IEA Bioenergy
Technology Collaboration Programme
Task 34

Newsletter
Direct Thermochemical Liquefaction

PyNe 59
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We are pleased to present this new issue of the PyNe Newsletter. It brings together contributions that reflect the current scope of Task 34: direct thermochemical liquefaction technologies, fuel applications, system integration, standardization questions, and exchange with related fields.

Before turning to the individual articles, we would like to briefly look back on a very productive Task Meeting and National Stakeholder Workshop on Direct Thermochemical Liquefaction, hosted by BEST in Wieselburg, Austria. The event brought together researchers, industry representatives, and international experts and provided an excellent opportunity to learn from each other, discuss current developments, work together on relevant Task topics, and strengthen exchange within the network.
This gathering proved to be valuable, not only for sharing scientific and technical progress, but also for identifying common questions, building connections, and jointly developing the next steps. A report on the workshop is also included in this issue.
(continued on page 2)

Inside this Issue:

This issue opens with an important update for the Task: France is joining IEA Bioenergy Task 34 through ADEME as National Delegate. Represented by Jean-Henry Ferrasse from Aix-Marseille University, France adds expertise in biomass conversion technologies, particularly hydrothermal liquefaction, and brings in a broad perspective on national research activities, industrial developments, and biomass mobilization strategies.

The first technical article focuses on the determination of total sediment in marine fuels containing polar compounds. As bio-based liquids from fast pyrolysis, hydrothermal liquefaction, and related routes are increasingly considered for marine fuel applications, established test methods need to be checked for their suitability. The article shows that additional washing steps with polar solvents can improve the reliability of hot filtration methods when bio-oil components are present.

The second article presents work on advanced biofuels from biomass residues via fast pyrolysis. Poplar forest residues and barley straw were converted into fast pyrolysis bio-oil, upgraded by hydrotreatment, and fractionated into drop-in fuel fractions including naphtha, jet fuel, and marine fuel. The results show that good-quality biofuels can be produced from these residues, while also making clear where further optimization is needed, especially regarding aromatics, nitrogen content, and final fuel properties.

The following article broadens the perspective by introducing the Energy Lab at Karlsruhe Institute of Technology. As a large-scale research platform, the Energy Lab connects electricity, heat, gas, and chemical energy systems and combines real installations with simulations, digital twins, and experimental testing. Of particular relevance to Task 34 is the Carbon Cycle Lab, where thermochemical processes such as pyrolysis, gasification, and hydrogenation are investigated for the conversion of biogenic residues and plastic waste into chemical energy carriers and for the development of closed carbon cycles.

In addition to the technical contributions, this issue includes reports from several events that underline the active exchange within our field. The 9th Expert Forum on Hydrothermal Processes, PYRO2026 in Pisa, and the CEBC BECCUS3.0 Biochar Workshop each addressed different aspects of thermochemical conversion, from hydrothermal technologies and pyrolysis research to biochar production, carbon dioxide removal, standardization, and policy frameworks. Taken together, these events show that the field is moving forward on several levels at once: scientific understanding, technology development, market orientation, and cross-sector collaboration.

Taken together, the articles in this issue show how broad the field of direct thermochemical liquefaction and related technologies has become. They range from detailed analytical method development to residue-based biofuel production, from integrated energy system research to standardization, conference exchange, and carbon management. This breadth is demanding, but it is also what makes the work of Task 34 relevant: the technologies cannot be assessed in isolation, but need to be considered in relation to fuel markets, infrastructure, sustainability requirements, and future energy systems.

I would like to thank all authors for their contributions to this issue and all readers for their continued interest in the work of Task 34.

Yours sincerely,
Alexandra Böhm
Task Manager

France joins IEA Bioenergy Task 34 with ADEME as National Delegate

Jean-Henry Ferrasse,
Aix-Marseille University (AMU), Marseille, France

France is joining IEA Bioenergy Task 34 focused on Direct Thermochemical Liquefaction technologies and processes. The coordinated actions dedicated to bioenergy in France are being systematically managed by ADEME (the French Ecological Transition Agency). This specialized agency coordinates among many other responsibilities the comprehensive national strategy for biomass mobilization and development.

Represented by Jean-Henry Ferrasse, Professor of Chemical Engineering at Aix-Marseille University (AMU), he is joining the existing members for the completion of the Triennium 2025-2027. He will represent the various national programs and ongoing actions, encompassing both private sector initiatives and academic research, in the production of biosourced liquid molecules and compounds.

Jean-Henry Ferrasse brings recognized and well-established academic experience and expertise in biomass conversion technologies, with particular emphasis on hydrothermal liquefaction processes. Although his research work is primarily focused on the optimization of operational conditions for biomolecule production and the relationship with inorganic compounds; he also brings a broad and comprehensive national perspective of French teams and national research programs. His participation in the ThermoBio research group, which brings together a large number of French actors and stakeholders in the thermochemical processes field, enables direct information dissemination and knowledge transfer linkage. France was a pioneer in the field of pyrolysis in the 1970s, and today its pyrolysis ecosystem is once again highly active and dynamic. With both academic laboratories covering a wide range of techniques and characterization concerns, separation methods, research agencies that drive technological development initiatives, and private companies that are undertaking initial commercial developments.

The current national priorities, particularly targeting nearly 60 TWh of biomolecule liquid production through thermochemical processes by 2050, clearly explain why participation in Task 34 is important and highly relevant to France's goals. With resource mobilization being very focused on agricultural resources and residues, it is crucial to develop sustainable and adapted technologies suited to each specific feedstock input.

Fig. 1: AMU Facilities for HTL

Jean-Henry Ferrasse

Aix Marseille Université, France

Towards a new method to determine total sediment in marine fuels containing polar compounds

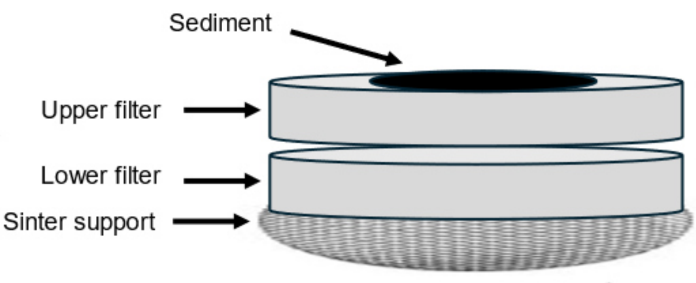
François-Xavier Collard, Finn Dooley, Martin Cooke-Willis, Tasman van der Woude, Bioeconomy Science Institute, New Zealand

Increasing biofuel consumption for shipping

The International Maritime Organization (IMO) is targeting to peak greenhouse gas emissions from international shipping as soon as possible and reach net zero emissions by 2050. Most decarbonisation scenarios predict a substantial increase in the use of biofuels. While fuels containing biodiesel from fatty acid methyl esters (FAME) are already available in several ports, meeting the demand of drop-in liquid carbon neutral fuels will require other feedstock such as lignocellulosic biomass. Direct thermochemical liquefaction technologies such as fast pyrolysis, hydrothermal liquefaction and solvolysis, with a potential upgrading step, are increasingly considered to convert lignocellulose into a liquid, for use as a drop-in marine fuel.

