IEA Bioenergy
Technology Collaboration Programme
Task 34

Newsletter
Direct Thermochemical Liquefaction

50

Jubilee PyNe – December 2021

50 PyNes in 25 years

This is a special jubilee PyNe – the 50th PyNe in the 25th year of its publication. We have to start this preface with some words from Alan Zacher, who lead Task 34 in the previous triennium and wrote this excellent statement in PyNe 40, which still holds true today:

> PyNe was born in 1996, coordinated by Tony Bridgwater out of Aston University. It is difficult to think of biomass pyrolysis without thinking about Tony, whose strong leadership in this area has shaped this history of pyrolysis research to where it stands today. PyNE was established in order to form a unified community out of activities supported by IEA Bioenergy as PYRA and the European Commission as PyNE. This original issue captures much of the excitement and promise of the pyrolysis community at that time. Its primary focus was to provide a forum for shaping the international dialogue on thermochemical liquefaction, identify research needs and priorities, encourage the active involvement of industry, and advance information dissemination and improve cooperation. History evidences the success of the original PyNE pioneers.

Stepping in this field just three years ago, we are mere newcomers and it is impossible to think of PyNe or the IEA Bioenergy Task 34 without also including the names of Anja Oasmaa, Douglas Elliott, Dietrich Meier, Stefan Czernik, Bert van de Beld, and many, many others.

These great people have paved the way to what PyNe, the Task and the community is and represents today. Surely, it is impossible to cover all aspects in this Jubilee PyNe, but by asking the people involved over decades to contribute yet again we hope to provide interesting insights into the history of PyNe that will never be lost.

As you are now reading this Jubilee PyNe, you'll get a glance of the rich pre-PyNe history dating back to the 1980's. You will also get more insight into one of the aspects of this network that created a huge impact for commercialization of fast pyrolysis: The development of analytics and standardization for fast pyrolysis bio-oil. You are also invite to explore with us numbers and figures belonging to PyNe and IEA Bioenergy Task 34. We hope you enjoy reading it as much as we enjoyed creating it!

Much to our regret, Tony Bridgwater was not able to contribute to this Jubilee PyNe and with him, one of the most influential persons of PyNe history is missing badly. Those of you who know him more closely will be aware how difficult it is for him not to be active part in this special occasion. Even more know his outstanding contribution to the field and we hope to continue learning from him!

Task 34 will continue in the upcoming triennium with many interesting work packages and we hope you continue the DTL journey together with us! There is still much to achieve to increase the use of bio-oil from direct thermochemical liquefaction, both by increasing the commercial implementation of production units and broadening added value use of the product(s).

Now it remains for us to say that we hope the next 25 years will be just as productive and good as the preceding 25 – surely we will do our best to fulfil our share in this endeavour.

Sincerly

Axel Funke — Task Lead

Alexandra Böhm — Task Assistant

Development of analytical methods and standardization

Anja Oasmaa[A] & Dietrich Meier[B]
[A] VTT Technical Research Centre of Finland Ltd, Finland
[B] thermophil international, Hamburg, Germany

Already in the 80s it was recognized that norms and standards for fast pyrolysis bio-oils (FPBO) are needed before they can enter into the market to replace natural gas, heating oil, or to be used in co-refining for higher value fuels.
It became also clear that standard analytical methods developed for mineral oils were not always suitable for bio-oils. The development of standards and norms was one of the key research topics of IEA (IEA Bioenergy sponsored Pyrolysis Activity, PYRA), the EU (the European Commission and IEA Bioenergy sponsored Pyrolysis Network, PyNe; EU sponsored ThermalNet), and present IEA Bioenergy Networks. Summary of the earlier work is presented as a series of pyrolysis handbooks.[1]

Development of test methods for FPBOs

VTT had strong background on measuring physical properties of liquid fuels for Finnish industry and therefore it was a logical consequence to test the applications of the standard methods developed for fossil oils also for bio-oils. Earlier IEA reports provided, for example, by Douglas Elliott (PNNL, USA), and Jim McKinley (BC Research) were included to the studies.

VTT provided guidelines and developed test and rapid characterization methods for FPBO since the 80s. IEA network provided an excellent platform to discuss on the validation of these methods. The test methods have been validated by several IEA round robins as co-operation within the IEA Pyrolysis Networks. These analytical test methods form the basis of present FPBO standards.[2]

Understanding the chemical composition of FPBOs

IWC (Institute of Wood Chemistry, Germany; later TI, Thünen Institute of Wood Research) has been the forerunner on developing quantitative determination of chemical compounds of various bio-oils. IWC has provided guidelines for accurate quantitative characterization of the FPBOs (Table 1) which was crucial, for example, to understand the stability behavior of FPBOs and to provide accurate data needed for REACH (Registration,

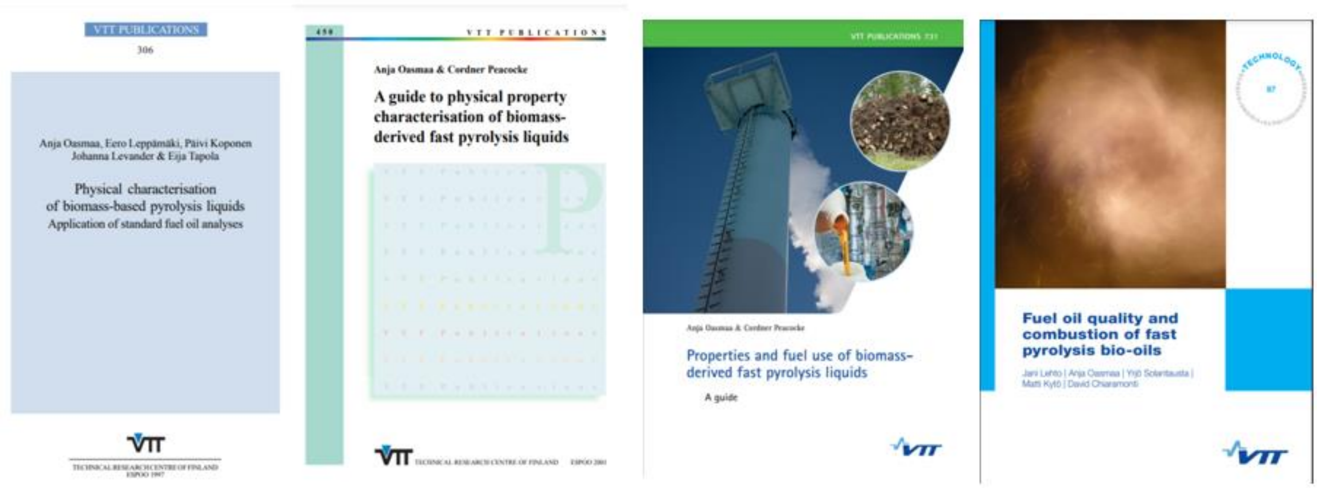


Fig. 1: Publications on properties of FPBOs.[2]

