Technology Collaboration Programme
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Task 34

Direct Thermochemical Liquefaction

Triennium 2016-2018

IEA Bioenergy

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IEA Bioenergy

Task 34
Direct Thermochemical Liquefaction

Prepared by:

Alan Zacher, Task Leader, Pacific Northwest National Laboratory

Operating Agent:

Jim Spaeth, US DoE, USA

Participating countries:

Canada, Finland, Germany, The Netherlands, New Zealand, Sweden, United States of America

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Introduction

This represents the final report of Task 34 on Direct Thermochemical Liquefaction of IEA Bioenergy. This report covers the triennium 2016-2018. Supplementary to this report is the progress reports provided to ExCo78-82 during the triennium.

The objective of the Task in this triennium was to consider the field of direct thermochemical liquefaction (DTL) technologies for biomass (both fast pyrolysis and hydrothermal liquefaction) and the upgrading of the products to liquid fuels in order to identify both technical and non-technical barriers to more rapid and wider spread implementation of the technologies. The activities of the Task focused on information exchange, technology review and technology implementation issues and opportunities. There has been considerable historical success in interaction between group participants in assessments and Round Robins; and these played leading roles in the Task this triennium.

The structure of Task 34 has been successful as an expert network of active technical scientists and industrialists in biomass liquefaction with overlapping spheres of influence including technology, policy, standards, and commercialisation. This has resulted in promoting productive technical exchanges among the national team leads, attracting active industrialists to meetings, and encouraging information exchange with local stakeholders in member countries as a side event to most Task meetings.

Table 1: Priority Topics for Task 34 (2016-2018)

Support commercialisation through standards development
Validate applicable analytical methods for bio-oil product evaluation
Facilitate information exchange with stakeholders
Support techno-economic assessment of liquefaction technologies

A more detailed overview of these topics is provided below.

Background

Originally, Task 34 focused on fast pyrolysis of biomass, which has historically been considered as the exclusive mainstream pathway for direct thermochemical liquefaction of biomass into a liquefied energy carrier, known as bio-oil. The process consists of a technically simple, flash thermal depolymerisation of biomass in a relatively dry, non-oxidising atmosphere.

However, due to advances in research and technology, solvent liquefaction has emerged as a viable process for producing a liquefied energy carrier. The Task was expanded in 2016 to include solvent liquefaction technologies, as pyrolysis and solvent liquefaction are closely related technologies. Solvent liquefaction can be thought of as "pyrolysis performed in a liquid solvent." The product of solvent liquefaction, known as bio-crude, shares some of the qualities and challenges of bio-oil as an energy carrier. Thus the technical alignment of pyrolysis and solvent liquefaction revealed that there would be research synergies to be had by expanding the focus of the Task to include the multiple paths to direct thermochemical liquefactions even though not all member countries are equally aligned in both.

The Task is respected in the international community for making contributions to the science, technology and understanding of biomass fast pyrolysis to liquids through the PyNe Newsletter, the website, publications and the many meetings and activities over the past 20 years.

Thus the efforts of Task 34 for the 2016 to 2018 triennium were aligned to advance the commercialisation and implementation of pyrolysis technologies and leverage that experience and momentum to advance solvent liquefaction approaches.

The Task continued to emphasise fast pyrolysis of biomass focusing on markets and technology implementation, including upgrading, in order to support those involved in commercialising and utilising fast pyrolysis for production of fuel oil and transportation fuels. In addition, the more recent developments in solvo- and hydrothermal-liquefaction, alternative biomass liquefaction technologies, were included in the information exchange.

For this new iteration of Task 34, the work programme was similar to that of the previous Task 34, however with more emphasis on leveraging the synergy between the parallel routes of DTL to identify and discuss barriers to commercialisation of liquid fuel production of biomass. The initial plan for this triennium was proposed in 2015 and iteratively revised in preparation for the new triennium anticipating changes in the member countries. For the start of the new triennium in 2016, the UK and Norway withdrew, while New Zealand and Canada joined the Task.