Marine residual fuels are blends composed of different products of an oil refinery, including residual fuel oil and other liquids added to ensure stability and compliance with other specifications (e.g. sulphur content, viscosity, density). The ideal short-term solution is when blends of biofuel and residual fuel meet the specifications and can be used without modification of current infrastructures. The specifications of residual and bio-residual marine fuels are detailed in International standard ISO 8217. A bio-residual fuel is defined as a blend of a petroleum residual fuel with bio-based liquid fuel. The introduction of bio-based fuel being quite recent, the applicability of some analytical techniques to assess their fuel properties has not been fully established. It can be expected that the introduction of biofuels from lignocellulose and therefore with different chemical compositions (paraffinic or aromatic nature, heteroatom content) will require the adaptation of some standard methods. For instance, when determining fuel stability of blends of bio-oil and residual fuels according to ASTM D7061, Zvereva et al. noticed that toluene did not fully dissolve the bio-oil component and suggested using ethyl acetate as a solvent instead [1].

Blending residual fuels with biofuels with extremely low sulphur contents provides an opportunity to limit the sulphur content in the final product. Once the biofuel share becomes significant, one can expect that blends of biofuels with different characteristics could be made to fine tune the fuel properties of the biofuel component and of the final product. For instance, blending FAME and pyrolysis bio-oils could be a way to adjust the fuel density and viscosity. In addition, the antioxidant properties of phenolic compounds in bio-oil could improve biodiesel's resistance to oxidation [2].



Sample mass (g)		10
Mass increase (mg)	Upper	7
	Lower	3
Sediment (mg)		4
Total sediment	%	0.04

Fig. 1: Determination of Total Sediment: Principle and example of calculation with a marine residual fuel

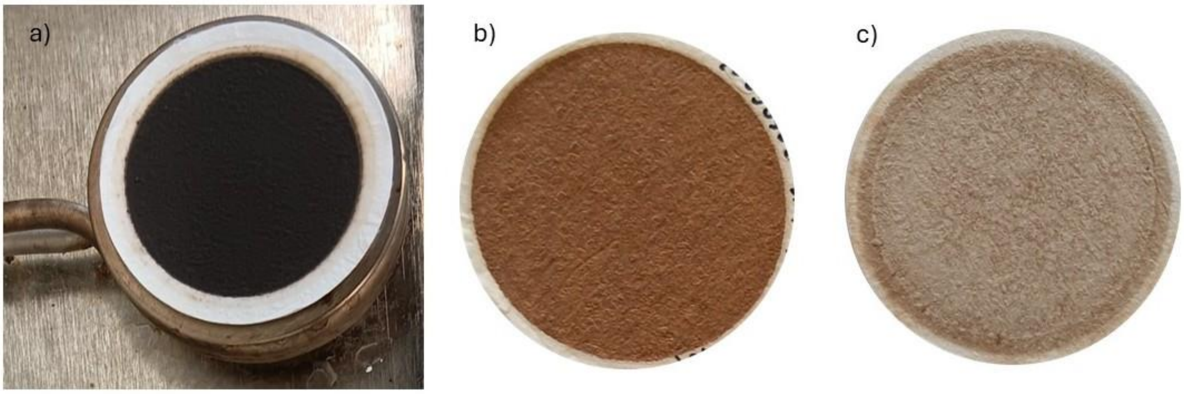


Fig. 2: Filters from hot filtration of blends containing bio-oils: a) Upper filter after filtration; b) Lower filter washed only with non-polar solvents; c) Lower filter washed with polar and non-polar solvents

Determination of fuel stability and compatibility by hot filtration

Stability and compatibility challenges are a recurring issue in marine fuel industry. Residual fuels are composed of liquid hydrocarbons, asphaltenes and resins. Asphaltenes are high molecular compounds with a predominantly aromatic structure and contain heteroatoms, making them relatively polar, compared to the other components of the residual fuel. In a stable fuel, asphaltenes are kept in colloidal suspension. Fuels with poor stability have a limited resistance to thermal or chemical stresses. Such stresses are likely to result in the formation of sediments made of an asphaltenic sludge and lead to problematic blockages.

Kass et al. have studied the miscibility and compatibility of a heavy fuel oil and the organic phase of a non-catalytic bio-oil [3]. Based on spot test method (ASTM D4740), they did not observe any significant sediment formation in blends containing 25, 50 and 75% of bio-oil. They suggested that bio-oil polar compounds could contribute to asphaltene dispersion. To further explore the possibility of blending pyrolysis bio-oils with marine residual fuels, the Bioeconomy Science Institute have investigated the compatibility of blends of catalytic bio-oils and marine residual fuels. According to ISO 8217, the sediment contents of fuels are determined by hot filtration under vacuum (ISO 10307). It is used to estimate Total sediment Existent (TSE), Total Sediment Accelerated (TSA) and Total Sediment Potential (TSP), the latter having a maximum acceptable limit of 0.1% in mass. The approach used to estimate total sediment is described in Figure 1. Two filters are placed on top of each other. After filtration, the sediments remain on the top filter. The filters are then washed with hydrocarbon solvents (n-heptane and toluene) to remove non-sediment compounds adsorbed at the filter surface and within the pores. Despite the filter washings, not all the non-sediment compounds are removed, as illustrated by the mass increase of the lower filter. Using the lower filter as a blank, the amount of sediment can be calculated as in the example of Figure 1.

Using two commercial Very Low Sulphur Fuel Oils (VLSFO) and several bio-oils, blends were prepared at varying ratios and tested for compatibility according to the hot filtration reference method [4]. When using blends containing pyrolysis bio-oils, the mass increase of the lower filter was frequently between 20 and 80 mg, even reaching more than 100 mg in some cases. It appears that the filter washings were not efficient in removing some bio-oil polar compounds, as evidenced in our publication [4]. This issue resulted in inconsistent results and poor test repeatability.

To address incomplete filter washing, a further washing step using a polar solvent (acetone) was investigated. Following this additional step, the colour of the lower filter changed from brown to a lighter colour, more expected for a well-washed filter, as seen in Figure 2.

Towards a hot filtration method adapted to blends with polar compounds

An accurate sediment determination requires an efficient washing of the filters. From our tests, using only n-heptane and toluene is not effective at removing polar compounds. When expecting similar challenges with biofuels containing polar compounds, the addition of a washing step with a polar solvent appears as a solution to get accurate results. In preparation of an adapted standard method, more blends of residual fuels and biofuels from different origins would have to be tested. Other polar solvents could also be considered. The order and volumes of the washing steps (polar and non-polar) will also have to be optimized.

Using the new method helped us to better understand the compatibility between residual fuels and biofuels. Some bio-oils were even found to have a positive effect and limit sediment formation. This work illustrates the need to adapt the current fuel standard methods in order to further support the adoption of biofuels from different sources. Following the IMO's 2020 marine fuel sulphur cap, transitioning to low sulphur marine fuels has led to some formulation changes. These include the use of lighter cutter stocks and additional additives to fix stability issues, ultimately resulting in increased production costs. A better understanding of the interactions between the fuels from different origins and their impact on fuel properties will not only help with decarbonization efforts, it could also be an opportunity to include biofuel components in the formulation of marine fuels and tune some properties for better operations.

References

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[2] Fonts, Isabel, et al. "Bio-oil fractionation according to polarity and molecular size: characterization and application as antioxidants." Energy & Fuels 38.19 (2024): 18688-18704.

[3] Kass, Michael D., et al. "Stability, combustion, and compatibility of high-viscosity heavy fuel oil blends with a fast pyrolysis bio-oil." Energy & Fuels 34.7 (2020): 8403-8413.

[4] Collard, François-Xavier, et al. "Novel Method for the Determination of Sediment by Hot Filtration for Bio-Oil and Residual Fuel Blends." *Energy & Fuels* (2026). pyrolysis bio-oil." Energy & Fuels 34.7 (2020): 8403-8413.