Evaluation and Authorization of Chemicals) registration.
Task 34 member Jan Piskorz (University of Waterloo, RTI, Canada) provided important insight in proceeding on understanding the nature of FPBOs.mVTT focused on developing fast chemical characterization of the whole FPBOs. Because of good co-operation these methods can be combined (Table 2). It was inevitable that VTT
and IWC would co-operate to increase the understanding of the overall physico-chemical composition of fast pyrolysis bio-oils. With good co-operation with the Task 34 researchers at NREL, especially James Diebold and Stefan Czernik, an accelerated stability test was developed and insight understanding of the storage stability of FPBOs was created. An excellent report ordered by IEA Task 34 was written by J Diebold. [3]

Norms and standards
The standardization of fast pyrolysis bio-oil as a fuel with CEN was initiated in early 2000. IEA Task 34 team was very active on this, published several papers, and participated as experts on standardization work. In 2007 a pyrolysis oil standard initiative for ASTM was initiated which led to a burner fuel standard ASTM D7544:2017. The European standard for the use of FPBO in large-scale industrial boilers (≥ 1 MWth) was obtained in 2017 (EN16900:2017). From the IEA Task 34 company representatives especially Steven Gust from Neste (Finland), Stefan Müller from Ensyn Ltd. (Canada), and Cordner Peacocke from PyroCore Ltd. (Ireland) were active on this. IEA Task 34 has been active in getting data for REACH registration of FPBO.

Task members got an EU Biotox project [4] to collect data needed for REACH registration. By coordination of Task 34 member Philippe Girard (CIRAD Forêt, France) data on toxicity of various pyrolysis oils was gathered early 2000.

Table 1. Conditions for GC/MS/FID analysis of FPBOs.[1*] Adapted from [1]

System	Description
Gas chromatograph	Hewlett Packard HP 6890, with microflow splitter
Mass selectiv detector	Hewlett Packard HP 5972
Autosampler	CTC Analytics (Combi Pal)
Carrier gas	Helium, constant flow
Column (medium polar)	Varian DB 1701, 60 m x 0,25 mm
	Film thickness: 0,25 µm
	Coating: 14 % - Cyanoprophylphenyl- 86%-dimethylsiloxan Copolymer
Injection Volume	1 µl
Split ration	1:15
Injector	250 °C
Flame ionization detector	280 °C
Ion source	140 °C
Ionization energy	70 eV
Oven programm	45 °C, 4 min. Hold 3°/min to 280 °C, 20 min. Hold
Data evaluation	MassFinder®

*IWC used two detectors in parallel, the MSD for identification and the FID for quantification of compounds. A 3-point calibration for about 60 substances was used and ca. 100 compounds have an assumed response factor based on their chemical structure. For cross validation a standard solution of 5 key compounds was used.

Table 2. Table combines the information on same FPBO samples using both solvent fractionation scheme at VTT and GC/MS at TI (Dr. D Meier). Adapted from [1]

Fast Pyrolysis Bio-Oils	Pine		Forest residue			
	Bottom 97 %		Bottom 89 %		Top 11 %	
	Wet	Dry	Wet	Dry	Wet	Dry
	w-%	w-%	w-%	w-%	w-%	w-%
Water	**23,9**	**0**	**24,4**	**0**	**19,5**	**0**
Acids	**4,3**	**5,6**	**3,3**	**4,4**	**6,4**	**7,9**
Formic acid		1,51		1,46		
Acetic acid		3,38		7,35		6,01
Propionic acid		0,2		0,18		0,18
Glycolic acid		0,55		0,33		
Alkohols	**0,23**	**0,93**	**0**	**0**	**0,16**	**0,20**
Methanol		0,63		0		0
Ethylene glycol		0,3		0		0,20
Aldehydes, ketones, furans, Pyrans	**17,4**	**22,3**	**20,4**	**27,0**	**12,8**	**15,9**
Acetaldehyde, hydroxy-		8,93		8,66		8,94
Propionaldehyde, 3-hydroxy		0,75		1,17		1,02
Hydroxypropanone (acetol)		2,84		2,55		2,25
Butanone, 1-hydroxy-2-		0,23		0,22		0,20
Butandial or Propanal		0,29		0,73		0,64
Cyclopentene-1-one 2-hydroxy-2-		0,84		0,21		0,19
Cyclopentene-3-one 2-hydroxy-1-methyl-1-		0,53		0,50		0,41
Furanone, 2(5H)		0,69		0,73		0,65
Furaldehyde 2-		0,54		0,67		0,55
Furaldehyde 5-(hydroxymethyl)- 2-		1,14		0,44		0,38
Pyran-4one 3-hydroxy-5,6-dihydro- (4H)-		0,72		1,38		1,18
Pyran-4-one 2 Hydroxymethyl-5-2,3-dihydro- (4H)-		0,39		0,14		0,12
Sugar type compounds	**34.4**	**45,3**	**28,8**	**38,1**	**21,9**	**27,1**
Anhydro-ß-D-arabino-furanose 1,5-		0,27		0,17		0,12
Anhydro-ß-D-xylofuranose 1,5-		0		0,33		0,31
Anhydro-ß-D-glucopyranose 1,4;3,6-		4,01		3,48		3,31
Dianhydro-a D-glucopyranose 1,4:3,6-		0,17		0,15		0,14
Cellobiosan		1,3		NA		NA
Cellotriosan		0,1		NA		NA
LMM lignin	**13,4**	**17,7**	**12,0**	**15,8**	**15,5**	**19,2**
Catechols		0,06		0,09		0,08
Lignin derived phenols		0,09		0,22		0,19
Guaiacol		0,52		0,28		0,25
Guaiacol 4-methyl		0,49		0,15		0,14
Guaiacol 4-prophenyl-(trans) (Isoeugenol)		0,40		0,12		0,13
Vanillin		0,50		0,23		0,21
Homovanillin (Phenylacetaldehyd, 4-hydroxy-3methoxy)		0,27		0,09		0,09
Acetoguaiacon (Phenylethanone, 4-hydroxy-3-methoxy)		0,22		0,09		0,08
Coniferaldehyde		0,26		0,05		0,04
Syringol		0		0,40		0,36
Syringol 4-methyl-		0		0,29		0,26
Syringol-4-allyl-		0		0,28		0,06
Syringol-4-(1-Propenyl)- trans		0		0,28		0,27
Syringaldehyd		0		0,41		0,37
Sinapaldehyde (trans)		0		0,57		0,54
HMM lignin	**1,95**	**2,6**	**4,3**	**5,6**	**7,6**	**9,5**
Extractives	**4,35**	**5,7**	**2,8**	**3,7**	**16,4**	**20,4**
Solids	**0,011**	**0,014**	**0,040**	**0,053**	**2,90**	**3,60**