Challenges for further market deployment

The overall objective of the Task is to facilitate commercialisation of liquid fuels from biomass and particularly fast pyrolysis and hydrothermal processing to maximise liquid product yield and production of renewable fuel oil and transportation fuels. The Task aimed to contribute to the resolution of critical technical areas and disseminating relevant information particularly to industry and policy makers. The scope of the Task is to monitor, review, and contribute to the resolution of issues that will permit more successful and more rapid implementation of biomass 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 byproduct. 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 addressed the concerns and expectations of the following:

- 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 was actively encouraged to be involved as Task participants, as contributors to events and publications. This involvement was a key factor in the value of the Task outputs as industrial involvement was high, including regular meeting participation by two of the leading industrial developers for fast pyrolysis of biomass with attendance at one of the Task meetings by the third.

Task objectives and work carried out

1. MEETINGS http://task34.ieabioenergy.com/meetings/

Task meetings were held twice a year at approximately 6 month intervals. Each meeting consisted of a regular Task business meeting but was often co-located with one or more of the following: workshops, seminars, technical tours, ExCo meetings, and/or IEA Bioenergy themed or sponsored conferences.

Workshops gather together research stakeholders to discuss current research, suggest ideas and approaches by national team leads, and to identify the technology barriers as identified by those actively doing research. Seminars featured speakers with an emphasis on industrial and commercial organisations. Technical tours encompassed both of these approaches. The conference involvements sought to communicate these findings to the greater stakeholder community. This approach successfully resulted in an excellent two-way interaction between

participants of the Task and external organisations. Each meeting devoted a portion of the session to country reports to facilitate exchange of research developments among the participants. The meetings were open to participation from those countries participating in the Task and usually included a number of visitors, in addition to participation by ExCo representatives.

Date	Location(s)	Related Events held ne
13-15 June 2016	Luleå/Piteå, Sweden	- Bothnia Bioindustries Cluster (BOBIC) Workshop in Piteå. (Task meeting and BOBIC Workshop were cancelled/ postponed due to airline strike in Sweden)
7-10 Nov. 2016	Rotorua New Zealand	- IEA Bioenergy ExCo78 Workshop - ExCo78 - ABRN Science Symposium: International Biofuels Developments - Technical tours at Scion
15-19 May 2017	Luleå/Piteå, Sweden Gothenburg, Sweden	- Bothnia Bioindustries Cluster (BOBIC) Workshop in Piteå - Technical Tours at RISE, LTU GreenFuels, SunPine, PREEM, Volvo, and Södra - ExCo79 - Task 34 Session at Advanced Biofuels Conference

Date	Location(s)	Related Events held ne
28 Nov – 2 Dec 2017	Ottawa, Canada	- Bioenergy for the Future, Mission Innovation Seminar - Scaling Up 2017 conference - Direct Thermochemical Liquefaction Workshop - Analytical Workshop - Technical Tours at CanmentENERGY
22-25 May 2018	Enschede, the Netherlands Karlsruhe, Germany	- Technical Tours at BtG-BtL, Empyro, and FrieslandCampina in the Netherlands. - Technical Tours at Fraunhoffer UMSICHT, Pyreg, and Karlsruhe Institute of Technology, Germany
4-9 Nov 2018	Richland, WA, USA San Francisco, CA, USA	- Technical Tours of Pacific Northwest National Lab and Washington State University - ExCo82 in San Francisco, CA - ABLC Global 2018 / IEA Bioenergy Conference

2. PUBLICATION OF THE RESULTS FROM THE ROUND ROBIN ON FAST PYROLYSIS BIO-OIL PRODUCTION

Manuscript of the Task 34 Round Robin on Fast Pyrolysis Bio-oil Production was completed and published in Energy and Fuel. The report is available to journal subscribers at Energy Fuels 2017, 31, 5, 5111-5119. https://pubs.acs.org/doi/abs/10.1021/acs.energyfuels.6b03502.

However, in order to facilitate dissemination to a wider audience, a 2-page summary was prepared and is available publicly and without condition on the Task 34 and IEA Bioenergy websites.

The manuscript and 2-pager summarises the work of fifteen laboratories in six different countries converting three different biomass samples into bio-oils via fast pyrolysis. Samples of the bio-oil were analysed at a central laboratory to validate the pyrolysis community understanding of production of fast pyrolysis bio-oil by providing a common feedstock for bio-oil preparation. The results showed that the bio-oil products were fairly consistent when produced in a fluidised bed fast pyrolysis system, while other reactor configurations produced products with somewhat different properties.