[4] Collard, François-Xavier, et al. "Novel Method for the Determination of Sediment by Hot Filtration for Bio-Oil and Residual Fuel Blends." *Energy & Fuels* (2026).

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Advanced biofuels from biomass residues via fast pyrolysis

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Introduction

The global ambition is to make transportation more sustainable and to reduce its dependency on fossil fuels. Obviously, a mix of different approaches and fuels will be needed to achieve a high share of renewables in transport. Advanced biofuels will certainly be required for specific sectors like e.g aviation, shipping and heavy/long-haul road transport where alternatives are scarce or highly unpractical. Drop-in biofuels have the clear advantage that a seamless introduction is enabled, and end-users don't have to invest in new engines or systems. The approach of BTG is a multistep process in which biomass is converted into fast pyrolysis bio-oil (FPBO) followed by the upgrading of the FPBO by hydrotreatment to produce Hydrotreated Pyrolysis Oil (HPO). The latter is then fractionated into the desired drop-in biofuels. The concept is illustrated in Fig. 1.

To date, commercial fast pyrolysis plants are using clean wood as feedstock. Furthermore, most of the development work on upgrading is based on FPBO from clean wood and the required FPBO is obtained from a commercial production plant. In the European project *BioTheRos* one of the objectives is to produce advanced biofuels from biomass residues via fast pyrolysis. For this purpose Poplar Forest Residues (FR) and Barley Straw (BS) have been selected as the feedstock. Main criteria in the selection process were the technological suitability and the potential availability in Europe.

Experimental work

Both feedstocks have been converted into FPBO in a continuous, bench-scale fast pyrolysis unit (~3 kg/h feed). From each feedstock around 25 kg of FPBO were produced and liquids yields were just above 60 wt%. Prior to further upgrading the FPBO's were filtrated to remove any solids. The hydrotreatment process developed by BTG involves two stages. Firstly, the FPBO is stabilized using a proprietary catalyst (Picula^{TM}) yielding Stabilized Pyrolysis Oil (SPO). Secondly, the SPO is fully deoxygenated using conventional hydrotreatment catalysts such as sulphided CoMo or NiMo to produce the HPO. Both stages were performed at BTG in continuous flow, bench-scale hydrotreaters (~1 kg/d feed, 24/7 operation). HPO is a wide boiling point range hydrocarbon fuel and eventually fractionated into a naphtha, jet (SAF) and diesel (SMF) by distillation. Fractionation was performed in a batch distillation unit (3-5 L/batch).
The hydrotreated products from Barley Straw and Forestry Residue are shown in Fig. 2.

Fig.1: The fast pyrolysis value chain to advanced biofuels.

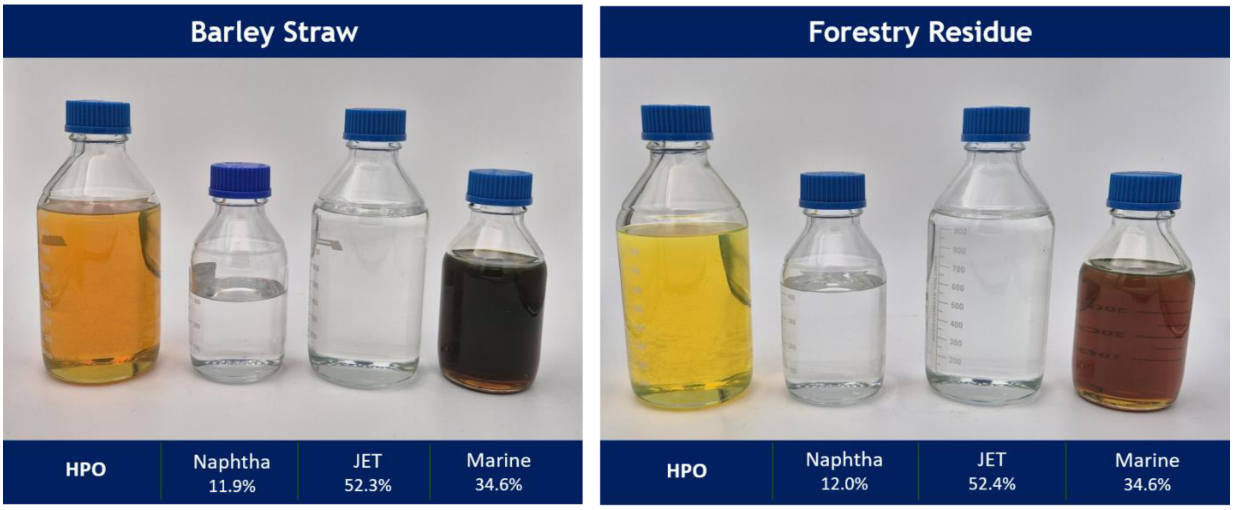

Fig. 2: Advanced biofuels from Barley Straw and Poplar Forestry Residues

Fuel properties & composition

The HPO and fractions thereof have been analysed in detail [1] and compared to available data on fuels derived from clean sawdust ('reference'). In *BioTheRos* the Jet and Marine fraction are the main targeted drop-in fuels. The Jet fractions generally comply with the properties listed in the ASTM Standard (D4054/D7566). Compared to the softwood reference, the aromatic content is relatively high and the hydrogen content rather low. Further hydrotreatment might be required to reduce the aromatic and nitrogen content and improve the fuel quality.

The Marine fractions do comply with the specifications given for the RMA20 in the ISO standard (8217:2024). Compared to the clean wood reference the Final Boiling Point (FBP) is significantly higher ("heavy tail") and also the nitrogen content is higher. Further hydrotreatment -similar to the HPO-Jet- will improve fuel quality. For the DMB quality the density as well as the viscosity are too high. Removal of the heaviest part, i.e. components with a BP> 400 °C- is likely an effective approach to reduce density and viscosity, improve fuel stability and achieve DMB quality.

The compositions of the different fractions have been analysed by GC-VUV (naphtha

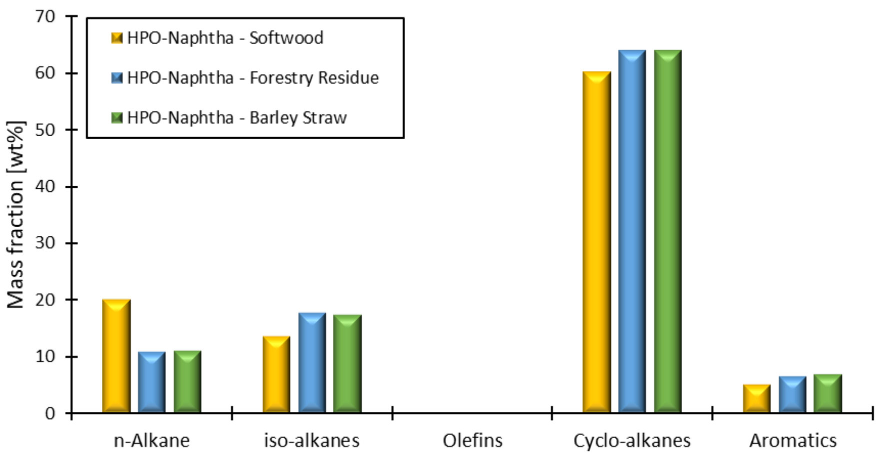

Fig. 3: Composition of HPO-Naphtha derived from clean softwood (reference), Barley Straw and Forestry Residues.