Fig. 2 and 3: PyNe Meeting Montreal 1999

Later on IEA Task 34 ordered a work from PNNL toxicology experts to select the relevant data to proceed on REACH registration of FPBO. These data were forwarded to industrial REACH consortium to finalize the registration. [5]

Present and future

The IEA Bioenergy Task 34 has over years created a long-duration co-operation. While the country representatives were changing the good co-operation continued with the ex-members. Examples are the continuation of complementing the REACH registration, co-operation with method validation by IEA Round Robins, and continuation of standardization of FPBOs in various EU projects.

References

[1] Fast Pyrolysis of Biomass – A Handbook. By A Bridgwater, S Czernik, J Diebold, D Meier, A Oasmaa, C Peacocke, J Piskorz, D Radlein. Published in the UK by CPL Press: Aston University, Bioenergy Research Group, ISBN: 1 872691 07, 2 May 1999.
Fast Pyrolysis of Biomass – A Handbook Volume 2, Edited by A.V. Bridgwater.
Fast Pyrolysis of Biomass: A Handbook Volume 3, Edited by A.V. Bridgwater, ISBN: 1872691927, Publisher: CPL Press.
[2] Oasmaa, A., Lehto, J., Solantausta, Y. & Kallio, S., Historical Review on VTT Fast Pyrolysis Bio-oil Production and Upgrading. 2021, In: Energy and Fuels. 35, 7, p. 5683−5695
[3] J.P. Diebold. A Review of the Chemical and Physical Mechanisms of the Storage Stability of Fast Pyrolysis Bio-Oils, January 2000, NREL/SR-570-27613, https://www.nrel.gov/docs/fy00osti/27613.pdf
[4] BioTox Final Publishable Report, Apr 2017, https://task34.ieabioenergy.com/publications/biotox-final-publishable-report/
[5] Oasmaa, A., Van De Beld, B., Saari, P., Elliott, D. C. & Solantausta, Y., Norms, standards, and legislation for fast pyrolysis bio-oils from lignocellulosic biomass, 2015, In: Energy & Fuels. 29, 4, p. 2471-2484

Anja Oasmaa

VTT Technical Research Centre of Finland Ltd, Finland

Dietrich Meier

thermophil international, Hamburg, Germany

Early Development of the IEA Bioenergy Collaborative Activity on Biomass Liquefaction

Doug Elliott (dcelliott52@gmail.com) and Yrjö Solantausta (yrjo.solantausta@gmail.com)

One of the earliest collaborative activities within the International Energy Agreement was undertaken within the IEA Bioenergy predecessor organization, the IEA Forestry Energy Implementation Agreement. The effort was undertaken as Project D of Annex 1 with the title Biomass Liquefaction Test Facility (BLTF). The effort originated with discussions between Sweden and the U.S. related to the hydrothermal liquefaction of biomass for fuel oil production. The U.S. interest was based on the Albany Biomass Liquefaction Experimental Facility which had been in operation for a few years using Douglas fir wood as the feedstock. The Swedish interest was centered at the Royal Institute of Technology (RIT) in Stockholm and their work on peat liquefaction via similar hydrothermal processing. Early technical discussions in 1980 included a visit to the U.S. by RIT researcher Arne Kannel from Pehr Bjornbom's research group, who met with Doug Elliott at the Pacific Northwest Laboratory. Subsequent discussions led to Finland's interest to join a collaboration. In addition, Canada was home to the R&D effort on fast pyrolysis at the University of Waterloo under Don Scott's leadership and with Ralph Overend's input, it was agreed to include that technology along with Canada's membership in the collaboration. In the summer of 1981 potential participants in the Working Group, Arne Kannel (Sweden), Doug Elliott (USA), David Beckman (Canada), and Yrjö Solantausta and Pat McKeough (Finland) gathered in Sweden to meet with Bjorn Kjellström, the task leader proposed from Sweden, which acted as the Project Managing Agent. The meeting discussed how the task would be accomplished, as it was planned at that time to include the participants living in Sweden for a year to perform the analysis work.

During the subsequent year the specifics for the BLTF collaboration were refined. The work of the task was preceded in 1982 with a first meeting of the proposed Working Group in Denver, prior to the first IEA Forestry Energy-sponsored Fundamentals of Thermochemical Biomass Conversion conference in Estes Park, Colorado, in early October.[1] The conference witnessed the last presentation on the Albany operation as it was being shut-down. Other conference participants of note were Prof A.V. (Tony) Bridgwater from Aston University, UK, and James Kuester from Arizona State University, Tempe, Arizona, US. Bridgwater's work on biomass gasification was presented as was Kuester's, who marveled the attendees with his discussions of gasification with subsequent catalytic processing to a wide range of potential products. Bridgwater and Kuester subsequently collaborated on the second gathering of the Thermochemical Biomass Conversion research community, which was held in Phoenix, Arizona, US in 1988.[2]

The collaborative project, formally initiated July 1, 1983, was agreed to evaluate the potential to build a test facility to operate biomass liquefaction technologies, both hydrothermal and fast pyrolysis, at sufficient scale to facilitate the further scale-up and commercialization and include both wood and peat as potential feedstocks. The placement of the working group in Stockholm went forward only in the case of Canada and Sweden. The Finnish members would remain based in Espoo, Finland, at VTT (Technical Research Center of Finland) while the US participant would remain at his home laboratory in Richland, Washington, USA. Quarterly gatherings of the Working Group, to rotate through the four participating countries, were determined to serve as the main means of coordination of the efforts to be undertaken at the participants homes. In addition, through Arne Kannel's efforts, a "packet-switched-account" based means of electronic communication (a predecessor to e-mail) was established to encourage the trans-Atlantic communication over the 10 time zones of separation. This operation allowed messages to be entered into the Stockholm

University-based system and then subsequently accessed by other participants. In this way the Scandinavian-based researchers could enter information and questions during their day of operation, which would be available for the North American participant to access during their day of operation. This way a response from North America could be sent and received by the Scandinavians the following day.