The results of the Round Robin were drafted into a technical journal manuscript under the authorship of the Task members. By this round robin, the research community could learn about the consistency of the bio-oil produced in the participating laboratories, and the participating laboratories could learn how their products compare to those produced elsewhere without the complication of feedstock effects.

3. ROUND ROBIN FOR ANALYSIS METHODS OF BIO-OILS AND BIO-CRUDES

A Round Robin was organised to compare existing methods for bio-oil analyses and extend those methods to bio-crude analysis. This was selected based on the need for bio-crude analyses and recommendations from prior rounds robin. A summary evaluation of the historical Analytical Rounds Robin was prepared to examine the results of round robins over the last two decades that have been initiated by the Task. Specifically, the summary looked for needs and gaps that were identified and recommended for future evaluation. This was combined with recommendations from current and prior Task members, with special input from Anja Oasmaa at VTT, and presented to the Analytical Workshop in Ottawa in 2017 that was held adjacent to the Task 34 meeting. This input was used to refine the approach. Additionally, participants in the Analytical Workshop helped develop laboratory instructions and handling requirements using examples from a successful recent bio-oil round robin that was found to be useful in maintaining consistency among laboratories for handling and reporting.

For oil selection, Task members approached a wide variety of oil manufacturers and research institutions with large and mature programmes, in order to select oils that would have a better chance of representing consistent oils. Ultimately, the oils selected for this study included both pyrolysis and solvent liquefaction oils as consistent with the current focus of the Task and this round robin. They were obtained from a variety of major manufacturers or larger scale research production sources to minimise the presence of less representative or less consistent oils in the batch to be sent out.

Identical sets containing all oils were sent to participating laboratories in 2018. The oils shipped were 8 different liquefied biomass samples along with one blind replicate. The oils were provided in 20ml aliquots which were anonymised such that individual manufacturers would not be identified in the study nor would the blind blank be easily identified. Differential handling

instructions were specified for certain oils, which would provide some information that could be used to un-blind the liquefaction technology, but not the manufacturer.

There were a variety of countries represented, as well as experience with handling and analyses of thermochemical oils. While nearly all of the laboratories were familiar with prior IEA Bioenergy techniques and analyses recommendations for pyrolysis oils, and have participated in prior IEA Bioenergy interactions, some were not as familiar and experienced challenges in oil handling. This information will be valuable in providing guidance to pioneer adopters as likely areas that need education when handling biomass derived materials for use in heating and power. It should be noted that the experience base of these analytical laboratories is not as wide for hydrothermal liquefaction and solvo-thermal liquefaction oils.

Initial findings for the Round Robin were presented at the IEA Bioenergy Conference 2018 adjacent to ABLC Global 2018. The results of the Round Robin were drafted into a draft manuscript by Task members and will be published in 2019.

4. BIO-OIL STANDARDISATION

Member countries of the Task, with input as needed from Task members, have continued to support the implementation of standard methods for the use of bio-oil. A summary of these efforts has been presented in the PyNe42 Task newsletter published in 2018, including inputs to CEN (European Committee for Standardisation) and to ASTM (American Society for Testing and Materials). Specifically, the continued development of the CEN standard EN 16900:2017 by Working Group 41 under CEN Technical Committee 19. This is a complementary effort to the now approved ASTM standard D7544 for fast pyrolysis bio-oils. This has resulted in a technical report with identified future actions in working towards establishing the standard, as well as efforts towards providing data for a potential HTL standard and REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) dossier. In other ASTM standards, participants in member countries were also working towards a carbonyl analytical standard for bio-oils E3146-17. Further details on the efforts are described in the PyNe42 issue where summaries have been published

5. INDUSTRY INTERACTIONS

Growth of the bio-oil and bio-crude industry has been significant over the last few years. For many years, the activity in this area has been at a research level. This triennium saw more companies becoming interested in the potential of producing and using a biomass derived liquid fuel, with applications in multiple countries being established. There has been extensive interest by industrialists in the fast pyrolysis seminars, and this interest continued to develop over the triennium as commercial fast pyrolysis plants enjoyed active heat and power applications in Canada, Finland and the Netherlands. National team leads in these countries play active roles in aiding commercialisation efforts in their countries while maintaining requisite confidentiality. Additionally, startups for hydrothermal liquefaction have appeared in the USA, Denmark, and Australia. Of these, the USA is a member of the Task and efforts have continued to encourage Denmark and Australia in similar interactions.