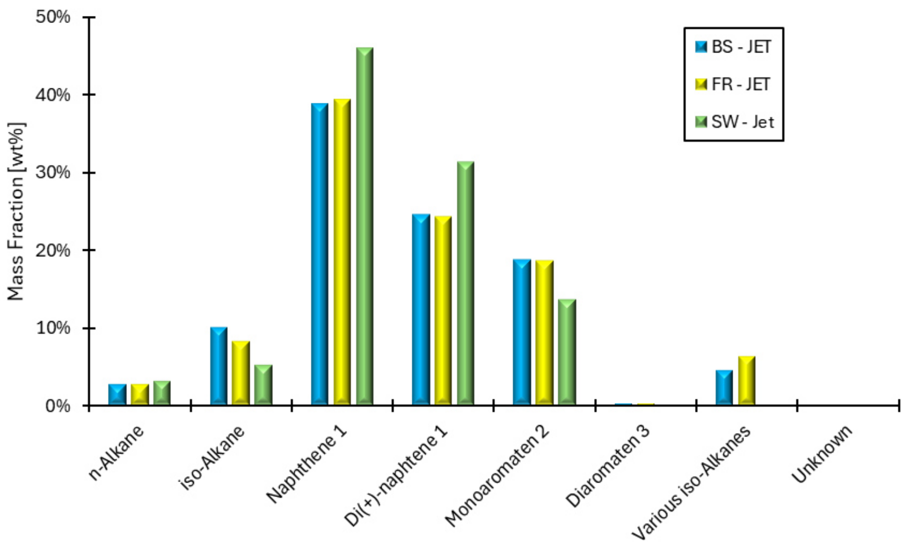

Fig. 4: Composition of HPO-Jet derived from clean softwood (SW, reference), Barley Straw and Forestry Residues.

fraction) and GCxGC- FID (Jet & Marine). Results for the Naphtha samples are shown in Fig. 3. It consists primarily of cyclo-alkanes (methyl-, ethyl- and propyl cyclohexane), and over 95% is covered by C6 – C9 molecules. It is known that GC-VUV sometimes overestimates the iso-alkanes and underestimates cyclo-alkanes.

The Jet fractions were analyzed with GCxGC FID and the results are shown in Fig. 4. The majority of the fuel consists of cyclo-alkanes and typically the sum of n- and iso-alkanes are below 10wt%. The aromatics content depends on the hydrotreatment severity and reducing aromatics content leads to a similar increase in cyclo-alkanes. For the softwood reference di-aromatics are virtually absent whereas small amounts of di-aromatics were detected in the Barley Straw and Forestry Residue derived jetfuels. Lower aromatics content leads to better fuel properties (e.g. reduction in density, increase in Cetane Number & Heating value).

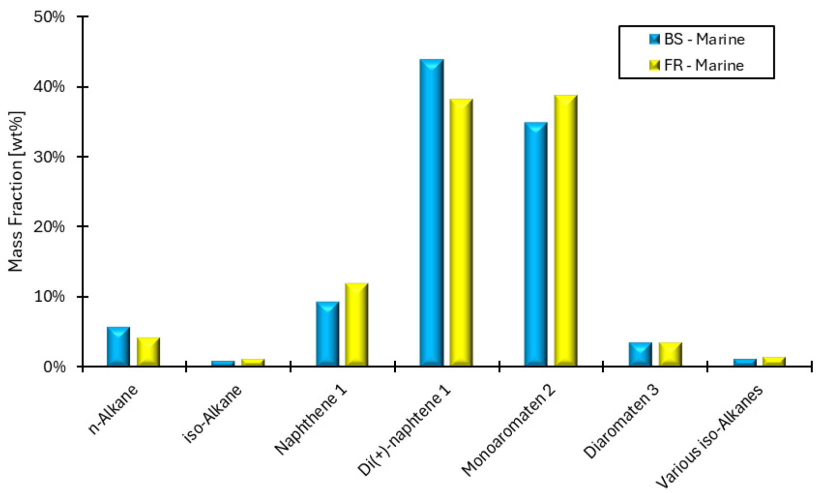

Fig. 5: Composition of HPO-Marine derived from Barley Straw and Forestry Residues.

The results for the marine fraction are shown in Fig. for the BioTheRos feeds. The overall composition is very comparable for both samples, and in both cases a rather high aromatics content (~40%) is observed. Regretfully, no data is available for the softwood reference, but likely the aromatic content will be somewhat lower. The Carbon Number distribution covers the range from C14 till C28.

In summary, good quality biofuels have been produced from Barley Straw and Poplar Forest Residues. The process conditions of the different steps (pyrolysis, hydrotreatment, distillation) were similar as used for the value chain based on clean softwood. To obtain a similar quality fuel as for softwood the final hydrotreatment step should be further optimized to reduce aromatics and nitrogen content.

Reference

[1] The production of advanced biofuels from biomass via fast pyrolysis, BioTheRos deliverable D3.3, BTG Biomass Technology Group BV, 2026, https://www.biotheros.eu/en/project-outputs/public-deliverables/

Acknowledgement

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BioTheRoS

Collaborative actions to bring novel BIOfuels THErmochemical ROutes into industrial Scale

The Energy Lab – Research Platform for Integrated Energy Systems

Iuri Maia Jost, Christian Wetzel
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The Energy Lab at Karlsruhe Institute of Technology (KIT) is one of Europe's leading research platforms for the future energy supply. Researchers there test how an energy system based on renewable energies can operate reliably, efficiently, and resiliently – despite fluctuating generation, increasing electrification, and high demands on security of supply. The results directly inform decisions by policymakers, industry, and energy providers and thus have a tangible impact on everyday electricity and heat supply.

As a large-scale laboratory, the Energy Lab connects electricity, heat, gas, and chemical energy systems. The teams systematically combine real installations, their digital twins, simulations, and experimental tests. In this way, they can trial new technologies under conditions close to reality and assess their impact on the overall system.

System Integration as Guiding Principle: Smart Energy System Simulation and Control Center

The Smart Energy System Simulation and Control Center (SEnSSiCC) serves as the central connecting element of the Energy Lab.

As the "brain" of the infrastructure, it links physical installations with virtual models, collects and analyzes large volumes of data, and controls complex energy systems in a secure way. Grid simulations, the development of control concepts, digital twins, and cybersecurity research all come together here – including experimental studies on the resilience of critical infrastructures.

Real-World Laboratories for Power, Grids, and Consumers

Several laboratories focus on the electrical energy system at different levels:

- Large-scale battery storage systems and a photovoltaic field with a capacity of one megawatt demonstrate how renewable energies are changing generation, storage, and grid integration.

- Specialized grid and hardware-in-the-loop laboratories (Smart Energy System Control Laboratory, Power Hardware in the Loop, Energy Grids Simulation and Analysis Laboratory) enable tests with real components, analyses of grid dynamics, and the trial of new control strategies right up to stability limits.

- In the Smart2DC Microgrid Laboratory, researchers investigate direct current grids as efficient infrastructure for future decentralized energy systems.