Not quite live interaction, but much better than surface or air mail; however, data files could not be exchanged in this manner. By the end of the project the system had been expanded to allow "live conferencing" based on text entering similar to today's "chat" capability, albeit with a significant time lag.

Throughout 1983 the task Working Group members undertook an analysis of biomass liquefaction technologies under development within the participating countries. Information was gathered by interview and from the literature for vacuum pyrolysis, fast pyrolysis, super-critical extraction, solvolysis from Canada; information on recycle-oil liquefaction, as well as, water-based, single-pass hydrothermal liquefaction, sourced from the Albany operations in the U.S.; and peat liquefaction efforts in Sweden and Finland. Comparisons were also made of wood fed systems and peat-fed systems to identify the advantages and disadvantages of each.

Technologies for sewage sludge liquefaction were also reviewed. Following a year's effort including meetings in Richland in March, Stockholm (and Trosa) in June, and Trosa again in December, a 6-volume final report was completed and delivered in early 1984.

The final report, attached to a much-more-widely-available, single volume, Executive Summary document, [3] included volumes on Summary, Conclusions and Recommendations (I),[4] State of the Art of technologies (II),[5] Comparative Tests in participating laboratories using IEA-provided feedstocks (III), Analysis and Upgrading of the products from biomass liquefaction (IV),[6] Techno-Economic [7] liquefaction and catalyzed liquefaction, all Assessment (TEA) of selected technologies (V),[8] and Recommendations for future efforts (VI).[9] The TEA focused on the liquefaction in recycled wood oil, or with solvolysis pretreatment; fast pyrolysis of either wood or peat, and vacuum pyrolysis of wood and liquefaction of peat.

The design effort was supplemented by two additional Swedish participants, Anders Bergh and Anders Östman and support from Finland by Minna Nissilä. It was agreed that hydrothermal liquefaction and fast pyrolysis were sufficiently different that a single test processes of most interest and included facility to evaluate both would not be practical.

Fig. 1: BLTF Working Group 1983 - Solantausta, Kannel, Bergh, Beckman, Elliott, Kjellström, McKeough

After an interim period, the collaborative activity was restarted in 1986 as the Direct Biomass Liquefaction (DBL) task as part of a 3-yr cycle of IEA Biomass Agreement activities. The participating countries were the initial four, represented in the Working Group by Beckman-Canada, Solantausta-Finland, Östman-Sweden, and Elliott-US, under the leadership of Kjellström-Sweden and joined by Virve Tulenheimo-Finland, and Börje Gevert and Christina Hörnell-Sweden. As in the first activity, information exchange was the primary goal. A similar effort was made for technology assessment and design resulting in TEA for several improved technology approaches.[10] The final report for the effort[11] included TEA for a "present" case and a "future" case of "liquefaction in pressurized solvent" (LIPS) and "atmospheric fast pyrolysis" (AFP) as each was applied to a wood feedstock and a peat feedstock. A significant addition to these TEAs was including the assessment of hydrotreating technology for production of market blendable hydrocarbon liquid fuels.

In the next 3-yr cycle of IEA Biomass Agreement, a continuation of the collaboration was supported under the title of Assessment of Liquefaction and Pyrolysis Systems (ALPS) and the leadership of Finland (Solantausta). In this activity James Diebold served as the US representative and Elliott, following an interim appointment at VTT in the summer of 1989, served as the Finnish working group member. Beckman-Canada also continued and was joined by Tony Bridgwater as the UK working group member and initial support from Aldo Lucchesi -Italy , as the European Community representative. This task[12] included both an updated state of technology review[13] as well as TEAs.[14] The processes included in the techno-economic assessments were MANOIL (liquefaction of straw with a nickel metal catalyst) and ablative fast pyrolysis with zeolitic catalytic cracking to aromatic gasoline, both a present case and a future case. Chemical products from biomass liquefaction were also assessed, including formulation of a list of 115 components found in wood liquefaction and 63 found in peat liquefaction. A presentation was made on some of these results at the Thermochemical Biomass Conversion conference in Interlaken in 1992.[15] Following this 3-yr task, the IEA Bioenergy support was discontinued for several years and in the interim Tony Bridgwater initiated the PyNe (pyrolysis network) to continue the interaction on biomass pyrolysis. But that is a story for others to tell.

Fig. 2: ALPS Working Group 1991 – Elliott, Diebold, Solantausta, Beckman, Bridgwater