6. PYNE NEWSLETTER http://task34.ieabioenergy.com/iea-publications/newsletters/

The new newsletter was published approximately twice a year in electronic format. Articles and information were gathered from the Task participants to feature research and commercialisation efforts in member countries and contacts throughout the world. The article count ranged from 8 to

12 articles per issue, and technologies represented included a mixture of pyrolysis and solvent liquefaction applications focused on use of the product as an energy carrier, chemical source, and intermediate for derivative fuels and chemicals. The technology readiness level of the topics ranged across fundamental research, applied research, and commercialisation efforts. In addition, there were updates on outputs including analytical methods, CEN, REACH, and ASTM standardisation efforts.

This triennium, the newsletter and webpage underwent a major transition. For the past 20 years, Tony Bridgwater at Aston University in the UK had published the PyNe newsletter and managed the PyNe website initially under the European Pyrolysis Network (PyNE), which had become the de facto face and primary outreach vehicle of Task 34. In 2016, Task 34 was given the opportunity by ExCo to re-establish Task 34 on the IEA Bioenergy servers, and to perform the newsletter functions internally rather than contracting with non-member countries. Aston graciously agreed that the PyNe identity should remain with Task 34 and the international network. In the interim, the PyNe editorial and website management duties were performed this triennium by the Task leader in addition to management of the Task. While there were many benefits to the transition, a significant challenge was that the large Task 34 network mailing list that had been built up over 20 years could not be transferred from Aston to another entity due to internet privacy concerns. Thus, the mailing list had to be rebuilt from scratch during this triennium resulting in a loss of continuity for many members of the international network. In order to correct this, the mailing list has been rebuilt on a 3rd party platform accessible to any member of Task 34 such that future transitions of editorship would avoid this disruption. This also included establishing the PyNeEditor@gmail.com account to serve as the primary contact account for the newsletter and to ensure a consistent contact vehicle during future transitions of the PyNe editorial duties.

As such, by the end of the triennium, a new newsletter template was created, a new mailing list established, a new editorial contact was created, and the continuity of the newsletter remained.

7. PYNE WEBSITE http://task34.ieabioenergy.com/

The website was maintained during the triennium as the primary information vehicle for interactions with Task 34 and the national team leads. As with the PyNe newsletter, the website was transitioned to the IEA Bioenergy servers away from the Pyne.co.uk site where it had resided for more than 20 years. The transition offered an opportunity to update the information to include both pyrolysis and solvent liquefaction topics to reflect the expansion of the Task this triennium. The transition occurred over the 3 years of the triennium, due to the large amount of information that had to be transferred on the site, in addition to updating a wide variety of links and deep-linked images. While there was some community confusion during the period where two separate PyNe websites were present on the search engines, midway through Aston was able to take down the old PyNe site and leave behind a temporary redirect to aid in the transition.

In 2018, the Task directed the Task Lead to perform a major overhaul of the information, links and resources. To fully align with the expansion of the Task technologies this triennium, a complete rewrite of the site was completed. During the overhaul, a new template for every page was established that leads with key summary points, hyperlinks to current examples (both onsite and offsite), and hyperlinks adding reading links to Task 34 publications. The original template shut out non-technical stakeholders, as it relied significantly on text and was geared for a research audience with a familiarity with the technologies. The new template will appeal to stakeholders of any level of experience with direct thermochemical liquefaction. The site allows for both casual and deeper browsing.

Additionally, the update included the creation of new content to provide current reference

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

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

8. DIRECT THERMOCHEMICAL LIQUEFACTION BROCHURE http://task34.ieabioenergy.com/liquefaction-technology/

The deliverable for an updated paper brochure was been replaced with a web-interactive electronic brochure as part of the PyNe website. This was determined to be the best use of Task resources based on three factors: 1) Technology, 2) Flexibility, and 2) Avoids duplication of effort that results in contradictory references over time.