Fig. 1: ENERGY LAB

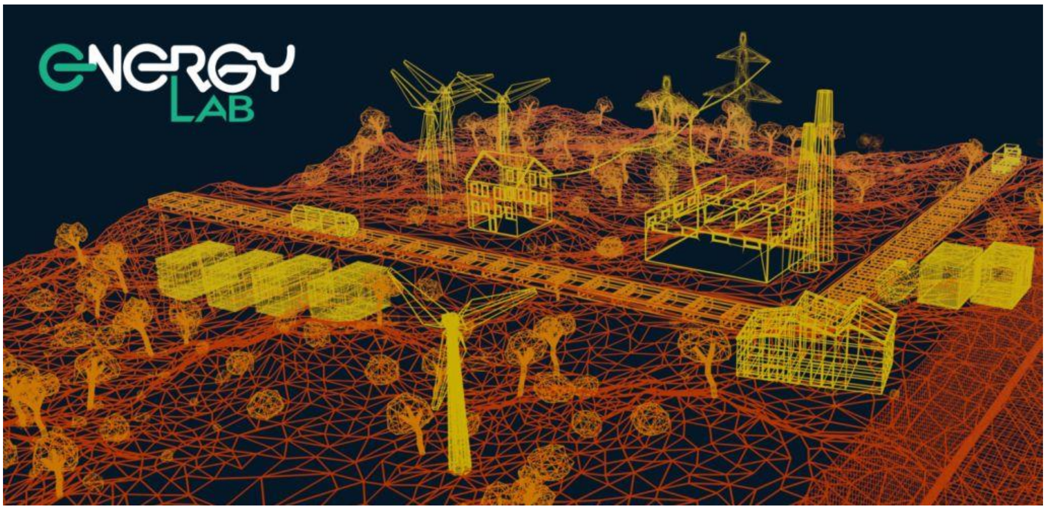

Fig. 2: Conceptual illustration of the ENERGY LAB and its integrated energy

The Energy Smart Home Lab and the Living Lab Energy Campus involve buildings, households, and users directly in the research and show how the energy system is transforming all the way into everyday life.

Power-to-X and Carbon Cycles
In the Power-to-X Lab, the Energy Lab explores how to store renewable electricity in chemical form – for example by producing climate-neutral fuels or synthetic methane. The laboratory thus addresses key questions in the transformation of transport and industry: How can ships, aircraft, or high-temperature processes operate in a climate-friendly way?

The Carbon Cycle Lab complements this approach. Here, researchers investigate thermochemical processes such as pyrolysis, gasification, and hydrogenation. Their goal is to convert biogenic residues and plastic waste into high-value chemical energy carriers and to enable closed carbon cycles.

Hydrogen, Heat, and Future Grid Infrastructures
Further research priorities include integrating hydrogen technologies into the energy system (Hydrogen Integration Platform), developing power-electronics-dominated grids in the multi-megawatt range (High Power Grid Lab), and making systematic use of heat across all temperature levels (HeatLab). This work produces solutions that consider electricity, gas, and heat grids together instead of planning them separately.

Conclusion
The Energy Lab sees itself as an integrated research environment for the energy transition: open to different technologies, coupling multiple sectors, and firmly grounded in experimental work. By closely interlinking real installations, simulation, and system analysis, it develops robust and transferable solutions – to ensure that the energy transition works not only in the laboratory, but also in practice.

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"News from the PhD Community" – Giving Young Researchers a Voice in Task 34

Alexandra Böhm, Task Manager IEA Bioenergy Task 34,
Karlsruhe Institute of Technology, Germany

At the core of every scientific breakthrough, there is a question. And more often than not, that question comes from someone who's just starting out – curious, determined, maybe a little uncertain, but full of drive. With our new section **"News from the PhD Community"**, we want to open a space for exactly those people: PhD students who are shaping the future of DTL research.

IEA Bioenergy Task 34 is proud to introduce this platform to bring visibility to the next generation of scientists and engineers working in the field of thermochemical biomass conversion. We want to hear their stories. Not just their results.

What is "News from the PhD Community"?
It is a recurring section in our newsletter, dedicated to showcasing the work and experience of PhD candidates connected to our international network. Each edition will highlight one young researcher, their academic and professional path, and the research questions they are tackling – whether it's the intricacies of fast pyrolysis, the scaling of HTL reactors, or the potential of novel feedstocks.
But more than that, we are interested in the *person* behind the project:

- What led them to this field?
- What keeps them motivated through setbacks?
- What part of their research excites them the most – or surprised them the most?
- And what do they wish more people in the bioenergy community understood?

Introducing our next contributor:
Ana Cristina Correa de Araujo
We are pleased to introduce Ana Cristina Correa de Araujo. After completing her PhD at KIT, Ana Correa has returned to her hometown of Rio de Janeiro, Brazil, where she is preparing for the next step in her research career. Her work focuses on bioenergy research, ranging from the characterization of lignin bio-oils to broader questions around circular approaches for agricultural and industrial residues.

Ana's final PhD paper has recently been accepted for publication in Energy & Fuels. She has also been selected for the DAAD SDG Alumni Project INICIAR-PM in Mexico, where she will join a training seminar on circular approaches for animal and agro-industrial residues and attend Intersolar Mexico. Ana looks forward to staying connected with the international bioenergy community

We hope you enjoy this contribution, and we look forward to hearing from more PhD candidates in our network in the coming editions.
If you are a PhD student working in this field, or supervising someone who is – we'd love to hear from you.

What we are looking for:
We invite contributions that are:

- 1–2 pages long
- Written in a personal but informative style
- Including a personal photo (e.g. in the lab, during fieldwork, at a conference)
- Focusing on current research in the field of DTL or related), challenges, milestones, and insights

Alexandra Böhm

Karlsruhe Institute of Technology (KIT), Germany

Continuing the Bioenergy Journey: New Steps, New Perspectives and International Exchange

Ana Cristina Correa de Araujo,
Karlsruhe Institute of Technology, Karlsruhe, Germany

Hello everyone! It's been a few months since I finished my PhD, and it's nice to have the opportunity to share a few updates with the bioenergy community.

Since finishing my PhD at KIT, I've moved back to my hometown in Rio de Janeiro, Brazil. Returning home after several years abroad was a major transition in itself, and I've been taking some time to settle in before starting the next chapter. I'm now looking forward to continuing my research career, hopefully through a postdoc position, with the long-term goal of building an academic career and, one day, becoming a professor.

Looking back, I'm proud of everything I had the opportunity to do during my PhD. At KIT, I got to work on a bit of everything, from experiments and characterization to process simulations, which gave me a broad view of bioenergy research. I also really enjoyed being part of the Flexi-Green Fuels project and presenting my work at conferences, where I met researchers from many different backgrounds and gained confidence in communicating my research. And speaking of communicating my research, I am happy to announce that the last paper from my PhD has just been accepted for publication in Energy & Fuels. The paper, titled *Comprehensive characterization of lignin bio-oils from alkali and Kraft lignin with integrated ^{1}H-NMR spectral modeling*, is the result of a collaboration between KIT, AUTH and UFS, and was a nice way to close this chapter.

In this study, I worked closely with Myriam at KIT on developing the NMR spectral model used to describe the lignin bio-oils. For the characterization, our project partners at AUTH were responsible for the FTIR, GC-MS and NMR analyses, while Prof. Alberto's group at UFS in Brazil performed the UHRMS Orbitrap analysis, which was essential for understanding the composition of the heavier compounds present in the lignin bio-oils.

Fig. 1: A joyful moment after her PhD defense: celebrating with our traditional "Doktorwagen" ride.

Fig. 2: Visiting a sugar factory in Brazil with colleagues during the BBEST Conference

If you're interested in this topic, feel free to reach out. I'd be happy to share the paper once it's available!