References:
[1] Fundamentals of Thermochemical Biomass Conversion, RP Overend, TA Milne, LK Mudge, eds. Elsevier Applied Science Publishers Ltd. Barking, UK 1985.
[2] Research in Thermochemical Biomass Conversion, AV Bridgwater, JL Kuester, eds. Elsevier Science Publishers Ltd. Barking, UK 1988.
[3] A Study of a Biomass Liquefaction Test Facility, Final Report of IEA C88ooperative Project Biomass Liquefaction Test Facility, Kjellström, B., (ed) (1985), Statens Energiverk R:1, Stockholm.
[4] D Elliott, IEA Co-Operative Project D1, Biomass Liquefaction Test Facility Project, Volume 4: Analysis and upgrading of biomass liquefaction products. DOE/NBM--1062 Vol. 4. National Technical Information Service: Springfield, Virginia, 1988.
[5] D Beckman, A Bergh, DC Elliott, A Kannel, IEA Co-Operative Project D1, Biomass Liquefaction Test Facility Project, Volume 2: State-of-the-Art Review. DOE/NBM--1062 Vol. 2. National Technical Information Service: Springfield, Virginia, 1988.
[6] D Beckman, D Elliott, Comparisons of the Yields and Properties of the Oil Products from Direct Thermochemical Biomass Liquefaction Processes, Canadian Journal of Chemical Engineering, Vol 63, pp. 99-104, 1985.
[7] B Kjellström, D Beckman, A Bergh, DC Elliott, A Kannel, P McKeough, M Nissilä, Y Solantausta, A Östman, IEA Co-Operative Project D1, Biomass Liquefaction Test Facility Project, Volume 1: Summary, Conclusions and Recommendations. December 1983.
[8] P McKeough, M Nissilä, Y Solantausta, D Beckman, A Östman, Techno-ecomonic assessment of direct biomass liquefaction processes. Final Report of IEA Cooperative Project Biomass Liquefaction Test Facility. Espoo: Technical Research Centre of Finland. 139 p. (VTT Research Reports 337), 1985.
[9] B Kjellström, D Beckman, DC Elliott, A Kannel, P McKeough, Y Solantausta, A Östman, IEA Co-Operative Project D1, Biomass Liquefaction Test Facility Project, Volume 6: Work Elements for Stage 2 of the Project, December 1983.
[10] DC Elliott, EG Baker, D Beckman, Y Solantausta, V Tulenheimo, B Gevert, C Hörnell, A Östman, B Kjellström, Technoeconomic Assessment of Direct Biomass Liquefaction to Transportation Fuels. Biomass, Vol 22, Nos 1-4, pp. 251-270 1990.
[11] D Beckman, DC Elliott, B Gevert, C Hörnell, B Kjellström, A Östman, Y Solantausta, V Tulenheimo, Techno-Economic Assessment of Selected Biomass Liquefaction Processes. Final Report of IEA Cooperative Project Direct Biomass Liquefaction. Espoo: Technical Research Centre of Finland. 169 p. + app. 95 p. (VTT Research Reports 697) 1990.
[12] Y Solantausta, JP Diebold, DC Elliott, T Bridgwater, D Beckman, Assessment of liquefaction and pyrolysis systems. Espoo: Technical Research Centre of Finland. 123 p.+ app. 79 p. (VTT Research Notes 1573) 1994.
[13] DC Elliott, D Beckman, A Bridgwater, JP Diebold, B Gevert, Y Solantausta, Developments in Direct Thermochemical Liquefaction of Biomass: 1983 - 1990. Energy & Fuels, Vol. 5, No. 3, p. 399 – 410 1991.
[14] Y Solantausta, D Beckman, A Bridgwater, J Diebold, D Elliott, Assessment of liquefaction and pyrolysis systems. Biomass & Bioenergy, Vol. 2, Nos 1-6, p. 279-297 1992.
[15] JP Diebold, A Bridgwater, D Beckman, DC Elliott, Y Solantausta IEA Technoeconomic Analysis of the Thermochemical Conversion of Biomass to Gasoline by the NREL Process. In: Advances in Thermochemical Biomass Conversion. AV Bridgwater, ed. Blackie Academic & Professional, Glasgow Vol. 2. pp. 1325 – 1342 1994.