It became apparent that this approach was necessary, as website analytics proved that the static pdf-based brochure on the Task 34 website was rarely, if ever, accessed. Conversely, the pages containing web-based content of similar information in the brochure were most frequently accessed.

Thus, as part of earlier Task activities towards bringing in the new focus on multiple liquefaction routes, instead of merely pyrolysis, a new framework was established to demonstrate the similarities and differences among these routes to a liquid energy carrier, The new framework was established in graphical format to show the operations from biomass to energy and end products, showing harmonisations and differentiations among the direct thermochemical liquefaction routes. The primary graphic became the front of the E-brochure and was rendered as a clickable index. This brochure front deep-links into new and existing pages within the Task 34 site and serves as a contextual interface to the information.

This has three primary advantages.

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

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

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

Thus, it was decided to expend the resources originally slated for the brochure on the website

making the Task efforts and the dissemination of data more efficient and timely.

Conclusions and recommendations

Through this transition period in changing marketplace of thermally liquefied biomass as an energy carrier, Task 34 has continued to play an active role in supporting the market penetration of multiple liquefaction routes including hydrothermal liquefaction and fast pyrolysis of biomass to produce bio-crudes and bio-oils.

A number of commercialised startups and commercialisation expansions have been demonstrated worldwide for multiple routes to liquefied energy carriers, and most of them have routine interactions with Task 34 members and member countries. These include expansions led by Ensyn, btg-btl, and Fortum, as well as startups such as Steeper, Lycella, and Genifuel.

The support has included major roles in standards development, organisation of round robins to validate important bio-oil analytical methods; and providing a source of useful information to interested parties who might want to get involved in thermal liquefaction. The Task has successfully disseminated the results of their work in technical journals and on the Task website. Further the Task has provided thought leadership in informing the technical community through organisation and participation in workshops and conferences alongside industrial participants in the field. This includes interactions, guidance, and information sharing with researchers who are actively participating, or engaging in important research topics that will continue to overcome barriers to wider adoption of thermally liquefied biomass as energy carriers.

Attachments

PARTICIPATION IN MAJOR EVENTS

Marine and Aviation Fuels Workshop, IEA Bioenergy ExCo78, 9 Nov 2016. Rotorua, New Zealand

ABRN Science Symposium: International Biofuels Developments, 10 Nov 2016, Rotorua, New Zealand

Bothnia Bioindustries Cluster (BOBIC) Workshop, 16 May 2017, Piteå, Sweden

Advanced Biofuels Conference, 17-19 May 2017, Gothenburg, Sweden

Forum on Hydrothermal Processes 2017, 12-13 Sep 2017, Germany

Tcbiomass2017, 19-21 Sep 2017, Chicago, IL, USA

Bioenergy for the Future, Mission Innovation IEA Bioenergy, 27 Nov 2017, Ottawa, Canada

Scaling Up 2017, 27-29 Nov 2017, Ottawa, Canada

Direct Thermochemical Liquefaction and Analytical Workshop, 1-2 Dec 2017, Ottawa, Canada

26th European Biomass Conference and Exhibition 2018, 14-18 May 2018, Copenhagen, Denmark

IEA Bioenergy Conference 2018, 7 Dec 2018, San Francisco, USA

ABLC Global 2018, 8-9 Dec 2018, San Francisco, USA

DELIVERABLES FOR 2016-2018

Deliverable	Link	Notes
Publication of 2015 Round Robin for Fast Pyrolysis Bio-Oil Production	https://pubs.acs.org/doi/abs/10.1021/acs.energyfuels.6b03502	Publication carried over from prior triennium.
2-page Stakeholder Summary of 2015 Round Robin	https://www.ieabioenergy.com/wp-content/uploads/2018/02/Two-page-summary-%E2%80%93-Round-Robin-on-Fast-Pyrolysis-Bio-oil-Production.pdf	2-pager to summarise above publication for stakeholders without journal access