Another piece of good news that came recently was being selected for the DAAD SDG Alumni Project (INICIAR-PM), which will take place in Mexico later this year. Thanks to my friend Ayumi from the University of Stuttgart, who shared this opportunity with me, I'll have the chance to take part in a training seminar on innovation and circular approaches for animal and agro-industrial residues, as well as attend Intersolar Mexico later this year. I'm very grateful to DAAD for this opportunity and I’m looking forward to meeting researchers from across Latin America and Germany, exchanging ideas, and staying connected with the international bioenergy community.
I'm looking forward to staying part of this network as I take my next steps, whether through new projects, conference catch-ups, or simply swapping ideas over email. Feel free to reach me at anaccorreaa@gmail.com if you'd like to connect!

Ana Cristina Correa de Araujo

Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

National Stakeholder Workshop on Direct Thermochemical Liquefaction (DTL)

Manuel Schwabl,
Best, Wieselburg, Austria

The IEA Bioenergy Task 34 Workshop on Direct Thermochemical Liquefaction (DTL), held in Wieselburg on 1 July 2026, brought together national stakeholders from Austria, the Czech Republic, and Italy, along with international experts from the IEA Bioenergy Task 34 network.

The event combined presentations, discussions, and a site visit to BEST's GreenCarbon Lab, showcasing thermochemical conversion technologies from lab to pilot scale.

IEA Bioenergy Task 34: A Global Snapshot
Members from Germany, the Netherlands, Denmark, France, Canada, New Zealand, and the USA provided an overview of their national activities in DTL, covering research priorities, technological advancements, and industrial applications. This set the stage for discussions on potential synergies and joint projects.

National Stakeholders: Regional Innovations in Focus
The workshop placed a strong emphasis on national and neighboring stakeholders, who shared their latest projects and insights. Below is a thematic summary of their contributions:

Turning Waste into Value
A core theme was the valorization of regional waste streams through DTL, demonstrating circular economy approaches:
BOKU Wien (Austria) presented the VINNY project, which explores pyrolysis of wine industry residues (e.g., vine prunings, pomace) to produce bio-oil and biochar. The bio-oil, generated at 350 °C, shows fungicidal and pest-repellent properties, offering a sustainable alternative to chemical pesticides.

Bio Fuel Systems (Austria) shared their presentation with the network. Their plans to transform a biogas plant into a biorefinery – including pyrolysis of packaging waste and sewage sludge, as well as HTC of digestate – will be available for download. The project aims to produce biomethane for grid injection and liquefied CO_2 for industrial use, demonstrating how existing infrastructure can be repurposed for greater sustainability.

Austria's ecoplus presented their industrial and technological network pursuing Austria's Mission Klimaziele roadmap (2020–2027), focusing on climate-neutral carbon cycles from plastics recycling and transforming CO_2/H_2O into methane/MEOH for circular plastics.

Fig. 1: Stakeholders attending the workshop hosted by BEST

Biochar: A Product with Multiple Benefits
Biochar was highlighted as a versatile byproduct of DTL, with applications in soil improvement, carbon sequestration, and pollution control:
CZU Biochar Research Centre (Czech Republic) introduced the Czech National Biochar Research Network, coordinating pilot-scale pyrolysis plants and conducting LCA and techno-economic assessments (TEA). Their work focuses on soil amendment, environmental remediation, and biochar as a polymer filler, emphasizing the need for interdisciplinary collaboration.

CNR-STEMS (Italy) shared research on biochar production under different atmospheres (N_2 and CO_2) and its potential for adsorbing pollutants like ammonia and dyes. This work underscores biochar's dual role as a carbon sink and environmental cleanup tool.

Innovative Reactor Designs
Stakeholders presented novel reactor concepts to improve efficiency, flexibility, and cost-effectiveness:
MCI Innsbruck (Austria) introduced the HoPyro project, developing a horizontal pyrolysis reactor for low-quality biomass (e.g., contaminated with stones or sand). This design aims to reduce costs and increase flexibility compared to traditional vertical reactors.

CNR-STEMS (Italy) discussed MILD combustion (Moderate or Intense Low Oxygen Dilution) of pyrolysis gases, enabling efficient energy recovery from byproducts.

Scaling Up for Industrial Use
Several projects focused on scaling up DTL technologies for industrial applications:
Tech Consulting Services(Austria) outlined plans for the Advanced Bioenergy Lab Austria, a ≥5 MW research facility for producing synthetic natural gas (SNG) and Fischer-Tropsch (FT) diesel from biomass using dual fluidized bed (DFB) gasification. The project, approved in 2026, aims to demonstrate scalability and serve as a testbed for industrial partners.

SCHUNK Carbon Technologies (Austria) highlighted industrial applications of biochar and pyrolysis oils, such as electrode materials, functional fillers, and catalyst supports, bridging DTL technologies with high-value industrial markets.

Fig. 2: Axel Funke (Task Lead) and Manuel Schwabl (NTL Austria) welcome the participants.

Site Visit: GreenCarbon Lab in Wieselburg
A highlight of the workshop was the site visit to BEST's GreenCarbon Lab, where participants saw thermochemical conversion technologies in action. The lab showcases: Pyrolysis and gasification from lab to pilot scale.

Demonstration batches of bio-oils and biochars, highlighting the practical applications of DTL technologies. State-of-the-art infrastructure for feedstock flexibility, process optimization, and product characterization.

The visit provided a hands-on opportunity to discuss technical challenges, scalability, and real-world applications of DTL, fostering deeper collaboration among participants.

Key Takeaways

- Waste Valorization: DTL offers solutions for converting agricultural, industrial, and municipal waste into high-value products.
- Biochar: A versatile byproduct with applications in soil improvement, carbon sequestration, and pollution control.
- Innovative Reactor Designs: New concepts are improving efficiency, flexibility, and scalability.
- Scaling Up: Projects like the Advanced Bioenergy Lab Austria and the GreenCarbon Lab demonstrate efforts to bridge the gap between research and industry.
- Collaboration: Regional and international partnerships are key to advancing DTL technologies.

For more information or to explore collaboration opportunities, contact the Austrian Task Delegates: Manuel Schwabl (manuel.schwabl@best-research.eu) and Elisabeth Wopienka (elisabeth.wopienka@best-research.eu).

Manuel Schwabl

Best, Bioenergy and Sustainable Technologies
Wieselburg, Austria

Hydrothermal Processes at the Tipping Point: Highlights from the 9th Expert Forum

Hendrik Etzold,
DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH, Leipzig, Germany

Over two days, the 9th Expert Forum on Hydrothermal Processes brought together 25 talks, a discussion panel, and poster presentations that fostered valuable exchange across the hydrothermal community.

The program covered the full range of hydrothermal technologies and showed how broad and dynamic the field has become. Contributions addressed hydrothermal liquefaction for converting diverse waste streams into renewable fuels and chemicals, innovative fractionation approaches for improving lignin and hemicellulose separation, hydrothermal carbonization pathways for producing value-added materials, and the treatment and valorization of aqueous phases from hydrothermal processes.

Across the different thematic blocks, recurring topics included process optimization, scale-up, industrial integration, material performance, energy recovery, nutrient recycling, and resource circularity. The diversity of applications highlighted both the maturity of the research field and the continued need for exchange between researchers, developers, and industry stakeholders.

A central message of the discussion panel was clear: hydrothermal processes are approaching a tipping point. Further progress toward commercialization will depend on focusing on clear markets and products, while also maintaining strong collaboration within a well-connected network.
Overall, the event demonstrated the strong momentum of the field and the importance of continued dialogue, shared learning, and cross-sector collaboration to support the next steps in development and commercialization.

Further information and event materials can be found here. The 10th anniversary edition will take place on 13–14 June 2028.