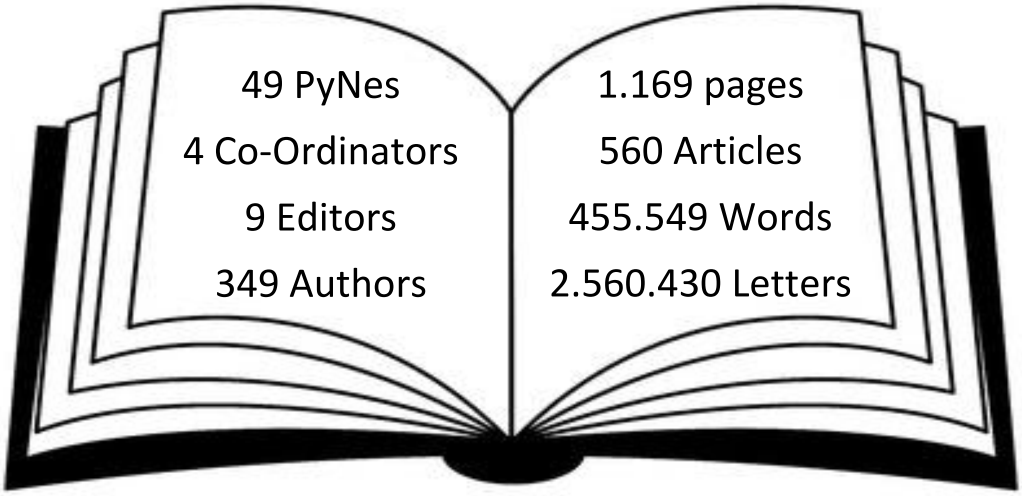
Douglas C. Elliott

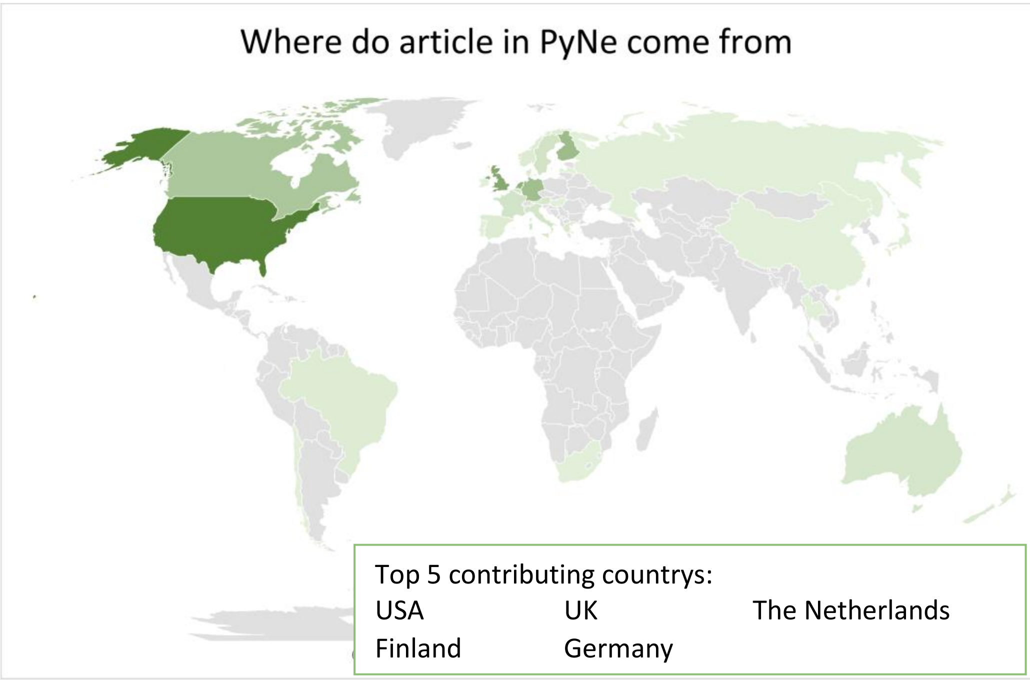
Yrjö Solantausta

PyNe and IEA Bioenergy Task 34
25 years in numbers and figures

Alexandra Böhm, Karlsruhe Institute of Technology

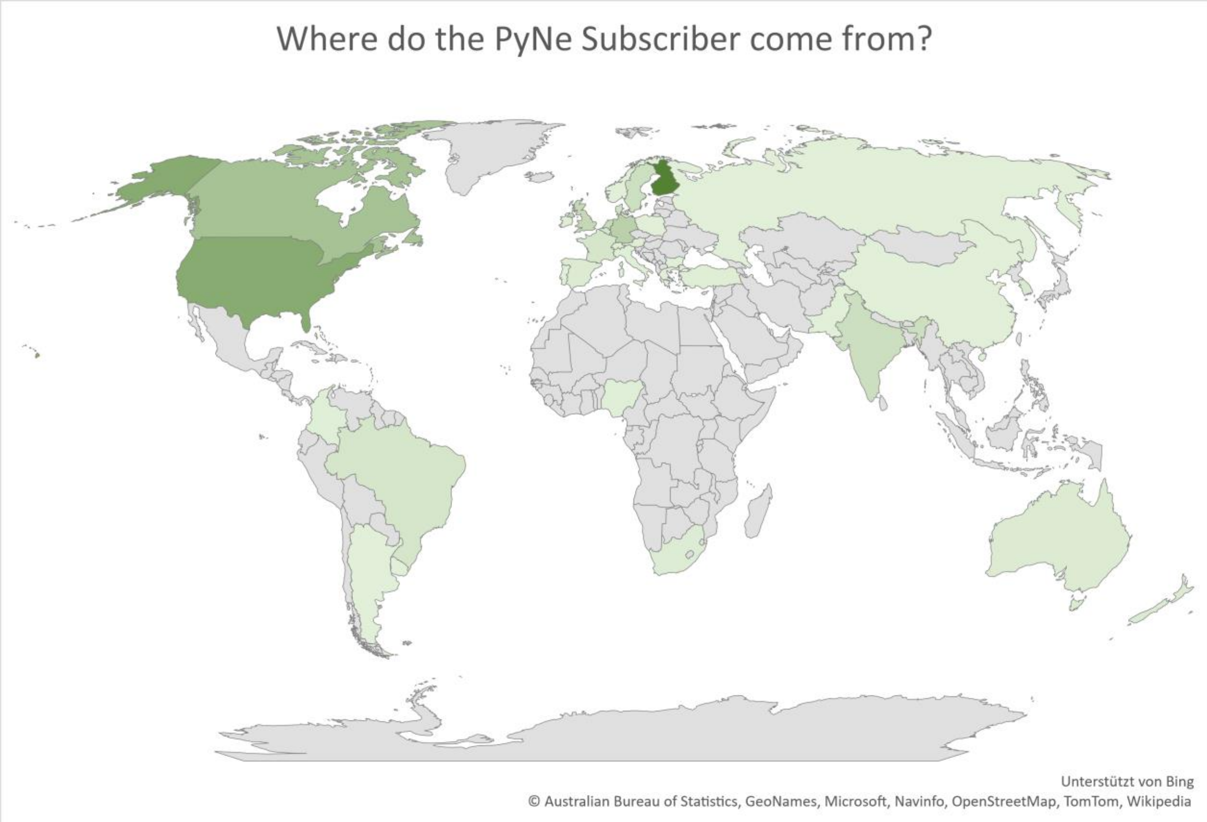
Some information about PyNe





If you want more information or count yourself feel free to visit our new PyNe Archive:

