks	Probiogas UK University of Southampton

TASK 39 – Commercialising Conventional and Advanced Transport Biofuels from Biomass and Other Renewable Feedstocks

Operating Agent: Alex McLeod, Natural Resources Canada, Canada.
For contacts see Appendix 7.

Task Leader: Jim McMillan, NREL, United States of America. For contacts see Appendix 6.

Associate Task Leader: Jack Saddler, University of British Columbia, Canada.

The Task is organised with 'National Teams' in the participating countries. The contact persons for 2019 (National Team Leader) in each country are listed below, and an up-to-date list can be found at <http://task39.ieabioenergy.com/about/experts/>.

Country	National Team Leader	Institution
Australia	Steve Rogers	Licella
Austria	Dina Bacovsky	Bioenergy and Sustainable Technologies GmbH
Brazil	Glaucia Mendes Souza	University of São Paulo and FAPESP Bioenergy Program BIOEN
Canada	Jack Saddler	University of British Columbia
Denmark	Henning Jørgensen Michael Persson Sune Tjalfe Thomsen	University of Copenhagen Danish Bioenergy Association University of Copenhagen
European Commission	Adrian O'Connell Laura Lonza	Joint Research Centre, European Commission
Germany	Franziska Mueller-Langer Nicolaus Dahmen	Deutsches Biomasseforschungszentrum (DBFZ) Karlsruhe Institute of Technology
India	TBA	TBA
Ireland	Stephen Dooley	University of Dublin
Japan	Shiro Saka Yuta Shibahara	Kyoto University New Energy and Industry Technology Development Organization
The Netherlands	Paul Sinnige Timo Gerlagh Johan van Doessum	Netherlands Enterprise Agency Netherlands Enterprise Agency DSM
New Zealand	Paul Bennett	Scion
Norway	Duncan Akporiaye	SINTEF Industry
South Korea	Jin Suk Lee Kyu Young Kang	Korean Institute of Energy Research Dongguk University
Sweden	Tomas Ekbohm Leif Jonsson	Swedish Bioenergy Association Umea University
USA	Jim McMillan	NREL

TASK 40 – Deployment of biobased value chains

Operating Agent: Birger Kerckow, Fachagentur Nachwachsende Rohstoffe e.V. (FNR), Germany. For contacts see Appendix 7.

Task Leader: Uwe R. Fritsche, IINAS, Germany. For contacts see Appendix 6.

Co-Task Leader: Christiane Hennig, DBFZ (Germany), Olle Olsson, SEI (Sweden)

Task Secretary: Nora Lange, DBFZ, Germany.

The Task is organised with 'National Teams' in the participating countries. The contact persons for 2019 (National Team Leader) in each country are listed below, and an up-to-date list can be found at <http://task40.ieabioenergy.com/>

Country	Name	Org	Role
Belgium	Ruben Guisson	VITO	NTL
Denmark	Christian Bang	EA Energy Analyses	NTL
Germany	Christiane Hennig	DBFZ	NTL and WP3 Lead
Germany	Nora Lange	DBFZ	Task Secretary
Germany	Daniela Thrän	DBFZ/UFZ	Alternate NTL
Germany	Uwe R. Fritsche	IINAS	TL
Germany	Birger Kerckow	FNR	Operating Agent
Japan	Hiroyuki Asano	NEDO	NTL
Netherlands	Ric Hoefnagels	Copernicus Institute	NTL
Netherlands	Ronald Zwart	RWE	industry
Sweden	Olle Olsson	SEI	NTL and WP2 Lead
USA	Richard Hess	INL	NTL
USA	Chenlin Li	INL	Alternate NTL

TASK 42 – Biorefining in a Circular Economy

- Operating Agent:** Kees Kwant, NL Enterprise Agency, Ministry of Economic Affairs, The Netherlands. For contacts see Appendix 7.
- Task Leader:** Bert Annevelink, Wageningen Food and Bio-based Research, The Netherlands. For contacts see Appendix 6.
- Assistant Task Leader:** Ed de Jong, Avantium Technologies B.V., The Netherlands.
Michael Mandl, tbw Research GesmbH, Austria.
- Secretariat:** Wageningen UR, +31-317481165, secretariaat.bbp@wur.nl

The Task is organised with 'National Teams' in the participating countries. The contact persons for 2019 (National Team Leader) in each country are listed below, an up-to-date list can be found on <http://task42.ieabioenergy.com/>

Country	National Team Leader	Institution
Australia	Geoff Bell	Microbiogen Pty Ltd
Austria	Michael Mandl Johannes Lindorfer	tbw Research GesmbH Energie Institut an der Johannes Kepler Universität Linz
Denmark	Franziska Hesser Henning Jorgensen	WoodKplus University of Copenhagen
Germany	Solange I. Mussatto Heinz Stichnothe	DTU Biosustain Thünen-Institute of Agricultural Technology
Italy	Isabella de Bari Vincenzo Motola	ENEA C.R. TRISAIA ENEA C.R. ISPRA
Ireland	J.J. Leahy	University of Limerick
Netherlands	Bert Annevelink Ed de Jong René van Ree	Wageningen Food and Biobased Research Avantium B.V. Wageningen Food and Biobased Research
Sweden	Johanna Mossberg	RISE Research Institutes of Sweden (RISE Innventia AB)

TASK 43 – Sustainable biomass supply integration for bioenergy within the broader bioeconomy

Operating Agent: Shahana McKenzie, Bioenergy Australia, Australia. For contacts see Appendix 7.