Fig.1: Impressions from the HTP Expert Forum

PYRO2026

in Pisa, Italy, from 7 to 11 June 2026

Axel Funke,
Karlsruhe Institute of Technology, Karlsruhe, Germany

The PYRO2026 was the 25th edition of the International Symposium on Analytical and Applied Pyrolysis, a premier global event for researchers, industry experts, and policymakers focused on pyrolysis science and technology. Held in Pisa, Italy, the conference maintained its high quality as a platform for sharing cutting-edge advancements in pyrolysis, biomass valorization, plastic pyrolysis, thermal decomposition, and innovative analytical methods.

As usual, the conference covered a wide range of topics, including fundamentals of pyrolysis (mechanisms, kinetics, and modeling), biomass and waste valorization (conversion into biochar, bio-oil, and syngas), and analytical techniques (spectroscopy, chromatography, computational tools, etc.). Moreover, industrial applications where covered, the environmental impact of pyrolysis and its contribution to a circular economy.

There are several of the high-quality key notes presented during PYRO2026 that could be highlighted for the Direct Themochemical Liquefaction community. Among them are newest insights into pyrolysis modeling presented with contribution of biomass constituents by Osvald Senneca from STEMS-CNR/ Italy and work by Alba Dieguez-Alonso from TU Dortmund University/ Germany with a focus on the particle level and a specific take on combining experiments with model development. An interesting take on the selective production of platform chemicals via thermochemical reactions was presented by Stef Ghysels from Ghent University/ Belgium. Last but not least, Hongwei Wu from Curtin University/ Australia was focusing on concepts for the realization of biobased value chains in the context of Western Australia. This selection of key notes is a very brief representation of the convincingly high quality of almost all presentations and posters.

Interesting to note is also the ambition to set up an International Pyrolysis Association, which was proposed by Paola Giudicianni, Anthony Dufour, Daniele Fabbri, and Osvalda Senneca. Participants of the conference were largely supportive of this initiative, and next steps for an implementation will be taken.

CEBC BECCUS 3.0 Biochar Workshop

Manuel Schwabl,
BEST, Bioenergy and Sustainable Technologies GmbH, Wieselburg, Austria

Introduction

The **CEBC BECCUS3.0 Biochar Workshop** brought together experts from various IEA Bioenergy Tasks to discuss the latest advancements in biochar technologies, their applications, and their role in carbon dioxide removal (CDR) and bioenergy systems. The workshop focused on identifying valuable production routes, applications, standardization, and policy frameworks to support biochar deployment.

Summary of Presentations

Task 32: Biomass Combustion

Elisabeth Wopienka from Task 32 presented on biochar production from biomass combustion, emphasizing its role in small to large-scale heating and combined heat and power (CHP) plants. Key challenges included optimizing boiler retrofits for controlled partial oxidation, ensuring safe ash/char discharge, and managing flue-gas recirculation. The presentation highlighted a case study of a decentralized biochar production system in operation, which co-produces heat and biochar (2-7 tons per year) suitable for soil improvement and composting. The discussion underscored the need for further R&D to address technological and regulatory gaps.

Task 33: Gasification of Biomass

Gerhard Soja from Task 33 explored biochar as a co-product of biomass gasification. They discussed how gasification technologies impact biochar quality and highlighted examples like SynCraft and Aries Clean Technology, which process wood chips and biosolids, respectively. The presentation emphasized the importance of biochar certification (e.g., European Biochar Certificate, EBC) and its applications in agriculture, soil remediation, and industrial sectors. The discussion also addressed the need for standardized quality control to ensure biochar's effectiveness in carbon sequestration and other applications.

Task 34: Direct Thermochemical Liquefaction

Manuel Schwabl from Task 34 provided an overview of biochar production via slow and fast pyrolysis, as well as hydrothermal liquefaction (HTL). They compared key parameters such as heating rates, temperatures, and residence times, noting that slow pyrolysis yields higher-quality

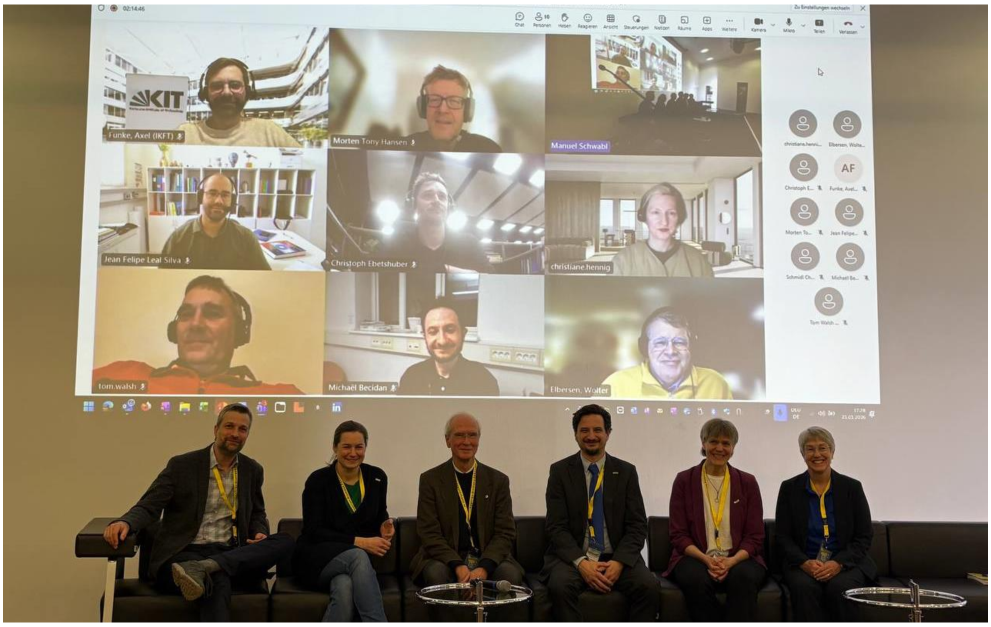

Fig. 1: Speakers at the BECCUS Biochar Workshop

quality biochar with higher carbon content and porosity. The presentation also showcased a case study by Sonnenerde GmbH, which integrates biochar production with compost screening and energy recovery.

The discussion highlighted the need for standardized product quality assessments and the potential of biochar in soil improvement and carbon sequestration.

Task 40: Deployment of Biogenic Value Chains and Carbon Management

Sara Shapiro-Bengtsen from Task 40 discussed policy and regulatory aspects of biochar for carbon sequestration. They highlighted the EU’s evolving framework for carbon removals, including sustainability criteria for biomass sourcing and the allocation of environmental burdens. The presentation emphasized the need for a 2-pager policy brief to guide biochar accounting and certification. The discussion explored country-specific examples and the role of biochar in achieving negative emissions.

Task 43: Biomass Supply in a Nature-Positive Circular Economy

Wolter Elbersen from Task 43 addressed feedstock availability and competition for biochar production. He presented data on global crop residues, noting that biochar production must compete with other uses like mulching and energy generation. The discussion focused on optimizing biochar’s carbon sequestration efficiency and ensuring its economic viability compared to alternative biomass applications. The presentation underscored the need for a holistic assessment of biochar’s environmental and economic benefits.

Task 45: Climate and Sustainability Effects of Bioenergy

Annette Cowie from Task 45 examined biochar’s climate mitigation potential and quality control. She discussed the IPCC methodology for assessing biochar’s carbon permanence and the development of the Australian Biochar Standard (AS 5541). The presentation highlighted the importance of quantifying biochar’s persistent and semi-persistent carbon fractions and ensuring its sustainable production and utilization. The discussion emphasized the need for standardized testing and certification to support biochar’s role in climate-positive energy systems.