https://task34.ieabioenergy.com/pyne-archive-1996-2020/



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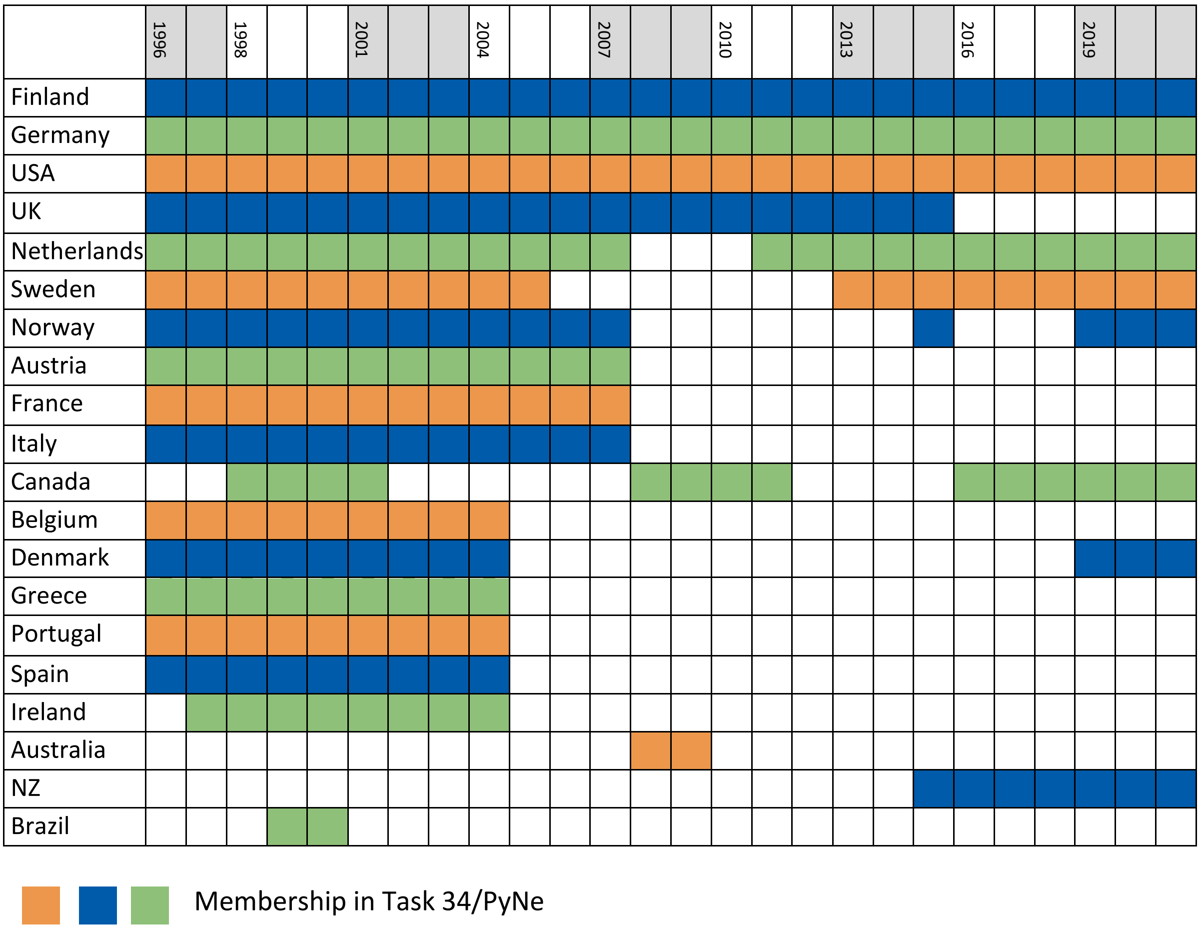
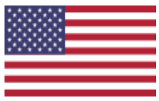


Duration Membership in the Task



If you want to know who is National Team Lead at the moment:

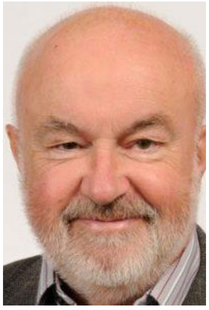
https://task34.ieabioenergy.com/country-members/

22 years

Anja Oasmaa

1996 - 2018

19 years



Anthony Bridgwater

1996 – 2015

19 years

Dietrich Meier

NTL from 1996 – 2015

19 years

Douglas Elliott

NTL from 1996 – 2015

Representing a total of 48 NTLs from the last 25 years, here you can see the 8 National Teamleads who have been contributing the longest in PyNe and Task 34.

Our thanks, however, goes to all those who have filled the task with knowledge and life through heart and passion.

12 years

Stefan Czernik

NTL from 1996 – 2007

10 years

Bert van de Beld

NTL from 2012 - 2021

9 years

Colomba di Blasi

NTL from 1998 – 2007

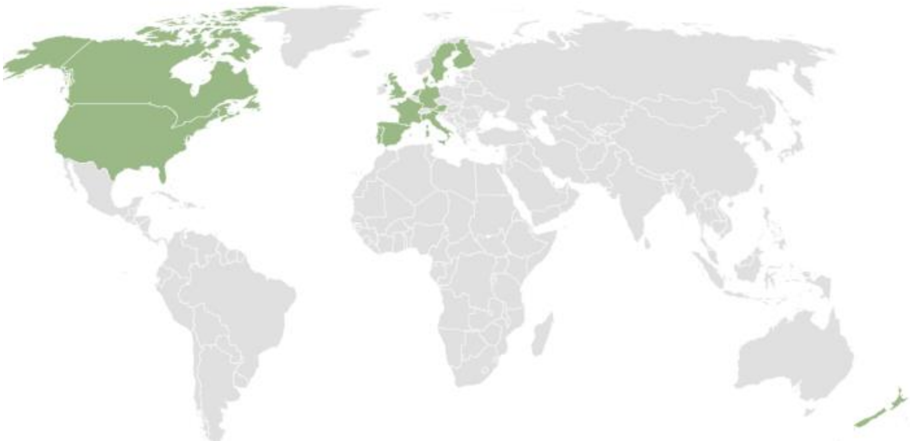
8 years

Fernando Preto

NTL from 1996 – 2015

Some information about the task meetings

Where did Task 34 meet?



There have been 42 Task meetings during the last 25 years

7 times in Austria
6 times in Germany
5 times in the UK
4 times in USA and in France
3 times in the Netherlands and in Finland
2 times in Canada, Italy and in Denmark
1 time in New Zealand, Portugal, Spain and Sweden

That means, we are still missing South america, Africa, Asia and Ireland.

We know that some of you secretly call us the International Eating agency
So this means, that IEA Task 34 Bioenergy had around

84 breakfasts full of ideas and discussions
105 creative working lunchs
42 working diners with a great efficiency
42 networking diners with wonderful people

If anyone spent all his time traveling from task meeting to task meeting, he would have traveled 92.280 miles. (148.511 km)

The task meeting reports are available here:
https://task34.ieabioenergy.com/meetings/

Some information about Round Robins

IEA Bioenergy task 34 has prepared and conducted 15 Round Robins over the past 25 years.