Deliverable	Link	Notes
Task Meetings	http://task34.ieabioenergy.com/meetings/	The Task met two times in each of the three years (except 2016) and minutes were prepared, reviewed and distributed.
PyNe Newsletters	PyNe 39 http://task34.ieabioenergy.com/publications/issue-39-task-34-newsletter/ PyNe 40 http://task34.ieabioenergy.com/publications/pyne-40-march-2017/ PyNe 41 http://task34.ieabioenergy.com/publications/pyne-41-december-2017/ PyNe 42 http://task34.ieabioenergy.com/publications/pyne-october-2018/ PyNe 43 http://task34.ieabioenergy.com/publications/pyne-43-january-2019/ PyNe Archives: http://task34.ieabioenergy.com/iea-publications/newsletters/	Newsletter electronically published on research, standards development, advances, and commercialisation efforts in direct thermochemical liquefaction.
Proceedings from Analytical Workshop of Liquefaction Oils	http://task34.ieabioenergy.com/wp-content/uploads/2019/01/IEA-T34-Bio-oil-and-Bio-crude-Characterization-Workshop_December-1-2017.pdf	Ottawa, Canada in 2017
Proceedings from Liquefaction Workshop	http://task34.ieabioenergy.com/wp-content/uploads/2019/01/IEA-T34-Biomass-Liquefaction-Workshop_November-30-2017-v2.pdf	Ottawa, Canada in 2017

Deliverable	Link	Notes
Website Overhaul	http://task34.ieabioenergy.com/	In addition to regular improvements as needed the website was transferred from the prior host on Aston servers (http://www.pyne.co.uk) to the IEA Bioenergy servers. In 2018, the website underwent a major overhaul of content, added summaries and hyperlinks to current news for all content, and created new content for hydro- and solvo-liquefaction structure and resources similar to the information on pyrolysis, which was the original focus of the Task
E-Brochure on Direct Thermochemical Liquefaction	http://task34.ieabioenergy.com/liquefaction-technology/	Brochure deliverable was commissioned as a "living web-brochure" in order to allow for the flexibility of quick, targeted updates of fresh content as it is developed.
2018 Round Robin on Analytical of Bio-Oils and Bio-Crudes, initial findings	https://www.ieabioenergy.com/publications/iea-bioenergy-conference-2018/	Initial findings published at IEA Bioenergy Conference 2018 held as part of ABLC Global 2018
Manuscript on 2018 Round Robin on Analytics of Bio-Oils and Bio-Crudes	In draft, pending review and journal selection	Journal article on 2018 Round Robin findings. A 2-pager will be produced once published.
Annual reports to ExCo	Distributed by ExCo	Annual reports were presented at ExCo 78, 80, and 82 including progress description and budget information

Deliverable	Link	Notes
Progress reports to ExCo	Distributed by ExCo	Progress reports were prepared for ExCo 77, 79, and 81 including budget information and website statistics.
Task 34 Final Triennium Report	This document	Report on 2016-2018 Triennium

INDUSTRIAL PARTICIPATION

During this triennium, Task 34 has maintained strong connections to industrial leaders in thermal liquefaction of biomass.

Connections with BTG represent a direct link towards a successfully commercially operated fast pyrolysis plant in Europe, in Hengelo, Netherlands, which is maintained by Bert van de Beld of BTG.

Connections with the consortium in Finland including Valmet, Fortum, and VTT that opened a commercial biomass fast pyrolysis plant in Joensuu are maintained by Kristin Onarheim of VTT.

Connections with Ensyn, who has commercialised production of bio-oil in Canada with commercial use of fast pyrolysis oil as an energy carrier at a growing number of sites within the USA, are maintained by Fernando Preto of CanmetENERGY.

Connections with KIT who is piloting the Bioliq process for eventual commercialisation is maintained by Nicolaus Dahmen of KIT.

Connections with Genifuel, who is advised by PNNL and is piloting hydrothermal liquefaction for the production of bio-crudes is maintained by Alan Zacher of PNNL.

Routine interactions with Steeper and Lycella have been had by multiple Task members in seeking to provide information and guidance that may be of use to these commercialising enterprises.

The Task as a whole worked with and through many of these participants to address the commercialisation barriers. The Task supported the development in Europe of the CEN standard for bio-oil. The Task provided continuing input to the REACH registration process for bio-oil which was completed in the past triennium.

In addition, as part of Task 34 meetings, the Task maintained a presence in the seminars involving commercial stakeholders in Finland, Canada, and Netherlands.

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Further Information

IEA Bioenergy Website
www.ieabioenergy.com

Contact us:
www.ieabioenergy.com/contact-us/