Fig. 2: Impression from the BECCUS Biochar Workshop

ASTM and ISO Standards

Keith L. Kline from Oak Ridge National Laboratory provided an overview of international standards relevant to biochar and BECCUS. He discussed certification schemes like the European Biochar Certificate (EBC) and the World Biochar Certificate (WBC), as well as ISO and ASTM standards for GHG accounting and carbon footprinting. The presentation emphasized the importance of consensus-based standards in ensuring biochar's sustainability and market acceptance.

The workshop provided valuable insights into the future of biochar technologies and their role in achieving sustainable energy systems. The next steps include further collaboration, standardization efforts, and policy advocacy to support biochar's integration into global climate strategies.

Key Discussion Points

- Standardization and Safety: Participants emphasized the need for technology and product standards to ensure efficiency, safety, and market consistency.
- Policy Support: The discussion highlighted the importance of EU and international policies in accelerating biochar adoption.
- Industry Collaboration: The workshop underscored the need for cross-sectoral collaboration to address techno-economic challenges and scale up biochar deployment.

Conclusions

- Biochar as a Strategic Asset: Biochar is a dual-use technology with applications in both civilian and military sectors, making it a key component of energy security and climate strategies.
- Standardization is Critical: Clear technology and product standards are essential for ensuring efficiency, safety, and market uptake.
- Policy and Industry Alignment: Stronger policy frameworks and industry collaboration are needed to overcome barriers and accelerate biochar deployment.

Manuel Schwabl

Best, Bioenergy and Sustainable Technologies,
Austria

What happened 20 years 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 twenty years ago in this regular feature...:

PyNe

New Developments in Ablative Fast Pyrolysis at PYTEC, Germany

By Dietrich Meier, BFH-Institute for Wood Chemistry, Germany; Stefan Schoell and Hannes Klaubert, PYTEC, Germany

Introduction

PYTEC Thermochemische Anlagen GmbH, Lüneburg, Germany, has installed the first fast pyrolysis plant in Germany operating with an ablative pyrolyser. Inauguration of the plant was on 4th August 2005, with the Minister for Environment of Lower Saxony; Hannover in attendance, as his office is strongly supporting the pyrolysis project. Commissioning of the plant is envisaged for October 2005. Figure 1 shows an overall view of the new PYTEC site.

Figure 1: The PYTEC site.

Figure 3: Insulated disc compartment.

Figure 2: Feed bin and drum dryer.

Figure 4: CHP plant.

Figure 5: Mercedes Engine.

The plant is designed for 6 tonnes per day throughput of normal wood chips without prior grinding. Figure 2 shows the feed bin (blue container) and below the drum dryer. The chips fall from the top bin into the dryer and are then transported via a conveyor to the top of the pyrolyser where they enter the compactor unit. From here the chips are hydraulically pressed against a heated rotating disk which forms the heart of the plant. Figure 3 shows the insulated disc compartment. After collection and storage of the bio-oil it is burnt in the CHP plant (see Figure 4).

The special feature of the plant is that all system components are placed in standard containers in order to facilitate authorisation, transportation and assembly. The pyrolysis plant is erected at a saw mill site in Bülkau (near Cuxhaven, North Germany) which is producing roughly 100 tonnes per day of untreated waste wood chips.

An important milestone was reached by PYTEC in December 2004, when they continuously operated a modified 12 cylinder Mercedes-Benz CHP diesel engine on bio-oil for 12 hours (Figure 5). Only 4 vol.% of fossil diesel fuel was added. The bio-oil was delivered by FORTUM, Finland, and produced in their Forestera® plant. During the smooth engine operation, ca. 3 MW electricity (300-320 kWel/h) were produced and fed into the grid. No fouling of the motor parts could be observed. These results encouraged PYTEC to install the same CHP-type system at their ablative pyrolyser plant in Bülkau.

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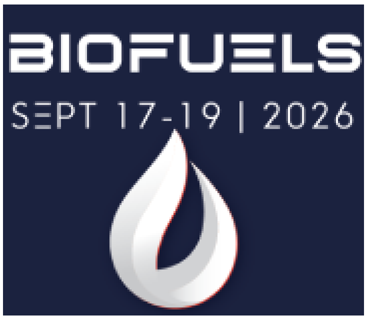
You can access the full article by using the following link:

[Pyne 19]

Upcoming Events

25. - 27. August 2026
tcbiomass+2026, Denver, United States
https://www.gti.energy/training-events/tcbiomass/

27. + 28. August 2026
4th International Conference & Expo on Biofuels and Bioenergy, Lisbon, Spain
www.alderbioinsights.co.uk/event/4th-international-conference-expo-on-biofuels-and-bioenergy/



17. - 19. September 2026
3rd Edition of Global Conference on Biofuels and Bioenergy; Rome, Italy
https://biofuels-energy.magnusconferences.com/

22. – 23. September 2026
SAF Global Summit, London, UK
https://www.alderbioinsights.co.uk/event/saf-global-summit/

23. – 24. September 2026
6th Biofuels Forum, Brussel, Belgium
https://inventu.eu/6th-biofuels-forum/

07. – 08. October 2026
Biomass PowerON, Stockholm, Sweden
https://fortesmedia.com/biomass-poweron-2026,4,en,2,1,117.html

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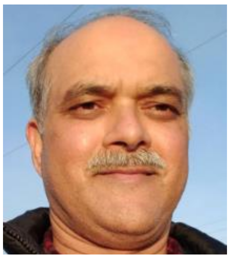

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How To
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Contact your national representative in the IEA Bioenergy ExCo to assess the benefits of joining Task 34.
https://www.ieabioenergy.com/directory/executive-committee

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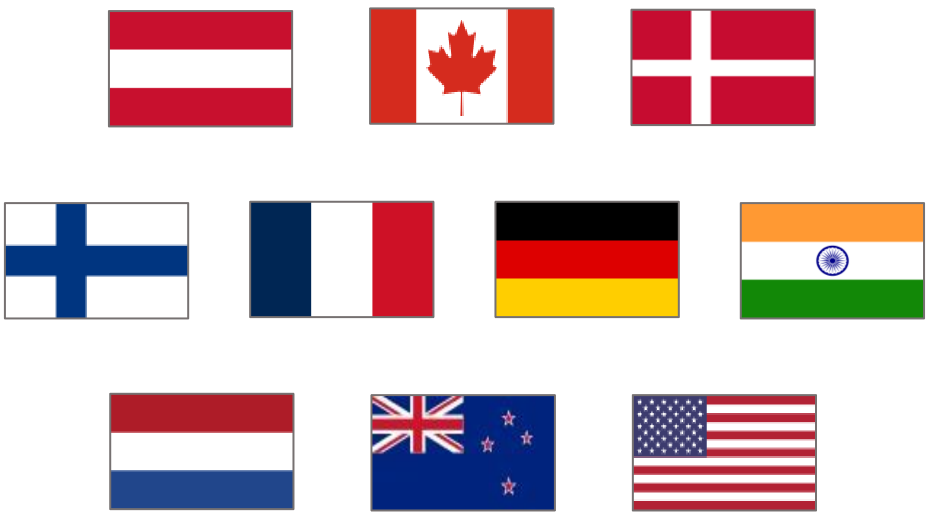
Task 34: Direct Thermochemical Liquefaction



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