The following members were most frequently involved:

Anja Oasmaa 13 times
Doug Elliott 9 times
Dietrich Meier 7 times
Anthony Bridgwater 5 times
Bert van de Beld 3 times

Here are the last 5 Round Robins as examples:

Energy Fuels 2020, 34, 9, 11123–11133

energy&fuels article

Results of the International Energy Agency Bioenergy Round Robin on the Analysis of Heteroatoms in Biomass Liquefaction Oils

Philip Bulsink*, Ferran de Miguel Mercader, Linda Sandström, Bert van de Beld, Fernando Preto, Alan Zacher, Anja Oasmaa, Nicolaus Dahmen, Axel Funke, Benjamin Bronson

Energy Fuels 2017, 31, 5, 5111–5119 DOI: 10.1021/acs.energyfuels.6b03502

energy&fuels article

Results of the International Energy Agency Round Robin on Fast Pyrolysis Bio-oil Production

Energy Fuels 2015, 29, 4, 2471–2484, DOI: 10.1021/acs.energyfuels.5b00026

energy&fuels article

Norms, Standards, and Legislation for Fast Pyrolysis Bio-oils from Lignocellulosic Biomass

Anja Oasmaa, Bert van de Beld, Pia Saari, Douglas C. Elliott,Yrjö Solantausta

Energy Fuels 2012, 26, 4, 2454–2460, DOI: 10.1021/ef300252y

energy&fuels article

Development of the Basis for an Analytical Protocol for Feeds and Products of Bio-oil Hydrotreatment

Anja Oasmaa, Eeva Kuoppala, Douglas C. Elliott

Energy Fuels 2012, 26, 6, 3769–3776 DOI: 10.1021/ef300384t

energy&fuels article

Results of the IEA Round Robin on Viscosity and Stability of Fast Pyrolysis Bio-oils

Douglas C. Elliott, Anja Oasmaa, Fernando Preto, Dietrich Meier, Anthony V. Bridgwater

The full variety of past Round Robins and more information you can find in our brand-new Round Robin Archive:
https://task34.ieabioenergy.com/round-robin-archive-2/

Some information about our website

Our website has 100 pages
Information: 35
Round Robins: 18
Information about participating countrys: 12
Reports: 7
Newsletter 7
Events & Meetings: 7
Infrastructure web page: 7
In edition a total of Medias (pictures and pdfs): 238

Top 5 most visited pages

1) Home: https://task34.ieabioenergy.com/
2) https://task34.ieabioenergy.com/pyrolysis-reactors/
3) https://task34.ieabioenergy.com/bio-oil/
4) https://task34.ieabioenergy.com/bio-crude/
5) https://task34.ieabioenergy.com/iea-publications/newsletters/

Most Visitors come from these Countries

United States	Netherlands
India	China
UK	Brazil
Canada	Finland
Germany	Malaysia

The most downloaded newsletter is PyNe 41, followed by PyNe 40 and PyNe 44.

Have we aroused your curiosity?
Visit or contact us
https://task34.ieabioenergy.com/
alexandra.boehm@kit.edu

IEA Bioenergy
Technology Collaboration Programme

What happened 10 PyNes ago

It is interesting to see how the field of direct thermochemical liquefaction developed over the years. We are thus presenting one example highlight from the PyNe newsletter

Faces of PyNe History

Dietrich Meier, Rosanna Maggi, Tony Bridgwater, Wolter Prins, Philippe Girard, Karsten Pederson

Josef Spitzer, Yrjo Solantausta, Erik Rensfelt, Morten Fossum, Filomena Pinto, Angel Cuevas

Jesus Arauzo, Anja Oasmaa, Jan Piskorz, Yannis Boukis, Colomba Di Blasi, Stefan Czernik

Ed Hogan, Doug Elliott, Max Lauer, Wolfgang Baldauf, Jan Barymin, Yves Schenkel

Elma Gyftopoulou, Robert Brown, Desmond Radlein, Cordner Peacocke, Robbie Venderbosch, Ton Beenackers

You can access the full article by using the following link:
https://task34.ieabioenergy.com/wp-content/uploads/sites/3/2019/12/PyNe-40.pdf

Canada
Benjamin Bronson
CanmetENERGY,
1 Haanel Dr
Ottawa ON, K1A 1M1
Tel: +1-613-797-3097
Benjamin.Bronson@Canada.ca

Netherland
Bert van de Beld
BTG Biomass Technology Group bv
Josink Esweg 34, 7545 PN
Tel: +31 53 486 1186
vandebeld@btgworld.com

Denmark
Lasse Rosendahl
Aalborg University Denmark - Department of Energy Technology
Pontoppidanstræde 111,
DK-9220 Aalborg
T: (+45) 9940 9263
lar@et.aau.dk

New Zealand
Kirk Torr
Scion
49 Sala Street, Private Bag 3020
Rotorua 3046
Tel: +64 7 343 5601
kirk.torr@scionresearch.com

Finland
Christian Lindfors
VTT Technical Research Centre
Ruukinmestarintie 2,
02330, Espoo
T: +358 40 515 0429
christian.lindfors@vtt.fi

Norway
Kay Toven
RISE PFI
Høgskoleringen 6b
NO-7491 Trondheim
Tel: +47 95 21 17 04
kai.toven@rise-pfi.no

Germany
Axel Funke (Task 34 Leader)
Karlsruhe Institute of Technology (KIT) Hermann-von-Helmholtz-Platz 1
D-76344 Eggenstein-Leopoldshafen
Tel: +49 721 608 22391
axel.funke@kit.edu

Sweden
Linda Sandström
RISE Energy Technology Center
Industrigatan 1
941 38 Piteå
Tel: +46 10 516 911 23 23 85
linda.sandstrom@ri.se

India
Pramod Kumar
HP Green R&D Centre
Bengaluru, India 560067
Tel: +91-80-28078630
Mobile: +91-9740808877
Pramodkumar@hpcl.in

USA
Michael Thorson
Pacific Northwest National Laboratory
902 Battelle Boulevard
PO Box 999, Richland, Washington 99352
michael.thorson@pnnl.gov

IEA Bioenergy Task 34 Website

www.task34.ieabioenergy.com

IEA Bioenergy

www.ieabioenergy.com

Past Issues of the Task 34 Newsletters

http://task34.ieabioenergy.com/iea-publications/newsletters/

If you would like to contribute an article to the Task 34 newsletter or have questions, please contact:

Coordinator	**PyNe/Website administration**	**Your national**
Axel Funke	**Alexandra Böhm**	**representative**
Tel: +49 721 608 22391	Tel: +49 721 608 28425	
axel.funke@kit.edu	alexandra.boehm@kit.edu	http://task34.ieabioenergy.com/country-members/

Task 34: Direct Thermochemical Liquefaction

Disclaimer: This Task 34 newsletter was edited and produced by the Task Leader on behalf of IEA Bioenergy Task 34 Direct Thermochemical Liquefaction. Any opinions or material contained within are those of the contributors and do not necessarily reflect any views or policies of the International Energy Agency or any other organization.