Task Leader: Professor Mark Brown, University of the Sunshine Coast, Australia. For contacts see Appendix 6.

Deputy Task Leader: Ioannis Dimitriou, SLU, Sweden

Work Package Leaders: Biljana Kulisic – Work Package 1 Leader, Croatia
Évelyne Thiffault – Work Package 2 Leader, Canada

The Task is organised with 'National Teams' in the participating countries. The contact persons for 2019 (National Team Leader) in each country are listed below, an up-to-date list can be found on <http://task43.ieabioenergy.com/>

Country	National Team Leader	Institution
Australia	Mark Brown	University of the Sunshine Coast
Belgium	Lucas Gossiaux	ValBiom
Canada	Daniel Mazerolle	Natural Resources Canada
	Bruno Gagnon	Natural Resources Canada
Croatia	Biljana Kulišić	Energy Institute Hrvoje Požar
Finland	Johanna Routa	Natural Resources Institute Finland
Germany	Jörg Schweinle	Thünen Institute of International Forestry and Forest Economics
Sweden	Ioannis Dimitriou	Swedish University of Agricultural Sciences
	Dan Bergström	Swedish University of Agricultural Sciences
USA	Tomas Schuler	USDA Forest Service

TASK 44 – Flexible Bioenergy and System Integration

Operating Agent: Antti Arasto, VTT Technical Research Centre of Finland Ltd., Finland. For contacts see Appendix 7.

Task Leader: Dr Ilkka Hannula, VTT Technical Research Centre of Finland Ltd., Finland. For contacts see Appendix 6.

Assistant Task Leader: Prof Dr-Ing Daniela Thrän, Helmholtz Centre for Environmental Research – UFZ, Germany

Work Package Leaders: Tilman Schildhauer (Switzerland)
Daniela Thrän (Germany)
Ilkka Hannula (Finland)

The Task is organised with 'National Teams' in the participating countries. The contact persons for 2019 (National Team Leader) in each country are listed below, an up-to-date list can be found on <http://task44.ieabioenergy.com/>

Country	National Team Leader	Institution
Australia	Amy Philbrook	ARENA
Austria	Erns Höftberger	BEST
Finland	Ilkka Hannula	VTT
Germany	Daniela Thrän	UFZ
Ireland	Brian O'gallachoir	UCC
The Netherlands	Sjaak van Loo	TNO
Sweden	Karolina Norbeck	Svebio
Switzerland	Tilman Schildhauer	PSI
USA	Ian Rowe	USDOE

TASK 45 – Climate and Sustainability Effects of Bioenergy within the broader Bioeconomy

Operating Agent: Mr Jonas Lindmark, Swedish Energy Agency (STEM), Sweden.
For contacts see Appendix 7.

Task Leader: Professor Göran Berndes, Chalmers University of Technology, Sweden. For contacts see Appendix 6.

Work Package Leaders: Annette Cowie (Australia)
Floor van der Hilst (The Netherlands)
Uwe Fritsche (Germany)

The Task is organised with 'National Teams' in the participating countries. The contact persons for 2019 (National Team Leader) in each country are listed below, an up-to-date list can be found on <http://task45.ieabioenergy.com/>

Country	National Team Leader	Institution
Australia	Annette Cowie	NSW Department of Primary Industries
Brazil	Glaucia Souza	University of Sao Paulo
Denmark	Niclas Scott Bentsen	University of Copenhagen
Finland	Kati Koponen	VTT
France	Miriam Buitrago	ADEME
Germany	Stefan Majer	DBFZ
Ireland	Rory Monaghan	National University of Ireland
The Netherlands	Peter-Paul Schouwenberg	RWE
Norway	Francesco Cherubini	NTNU
Sweden	Gustaf Egnell	Swedish University of Agricultural Sciences
United Kingdom	Zoe M. Harris	Imperial College London
USA	Alicia Lindauer	US DOE

APPENDIX 6: OPERATING AGENTS AND TASK LEADERS

Operating Agent Task 32: Denmark

(duration 1 January 2019-31 December 2021)

OA: Ms Annika Fischer

TL Morten Tony Hansen

Ea Energy Analyses
Gammel Torv 8, 6. Sal
DK-1457 Copenhagen
DENMARK

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Current ExCo Members and Alternates are listed at <https://www.ieabioenergy.com/directory/executive-committee/>

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